The Framework of Intelligent Factory
Qing-yu YUAN¹, Dan-li WEN¹,* and Zhi-xun CHEN²
¹Software College of Shenyang Normal University Shenyang, 110034, China
²Ansteel Information Industry Corporation, Anshan, 114010, China
*Corresponding author

Keywords: Intelligent factory, Framework, Deep integration.

Abstract. Based on the current situation of the automation and management of the on-site equipment, and according to the actual situation of a domestic enterprise, the "Intelligent Factory" architecture is designed with the integration of people, machines and things in the factory, and the goal of the "improve efficiency, reduce personnel, stabilize production, and improve quality" is realized.

Introduction

The post-industrialization era has brought new challenges to the traditional manufacturing industry. At present, the overcapacity of domestic manufacturing industry, the continuous improvement of labor cost, the small batch, multi-variety, personalized, high quality, high stability demand and punctual delivery of the customers urge many enterprises to innovate ideas, reduce production costs and adjust the production and management organization model to meet the needs of customers. The contradiction between industrial large-scale production and personalized needs of customers is solved by improving the level of information application in factories. In April 2013, the German government put forward the national development strategy of "Industry 4.0" at Hannover Messe. In the first half of 2015, the Chinese government put forward the development plan of "Made in China 2025". At home and abroad, the application of information technology and speeding up the transformation of manufacturing industry are regarded as the national strategy to encourage the development. The establishment of intelligent factories is the specific measures of this strategy and the basis of manufacturing industry.

A factory that practices Industry 4.0 is called an Intelligent Factory, or iFactory. The principle Industry 4.0 concept is connecting machines, work pieces, and systems to a network, allowing them to communicate with each other to become an intelligent system where individual units influence each other automatically to maximize quality and throughput. "Intelligent Factory" is based on digitalized plant, data statistics and analysis are the core, integrated with manufacturing technology, new information technology and intelligent science and technology, covering the whole life cycle and process of manufacturing, it integrates people, technology, management with information flow, logistics, capital flow, knowledge flow, service flow, through perception, interconnection, control, execution, coordination, analysis, prediction, decision-making, to achieve customization, high efficiency, high quality, low consumption, green effect[1]. It is manifested in the automatic detection and monitoring of production process parameters, agile control of production equipment, state diagnosis, life cycle maintenance, optimal scheduling of production plan, product quality design and tracking, process cost accounting, intelligent dispatching command, warehousing logistics management and optimization, production and marketing integration and user value digging, etc [2].

"Intelligent manufacturing" has increasingly become a consensus in our country and even in the world. Like "Made in China 2025", the United States Industrial Internet and "Industrial 4.0" are recognized as the same main attack direction. Their common characteristic is to transform and upgrade the traditional industry with information technology, and at the same time to construct a new advanced intelligent manufacturing system supported by networking and big data [3]. For example, POSCO, South Korea, has designated the heavy plate factory of Guanyang Iron and Steel Institute as an intelligent factory based on Industry 4.0, relying on the Internet of things and big data to build
an "intelligent factory", which is designed to ensure that competitors cannot exceed the "super gap" cost, quality competitiveness, and the ultimate goal is to build an unattended intelligent factory [4].

At present, many manufacturing industries in China are in a major structural adjustment period, and the large-scale industry is promoting "Made in China 2025", with the aim of improving the product quality and resource utilization efficiency, saving energy and reducing emission, reducing production cost, optimizing the labor environment, and improving the labor efficiency. It is also the only way out for many large enterprises in our country to make a contribution to the protection of the natural environment, to deal with the aging of the population and to promote the free development of human beings.

In this paper, based on the actual situation of a domestic enterprise, the "Intelligent Factory" architecture is designed based on the current situation of the automation and management of the on-site equipment, and the goal of the "improve efficiency, reduce personnel, stabilize production, and improve quality" is realized.

The Framework Strategy of "Intelligent Factory"

Design the framework of "intelligent factory" taking information physical system as the basic unit of intelligence, integrating all production factors through Internet, and realizing horizontal integration of supply chain, vertical integration of value chain and end-to-end integration to create life-cycle value according to the automatic collection and analysis of all data of production process and market process[5]. Realize social value creation, networked ecological existence, real-time market insight, and accurately meet the needs of consumers.

The Internet of Production Factors Meets the Requirements of Information Exchange. To realizing the integration of human, technology, management and information flow, logistics, capital flow, knowledge flow and service flow, the transformation of traditional island system architecture to Internet big data and distributed service architecture, the establishment of an open platform, and better depth with upstream and downstream customers of supply chain, as well as the fusion of people, machines and things in the factory.

The Intelligent Machine can Meet the Requirements of High Quality, Low Consumption, Stable and Flexible Production. The application of information physical system in the production is reflected in the following aspects: improving the perception, monitoring and monitoring ability of technological process through complete sensors; improving the ability of artificial intelligence through data analysis and model adoption; generally adopting logic derivation, self-adapting, self-learning and flexibility, virtual To be manufactured, man-machine cooperation.

The Automation of Knowledge can Realize the Optimization, Prediction and Decision-making of Production Process. summarize the experience, knowledge and wisdom of production and operation management of production, sales, logistics, etc., utilize data resources, adopt analysis means, refine and share, and improve the overall optimization and continuous improvement ability of design, decision-making, production organization process.

Integration of Resources, Response to Users, Order Control, All Process and Life Cycle Management. The three types of business of large manufacturing industry are integrated from the following three dimensions: purchase and sales, production and manufacturing, and R & D services. That is, horizontal integration, vertical integration and end-to-end integration of information system. Horizontal integration is the information integration of enterprises in the value chain. Horizontal integration will lead to significant changes in business models and business processes, and lead to the refinement of division of labor, the demise of traditional middlemen, and the rise of new service industries. Vertical integration is the integration of resource management in manufacturing process and the integration of information among different levels such as production organization and process control. Depending on vertical integration, cross process coordination and interaction can be realized.

The framework of "intelligent factory" is show in Figure 1.
**The Composition of "Intelligent Factory"**

**Service Network Platform (Industrial Internet).** Realize zero distance with users, reflecting market perception, market feedback and interoperability, from order organization production to demand organization production, from product production to relying on product services. The design includes supply collaborative management + e-commerce, sales collaborative management + e-commerce, industrialized customized production, logistics services and collaboration.

**Manufacturing Network Platform.** The design includes networked manufacturing, networked design, networked raw material product management, networked security environment management and data application.

**The Design Includes Knowledge Base, Algorithm Base, Rule Base and Parameter Base.** In addition, it also includes the design of integrated scheduling support platform for production control, intelligent monitoring platform for plant environment, mobile network application support platform, networked virtual plant support platform and intelligent analysis and decision-making platform.

**Intelligent Factory is Built on the Basis of Digital Factory.** To achieve all the goals of intelligent factory, it needs a continuous and gradual process. The standardization, modularization and digitalization of production and manufacturing are the foundation of our intelligent factory. Organize the fragmented information and knowledge in the process of R & D, production and service effectively, and extract the fuzzy experience: relying on such a carrier, transform personal knowledge into enterprise knowledge, transform tacit knowledge into explicit knowledge, realize the effective accumulation of knowledge, promote the transformation of our enterprise to R & D and service, and realize the big data infrastructure of knowledge automation Demand driven.

**Establish the Intelligent Management and Control System of Equipment Spot Inspection and Maintenance.** Improve the efficiency and quality of equipment spot inspection information collection by using the automatic collection technology of equipment spot inspection information, organize and analyze these information to realize the online intelligent diagnosis function, and carry...
out the quantitative evaluation of the equipment capacity and accuracy level. On this basis, realize the equipment life cycle management and complete the equipment based on the intelligent factory. The effect is to gradually realize the whole life cycle management of the equipment, improve the efficiency and quality of spot check, expand the scope of predictive maintenance, reduce the proportion of preventive maintenance and emergency repair, improve the maintenance effect and quality, improve the accuracy of the equipment, play the function of the equipment, and reduce the maintenance cost.

Establish the Intelligent System of Logistics Automatic Tracking, Storage and Transportation Management. Realize the tracking feedback of production process, raw material and finished product storage, logistics, timely and synchronous logistics and information flow of production process; optimize production and operation plan, make weekly delivery statistics, do well in user communication, and initially build the logistics information foundation of intelligent factory service network. Its effect is to realize the tracking, correction, monitoring, scheduling, tracing and other functions of the whole process of logistics data, so as to reduce the human intervention: to realize the intelligent control of warehousing logistics, to achieve the effective management of raw materials and finished products; to make materials and finished products flow in an orderly and reasonable way, so that users can grasp the real-time transportation information of goods and improve customer satisfaction.

Establish High Precision Production Preparation Intelligent System. The effect is to improve safety factor, production efficiency, product quality and precision, reduce the number of personnel, and lay the foundation for realizing the goal of intelligent factory.

Establish the Intelligent Monitoring System of the Factory Environment. Use the smart card technology, intelligent environment detection and alarm technology, intelligent video technology, intelligent light control technology, indoor intelligent positioning technology, industrial intercom and industrial broadcast technology to realize the functions including closed management, visual management, factory green environmental protection management, remote centralized monitoring management, etc., to realize less people and no artificial management objectives of the plant. The effect is to establish a modern intelligent factory environment, which can achieve green, low-carbon, safe, visual and other factory environment.

Establish Business Decision Support System. Marketing information, customer relationship, industry benchmarking, resource balance, benefit accounting and product R & D, establish support points for marketing, service, production, cost and R & D Decision of intelligent engineering, preliminarily achieve market perception, feedback and interconnection, and lay a foundation for the final realization of product + service goal. The effect is to grasp the market change and trend in real time, adjust the marketing strategy effectively, realize the marketing and product development for the purpose of customer demand, share information, utilize resources effectively, reduce the marketing cost, improve the standard cost accounting system, realize the real-time collection of process cost, analysis and prediction of cost and standard cost.

Establish Production Management and Control System of “Intelligent Factory”. Realize the collection, monitoring and statistics of the primary and secondary energy consumption of the factory and the operation data of the energy system of the factory, and finally realize the management and control strategy for the efficient utilization of primary and secondary energy and green operation. Through the use of Internet of things technology to summarize the information of the whole production line, a visual simulation platform of intelligent factory is established to realize the integration of planning, scheduling, control and production decision-making information presentation and human-computer interaction.

Establish a Support Platform for “Intelligent Factory”. The effect is to improve the utilization rate of equipment, be flexible scheduling of computing resources, simplify operation and maintenance, reduce operation and maintenance costs and green environmental protection, and reduce energy consumption.

The composition of "intelligent factory" is shown in Figure 2.
Summary
This paper used the information resources of the enterprise, fully considered the current situation of the factory, adopted the advanced management concept, designed and constructed the intelligent factory, which will improve the management level and core competitiveness of the factory as a whole, and will bring good economic and management benefits to the enterprise.

Acknowledgement
This research was financially supported by the Funds of National Science of China (Grant No. 61703289). The authors also gratefully acknowledge the helpful comments and suggestions of the reviewers, which have improved the presentation.

References
[1] S. Yang, M. R. Aravind Raghavendra, J. Kaminski, H. Pepin, Opportunities for Industry 4.0 to support remanufacturing. J. Applied Sciences. 8(2018)1177.1-11.
[2] A. Calleja-Ochoa, H. Gonzalez-Barrio, R. Polvorosa-Teijeiro, N. Ortega-Rodriguez, L.N. Lopez-de-Lacalle-Marcaide, Multitasking machines: evolution, resources, processes and scheduling. DYNA 2017, 92, 637-642.
[3] D. Park; W. Liu, S. Lee, Big Data Platform Development for Environmental Monitoring in Plant Factory, J.International Journal of Innovative Technology and Exploring Engineering.8 (2019).
[4] L. Wimalin, C. Wichai, Industry 4.0 gap analysis for Thai industries with association rules mining, Proceedings of the 9th International Conference on Industrial Engineering and Operations Management. (2019) 288-299.
[5] Information on https://www.dbhrobot.com/Intelligent-factory/