Design and Implementation of MES System in A Discrete Manufacturing Enterprise

Panlong Sheng[1*], Hao Zeng[2]

[1,2]*Xi'an Eurasia University, No. 8, Dongyi Road, Xi'an, China*
shengpanlong@eurasia.edu, zenghao@eurasia.edu*
Corresponding Author: Panlong Sheng

Abstract

Taking a discrete manufacturing enterprise as an example, this paper designs a set of MES application scheme for the enterprise by analyzing the production status of the enterprise and the development requirements of MES, including the selection of technical route, the design of software architecture, the design of database, and finally realizes the system with code. The problems encountered in the implementation of MES system are analyzed and solutions are proposed. Finally, the system was successfully applied in enterprises, which brought the improvement of production management ability and production efficiency to enterprises.

Keywords*: MES system; Software design; Production management*

1. INTRODUCTION

With the rapid development of China's social economy and the proposal of the "Made in China 2025" strategy, the manufacturing industry has ushered in new development opportunities. However, in traditional manufacturing enterprises, in the process of information interaction between the upper management system and the lower control system, due to the occurrence of abnormal events in the workshop, the real-time status of production resources in the workshop cannot be effectively mastered in the production planning process, and the job plan obtained in the production process is not feasible, The upper managers and the lower operators cannot determine the product information in real time, and the users cannot know the execution of the order state [2]. Based on this, AMR (Advanced Manufacturing Research) proposed the concept of manufacturing execution system (MES) in 1990. MES system is a management technology and real-time information system for workshop level, which is mainly used to solve the problem of disconnection between production plan and production process in the production process of enterprises. The relevant data of each important link in production is recorded in a certain data format with terminal hardware, and then transformed into effective information after system classification and analysis, which is provided to each production function and management department use [3].

At present, the application of MES system in developed countries has achieved industrialization, and the scope of application is also expanding. At the same time, it has also brought huge economic benefits to manufacturing enterprises. However, in China, due to the late start of the manufacturing industry, the low level of informatization, and the certain complexity of the control objects of different types of enterprises in the production and manufacturing process, there are also great differences in the application forms of MES system. The existence of these objective factors makes the application of MES system have the characteristics of diversity and complexity. At present, in general, the development and application of MES system in China is still far behind some western developed countries, so it is necessary to further improve the research and development intensity of MES system [1] [4] [5].

This paper takes the MES system construction of an enterprise as an implementation case. The enterprise is a typical discrete manufacturing enterprise. Its products include industrial parts, alloy materials and products, electrical contact materials and products, etc. it has the characteristics of many kinds of products, immature process and changeable production plan. Based on the full study of the current situation and actual needs of the enterprise, the MES software system is designed and coded for the enterprise. Finally, through the implementation of the MES system, the automation of the production plan management process, the electronization

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and real-time of data collection and production monitoring are realized, which improves the operation efficiency of the enterprise business process, reduces the production cost, and improves the management level.

2. SYSTEM REQUIREMENTS ANALYSIS AND CONSTRUCTION OBJECTIVES

This enterprise is a traditional manufacturing enterprise. At present, it has an ERP planning resource management system, but the overall informatization level of the production workshop is low. The allocation of production tasks still depends on the workshop director and the production team leader through meeting assignment, and the workers confirm the workload and calculate wages by manually signing, which is inefficient and prone to errors. The recorded data is not comprehensive and accurate, and there is a lack of some key data in the production process, such as the record of working hours, etc. There is also a lack of effective data analysis and display tools.

In view of the above problems, it is particularly necessary to establish an integrated information system suitable for the enterprise. The system should be able to realize the integration and data exchange with the old ERP system. It is common to all personnel of the enterprise, common to multiple terminals, and has the functions of real-time information collection, analysis and display, including reasonable hardware and software configuration.

2.1 Production Data Integration Management

The cooperative enterprise has completed the deployment of SAP ERP system for the whole business process management of the enterprise. The production execution system developed by the project needs to realize the docking with SAP ERP system, and read the production order data, material data, personnel data and process parameter data in SAP ERP system through the system interface, so as to support the function realization of MES system; At the same time, the completion status of the production order in the MES system needs to be written into SAP ERP in time, so that the system can objectively reflect the true status of the production order.

2.2 Unified Hierarchical Management of Enterprise Users

This enterprise is a traditional manufacturing enterprise, with a total of six business departments. Because there are many business departments and they are relatively independent, each business department is treated as a sub tenant of the group for unified management. All data is uniformly imported into the data center, but the business is independent. The display interface is also customized according to the needs of each business department. The personnel of each business division can only see the relevant interfaces of the business division, and can see the pages and data within the corresponding authority according to the authority settings. Because each workshop is responsible for different parts, the finished products of one workshop may be the raw materials of the next workshop, and the timely transmission of information between workshops is particularly important. Adjust the operation plan of the workshop in time according to the production of the related workshop. In order to achieve the best utilization of personnel and equipment and the minimum backlog of inventory.

2.3 The Quality of Production Process Is Controllable and Traceable

The quality inspection department can see the completion of each process of the order, inspect the quality of process products, repair unqualified products, and record the types of unqualified products in the system for subsequent statistics and analysis.

2.4 Real Time Display of Production Data and Reports

Formulate rich reports and graphical display forms according to department needs. Workers can see their daily work completion through the report at any time; The workshop director can see the completion and quality of production tasks in the workshop; The top management of the company can also check the production progress of each workshop through reports and displays, and establish a high-level accountability mechanism, which is conducive to the promotion and implementation of MES system.

3. SYSTEM IMPLEMENTATION

When designing the software system, we should ensure the unity of the whole system format and the standardization of software function modules. The software system adopts Microsoft company .Net technical framework, C# language programming, SQL Server and MongoDB database, and C/S architecture for the system.

As shown in the Figure 1, The system adopts a three-tier logic architecture, which is composed of interface presentation layer, business logic layer and data access layer. BLLFactory is a factory class that constructs business classes, IDAL is the interface to be implemented by the class of DAL layer. The system also includes components such as authority component, dictionary component, enclosure component, etc. In software architecture design, hierarchy is the most common and important design idea, which aims to realize the design idea of "high cohesion and low coupling". At the same

time, the system also adopts WinForm framework, which can be compatible with multiple database types and can reduce a lot of trouble for our developed system to support the switching of multiple databases.

The system adopts the method of modular development. The realization of system function modules is shown in the Figure 2 and detailed descriptions followed.

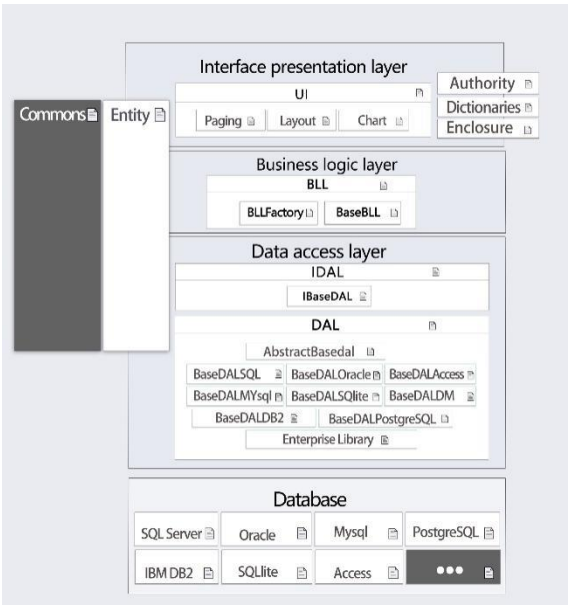

Figure 1: Software development architecture.

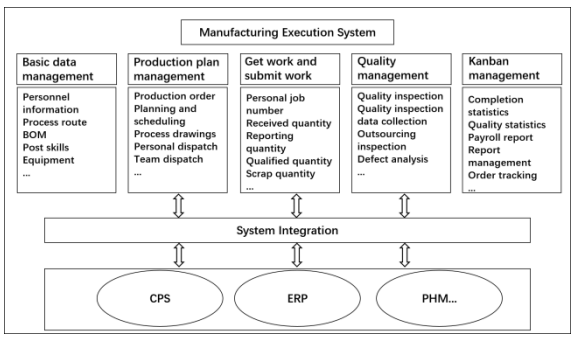

Figure 2: Software function module diagram.

3.1 Basic Data Management

Basic data management is mainly to provide the basic data of operation for the whole system, and realize the maintenance of user basic information, user grouping, user role division, user authority management, etc. At the same time, this module can integrate data with SAP system, realize the synchronization of data with SAP, and maintain data information, including process route, BOM, post skills, equipment capacity maintenance, process labor price maintenance, production team information, etc. It can also realize the operations of data addition, deletion, modification, query, etc.

3.2 Production Plan Management

The production plan management module mainly obtains production orders from the system. The MES system obtains production BOMs, process routes, process drawings, etc. through real-time synchronization of data. According to the factory calendar, personnel status, machine status, the order is automatically decomposed to generate a dispatch plan. The dispatch order realizes the binding of workers, machines, materials and orders, and is dispatched to individuals. Considering the changeable situation of the production site, some processes will change during production, so greater flexibility is set. The workshop director can add, delete and modify processes according to the actual situation. The dispatch methods can be divided into individual dispatch and team dispatch. Increasing the flexibility of the dispatch process is conducive to reducing the resistance to the promotion of MES system. In addition, the module also provides work order printing, work order query, production order tracking and other functions.

3.3 Get Work and Submit Work Management

The submit work module is mainly the worker operation interface, which can be viewed and operated through mobile phones, pads, station machines, computers and other terminals. After the worker scans the code or manually enters the job number, the system loads all the dispatch information under the worker's name, including the process name, machinery and equipment, dispatch quantity and other necessary information. After the worker checks and confirms that it is correct, click OK to receive the work order, and the system will record the time of receiving the work order at the same time. After the workers complete the corresponding tasks, they should submit to the system in time, input and confirm the completion quantity, self inspection qualified quantity, unqualified quantity, scrap quantity, etc. of the day, and then the process will enter the next stage of quality inspection. The corresponding flexibility is also set for the work order get and submit. For the assigned work order tasks, workers can choose to claim multiple times or one time. The submit can also be submitted multiple times or one time to adapt to the changing situation of the workshop at any time.

3.4 Quality Management

The quality management module is a module that can be operated by the quality inspector. After the workers complete the work report, the quality inspector can see the relevant work order information. The quality inspector can inspect the work order by sampling inspection or full inspection, and enter the qualified quantity, unqualified quantity, work waste quantity, material waste quantity, etc. according to the inspection results. For unqualified products, you can also select the

reason for nonconformity and whether further technical review is required from the drop-down list. At the same time, the system can upload relevant pictures. These data provide convenience for further quality statistics and analysis. At the same time, the quality inspection module can also query the corresponding batch orders according to the order number.

3.5 Kanban Management

Kanban management module includes workshop large screen Kanban, workstation Kanban, etc., which mainly displays some important real-time data, such as the dispatch, receive and work report information of the day, as well as quality inspection and review information, order completion, etc. the information can be scrolled on the screen, and workers and workshop managers at all levels can know the current production situation of the workshop in real time through Kanban. It is convenient to know the production progress and deal with emergencies in time.

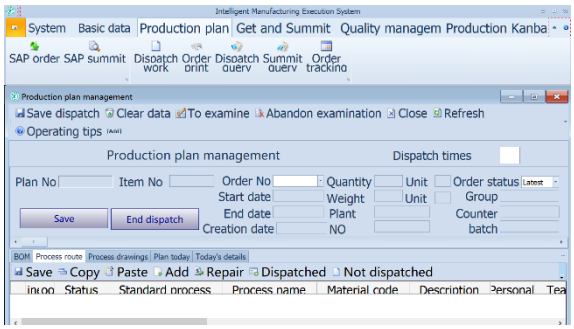

Figure 3: Software implementation diagram.

The final implementation effect of the software is shown in the Figure 3. Some problems should be paid attention to when developing based on WinForm technology. First of all, we should clarify the hierarchical relationship of controls. Generally, the container control acts as the parent control. In order to facilitate the form to adapt to computers with different resolutions, we should pay attention to the attribute management of containers and internal controls when laying out. When the UI control on the interface wants to update the displayed data, it is best to use the Background Worker class and Forms. Timer class to operate, otherwise the control may not respond and refresh in time. Do not use Background Worker class and Forms. Timer class for complex and long-time operations, otherwise the interface may lose response.

4. DISCUSSION ON IMPLEMENTATION RESULTS

Through the design and development of MES software system, it finally realizes the real-time reading of production orders, industrial parameters, BOM, personnel information, process route and other data from SAP ERP system, and realizes the functions of MES dispatch, workshop Kanban, workstation Kanban, WeChat work report, production report and so on. The system response time is less than 2 seconds, and the complex query time is less than 20 seconds, which meets the established needs and goals of the enterprise.

First, the production plan management process is automated. From the original way of manually assigning tasks and confirming work orders with paper orders to the current way of automatically loading and allocating order tasks by reading order data and basic data from SAP system, workers have also realized operations such as reporting and querying by scanning job marks, realizing the informatization and automation of production plan management process. The efficiency of workshop management is improved.

Second, production data acquisition is automated and real-time. From the original manual statistics of relevant information of paper materials, to now realize the paperless and real-time collection of data. For example, when workers get work, record the get work time, and when reporting, record the report time, so as to calculate the standard working hours of each process, which provides a basis for workshop managers to make management decisions.

Third, real-time statistics and display of production data. Through data statistics and display functions, production visualization, anomaly visualization and user-defined analysis of data are realized. The data in production can be displayed in real time through various channels and display forms. The completion of production orders, equipment operation status, on-site emergencies, etc. can be seen intuitively through reports and graphical display methods.

Of course, there are also some problems in the implementation process. Because the current management process of the company is not very standardized, how to make workshop managers and workers smoothly transition and accept the new MES system, it is necessary to retain enough flexibility for the system. In the production plan management phase, you can add or delete processes. In the dispatch phase, you can retain two modes: individual dispatch and team dispatch. When workers get work and submit work, they can be completed at one time, or they can get work or submit work in batches. These are improvement measures made according to the needs of relevant personnel in the actual implementation process. In addition, it is necessary to ensure strong promotion in management. Because grass-roots employees are resistant to new things, how to promote the implementation of MES system is also an important part. Only by making the system truly meet the concerns of relevant personnel can we better implement MES system. The leadership should be able to visually and conveniently see the overall production status and existing problems of the enterprise every day, and the workers should timely see the completion and wages of

the day. Only in this top-down way can the implementation of MES be smoothly promoted.

5. CONCLUSION

MES system is of great significance for manufacturing enterprises to realize information management. It is an important link between the upper management system and the lower control system, and has a significant effect on improving the efficiency of enterprise production management. In the process of this research, the overall design of the system is carried out according to the actual situation of the enterprise by investigating the current situation of the enterprise and the demand for the system. As the target enterprises are small and medium-sized manufacturing enterprises, they should make full use of existing equipment and conditions in the design and implementation process and save costs as much as possible. Software development mainly adopts the method of iterative and incremental development, first developing the most urgently needed and most important functions, and then adding functions step by step after going online, this significantly reduces the risk of system development and ensures the rapid promotion of the launch in the later stage.

Through continuous efforts, the MES system was finally successfully put into operation in the enterprise, and brought the improvement of management ability and production efficiency to the enterprise, and achieved good results. The implementation of MES system is a process of continuous improvement and perfection. In the subsequent development, it is necessary to combine the continuous improvement of enterprise needs and the latest technical direction, realize the ability of complex big data processing and rapid decision-making, and further develop and improve the system in depth and breadth.

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