Safety Management and Industry 4.0 for IoT & Intelligent Manufacturing

Major: Automotive Engineering

Name: Meng Fanshu

Student ID: S244422

Professor: Micaela Demichela

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ABSTRACT

This paper focuses on the details related to Industry 4.0 and safety management. It also discusses how to translate Industry 4.0 content into “Made in China 2025” in the background of Chinas current industrial development. The concept of “Made in China 2025” has received more and more attention from the whole society since it was first proposed in December 2014. This will be the top-level design of Chinas industrial development agenda for the next 10 years. On the difficult road to practice and complete the fourth industrial revolution, this paper generally summarizes the laws of development and historical lessons learned from the routes of the first three industrial revolution processes. This paper also offers a discussion of the control of safety management details in the machinery manufacturing industry while promoting the fourth industrial revolution. The author aims to explain that safety production not only protects the operators personal health but also improves the pro duction efficiency of the enterprise and makes the production process standardized. Only by understanding the occupational hazards and effective prevention and control can we make the safety production effectively and efficiently to do protective approaches.

Key Words: Safety management, Industry 4.0, “Made in China 2025”, Occupational hazards, Intelligent manufacturing, Internet of Things.

INTRODUCTION

Safety management is an important part of enterprise production management and is a comprehensive system science. The object of safety management is the state management and control of all people, things and environment in production, and safety management is a kind of dynamic management. Safety management, mainly the organization and implementation of enterprise safety management planning, guidance, inspection and decision-making, at the same time, is the fundamental link to ensure that production in the best safety state. The content of construction site safety management can be broadly summarized into four aspects: safety organization management, site and facility management, behavior control and safety technology management, which are specific management and control of the behavior and state of people, materials and environment in production.

In the context of the current complex world epidemic, combining safety management with Industry 4.0 is a priority topic to discuss. The concept of Industry 4.0 first appeared in Germany and was officially launched at the Hannover Messe in 2013 with the core aim of improving the competitiveness of German industry and taking the lead in the new round of industrial revolution. After this in 2015, China put forward the strategy of “Made in China 2025” to realize Chinas transformation from a basic and mass

manufacturing country to a strong and intelligent manufacturing country. The strategy points out that Chinas manufacturing development should be directed to high-end manufacturing.

1. Safety management in machinery manufacturing industry

In the process of social transformation, in order to ensure that the national economy can still rise steadily, it is necessary to follow the requirements of the supply-side reform strategy and optimize the industrial structure. At the same time, machinery manufacturing is also an important pillar industry of our national economy. In the process of modernization and development, it has an irreplaceable role in the economic development. The machinery manufacturing industry needs to follow the requirements of the supply-side reform strategy proposed by the state under the development trend of economic integration, optimize the structure of enterprises and change the mode of supply.

1.1 Safety manufacturing standardization

Machinery manufacturing enterprises need to clarify the development trend of the times, while the characteristics of the industry should be combined with the development of stage tasks, but also need to focus on safety management, to ensure that production operations during the period, not because of safety issues affect the development of enterprises. Through safety production management to create a safe working environment for staff, the safety production standardization, to ensure the smooth implementation of production operations.

1.1.1 Characteristics of machinery manufacturing companies

(1) Machinery manufacturing equipment is very complex, with strong professionalism and operability.

First of all, in order to produce the relevant products as planned, special attention must be paid to the maintenance and refurbishment of the equipment, as the complex structure of the production equipment may require the replacement of the equipments components, which requires securing them. Second, adequate equipment inventory and clarification of maintenance work to ensure that a robust support unit with relevant technology available allows maintenance work to be performed during the first cycle in case of failure. In view of the increasing complexity of production operations, the structure of equipment is becoming increasingly complex, as are the safety techniques. This makes the maintenance of equipment increasingly difficult, so security managers must master the skills of maintenance which is essential to the smooth operation of equipment maintenance.

(2) Machinery manufacturing operations have dual responsibility characteristics

Safety management programs must be designed in consideration of safety and production process. In addition, due to the complex structure of mechanical devices, it

is difficult for production equipment to be unaffected by aging parts and other factors that cause the devices to work poorly. If the machine fails, the operators personal safety is also at risk. Therefore, it is important for safety managers to clarify their dual responsibility for mechanical engineering, to pay attention to safety management and maintenance, and to detect unsafe factors in the device in time to minimize the possibility of device failure.

(3) Machinery manufacturing operations have diversified characteristics

With the continuous development of industry, more and more types of mechanical products, in order to meet the needs of production, the diversification of mechanical products is inevitable. In the context of the increasing variety of mechanical products and more complex structure, we should pay attention to safety management work, understand the main points of equipment repair and maintenance, and pay attention to capital, production technology and other factors that have an impact on safety management. To improve the safety management content from the overall situation, and improve the safety management mechanism under the industry level.

1.1.2 Problems and deficiencies of safety production standardization in safety management

(1) Management Scope.

The implementation of safety management in the machinery manufacturing industry must be clear about the scope of management to which it belongs. Safety production responsibility system and the whole process of production and manufacturing belong to the content of safety management. At the same time, according to the requirements of machinery manufacturing management, daily training is carried out to improve the business quality of operators so that employees can master the key points of safety management. Through training activities, operators can be taught the skills to solve production faults and identify hazards. Establish a safety management file to track the progress of safety management in real time and record the management information into the safety file in time as a reference material for future production safety management.

(2) Management concept.

At present, many employees of machinery manufacturing enterprises do not have the awareness of safety management, which will lead to poor implementation of safety

management. Whether the safety management can achieve the preconceived effect is closely related to the implementation of the workforce. However, because most employees do not receive professional training, they are not clear about the link between safety management and production and their own safety, which makes it difficult for staff to form an awareness of safety management. For example, employees quickly evacuate the work site at the end of the work without regulating the construction tools, or do not stop to measure the components during the work, which are caused by the operators do not have the awareness of safety management. For this reason, it is necessary to strengthen the safety knowledge propaganda at a later stage to solve this problem.

(3) Management Implementation.

A survey of machine building enterprises revealed that they did not develop safety management mechanisms to ensure smooth production according to the production operation model. At the same time, the internal management of the enterprise did not strictly follow the safety supervision requirements to perform the work. Safety managers are unable to carry out all production operations in accordance with safety management guidelines, resulting in insufficient safety management execution. In addition, there are many unreasonable internal safety management mechanisms in

machinery manufacturing enterprises, and there is no specific implementation method filled in the management plan, which will make it difficult for staff to operate in accordance with safety management requirements. Therefore, there are great safety hazards during the production operations.

1.1.3 Application strategy of safety production standardization in safety management

(1) Increase the investment in standardization management

At this stage, machinery manufacturing enterprises must pay great attention to safety management, which is an effective way to ensure that the work of the enterprise can be carried out smoothly, and to ensure that product output is not affected by equipment failure. At the same time, should also be for the current lack of safety awareness of operators and other shortcomings, the introduction of funds to vigorously promote safety technology training activities, through various training activities, training staff to form a sense of safety management, and let employees learn mechanical manufacturing technology and maintenance knowledge, through the standardization of safety training activities to enhance the professionalism and ability of staff.

(2) Establish a safety production management and supervision mechanism.

In order to improve the level of safety control of machinery manufacturing enterprises, it is necessary to establish a robust supervision and control system and supervision mechanism according to the work needs. Machinery manufacturing enterprises in the past safety management use rough work mode, which cannot be in accordance with the requirements of the implementation of relevant operations. For this reason, it is necessary to adopt refined management under the safety production management system, to clarify the work content of each staff member, through procedural management, to ensure that the supervision work is carried out in an orderly manner, through the supervision and management of safety production, to eliminate the hidden safety hazards of the equipment in a timely manner, and in accordance with the safety management standards, to clarify the nature of the production of the unit, to develop a fault detection program, to standardize the development of safety and quality supervision work.

(3) Adopt a safety management evaluation system.

In order to further improve the safety management level of machinery manufacturing enterprises, it is necessary to establish a safety management evaluation system for small, medium and large production equipment held by enterprises, in accordance with the set management standards for safety management requirements, and to understand the

factors affecting production operations. In the safety management program, clarify the operation technology methods, pay attention to the safety supervision of material transportation equipment, and need to develop a scientific inspection process according to the safety management standards of different types of equipment, and determine the operational content of each inspection procedure, optimize the allocation of human resources in the safety supervision department. At the same time, supervision should be strengthened to ensure that staff can perform equipment inspection work in accordance with the program requirements, and minimize the possibility of equipment failure during production operations through regular maintenance and fault detection. Whether the equipment can operate safely directly affects the work efficiency of machinery manufacturing enterprises, for this reason, it is necessary to pay attention to safety management, and set up a scientific safety evaluation system to ensure the smooth implementation of safety management.

1.2 Occupational hazards in the manufacturing industry

Machining manufacturing is usually carried out in a relatively sealed environment. Forging, forging and other production processes will generate a lot of dust and noise. Various toxic chemicals are also formed in the heat treatment and other processes, which can have certain effects on the operators body. Occupational disease prevention

has become the focus of attention in the current field.

1.2.1 Main occupational hazards.

(1) Dust.

Dust is the solid particles suspended in the air. There are many types of dust, including dirt, soot, sand, etc. In machinery manufacturing enterprises, operators will use a variety of equipments, such as welding, grinding machines, etc., the application of these devices will produce a large amount of dust, bringing a certain impact on peoples health. If the operators involved are not protected in time, and for a long time, this will cause employees to suffer from pneumoconiosis, etc. Common respiratory diseases include coughing, chest pain, and difficulty in breathing.

Dust will also have the risk of combustion and explosion. Dust explosion refers to a dust cloud formed by combustible dust mixed with air in a confined space. Under the action of the ignition source, the formed dust-air mixture burns rapidly and causes a chemical reaction with a rapid increase in temperature and pressure.

(2) Noise.

Common environmental pollution problems include air pollution, water pollution, and

noise pollution. In the manufacturing process of machinery manufacturing enterprises, operators will use various equipments. The noise at the construction site far exceeds national standards. The noise is concentrated in cutting, grinding, drilling machines, etc.

If operators stay in a high-decibel noise environment for a long time, it will have a certain impact on the human body. If the noise is loud enough, it will cause irreversible hearing damage.

(3) Toxic and harmful substances.

Toxic and harmful substances usually appear in the production process, use and other aspects, which will affect the human body and the environment. In machinery manufacturing enterprises, common toxic and hazardous substances include fumes, paint, etc. These substances pose a threat to the relevant operators and workers.

1.2.2 Occupational hazard prevention strategies

(1) Dust Prevention

Wet dedusting is a convenient, economical and practical way to remove dust. when dust meets water, it is absorbed and condensed to effectively reduce dust generation and improve the air quality of the working environment. The advantages of wet dedusting

are good effect and low cost.

Combined with the working principle and structure of wet dedusting, wet dedust collectors are divided into self-excited dust removal and granite water film dust removal.

Among them, the self-excited dust collector is relatively compact in structure, small in area, convenient in operation, and strong in load responsiveness, and is more suitable for applications in welding, polishing and other work. After the dust-containing gas is sucked into the dust collector, the airflow moves downwards, hits the water surface, sucks most of the dust particles into the water, and settles in the mud bucket. After that, the dust-containing gas passes through the “S-shape” channel composed of upper and lower blades at a speed of about 25m/s, and agitates water droplets. After the water droplets and smoke merge with each other, most of the dust particles will enter the water, allowing the dust-containing gas to achieve purification treatment. The purified air flow passes through the gas-liquid separation chamber and the dehydration baffle to remove the internal moisture, and is discharged from the dust collector under the action of the induced draft fan, sinks into the funnel, and is discharged with the help of the scraper conveyor. The water level in the dust collector usually needs to be controlled under the action of an overflow tank. An automatic water level control device is installed in the liquid tank to ensure that the water level of the dust collector is at a fixed position and

the stability of the dust collector operation.

(2) Prevention for occupational hazards caused by noise.

1. Control and eliminate noise sources

Machining process reform as an important factor in controlling noise, there are more ways to reduce noise. For example, using plate machine instead of hand hammer to calibrate copper plate. Also, the noise can be reduced by using nylon parts instead of metal parts. However, when using this method, there will be strict requirements for the process. For the workshop where the equipment is concentrated, it should be installed reasonably with the actual situation to reduce the friction between the equipment as much as possible. In addition, because the equipment will produce air flow in the process of operation, operators should do a good job to prevent vortex.

2. Control the propagation of noise

First of all is sound absorption. In mechanical processing production, in the use of mechanical equipment for processing, processing noise if it cannot be fully reduced, for some noise generating equipment or workshop, should be installed in the surrounding location of some sound-absorbing panels, so as to reduce the noise

intensity. Through investigation, we know that the workshop with sound-absorbing panels installed can reduce about 10 decibels in noise intensity.

Secondly is sound insulation. Sound insulation mainly refers to the installation of some sound insulation panels, sound insulation layer or sound insulation cover around the noise, and enterprises with conditions can establish a sound insulation room. By using sound insulation, the noise that can be reduced is about 30 decibels.

Additionally, vibration isolation and damping are significant approaches. It is well known that noise transmission is formed by vibration. Multiple noise and vibration action on the human body will bring direct impact on health, so it is very necessary to do a good job of protection. In practice, the vibration should be reduced by vibration isolators, such as the use of rubber dampers, spring dampers. The noise decibels that can be reduced in this way is about 15.

3. Strengthen personal noise protection measures.

For some places, if only rely on the above methods will not be able to obtain the desired effect of noise reduction. In this case, the operator needs to do a good job of personal noise protection. Personal noise protection means that workshop staff are required to wear professional noise protection devices. In general, anti-

sounders can be divided into two types, one is internal anti-sounders and the other is external anti-sounders. In this case, the inner anti-sounders also refer to the ear plugs, while the outer anti-sounders refer to the ear muffs. Regardless of which type of anti-speaker, they all show advantages such as easy to carry and easy to wear. The noise can be reduced to about 15 decibels in the low frequency, 25 decibels in the middle frequency and 35 decibels in the high frequency.

In the noise control, not only to take the above countermeasures, but also to do a good job of safety management, requiring enterprises to build a comprehensive safety management system. Only when applied for a long time can we obtain the ideal control effect. Health inspection should be carried out in strict accordance with national legal requirements, and the working hours of personnel should be reduced, or the operating activities directly exposed to noise should be reduced to reduce the impact of noise on human body. For the staff directly exposed to noise, enterprises can arrange regular physical examination for them, and if they are unsuitable for noise work, they must not be arranged to engage in noise work. If employees are found to be suffering from occupational deafness, they should be arranged in a noise-free working environment at the first time and be given appropriate treatment.

(3) Preventive measures against occupational hazards caused by toxic and hazardous substances.

1. Installation of purified paint spraying equipment.

Purified paint spraying equipment usually consists of two parts, one is the paint spraying room and the other is the purification room. Among them, the structure consists of axial flow fan, air supply system, water storage tank, washing tank of the purification room, water stopper, etc. in the paint spraying room; and the paint spraying room with axial flow fan, after starting the axial flow fan, the air supply system of the paint spraying room produces laminar air mist after the upper filtering and even wind. In the purification room, two impact washing is implemented, and water film and water bubble are formed by the impact of exhaust on the water surface, so as to realize the effect of full contact between water and gas. Paint-containing exhaust gas in the process of entering the impact chamber, at a relatively high flow rate, gas and water will be mixed together, paint particles are also affected from the airflow, and the paint obtained by rotating centrifugal action in the paint particles are separated, while the water is shielded by the water baffle, the purified gas will be passed to the exhaust hole and discharged to the atmosphere, so as to achieve a reduction in the concentration of mixed benzene in the paint

spraying process.

2. Process reform

For the reform and optimization of the production and processing technology of machinery manufacturing enterprises, it should be combined with the requirements and types of machinery manufacturing, and there will be certain differences in the requirements for process reform. As an example, the material applied in manual priming work is nitrocellulose paint, which contains a large amount of triphenylene. Therefore, in practice, water-based paint with triphenylene should be used instead of nitrocellulose paint with high triphenylene content. The electrophoresis method is used to replace the traditional manual operation to realize automatic painting. This can not only ensure the quality of work, but also relieve the work pressure of related personnel and reduce the harm to the human body.

3. Enhance personal protection.

In the production of machinery, spray paint contains a lot of toxic and harmful substances. Operators need to have a full understanding of the composition of the paint, and take corresponding protective measures through the investigation and assessment of the hazards of its composition. In practice, it should be noted that

before wearing the respirator, the trial load test should be done to prevent physical injuries and other conditions due to some employees not being fit to wear it. Moreover, the operators concerned should be provided with disposable protective clothing to reduce the direct contact between paint and human body using protective clothing. In addition, operators can choose suitable protective clothing in combination with the selected paint type and penetration. Finally, separate wardrobes, storage rooms and canteens should be set up to provide storage places for personal protective equipment, so as to avoid cross-contamination between them. In cases where the air concentration exceeds the national standard, the operator concerned is required to wear a gas mask. In case of hand contact with the production process, personnel are required to wear good protective gloves, and skin protection film can also be used. At the work site, smoking and eating are strictly prohibited. Operators change clothes in time after work to maintain personal hygiene.

All in all, the processing and production of machinery manufacturing enterprises will produce a large amount of dust and noise, which will pose a threat to human health and easily cause various occupational diseases. At this stage, only in strict accordance with the safety production standards, from top to bottom, to strengthen the awareness of occupational disease protection of personnel at all levels. Strengthen publicity and

education for personnel at all levels to improve employees occupational disease hazards and defensive capabilities. Carry out management work on a regular basis to standardize the work behavior of personnel from the root cause. Improve the safety awareness of machinery manufacturing enterprises and strengthen occupational protection of machinery manufacturing enterprises. Reduce the occurrence of occupational diseases from the root cause, and provide people with a safe and healthy working environment.

2. “Made in China 2025” Strategic Significance

2.1 Definition of “Made in China 2025”

“Made in China 2025” is signed and approved by Premier Li Keqiang, issued by the State Council in May 2015 to deploy a strategic document to comprehensively promote the implementation of a strong manufacturing country, which is the action plan for the first decade of Chinas strategy.

2.2 Background and significance of “Made in China 2025”

The manufacturing industry is the mainstay of the national economy and the foundation of the country. Since the beginning of industrial civilization in the middle of the 18th century, the history of the rise and fall of the world powers and the history of the struggle of the Chinese nation has repeatedly proved that without a strong manufacturing industry, there is no national and ethnic strength. To build a manufacturing industry with international competitiveness is the only way to enhance Chinas comprehensive national stren gth and guarantee national security.

In recent years, with the development of the domestic economy and the rise of labor costs, low-cost labor is no longer an advantage for the development of Chinas manufacturing industry and cannot continue to add momentum to the development of

Chinas manufacturing industry. We can maintain Chinas position within the world manufacturing industry only through innovation in the field of technology and continuous technological revolution.

2.3 The similarities and differences between "Made in China 2025" and Industry 4.0

"Made in China 2025" and Germanys "Industry 4.0" are both important strategic initiatives for manufacturing development in the context of the new round of technological revolution and industrial change. Comparing the two strategies, we can see that each has its own characteristics. In addition to the different technical and industrial bases, there are also obvious differences in strategic thoughts and other aspects. German Industry 4.0 has drawn a meticulous blueprint for German industrial development, reflecting the unique seriousness and rigor of the German nation, and has much to learn and refer to in terms of strategic thinking, basic research, technical education, policy institutions and measures.

(1) Differences in strategic thinking

Comparing Germanys Industry 4.0 with Made in China 2025, an important difference is that the German Industry 4.0 strategy is a revolutionary and

fundamental technology strategy. It is not simply to upgrade a few industrial manufacturing technologies, but to make changes at the basic level of manufacturing methods, so as to achieve a qualitative leap in the development of the whole industry. Therefore, the core of Germanys Industry 4.0 strategy is not limited to the “quantitative changes” in industrial output data, but is more concerned with the “qualitative changes” in industrial production methods.

Compared to Germanys Industry 4.0, “Made in China 2025” emphasizes structural changes and production increases through the application of “Internet+” tools on top of existing industrial manufacturing levels and technologies. But this also shows that “Made in China 2025” lacks strategic theoretical depth and technical height, as well as market appeal and influence.

(2) Differences in strategic foundations

The foundation of the strategy includes basic research, technical education and human resource development, which are the basic conditions for the success of the strategy. While we are discussing Germany s Industry 4.0, we can easily find that an important factor of this strategy is basic scientific research, and many detailed aspects of the task objectives are based on high theoretical knowledge.

In contrast, Chinas research in basic disciplines is relatively weak, with little capacity for scientific innovation, which makes it difficult to make major breakthroughs. The fundamental reason for this is not only the factors of historical basic conditions, but also factors of policy. In terms of policy support, horizontal research in China is much greater than vertical research both in terms of number and support, resulting in a stronger applied research area and weaker theoretical basic research in China. China also lacks experience and conditions in developing internationalized industry standards. Therefore, it is necessary for us to make great efforts to strengthen basic research. At the same time, it is also necessary for us to adopt an open approach to cooperation, actively become an important accessor to the advanced theory and advanced standard system of networking, actively carry out international cooperation, and share the theory, technology and market with developed countries, including Germany.

(3) Differences in strategic measures

In terms of supporting policies, Germany pays more attention to the assessment and adjustment of technology, policy and environment in order to effectively implement Industry 4.0. For example, Germany systematically assesses the possible disruptive impact of new technologies on relevant laws, as well as the shortening of the

innovation cycle that may lead to frequent updates of the relevant rule structure, and makes timely changes to the existing rules and regulations that are not conducive to development. Germany attaches more importance to building a legal environment that supports Industry 4.0, making timely adjustments to regulations related to corporate responsibility, data protection, trade restrictions, password systems, etc., and attaching more importance to reflection and self-adjustment.

In terms of synergistic institutions, Germany has established a unified governmental coordination body and a platform for the fourth industrial revolution. Three professional associations, the German Association for New Media in Information Technology and Communication, the German Federation of Mechanical Engineering and the German Federation of Electronics Industry, have jointly established a secretariat to develop a roadmap for priority subjects. In addition to setting up leading bodies and strategic advisory committees at the central government level, China should also vigorously play the role of industry associations and strengthen the construction of industry collaboration mechanisms.

On the surface, Industry 4.0 seems similar to Made in China 2025, but the latter covers a much broader scope. Whereas Industry 4.0 is technology-focused and aims to develop technologies and apply them to factories as well as synergize all elements to work

together, Made in China 2025 is also not limited only to a complete restructuring of Chinas manufacturing sector.

Dan Kara, director of robotics research at market research firm ABI Research, points out that the driving forces behind the two programs are clearly different: The main motivation behind the launch of Made in China 2025 was that Chinas economy reached the Lewis turning point. As China entered the new industrialization era, the cost of human resources began to rise due to a shortage of low-cost labor supply from otherwise less developed countries. Kara said, “It doesnt matter how much labor is being paid, the labor market in China is in a volatile phenomenon; for example, there is a rapid loss of labor after the holidays and people just dont go back to work or return to their home villages or towns.” These labor issues have spurred the Chinese government to increase factory automation, including the adoption of robots. This is why the “Made in China 2025” strategic plan was created.

On the contrary, labor costs in Europe have always been high, but the source of manpower is relatively stable. European countries already have high-tech manufacturers. The problems they face are the production volume and gross domestic product (GDP) of the manufacturing industry.

In Europe, manufacturing wages are high, so European countries want to increase GDP

through manufacturing economic activities, which means hiring more workers or increasing productivity. However, the EU does not have as many laborers as India and Thailand, and its immigration rate is lower than that of the United States. It is difficult to increase productivity. Therefore, the EU has begun to develop toward automated production to increase productivity, using technologies such as collaborative robots that can work and interact with humans.

2.4 Intelligent Factory in "Made in China 2025"

Nowadays in the industrial field, including intelligent manufacturing engineering information technology field and high-end equipment engineering are using high-end technology, but also in the breakthrough technology barriers to achieve higher-level development. For example, in the machining industry, various colleges and universities have integrated the traditional CNC machining and electromechanical professions into the intelligent manufacturing professions to train intelligent technical talents which are in line with enterprises. So, what is an intelligent factory? What features does an intelligent factory have?

At present, in China and even in developed countries, there is no clear unified standard for intelligent factories. My view is that a factory reaches a fairly high level of automation, without more workers to carry out the work. The factory has more high-

performance equipment, robots to replace manual labor, and then realize the operation of the whole workshop, including manufacturing, processing, inspection, transportation, etc., and finally achieve the smooth operation of the whole industry with high efficiency, high productivity, high automation and high flexibility.

Several characteristics of intelligent factory:

(1) When an intelligent factory designs products, the design methods and design process should be intelligent, digital and accurate.

(2) Intelligent factory can realize the simulation operation in the production, thus reducing the error rate of products.

(3) In terms of products, the intelligent factory should make the process database, and finally reach the callable efficiency. It realizes the accumulation and summary function, and finally make the processed products more optimized.

(4) Intelligent factory should be traceable in terms of information collection.

(5) Intelligent factory should have the characteristics of delivery in order and inspection out by code.

(6) Intelligent factory should achieve cycle management for products, which in turn

should be seamlessly integrated with enterprise resource planning and production management systems.

(7) Intelligent factory should gradually realize the whole production process without paper, and the equipment utilization rate should reach more than 80%.

(8) Intelligent factory in the production process for the production site information and processing and manufacturing process to achieve real-time display and analysis of live status and online diagnosis. Intelligent factory should provide high implementability analysis and decision collection for the whole enterprise management.

(9) The application of intelligent factory in terms of Internet should reach the highest level, and finally realize the direct connection with customers efficiently, shorten the service time and improve the service quality. Such as helping users to carry out timely maintenance and repair or even maintenance, and thus achieve efficient return visits to customers and improve the quality of service to stabilize the customer base.

3. Industry 4.0 Ecosystem

Since the Germanys "Industry 4.0 Strategic Plan" officially released in 2014, the fourth industrial revolution has been slowly entering the worlds production environment. Industry 4.0 is a significant signal for the full digitalization of future industrial production and is a preparation for a more perfect production system in the future. Innovation and transformation are necessary in industrial production, and this transformation is driven by the new dynamics of economic production. Shaping the Industry 4.0 ecosystem requires a focus on the combination of multiple technologies and resources, as well as an emphasis on the diversity and openness of the ecosystem to accommodate a wide range of complex economic and social production. The aim of Industry 4.0 is to build a new production ecosystem with high requirements for technology and social development.

3.1 Industry 4.0 Ecosystem Technology Support

3.1.1 The essence of Industry 4.0

Real-time communication between people, robots, factory logistics and products is a fundamental prerequisite for Industry 4.0. Real-time data will generate transparency and actionable insights, while edge analytics will help get the most value out of

machines and optimize production. All of the above concepts clearly require standardization and data security. With its standardized network capabilities, built-in security, guaranteed service levels, and distributed cloud and network slicing concepts, 5G networks are the perfect tool for advanced industries looking to take advantage of digital transformation.

In essence, the fourth industrial revolution is the Internet of Things applied to manufacturing, where physical systems communicate with each other and with humans remotely via wireless networks.

The essence of Industry 4.0 is the internetization of industry, the integration of "Internet + manufacturing". This is a revolution of the times, a disruption and self-subversion. The core concept of Industry 4.0 is to deeply apply information and communication technology, promote the integration of the physical world and the virtual network world, and form an "information-physical system" in which resources, information, objects and people are interrelated in the manufacturing field. In the past 15 years, from automation to internetization, "Internet+" is a big concept, and "Industry 4.0" will become one of the first areas where "Internet+" will break through.

Industry 4.0 is mainly applied in 6 areas: automated intelligent transportation system, digital workshop management, production data analysis, management view system,

automated production auxiliary system, 3D printing, etc. The advantage of Industry 4.0 is that it has always been the direction of the joint efforts of the government, universities and industry. Together, they promote growth, use fewer resources, reduce risk, and increase productivity and flexibility. Many breakthrough concepts have been proposed in science and technology research that have led to huge leaps in the networking of humans, machines, robots and products. Manufacturing leaders are combining information technology and operational technology to create value in new ways.

3.1.2 Multidisciplinary and multi-technical requirements

Industry 4.0 involves multiple disciplines and the mutual integration of multiple technologies. Accelerating the development of the industrial revolution will inevitably require multiple technologies to break through theoretical development as well as break through bottlenecks in practical application, while solving the challenges of multi-technology integration. In the process of accelerating the implementation of “Made in China 2025” (which is basically a part of the practical version of Industry 4.0 in China), China is vigorously promoting the transformation of traditional manufacturing industries to intelligent manufacturing, and the upgrading of technology is imminent. The advantage of intelligent manufacturing lies in the data analysis and artificial intelligence algorithms for “mechanization” and “modeling” of data that needs to be

processed manually, and the computer can almost completely replace the human brain. The machine needs to perform high-intensity calculations in the learning process, which poses a huge challenge to the computing power of the machine and the applicability of the algorithm. In addition, the production process will encounter a variety of completely new problems, whether the learning capacity of the machine can meet the sufficient autonomous learning ability, and can successfully form a “mechanical” memory to deal with the same problems encountered subsequently. This poses a challenge to the pre-learning ability of artificial intelligence. Industrial production has requirements for periodicity. After a company has experienced long-term production, there will be a large amount of production data that needs to be stored. When there is a demand for data, the data needs to be read quickly in order to solve production problems in a timely manner with reference to previous production data. The data storage and reading system is an essential module for the entire production system. Virtual reality technology has obvious advantages in remote problems as well as in building models to achieve real-time observation of production conditions as well as production failures, which can be used as an important means of production supervision, thus enabling rapid reaction to adjust production status. But in the application process need to ensure the stability and the application of the combination with the equipment.

3.1.3 Hardware construction requirements

Germany, for example, is one of the most developed countries in production and manufacturing, and is the initiator and pioneer of the Industry 4.0 concept, but there are also many problems regarding the construction of Industry 4.0, and the process of intelligent upgrading is difficult. Firstly, the existing production mode of the enterprise can fully meet the needs of users, and is unwilling to invest funds for upgrading. Secondly, the Internet of Things and intelligent manufacturing need to use the Internet. When the closed production network is upgraded to an online public network, it will bring severe network security issues. In addition, information and other infrastructure is not perfect, a lot of information transmission and communication needs the support of 5G technology, but now the base station construction and coverage capacity is far from adequate.

In the process of upgrading traditional production companies, hardware upgrades are required in many aspects, including but not limited to the following hardware needs - data storage related equipment, data transmission related equipment, and new production equipment upgraded to suit intelligent production. If 5G transmission needs to be utilized, 5G signal coverage must be carried out. In China and around the world, the construction of 5G base stations is still in progress, and only some areas have

completed the construction of base stations and 5G signal coverage. the popularity and application of 5G is still in the middle stage of development, except for the weak perception of cell phone users for upload and download speeds is not enough to support the widespread promotion of the emerging technology in the 5G era. Many technological blueprints are still being explored and put into practice. Just like the promotion of the 4G era, we need to get hold of the core of 5G technology. In this way, the transformation of intelligent production of traditional production enterprises is required to upgrade the enterprise and the state as well as society together to complete.

For Chinas intelligent development process, the basic conditions for construction are now available in many aspects. Firstly, with the strong support of national policies, 5G base stations have been put into operation in many areas and 5G communication transmission has become a reality. 5G cell phones have long been popular among the Chinese population. From January to December 2020, 5G mobile phone shipments in the Chinese market reached 163 million units, accounting for 52.9% of all mobile phone shipments in the same period. In 2021, Chinas 5G industry will accelerate its development. As of August, China has built the worlds largest 5G network, and the penetration of 5G mobile phone products has accelerated. In August, 5G mobile phone shipments accounted for nearly 80%.

Secondly, the booming development of Chinas logistics industry provides a strong guarantee for the input and output of raw materials for products in the intelligent production process, and when logistics enterprises and manufacturers complete the “unified USB interface docking”, they can realize the intelligent logistics function of real-time online supervision.

In addition, some German industrial and commercial enterprises are trying to create a framework to meet the needs of the future economy in line with the socialist market economy, which is what the Chinese market is, and to meet this need on a large national level as a whole. Not only the upper level could unify management organization and development planning, but also can be able to give full play to the market open self-regulation and self-progressing ability.

3.1.4 Safety and Security

The Internet of Things and Intelligent Manufacturing under the concept of Industry 4.0 means that the production, operation and logistics of enterprises need to be networked, and they face greater network risks while directly connecting to the market and customers and ensuring seamless information connection between production and sales in all aspects. A regional cyber-attack could bring production to a halt. Production in the Industry 4.0 model requires even stronger support from Internet technology. The

new secure storage of data as well as the new secure transmission of data pose a huge challenge to traditional network security protection. Safe production must ensure network security and form a secure interface between the internal network and the public network. Different stakeholders (production stakeholders) must share resources and data as well as interoperate through the network in the production process. Conflicts and risks of information leakage may arise from the inter-operation of all interested parties. Complex and decentralized interoperable organizational structures require a high level of interoperability in the face of risk. At the same time, companies, employees and individuals will increasingly need to rely on the security of their networks to protect their data in the future. Even if the storage is “public”, all means of access to the data must be disabled without formal authorization.

3.1.5 Technology development and upgrading

Industry 4.0 is constantly evolving and is not a fixed production model. As new technologies emerge and are better adapted to the equipment to meet intelligent production, productivity requirements and user needs, companies and the market have to adjust their long-term development plans, update their technology and equipment in time to complete further product updates.

3.2 Social participation

3.2.1 The development of standards

A sign of mature technology development is the development of standards, which may be industry standards or national or even international standards. The process of continuous development and upgrading of technologies related to intelligent production requires the continuous development and improvement of standards, so as to "constrain" the manufacturing industry to develop together more rapidly. The "USB standard for Industry 4.0" will complete business-to-business and business-to-customer interface docking. The work of the Sino-German Working Group on Intelligent Manufacturing/Industry 4.0 Standardization is of great importance for the rapid development of Industry 4.0.

The standard of product production plays an important role for a particular product. One of the production and manufacturing models of intelligent manufacturing is to meet the individual production of the user, which is customization. It can be seen that the development of production standards is conducive to daily production and manufacturing, but standards should not be used as a set law, and product production should not be subject to production standards.

3.2.2 Rules and Regulations

On October 31, 2019, Professor Chen Chun, academician of the Chinese Academy of Engineering and director of the Blockchain Research Center of Zhejiang University, proposed that the most important application space of "blockchain+" is the industrial manufacturing field, which should receive extra attention and focus from government agencies, industrial enterprises and information industry departments. The upgrading of production methods will lead to the reorganization of some interest structures, the need for equal development opportunities and production conditions for multiple stakeholders, the need for multi-level management at the enterprise, regional, national and international levels, and the construction of a new management framework. To ensure that criminals have no chance to take advantage, and stakeholders can develop correctly, and guarantee the interests of individuals, small groups, and all aspects of the production system.

3.3 Reasonable Development

3.3.1 Better job offer and development prospects

The development of productivity is continuous, and the realization of Industry 4.0 requires continuous development. Progress in production cannot be achieved without the support of individual mental work. These are the necessary approaches such as

improving the treatment of the corresponding work, enhancing the employment treatment of relevant graduates, or even fundamentally adjusting the training program for talents appropriately. Increasing the level of education and knowledge of the working population can provide a stable basis for increasing productivity. One of the possible ways to fundamentally adapt the level of knowledge of producers to the requirements of productivity is to appropriately revise the training programs for highly educated personnel and to improve further training of practical workers.

3.3.2 Participation and monitoring of society

Economic production should not only promote economic development but also meet social development, and when there is a conflict, the needs of society should be met first. Industry 4.0 represents the transformation and upgrading process of the whole social production, which eventually needs to form a production ecosystem within the whole society. Take the country as a unit to build a global production ecosystem. In this process, social participation is essential. A full-time department of the corresponding level should be established for direct management and adjustment, and various signs of development with uneven events should not be allowed to exist in the market.

In addition, changes in production methods bring about profound changes for stakeholders and a restructuring of interests, with the ultimate goal of adapting and

improving the productive capacity of society as a whole. However, the mere improvement of economic benefits does not represent the pace of the whole society, and the process of production change should be regulated by the society or the government to eliminate the production model that completely abandons social benefits for economic benefits.

3.3.3 Sustainable production with zero pollution

The implementation of sustainable development strategy is conducive to promoting the unification of ecological, economic and social benefits. Industry 4.0 is an advanced production model and a manufacturing model for green development of sustainable production, and an ecosystem for production manufacturing. Ecosystems need a balance of inputs and outputs to function consistently and stably. When machines replace manual labor, it is inevitable that some of the production waste will be difficult to recycle and dispose of. In the production process, it is important to consider not only the sales logistics of the product, but also the "intelligent logistics" of the waste. Truly achieving zero pollution output after raw material input is the real sustainable and long-lasting production.

Todays society not only promotes sustainable production, but also focuses on creating zero carbon emissions. Apple has been at the forefront of this in the world. Apple

announced an ambitious plan to achieve carbon neutrality in the entire industry chain and the entire product life cycle by 2030. Apples goal is to make better use of the raw materials in it by producing durable products. Another ambition set up by Apple is that one day all Apple products and packaging will only use recycled and renewable materials. Apples determination has also set an example for other manufacturing brands . In September 2021, the 17th China Automotive Industry Development Co-organized by China Automotive Technology Research Center Co., Ltd., China Automotive Engineering Society, China Automotive Industry Association, China Automotive News Agency, Japan Automotive Industry Association and German Automotive Industry Association International Forum was held in Binhai New Area, Tianjin. This forum focused on the annual theme of “Integration • Innovation • Green”, focusing on industry hot topics to conduct discussions. The recently released UN Intergovernmental Committee of Experts report shows that greenhouse gas emissions caused by human activities are causing the world to warm at an unprecedented rate. Extreme weather events such as high temperatures, droughts, heavy rains, and floods have become more frequent. Climate change is no longer in the future. Challenges are immediate threats, and all countries need to work together to deal with them. Facing the dual challenges of climate change and epidemic, many developing countries, such as the EU, the US, Japan and Korea, South Africa and Mexico, have put forward carbon neutral target

strategies to promote green and low-carbon transformation of their economies and societies. The world is ushering in an energy revolution, industrial revolution and technological change characterized by green and low-carbon.

As the worlds largest developing country and a major emitter, Chi nas manufacturing industry is still in the middle and low end of the global industrial chain value chain, coal consumption still accounts for more than 50% of energy consumption, and energy consumption per unit of GDP is about 1.5 times the world average. China needs to complete the highest intensity carbon emission reduction in the world to achieve carbon peak and carbon neutral. Compared with the United States, Europe, Japan and other developed countries, Chinas carbon peak per capita GDP and per capita carbon emissions will be significantly lower than the level of these countries when the carbon peak, from the carbon peak to carbon neutral, the EU needs about 70 years, the United States needs 45 years, while China should strive to complete the mission within 30 years.

3.4 The relationship between 5G network & Industry 4.0

In the near future, intelligent manufacturing will be a significant part of the IoT market revenue. Intelligent manufacturing relies on AI, which in turn relies heavily on the use of robotics and machine intelligence. In the era of Industry 4.0, the factory of the future

will be digitalized by 5G networks and the functional modules they are built on. 5G networks will enable further expansion of AI applications and greatly increase production efficiency.

Since 2005, when the State Administration of Radio, Film and Television issued a number of IPTV (Interactive Network Television) licenses for pilot operation, operators have cooperated with CCTV and other integrated broadcasters to carry out IPTV business, gradually establishing a more complete technical standard system and a mature business model. Each of the previous industrial revolutions experienced by mankind has led to dramatic changes in the way of production and life, bringing about far-reaching effects on society. The fourth industrial revolution is coming, and it is an era of intelligence. The Evolutionary route of these revolution is as below in Figure 3.1

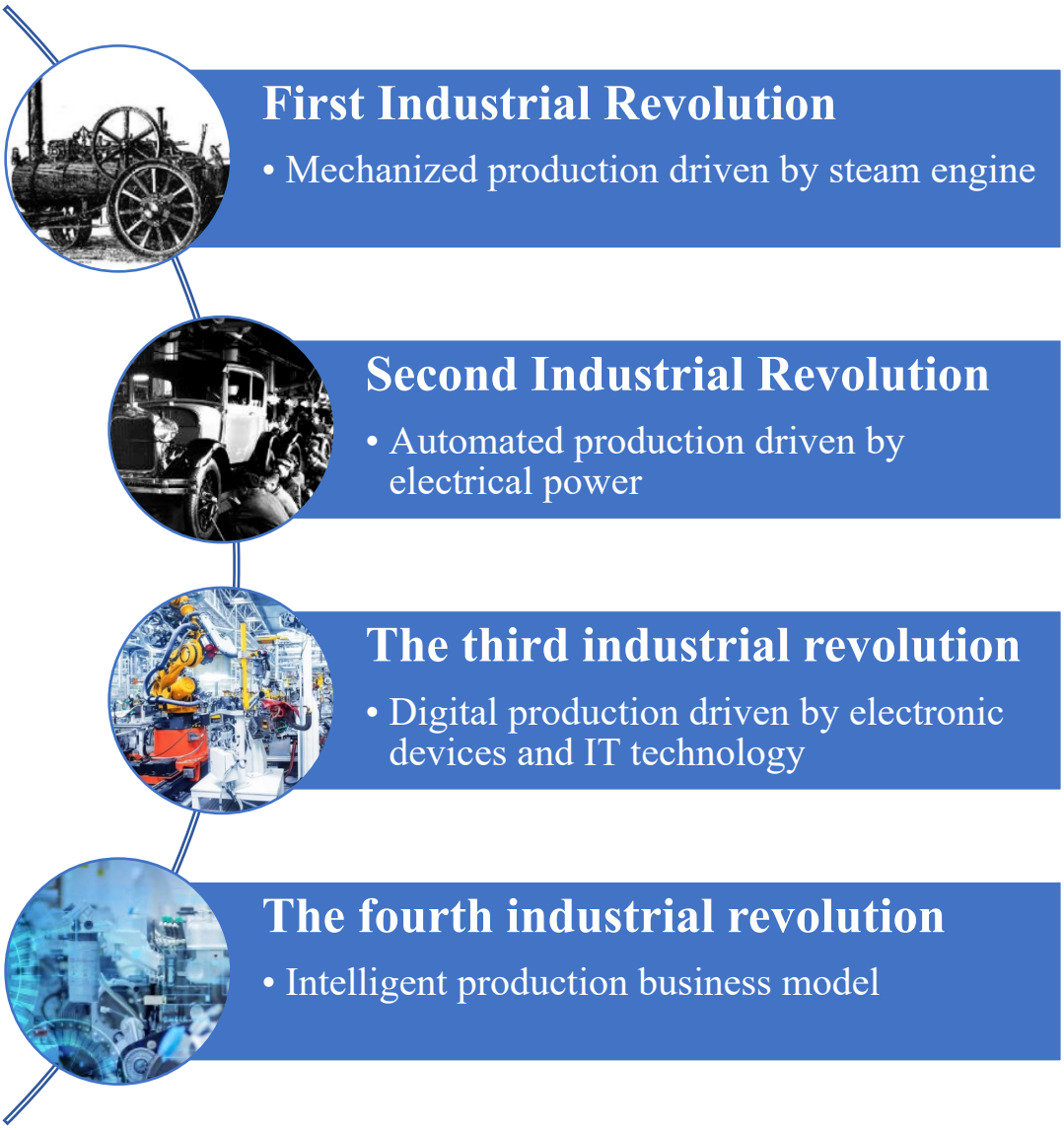

Figure 3.1

The global 5G market is gaining strength and has entered a critical period of commercial deployment. Several regions around the world are currently deploying 5G networks and have already begun commercial launches. On June 6, 2019, the Ministry

of Industry and Information Technology officially issued 5G commercial licenses to China Telecom, China Mobile, China Unicom, and China Radio and Television. China has officially entered the first year of 5G commercial use. It is worth noting that China Radio and Television has become another company, in addition to the three major basic telecom operators, to receive a commercial 5G license. Adhering to the combination of independent innovation and open cooperation, Chinas 5G industry has established a competitive advantage. At present, Chinas 5G medium-band system equipment, terminal chips and smartphones are in the first tier of the global industry and have the conditions for commercial deployment. 5G supports the expansion of application scenarios from mobile Internet to mobile Internet of Things, and will build a new generation of information infrastructure that is high-speed, mobile, secure and ubiquitous. At the same time, 5G will accelerate the digital transformation of many industries and will be used more for industrial Internet and Telematics, expanding large markets and bringing new opportunities to strongly support the dynamic development of the digital economy.

3.4.1 Production efficiency urgently needs improvement

Manual production models are becoming increasingly difficult and costly to produce at consistently high-quality levels, due to demands such as product complexity and shorter

time-to-market. Despite these challenges, companies must make quality a top priority given the high cost of defective product recalls, the importance of a good product experience for customers, and the importance of customers driving brand development. Improving product quality, while costing companies more, can solve common problems that cause companies to lose quality in the first place by using AI algorithms developed based on machine learning.

Manufacturing is shifting from mass production to mass customization (through digital factory operations). The industrial revolution at the end of the 18th century catalyzed the emergence of mechanization, but thereafter industrial production remained largely at the manual level until the 20th century, when true mass production began in the automotive industry, with assembly line production becoming the paradigm of mass production and having a profound impact on society. In fact, what is known in the social sciences as “Fordism” describes an economic and social system based on industrialization, standardized mass production and mass consumption.

The demand for flexible customization has grown in recent decades. The ultimate in this trend is “personalized production”, for example, which allows goods to stand out from competitors and expand their product range, to the extent that manufacturing costs are kept low enough to make sustainable profits and a wide range of products stimulates

the consumer market. The use of new technologies throughout the value chain, from supplier to customer, can significantly increase the flexibility of production lines, shorten production cycles, and drive demand for more affordable and scalable customization.

The trend of personalized product customization is growing and preference is given to online purchases. As a result, current processes need to be adapted to be more flexible and customizable, while still protecting the initial investment in the production line. High-speed wireless infrastructure such as 5G networks can facilitate rapid and flexible modifications to OEM machines with less impact and improved efficiency.

The digitization of factory operations brought about by IoT technology is expected to drive this goal. Digital tools will be able to monitor and control all production tools, collecting data through thousands of sensors to create a digital image of the product. Once a digital image is created for a physical product and has its specific ID, then that product can be manufactured more efficiently and with higher quality in a digital production facility. In this way, manufacturing processes can be optimized, quality problems can be detected in advance to prevent defects at the end of the production line, continuous improvement can be carried out, and predictive and preventive maintenance can be performed.

The combination of wireless sensors and high-capacity communication networks such as 4G/5G plays a key role in this context, by collecting data from the shop floor level (production line) and transmitting it to the cloud system for continuous monitoring. Virtual controllers that combine control, data logging and alarms in a cloud-based platform help drive digitalization and save costs compared to traditional systems. In addition, the cloud platform can control a variety of production tools and is a solution for remote machines and portable systems that can operate independently.

3.4.2 The role of artificial intelligence in Industry 4.0

Automation and robotics provide the “senses” for Industry 4.0, while data and connectivity are the “central nervous system”. But the real brain behind this industrial revolution is artificial intelligence (which is abbreviated as AI).

The complexity of using AI in industrial automation requires manufacturers to work with experts to obtain custom solutions, the cost of trying to build the required technology is high, and most manufacturers do not have the necessary in-house knowledge of the skills. Machine learning makes it possible to make predictions based on large amounts of data, and this branch of AI is built on pattern recognition and is able to draw knowledge from experience independently.

Artificial intelligence is no longer a vision of the future; today, large data centers and huge storage capacities make possible what was considered a distant concept for many years. For artificial intelligence, the two branches of machine learning and deep learning use the possibilities of big data to optimize processes, find new solutions and get new ideas.

Algorithms form the basis, and every organization, from small and medium-sized companies to large multinational corporations, accumulates data that can be used. Using software, data can be mined and evaluated to make predictions. Machine learning identifies features and relationships and uses algorithms to derive solutions from them.

Making quality products is critical to a manufacturers success, but it is not enough to simply make a profit and stay in business. Production costs must be low enough to make the right profit, and this can be achieved by continually improving the efficiency of manufacturing systems. Automation is critical to this. Manufacturing systems require significant investment and must be designed to remain profitable over time. If companies are to remain competitive in an ever-changing market, they must continually improve their products and production systems. Therefore, virtual commissioning is necessary to continually upgrade production systems with reasonable incremental investments, which requires a virtual environment that can simulate a manufacturing

plant.

The simulated plant model must be fully defined at the sensor and actuator level, and a major benefit of this is that it replaces the need for actual commissioning of the real plant and controller, which is very expensive and time-consuming. In contrast, virtual commissioning allows for the identification of possible design flaws and operational errors prior to investment in physical plant infrastructure. The digitization of manufacturing plants allows their designers to improve the efficiency of the production process, increase the automation density and optimize the handling of the materials needed to realize the product.

3.4.3 5G network drives virtual factory

The virtual factory makes it possible to perform global system design, simulation, verification and physical mapping at a much lower cost than the physical factory. However, to do this, virtual factories require new types of robots that increase the flexibility of global production systems. These robots need to be intelligent and require a suite of systems to globally manage to interact with each other and with humans.

High quality wireless connectivity is critical to the implementation of a virtual factory. Because of the high operating expenses required for cable upgrades, wired connections

and their complex cabling would not be feasible in this ever-changing environment. Wireless connectivity must connect all the physical elements of the production plant to the cloud capable of collecting and processing large amounts of data, and communication between all these elements must work in a challenging environment characterized by electromagnetic interference. While LTE connectivity is robust and adequate for todays environment, stringent latency requirements will soon require 5G connectivity. Once large amounts of data have been collected over wireless connections, new methods can be used to process it, convert it into a format that can be used by people or machines or both, and unlock the value of the information through cloud platforms.

Therefore, big data and analytics systems are critical in the digital factory. Ultimately, a networked system will be needed to handle the complex production process, including IT systems built around machines, storage systems and All of this reduces plant out-of-service time by allowing preventive and predictive maintenance, minimizing production delays and avoiding breakdowns, thus further improving plant efficiency, with a direct effect of efficiency gains being reduced energy consumption.

High-speed communication networks, infrastructure and cloud computing technologies can enrich automated factories with new and relevant features while reducing costs

through cloud technologies. As a result, smarter robots with “brains” (virtual controllers) can be created in the cloud. The “brain” consists of a knowledge base, program paths, models, communication support, etc., effectively transferring the intelligence of the controller to a remote virtual controller.

This approach has many benefits:

(1) Cloud platform functionality that can co-exist with traditional infrastructure, compatible with traditional service evolution and new services;

(2) Reduced operational costs by maximizing the performance and capacity of the virtual platform, thus providing high reliability and performance;

(3) Fault tolerance for multiple software and hardware failures to minimize service loss;

(4) Comprehensive fault management, isolation, and recovery;

(5) High scalability.

3.4.4 The meaning of 5G network for Industry 4.0

High-performance wireless networks are used to connect a large number of sensors,

robots and information systems in the factory, and the massive amount of data and quality data generated by the connection constantly feeds the artificial intelligence and brings the analysis and decisions back to the factory.

With the increasingly deep integration of information technology and manufacturing industry, the trend of digital transformation and upgrading of manufacturing industry has become more and more obvious, and data has become a new key factor of production. As a product of the deep integration of new generation information technology and manufacturing industry, the industrial Internet builds up an advanced manufacturing system and modern service system with full connection of all elements, industrial chain and value chain through the comprehensive interconnection of people, machines and things. It is a new infrastructure to realize the development of industrial digitalization, networking and intelligence, an important cornerstone of the fourth industrial revolution, and an important way to realize a strong manufacturing country and a strong network country. This means that the integration of 5G and industrial Internet has a top-level design and has entered the implementation stage.

Industrial Internet emphasizes the deep integration of industry and Internet, so in the process of industrial Internet to promote the digital transformation of traditional enterprises, there is a demand for high reliability, low latency and security of the

network. 5G, as an important direction for the evolution and upgrading of the new generation of information and communication technology, has the advantages of ultra-high speed, low time delay and massive connection, and will become one of the core infrastructures and important supporting technologies for promoting cross-industry and cross-domain integration of industrial Internet. 5G is the key enabling technology for the industrial Internet, and the industrial Internet is the most important application scenario for 5G. The integration and innovative development of 5G and the industrial Internet can further promote the efficient collaboration among various production factors, and will promote the transformation of the manufacturing industry from a single point and local information technology application to digitalization, networking and intelligence. It is an important driving force to help enterprises realize digital transformation and upgrading, thus strongly supporting the construction of a strong manufacturing country and a strong network country and serving the development of the national digital economy.

The factory of the future is where digital virtual and physical reality merge and ICT technologies merge with modern manufacturing to improve the flexibility, traceability, versatility and productivity of industrial production and to open up new business models for manufacturing.

The rise of todays digital economy is accelerating the digital transformation of Chinese industries. As a product of the deep integration of new generation information technology and manufacturing industry, industrial Internet is a key enabler of industrial digital transformation and a cornerstone of digital transformation of manufacturing industry. 5G is the key enabling technology to drive the development of industrial Internet, and “5G+industrial Internet” is an important driving force to help enterprises realize digital transformation and upgrade. At this stage, Chinas automotive industry is facing severe competition and environmental pressure, hence the digital transformation of the industry is the trend. The possible application prospects of “5G+Industrial Internet” in Chinas automotive industry are proposed, and the current situation of digital transformation in Chinas automotive industry is analyzed. The purpose is to promote the “5G+Industrial Internet” to enable the digital transformation and upgrade of the automotive industry and enhance the international competitiveness of Chinas automotive industry.

Entering the 5G era, the 5G network provides more possibilities for innovation and empowerment for industrial Internet development, and the two complement each other. By the end of March 2021, China completed 819,000 5G base stations, accounting for more than 70% of the world, and build up the worlds largest 5G independent networking network. In addition, the industry is actively exploring the integration

application of “5G+Industrial Internet”, and the number of 5G base stations applied to industrial Internet has reached 32,000, and ten typical application scenarios of “5G+Industrial Internet” have been formed, such as: collaborative R&D and design, remote equipment control, collaborative equipment operation, flexible manufacturing, on-site auxiliary assembly, machine vision quality inspection, equipment fault diagnosis, plant intelligent logistics, unmanned intelligent inspection, production site monitoring.

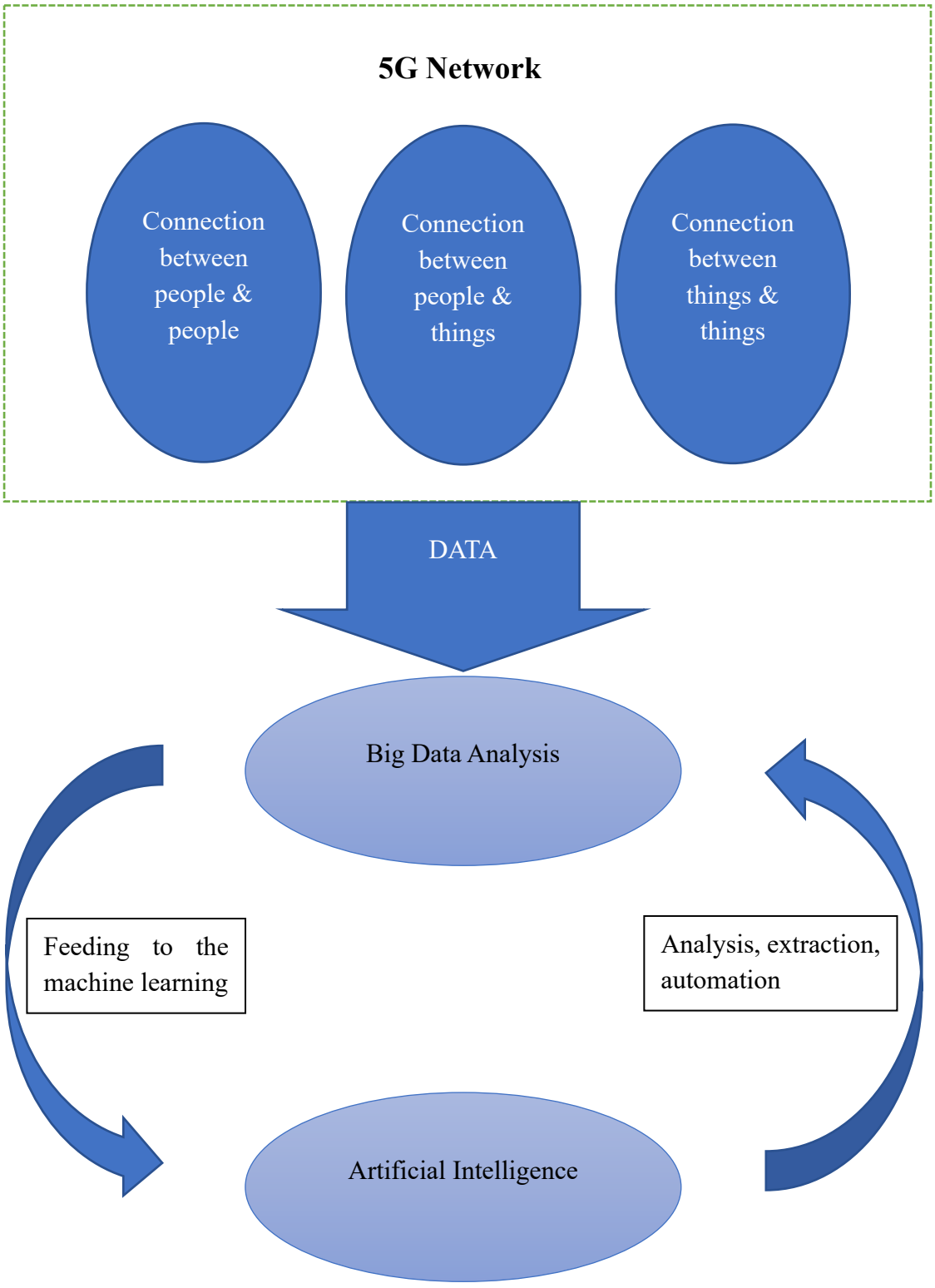
5G Network
Connection between people & people
Connection between people & things
Connection between things & things
DATA
Big Data Analysis
Feeding to the machine learning
Analysis, extraction, automation
Artificial Intelligence

Figure 3.2

3.5 Opportunities and Challenges

Although the concept of Industry 4.0 has been proposed for many years, the maturity of the development of new technologies and the degree of adaptation to economic production has yet to be considered. Some companies have already started to make experimental upgrades, for example, establishing pilot factories for intelligent production and setting up intelligent manufacturing ecological parks. But for the development of the socialist market economy there are laws regulating the market and it is not possible to force all enterprises to upgrade directly. Small and medium-sized enterprises, in particular, may be under financial pressure and risk to upgrade. Of course, the first companies to upgrade will also be the first to receive the economic benefits of intelligent manufacturing and intelligent production while increasing investment to bear the risk.

4. Occupational Safety & Health in Industry 4.0

The loss of employees lives and health caused by hazards and safety accidents in production activities not only violates employees right to life and health, but also impairs human capital and affects sustainable economic and social development.

With the strengthening of supervision of production safety in China, the number of deaths in safety accidents has been decreasing year by year since 2003. However, compared with developed countries, occupational safety and health problems are still more prominent and are one of the important causes of labor conflicts. With the development and penetration of Industry 4.0 technology, human society has entered the era of big data economy. Intelligent manufacturing, Internet of Things, and AI devices have triggered a revolution in production mode, while also bringing new uncertainties and risks for occupational safety and health, and putting forward new requirements for occupational safety and health supervision.

4.1 Occupational safety and health situation in China

In the 1990s, with the rapid development of Chinas economy, the number of fatalities in production safety accidents also continued to increase. Since 2000, China has strengthened the supervision of production safety, and the situation of production safety

has continued to improve, with the annual number of fatalities continuing to decline after peaking in 2003. After ten years of development, the occupational safety risk ranking of different industries has changed significantly. The occupational safety situation of the mining industry has been significantly improved; the construction and manufacturing industries have not improved significantly, but still are the industries with high occupational safety risks which could be found in the Figure 4. In 2006, mining was the industry with the highest occupational safety risk, with 7,023 deaths in occupational accidents throughout the year; in 2016, the number of fatalities in mining decreased to 1,061, with the largest number in construction, with 3,806 workplace deaths throughout the year, followed by manufacturing, with 3,219 deaths due to occupational accidents throughout the year.

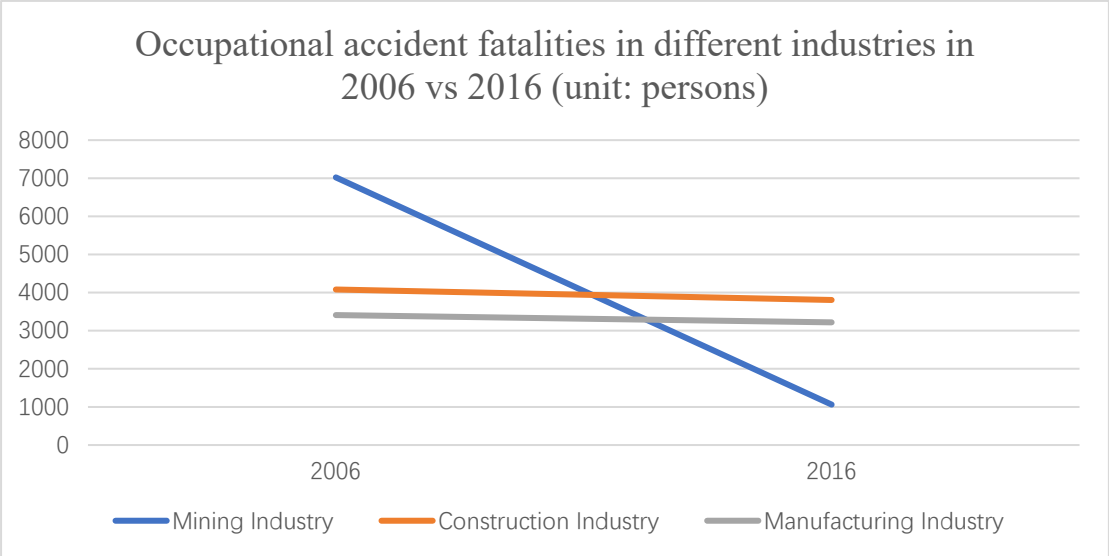

Figure 4

As a major manufacturing country, manufacturing has been the main industry for China to undertake international industrial transfer and integrate into the global supply chain. Developed countries usually strictly control the transfer of high-tech and strategic technologies to the territory of China, (such as the 2018 U.S. sales restrictions on Huawei and the incident of chip supply restrictions, as well as Google stopped providing Huawei mobile with Google services), and encourage the transfer of backward or even eliminated equipment or production processes on a priority basis, not least of which are technical processes with outstanding occupational hazards. Compared with the mining industry, the manufacturing industry has a lower degree of industrial concentration, more SMEs and non-state enterprises, complex types of enterprises and ownership types, and less efficient administrative directive regulatory instruments. In addition, the manufacturing industry is also exposed to a large number of occupational hazards, and new occupational hazards are constantly emerging. The change in the total number of reported cases of occupational diseases in China from 2006 to 2016 showed a significant growth trend. The total number of reported cases of annual occupational diseases increased from 11,519 cases in 2006 to 29,180 cases in 2016.

4.2 Challenges we are facing

4.2.1 The contradiction between complex risks and regulatory policy fragmentation

Industry 4.0 technologies such as the Internet of Things, cloud computing, big data, and artificial intelligence are transforming traditional production processes and advancing business and production model innovation by challenging traditional corporate boundaries, expanding global supply chains, and changing the geographic location and nature of employment. Increasingly complex supply chain networks, emerging occupations, human interaction with AI machines, and many other factors are creating new uncertainties in OSH management, requiring a forward-looking, proactive, regulatory approach to monitoring and managing risk. For a long time, Chinas occupational safety and health management institutions have undergone many changes, the organization has been adjusted many times, the division of supervisory powers and responsibilities is crossed, the relationship is complex, and is still in a state of incomplete clarity. For a long time, Chinas occupationa l safety and health management institutions have undergone many changes, the organization has been adjusted many times, the division of regulatory powers and responsibilities cross, complex relationships, still in a state of incomplete clarity, resulting in the fragmentation of regulatory policy, departmentalism and local interests caused by fragmentation, multi-

discipline, the lack of policy integrity, stability and continuity, low regulatory efficiency, it is difficult to achieve forward-looking, proactive, proactive regulatory governance.

4.2.2 Marketization and the Dilemma of Single Government Governance

Although the responsibilities related to occupational safety and health have been adjusted and reconstructed among relevant departments for many times, they have never got rid of the single governance model led by the government, which is the absolute main body of occupational safety and health governance, with funding, policy formulation, implementation of measures and post-accident handling, etc. Basically, the government is in action. In the field of economic life, many private, private, joint-venture and foreign-funded enterprises with various forms of ownership have emerged, and the non-state economy has developed rapidly and become the main field of absorbing employed people. In a market economy, both state-owned and non-state-owned enterprises face market pressures and need to make trade-offs between the goals of economic efficiency and a safe and healthy environment. The traditional regulatory approach (administrative instructions) is no longer effective in restraining the occupational safety and health behavior of enterprises, especially non-state enterprises. The change in the percentage of occupational accident fatalities in state-owned and non-state-owned enterprises from 2001 to 2008 shows that the number of occupational

accident fatalities occurring in non-state-owned enterprises is significantly higher than that in state-owned enterprises. Excessive regulatory division of labor, fragmented regulatory functions and regulatory power configuration, not only reduces the efficiency of regulatory governance, but also leads to the coexistence of duplicative regulation and functional deficiencies. In addition, the residual planned economy mentality in the design of the governance system poses an obstacle to workers rights to health and safety. For example, the identification procedure for occupational diseases requires workers to present documents issued by their units before they can go to designated identification institutions for identification, and work injury insurance benefits must be transferred from enterprises after payment from social security funds.

4.2.3 The imbalance of power in multiparty games and the weakening of corporate social responsibility

Before the 1990s, China adopted the occupational safety and health management system of “state supervision, industry management, and mass supervision”; after the establishment of the socialist market economy system in 1992, the State Council decided to implement the management system of “enterprise responsibility, industry management, state supervision, and mass supervision” in 1993. After the establishment of the socialist market economy system in 1992, the State Council decided in 1993 to

implement the management system of “enterprises are responsible for, industry manages, the state monitors and the public supervises”, which further clarifies that enterprises are the main body of work on safety production. In the market economy environment, enterprises are the main body of the market economy, and economic efficiency is the priority for their survival and development. In the absence of effective force checks and balances, it is difficult for enterprises to make spontaneous socially responsible behavior in the pursuit of profit.

Government regulation, public opinion pressure and internal staff supervision are the main check and balance forces to restrain enterprises malpractices. Since the reform of the economic system, labor relations in China have changed greatly, and the role of labor unions and their ability to defend rights have been weakened to varying degrees, even to the extent that there are no labor union organizations in many non-publicly owned enterprises. Due to the lack of collective bargaining power with enterprises, workers demands in occupational safety and health are not reflected in a timely manner, and “mass supervision” is difficult to achieve effectively. When facing multiple goal trade-offs such as economic development, political stability, and environmental protection, the governments choice of priority for OSH goals will be influenced by public opinion in a given situation. Because occupational safety has a conspicuous character (such as mining accidents with a high death toll), it is more likely to attract

public attention and condemnation by public opinion, which in turn affects the governments choice and preference for occupational safety priorities; occupational health hazards are relatively more hidden and less likely to attract public attention. Employees exposed to occupational health hazards are mostly at the bottom of society, with weak social voice and influence, leading the government to pay much less attention to occupational health management than to occupational safety. In addition, the complexity of issues such as diagnosis, treatment, occupational injury insurance and labor protection of occupational diseases is far beyond that of accidental death compensation matters. The overly detailed division of labor and fragmentation of regulatory policies have led to duplication, crossover and even contradiction in the regulation of occupational diseases, resulting in occupational safety and occupational health governance being out of sync and occupational health as a whole lagging behind occupational safety.

4.3 Occupational Safety and Health Governance Innovation

(1) Integrating power and cohesion in governance.

Occupational safety and health regulatory governance is a social control, the power configuration of the governance body is an important means and institutional basis to ensure the effectiveness of governance. Before 1998, occupational safety and

health regulatory agencies in China were frequently adjusted, but the mode of comprehensive management by the labor department remained unchanged, reflecting the characteristics of monolithic and comprehensive management. 1998 national institutional reform changed the configuration of the governments occupational safety and health governance agencies from a monolithic configuration to a decentralized configuration of multiple departments, successively assigning labor security, production safety, occupational health, and special operations to different departments for supervision. The existing multi-decentralized and coordinated management of occupational safety and health governance pattern has been formed with the promotion of successive national institutional reforms. Among them, occupational health supervision functions are repeatedly transformed between health department-led and safety supervision department-led, and this organizational design disperses the supervisory power of occupational safety and health and affects the effective interface and operation of supervision. In the actual supervision, although the establishment of a multi-departmental participation in the joint meeting system, clearly stipulates that health, safety supervision, labor, trade unions and other four departments must hold regular joint meetings to inform the situation, exchange of work, and in the form of minutes of meetings to clarify the matters agreed upon, but due to loose links between

departments, the meeting is often a formality, and does not achieve the desired results. Therefore, in order to improve the efficiency of occupational safety and health governance, it is necessary to improve the organizational design of occupational safety and health, integrate regulatory powers, eliminate the problem of overlapping departmental functions, and coalesce governance forces.

(2) Improve legislation to clarify the boundaries of corporate behavior

At present, the Work Safety Law, the Occupational Disease Prevention and Control Law and the Labor Contract Law cannot be used as the basic law for occupational safety and health. Hence there is an urgent need to formulate an integrated basic law of occupational safety and health to clarify the boundary of occupational safety and health behavior of enterprises and eliminate the phenomenon of cross-function or lack of position that may occur in the process of joint enforcement by multiple functional departments, so as to effectively reduce the cost of legislation, enforcement and compliance.

(3) Multi-party cooperation to promote collaborative governance

Occupational safety and health (which can be abbreviated as OSH) is a typical public affair, and the construction of a multi-subject and multi-dimensional

partnership is an inevitable requirement for modern society to govern occupational safety and health issues. The big data economy promotes the close connection of physical system, data system and social system, and developed countries have adopted cooperative governance as the mainstream mode of occupational safety and health governance, in which government, industry, enterprises, labor unions and communities participate and negotiate together. Chinas occupational safety and health supervision and governance model is government-led, and the control method of administrative order compulsion will be difficult to effectively monitor the dynamic and open large integrated system. It is necessary to combine the characteristics of national conditions, promote the gradual transformation of occupational safety and health supervision to public management, and form a cooperative mechanism of extensive participation and multi-faceted interaction by establishing and improving a multi-faceted consultation platform for occupational safety and health.

(4) Occupational Safety and Health Big Data Management

The development of technologies such as the Internet of Things, intelligent sensing devices and cloud computing has helped to collect more occupational safety and health data. However, in order to transform data into useful information, firstly, a

unified statistical caliber and index system is inseparable, and the practicality, stability and continuity of monitoring data need to be maintained. Secondly, it is necessary to eliminate the isolation of occupational safety and health information and promote the integration of occupational safety and health information systems to form a relatively complete and continuous information system. In addition, in order to give full play to the functions of the database, it is necessary to improve the public data service function, which is convenient for enterprises to report data, obtain information and obtain one-stop public service supply, and also convenient for the government or social institutions to integrate occupational safety and health data, scientifically analyze and evaluate the development status of occupational safety and health, provide a basis for major decisions, and promote the development of the theory and practice of occupational safety and health.

5. IOT technology and centralized control system in intelligent manufacturing

With the development of information technology, IoT technology has been widely used in intelligent manufacturing enterprises. Taking the intelligent manufacturing factory project as a push point, it will certainly integrate the manufacturing cycle and multiple processes, such as design management, production control, multi-point control and system network security.

The intelligent manufacturing platform based on IoT technology stores and shares information uniformly, and initially builds and develops a network control service platform for enterprises in intelligent manufacturing, and forms a milestone.

5.1 Industrial IoT system architecture and requirements

Intelligent factory IoT usually, three dimensions of intelligent factory can be described from manufacturing intelligence, product intelligence, and management intelligence, and if these descriptions and expressions can be supported by real-time data, real-time instructions, and interaction between these three dimensions. This is the so-called intelligent factory, the specific framework of which is shown in Figure 5.

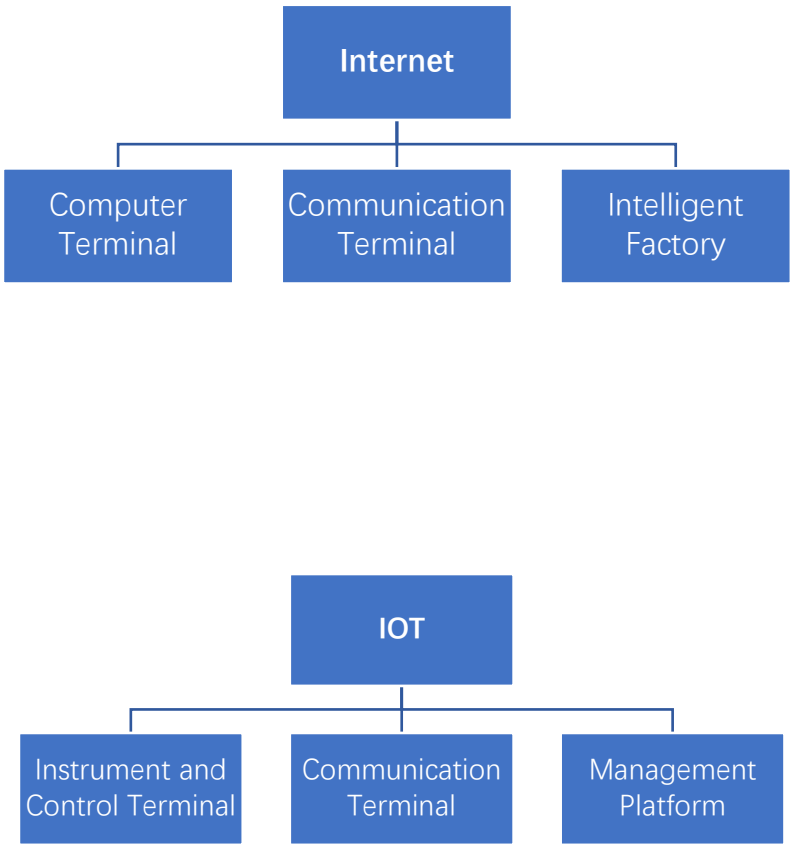

Figure 5

5.1.1 Architecture of centralized control system functions

System application intelligent manufacturing factory control side downstream equipment and control equipment is through the field bus control to realize the industrial environment data sensing and control command issuance. At the same time,

by monitoring the production process and tracking the operation status of production equipment, the optimal allocation of resources and optimization of the production process can be achieved, thus facilitating the reduction of energy consumption, remote communication and centralized control, and improving production efficiency.

The functions of the centralized control system mainly include: (1) Web side. The main function is production management and decision analysis. (2) Machine side. The main function is workshop management and task query. (3) Mobile side. The main function is production progress inquiry. (4) Big screen. The main display is real-time operation status and progress.

(1) Web side. Production management is a system in which production tasks can be assigned to production equipment, and after confirming the assignment information, the tasks are formally issued to the equipment, which is equivalent to issuing the work directly to the equipment. Production registration allows you to adjust abnormal production data or make up and delete some production data to make production data more accurate.

Decision analysis is mainly able to view the information of production tasks, information of reported work output and information of task progress. The reports show information from multiple angles and different dimensions, which is

convenient for managers to view and assist management.

(2) Machine side. Workshop management mainly allows production personnel to log in to the system and view the production tasks and the progress of production tasks through the system, allowing production personnel to eliminate paper documents and thus quickly report production and easily and quickly view the progress of tasks. Process instructions can be downloaded directly from the system, eliminating the work of copying process instructions from the office. It changes the original way of working, eliminating the need to pass paper documents, making the work simple and fast, and improving the efficiency of communication and interaction.

(3) Mobile side. View production task information and real-time progress of production tasks through cell phone mobile devices, and check the progress of tasks anytime and anywhere. It allows managers to view and control production progress in real time regardless of time and location, making management simple and efficient.

(4) Big screen. The big screen electronic signage can show the running status of the equipment and the real-time progress of the production tasks, so that every person passing by the big screen can have an insight into the production situation of the whole workshop.

5.1.2 Requirements for system construction

(1) Unified and advanced. The system construction follows the unified planning of information construction of intelligent manufacturing factories to meet the information management requirements. The system is designed with advanced concepts and technologies, using advanced and mature technologies, and all the technologies used in this paper have been successfully applied by several manufacturing enterprises. Considering the information development trend, while adopting mature technologies, the current popular technologies are widely used, including big data technology, artificial intelligence technology, support mapping technology and other advanced technologies to ensure that the system can adapt to the future development of modern technology.

(2) Mature and stable. The system structure design, system configuration, system security and other aspects use advanced, mature and practical technology. The system should ensure 7×24 h stable and reliable operation. Meet the requirements of high availability and high performance, and support sufficient number of concurrencies. With backup Recovery mechanism, in case of system failure, the system can be quickly restored to normal operation.

(3) Efficient and practical. The system has strong business processing capability to meet

current and future business needs It has good performance expansion capability. The system design should fully consider the practicality and provide a good operating environment for users. Support at least 50,000 users. Meet concurrency requirements. The operating habits of various users at all levels should be fully considered. Simple operation, friendly interface and easy to use system.

(4) Regulation and safety. The system construction is based on the standard index system of the electric power industry and the concept of standardized business management, and should be compatible with the information management system of the intelligent factory. The system can prevent security risks such as illegal invasion from outside the system and overstepping operation of operators to ensure system data security, stability and reliability. A complete security model should be provided to design and implement security from application security, data security, user access security, and architecture security for data, access, development, and architecture at all levels of the software and application process.

(5) Expansion and compatibility. The system design fully considers good scalability and flexibility, and adopts flexible mechanisms from software architecture, software functions, data structure design and other aspects to facilitate business expansion and changes, and is compatible with the existing environment.

5.2 The core problems encountered in the centralized control system

The core technology of the centralized control system is dependent on the Internet of Things technology for long-term development, so it should continuously improve the core technology level of the centralized control system, actively develop and introduce new technologies, and promote scientific and technological innovation.

Firstly, a public service platform should be established to solve the technical problems encountered in the development of Maxs centralized control system, and technical research and development can be conducted on the platform to accelerate technological innovation on the basis of applied technology, to do a good job of top-level design, and to meet the needs of the development of intelligent manufacturing plants.

Second, focused technology development and research, to increase the research on key business and key technologies, to establish a service platform for standard verification and simulation, and to accelerate the construction of the standard system.

Again, we should not stick to the old ways in technology development, we should actively learn from excellent foreign cases, combine the current situation of Chinas intelligent manufacturing industry and the future industry development of intelligent manufacturing factory for comparison and analysis, and accelerate the domestic

technology development.

5.3 Future upgrade direction of centralized control system

Although the operational division of labor of each layer and the business realization process of each layer in the application of the centralized control system in the intelligence factory are clear, the current research is not deep into the problem of coupling association between the hardware equipment building connection, division of labor control (of complex kinds) and large amount of data transmission of signal information and virtual space between the centralized control system in each layer. To realize the perceptual interaction in the complex environment of intelligent manufacturing and centralized control, the Internet of Things needs to be established as a virtual model of physical simulation space and information simulation space, as well as a model of electromagnetic interference in the complex factory environment.

5.4 The achievements obtained by the centralized control system

After years of deep research and practical theory, the centralized control system has improved the resource utilization rate for intelligent manufacturing factories, saved a lot of labor costs, improved many problems of the management system, solved a series of problems such as interconnection and interoperability between manufacturing

equipment and intelligent networking of wireless sensing to improve the efficiency of enterprises in the production process, and these perfect technologies have the conditions for application in intelligent manufacturing factories, and have also gained the reputation and appreciation of manufacturing enterprises.

With the advent of Industry 4.0 era and the development needs of national equipment manufacturing industry, we need to develop new technologies such as integrated planning and scheduling, production modeling and material tracking, equipment data energy collection, quality control and statistics based on the latest industrial IoT technology, system optimization scheduling methods and advanced manufacturing ideas. After years of deep research and practical theory, the centralized control system has improved the resource utilization rate for intelligent manufacturing factories, saved a lot of labor costs, improved many problems of the management system, solved a series of problems such as interconnection and interoperability between manufacturing equipment and intelligent networking of wireless sensing to improve the efficiency of enterprises in the production process, and these perfect technologies have the conditions for application in intelligent manufacturing factories, and have also gained the reputation and appreciation of manufacturing enterprises.

With the advent of Industry 4.0 era and the development needs of national equipment

manufacturing industry, we need to develop new technologies such as integrated planning and scheduling, production modeling and material tracking, equipment data energy collection, quality control and statistics based on the latest industrial IoT technology, system optimization scheduling methods and advanced manufacturing ideas. We could empower the new era of industrial intelligent manufacturing through new technologies such as 5G communication and Artificial Intelligence Deep Learning.

CONCLUSION

The paper summarizes the importance of safety management and safety production for the new era of industrial revolution. In order to implement the "Made in China 2025" vision, firms would need not only their own efforts, but also the governments assistance and the training of talents from universities to supply inventive strength to businesses. The article explores the network significance of "internet+" and the Internet of Things for intelligent manufacturing, as well as their future development path.

Innovation is the fundamental way for manufacturing industry to achieve rapid development. Through innovation, enterprises can not only improve the competitiveness of their products, but also enhance their status in the industry. In the process of transformation and upgrading through innovation-driven enterprises, the first thing that enterprises should pay attention to is the construction of innovation capacity, so the training of innovation talents is crucial.

Artificial intelligence, big data systems can be used into implement intelligent safety management. It will break through the traditional mode of safety management, to achieve intelligent control, protect the future of enterprise safety production and meet the needs of production management in the era of Industry 4.0.

Under the requirements of the new era, the occupational health management model should be continuously innovated to meet the needs of the scientific research and production tasks. Once occupational hazards occur, they not only seriously endanger the health of workers, but also bring huge economic losses to enterprises. Through systematic, professional and targeted special training, we can improve the sense of responsibility and consciousness of employees and enhance the occupational health knowledge and skills of operators. Combining 5G communication technology with real-time live streaming technology to closely monitor the safety behavior of plant operators. Establish an occupational health management mechanism to identify occupational hazards. It is a responsibility to make employees health awareness a safety culture of the company. The life safety and health of workers is the first priority, production and safety and health are interdependent and inseparable.

In the new industrial era of safety, efficiency and intelligence, both China and other countries will actually feel the realization of new technological scenarios brought out by the Industry 4.0 revolution. Countries should break down barriers and put aside preconceptions. Each of us should actively participate in the construction of economic globalization by revitalizing machinery manufacturing.

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