

Research on quality information integrated management for complex precision parts in multi-varieties and small batch manufacturing mode

Lihua Yu^{*}, Qingsheng Xie

Key Laboratory of Advanced Manufacturing Technology, Guizhou University, China

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Abstract

There were many problems such as quality information interaction low, real-time monitoring and tracing of production quality difficulty in workshops for multi-varieties and small-batch complicated precision parts. These problems restricted seriously the improvement of product quality. Therefore, a quality information integrated operation mode was built, combining with advanced management thoughts of lean management and integration. The main characteristics of quality information integrated management process were analysed. At last, the mode was applied in a manufacturing enterprise in CASTC 061 base for testing its effects. Results show that it is successful and satisfactory in practical application effect.

Keywords: workshop, integration, multi-varieties and small-batch, quality control

1 Introduction

With more and more various customer requirements and rapid product renewal, the production mode of manufacturer has been gradually changing from the traditional mass production into multi-varieties and small-batch production. More stringent requirements on quality control must be imposed for complex precision parts [1-4]. How to achieve quality information integrated management has become an urgent problem for the manufacturing enterprises.

A lot of research on quality information integration technology has achieved fruitful results at home and abroad. Gen-bao Zhang proposed a dynamic quality tracking model to achieve dynamic tracking and traceability of product quality in the manufacturing execution processes based on Computer Aided Process Planning (CAPP) and Manufacturing Execution System (MES)[5]. Liang Tong presented a function interoperation method of multiple heterogeneous systems in discrete manufacturing process according to problems [6]. Hui-ying Qi Proposed an integrated system scheme to realize uniform access of distributed and heterogeneous network resources [7].

In summary, domestic and foreign scholars have made many valuable results from the viewpoint of integration technology. However, research on quality information management is still relatively scarce from integration operation between departments and workshop. Therefore, the paper researched deeply the problem on quality information integrated management in the workshop.

2 Establishment of the quality information integrated operation mode

2.1 EXISTING PROBLEMS

Quality information has the characteristic of more sources, large volumes of data and frequent flow in workshops for multi-varieties and small-batch complex precision parts. Moreover, the traditional quality control mode often results in poor credibility, interactivity, utilization and traceability of quality information. Production quality cannot be controlled effectively. The main problems are as follows [8-16]:

- 1) Quality instruction information such as quality control tasks, CAD models and technology documentation was transmitted in hand-form in workshop, which made its adjustment and conversion inconvenient and often caused production confusion.
- 2) Dynamic quality information such as quality inspection, unqualified parts and equipment running information was collected in hand-form and recorded in paper-based way in workshop at present. The backward way made its consistency, confidence and systematization poor.
- 3) Various departments such as product design, materials, production and quality control department respectively managed their own quality information. This kind of operating mode made quality information scattered, nonstandard, and isolated in the process relatively. Meanwhile, it became difficult to share, query and trace one for the workshop.
- 4) Quality information transmitting was by form and hand. This kind of ways not only made interactivity

^{*}Corresponding author's e-mail: yulihua01@163.com

and utilization poor, but also showed abnormal quality-events not to be found in time and tackled efficiently. At the same time it was hard to monitor production quality effectively on line.

These problems above had not only seriously affected the comprehensive utilization and effects of quality information and reduced the quality control capacity, but also greatly restricted the improvement in quality management level.

2.1 THE GENERAL FRAMEWORK OF QUALITY INFORMATION INTEGRATED OPERATION MODE

According to quality information characteristics and management problems for this workshop, a quality information integrated operation mode was proposed. Its basic idea was that real-time interaction of quality information was extended to the workshop field, based on network multi-function interactive information terminal [17]. Quality information integrated operation has achieved among personnel, equipment, workshop scheduling, quality department, design department and enterprise senior by real-time transmission, adjustment and interactive feedback of quality information.

Based on the idea of establishing the operation mode, its general framework was constructed. As Figure 1 shown, it is mainly made up of five-level which is respectively objective, business execution, information interaction, status analysis and information collection level.

1) Objective level.

In order to achieve operation mode above, according to quality information characteristics and management problems existed currently in workshop, an optimal operating objective set was established as follows:

- a) the collection efficiency, accuracy, interaction, comprehensive utilization and traceability for quality information was always expected,
- b) abnormal quality-events were processed as efficiently as possible,
- c) reject parts were as few as possible.

2) Business execution level.

The achievement of operating objective needed the support for business activities under the operation mode. The departments related to business activities included design, production, quality, equipment and measuring instrument supplies department.

3) Information interaction level based on network multi-function interactive information terminals.

Information interaction level described information interacting process of the operating mode. Network multi-function interactive information terminals were the key of information interaction. All quality information would eventually be pooled into interactive information terminals, which are from product and process design, production job scheduling arrangements, production information collection and quality management.

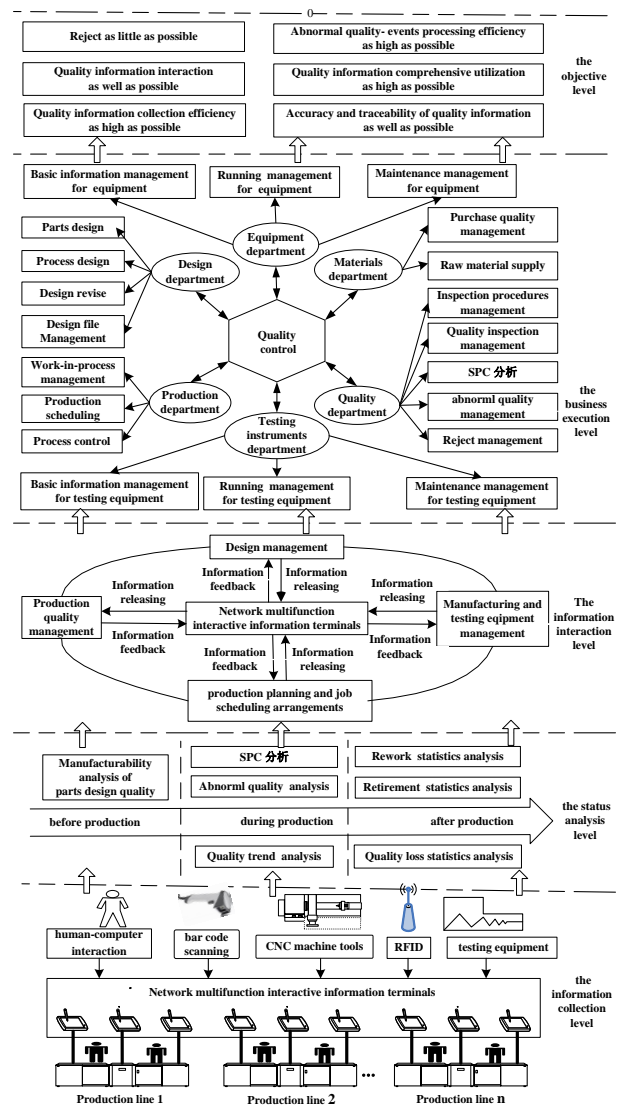


FIGURE 1 General framework of quality information integrated operation mode for workshop of multi-varieties and small-batch complex precision parts

4) Status analysis level.

The status analysis level provided various analysis and decision-making tools of quality state for production quality control. The tools included as follow:

- a) manufacturability of parts design quality before production,
- b) SPC(Statistics process control)of key process, abnormal quality and quality trend analysis during production,
- c) rework, retirement and quality loss statistics analysis after production, and so on.

5) Information collection level.

The information collection level obtained the quality-related information to support quality information integrated operation by various means during production in workshop. The information collecting was by means of testing equipment, bar code scanning, FRID, CNC machine tools, and human-computer interaction, and so on. All pro-

duction quality information collected were transferred and integrated into network multifunction interactive information terminals.

2.1 THE MAIN PROCESS FOR QUALITY INFORMATION INTEGRATED MANAGEMENT

The main purpose of quality information integrated management is to support the integrated operation of quality management activities. The management business includes the quality control plan made and issued, production quality information collected real time, quality inspection and control, statistical analysis and query for quality information, nonconforming product management, quality improvement, quality information feedback, etc. Quality information integrated management process is as shown in Figure 2.

The main characteristics of quality information integrated management process:

1) Based on the multi-function interactive information terminal, production workers and quality inspection personnel

can receive quality control tasks, the machining process document and quality inspection procedures in real-time. They can collect and feedback quality data in real-time on site.

2) Based on the management terminal, the process management is realized easily. the process includes the disposition of nonconforming products, the process for scrap, the process for repair and so on. For another, the process management is integrated into the news system with a prompt, from "people work" into "thing for people". Then the efficiency of nonconforming products disposition is improved greatly.

3) Based on the management terminal, multi-function interactive information terminal and integrated interface, the organic connection of quality planning layer and workshop site and operation workers is established, Collaborative quality control capacity is improved through quality information interactive feedback and closed-loop control between departments.

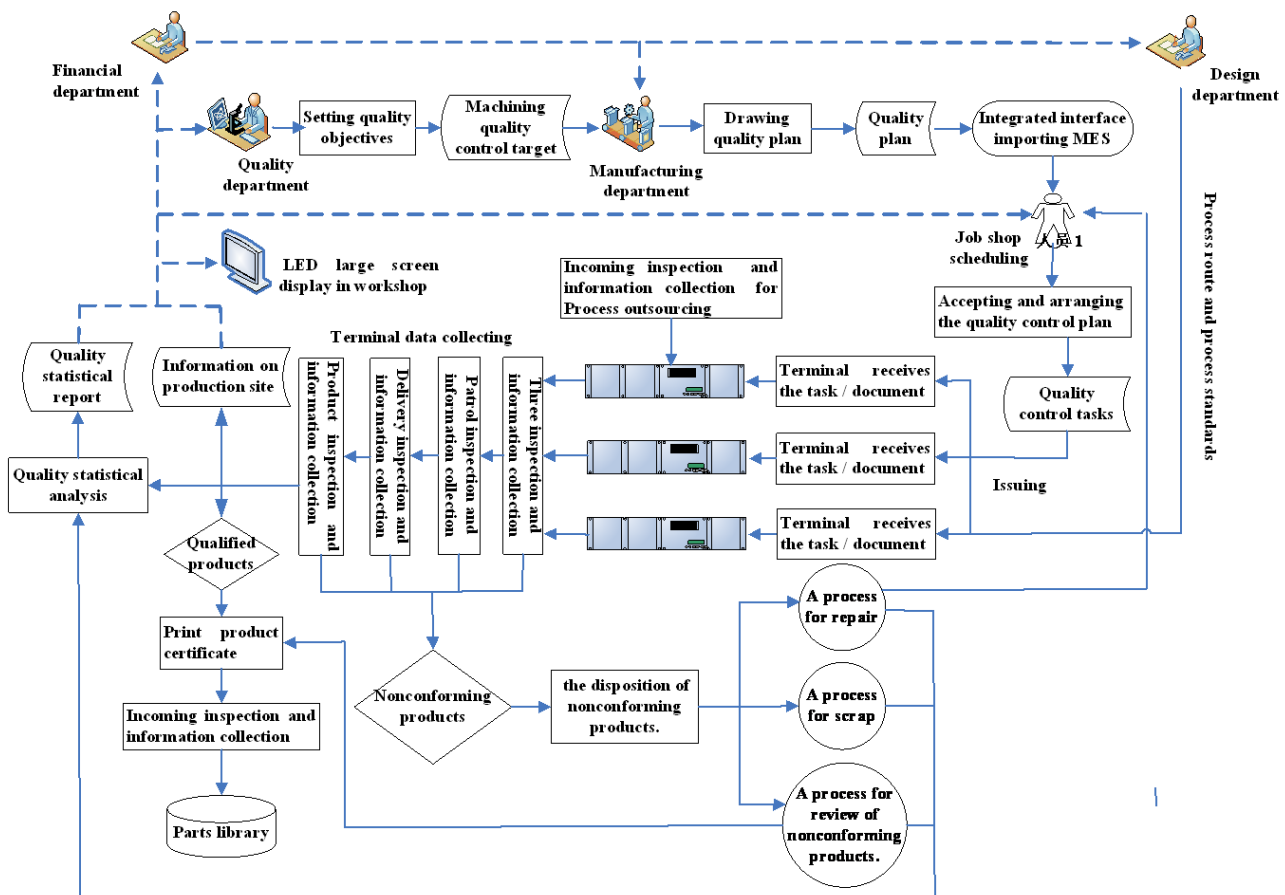


FIGURE 2 Main process of quality information integrated management for workshop of multi-varieties and small-batch complex precision parts

3 The application and practice of the mode

At present, the management mode above has been successfully applied in a manufacture enterprise in 061 manufacturing base of China Aerospace Science and Industry. The manufacturer is a large industrial enterprise, and has typi-

cal production mode for multi-varieties and small-batch complex precision parts. The characteristic of its workshop is diversified process rout and high-quality requirements, which makes information sources a lot, amount of quality information large and information flow frequent among departments. However the old mode had failed to meet the

confidence, interactive feedback and traceability requirements of quality information. So the manufacturer had implemented manufacturing process information systems lean production planning and manufacturing execution system (HTK-eMES). As a result, production management and manufacturing capabilities of the enterprise has improved effectively. Quality information integrated operation is

an important part of the HTK-eMES in parts production workshop. Quality information integration and application is shown in Figure 3. The operating mode has achieved many processes integrated operation and improved the quality management. These achievements and improvements include as follows:

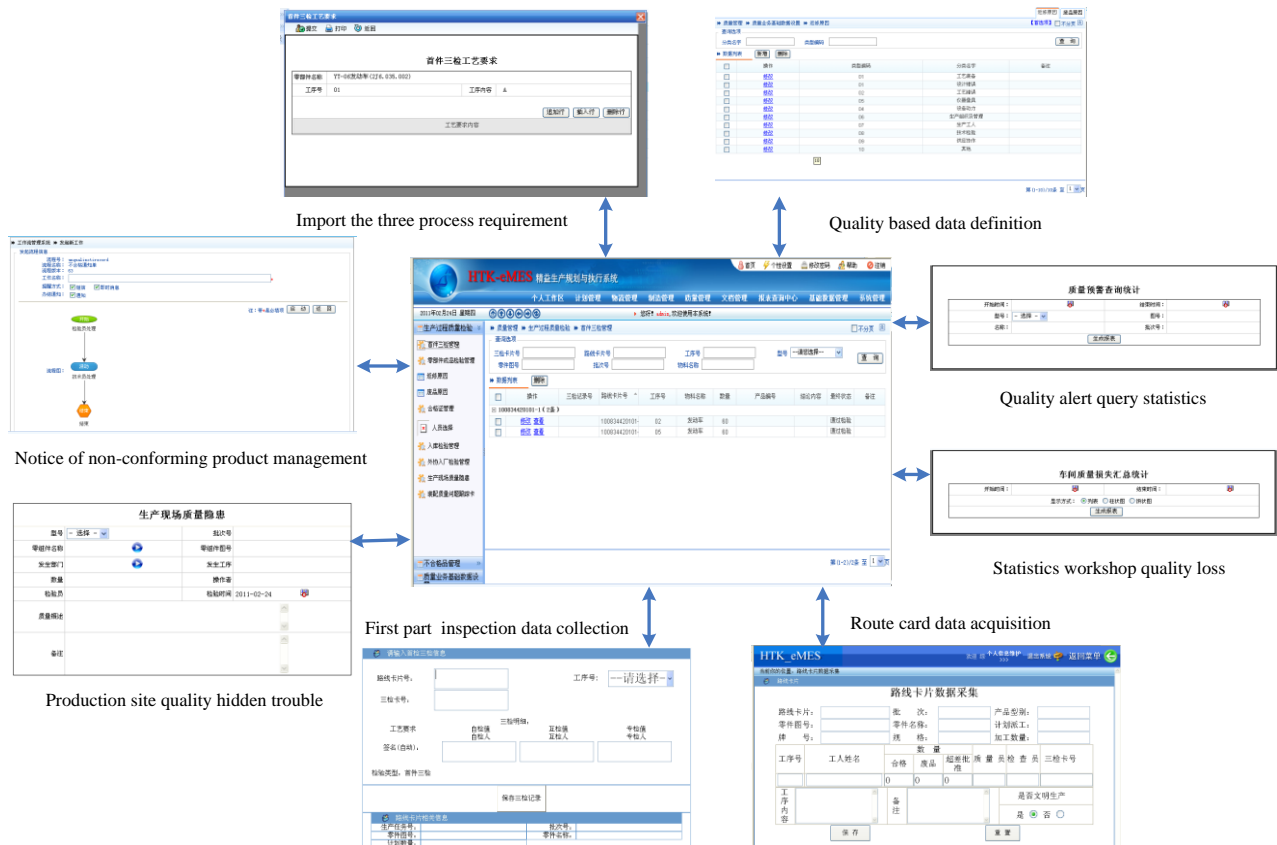


FIGURE 3 System integration and application diagram

- 1) The operating mode has achieved the efficient of quality information collection and improved its accuracy, real-time and systematic.
- 2) The operating mode has achieved the real-time, electro-nization of information transmission and improved information interaction and traceability.
- 3) The operating mode has achieved the real-time and hyalinization of quality control, and reduced reject and rework rate and quality loss.
- 4) The operating mode has achieved the interactive feedback of quality information and the close-loop operation of quality control, and improved the optimized organization capacity of quality information management and cooperative quality control capacity.

Conclusions

There exists many problems on quality information management in workshops for multi-varieties and small-volume complex precision parts. These problems include low con-

fidence, interactivity and utilization of quality information and difficulty in real-time monitoring effectively and tracing of production quality. In order to solve these problems, firstly a quality information integrated operating mode was proposed in this paper. Secondly, the general framework of the operating mode was build. And the main characteristics of quality information integrated management process were analysed. At last, the mode was applied in a manufacturing enterprise in CASTC 061 base for testing its effects. The operating mode gets many achievements including: realizing the accuracy, real-time and systematic of quality information collecting, achieving the real-time of information transmission, achieving the real-time and hyalinization of quality control, achieving the interactive feedback of quality information and the close-loop quality control. In a word, the mode had not only realized quality information integrated operation through whole quality information chain among departments, but also improved quality control efficient and reduced reject and rework rate and quality loss.

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Authors



YU Lihua, born in November 1975, Tongren, China.

Current position: senior experimental division and PhD in Guizhou University.

University studies: mechanical design and manufacturing in Jiangsu University.

Scientific interest: manufacturing quality management, advanced manufacturing technology.

Publications: 1 patents, 10 papers, 1 book



XIE Qingsheng, born in October 1954, Guiyang, China.

Current position: doctor of Mechanical Engineering, professor and doctoral supervisor in Guizhou University.

University studies: railway vehicles in Southwest Jiao Tong University.

Scientific interest: advanced manufacturing mode and information system.

Publications: 2 patents, 50 papers, 3 books.