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# Transformation in manufacturer in the era of “Made in China 2025”

*Faculty of Engineering Science and Technology*

**Xuancheng Li**

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# Abstract

China's state council has unveiled a ten-year national plan, Made in China 2025, designed to transform China from a manufacturing giant into a world manufacturing power.

Of all the projects included in the "Made in China 2025" plan, intelligent and automated manufacturing is crucial. It is based on concepts i.e., internet of things, cloud computing, and big data. These technologies will be involved in every aspect of the manufacturing process, to realize optimized decisions in manufacturing operations.

Manufacturing is the engine to drive rapid growth of economy, which is also one of the basic elements to the development of the country. Advanced manufacturing technology (AMT) benefits from the development of a new generation of information technology. And concept i.e., Intelligent Manufacturing Technology (IMT), has become the mainstream in AMT.

This project aims to explore "Made in China 2025" and apply to a manufacturer. To show that will improve the manufacturing industry. In this project, a case study at a Chinese company in introducing the concept "transformation" (from the traditional to Made in China 2015) will be conducted.

# Preface

This Master' Thesis was conducted during November 2018 to June 2019. This report summarized the understanding of the advantages, characteristics and development of intelligent manufacturing system and automated manufacturing system, in order to introduce the "Made in China 2025" plan, and give some suggestion to the Chinese Faw company.

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Narvik, 01.01.2019

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# 1 Chapter 1 Introduction

## 1.1 Background

### 1.1.1 “Made in China 2025” plan

“Made in China 2025” include these five characteristics: interconnected, data, integrated, innovation and transformation. And it mainly focus on automated manufacturing and intelligent manufacturing, and the intelligent manufacturing is more important.

According to the plan, by 2025 China will basically realize industrialization nearly equal to the manufacturing abilities of Germany and Japan at their early stages of industrialization.

Made in China 2025 represents anything but reckless state intervention. Instead it stands at yet another clearly thought-out government initiative that should enable Chinese industry to move to a more modern culture of high quality, high investment and a brand-oriented business environment.

Text The traditional mechanical automation mainly use the weak current system, electrical switch and other electronic components to realize the manufacturing automation. Strictly speaking, this automation is not completed, it is equal to half-automation technology. With the development of the computer technology and network communication technology, there appeared intelligent mechanical automation technology gradually. This is a kind of automation technology which based on weak current system, and can realize the remote control. This is also one of mainstream technology for the development of mechanical automation techniques.

Manufacturing industries are concerned with producing higher-quality products, while minimizing production cost and time. Therefore, many factories or companies only pay the attention to the goal, they do not care about the cost and efficiency enough. At the same time, their interactions and effects are often difficult to uncover. As the demands of consumer economy grow exponentially, the ever-increasing requirements of the consumer need to be met through a variety of products of high precision, low cost, high quality and durability

The primary requirement of manufacturing is to produce as many products as soon as possible, at the lowest possible cost, but of course with the highest quality. So, improving the manufacturing systems in the factory should be attached importance to pay attention to. Intelligent and automated manufacturing system can flexibly respond to changes in entering and exiting the process in interaction with the surroundings.

A systematic research is made based on the characteristics of general Artificial Intelligent techniques, including Expert System, Fuzzy logic, Artificial Neural Network, Pattern Recognition, Genetic Algorithms etc.

According to the development trend of the intelligent and automated technology, the first one is that the intelligent and automated technology will take the place of the manpower. Robot is one of the widely used intelligent and automation system, the robotic system has more completely function of the system, which is equal to the intelligent system of brain and the operation system of limbs. The second one is that the intelligent and automated technology will realize the interactive remote control of

intelligent information. The coverage of the computer network, has further promote the communication and control of the intelligent and automation technology's transregional remote information.

### **1.1.2 Chinese manufacturing status analysis**

Machinery manufacturing industry is a national of the most basic industry, which also determines the whole level of a country's manufacturing. The level of its development directly affects the technology level of the national economy departments and the improvement of economic benefits.

Chinese machinery industry in addition to face a "foreign", there are many problems itself. The equipment in enterprise are obsolete, and the technology of production is backward. In existing equipment of production, CNC, precision and high efficiency equipment are insufficient, low degree of automated manufacturing system, and low level of worker skills.

Many investigation of the high and new technology enterprise show that, many new technologies, new inventions, which have broad market prospects, always encounter great resistance in the process of transforming to commodity, because of the lack of corresponding levels of mechanical processing, mould processing, and skilled workers.

At present, some mechanical products do not have enough market, but have more inventory backlog, instead of the market of mechanical products, but the low level of products, the lack of competitiveness, and the poor quality and low level of domestic machine tools.

The situation of Chinese manufacturing production technology, especially the key technology mainly rely on overseas, still does not change fundamentally. Although Chinese manufacturing technology and innovation have improved, the ability of develop independently is still relatively weak, the new technology of intellectual property is lacked, and there also should be the first-class research and resources of the world and the knowledge of technical. The Chinese manufacturing technology does not gain the initiative of the development of new product.

## **1.2 Research objective**

The main purpose of this report is to integrate the advantages and development of the automated manufacturing system and intelligent manufacturing system, and contrast a Chinese company, to show the benefit of this kind of system, and explain the reason of transformation towards intelligent and automated manufacturing system. The figure 1 shows the connection between intelligent manufacturing and automated manufacturing, and different system in different years. It shows mechanical manufacturing need to develop automated and intelligent at the same time.

The aims of the intelligent and automated systems are: shortening of running production times, higher production productivity, economic expediency, elimination of worker hand intervention. This report will show these high-technology and innovative advantages can improve the manufacturing industry.

In this Chinese factory, the manufacturing systems are not very advanced. For example, the robot arm, it always has different problem when it is working, it always need workers to repair and adjust. As for the assembly line, there are also some problems that all parts cannot coordinate very fluently.

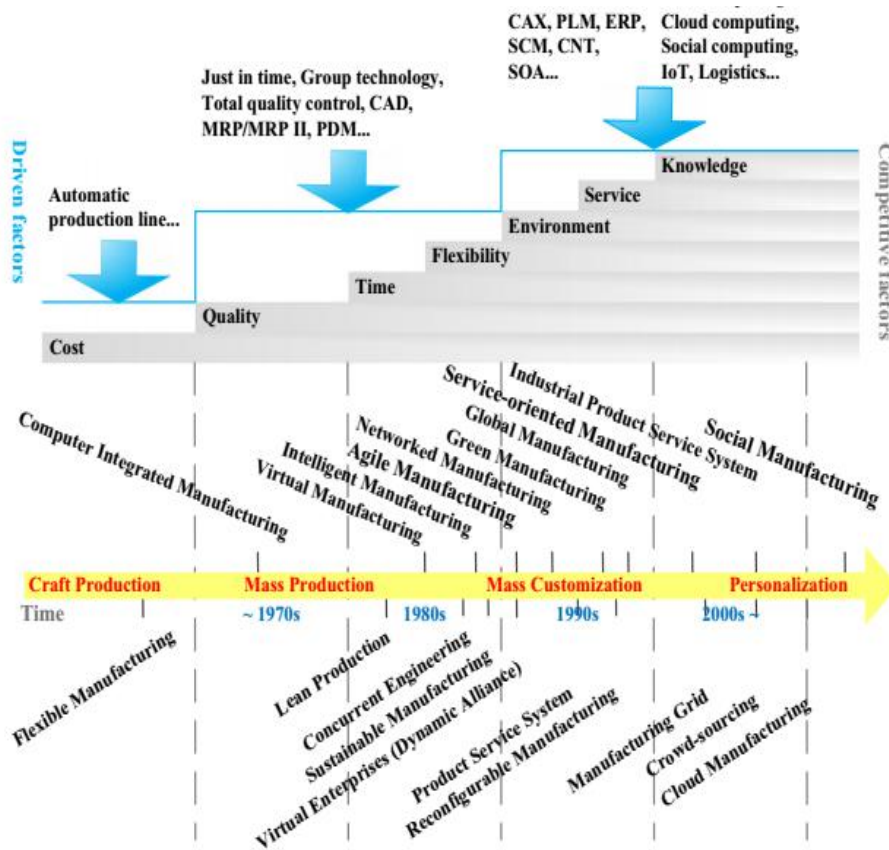


Figure 1 - the brief development process of advanced manufacturing systems

## 2 Chapter 2 “Made in China 2025” plan

Manufacturing industry is the main part of national economy, to build an internationally competitive manufacturing industry is the only way which must be passed to enhance its comprehensive national strength, guarantee its national security and build itself into a world power.

In order to strengthen the basic industrial capacity, improve the level of comprehensive integration, improve the multi-level and multi-type personnel training system, promote industrial transformation and upgrading. The basic principle of “Made in China 2025” includes”

- Innovation driven. Putting innovation at the core of manufacturing development, improving the institutional environment that could conducive to innovation, promoting digitization, networking and intellectualization of the manufacturing industry, to take an innovation driven development path.
- Quality first. Insist on quality as the lifeline of building a manufacturing power, strengthen the responsibility of quality of the corporate, strengthen the quality and technology research, and develop own brands, establish a system of laws and standards and quality supervision system, to build a honest management environment of market, take the development path that wins by quality.
- Green development. Promote the use of energy conservation and environmental protection technologies, process and equipment, promote clean production. Developing circular economy, to improve recycling efficiency, build a green manufacturing system, follow the path of ecological progress.
- Structure optimization. To continue to take structural adjustment as a key link in building a strong manufacturing country, vigorously develop advanced manufacturing, transform and upgrade traditional industries. Optimizing the industrial spatial layout, to cultivate a number of industrial clusters and enterprise groups with core competitiveness. Follow the path of improving quality and efficiency.
- Talent first. Insist on talents as the foundation of building a powerful manufacturing country, build scientific and rational selection, appointment and education mechanism. Accelerating the training of professional and technical personnel, management personnel and skilled personnel that urgently needed for the development of the manufacturing industry. Follow the path of talent-led development.

### 2.1 The present situation and main problems of Chinese manufacturing industry

Manufacturing is not only the pillar industry of China's national economy, but also the leading field of China's economic growth. The main problems of Chinese manufacturing industry include:

- Low R&D intensity.

China's R&D investment intensity continues to rise, but compared with developed countries, China's R&D investment intensity is significantly lower. Although China is increasing its R&D investment, the intensity of R&D investment is still lower than the world average. China's R&D expenditure is

relatively small in terms of absorbing funds for introducing technologies and purchasing domestic technologies, but more spent on technology introduction. So China's manufacturing industry is still at the lower end of the chain, and with a lack of innovation ability.

- Lack of core technology

China's manufacturing industry is not strong in independent innovation, and the key technologies and high-end equipment are mainly exported. The manufacturing innovation system with enterprises as the main body is not perfect. Compared with developed countries, Chinese manufacturing enterprises lack the motivation and investment to carry out technological innovation, so that it has not become the main body of technological innovation.

- Fewer internationally known brands

In terms of volume, "made in China" has certain advantages, in terms of quality, those brand products with high technology content and high added value are still controlled by foreign enterprises. The lack of international brand, not only make China's international status and economic profit decline. It will further make Chinese manufacturing enterprises in a weak position in the international division of labor. On the other hand, Chinese enterprises are seriously under-invested in brand design, brand building and brand maintenance.

- Information level gap

Deep integration of informatization and industrialization is an important driving force for building a strong manufacturing country, taking a new industrialization path and transforming the development mode. At present, developed countries and regions have begun to enter a new stage of comprehensive integration of manufacturing industry and information technology, characterized by digitization and network application. By Germany industrial 4.0 standards, China's information technology is not high, and the depth of integration with industrialization is not enough. The high-end core industrial software related to national economic and social security mainly depends on imports, the talent reserve of informatization and information security is seriously insufficient.

- The industrial structure is unreasonable

On the one hand, The proportion of high-tech industries such as electronic information, high-end equipment manufacturing and new energy is still relatively low. At present, resource consumption and labor intensive, are still the overall pattern of China's industrial structure. The unreasonable industrial structure makes the industrial upgrading slow. On the other hand, the proportion of processing trade enterprises is too large, and the proportion of foreign enterprises is too high.

## **2.2 Carry out “Made in China 2025” plan**

Machinery manufacturing industry is a national of the most basic industry, which also determines the whole level of a country's manufacturing. The level of its development directly affects the technology level of the national economy departments and the improvement of economic benefits. The ministry of industry and information technology summarized the main contents of the plan with “One Two Three Four Five Nine Ten” .

“One” means a target: China will develop to a manufacturing power.

“Two” means integrating information technology and industry to achieve the goal.

“Three” means achieving the goal through a “three step” strategy:

- (1) First decade: China will be ranked among the manufacturing powers.
- (2) Second decade: China will reach a generally moderate level among the manufacturing powers.
- (3) Third decade: China will transform into a leading manufacturing power.

“Four” means four principles:

- (1) Market-oriented and government-guide.
- (2) Based on the present and having a long-term perspective.
- (3) Comprehensively pressing forward and making breakthroughs in key areas.
- (4) Independent development and win-win cooperation,

“Five” means five guidelines:

- (1) Innovation-driven.
- (2) Giving priority to quality.
- (3) Green development.
- (4) Optimizing structure.
- (5) Talent oriented.

“Nine” means nine tasks:

- (1) Promoting international manufacturing.
- (2) Improving manufacturing innovation.
- (3) Integrating technology and industry.
- (4) Strengthening the industrial base.
- (5) Fostering Chinese brands.
- (6) Enforcing green manufacturing.
- (7) Promoting breakthrough in 10 key sectors.

(8) Advancing restructuring of the manufacturing sector.

(9) Promoting service-oriented manufacturing and manufacturing-related service industries.

“Ten” means 10 key sectors:

(1) New information technology.

(2) Numerical control tools and robotics.

(3) Aerospace equipment.

(4) Ocean engineering equipment and high-tech ships.

(5) Railway equipment.

(6) Energy saving and new energy vehicles.

(7) Power equipment.

(8) New materials.

(9) Medicine and medical devices.

(10) Agricultural machinery.

To fulfill the tasks, “Made in China 2025” will focus on five major projects, including establishing a manufacturing innovation center and boosting intelligent manufacturing.

Of all the projects included in the “Made in China 2025” plan, intelligent manufacturing is crucial. Intelligent manufacturing is based on internet of things, cloud computing, and big data. These technologies will be involved in every aspect of the manufacturing process, to realize machine optimized decisions.

Compared with industry 4.0, “Made in China 2025” and Germany raised ideology industry 4.0 are largely similar. It is a combination of internet and advanced technology, it will push up a new round of manufacturing development. But there are still have big difference among regions and sectors in China in terms of technology. There are still have to catch up on industry 2.0 and industry 3.0 before we reach the stage of 4.0. But the binding of internet and manufacturing is a good opportunity to speed up our development.

“Made in China 2025” represents anything but reckless state intervention. Instead it stands as yet another clearly thought-out government initiative that should enable Chinese industry to move to a more modern culture of high quality, high investment and a brand-oriented business environment.

To make “Made in China” truly brilliant, it is necessary to adopt the “Made in China 2025” strategy, depend on long-term efforts, make China a manufacturing power in the world. During the “Made in China 2025” plan, automated manufacturing system and intelligent manufacturing system should be improved crucially. Both are the most important parts of the Chines plan.

## **3 Chapter 3 Automated manufacturing system**

### **3.1 Theory of automated manufacturing system**

#### **3.1.1 Automated manufacturing system**

At present, the word “automation” that we talked about, has developed from the automatic control, automatic compensation, automatic adjustment, and automatic identification to a higher degree of automation, such as the automatic learning, automatic organization, automatic maintenance, and automatic restoration etc [1]. The applications of automation technology in the field of mechanical manufacturing industry are mainly reflected in the following aspects.

The first one is about the modality. The machinery manufacturing automation mainly revealed on the substitute for physical labor. The heavy manual work can be finished by automated machinery. Personnel, machinery and automation equipment can compose as a system, which can implement coordination operation and control.

The second one is about the verticals. The machinery manufacturing automation technology not only involves the trans-version of processing, but also touches upon the life cycle of products. It can extremely improve the production efficiency, to create more economic benefits for enterprises.

The third one is about the function. The machinery manufacturing automation also shows the many advantages, for example:

- Machinery manufacturing automation technology can greatly improve the production efficiency, and shorten the production period, to provide the time guarantee for taking market.
- The machinery manufacturing automation technology can ensure the standardized rates and consistent spec of the quality.
- The machinery manufacturing automation technology can reduce the production cost by reducing the consumption of labor.

Automation manufacturing system is an organic whole composed of various devices which consists of a range of processed object, flexible and automated equipment. It accepts outside information, energy, funding, parts and components, and raw materials. It can achieve a certain degree of flexible automation manufacturing with the joint action of people and computer control system.

Automated manufacturing systems including rigid and flexible manufacturing, “Rigidity” means that this production line can produce a certain product, show the simplicity of the products. “Flexibility” means the diversity and variability of the production organization and production process.

#### **3.1.2 The advantage of the machinery manufacturing automation system**

- Improving the capacity of the products, and quality of work.

Most mechanical automation productions possess the functions of information processing and control automatically. The sensitivity, precision, and scope of the control and detection, have



greatly improved. Through the automatic control system, it can accurately ensure that the mechanical actuator accomplishes the action according to the requirements of design, to achieve the best operation, ensure the best quality of work and high product qualification rate. At the same time, because of the working automation, the productivity has greatly increased.

In addition, due to the working of mechanical automation has good flexibility that can adapt to the demand by adjusting software. It is the important channel to reduce the product development cycle, and accelerate the upgrading.

- Improving the security and reliability of use [1].

Mechanical automation products generally have the functions such as automatic monitoring, alarm, automatic diagnosis, automatic protection etc. In the process of work, if there are power failures like overload, over voltage, and short circuit etc., it can adopt the safeguard procedures automatically, to avoid the personal and equipment accident.

Due to the mechanical automation products adopt electronic components, it reduces the moveable components and abrasion parts in the mechanical products, thereby, and it has high sensitivity and reliability.

- It is convenient to adjust and maintain, improve the use of performance.

When the mechanical automation products are installing and debugging, it can change the manner of working through changing the control procedures, to adapt to the needs of different users, and the needs of parametric variation. These controlling programs can be input to control system of mechanical automation products through various means, without changing any components or parts of products.

For the machinery automation products which have the function of storage, can be able to deposit several different sets of executive programs in advance, then according to different work objects, and give a code signal input, it can work automatically according to specified scheduled program [1].

The function of automatic inspection and automatic monitoring can take measures automatically with the fault in the working process, it can greatly simplify the operation, and convenient and simple.

Senior mechanical automation products can find the best program randomly through the mathematical model of controlled object, and the change of the external parameters, to realize the automated optimization operation.

- Having the function of the composite, and widely applicable.

Mechanical automation products are out of the limitation of single technology and single function, it greatly improves the degree of automation and the level of function, with the composite technology and composite function.

Mechanical automation products have the function such as automatic control, automatic compensation, automatic calibration, automatic adjustment, automatic protection, and intelligent etc., it can be applied to different occasions and different fields, to meet customer demand. It has a strong strain capacity.

- Improving the working conditions, it is conducive to automated production.

Machinery automation products have a high degree of automation, and it is a product with knowledge-intensive and technology-intensive. It is the important way to liberate people from heavy manual labor.

It can speed up the factory automation, office automation, agricultural automation, and traffic automation.

## 3.2 Flexible manufacturing system

FMS is a manufacturing system which is managed and controlled intensively by computer, which is used to manufacture components of medium and small batch efficiently for automated production systems. It includes the standard NC-machine tools or manufacturing unit, a system of release command and monitoring system.

The key technology of FMS includes:

- Computer aided design. It will introduce expert system, to make it intelligent in order to deal with all kinds of complicated problems.
- Fuzzy control technology [2]. The practical application of fuzzy mathematics is fuzzy controller. High performance fuzzy controller has the function of self-learning, it can get new information continuously in the process of control, and adjust the controlled quantity automatically, to improve the system performance greatly.
- Expert system. Most artificial intelligence that used in flexible manufacturing technology is based on regular expert system. Expert system uses expert knowledge and the inference rules for reasoning, to solve the various problems. Because of the expert system can easily combine all kinds of facts and theories with the knowledge which is gained through experience, the expert system enhance the flexibility for different aspects of flexible manufacturing work.
- Ann technology. ANN is an information processing method which simulates intelligent creatures of neural network. In the field of automatic control, ANN tied in expert system and fuzzy control system, becomes an integral part of modern automation system.

The basic components include:

- Automatic processing system. It means that the system is based on the group technology, it puts the components that have similar dimensions, same material, similar process to one or several numerical control machine tools.

- Material storage system. It is mainly realize the transportation and warehousing storage of the work piece and tools.
- The information system. It consists of the main computer, classification computer and its interface, external equipment and various control devices. Its main function is to link the information between each system, and ensure the normal operation of the system.
- The operator. The main work is programming, detection, control and maintain.
- Flexible manufacturing technology is based on the automation technology, information technology and manufacturing technology. It forms a complete and organic system with the support of computer and software, by mutual independence such as engineering design, production and management process [2].

Flexible manufacturing cell is developed on the basis of the manufacturing unit. It is a unit FMC with some characteristics of flexible manufacturing system. It has the function of independent processing, automatic transmission and monitoring management. There are two categories of the composition of the FMC, the first one is Automated Pallet Changer (APC), and the other is Robot.

APC possess the functions of storage, transportation, automatic detection, and the classification of work piece and tool. It is very effective to realize 24-hour automatic process.

The characteristic of the flexible manufacturing cell:

- Adjust the processing object automatically.
- Automation.
- High machining precision and efficiency.
- High profits.
- Easy to develop toward CIMS.

### **3.3 Modern manufacturing system**

There are two meanings of machinery manufacturing technology, the first one is the technology of machining parts with machinery. It means that the parts can be processed on the machine with the method of cutting, this kind of machine is often referred to machine tools. The other one is the technology of manufacturing the machinery, such as automobile manufacturing and turbine [3].

Advanced mechanical manufacturing technology is to fuse the technology of mechanical, electronic, information, materials, energy and management. It comprehensive application in the whole process of manufacturing that includes the market demand, product design, process design, processing and assembling, detection, sales and maintenance, in order to realize the production achieve high quality, high efficiency, low consumption and clean.

Modern manufacturing system has the new concept of manufacturing, it proposes a series of new manufacturing systems, such as computer integrated manufacturing system, intelligent manufacturing

system, agile manufacturing, concurrent engineering. The modern manufacturing technology is mainly manifested in two directions of development. One is precision engineering technology, it is representative of the forefront parts of ultra precision machining, fine processing, and nanotechnology. The other one is the supermatic of mechanical manufacturing, it is represented by the further development of CIMS and agile manufacturing etc [4].

According to the function and research object of the modern manufacturing technology, it can be summarized as the following several aspects:

- Modern design technology.

The modern design technology is on the basic of the product functional requirements, and it uses the application of modern technology and scientific knowledge to make plan and make it into practice. The modern design technology includes computer aided design, technology of creating competitive edge, technology of design experiment etc.

- Modern manufacturing technology.

The modern manufacturing technology includes precision and ultra precision machining, precision forming, and unconventional machining technology.

- Manufacturing automation technology.

Manufacturing automation means the mechanical and electrical equipment can replace human labor, even replace and extension part of the intellectual. It can finish the work automatically, includes material storage, transport, processing, assembly, and inspection. Manufacturing automation technology, numerical control technology, industrial robot technology and flexible manufacturing technology are the most important basic of machinery manufacturing industry.

- Advanced manufacturing mode and manufacturing system.

The advanced manufacturing mode and manufacturing system face the process of enterprise production, it is a new idea and philosophy of combining information technology and production technology. Its functions cover the market forecast, product design, processing and manufacturing, management of information and resources.

### **3.3.1 The feature of precision machining and ultra precision machining**

With the development of modern industry, the precision machining and ultra precision machining occupy more and more important role in the field of machinery, electronics, light industry and national defense. Precision machining means in a certain period of development, the machining accuracy and surface quality to achieve a high degree of processing technology. Ultra precision machining means the machining accuracy and surface quality achieve a higher degree of processing technology [4].

The characteristic of precision machining and ultra precision machining:

- Precision machining and ultra precision machining use the machining precision of the original as the object, it is closely combine with the original to develop.

- The precision machining and ultra precision machining should not only ensure the high precision and surface quality, also requires a high stability or stable.
- Precision measurement is necessary for precision machining, if there is no corresponding precision measurement method, there will no scientific measure and surface quality of the precision machining.
- Modern precision machining and ultra precision machining often link together with the automatic control. It widely used in microcomputer control and adaptive control system, to avoid the error of manual operation.

The goal of advanced manufacturing technology is to improve the competition between enterprises and promote the national economy and comprehensive strength. It has to constantly absorbing high-tech achievements, to combine with the traditional manufacturing technology, In order to improve the comprehensive economic benefits of manufacturing.

### **3.3.2 Computer aided design and manufacturing technology**

Computer aided design and manufacturing (CAD/CAM) is a modern technology that uses the computer to complete the product design and manufacturing.

CAD/CAM system is the information processing system in the process of design and manufacture. It needs to deal with the information of whole manufacturing process and product design, including the numerical calculation of design and manufacture, design and analysis, three-dimension modeling, engineering drawing, technology analysis, NC automatic programming etc [4]. The input of CAD/CAM system is design requirement, and the output is manufacturing process information. A complete CAD/CAM system includes the following aspects.

- Investigate the requirements of product performance of users through the demand, and input the design requirements to CAD/CAM system.
- Design calculation and optimization analysis should be carried out on product model by using the program which has been compiled in the CAD/CAM system, to determine the design scheme and main parameters of product components.
- Through using the function of analysis and calculation of the computer aided engineering to proceed the prediction of product performance, structure analysis, engineering calculation, motion simulation and assembly simulation.
- Designers make judgment of the preliminary result according the results that the computer shows. It could be modified in human-computer interaction operation way.
- CAD/CAM system derived the information of design and manufacture from the product database, and analyzes the geometry features and related technical requirements of the components to produce the design of product.
- Designers can analyze and judge the results of process planning, It could be modified in human-computer interaction operation way.

- Output the process card from the printer.

According to the above process, the initial design requirements, the intermediate result of product design, and the final machining instructions, are the process of product, modify, exchange and access of the product data.

### **3.3.3 CIMS**

CIMS is an engineering integrated system which based on CIM philosophy, it is the realization of CIM, and it is a new kind of manufacturing model. The core of CIMS is integration, not only the related technology of comprehensive integrated each production link of the enterprise, the more important point is to integrate people/organization, management and technology, to ensure the work flow, material flow and information flow unimpeded in the enterprise.

CIMS is the development trend of enterprise. It makes all the resources integrated into an organic whole by integrating system engineering, computer technology, management technology, manufacturing technology and automation technology. As a kind of advanced integrated manufacturing system, CIMS can not only enhance the response speed of changeable market demand, also can effectively improve the innovation ability and competition ability of the enterprise. CIMS is a thinking method which uses computer technology to integrate the production, management, planning, product design, manufacture, sale and service of the enterprise with the production factors like human resources, financial resources and equipment, in order to make the production optimization.

There are six parts in computer integrated manufacturing system: integrate management information system, engineering design integrated system, manufacturing automation integrated system, quality assurance integrated system, computer network integrated system, and the CIMS database system. The function of CIMS is showed in the figure 2.

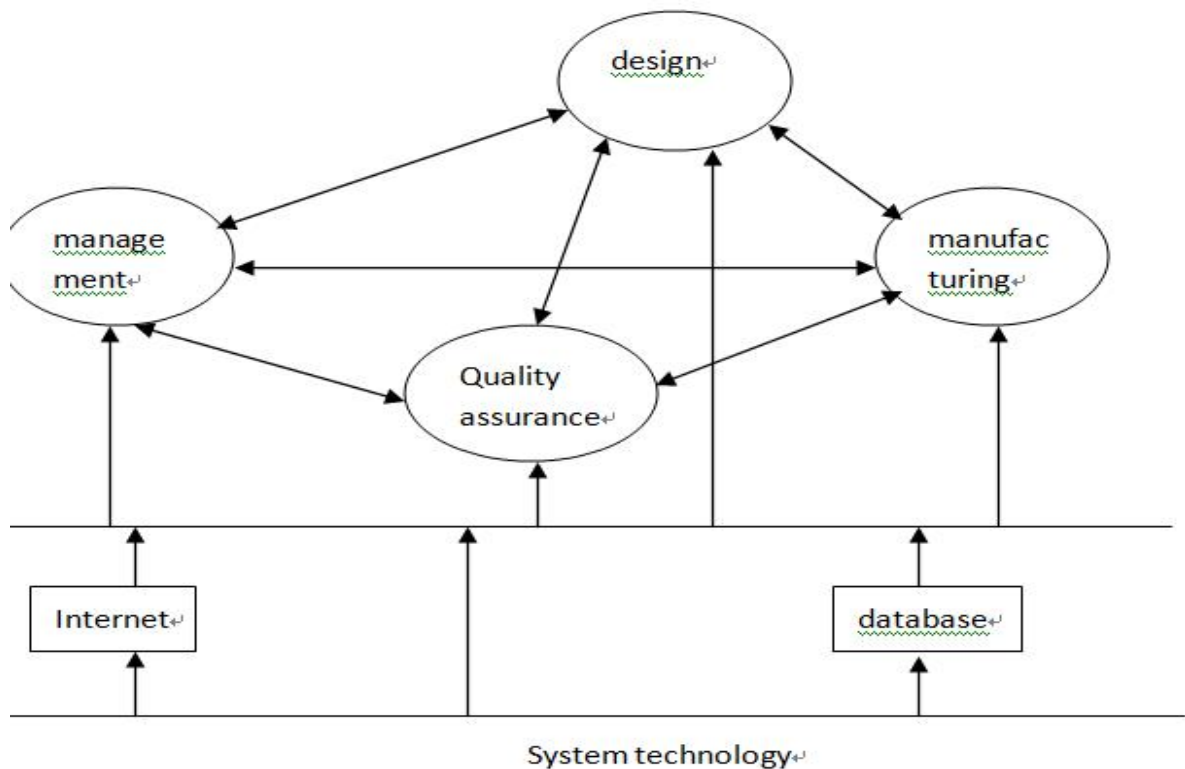


Figure 2 - Function of CIMS

Computer integrated manufacturing system is the comprehensive application of information technology, advanced management technology and manufacturing technology, to achieve function integration on the basis of information sharing. Its content includes management information system (MIS), engineering design integrated system (EDIS), manufacturing automation system (MAS) and quality management system (QMS).

Management information system (MIS) is the nerve center of CIMS. The information processing includes information collection, transmission, processing and query. Management includes plan management, material management, production management, financial management, human resource management etc. The aid decision uses mathematical analysis method to predict the future which according to the existing information. The core tool is manufacturing resource planning. It integrates each link of management in the enterprise, in order to shorten the production cycle, reduce inventory and reduce the cost.

Engineering design integrated system (EDIS) means reference the computer technology in the process of product design and development, to make the product design and development work more efficient, higher quality and more automatic. It includes CAD/CAPP/CAM system.

Manufacturing automation system (MAS) located in the basement of the enterprise, it is the point of information flow and material flow. MAS is constituted by CNC, MC, FMC, FMS equipment, logistics system and control system.

Quality management system (QMS) establishes the quality and technical standard firstly, quality inspection management includes the factory material, product quality inspection management,

production quality data management and design quality management. The quality analysis and evaluation can analysis all kinds of quality problems, and find out the main reason. Quality information control needs to generate the report, and take various quality control measures.



## **4 Chapter 4 Methodology/Intelligent manufacturing system**

### **4.1 Theory of intelligent manufacturing system**

Intelligent manufacturing system is possible to consider as higher phase of flexible manufacturing systems. Intelligent manufacturing systems like flexible manufacturing systems consist of individual subsystems (technological, transportation and handling, control, store and operative). Each subsystem has to contain of intelligence elements, which give to these subsystem certain degree of intelligence [5].

Since the world economy becomes globalized, and the competition among the market is growing obviously, these circumstances impose more demands and claims on entrepreneurs. The objective of intelligent manufacturing systems is to make any normal manufacturing systems to satisfy the needs of all kinds of customers with the lowest possible cost and the most efficient level [6]. To achieve this purpose, the manufacturing technology must be improved at the first of all. In the human development in future, manufacturing technology is the most important part in the manufacturing market. It includes new knowledgeable and new science. Therefore, the intelligent manufacturing technology will occupy the dominant position.

Intelligent manufacturing technology means that in every link of manufacturing industry, it simulates the intelligent activity of human experts through the computer in the form of a highly flexible and highly integrated. Thus, the main development object of intelligent manufacturing is the whole manufacturing enterprise. The first main development goal is to improve the comprehensive intelligent manufacturing of manufacturing work, it is the first time to put forward the main target of using the machine intelligence to replace human labor in the practical manufacturing system. It also emphasizes the ability of a wide range of organization during the whole process of enterprise production and management. The second one is about the integration and sharing of information and manufacturing intelligent, to highlight the intelligent integrated automation.

Intelligent machinery manufacturing combines the advanced mechanical manufacturing technology and intelligent technology. It utilize the method and technology of artificial intelligence, material technology, intelligent machine and system engineering, to realize the specialist analysis, judgment, reasoning, decision and other activities. In order to realize each part of the intelligent manufacturing system to be intelligentizes. Eventually, it becomes to a highly intelligent and unified machinery manufacturing system.

The research object of intelligent manufacturing is the machinery manufacturing enterprises. First is to realize the comprehensive intelligence of the whole manufacturing process, and the second one is the integration and sharing of then information and manufacturing intelligence, highlight the intelligent integrated automation.

At present, the IMS network model which is based on agent is more used [7]. On the one hand, it gives sovereignty to each manufacturing unit through agent, to improve it to a functional and self-control separate entities (see fig. 3). On the other hand, it gives the system self-organizing ability through the coordination and cooperation between the agents.

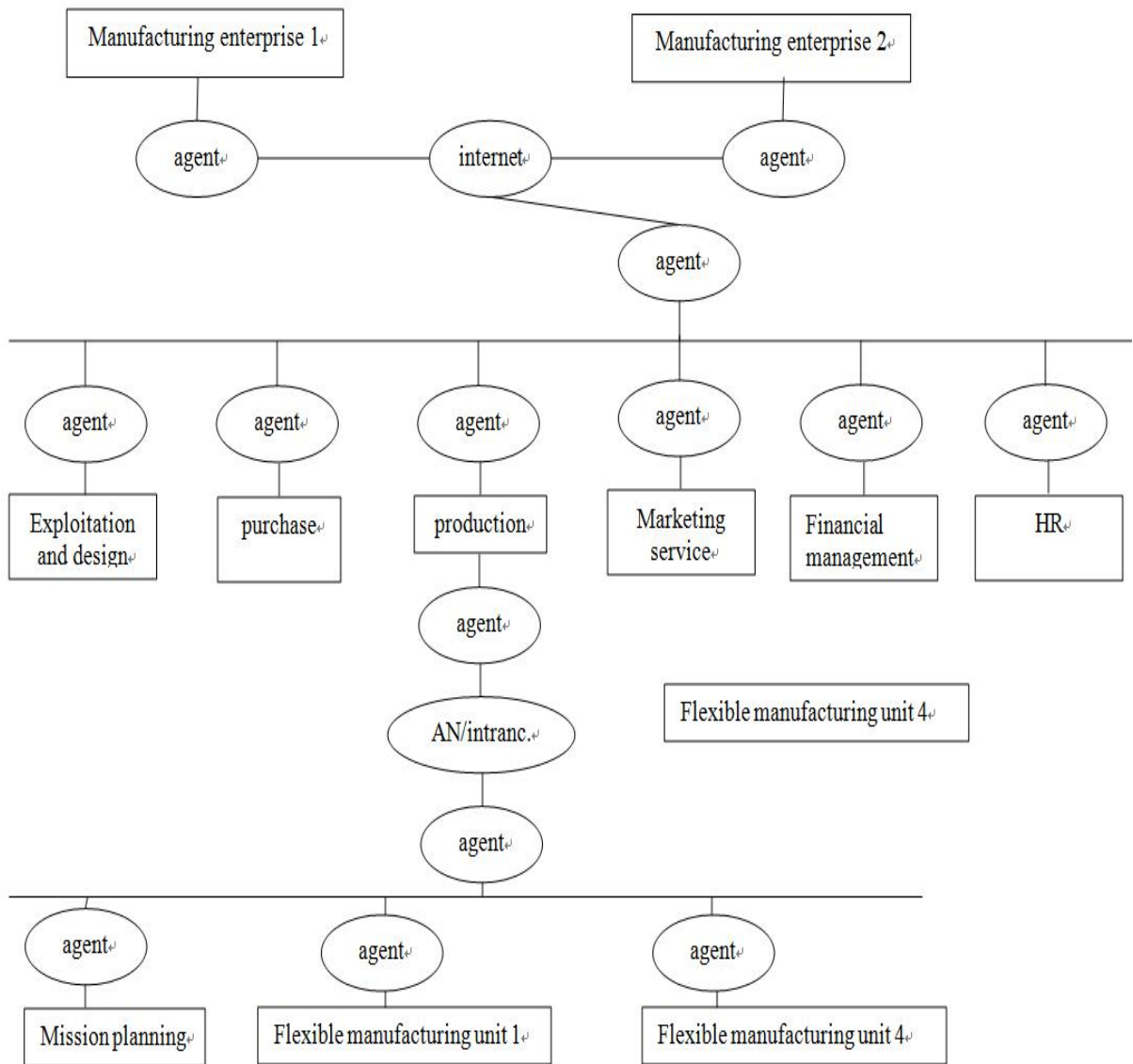


Figure 3 - Internationale model

The intelligent production systems consist of subsystem like automatic production systems (technological, supervisory, transportation, manipulating) ,which include: (see in figure 4.)[8].

Intelligent design

Intelligent operation

Intelligent control

Intelligent planning

Intelligent maintenance

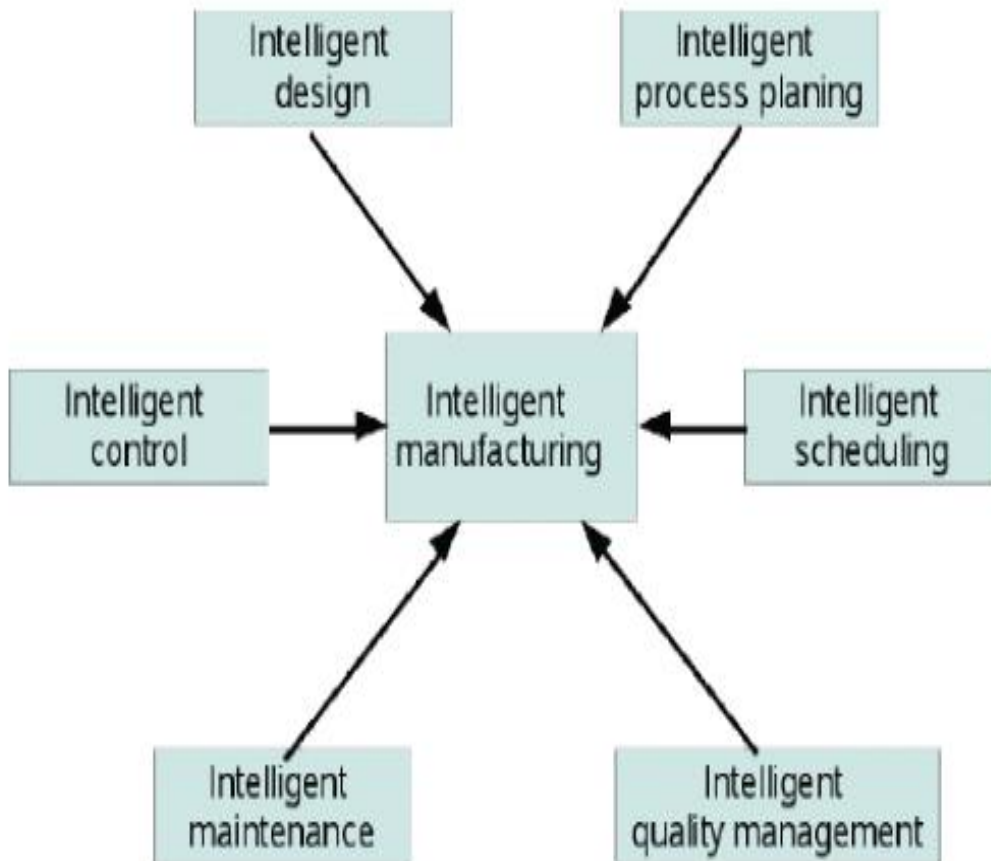


Figure 4 - Intelligent product system

- Intelligent design:

The design of a manufacturing system is normally performed in two distinct stages, like steady state design and dynamic state design. Within each system design stage a variety of decisions need to be made of which essential ones are the determinations of the product range to be manufactured. In addition, a variety of limitations have been identified that restrict the use of existing techniques.

Steady state design: Steady state design is normally concerned with the following decisions, [9] i.e.:

- determining the type and number of each item of processing equipment,
- determining the type of facilities layout required, and
- designing the layout in terms of the positions of equipment on the shop-floor.

Dynamic state design: Decisions that need to be made at this stage are essentially planning in nature and can be grouped by the length of the planning horizon as such:

- medium to long term planning - aggregate planning,
- short to medium term planning - master production scheduling, material requirements

planning, capacity requirements planning and inventory planning and

➤ short term planning - production scheduling, daily line sequencing.

- Intelligent process planning and scheduling:

Manufacturing process planning and scheduling are usually considered to be two separate activities in manufacturing. Manufacturing process planning determines how a product will be manufactured. It is the process of selecting and sequencing manufacturing processes and parameters so that they achieve one or more goals (e.g. lower cost, shorter processing time, etc.) and satisfy a set of domain constraints.

Manufacturing scheduling, on the other hand, is the process of assigning manufacturing resources over time to the set of manufacturing processes in the process plan. It determines the most appropriate time to execute each operation, taking into account the temporal relationships between manufacturing processes and the capacity limitations of the shared manufacturing resources.

- Intelligent quality management:

The quality management system that can be integrated with the environmental and energy management systems in compliant with the international standards is the fundamental strategy to obtain the required operation conditions for a competitive manufacturing organization.

The modern methods of quality management intelligently integrated with environmental management and energy management will be the main strategy developed and refined in manufacturing organizations where advanced meteorology enable to perform industrial and technological developments by practicing high precise measurement tasks and essential measurement know-how within the sophisticated production systems.

- Intelligent maintenance:

The evolution of maintenance has gone through different stages of transformation for the past decades. The traditional approach to maintaining components, equipment, and processes, has been one that is purely reactive. Mitigating procedures are performed on the equipment once it breaks down. Many manufacturing companies have been adopting condition-based maintenance (CBM) or predictive maintenance techniques (PdM) as the best practices. To transform maintenance to become a truly proactive and value-added productivity improvement, major innovation is needed to elevate the value to a new level[9].

- Intelligent control:

The intelligent control mechanism relies on neural networks to model quantitatively semiconductor manufacturing processes. The learning capability of neural networks provides accurate approximations to these processes. The control strategy is based on fuzzy logic for capturing the heuristic knowledge and a feed forward neural network for capturing the process models.

### 4.1.1 The The characteristics of intelligent manufacturing technology

- Universality. It covers the whole process of product design, production preparation, processing and assembly, sale and use, maintenance services and recycling.
- Integration. It gathers the mechanical, electronic, information, automation, intelligent control as an organic whole of new comprehensive technology. The interdisciplinary penetration and integration, makes the line desalts or even disappears gradually.
- Systematization [10]. The ambition is to improve the entire manufacturing system intelligentialize. The intelligence of manufacturing system is not the accumulation of the system, rather than the system engineering which can control the material flow, energy flow and information flow during the production process. At the same time, people is an important source of manufacturing intelligence, it will realize the real intelligent system if highly combine the people with the machine.
- The dynamic characteristics. The connotation of the intelligent manufacturing technology is not absolute and unalterable, at different time, different countries and regions, the development objectives and content will be different.
- Practicability. From the development and application in the manufacturing process, especially the goal and effect, it reflects an important practical technology of manufacturing industry.
- Openness. According to the theory of dissipative structure and the theory of evolution, to make the machine has high intelligent behavior; it depends on people to introduce negative entropy flow to the system. It means that the basic knowledge need to be transplanted by artificial, to make the system has the stages of self study, self accumulation, self adjusting and self expansion.
- Green attributes. The constraints of environmental and resource is increasingly stringent, green manufacturing industry is more important. Green manufacturing technology is an important content of intelligent manufacturing technology.

The main types of the structure of intelligent manufacturing system include:

- The intelligent manufacturing system which in order to improve the manufacturing system as the goal, and the intelligent body as the means.
- The intelligent manufacturing system which operate integration between the enterprises or enterprises modeling, processing, measurement, robot operation through the internet. To make the manufacturing system possesses the biological characteristics.

Intelligent manufacturing is the most promising and future-oriented of production system developments aiming at further automatization, optimization and integration of manufacturing processes [6]. Manufacturing is defined very broadly as the process by which material, labor, energy, and equipment are brought together to produce a product having a greater value than the sum of the material put in [11]. It is a manufacturing system that shows below in figure 5.

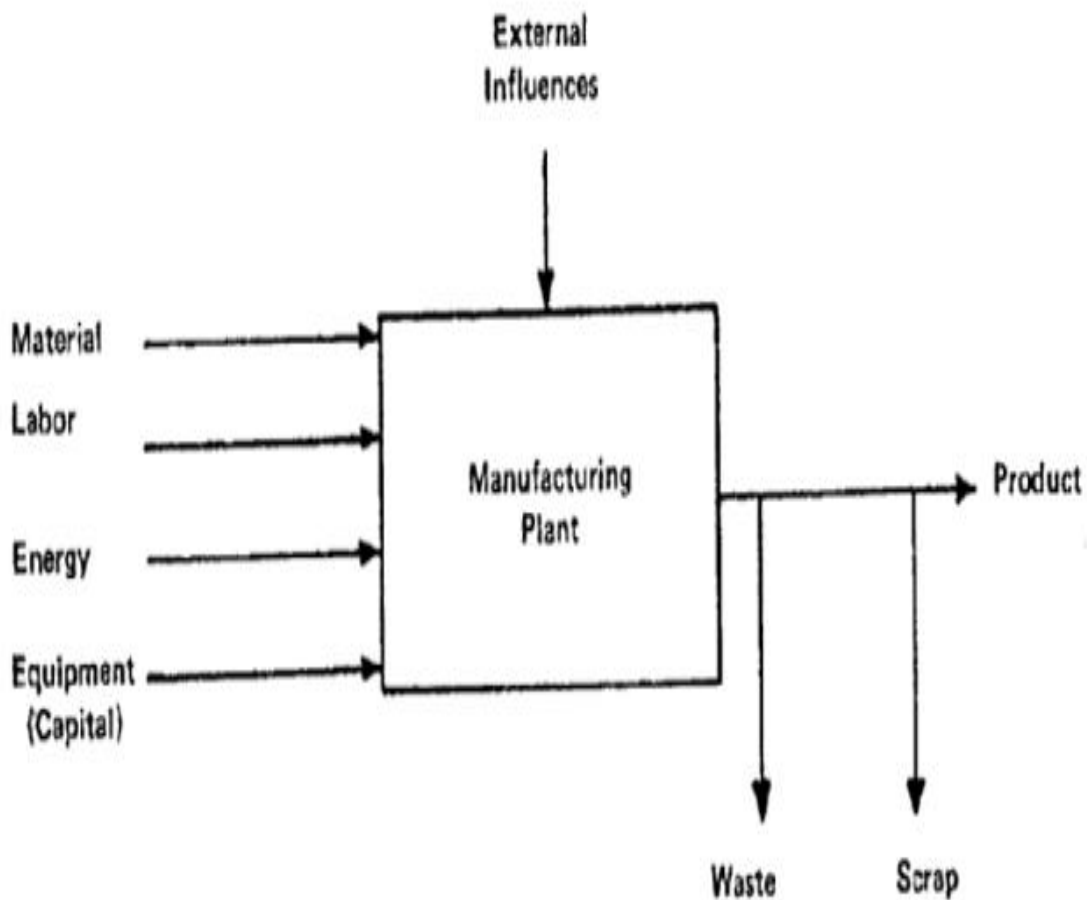


Figure 5 - Manufacturing system

#### 4.1.2 The advantages of intelligent manufacturing system

Intelligent machinery manufacturing has good technical value [12]. It can achieve the purpose of using intelligent machines to conduct the small batch production through the integration of artificial intelligence, the system of manufacturing software, robot control and decision. During this process, it dispenses with the intervention of human. Machinery manufacturing intelligence can replace part of mental work, it implements the automation and modernization of the machinery manufacturing system. In the manufacturing process which is unsuited to participate for human, it can be more convenient and precise to product within the introduction of intelligent machines.

Intelligent machinery manufacturing has good economic value [12]. The main purpose of intelligent machinery manufacturing is to adapt to market changes, in order to survive and develop in the fierce competition. The application of intelligent can reduce or even eliminate the dependence of labor, and save the cost of the enterprise. At the same time, it also can improve the quality of production.

Global manufacturing represents twenty-five percent (25%) of world GDP with over twenty million enterprises, and twenty-eight percent (28%) of world employment [13]. Manufacturing is one of the most important economic drivers in the global economy. Because of the collaboration of the manufacturing enterprises from the world-wide, IMS can give the opportunities for value-chain

participants to solve the world-class problems, and it is the only methods to collaborate the global consociation. The improvement of the technology can catch up the increasing demands of the customers.

In many situations, cooperating can get more advantages, if compares with working it along. Collaboration can help the project to achieve the maximize demands, and at the same time, it can reduce the commercial risk for the enterprises which participate the cooperation, and provide a leverage effect for personal investment.

### **4.1.3 Tools in IMS**

Normal tools in intelligent manufacturing are showed below: Fuzzy logic, Genetic Algorithms, Neural Net Works, Case tools, Simulation Algorithms and Artificial Intelligence.

- Nerual Net Works: the goal of Nerual Net Works is to make the networks modeling achieve real neural. The real neural includes robustness, fault tolerance, biological brains and processing elements etc. they are similar to their biological counterpart.

The short term production has an interactive tool that has both system features and graphical interface, it allows the operator to control the short term schedule generation, and find the effect on the key parameters.

- Case: It is normally used as a tool to translate the process parameters. And it will give more opportunity to improve the program with an expert system.
- Fuzzy logic: Fuzzy logic system provides a means of expressing the linguistic variable in suitable form for processing using a Computer Fuzzy logic Control of processes offer flexibility by which process states and control actions can be described directly from the experience and advice of the human operators, thus making it possible to apply practical operational experience in the computerized control of complex multi-variant process [2].
- Genetic Algorithms: Genetic Algorithms has a huge probability on global search and majorization in multi-parameter search that based on mechanics physical genetics. It locates new points of the search space and improves the capability by exploiting historical communication.
- Artificial Intelligence: AI is a tool that has ability to attempt to improve the quantity of human characteristics and computer-controlled systems. It is an ability to simulate the human intelligence.

## **4.2 Agent technology**

### **4.2.1 Agent system**

Manufacturing industry is sheering off from mass production to mass customization, because of the competition of world market. Intelligent agent-based approaches as a new paradigm for manufacturing technology have been provided [14]. Agent-based manufacturing system can adapt the changes in market and deal with the emergency problems in the process of the manufacturing. Artificial Intelligence (AI) has already been used in Intelligent Manufacturing for more than twenty years.

However, the multi-agent systems are developing in the new region of Distributed Artificial Intelligence (DAI), this phenomenon provides new possibilities of manufacturing. In the distributed intelligent manufacturing systems, what can the agent do is showed below:

- Encapsulating existing software systems so as to resolve legacy problems and integrate manufacturing enterprises' activities such as design, planning, scheduling, simulation, execution, and product distribution, with those of their suppliers, customers and partners into an open, distributed intelligent environment via networks [15].
- Representing manufacturing resources such as workers, cells, machines, tools, fixtures, AGVs, as well as products, parts, operations to facilitate manufacturing resource planning, scheduling and execution control [15].
- model special services in manufacturing systems, such as: Agent Name Server in CIIMPLEX and Enterprise Mediator in MetaMorph for providing registration and administration services; Facilitator agents in PACT and CIIMPLEX and Mediator Agents in MetaMorph for facilitating communication, cooperation and coordination among other agents; Database Agents and Information Agents for providing information management [15].

Agent-based computation is a exemplification of ICT, and it can give supporting technology to the trends. An agent can make decisions by itself, to react to real-time perturbations. Agents are popular in manufacturing, because they can help to achieve the characteristic which is necessary, such as responsiveness, redundancy, and openness etc. Agents could be designed to work with uncertain and/or incomplete information and knowledge [16]. Therefore, from engineering design to supply chain management, most jobs which are concerning about the manufacturing, can utilize the agents.

An agent is a computational tool that can display the self-existent and intelligent behavior. It is located in the dynamic condition. An agent may have an environment that includes other agents. The community of interacting agents, as a whole, operates as a multi-agent system [16]. The figure 6 shows the relation of the agent and its environment.

Agents always work in the observable and predictable environment which is known partly. The opportunity to decide by themselves is given to the autonomous agents. The rational agents will choose the most suitable method to face the situation currently, and do the best for their own.

The features of the further agents, which are in special situation and applications, are mobility, genuineness, transparency, and credibility. The agents can also have only a part of the model in their specific situation. They can use their limited set of measures to make the new knowledge into the model, in order to get their goals in the systems.





Figure 6 - Agent and its environment

An agent is a computer system situated in some environment, and that is capable of autonomous action in this environment in order to meet its design objectives. An autonomous agent should be able to act without the direct intervention of humans or other agents, and should have control over its own actions and internal state [15].

#### 4.2.2 Multi-agent system

The main research of multi-agent system (MAS) includes task decomposition and distribution, cooperation between the agents, and the structure dynamic organization of the system [17]. The mainly related problems include:

- Individual agent reasoning. The behavior of MAS is the cooperation of the behavior of each agent. The individual reasoning ability of the agents directly affects the collaboration between members, and also affects the consistency of the target between members and entirety.
- Task allocation. It involves task decomposition, the responsibility of agents and the allocation of resources. The correlation of the minimized task can reduce the time of conflict, to improve the efficiency of problem solving.
- More agent planning. It should not only consider the constraints of the agent individual goals, capabilities and environment, but also the interaction between agents.

- Consistency of target and behavior. MAS should ensure the local decisions of agents should adapt to the objective of system, to ensure the stability of the system.
- The identification and resolution of conflict. Because MAS and agents have the lack of global view, knowledge and control, the conflict between target, plan, knowledge and belief of agents is inescapability. In order to achieve coordinated problem solving, these different should be detected and eliminated.
- Set up other agent model. It can provide information, belief and target about other agents for the agent.
- Communication management. Communication management mainly includes the timing, content, type and quantity of the communication.
- Resource management. The goal of resource management is to distribute the resource of system to agents reasonably and accurately. It can ensure the collaboration between agents and make the tasks of cooperation to be most effective.

Coordination, cooperation and negotiation are aspects of group or joint activities of agents. Planning can be an individual activity of an agent, but in a group it is normally desirable that the plans be coherent and contribute towards the achievement of goals or objectives [18].

Coordination is a machining that could ensure the agent activities can reserve the relationship of desire. The information of coordination should be realized by a recipient agent. Coordination module is made up of many coordination mechanism, these mechanisms are used to find and coordinate the relationship of tasks that the agents undertake. Local scheduler is according to the content of belief database, to consider the virtual task and local tasks. Belief database can save the task structure information, this information can change with the change of time and interaction of other agents. The structure among these parts is showed in figure 7.

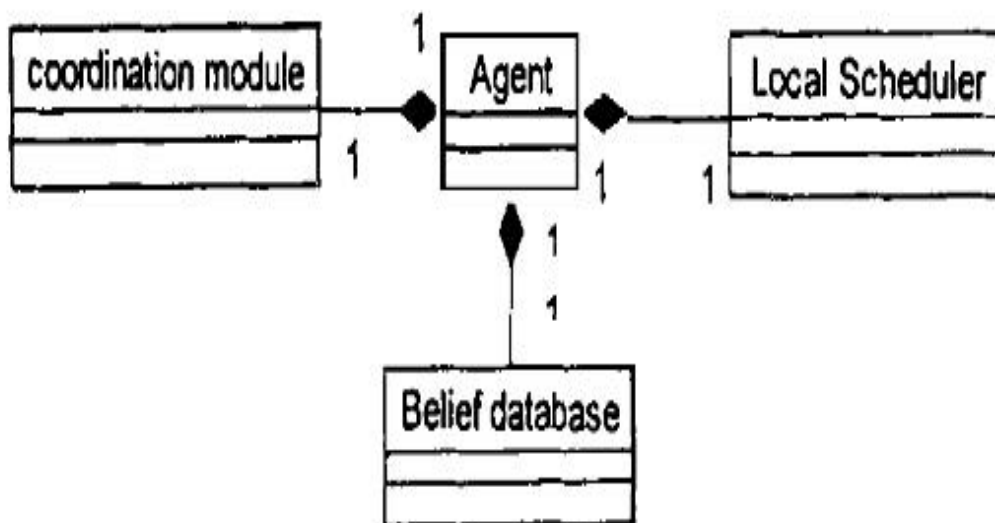


Figure 7 - Structure of agent

The organization structure of MAS provides an interactive framework between agents, and also provides high level concepts and related information for more comprehensive and more effective cooperation. It is a kind of service and coordination relationship between the agents; it cannot limit the ability of self-control of each agent.

### **4.3 Cloud manufacturing service platform**

In order to face the key problems, small and medium-sized enterprises should use new emerged technologies to solve the problems in that situation. Cloud computing for SMEs is another idea of manufacturing resources, and the cloud manufacturing service platform (CMfgSP) is introduced in this paper.

The small and medium-sized enterprise (SMEs), which involves a lot of foreground, is an important part of manufacturing trade. There are most of the SEMs are facing the problem of shortage of the abilities, operating administration, and industrial chain. Thus, a new computing and service manufacturing model has been put forward that is called cloud manufacturing (CMfg). It combined the cloud computing and internet.

CMfg program is an important tool to develop the manufacturing trade, operation administration, and improve the capability of the SMEs.

In CMfg system, improving manufacturing resources will be various and connect into a better and wider internet, and control the internet of things technologies automatically.

Cloud manufacturing is a computing and service-oriented manufacturing mode developed from existing advanced manufacturing modes and enterprise information technologies under the support of cloud computing, IoT, virtualization and service-oriented technologies, and advanced computing technologies. The abstract running principle for CMfg is shown in the figure 8 [19].

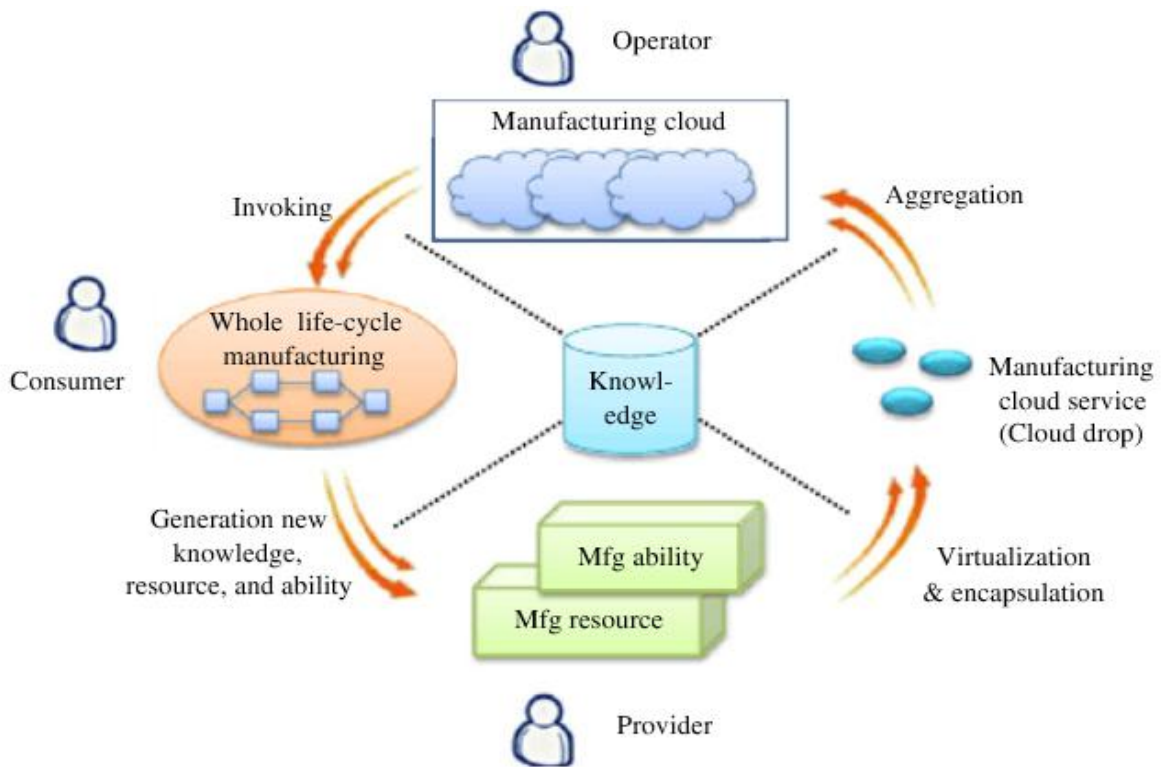


Figure 8 - Abstract running principle

There are primarily three kind's users in a CMfg system, which is showed in the fig.7, the first user is providers: they can not only own the manufacturing resources also give the abilities. The second one is operators; they can use the platform to transport the services among the providers, consumers, and others. The last one is consumers, they are the subscribers of the CMfg service platform [19].

CMfg platform is a new kind of manufacturing service platforms on internet. It is helpful to share the manufacturing resources coordinate the technologies among the SMEs. It can give the full size of scale, and more convenient, higher quality, and lower price than other original service platforms.

The structure of cloud manufacturing is a kind of hierarchical structure, it includes:

- Resource: it provides the resources and capabilities of manufacture which involves the whole life cycle.
- Perception: the effect is to perceive the ability of physical manufacturing resources, to link to further data and information.
- Virtual resource: the aim is to create resource and make the ability virtual, and then encapsulated in manufacturing and service.
- Cloud service: it mainly provides two kinds of service. The first one is manufacture of cloud service, and the other one is manufacturing service function. The manufacture of cloud service is the result of manufacturing resources and encapsulates the ability. The manufacturing service function is the service which provided to three types of users by the cloud manufacturing service platform.

- **Application:** it is a special manufacturing application system for the enterprise which has a cloud manufacturing system.
- **Entrance:** it can provide all kinds of man-machine interface for users to enter the cloud manufacturing system and use the cloud manufacturing resources.
- **Enterprise cooperation application:** with the support of the cloud manufacturing system and core function of cloud manufacturing, it can realize different kinds of application of cooperation.
- **Knowledge:** it provides a variety of knowledge that other layers need.
- **Cloud security:** it provides a variety of different security structure for the cloud manufacturing system.
- **Wider network:** it provides the basic communication environment for all the resources, service, user, and operation.

Cloud manufacturing is described as a manufacturing model which is developed from the existing advanced manufacturing mode that used to compute and service [20]. This kind of manufacturing model can reduce the cost and increase the utilization rate of resources.

## 4.4 Remote monitoring and control

To make the internet can switch the information and achieve the response rapidly in the dispersed manufacturing situation, the methods that always be used is called “e-manufacturing”.

The standard of remote monitoring and control system is divided into five steps. The first step is to define the objective of the remote access system. In a remote access system, the information collected from the local manufacturing system is available in real-time in the remote destination [21]. The second step is to define the data that is delivered between the remote and local systems. The third step is discussing the hardware analysis of the remote access system. And the fourth step is discussing the software analysis of it. As for the last step, the last step of the remote system specification regards the requirements related to the remote nature of the monitoring and control system.

Remote monitoring and control system can be used to perform varied tasks, like on-line monitoring of automated machine tools, detecting and reporting problems, remote diagnostics and maintenance of machines, and supply chain management [22].

The potential benefits of remote monitoring are significant: minimizing labor costs, filling the knowledge gap resulting from experienced operators retiring, prolonging equipment life, preventing unplanned downtime, and more [23].

The functions of remote control include:

- **Acquisition and processing:** this function mainly tests all kinds of analog or digital quantity during the production process, and sampling and necessary preprocessing. It can provide detailed data for production personnel, help them to analysis.

- Supervision function: it can analysis the real-time data, the instruction in the process of production and the input data, and then storage real-time data and historical data respectively.
- Management function: it uses existing data, images and reports to realize the condition analysis, fault diagnosis, risk prediction.
- Control function: it can realize the information processing on the basic of test conducted. It can realize control output according to the predetermined control strategy, directly effect on the production process.

With the aid of remote monitoring, it can connect the information network (intranet) with the control network in the enterprise effectively, in order to realize master the production and operation at any time. Because of the close integration between the conditions of production operation and management strategy, it can achieve the comprehensive automation of the enterprise. According to the remote monitoring, it can rapidly concentrate the operation data and real-time data, to provide material foundation for remote fault diagnosis technology. Technical personnel can monitor the production system and devices running state without attending to the field through the remote monitoring, to increase the efficiency and reduce the personnel. To realize the remote control with the network technology, it has very vital significance to reduce the production cost, improve labor poductivity, and enhance enterprises' comprehensive competitive.

# 5 Chapter 5 Status and trends of manufacturing system

## 5.1 The status of mechanical automation

### 5.1.1 management aspect

The advanced management of industrial production, universally use the computer technology for the management of industrial production. With the development of computer technology, the thought of management is constantly updated. Industrial development countries widely use computer management, they pay attention to the organization and management system, and the development of the production model. They released new ideas and techniques of management such as JIT, Agile Manufacturing (AM), Lean Production (LP), Concurrent Engineering (CE).

- JIT

The basic idea of JIT is to produce the required product according to the required amount, only when needed. The core of JIT is to quickly respond to market changes and zero inventory.[24]

Aims	Purpose	Current Situation	Principle and Methods of Thinking
Zero switch waste	Multi-species correspond	Long switch time, Unstable after switching	<ul style="list-style-type: none"> <li>● Economic volume</li> <li>● Shipping method JIT</li> <li>● Standardization of production planning</li> <li>● Job management</li> <li>● Standardized operation</li> </ul>
Zero inventory	Discover the real problem	Large inventory can cause the high cost and difficult turnover. And also cannot find the real problems.	<ul style="list-style-type: none"> <li>● Explore the reason of necessary inventory</li> <li>● Reasonable use of inventory size</li> <li>● Balanced production</li> <li>● Pipelining equipment</li> </ul>
Zero waste	Reduce cost	Serious waste cannot be found and eliminate	<ul style="list-style-type: none"> <li>● Coordination of overall ability</li> </ul>

			<ul style="list-style-type: none"> <li>● Process road-map</li> </ul>
Zero bad	Quality assurance	Low-level errors are frequent, bad rate is high. And batch accidents are multiple.	<ul style="list-style-type: none"> <li>● Zero defect movement</li> <li>● Work quality</li> <li>● Independent research</li> <li>● Full quality improvement</li> </ul>
Zero fault	Productivity	Malfunction is happened frequently	<ul style="list-style-type: none"> <li>● Efficiency management</li> <li>● TPM comprehensive equipment maintenance</li> <li>● Failure analysis</li> <li>● Self maintenance</li> </ul>
Zero stagnation	Shorten the delivery time	Long delivery time, and many delay in delivery	<ul style="list-style-type: none"> <li>● Synchronization</li> <li>● Equalization</li> <li>● Improve production layout</li> <li>● Equipment miniaturization and specialization</li> </ul>
Zero accident	Security assurance	Safety awareness is weak, ignore the frequent occurrence of security assurance	<ul style="list-style-type: none"> <li>● KYT risk predictive training</li> <li>● Regular inspections</li> <li>● Activities of safety education</li> </ul>

Table 1 - Aims of JIT

Compare with traditional mass production, JIT can produce the products with higher quality and more varieties with only half of the staff, half of the production site, half of the investment, half of the production cycle and much less inventory.

- AM

Agile manufacturing is a mode of production organization. It changes the traditional mass-production organization through multifaceted collaboration to change the complex multi-level



hierarchical structure which is followed by business by using the technology of human intelligence and information [25]. To improve the rapid response ability of changes in the market, and meet customer requirements. In addition to making full use of internal resources, but also can make full use of other corporate and community resources to organize production.

Agility is achieved by integrating the three resources of technology, management and staff into a coordinated and interrelated system. In the process of product development and manufacturing, it can use the computer skills and knowledge base of the manufacturing process to design complex products by using numerical methods, reliably simulate the characteristics and status of product, and accurately simulate the product manufacturing process.

In agile manufacturing (AM), the speed of new products on the market is the most important competitive advantage today. One of the most innovative idea which agile manufacturing puts forward in the management is “virtual company”, it is similar as a company that specializes in a specific plan, the virtual company exists as long as the market opportunity exists. The ability of forming the virtual company will be a powerful competitive weapon for businesses.

The basic idea of agile manufacturing in human resources is that in the dynamic competition environment, staff is the key factor. The continuous innovation and development of products and services, and the continuous improvement of the manufacturing process is a competitive advantage in the agile manufacturing era, it needs the agile manufacturing enterprises to maximize the people’s initiative. Knowledgeable people are the only precious treasure in the agile manufacturing enterprises.

- LP

The aim of lean production is to get the right things to the right place in the right time, while minimizing the waste and adapting to change. The content of lean product can be described as “one goal, two pillars, and one foundation”.

The goal is to produce at low cost, with high efficiency and quality, to make customers satisfied maximally. It shows that the lean product makes the market-oriented and users as a starting point. The first pillars called “on time” which means just in time (JIT). JIT needs to be based on stimulating production, and use the leveling system as a condition. And the second pillars is personnel autonomy. It is the organic cooperation of personnel and machinery and equipment. When there is the problem of quality, quantity and variety on the mechanical equipment of the production line, it will automatically shut down and show instructions. But anyone who finds the problems has the right to stop the production line immediately, to exclude the malfunction initiative, and solve the problems. The foundation is improvement. In lean production, there will always be room for improvement from the part to the whole. Thus it should continue to improve in the work, methods of operation, quality, production structure and management. In lean production, everything is a waste if it cannot improve the additional value. Such as overproduction, inventory, extra actions and rework of defective products. These waste must be constantly eliminated after full efforts.

Ten tools of the lean production:

➤ JIT

The core of JIT is to pursue a production system with “zero” inventory, or a production system which can minimize the inventory.

➤ One-piece flow

It is one of the key ways to help to achieve the goal of JIT.

➤ Kanban management

Kanban can be used as a method of communicating the information of production management. Kanban cards contain a lot of information and can be used repeatedly. There are two commonly used kanban, one is production kanban, the other is delivery kanban.

➤ Zero inventory management

Inventory management is part of the supply chain, but also the most basic part. For the manufacturing industry, strengthening inventory management can shorten and gradually eliminate the residence time of the raw materials, semi-finished products, and finished products. To improve the customer satisfaction of quality, cost and delivery.

➤ Total productive maintenance (TPM)

To create well-designed equipment system, increase the utilization of existing equipment and prevent failure, by the way of full participation. So that the enterprises can decrease the cost and the overall productivity can be improved.

➤ Use value stream mapping to identify waste

Value stream mapping is the key points and fundamentals of implementing the lean system and eliminating the waste of the process.

➤ The balance design of production line

Due to the unreasonable pipeline out, the productive workers move meaninglessly, the production efficiency has been reduced. Due to the unreasonable arrangement of actions, and the unreasonable process route, the workers repeatedly picked up and dropped the workpiece.

➤ Pull system

JIT needs to be based on pull production, and the pull operation is a typical feature of lean production. “Zero” inventory is mainly achieved by the operation of pull system.

➤ Setup reduction

In order to minimize the waste of waiting, the process of shortening setup time is to gradually remove and reduce all non-value-added homework. Lean production is achieved through

eliminating waste constantly, reducing inventory, reducing bad and shortening the manufacturing cycle time. Reducing setup time is one of the key ways to achieve this goal.

➤ Kaizen

Accurately identify values, and identify the value streams, to make continue flow of steps that create value for a particular product.

● CE

The concurrent engineering is a systematic approach to design products and their related various processes integrately and parallel. This method requires the production staff should consider about all of factors in the entire life-cycle of a product from concept formation to product scrap process at the beginning of the design. Including quality, cost, schedule, and the requirements of the customer [26].

Concurrent engineering emphasizes that various activities such as product design, process design, production technology preparation, procurement, and so on are carried out in parallel. There are two forms of concurrent cross. One is concurrent cross by components, that can divide a product into several parts, so that all the components can be cross-parallel design and develop. The other one is to make the activities cross as much as possible in parallel, such as the design, design process, preparation of production technology, and procurement, for each individual part.

Concurrent engineering emphasizes to face the process-oriented and object-oriented. It is a complete process from concept to produce for a new product. It especially emphasized that the designers should not only consider design, they should also consider the process-ability, manufacture-ability, and maintain-ability of the design. When design a component, the cooperation with other components should be considered. Therefore, the entire development work is to focus on the entire process and product object. It is a great change of concept from serial to parallel.

Concurrent engineering emphasizes the system integration and overall optimization. It does not only completely pursue the best of individual departments, local process and individual component, but the pursuit of global optimization and the overall competitiveness of the product. For the product, this competitive ability is the TQCS composite indicators, which T means time, Q means quality, C means cost and S means service. The emphasis is different in different situations, as long as the overall optimization and overall object are achieved, the best of each department work is not pursued [26].

### 5.1.2 Design aspect

With the development of technology, some developed countries are more and more strict on mechanical design requirements, and they often update the technology, most of them are using the computer aided design, even no longer use the drawings for design, manufacturing has also been detached from the drawings, and it has high productivity and good quality. It is conducive to the rapid development of machinery manufacturing industry, to make the national economic benefits effectively improving.

The extensive use of computers and increased automation in machinery, is the obvious characteristics of the modern design.

Here are some design methods which are used more.

- Theoretical design

It is called the theoretical design which is according to the long-term summed up design theory and experimental data. As the actual situation is complicated and changeable, if the safety factor is selected too lager, the quality will be declined. If the safety factor is selected too small, it is difficult to ensure the safety.

- Experience design

Experience design is an empirical relationship which is summed up according to the existing design and usage practice of certain parts, or a design which is analogized according to the personal work experience of designer's. This is a very effective method of the parts which are little change in use requirements and the structure and shape has been typical. With the technical system of the product is more and more complicated, and the technical content constantly improve. The development speed of product update is accelerating, the design method of experience analogy cannot meet the remands of the market.

- Model experience design

For some important parts which are huge size and have complex structure, especially some heavy overall mechanical prats, the model experience design method can be used to improve the quality of design. It makes the initial design of the components or machines as a small model or a small size prototype, to test its various characteristics through the experiment mean, and gradually modify the design to achieve perfection according to the result of experiment [27].

With the development of the computer technology, computers gain more and more use in the mechanical design, and also appeared various software of efficient design and analysis. With the effect of these software, multi-program comparison can be done during the design phase, it also can accurately analyze the structural strength, stiffness and dynamic properties of different programs which including large and complex programs. At the same time, the virtual prototype can be build on the computer, it can use the simulation of the virtual prototype to verify the design, thereby to fully evaluate the feasibility of the design in the design phase. The promote use of the computer technology in mechanical design has changed the process of mechanical design, the advantages of improving design quality and efficiency is unpredictable.

The industrialized countries continuously update the design data and guidelines, adopt new method of design, and widely use computer aided design (CAD). Large-scale enterprises begin to design and produce without drawings. The rate of adopting CAD in China is relatively low.

With the development of mechanical design basic theory, new concepts, new methods and new processes continue to emerge, so that the mechanical design has also been rapid development. The latest developments in mechanical design can be summarized as following five aspects.

- Mechanical and electrical further integration, it has become the trend of today's mechanical products.
- The degree of mechanical is higher and higher, there are more and more extensive and interdependent with other sciences.
- Mechanical design method are constantly updated.
- Theory of design continues to improve and develop.
- Experimental research technology of the mechanical design has great development and improvement, experiment and theory promote each other.

### 5.1.3 Manufacturing process aspect

Machinery manufacturing process is the core technology which is used to the process of making the raw materials into products. Machinery manufacturing technology and crafts is not only a complete system engineering, but also the foundation and pillar of industrial manufacturing. In the twenty-first century, various industries have been in steady development, the key point of mechanical manufacturing process lie in two aspects which is automation and management. Among them, the automation technology is the integration of operation flow of the electronic information technology and computer technology and other advanced technology. Modern management technology is the concise path which can improve machinery manufacturing technology and enhance craft level [28].

The applications of mechanical manufacturing process is as follows:

- Application of laser technology

Mechanical manufacturing process uses laser processing technology in many areas, mainly because the laser has not only better monochromatic and directions, but also has high brightness. Therefore, against the advantage of laser, it is divided into rapid prototyping technology and laser heat treatment technology in the mechanical manufacturing process [28].

Rapid prototyping technology is the technology which aims to cut raw materials directly, and make it rapid prototyping, through the computer's CAD unit operation.

Laser heat treatment technology is that in the process of manufacturing products, in order to increase the wear and performance of the parts, it needs to use the laser heat treatment technology to generate a large amount of heat auxiliary.

- Automated control technology

Automation control technology is divided into three technical methods, including automated manufacturing line, automated manufacturing plant and automated manufacturing cell. First, automated manufacturing line is a technique that is used more often in automated manufacturing processes, all the equipment is controlled by a computer, it is the most convenient system to operate. Second, automated manufacturing plant is a highly integrated automation technology with a high technological content. The automated manufacturing plant is controlled by an automated

manufacturing system, it can phase auxiliary with the automated transportation system within the computer, to achieve the product automation manufacturing. At last, automated manufacturing cell is an automation technology relative to the high cost of the automated manufacturing plant. It only needs to use single or multiple mechanical equipment to complete the manufacturing task independently. Thus, it gradually replace other technologies and get more widely used in the manufacturing process.

The specific development of modern manufacturing technology can be summarized into four aspects and multiple large projects [29]. These four aspects are reflected as technology of modern design, modern forming and modified technology, modern processing technology and manufacturing system and management techniques. And the large projects including reverse engineering, layered manufacturing technology, micro-scale manufacturing technology, meson-scale manufacturing technology, extreme manufacturing technology, high-speed processing technology, surface engineering technology, quality control engineering, virtual manufacturing, smart manufacturing, collaborative manufacturing, green manufacturing and symbiotic manufacturing. At present, the focus of process development is parallel design, innovation design, modified technology and modern forming, and the simulation and optimization of material forming process.

#### **5.1.4 Automation technology aspect**

Automation technology can help the manufacturers improve the manufacturing efficiency quickly, and also can make the manufacturing quality more excellent. It greatly shorten the production time of the mechanical manufacturing process, save the human resources, and also make the cost be controlled effectively [30]. Automation technology effectively enhance the competitiveness of enterprises in the market, because of the benefit of the enterprises has been rapidly improved, and the work environment has also been significantly improved.

In industrial countries, they generally use CNC machine tools, machining centers, flexible manufacturing cells (FMC), flexible manufacturing systems (FMS) and computer integrated manufacturing systems (CIMS), to achieve the flexible automation, intelligent and integrated.

The essence of advanced manufacturing technology is the application. It should make the production of enterprises and the actual needs and specific conditions of technology development as a guide, to develop mechanical automation technology.

There are two manufacturing methods of automation technology, one is network virtualization manufacturing method, and the other one is green manufacturing method [30].

- Network virtualization manufacturing method

Network virtual manufacturing technology is a kind of virtual environment which uses the computer hardware and software features, processing technology and other interactive devices through the computer platform.

The technology belongs to a new type of technical means which depends on man-machine interface forms. It conducts a comprehensive modeling and simulation of the required product and manufacturing activities, through mainly on the human perception and knowledge and skills, thereby, to achieve the role of mutual exchange in the virtual world, and it can also simulate the

entire process of the design and manufacturing of the product before the product is not in production. At the same time, it able to accurately carry out a series of predictions, including product design, performance after manufacturing, manufacturing cycle and application rationality, to let the design and manufacture to achieve the best, to ensure the high quality, low cost and short cycle of the product.

- Green manufacturing method

It is the inevitable trend of the development of human society that the harmonious development of human society and nature. The green manufacturing method is quoted from the field of environment protection. In the process of developing science and technology, an important issue that cannot be ignored is to maintain harmony between human beings and nature, the science and technology cannot be developed at the expense of destruction of nature, thus causing irreparable harm to nature. In machinery manufacturing, the green manufacturing methods must first consider the energy-saving emission reduction, to effectively control the carbon dioxide during the production process, and total COD emissions.

With the rapid development of automation technology in the machinery manufacturing industry, it was paid high attention by the machinery manufacturing industry. During the research of mechanical manufacturing automation technology, it is needed to make automation technology more suitable for actual production. It must be combined with the actual business and development needs, to utilize them to all aspects of production.

At present, most of the machinery manufacturing industry has invested automated equipment, this fully proves that the the mechanical intelligent, digital and automatic control are realized in the development of the machinery manufacturing. With the continuous improvement of the science and technology, machinery manufacturing also gradually realized automation, automation technology make a virtuous circle between machinery manufacturing and automation.

## **5.2 The status of intelligent manufacturing**

Intelligent manufacturing technology is one of the most important directions of the future development of the manufacturing industry in the world. Intelligent manufacturing technology is that based on the modern sensing technology, network technology, automation technology, anthropomorphic intelligent technology and other advanced technologies to achieve the design process, manufacturing process and manufacturing equipment intelligent [31].

At present, computer technology and network technology are the core technologies of the international machinery manufacturing intelligence. These two technologies combined new processing methods to achieve the cross-disciplinary and professional integration.

### **5.2.1 The status of intelligent manufacturing in China**

Science the reform and opening, mechanical intelligence in China has gradually started, and with the joint effort of government and professional experts, the great progress has been made, and the distance between developed countries has been gradually narrowed [32]. However, due to the late start

technology with foreign countries. Mechanical intelligent technology in China presents the following deficiencies.

- The level of intelligent processing technology is low.

Compare to the CNC machine tools and flexible manufacturing systems that commonly used in foreign countries, Chinese machinery used less, most are still in the stand-alone intelligent and rigid intelligence level, it does not reflect the advanced of technology.

- The level of mechanical design is relatively backward.

The use of computer aided design (CAD) in mechanical design is not universal. Most mechanical designers still use the design drawings when designing, there are few people use mechanical drawing software such as CAD for the work. It seriously restricts the production efficiency of the machinery manufacturing industry, it is difficult to meet the demand of market development.

- The level of mechanical manufacturing intelligent technology is still low

Manufacturing process and technology often determines the quality of product, machining in China still stuck in the stage of elaborate processing, intelligent processing methods have not been introduced and tried on a large scale yet. It restricted the efficiency of machinery manufacturing processing and improvement of the technology level in a certain degree.

## 5.2.2 The status of intelligent manufacturing in foreign countries

In recent years, industrialized countries widely adopt computer management, they paid attention to organization and management system and the development of the mode of production. The JIT, agile manufacturing, lean production, concurrent engineering and other new management ideas and technologies are promoted. The industrialized countries in the world made smart manufacturing as an important starting point to develop manufacturing strategy. Here is a table of series of initiatives in industrialized countries.

Country	Mechanism or personnel	Heading	Release date
America	President Obama	Advanced manufacturing partner	2011.06
	Presidential executive office, National science and technology commission	National strategic plan of American advanced manufacturing industry	2012.02
	Vivek wadhwa		2012.01



	Obama government		2012-2013
UK	Economist	The third industrial revolution	2012.04
Germany	Work group of industry 4.0		
Europe	European commission	European strategy 2020	2010.06

Table 2 - Series of initiatives in industrialized countries.

## 5.3 Industry 4.0

Industry 4.0 is a high-tech strategic plan which is proposed by the German government. Its technical basis is the network entity system and internet of things (IOT). It can enhance the intelligent level of manufacturing industry, to establish a smart factory with adaptability, resource efficiency and human factors engineering, integrate the customers and business partners during the business process and value process [33]. Industry 4.0 uses things information system to make the supply of production, manufacturing, and intelligence to achieve fast, effective and personalized product supply. It can promote the transformation from manufacturing industry to intelligent industry through fully use the method of combining the communication technology and cyber physical systems (CPS). It shows mainly in the following areas:

- Industry 4.0 is interconnection

It is the interconnection between production equipment, equipment and product, and also the interconnection between virtual and reality.

- Industry 4.0 is integrated system

Industry 4.0 made the ubiquitous sensor, embedded terminal system, intelligent control system and communication facilities form an intelligent network through CPS. That made people, people and machines, machines and machines, services and services can be interconnected, thus to achieve the high degree of integration with horizontal, vertical and end-to-end. That is showed in figure 9 and figure 10.

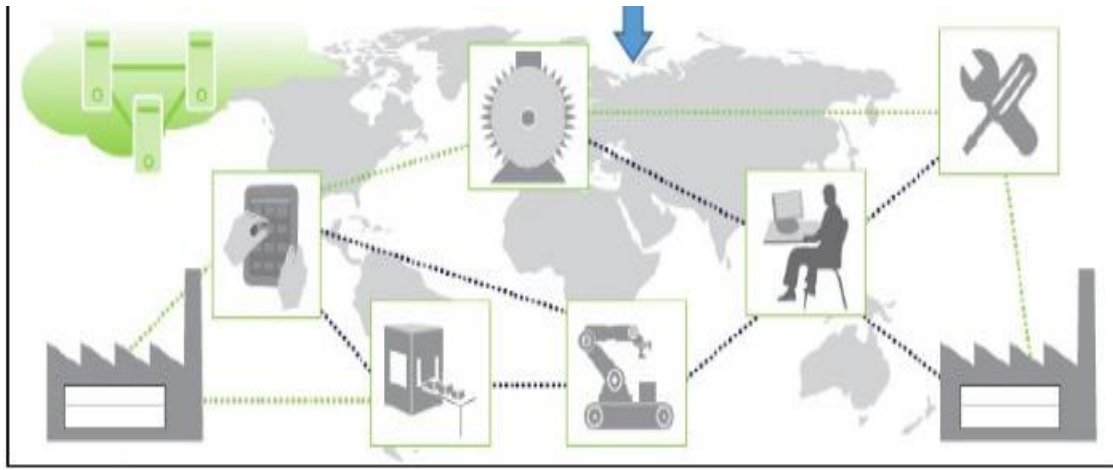


Figure 9 - Achieve the horizontal integration through the value chain

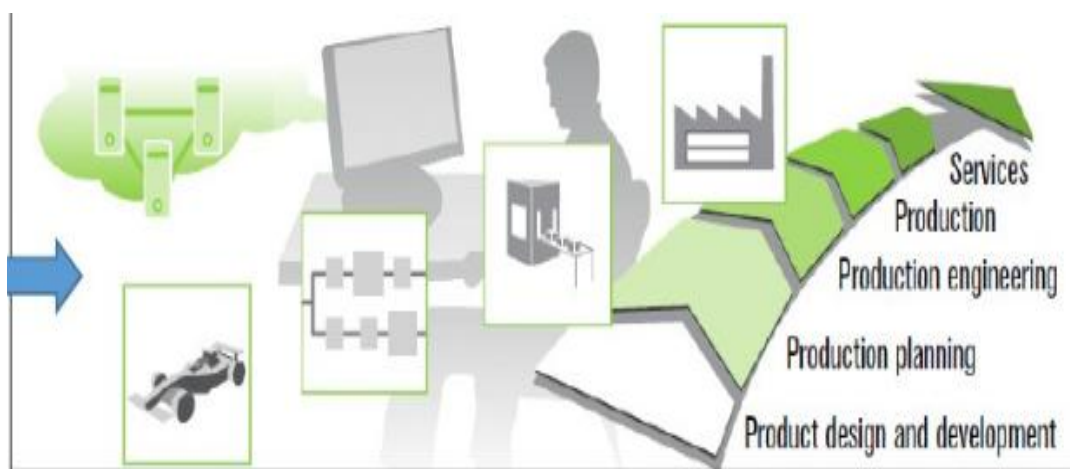


Figure 10 - Engineering across the entire value chain

- Industry 4.0 is data

With the promotion of CPS, the popularity of smart equipment and terminals, and the use of a wide variety of sensors, the ubiquitous perception and connection will be brought. All the production equipment, sensing devices, network terminals and the producers themselves can constantly producing data. These data will infiltrate the business operations, the value chain and even the entire life cycle of the product, it is the cornerstone of the industry 4.0 and the manufacturing revolution.

- Industry 4.0 is innovation

The implementation process of "Industry 4.0" is actually the process of innovation and development of manufacturing industry. The innovation of manufacturing technology, products, models, format, and organization will emerge in endlessly.

- Industry 4.0 is transformation

In the industry 4.0 era, internet of things and service networking will be infiltrated into all aspect of industry, to form the production mode which is highly flexible and personalized and also have

intelligent products and services. That can promote the transformation of the mode of production to mass customization, service-oriented manufacturing and innovation.

Industry 4.0 is the further evolution on the basic of the previous three industrial revolutions, which is a new manufacturing method that based on cyber physical system (CPS). Cyber physical system means to effectively use the advanced computing power in cyberspace in the real world through the sensor network. Thus, in the manufacturing process, all the data about design, development and production will be collected and analyzed by sensors, to form an intelligent production system which can be self-operation [33].

Cyber physical system emphasize the feedback between physical processes and information, it is the integration of computing and physical processes, the embedded computers and networks can monitor and control the physical processes. From the point of view of automation technology, CPS is a kind of engineering system, which is monitored and controlled by a kernel of computation and communication that embedded in an object and the structure of the physical environment.

In the industry 4.0, all the aspects of application will use the internet technology, and visualize the connection between digital information and physical reality, in addition, it will make the production process and management processes fully integrated. Relative to the traditional manufacturing industry, the future intelligent manufacturing which is represented by the smart manufacturing industry is an ideal state of the production system. It can intelligently judge the product attributes, production costs, production time, logistics management, safety, reliability and sustainability and other factors, thereby, it can optimize the product custom manufacturing for each customer.

Seven core industrial technologies of constituting the industry 4.0 are shows following.

- Cyber physical system (CPS)

CPS is able to cope with the changing environment even predict the changes in physical system processes through (wireless) sensing and driving.

- Cloud computing

Cloud computing makes it possible to connect locally stored applications or services to the internet of things.

- Big data analysis

Big data means that typical data sets that cannot be collected, stored, managed and analyzed by the database software tools. Big data analysis makes the industrial intelligence possible, such as the machine learning.

- (IT) System security

Data, the spread of data and all other industrial systems, machinery and equipment should be adequately protected.

- Additive manufacturing

Additive manufacturing is a technology for manufacturing solid parts by using the method of gradually adding material. Relative to the traditional material removal-cutting technology, AM is a “bottom-up” manufacturing method.

- Augmented reality (Human machine interface)

Workers can assemble parts or assist in commissioning correctly through accepting commands remotely.

- Robot/humanoid robot (Human machine interface)

New technology makes interaction more secure. For example, let robots perform the task at where humankind cannot reach. These robots are often designed to look like human beings.

Industry 4.0 is a new mode of industrial development which produced when the information technology developed to a new stage. From the ultimate goal, the core of industry 4.0 is to improve competitiveness of enterprises, industries and even countries. Through the industry 4.0, labor productively has risen dramatically, and the product innovation speed up. It can meet the individual needs, reduce energy consumption, improve the quality of product and add value dramatically, and also enhance the core competitiveness of enterprises significantly.

## 5.4 IOT

Internet of things (IOT) collects any objects or processes that need to be monitored, connected and interacted in real time through a variety of information sensing equipment, such as sensor, radio frequency identification (RFID) technology, global positioning system, infrared sensor, laser scanner, gas sensor and other various devices and technologies. It collect the information like sound, light, heat, electricity, mechanics, chemistry, biology, location and other needs of information, to combine with the internet and form a huge network. The purpose is to achieve the connections that between objects and objects, objects and people, all the items and network, are easy to identify, manage and control.

First of all, IOT is widespread application of various perception technologies. IOT deployed a large number of various types of sensors, each sensor is a source of information, different content of information and format of information are captured by different types of sensors. Sensor data obtained with real-time, it constantly updated data according to a certain frequency of periodic environmental information collection. Second, it is a ubiquitous network that built on the internet. The important foundation and core of IOT technology is still the Internet. The object's information will be transmitted in real time and accurately through the integration of A variety of wired and wireless networks and the Internet. The information collected by the sensors on the Internet of Things needs to be transmitted over the network, Due to its has extremely large number and forms a huge amount of information, it Must adapt to a variety of heterogeneous networks and protocols in order to ensure the correctness and timeliness of the data in the transmission process. In addition, The Internet of Things not only provides sensor connectivity, It also has the ability to handle intelligently itself, it can enable intelligent control over objects. The Internet of Things combines sensors and smart processing, to Use cloud computing, pattern recognition and other intelligent technologies to expand its application areas [34].

The classification of IOT:

- Private IOT

It generally provides services for single-agency internal.

- Public IOT

It provides services for public or large user groups based on internet.

- Community IOT

It provides services for an associated “community” or society, such as the Public Security Bureau, Transport Bureau, Environmental Protection Agency, Urban Management Bureau, etc.

- Hybrid IOT

This is a combination of two or more of the above Internet of Things, but there is a unified operation and maintenance entity on the background.

Three important features of the IOT:

- Fully aware

It uses RFID, sensors and two-dimensional code to get the information of the objects anywhere and anytime.

- Reliable delivery

Deliver the information of objects accurately at real-time, through the integration of a variety of telecommunications networks and Internet.

- Intelligent processing

Process and analysis a large amount of data and information, expand its application areas, through the use of cloud computing, fuzzy recognition and other intelligent computing technology.

From the technical architecture point of view, Internet of Things can be divided into three layers: Perception layer, network layer and application layer. The perception layer consists of various sensors and sensor gateways, including carbon dioxide concentration sensor, temperature sensor, humidity sensor, two-dimensional code labels, RFID tags and reader, camera, GPS and other sensing terminal. It is the resources of identify objects and information for the IOT, Its main function is to identify objects and collect information. The network layer consists of various private networks, the Internet, wired and wireless communication networks, network management systems and cloud computing platforms. It is responsible for transmitting and processing the information which is obtained by the perception layer. The application layer is the interface between the Internet of Things and users, including people, organizations, and other systems. It combines the needs of the industry to achieve the intelligent application of things [34].

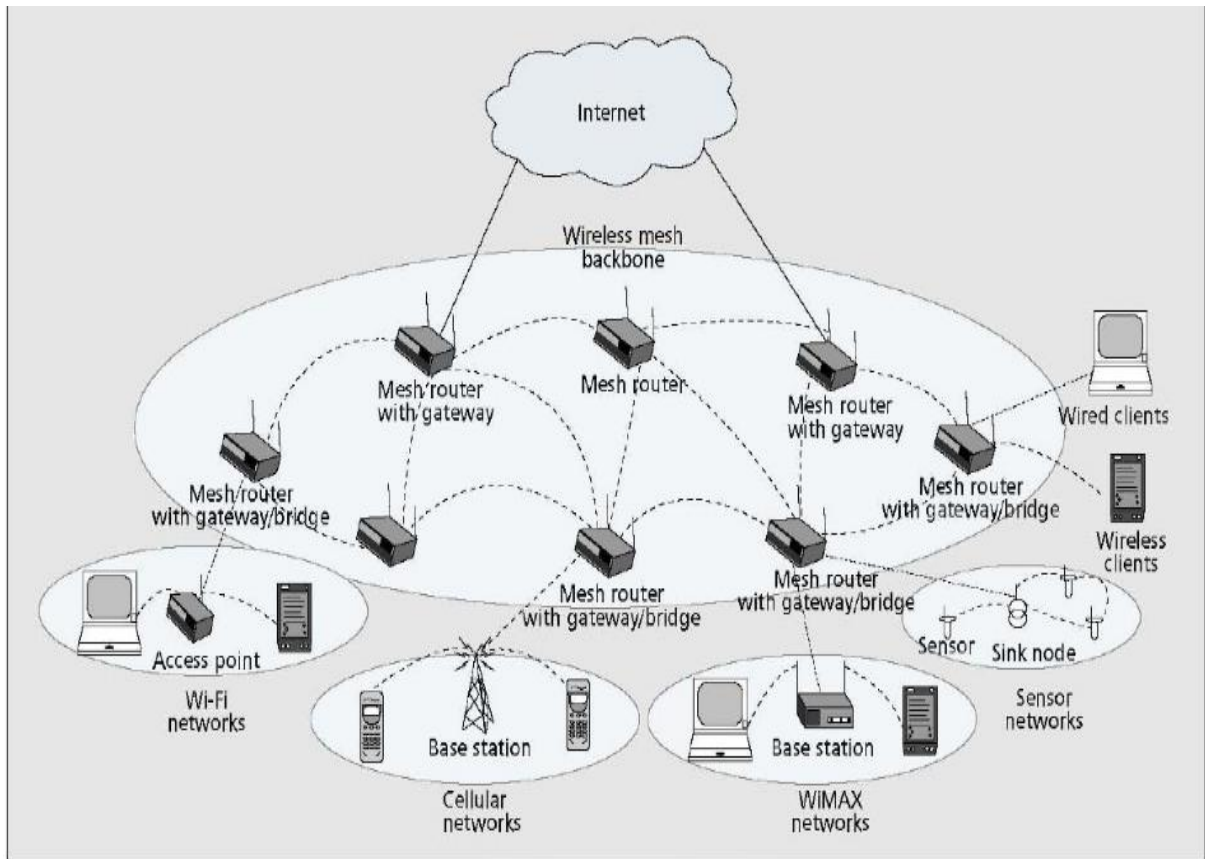


Figure 11 - Technology of IOT

The key technology in IOT applications is sensor technology. So far, the signals that most computers can handle is digital signals. It needs sensors to convert analog signals into digital signals to let the computer handle, since the computer has been. Among them, RFID tags are also a sensor technology. RFID technology is an integrated technology which combines the radio frequency technology and embedded technology. RFID technology includes wireless communications, chip design and manufacturing, system integration, information security and other high-tech fields. RFID has a broad application prospects on automatic identification and Item logistics management.

In the process of industrial IOT, the bottleneck of equipment interconnection is gradually broken by the development of Internet technology. Industrial IOT brings more flexibility to production through the effective integration of IT/OT. It realized the remote monitoring to sensor data through the interconnection equipment, as a result, it effectively reduces the downtime, to achieve predictive maintenance and tracking services.

## 5.5 Big data

Big data means that the amount of information involved is so large that it cannot be captured, managed, processed and organized to become a helping business decision in a reasonable time by the current mainstream software tools.

Big data has four features that called “4V” features:

- Volume:

A recent IDC report predicts that by 2020, the global data volume will expand 50 times. Currently, the size of big data is still an ever-changing indicator, the size range of single data set is from tens of terabytes to several petabytes.

- Variety:

The increase in data diversity is mainly due to the new multi-structure data, and also it is caused by the data types including we-blogs, social media, internet searches, phone calls and sensor networks. Every sensor increases the diversity of data.

- Velocity:

High-speed means the speed at which data is created and moved. In the era of high-speed of internet, it has become a trend to create real-time data streams by implementing high-speed computer processors and servers that achieved software performance optimization. According to IMS research about the speed of data creation, it is predicted that there will be 22 billion Internet connection devices in the world by 2020.

- Volatility

Big data has a multi-layer structure, this means that big data can come in many different forms and types. Compared to the traditional business data, big data is difficult or even impossible to analyze by using traditional applications, because it exists irregular and vague characteristics.

Big data has three characteristics:

- The first characteristic is the wide variety of data types.

The processing capabilities have been put forward higher requirements, including network log, audio, video, pictures, location information, and many other types of data.

- The second characteristic is density of data value is relatively low.

With the widely used in internet of things (IOT), information perception is everywhere, information is massive, but the value is lower. How to "purify" the value of data more quickly with powerful machine algorithms is a pressing issue to be solved in the big data era.

- The third feature is the high processing speed and high timeliness requirements.

This is the most distinctive feature of big data from traditional data.

From a technical point of view, big data cannot be handled by a single computer, it must use the distributed architecture. The character is that it can conduct distributed data mining to a large amount of data, but it must rely on the distributed computing and distributed database of the cloud computing and cloud storage and virtualization technology.

With the cloud era coming, big data has also attracted more and more attention. Big data analysis is often linked to cloud computing, Because the real-time analysis of large data sets need the same framework as MapReduce to distribute work to tens, hundreds or even thousands of computers. Big

data requires special technology to handle large amounts of data efficiently. Technologies for big data include massively parallel processing (MPP), database, data mining grid, distributed file system, distributed database, cloud computing platform, the internet, and scalable storage system.

In big data environments, many data sets no longer have keywords that identify individuals, the traditional connection methods of relational database is no longer applied. Discussion need to use the overlap between the project to combine different databases. The big database approach of using conditional independence between variables to integrate data from multiple different variable sets into a complete set of variables. Exploring the multi-database that does not have to be integrated, to directly use local data to infer and infer the results of the method of dissemination. On the other hand, utilizing statistical methods to decompose and compress big data without loss of information.

## **5.6 Trend of manufacturing system**

With the increasingly fierce market competition, mechanical automation technology, as the core of advanced manufacturing technology has constantly deepen the reform and improved innovation, to achieved a qualitative leap and amount of improvement. It fully promoted the manufacturing industry to get a further broaden in today's field, and made it possible that the automation can instead of human labor and assist mental work. In order to further deepen the high-quality service performance of mechanical automation technology, it is need to promote the full integration of human and machine systems and full range of mechanical automation technology applications through the scientific coordination and management and optimization of control. Overall, automation will develop in the following areas.

### **5.6.1 Trend of automated manufacturing system**

- Pay more attention to practical.

In fact, no matter how advanced automation technology must have its value embodied through practice, this is the only way to promote the development of machinery manufacturing. And also automated development must take the mechanical manufacturing and technological development as the goal. In the future, Mechanical manufacturing must be combined with the actual production, and pay attention to practical, to provide benefits to the development of the national economy [35]. Today, automation is mainly reflected in the integrated technology and man-machine integration, manufacturing process planning, scheduling and other manufacturing environments. To adapt to the market competition, machinery manufacturing industry must have the advanced level, and make automation more applicable, so as to be able to gain a place in the manufacturing market.

- More close to the foundation.

To apply the application of advanced automation technology to machinery manufacturing, one of the more critical is the computer-aided design, it can handle more complex issues through the intelligence. When the automation technology developing, first, the application of automation technology need to be strengthened, and it need to promote the application from the actual situation, it not only need the motivation for development, but also must have the necessary automation control components and systems. Relevant personnel must pay more attention to parts testing, computer technology and electronics automation and more, and use the program CNC



machine tools, to make the reliable and efficient computer to automated production lines, production information systems and automated control systems and other aspects. When applying automation to produce, it need to use waiting system, automatic detection and automatic control system, to proceed information processing and computing, exchange, decision-making, judgment and access. It need the Organic combination of machinery manufacturing and automation technology, to develop machinery manufacturing rely on scientific knowledge.

- Low investment, low cost, and quick results.

Machine building and automation will inevitably move towards the direction of low cost, quick success, broad prospects, low investment and great potential. Only in this way can effectively enhance automation, and enough to get the multiplier effect, this is an inevitable trend of development [36]. To develop machinery manufacturing industry, it must be based on the original equipment, reasonably adjust the distribution of various CNC machine tools, and introduce some advanced equipment, and then achieve the network management as far as possible. In particular, it should achieve the organic integration of high-tech automated production and advanced network virtualization technology, to form a production management model of human-computer interaction.

- Develop advanced automation technology

It needs to rationally use the automatic stand-alone and automatic line technology, to make the enterprises to obtain certain economic benefits. If the variety is too much more, it should quickly adjust the device, change the spindle box machine to automatic lines, then the automation of production can be able to achieve. If the small quantities are produced, the technical staff should be allowed to promote, then to make rational use of data processing, only in this way can the mechanical manufacturing automation be realized.

- Green development of mechanical automation

The trend of economic globalization makes people feel the full advantages that brought by economic growth, at the same time, people also face the negative impact that brought about by the rapid social development. The serious depletion of production resources and the worsening production environment all give people a wake-up call, and also set a basis for the reality and a wide range of space of development of the environmental protection green development trend of mechanical automation. The sustainable development of a society depends on good protection of production and living environment, and also depends on the scientific concept of development that people attach great importance to. Only establishing the scientific concept that the mechanical automated production is from the community and serve the society, and deepen the integrity and the principle of harmonious development, the manufacturing industry can achieve real sustainable development that based on perfect concept, scientific design, diversified sales, timely recovery and practical environmental protection concept. Green development of mechanical automation is not only a narrow sense of the production environment protection, but also should include the green production of product quality control, inexpensive, and high-quality after-sales service. This is also an extension of the green trend of mechanical automation.

- Intelligent development of mechanical automation technology

with the innovation of development of mechanical automation technology, manufacturing systems have changed from obsolete and traditional energy-driven into information-driven, this is an inevitable trend highlighted in the information era. It also provides a realistic basis for the intelligent development of the manufacturing industry at the same time. Compared with the traditional manufacturing methods, intelligent manufacturing system has the characteristics of human-computer interaction integration, self-discipline self-examination and efficient control, self-organization flexible control, self-maintenance and autonomous learning. With the continuous rebuilding of intelligent mechanical automation technology, the intelligent manufacturing system will combine more advanced human thinking ability in the future development. This shows that the model of intelligent manufacturing is the prototype of high integration, shared and automated, it is the incarnation of high-tech content and high-tech level and an innovation and perfection of man-machine integration, and it also is a successful example of a computer that highly simulates human intelligence. This fully reflects the great potential of mechanical automation technology and broad prospects for development.

- **Modular**

Modularization is an important and arduous project. Due to the variety of mechanical automation products and manufacturers, it is a very complex but very important thing is to manufacture and develop a mechanical automation product unit with standard mechanical interfaces, electrical interfaces, power interfaces, and environmental interfaces [37]. From the standardization of electrical products and the benefits of serialization, it can be sure that modularity will give machinery automation companies a better future, whether for the enterprises that produce standard mechanical automation units or the business that produce mechanical automation productions.

- **Miniaturization**

Micro-mechanical automation products in the work should have the characteristics like small volume, less energy consumption and flexible operation. But the existing design problem is how to have the main functions of traditional machinery and equipment at the same time and have the high precision mechanical operation. The development prospects in this area are to reduce the company's factory land and place more mechanical automation equipment. Micro-mechanical automation products are limited to use the devices with ultra-precision technology.

## **5.6.2 Trend of intelligent manufacturing system**

Automation is an important means and condition for the development of modern industry. At present, in various automation projects, there are more and more various intelligent systems and technologies. The level and degree of application of intelligent technology in automation engineering determine the level and extend of the project. Intelligence has become the most obvious sign of various project modernization.

Currently, intelligence in all sectors of the national economy has taken shape, intelligent products continue to emerge, the intelligent trend is more and more obvious. Some production and management systems also make extensive use of intelligent technologies, such as intelligent production control system, intelligent logistics system, intelligent manufacturing system, virtual enterprise and e-commerce. As for the management systems of these production and management, they realized

different degrees of intelligent realization more quickly, such as intelligent rail transport management system, intelligent air traffic control system, intelligent financial settlement system, intelligent financial management system, intelligent material management system and intelligent database management system. The development direction of intelligence is divided into the following aspects.

- Management intelligence

The enterprise management mode is to achieve their own development purposes, so an effective management has been got on to the production management. The allocation of resources and capital can be achieved only by choosing a reasonable management model, this will distribute the power and responsibility to individuals, to make the investment decisions effective. Intelligent management can achieve these functions by the more beneficial ways, and also can reflect more effective management through a minimum number of workers and resources, to ensure the transparency of the business information. Management intelligence has gone to international, with the development of management intelligence, mechanical engineering enterprises can be more convenient to achieve maximum benefits, it can be sensitive to detect the occurrence of future risks [38].

- Products intelligence

Products produced by the enterprise are directly related to whether the enterprise can achieve economic benefits. It is the basic of survival and development of the enterprises. The enterprises should guarantee the quality of their products, and also need to meet the demand of products in the market and other requirements for customers of the same product. The standard of people's living is constantly improving, naturally, there will be higher and higher requirements for the products, it performance for the features and diversity of the products. Products intelligence can meet the requirement of advancing with the times, the proportion that occupied in the market share is gradually increased. Compared to the traditional products, intelligent products are more advanced, such as the controller, therefore, the enterprises should achieve the products intelligence.

- Equipment intelligence

Equipment is the fixed assets for the enterprises that need to produce. Nowadays, society is making progress, the equipment intelligence is very popular to people, equipment intelligence can make the efficiency of business management improve. The mistake that made in the production can be promptly found and remedied, it will reduce the economic loss. It also can notify by tweet when there are problems in the equipment, to ensure the normal production.

- Technology intelligence

Whether the enterprises can achieve the intelligence depends on the technology, the enterprises will have the power to pursue intelligent because of the technology. The production and management of enterprises are inseparable from the use of technology, technology intelligence can make the enterprises achieve the reduction of staffs. It can not only improve the working environment for the staffs, but also reduce the workload of the staffs. It ensures the progress of the production and the quality of products have been improved [38].

- Using intelligent technology to improve and enhance the information and network of enterprises

Information is signals, data, instructions, procedures, messages, and intelligence that can characterize things. In essence, information is the knowledge. Information technology is the technology that can process information including collect, identify, transform, store, transport and display. Similarly, information technology is the technology that deals with knowledge essentially. The essence of knowledge is intelligence, the technology that deals with knowledge is intelligent technology. Therefore, information technology is intelligent technology. To use intelligent technology to improve and enhance the information and network of enterprises, the specific measures are as follows.

- Enterprises should establish a "people-oriented" thinking.

The enterprises should serve the customer wholeheartedly, and rely on staffs wholeheartedly. It should give full play to human intelligence and innovation, to ensure high quality, fast, low consumption, clean and efficient production.

- Make the development and utilization which is the resource of reflecting the modern science and technology as the core task of information construction.
- Reform enterprise management system, and create a good internal and external environment.

It should promote the wide application of network supply chain, network logistics, e-commerce, dynamic alliance, virtual enterprise and other technologies.

- Establish an enterprise research and development agencies which makes the intelligence as direction.

Using intelligent CAD, network cooperation design, intelligent database technology to design and develop new products. On this basis, the intelligent integration of CAD / CAPP / CAM is gradually realized.

- Establish the modern intelligent manufacturing system that combines human-machine.

Giving play to people's creative intelligence, to achieve the combination of human intelligence and machine intelligence. The basis for manufacturing systems is in the workshop, it need to build a workshop-level intelligent production planning and scheduling system.

- Create an open re-configurable intelligent manufacturing system.

Basic manufacturing equipment can not be completely updated as the product changes. However, the composition of the equipment program and processing, scheduling route is likely to vary with the product variety, volume, quantity changes. Intelligent reconstruction technology is the key technology.

- Attend and apply the latest achievements in computer science and artificial intelligence science.

One of the characteristics of the development of modern science and technology is that the time of transition from basic science to technology is getting shorter and shorter, and the application from technology to industry is almost simultaneous. The basis of information technology is computer science and the foundation of intelligent technology is artificial intelligence science. At present,

distributed artificial intelligence (DAI), which is formed by the combination of distributed computing and artificial intelligence, has become a research hot spot. Distributed artificial intelligence has two research areas, one is distributed problem solving (DPS) and the other one is multi-agent system (MAS). The former considers how to divide a solution to a particular problem between multiple collaborative and knowledge-sharing modules or nodes, it uses a "top down" solution to the problem. The latter mainly focuses on the coordination of intelligent behaviors among a group of autonomous agents. It uses a bottom-up approach to problem solving. This shows that the two methods of distributed artificial intelligence (DAI) (DPS and MAS) are the processing of knowledge resources to accomplish a given task. Therefore, this intelligent technology has been applied in the enterprise product design, manufacturing and production management quickly, especially in a variety of intelligent software system design and development. After the enterprises using these two technologies, the level of product quality, manufacturing quality, cost and management have been rapidly improved, and they achieved their own intellectual property rights in these areas, thus, it greatly enhances the competitiveness of enterprises in the global economy [39].

- Pay attention to select and train the high-quality talent.

If the modern enterprises want to continue to move forward in the fierce competition, the key is talent. The most need is two types of compound talents, one is compound senior professionals that master the high-tech know-how, understand technology, understand management and innovative (engineer). The other one is complex senior management personnel that with a strategic vision and innovative courage, know science and technology and management (entrepreneurs). For these talents, they must be entrusted with the task, and let them exercise in practice growth. There is another task for the enterprises, that is, it need to focus on product and enterprise production to popularize modern science and technology to all workers, especially the information technology and intelligent technology which is applied in the current factory.

Intelligent mechanical engineering is the inevitable trend of social development, it plays an extremely important role in the rapid economic development and the improvement of people's living standards. With the emergence of intelligent mechanical equipment, many people have realized the importance of the development of mechanical intelligence, it is bound to replace the original mode of production. Thus, all business managers should make the development of intelligence as one of the top priorities, choose the intelligent technology according to the different characteristics of different areas, to ensure the process of enterprise development.

## **6 Chapter 6 Case Study**

### **6.1 Introduction of FAW company**

FAW Group is a global leader in the vehicle manufacturing industry with a 60-year history of innovation. Founded in 1953, FAW employs 120,000 people around the world and sells products in over 70 countries. As China's state-owned automotive corporation, the company's total assets are valued at 244.575 billion yuan RMB. FAW is a diversified maker of quality light, medium, and heavy-duty trucks, automobiles, municipal buses and luxury tourist coaches, custom bus chassis, and mini-vehicles with total sales in excess of 18 million vehicles worldwide.

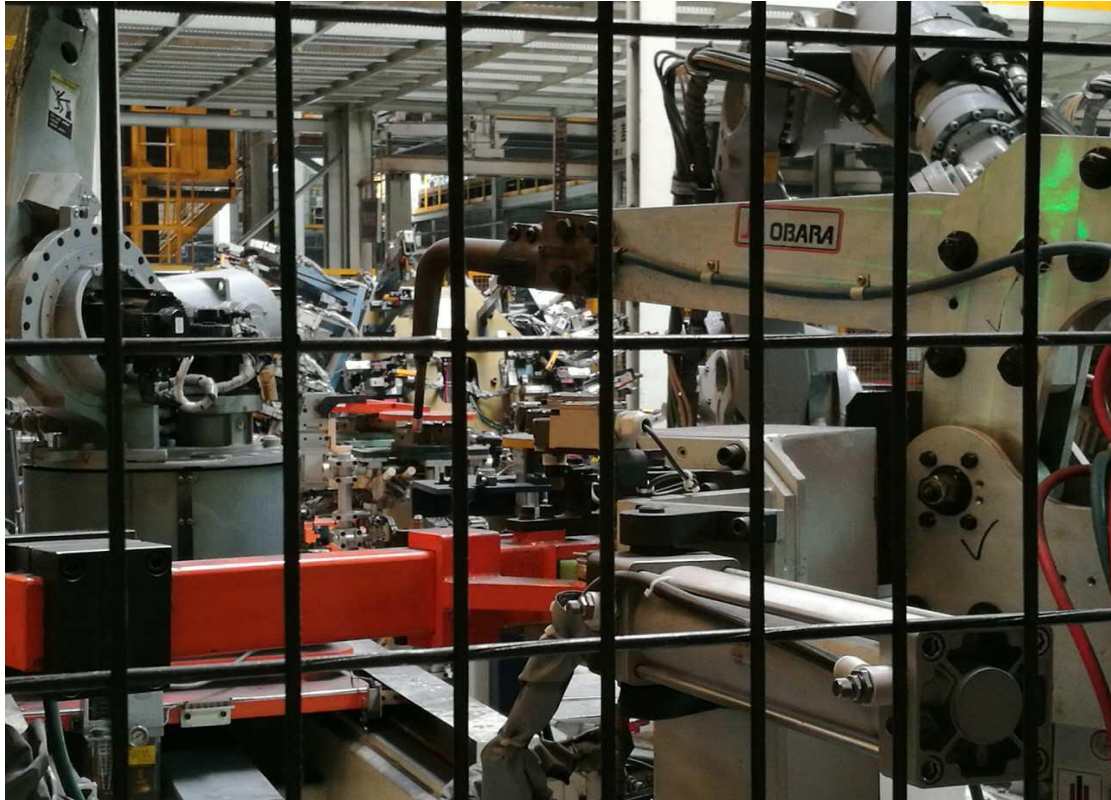
FAW Group Corporation is headquartered in China's northern city of Changchun, Jilin Province. FAW Group's domestic production facilities, subsidiaries, and engineering development and test centers are located in 18 locations throughout China. Products include a full range of passenger cars; light, medium, and heavy trucks; coach chassis; municipal transit and intercity buses; luxury tourist coaches; mini vehicles; engines; transmissions; axles; and components.

### **6.2 Problems in the factory**

Machinery manufacturing industry of China starts relatively late, and it has the problem of weak basis and blockade on techniques by other countries. Comparing with the industrial developed country, there is a large gap between them. The main show includes the low product quality and the technical level is not high, and there are little products with independent intellectual property and unreasonable institutions, the manufacturing technology and process has fall behind, and it also has certain gap in the advanced manufacturing technology, and production management.

With the development of the society, the standard of people's living is increasing day by day, all aspects of the individual requirements is increasingly strong. As the machinery manufacturing industry which has been deeply into all walks of life and has become the basic industry, it is facing a severe challenge.

The pictures in this Chinese factory are showed below.



*Figure 12 - Robot arms in factory*



*Figure 13 - Robot arm which is working*

These two pictures are the robotic arms in the workshop, the duty of them is to pick the door of car up, and then put it in to the machine, after processing, put it into the conveyer belt. Most of the machines

are main focus on welding. The electric spark is high and splashed everywhere. It is a hazard in the factory for the safety of workers and other products.

Figure 12 shows the welding technology, that the robotic arms work instead of manpower, and figure 13 shows the arms are working on the door of cars.

From these two pictures, we can see that the robots are shabby and heavy, they cannot be accurate enough, and the programming is not advanced, they often make mistakes, and need the technician check it frequently.

In the mechanical manufacturing industry, the machine tool, cutting tool, jig and other equipments largely determine the level of processing. But many key parts and key tools cannot manufacture by itself, it totally depends on imports, it has largely limited the development of the factory.

Mechanical manufacturing enterprises make the imported equipments as the emphasis propaganda object. For example, introducing the automated production equipment from Japan and United States, which have exquisite workmanship and good product quality. According to this reason, it shows a technology black hole of the machinery industry, that the dependence of foreign technology is high. There is less products with independent intellectual property in the core technology, and the clones are much more. This result will in addition to weaken the independent innovation ability, it will also vulnerable to the alleged infringement.

With the development of science and technology, especially the rapid development of electronic technology and information technology, more and more advanced technology used in mechanical manufacturing industry. Recently, “made in China” has become a familiar word, but at the same time, it also became the synonymous of the inferior products. Thus, the quality of Chinese product still need to be improved, it largely depends on the manufacturing process. Industrial developed country adopt the new processing methods such as high precision machining, micro machining, laser processing technology, electromagnetic processing technology and compound machining technology. But in China, it still uses the traditional processing as the main body, so that it limited the improvement of processing technology.

As for the automation technology, with the development of advanced technology such as computer technology, the degree of mechanical manufacturing automation technology has further improved. Industrial developed country adopts FMC, FMS, and CIMS, to realize flexible automation, intelligence and integration. But in China, it is still in the phase of single machine automation and rigid automation. The flexible manufacturing unit and system are only used in a handful of firms.

The industrial developed countries widespread adoption of computer management, and attach importance to the organization and management of the system and update development of the production mode. It has introduced new technology and thinking of management, such as just-in-time (JIT), agile manufacturing (AM), lean production (LP) and concurrent engineering (CE). But in China, most companies are still in the stage of experience management, most enterprises failed to establish modern scientific management system, and the organization system is not perfect.

More and more foreign companies invest in China, it leads China introduced a lot of advanced foreign equipments, but the core technology was not grasp.



These two pictures below show the production line of the factory. See in figure 14 and 15.



Figure 14 - Production line 1



Figure 15 - Production line 2

The generation of assembly line, makes the workers collaboration. They just repeat their own procedure, it makes the production efficiency improved rapidly. The division of labor between workers is more sophisticated, the yield and quality of product are also increasing significantly. These

results greatly promote the process of production and the standardization of product, and also solve the organization problem of combine the production information, technology, organization and process of production.

The assembly line changes the low efficient production mode of manual processing or separate scattered machine processing to mass production. It effectively reduces the cost and increase the efficiency. And on the other hand, each worker who directly engaged in the production line are only responsible for their share of the work, it reduces the quality requirements of operators and reduces the labor costs.

The current development status of assembly line:

- In the process of use, the basic time and auxiliary time are continuously shortening. The traditional production need to use the side-by-side double location to improve the production cycle. As for the modern mechanical processing production line, it mainly uses the new material of new cutting tool, new tools, and shorten the work piece delivery methods to improve the production cycle. At present, the mechanical processing production line also uses the electronically controlled hydraulic driving device, it laid a good foundation for shortening basic time and auxiliary time of the production line [40].
- Flexible manufacturing system has been taken seriously increasingly. The traditional machine tool control system is composed of relay circuit, but the applications of data-organization machine tool have effectively changed the mechanical structure of the modular machine tool. The flexible manufacturing system has been introduced in the traditional rigid transfer machine and production line. Flexible machine tool and automatic line adopt the NC machine model, it can effectively change the CNC program through the application during the processing of each link, in order to meet the processing requirement of variant products.
- Machining accuracy is able to improve. In order to meet the high demands of the work piece machinery accuracy of the customers. In addition to a series of measures such as further improve the precision of the spindle assembly, adopt new special cutting tool, and optimist the cutting process, at present, the application of the hollow taper shank tools (HSK) and statistical quality process control (SPC) have become a new and important technological means of improving automatic line and monitoring the machining accuracy. HSK is a kind of new tool which use two-way positioning of radial and axial, SPC is a method which is based on the process capability that can monitor the quality of the work piece.
- The reliability and utilization of the processing has been better promoted. In order to improve the reliability a utilization of the machining process and processing quality of the work piece, the whole unit adopts the monitor of machining process and the quality of work piece, to quickly identify the fault and quickly fault diagnosis. With the advance of technology, the control of automatic line has begun to the method of decentralized control. The decentralized control system can save more cost than the centralize control system, this is mainly due to the distributed control system can reduce the cost of cable laying, reduce the cost of electrical maintenance upkeep, and it does not need to set up centralized cooling device. In addition, because of this kind of distributed control system has simple whole allocation, it has benefit to speed up the operation of

transfer machine. It has the structure configuration which is clear at a glance, it can determine the location of fault easily when a failure has been produced.

### **6.3 The necessity of transformation**

Intelligent is the general trend of social development, it is not a simple meaning, but a integrated system which cover a broad. This system involves a variety of technologies, and use these technologies in a particular purpose of intelligent integrated. With the progress of science and technology, the intelligence is developing constantly, the deepening degree of intelligent and development of intelligent technology make the intelligent application scope more and more widely. At the same time, the economic demand of a new era determines the necessity of intelligent development.

Intelligence is the development direction of information science and technology. The direction of quality of human life is improving from material things to mental health, the development of information technology and its application should consider satisfying people's spiritual needs increasingly. Modern computer and communication science technology is the core of information science and technology. At present, it is development along the direction of digital, miniaturization, personalized, interactive, portable, integrated, network, and intelligent. According to modern information science and technology, it uses more and more natural language recognition and understanding, image recognition and understanding, computer vision, robot programming, multiple information sensing and control, the representation of knowledge, acquiring and processing, reasoning and solving, expert system and intelligent control. With the development of cognitive science and intelligent technology, artificial intelligence technology will be applied in information science and technology increasingly [41].

Intelligence is the development direction of life science and technology. The brain is the command of human intelligence system, brain science is the core of life science, and intelligence is also the development direction of life science and technology. It can realize the part of imitating the human brain function, and auxiliary human intelligence.

Intelligence is the development direction of automatic engineering. Automation is an important means of the development and conditions of modern industrial. The development of modern industrial process is the process of applying, improving and upgrading the automated production technology. At present, among various kinds of automation engineering, a variety of intelligent system and technology has been used increasingly. The level and degree of the automation engineering application and intelligent technology determines the level and degree of automation of the project.

Intelligence is the development direction of departments of mechanical engineering and national economic. Some production and management system also use the intelligent technology, such as intelligent control system, intelligent logistics system, intelligent manufacturing system, virtual enterprise and e-commerce.

The information technology develop rapidly and the trend of economic globalization is rising, the market changes frequently, product updates faster, product technology improves increasingly, and information technology uses widely, because of these reasons, it makes the manufacturing production mode and management mode changes. The enterprise changes from product oriented to customer

oriented, the main factors of product change from labor to knowledge, and the production process changes from assembly line type to intelligent intensive production. It can quickly response the intelligent distributed network cooperative production management system which is needed by the market demand.

Due to the intelligent management in the management of mechanical engineering permeates gradually, the management style of mechanical engineering enterprise has changed. The management mode changes from a multi-level and intersection management to a ladder type, and changes from original human management into a microcomputer. The intelligent management implement real-time monitoring to the production, sales, market development of the mechanical engineering enterprise. Such a management model shows the information management more transparent, and improves the management efficiency. On the other hand, it reduces the waste of human and the influence of human error to the enterprise. Intelligent management model makes the enterprise can better predict the change of market environment and risks, and the management decisions can quickly adapt to the market demand.

According to the intelligent product, with the development of the time, the demand for product of the consumer tends to personalized, diversified and intelligent. This rising demand is driving the mechanical engineering enterprise changes from traditional labor to technology production. Intelligent product has a variety of analysis functions of the human brain, such as remote control function, timing control function and linkage control function.

In modern society, with the deepening of the information construction, many mechanical equipment are tend to the development of automation, intelligent science and technology. The application of intelligent equipment promotes the development of the intelligent management model and management level. The management of intelligent devices make the managers can understand the equipment running status through the change of equipment performance parameter. If there is a fault occurs, the system can give the early warning signal timely, to reduce the loss of production. The running status of mechanical engineering equipment is the basis of the mechanical engineering production efficiency, it has influence for mechanical engineering enterprises and nation economic development.

The production of mechanical automated has prominent advantages in the aspect of information automatic processing and control. The sensitivity, precision and scope of the control and detection have significantly improved. It can accurately ensure that the mechanical actuator can accomplish the action which is according to the requirement of design through the automatic control system. Mechanical automation products generally have the functions of automatic monitoring, alarm, diagnosis, and automatic protection. Once meeting the faults of overload, over voltage and short circuit, it can take self-protection measures automatically, to protect the safety of the operator and device. Thus it can be seen that mechanical manufacturing and automation technology has very huge improvement of the safety and reliability of the product [42].

When the mechanical automation products are in the installation and debugging, it can implement the change of working by changing the control program, to adapt the needs of different users and the needs of the field parameters changing. These controlling programs can be imported to control system of mechanical automation products through various means, to make the product has more technology content.

The automation degree of mechanical automation product is high, it belongs to the knowledge intensive and technology intensive products, it is an important way to free people from heavy manual labor. It can speed up factory automation, office automation, agricultural automaton and traffic automation. Besides, mechanical manufacturing and automation technology also improve the product efficiency and reduce the labor intensity.

The continuous development of science and technology progress promotes the continuous development of today's society management pattern. The further promotion of intelligent management model can effectively improve the mechanical engineering enterprise to detect the market environment [42]. It ensures the effectiveness of decision, and has the benefit of avoiding the risk, to ensure the healthy development of the enterprise.

## **6.4 suggestion to the factory**

With the rapid global rise of smart manufacturing, intelligent factories have become the major breakthrough in the transformation and upgrading of manufacturing enterprises. In a narrow sense, intelligent factory is the application of mobile communications networks, data sensing and monitoring, information exchange integration and advanced artificial intelligence and other intelligent manufacturing-related technologies, in order to make the production system be intelligent, networked, flexible and green. In a broad sense, the intelligent factory is tissue vector which covers the implementation and realization of the intelligent whole-life cycle that is based on manufacturing. Against this, the development status and characteristics of the factory have been summarized and analyzed. And on this basis, some thinking and suggestions are put forward to accelerate the development of this factory, and a judgment on the development trend of the next stage has been made.

- Make a good top-level design, conduct demonstration pilot application orderly.

Focus on the global cutting-edge development trend, combined with the specific construction of key industries, the core idea of the domestic smart factory construction, phase goals, main direction, development path and safeguard measures need to be cleared. According to the specific characteristics of different industries to put forward the construction model suitable for both production and use, which make the enterprises as the main body, and continue to update and improve base on the technology and market changes. Popularize the intelligent manufacture unit - intelligent workshop a intellectual factory, cultivate a batch of industrial intelligent factory application model, explore the smart factory model to popularize the new mechanism, and gradually realize the industrial-level plant-level and factory-level intelligent transformation.

- Innovate management tools, effectively enhance safety and control-ability.

Effort to build hardware and software support system that related to the development of intelligent factories. Breakthrough in core electronics, high-end chips, key material core technologies and industrialization bottlenecks, and comprehensively enhance the capability of providing independent design tools, manufacturing execution systems, product life cycle management, industrial control systems and overall solutions for smart factories.

According to the problems in the factory, the factory should acknowledging the equipment are ageing, and it should provide scientific management to the maintenance of equipment through a series of

technical, economic and organizational measures. First, the factory should improve the performance of machine tools, robots and other machining equipment. It is best to create the advanced robots that can think and judge independently and autonomously. Further adjust the accuracy of machine equipment and enhance the intelligence, to reduce the manual labor. Carrying out the principle of combining repair, renovation and renewal, it can quickly improve and improve the quality of technical equipment to create conditions for improving economic efficiency. At the same time, the factory should strengthen the training of technical person and maintenance personnel internal enterprise, to improve the ability to deal with problems. The quality of technical personnel and maintenance staff play a leading role in the proper use of equipment, reduce failure to improve equipment utilization, ensure safe production, reduce equipment maintenance costs.

According to production needs, the company should use modern technological achievements and advanced experience to change the structure of existing equipment and to change the technical performance of existing equipment so as to achieve the technical performance of new equipment in whole or in part.

The future works for the company are following.

- Vigorously develop the high-technology intelligent devices, to achieve the machine-machine manufacturing system, and an unmanned workshop with efficient and flexible production, it can reduce the human labor greatly.
- Develop more intelligent systems in-depth, to make the intelligent systems have the function of independent identification, independent judgment and self-correction.
- Cultivate and recruit a large number of talents, to enhance the overall quality of the workers. It can make the workers have the relevant professional knowledge and ability to innovate.

## 7 Chapter 7 conclusion

Machinery manufacturing industry is one of the core industries. It is the pillar industry of the national economy, the level of the technology means the level of development of the country and market competitiveness. Only continue to strengthen the level of mechanical manufacturing technology, in order to improve the quality of product and the efficiency of enterprises.

Intelligent and automated mechanical technology, will bring change to many industries. Intelligent mechanical automation technology is especially needed, and the application is particularly extensive. Intelligent machining is the future machining technology in manufacturing, it will have a vital role in the development of the machinery industry. Especially in today's situation which pursuit machinery manufacturing automation, flexible and integrated, intelligent technology has brought a solution, it make the entire machinery manufacturing industry undergone profound changes on the mode of production, product structure and industrial structure.

Science and technology are primary productive forces, the degree of intelligent manufacturing machinery not only affects the efficiency and level of production, but also a representative of the development level of a national machinery manufacturing industry.

This paper proposed some advice to the Chinese factory, according to the advanced technology in the world, and the development direction which is summarized by the current level of industrial development. The categories and development of automated manufacturing system and intelligent manufacturing system have been summarized, to find a way to improve the manufacturing system of Chines factory, and realize the great potential of rejuvenating the economy and make contributions to the society and environment.

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