Research and Development of CAPP and Quality Control Integrated System

Yao Yiyong, Feng Hao, Zhao Liping, Yan Peng

State Key Laboratory for Manufacturing Systems Engineering, Xi'an Jiaotong University, Xi'an, Shaanxi, 710049, China
School of Mechanical Engineering, Xi'an Jiaotong University, Xi'an, Shaanxi, 710049, China
yyyao@mail.xjtu.edu.cn

***Abstract*—With the higher requirements on quality of products in the market, an integrated Q&P system based on the integration of CAPP (Computer-Aided Process Planning) with quality control technology is developed, and it respectively adopts SPC (Statistical Process Control) and process documents as its key quality control technology and direction. Then, the connection between network-based CAPP and quality control is established by the integration of CAPP resources with quality resources of the whole enterprise. In addition, based on the third-party COM component and C# software develop platform, several software packages such as CAPP process documents compiling, SPC and control charts are built to meet the demands for real-time data acquisition, statistic analysis and quality control in network-based manufacturing.**

Keywords-CAPP; SPC; C#; quality control

I. INTRODUCTION

As the traditional CAPP (Computer-Aided Process Planning) is not integrated with quality control technology when designing process, the quality of products cannot be effectively ensured with the disjunction in quality control between the process design stage and the manufacturing stage [1]. On the contrary, the quality control method which only depend on the checking and screening for the final products is an uneconomic after-test method, because the direction and real-time monitoring of CAPP are not used effectively [2,3]. Besides, as the quality data of different parts are several sets of independent data, and there are no real-time statistic analysis and quality prediction, they are hardly used to control the quality of products in manufacturing stage [4].

In this paper, based on the network-based SPC (Statistical Process Control), the CAPP system is integrated with SPC to develop the Integrated Q&P System for dealing with the quality data. As a result, the quality of products is ensured and improved by the controlling in manufacturing stage, and it gives guide and feedback to the CAPP system for improving process.

II. THE ARCHITECTURE OF INTEGRATED Q&P SYSTEM

A. The System Architecture of Integrated Q&P System

The C/S (Client/Server) structure is adopted for the network-based management of data [5]. The system is composed of three architectures, as Fig. 1 shows, the first of which is the data collection architecture including on-site collecting device, and the second one is client quality control architecture including terminal software, and the third one is process optimization architecture including quality evaluation and process improvement.

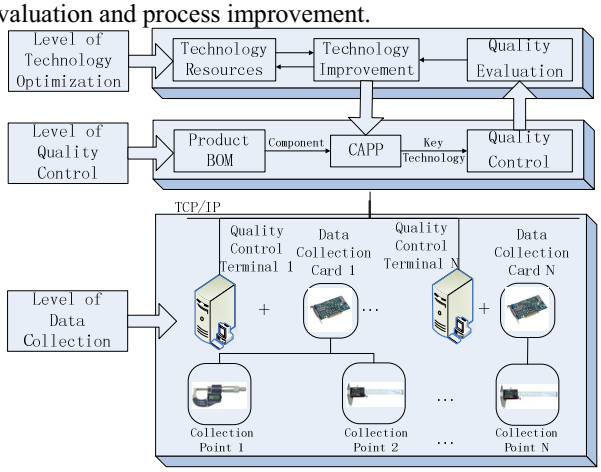

Figure 1. The architecture of integrated Q&P system

B. The Procedure of Integrated Q&P System

Process is designed and managed according to the design requirements of products, and then the quality control is done with the formed process documents during the manufacturing process. In the meantime, process can be improved and perfected based on the quality state. The procedure of integrated Q&P system is shown in Fig. 2.

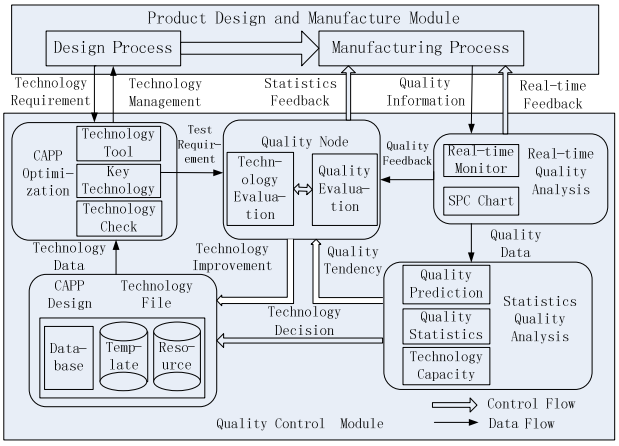

Figure 2. The procedure of integrated Q&P system

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As Fig. 2 shows, the process documents can be conveniently formed according to the design requirements of products with the help of process resources and process templates. Process resources are production tools of enterprise including workshops, machine tools, and tools and so on, which can be directly called by users. While process templates, which include self-contained templates and user-defined templates, can be used to compile the process documents of similar parts rapidly. In the process of manufacturing, the quality information is collected according to the checking demands of key processes, and the real-time monitoring and feedback are carried out based on the real-time analysis of collected quality data, such as real-time monitoring and SPC control chart. Then, the statistic analysis on quality is done, such as quality prediction, quality statistics and process capability analysis. By using these analytical data, process documents are optimized. Moreover, it can feed the quality trend back to the quality node for the further quality feedback by quality statistic analysis, and after the evaluation on the quality and process of node, it will go on to implement the process documents.

C. The Software Procedure of Integrated Q&P System

After the users login the system, the complete quality control procedure is realized by inputting product, compiling process, collecting quality information, analyzing process quality, evaluating quality and improving process under their limits, and it is shown in Fig. 3.

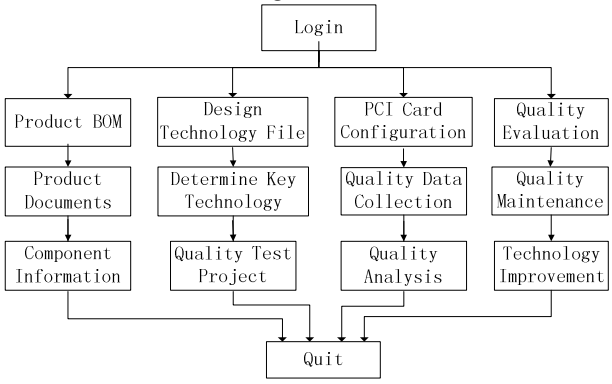

Figure 3. The flowchart of software

III. THE SOFTWARE DESIGN OF INTEGRATED Q&P SYSTEM

A. The Software Design of Integrated Q&P System

The SQL SERVER and C# are adopted respectively in system design as database on the server and platform for developing software on the client. Database is created in the Servers and can be connected and managed conveniently through ADO.NET with the friendly interface by C#.

The software consists of quality monitoring system, CAPP system and quality control system. In CAPP system, products BOM are built, technical files are provided and then process documents are compiled based on process cards. After that, analyze the critical process by SPC.

B. The Functional Analysis on Integrated System

Quality monitoring system is mainly for acquiring device configuration, confirming acquisition method and collecting data, which are transferred to quality control system.

Quality control system is used for real-time quality monitoring, quality statistic analysis, SPC control chart drawing and quality diagnosis on collected quality data. Besides, improving process is done by analyzing quality data, evaluating and predicting product quality and assessing process.

C. The Product Information of Integrated Q&P System

The integrated Q&P System is composed of product BOM and compiling of aided process documents. Product BOM is made up of the information about products and the relationships among products, components and parts that the enterprise needs. Quality verification model based on BOM and distribution of process task is shown in Fig. 4. To implement the process control on the quality of critical process, process templates and resources are called to enhance the efficiency and accuracy of process compiling.

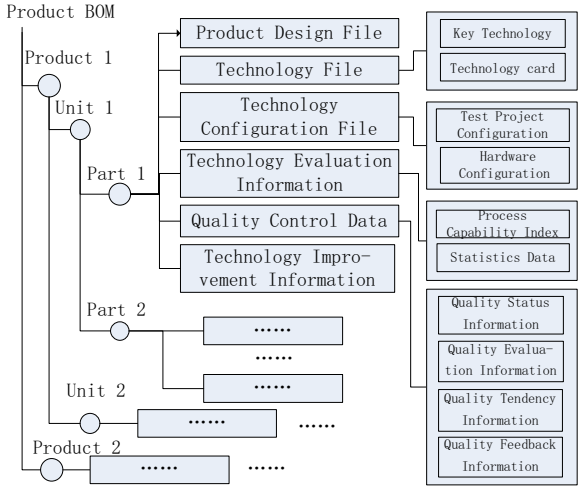

Figure 4. Quality verification model based on BOM and distribution of process task

D. Quality Data Acquisition and Quality Control System

In quality detecting system, data are collected by Advantech PCI-1741U acquisition broad, and controlling machine is linked by PCI. There are three data acquisition ways as following:

(i) External button is used to link to DI of data acquisition broad, and then it is known whether the data are acquired according to digital amount of the port. The program is as follows:

index = cmbDiChannels.SelectedIndex;// the number of DI

result = axAdvDIO1.ReadDiChannel(index);// the digital amount of the port

(ii) Calling acquisition programs through button click events.

(iii)Data acquisition will timed acquire through setting the interval time, and it will not stop until the number of data acquisition is enough through setting the number.

Real-time quality monitoring and SPC statistical control of quality data are implemented in quality control system. Product quality information is network-based managed and uploaded to database server through quality monitoring terminal. In addition, all other quality monitoring terminals can assess database server to conduct a comprehensive monitoring. Thus, real-time acquisition data can be shown in the control chart to make a decision in time.

IV. THE IMPLEMENTATION OF INTEGRATED Q&P SYSTEM

A. The Main Interface of CAPP

As described in Fig. 5, the interface of CAPP is used to select process template, compile process and then make process cards. After that, test items in process cards are matched with corresponding ones in acquisition broad, and detection configuration and data acquisition can be carried out in the interface of data acquisition.

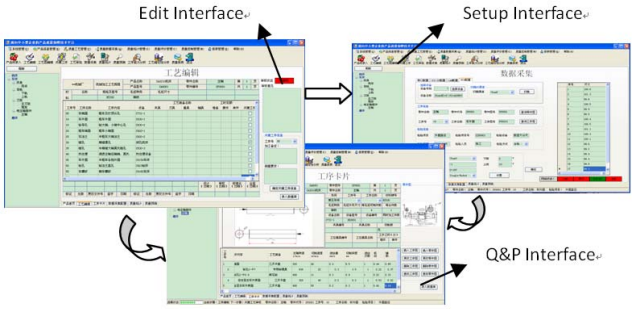

Figure 5. Process cards

B. The Main Interface of SPC

Quality control, which includes data acquisition statistics and quality monitoring about critical process, is based on SPC control charts. As shown in Fig. 6, the quality distribution of products can be seen.

Figure 6. The interface of SPC

V. CONCLUSION

In this paper, the C#.NET software platform with friendly graphical interfaces is used to manage data and support networking, and the network-based communication between ADO.NET and SQL SERVER database ensures the real-time statistic analysis and management on quality data. In addition, the preventive measure with the support of SPC network-based technology meets the demands of real-time and dynamic during the on-site quality control process, and thus the automatic collection and statistic analysis on data are accomplished. Furthermore, with the connection and interaction between CAPP and quality control system, the quality of products can be complete controlled from the process design stage to manufacturing stage, and it can provide some effective solutions for establishing manufacturing-faced enterprise quality control platform.

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