

Exploration and Practice of Intelligent Manufacturing Upgrade in the Printing and Packaging Industry

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Abstract

This paper analyzes the current situation of the printing and packaging industry in Longgang City. Taking Company J as the research object, it analyzes the pain points in the company's production and operation, proposes an intelligent manufacturing upgrading plan, aiming to promote the application of intelligent manufacturing technologies in the printing and packaging industry of Longgang City. Finally, in light of the current shortage of intelligent manufacturing talents in Longgang City, the paper puts forward countermeasures and suggestions for talent cultivation.

Keywords: Longgang City, printing, packaging, intelligent manufacturing.

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I. Introduction

"Made in China 2025" is the action plan for China's first decade of implementing the strategy to become a manufacturing power.[1]

With the advancement of the "Made in China 2025" strategy, a consensus has been reached across all sectors of society: it is essential to accelerate the transformation and upgrading of the manufacturing industry, and comprehensively enhance the quality of industrial development and core competitiveness. Longgang City has made a leap by upgrading from a township to a county-level city, setting a national example. However, in the industrial production of printing and packaging, the overall level of intelligent manufacturing remains relatively low. Taking Company J as an example, this paper explores the intelligent manufacturing upgrading of the printing and packaging industry in Longgang City.

II. Current Situation Of The Printing And Packaging Industry In Longgang City

Longgang is the city with the highest concentration of printing industry in China, boasting 30 printing industrial parks and nearly 150,000 employees. The printing and packaging enterprises in the city mainly engage in offset printing, gravure printing, letterpress (flexographic) printing, screen printing and digital printing. When subdivided by process, they also include heat transfer printing, water transfer printing, UV printing, 3D stereoscopic printing, sign and label printing, laser anti-counterfeiting printing, wooden box packaging printing and fabric printing. The substrates cover paper, plastic, metal, cloth, wood, plastic weaving and composite materials. With a complete supporting industrial chain, Longgang has earned the title of "China's Printing City". By the end of 2022, there were 867 enterprises holding printing operation licenses in the city, including over 180 above-designated-size enterprises and 95 high-tech enterprises (accounting for 63% of the city's total), with approximately 20,100 enterprise employees (Source: Longgang Economic Development Bureau).

To promote the transformation and upgrading of the industry, Longgang City has introduced many

policies. Specifically, the government focuses on upgrading billions-level traditional industries and vigorously fosters three key emerging industries. It also plans for a digital economy industry. From the perspective of key indicators, the entire industry has the following problems:

- (1) The three major traditional industries still occupy an absolute dominant position in Longgang City's manufacturing sector, facing enormous pressure for transformation and upgrading.
- (2) The output value of enterprises above designated size is relatively small. Among the 18,922 enterprises in Longgang in 2021, only 324 enterprises were above designated size, accounting for 1.71%. The total output value of these enterprises reached 14.179 billion yuan, with an average output value of only 43.76 million yuan and an even lower median (Source: Longgang Economic Development Bureau).
- (3) The industry lacks listed companies that hold a leading position in the sector.

The upgrading of Longgang City's printing and packaging industry requires the promotion and application of advanced intelligent products and new technologies, the empowerment of intelligent manufacturing technologies in the industry's production and operation, as well as the transformation and upgrading of a group of leading enterprises through intelligent manufacturing technologies to set examples, which can then be replicated and promoted.

III. Key Technology Of Intelligent Manufacturing In The Printing And Packaging Industry

Manufacturing execution systems

The core of the MES system platform is a factory modeling environment that combines different application functions together in a building-block-like manner to define execution logic. Based on actual equipment, areas, pipelines, and business processes, factory modeling is conducted using the factory model hierarchy of the international MES industry standard ANSI/ISA-S95, assisting enterprises in production planning management, process control, product quality management, inventory management, etc. [2]. For printing and packaging enterprises, due to the large number of production equipment and inconsistent interfaces, PLC transformation is currently widely adopted. By utilizing the existing interfaces of the equipment and then installing various sensors to complete equipment information data collection, monitoring of underlying equipment is achieved.

Enterprise Resource Planning

Enterprise Resource Planning (ERP) is a management philosophy for supply chains, based on information technology and systematic management concepts. It provides a management platform for decision-making and operational tools for enterprises. In the printing and packaging industry, real-time monitoring and management of the supply chain, system integration of information such as orders, shipping, raw material supply, and inventory, and adjustments based on plans and production conditions can assist in production decision-making. The application of ERP systems helps enterprises develop production management processes, establish inventory forecasting, material forecasting, and production process forecasting, thus facilitating decision-making for production material distribution and production inventory control. [3]

Warehouse Management System

The Warehouse Management System (WMS) is responsible for the dynamic management of material RFID barcodes and storage locations. Through the AGV scheduling module, it dispatches AGVs to complete material transportation and accurately feeds back real-time information about materials in the warehouse to MES and ERP systems, effectively supporting procurement planning and production execution [4].

IV. Practice Of Intelligent Manufacturing Upgrade In J Company

Basic information of J company

The company is a food packaging and printing enterprise specializing in the production of in-mold labeling and thermal transfer printing films. The company possesses a brand-new high-performance printing machine with 10-color electronic axis and printing equipment such as fully automated computer-controlled tracking and slitting machines, computer-controlled tracking coating machines, and infrared scanning detectors are employed.

Table 1 Basic Information of J Company

Business Type	Food packaging and printing	Main product categories	In-mold labeling & Heat transfer printing
Number of workers	300	output scale	100 million
Digitalization status		Use Yinzhi software	
Main equipment status		Currently available are 10-color electronic-axis high-performance printing machines, fully automatic computer-controlled tracking slitting machines, computer-controlled tracking coating machines, and infrared scanning inspection devices, among other printing equipment.	

Current status and pain points of J Company

Informationization status: There is a certain foundation, with dedicated personnel responsible for maintaining the currently in-use Yinzhi ERP software system, which can fulfill the issuance of sales and production tasks. However, there are pain points in the ERP production feedback loop, making it impossible to obtain real-time production data.

Management status: Currently, the costs of communication, tracking, and statistics are relatively high. Work reporting forms are generally entered manually. Without being entered into a digital management system, data flow cannot be formed, and data cannot be effectively utilized for production management.

By analyzing the company's production processes, significant issues were identified at certain process nodes, which are marked as shown in the figure below.

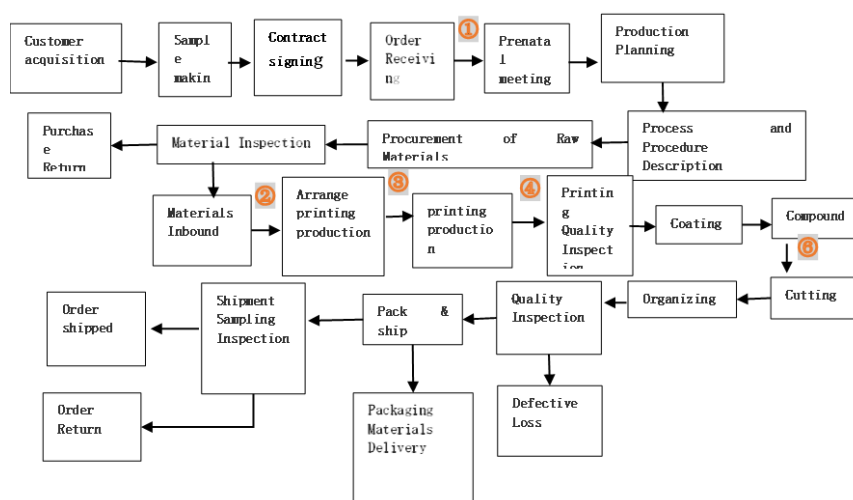


Fig1: Production flowchart of Company J

- (1) The estimated delivery date of orders is inaccurate, and the production progress cannot be monitored, resulting in widespread delays in order delivery.
- (2) There is no standardized warehouse management, and the data display boards for products, materials, and auxiliary materials are missing.
- (3) In the production scheduling process of the printing machine, scheduling personnel cannot understand the production load situation through the system, making scheduling difficult.
- (4) The information and data of each process are manually and time-laggedly recorded, resulting in poor timeliness and affecting the subsequent scheduling of work orders.
- (5) There is no inventory control in the workshop, and there is no association with production picking.
- (6) There are omissions in production, often resulting in the next process not receiving notification even after the previous process has been completed.
- (7) The amount of basic production data is large, and historical production data cannot be accessed.

Intelligent Manufacturing Upgrade Plan for J Company

Based on the current production status and pain points of the company raised in 4.2, solutions for upgrading and transforming to intelligent manufacturing are proposed, as shown in Table 2.

Table 2 Solutions for the Intelligent Manufacturing Upgrade of Company J

issue	solution	expected effect
Order delivery schedule is not accurately determined	Provide overall progress reports on sales orders, production progress reports in the workshop, workshop production load reports, and other production reports to provide data support for delivery time planning	Increase the order delivery accuracy rate by more than 10%, and Phase 2 can achieve automated delivery time estimation
Printing schedule work is difficult	Provide real-time production progress reports and workshop load charts of printing workshops, along with simple scheduling functions.	Improve scheduling efficiency by over 20% and enables planners to better control and make timely adjustments
Manual Process Reporting	The workstations utilize both tablet computers and data collection methods for production data reporting. The printing and quality inspection workshops automatically report production data through data collection methods, while other workshops provide machine station devices for reporting production data.	Real-time reporting provides real-time data support for production and management.
Omitted production process	The workstation tablet displays the production progress of the process task sheet and provides production delay warning.	Resolve process omission and improve production timeliness.
Improper inventory management	Implement standard ERP warehouse process control, and adopt material code + PDA operation solution	The inventory data for raw materials in the warehouse is accurate, and the inbound and outbound operations are efficient and convenient

Table 2 provides detailed solutions for each problem area. Based on the actual production and operation status of J Company, we have proposed the transformation plan shown in Figure 2 below.

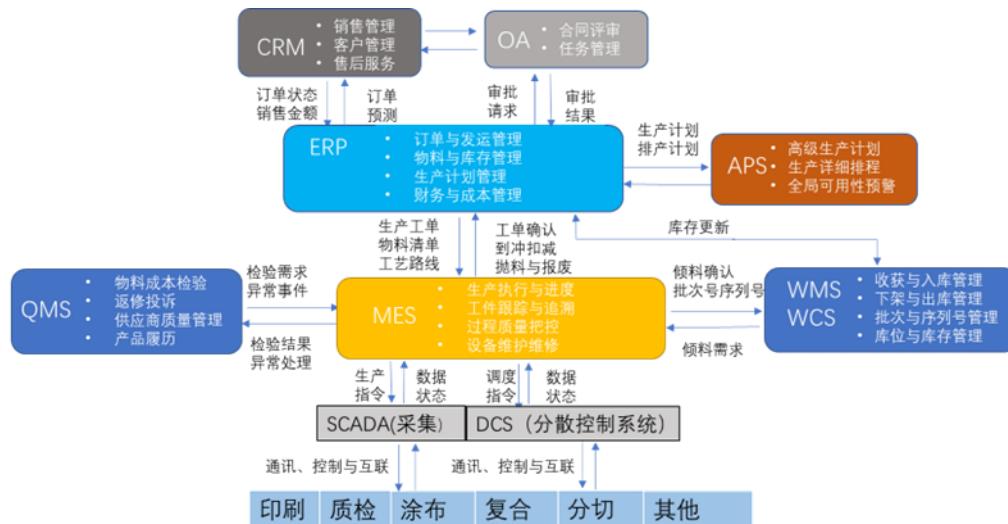


Fig 2: Intelligent Manufacturing Upgrading plan for J Company

Next, we will elaborate on some core functions based on the pain points.

- (1) Production scheduling: After the transformation and upgrading, the production progress can be checked in real-time, and the production delivery date is clear. The plan's executability is improved, and the scheduling is flexible and efficient.
- (2) Material/Finished Product/Defective Product/Semi-finished Product Warehouse Management: After the transformation and upgrading, material management has been digitized, enabling easy and convenient reconciliation of accounts and materials. Instant notification for incoming inspection and warehousing has eliminated management risks associated with incorrect or missed inspections.
- (3) Transparency of production management data: After the transformation and upgrading, production data is displayed on a large screen, making the entire production dynamics clear at a glance. Production operation indicator data can be displayed in graphical form, enabling rapid identification of production issues and effectively solving bottleneck problems.



Fig 3: Production management screen of J Company

- (4) Multi-terminal personalized adaptation: Based on business scenarios, various industrial APP applications are developed according to the role positioning of J company's employees, enabling intelligent management for

employees to "watch online, use online, handle online, and manage online". On-site dashboards can guide production in real time, provide real-time feedback on various abnormal data of the enterprise, and guide managers to quickly handle the abnormalities. They provided effective production data to help management make correct decisions. Multi-terminal adaptation can save operators' time and improve work efficiency.



Fig4: Personalized Adaptation for Multiple Terminals

After the upgrading, the level of intelligent manufacturing in Company J has been greatly improved, achieving. The specific manifestations are as follows: (1) The production process has become transparent, allowing departments to directly view the detailed production progress and the load status of each workshop. (2) The scheduling function has been optimized, giving planners more time to follow up on production plans. (3) Strictly control the record-keeping of inbound and outbound warehouse entries, ensuring that warehouse data is precise and standardized. (4) The warning system automatically reminds of production delays, imminent sales shipments, procurement delays, and other production situations, improving the work efficiency of various departments. (5) Real-time tracking of production progress, with workstation computers collecting real-time output and efficiency for individual process steps, and digital dashboards in the workshop visually displaying task progress. (6) Workers use tablet terminals to directly report work, just as scrap, repairs, and other matters, allowing for real-time tracking of the operating status of various production equipment.

V. Cultivation Of Talents In Intelligent Manufacturing

Due to the relatively low starting point of Longgang City's industries, there is a relative shortage of "high-end composite" talents. The insufficient supply of high-tech talents in Longgang City will restrict the transformation and upgrading of traditional industries. Therefore, it is important and urgent to address the issue of the lack of high-tech talents for intelligent manufacturing in Longgang City. The "National Plan for the Reform of Vocational Education" proposes that the supply of intelligent manufacturing technology talents should rely on vocational colleges to carry out academic education for training. However, the demand for high-end composite talents in the intelligent manufacturing industry is large, and it cannot be fully met by academic education alone. It also requires various training systems to jointly provide various talent support for the industry. [5]

Therefore, there are some suggestions for the cultivation of intelligent manufacturing talents in Longgang City:

- (1) Cooperate with vocational colleges to carry out school-enterprise cooperation in talent cultivation, adopting cooperation modes such as "order classes" and "modern apprenticeship training" to cultivate technical talents.
- (2) Cooperate with social training systems to provide pre-job technical training for new employees and new technology training for existing employees, encouraging them to pursue self-improvement. In this regard,

enterprises should introduce incentive measures, and the government should introduce relevant talent incentive policies.

(3) Led by the longgang government and leading enterprises, develop teaching resources for training in intelligent manufacturing technology and share them to enhance the professional skills of industry professionals.

VI. Conclusion And Outlook

The upgrading of intelligent manufacturing in the printing and packaging industry in Longgang City is not only a technological upgrade, but also an upgrade of technical talents, and a revolution of production management concepts and methods in industry. With the advent of the AI era, the manufacturing of the printing and packaging industry in Longgang City will further evolve towards self-sensing, self-learning, self-decision-making, self-execution, and self-adaptation, injecting new momentum into "Made in China".

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