Application of integrated manufacturing system of flexible production line in spacecraft manufacturing line

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Abstract. The realization of automatic control and information management is an important basis for the automation, information and intelligence of manufacturing industry. We have applied computer and network technology, programmable control technology, field-bus technology, information management and other technologies to the control, monitoring and management of the production line. We have developed a flexible production line integrated manufacturing system, which realizes the local monitoring and remote monitoring management of the operation status of multiple equipment on the production line of manned spacecraft manufacturing equipment, and creates a new intelligent manufacturing system Pattern.

1. Introduction
There are many kinds of spacecraft research and development, complex technical status, many types of manufacturing equipment, and a large amount of production information and quality information. Most of the equipment mainly relies on the way of manual collection of information on the process record card, which is inefficient and unreliable. The product quality reliability data package formed is not complete, detailed or targeted, with poor tractability, and the means to support refined quality management are insufficient. The parameter monitoring of some manufacturing equipment mainly realizes the real-time monitoring of the field equipment parameters through the touch screen mode, which can only see the operation of one equipment on site, and it is difficult to see the operation of other equipment synchronously and remotely.

The long-term operation of spacecraft in orbit puts forward higher requirements for the reliability of data package in the development process. For the key structure, the digital acquisition and storage of manufacturing process parameters must be carried out in the production. At the same time, a lot of process information needs to be monitored for tolerance and data mining for multi-information integration, so as to provide guarantee for the quality monitoring of manufacturing process. With the combination of advanced quality control technology, information processing technology and modern quality management methods, it can provide strong support for digital integrated manufacturing system, quality management and technical state control in the whole process of model manufacturing.

This design starts from the actual needs of the project, combined with scientific theoretical analysis, design and manufacture a production line integrated manufacturing system with practical application value. It realizes the seamless combination of information, automation, intelligence and on-site manufacturing process, and significantly improves the use efficiency and management level of production equipment.
2. System objectives
By means of digitization and information, the current production mode with paper drawings as the main control will be changed. Take the whole life cycle management of products as the core to improve the technical state control ability and process design ability of products. Through the information integration of digital system with existing equipment and new equipment to achieve production beat control and logistics collection. Through the combination of automation equipment and digital equipment, digital workshop bulletin board as the representative of workshop field digitization and digital means to coordinate production line capacity to improve the overall operation efficiency and production capacity of the production line; Through the integration of manufacturing equipment and digital system, improve product quality control ability; through the construction of manufacturing process information integrated platform. Realize real-time collection and centralized display of production process information, and improve production control capacity.

3. Overall system architecture
The integrated manufacturing system of manned spacecraft production line uses industrial protocols such as real-time database based on Industrial Ethernet and OPC-UA to connect manufacturing equipment distributed in different workshops. These manufacturing equipment are combined with the equipment or instruments for field information collection. It can sense the state of various parameters of the equipment in real time, convert these state signals into digital signals, and transmit them to the equipment PLC or computer through a specific digital communication network. When necessary, the upper control system can also send control signals to the equipment. After receiving the real-time information of the equipment, the upper control system displays it to the end-user in appropriate forms such as voice, figure, image, etc., so as to achieve the purpose of information integrated display. In addition, after the real-time data is processed, the user can be informed of the status of various parameters of the equipment (alarm, normal or alarm recovery). These processed data also need to be saved in the database of the integrated system, and can also be transmitted to different monitoring platforms through the network system.

According to the overall objectives and specific requirements of the project, combined with the existing business system, production characteristics and information level of the enterprise, the overall architecture of the system is shown in Figure 1. The equipment of each equipment workshop corresponds to a local database system, each local database system is directly connected with the corresponding equipment, and the real-time acquisition data is stored in the local database, where the data acquisition and local database storage are realized by the self-developed upper computer program. The equipment of each equipment workshop corresponds to a local database system, each local database system is directly connected with the corresponding equipment, and the real-time acquisition data is stored in the local database, where the data acquisition and local database storage are realized by the self-developed upper computer program. Then, through the developed data synchronization system, the local databases of 7 devices are synchronized to the system database in real time. Finally, through the information integration system installed on the PC client of each equipment workshop, the real-time data and historical data in each local database and system database are displayed through processing.
Figure 1. Overall system architecture
4. System function module design

The human spaceflight information integrated manufacturing system mainly includes the production equipment data integrated control management subsystem and system function management subsystem. The system function module design is shown in Figure 2.

![System function module](image)

**Figure 2.** System function module

4.1. Integrated control of production equipment data acquisition

The data acquisition integrated control includes the data acquisition of 7 devices on the production line. Data collection adopts a variety of data collection methods to achieve seamless integration of physical objects such as personnel, materials, products, instruments, equipment, tools and information systems. Collect the physical state data, record the state information of each business process in the scientific research and production process, realize personnel authority management and equipment monitoring, and lay the foundation for the final formation of closed-loop management of technical state and quality trace ability. Physical state integrated control includes four layers: physical layer, information medium layer, data acquisition layer and information system layer. The physical layer includes all entities involved in the field production process of the workshop, such as personnel, materials, products, instruments and equipment, tools, etc. The working state information of these entities needs to be collected in real time; the information medium layer includes information carriers such as magnetic card and bar code; the data collection layer includes data collection equipment such as card reader, scanning gun, equipment data collection module; the information system layer includes PDM, production planning and scheduling system, workshop manufacturing execution system, workshop bulletin board and other business systems. The integrated control technology of physical state is based on the unified physical identification, which combines the four levels organically, and realizes the functions of personnel authority control, material rapid positioning and tracking, equipment data identification and production process record.
4.2. System function management

The system interface is simple and comfortable, and the color matching and layout are coordinated and consistent. The function operation is simple and convenient. Meanwhile, it can optimize the detail design, reduce the operation, better serve the operators and improve the production efficiency by referring to the opinions of the field operators. The system function management subsystem mainly includes user management, task management, equipment management, data display management, historical data management, statistical analysis management and personal information management.

(1) User management: through the collection of personnel magnetic card data, to achieve the purpose of personnel authority control. By swiping the card to log in the system, the workshop personnel can identify the corresponding identity and authority, and carry out the corresponding business operation, which can not only ensure the security of the system, but also save the operation time and improve the work efficiency.

(2) Task management: task management module includes new task and historical task query. The new task is to create and manage the production task of the integrated manufacturing system. The new task flow chart is shown in Figure 3. By scanning the bar code of the material, the material information can be quickly and accurately identified. The system can automatically separate the plan number from the bar code, query the location in the MES system, obtain the task from the system, and record the operator, start time and finish time of the task; historical task query can retrieve all tasks by task number, plan number, batch number, product model, task number, product name, product drawing number, department and other parameters.
Figure 3. New task flow chart

(3) Equipment management: equipment management is mainly to introduce each equipment, with equipment name, equipment introduction, equipment picture and location information. In addition, the administrator can equip multiple operators for each device and set the information of the station where the device is located. The personnel equipped for each device can be deleted or added.

(4) Data display management: the data display module consists of two parts, one is dynamic real-time display, that is, the parameter value of the running equipment is displayed in real time, which is convenient for users to observe the equipment status in real time. The other part is data change trend display, that is, by selecting a parameter of a certain device in a certain period of time change trend, displayed by line chart.

(5) Historical data management: historical data retrieval supports data query, video query, pipeline file query, picture query, log query, etc. Data query is divided into query by equipment and query by
task. Query by equipment can retrieve historical data by retrieving equipment number, parameter and date; query by task can view corresponding historical data by retrieving task number, plan number, batch number, product model, task number, product name, product drawing number, Department, start time, end time, etc. Video query includes real-time video and history video. The real-time video does not need to be set, but can be played by clicking directly. The history video needs to be played by setting the start time and end time. Management file query can retrieve corresponding data files according to process ID, batch number, version number, measurement serial number, task number and other fields. Click the file name to open the corresponding folder and view the XML file under the folder. Image query can search task number, plan number and other information to view the corresponding theoretical model map and actual model map, and support image zooming, dragging and other comparative functions.

(6) Statistical analysis management: classify and count the collected data. The operator can query and count all kinds of data according to the existing database at the same time, and then display them in the form of pie chart, histogram, line chart and so on, which is convenient for the operator to analyze and draw conclusions.

(7) Personal information management: you can view personal information and modify personal information.

5. System hardware topology design
The system is based on the design concept of information chemical plant, advanced automation, information, network technology, process monitoring module and function management module of each subsystem. Combined with. Net development platform, SQL Server 2008 database platform, automatic detection technology, radio frequency identification technology, high-speed industrial Ethernet and other computer software and hardware technology, the various information management of spacecraft production workshop is organically combined with the automatic control of executive level equipment. It realizes the automation of workshop information management, production process and material flow. The hardware topology of the system is shown in Figure 4.
6. Conclusion
The integrated manufacturing system of the flexible production line of manned spacecraft realizes the data collection and centralized storage of the material status, production process, operation record, quality record, equipment status, workshop environment, production abnormal information, etc. in the production site, and completely records the status information of the production process. It realizes the integrated integration of key manufacturing equipment status, product physical information and production process management information system. The system assists the workshop to carry out production management, improve production efficiency, realize the whole process traceability of product quality and carry out intelligent transformation, and takes a new step in intelligent manufacturing.

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