# Design of Data Acquisition Scheme of MES System for Frame Production Line

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## ABSTRACT

For manufacturing companies, the ability to collect accurate, comprehensive, and real-time production process data is very beneficial to the refined management of the company. Based on technologies such as PLC and Code39 barcodes, this paper designs a data acquisition scheme for the data acquisition module of the MES system of a frame production line in an enterprise. First of all, it analyzes and summarizes the problems existing in the data collection link of the production line. Then, according to the data objects, the corresponding data collection schemes are designed. Practice has proved that the data collection program designed in this paper has brought certain reference value to the enterprise.

## CCS CONCEPTS

• **Information systems**; • **Information systems applications**; • **Enterprise information systems**;

## KEYWORDS

Frame production line, Data collection, PLC, Code39

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## 1 INTRODUCTION

Data collection is a very important module in enterprise production. It provides data support for numerous information management systems and lays a solid foundation for the implementation of information management systems [1] . A good data collection program is very beneficial to the refined management of an enterprise. On the one hand, real-time and accurate production process data is conducive to enterprises to strengthen the control of the workshop production site. Real-time data allows us to have an intuitive understanding of the production site. When problems such as shortage of materials, fluctuations in processing parameters, and equipment failures occur, planners can respond in time and give emergency solutions, such as emergency replenishment, finding reasons for fluctuations, and suspend equipment use [2], etc. On the other hand, a large amount of comprehensive production process data is helpful for enterprises to make production decisions. Through the analysis of production data, enterprise managers can fully understand the overall situation of the workshop, including the bottleneck process of the production line, personnel work efficiency, comprehensive equipment efficiency, material consumption, etc., to help managers find the problems of the production line and improve it to increase production efficiency [3].

## 2 DEMAND ANALYSIS

The manufacturing process data involved in the workshop manufacturing site can be divided into seven categories of data information according to data objects, including personnel information, equipment information, material information, tooling information, production information, quality information, and other information. At present, the data collection and processing links in the production process are still relatively weak in this enterprise. The following introduces the problems of the company's frame production line in terms of data collection from the aspects of equipment data, tooling tool data, material data, personnel data, quality data, and production execution data. The problems are as follows:

1. **Device data.** It can only rely on manual monitoring of the operating status of the equipment, such as switching on and off, and the data is not recorded. A large amount of valuable data generated during equipment processing has not been effectively collected and applied. Equipment operating efficiency cannot be directly analyzed and judged, and it is difficult to accurately assess capacity bottlenecks and quality risks.
2. **Tooling data.** The basic information of tooling storage location, accuracy, version, etc. is not comprehensively recorded, and it is prone to problems such as long time-consuming search for tooling and insufficient accuracy due to excessive use. There is a lack of real-time data records such as the use status of tooling, personnel, and working positions, and it is impossible to understand the whereabouts and dynamics of tooling tools.
3. **Material data.** There is a lack of real-time monitoring of the consumption of materials during processing. The status of materials such as in delivery, processing, to be repaired, scrapped, completed, etc. is missing records.
4. **Personnel data.** Lack of records for personnel attendance, such as on-duty time, off-duty time, working hours, etc.


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There is a lack of real-time monitoring of the work status of personnel, such as production preparation, processing, idle, and rest. There is a lack of real-time records of the work efficiency of personnel, such as per capita work-hour output, qualified rate, repair rate, reject rate, etc.

5. **Quality data.** Process inspection records are inefficient and data records are incomplete. Lack of real-time monitoring of parts, components, product inspection status and subsequent processing, such as inspection time, inspection results, inspectors, subsequent processing, etc. Lack of statistical analysis of inspection results, such as pass rate, reject rate, repair rate, etc. Lack of real-time monitoring of quality issues.
6. **Production data.** Lack of real-time records of processing and outsourcing progress, and unable to understand the current status of processing tasks.

From the above content, we can see that there are certain problems in the data collection link of the current frame production line, and the detailed design of the data collection scheme needs to be carried out for different data types.

## 3 DATA COLLECTION SCHEME DESIGN

This section explains the process of designing their corresponding data collection schemes for different data objects.

### 3.1 Equipment data collection design

At present, there are many sources of existing processing equipment manufacturers, and the equipment arrives in a large span. It is difficult for them to adopt a unified standardized data communication interface to restrain them. There are also some equipment manufacturers that do not consider data collection requirements when developing equipment. In view of the above situation, different data collection methods need to be adopted for different types of equipment. The specific methods are as follows:

1. **I/O acquisition**. First, add an I/O acquisition module in the electrical box of the equipment. Then, obtain the device status information from the device signal output point and collect the current or voltage signal of the device. Finally, it is converted and stored in the server database. The collection principle is shown in Figure 1. The collected data is the real-time status of the equipment, shutdown, running, idle, alarm, status change time and processing data, etc.
2. **PLC collection** [4]**.** First, the equipment has a PLC controller. Then, the equipment PLC interface is used to realize the collection of equipment status and process parameters through the industrial bus communication protocol. The PLC address data address table of the process parameters needs to be provided by the manufacturer. The collection principle is shown as in Figure 2. The collected data is the real-time status of the equipment, such as shutdown, running, idle, alarm, state change and processing data, etc.
3. **File reading collection.** This type of equipment is controlled by the host computer. First, read the files stored on the host computer. Then, collect equipment status and process data by analyzing the content of the data file. The collection principle is shown in Figure 3. The data files are mainly in log, txt, xls, csv, mdb and other formats, and the files stored by each manufacturer are different. File reading mainly collects process parameters, and status data needs to be collected by an additional I/O module. The collected data is the real-time status of the equipment, shutdown, running, idle, alarm, status change time and processing data, etc.

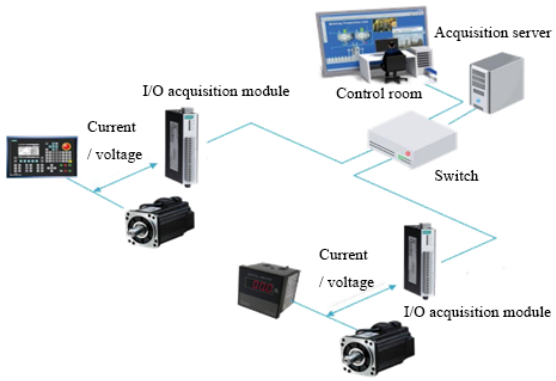


**Figure 1: I/O Acquisition Principle.**

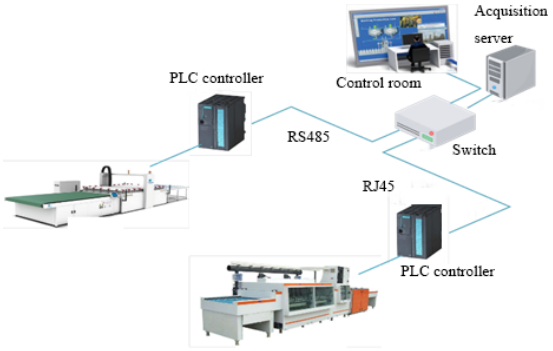


**Figure 2: PLC Acquisition Principle.**

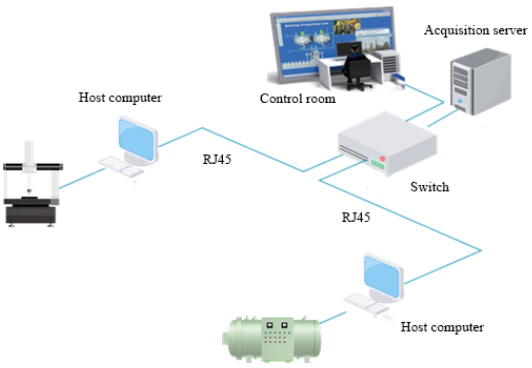


**Figure 3: File reading Collection Principle.**

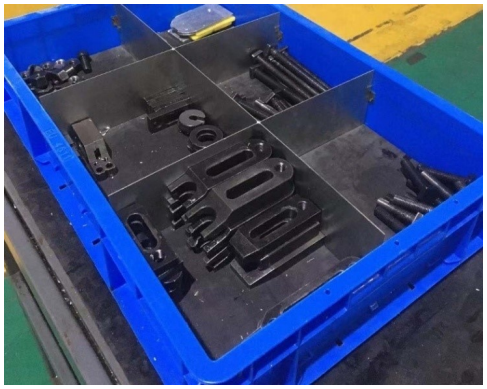

**Figure 4: Various Fixtures.**

**Figure 5: Various Tools.**

**Figure 6: 1105CD Barcode Scanner.**

## 3.2 Tooling data collection design

Tooling tools are mainly various tooling fixtures (Figure 4), knives and various tools (Figure 5). The collection of tooling tool data mainly adopts a combination of scanning bar codes and manual input on the PC side. The bar code mainly chooses Code 39 [5], and the bar code scanner chooses 1105CD bar code scanner (Figure 6). The detailed collection process of tooling tool data are as follows:

1. **Tooling tools are put into storage.** This stage is mainly responsible for recording the basic information of the tooling, including the type, model, warehouse, location, number, inventory, etc. of the tooling. After purchasing a new tooling tool, the administrator first pastes a unique numbered barcode to it (Figure 7). Then, manually input the relevant data through the PC terminal. Finally, put it in storage. When the employee returns the tooling after using the tooling, the administrator can query the basic information and borrowing information of the tooling tool by scanning the barcode of the tooling tool, and then put it into the warehouse after confirming that it is correct.
2. **Tooling tools are shipped out of the warehouse.** This stage is mainly responsible for recording the borrowing information of tooling tools, including the borrower, borrowing time, and expected return time of tooling tools. First, the employee fills out the loan form. Then, the administrator scans the barcode of the borrowed tooling and manually enters the borrowing information into the system. Finally, the tooling tools will be loaned out.
3. **Tooling tools are inspected regularly.** This stage is mainly responsible for recording the inspection information of the tooling, including the inspection date of the tooling, the inspector and the inspection records, such as availability, insufficient precision, maintenance, scrap, etc. First, scan the barcode of the tooling tool and enter the inspection information page of the system. Then, the maintenance personnel manually input the inspection information into the system through the PC.
4. **Real-time status of tooling tools.** This part is mainly for real-time monitoring of the location and status of tooling tools after loaning out, to prevent tooling tools from being idle for a long time. The main monitoring status information is status, working position, user and time. Its real-time status data is associated with the current working status of workers. When a worker makes a job report, the job report information will include the tool number currently in use, and you can know the current status of the tooling tool by querying the tool number.


**Figure 7: Tooling Number Barcode.**

## 3.3 Material data collection design

Materials mainly include raw materials, parts, components and products. For the collection of material data, the two methods of scanning bar code and manual input on the PC side are mainly used for collection. The detailed collection process are as follows:

1. **The consumption data of the material.** When the picker receives the raw materials through the raw material circulation order, the raw materials of this batch are bound with a specific production serial number and are only used for the


**Figure 8: Transfer Order Number Barcode.**


**Figure 9: Production Serial Number Barcode.**

production and processing of a certain part. When the workers are processing, they will manually record the loss data of this batch of raw materials, and will report the loss of the raw materials through manual input at regular intervals. The loss of work-in-process is specific to the individual. In the process of processing, workers will report after the completion of a certain process of each work-in-process, and record the number of work-in-processes that need to be repaired, scrapped, and completed in real time.

2. **The status data of the material.** The status data of raw materials is mainly related to their current business processes. When it is out of the raw material warehouse, the warehouse clerk will scan the barcode of the circulation order number (Figure 8) and the barcode of the production serial number (Figure 9), and the status of this batch of raw materials will change to have left the warehouse. When workers start processing, they will scan the barcode of the transfer order number, and the status of the raw materials will change to processing. Work in progress records status data through its unique barcode. When they enter the corresponding area, the workers will scan their barcodes to record their current location and status, such as warehousing, all sets, delivery, processing, completed, etc.

## 3.4 Personnel data collection design

The collection of personnel data mainly adopts the combination of scanning bar code and manual input on the PC side for collection. The objects collected are mainly processors on the workshop site. The detailed collection process are as follows:

1. **Attendance data.** The company will give each employee an employee card, which contains a unique employee number and employee number bar code (Figure 10). When an employee enters the company and is ready to go to work, he will first clock in at work, and the system will automatically generate the employee's clock in time. When employees are off duty, they also need to clock in after get off work, and the system will automatically generate the employee's clock in time. The system calculates and records the employee's working hours of the day based on the clocking time at get off work and the clocking time at off work.


**Figure 10: Employee Number Barcode.**

2. **Work status data.** The employee's work status data is associated with the employee's area. The workshop area is divided into production preparation area, processing area, assembly and debugging area, inventory area, inspection area and rest area. When an employee enters the corresponding area or leaves the corresponding area, he needs to scan the employee number barcode on the fixed barcode scanner, and the employee's status changes immediately.
3. **Work efficiency data.** When employees process, they will report processing information. By scanning the barcode of the work in process, the processor number can be associated with the work in process. Then, manually input the status of the work-in-progress on the PC terminal, such as repairing, scrapping, completed, etc. When one day's processing tasks are completed, the system will count the number of processing workers, the qualification rate, the repair rate, and the scrap rate based on the information reported by the workers.

## 3.5 Quality data collection design

The collection of quality data mainly adopts the combination of scanning bar code and manual input on PC to collect. The detailed collection process are as follows:

1. **Check and process real-time status.** The inspection process is mainly divided into process inspection, component inspection and final product inspection. After the processor completes the processing of each procedure, the processing of each component and the processing of each product, they need to be sent to the inspection department for inspection. When inspecting the workpiece, the inspector first scans the barcode of the workpiece (Figure 11), then performs the inspection, and finally enters the inspection result, inspection time, inspector, and processing method of the workpiece into the system through manual input.
2. **Real-time monitoring and handling of quality problems**. When the inspector finds that the workpiece is unqualified during the inspection process, he needs to enter the reason for the unqualified into the system and give the processing number bar code (Figure 12). After the processing personnel scan and process the serial number bar code, they analyze the reasons for their unqualified, and clarify whether it is caused by accidental factors or process problems during processing. Finally, manually enter the processing method

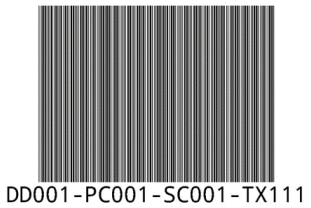


**Figure 11: Workpiece Number Barcode.**


**Figure 12: Processing Number Bar Code.**

in the system and send it to the corresponding department for processing.

3. **Statistical analysis of test results.** After a fixed period of time, the inspector needs to perform statistics and analysis on the inspection results of the completed inspection tasks. Enter the inspected quantity, pass rate, reject rate, repair rate, etc. by manual input on the PC terminal. After completing the one-day inspection task, enter the overall inspection result statistical analysis data.

## 3.6 Production data collection design

Production execution data mainly includes processing progress data and outsourcing progress data. Production execution data is mainly collected by scanning barcodes and manual input on PC. The detailed collection process are as follows:

1. **Processing progress data.** The processing progress data is mainly reported by the processor. When the processor completes a certain process, it will be reported on the processor's workbench. First, scan the barcode of the processed workpiece. Then, manually enter the content and processing quantity of the completed process and so on. When employees need to know the processing progress, they only need to enter the order number in the progress query interface to query the details of the processing progress of the products in the order.
2. **Outsourcing progress data.** The progress of outsourcing processing is mainly recorded by the personnel who contacted the outsourcing company. After the grandfather company completes the processing task, it will apply to the liaison for outsourcing inspection and storage. Then, the liaison officer will scan the barcode of the outsourced workpiece and manually enter its completion status and application inspection status.

# 4 CONCLUSIONS

Based on technologies such as PLC and Code39 barcodes, this paper designs corresponding data collection schemes for 6 objects, including equipment data, tooling data, material data, personnel data, quality data, and production execution data. This has laid a solid foundation for the design of the data acquisition module of the MES system of the frame production line. Practice has proved that the program has brought certain reference value to the enterprise. This article can bring some help to practitioners in related industries.

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