Design and Implementation of Practical Training Project of Mechanical Manufacturing Technology Course Based on Virtual Simulation Technology

Rong Zhang*, Yan Xue

Chongqing Vocational Institute of Engineering, Chongqing, 402260, China

*289847927@qq.com

Abstract. "Mechanical manufacturing technology" is an important course for the major of mechanical design and manufacturing technology in higher vocational colleges. The traditional teaching method has some problems such as few practical opportunities, for this reason, the virtual simulation training system of mechanical manufacturing technology is designed and developed. The system can simulate the real factory environment so that students can understand various process equipment, establish a shared example library for students to learn typical processes, and realize virtual simulation training of the whole process, so that students can quickly master the mechanical manufacturing process design method in an interactive design environment. This system solves the practical problems of traditional teaching, lets students get rid of the constraints of the environment to carry out practical training, reduces the cost, saves time, and improves the comprehensive ability of students.

Keywords: Mechanical Manufacturing Process, Virtual Simulation, Course Practical Training.

1 Introduction

"Mechanical Manufacturing Technology" is a course combining theory and practice in the major of mechanical design and manufacturing technology in higher vocational colleges. The course covers the basic theory of metal cutting, the basic knowledge of metal cutting machine tools, tools and fixtures, as well as the formulation of mechanical manufacturing process regulations and the analysis and control of machining quality. Theoretical knowledge is abstract, with many knowledge points and strong comprehensiveness [1]. In traditional course teaching, "infusion" teaching dominates, and students have few opportunities to practice based on actual cases [2], which is mainly attributed to two factors: first, the high cost of course practice, the processing of mechanical parts requires a variety of machine tools, tools, fixtures, measuring tools, consumables, etc., and the high price of mechanical equipment [3], Second, machining process practice takes a long time, students often need to spend a long time to master the use and characteristics of the machine tool, in order to be able to process their own parts, and there

D. Hu et al. (eds.), *Proceedings of the 2024 5th International Conference on Modern Education and Information Management (ICMEIM 2024)*, Atlantis Highlights in Social Sciences, Education and Humanities 29,
https://doi.org/10.2991/978-94-6463-568-3_22

is not enough time to repeatedly revise their own process design, it is difficult to achieve the expected goal of the practice. The introduction of virtual simulation technology into the practical training of mechanical manufacturing technology courses can effectively solve the above problems. Due to its excellent properties such as immersion, interaction and imagination [4], virtual simulation technology can provide rich data and application scenarios for students' deep learning, and is frequently used in experimental and practical training teaching. Virtual simulation technology can visually and rapidly present the process and results of mechanical manufacturing, which does not require the purchase of expensive mechanical equipment and can greatly save the time of mechanical processing [5].

Chongqing Vocational Institute of Engineering has designed and developed a virtual simulation training system for mechanical manufacturing process. The system uses virtual simulation technology to simulate the complete mechanical processing process design process, so that students can quickly master the design method of mechanical parts processing technology and the general process of mechanical processing. In the interactive process of process design, the system will simulate the parts according to the process flow, and quickly give the parameters of the parts after processing, students according to the results of the process repeatedly modify, and finally get qualified parts. Using this virtual simulation training method, students have an intuitive understanding of machine tools, fixtures, tools and measuring tools, and can put a lot of time into the research of the process flow, rather than the manufacturing of mechanical parts, to achieve the purpose of practical training of mechanical manufacturing process course.

2 The Whole Structure of Virtual Simulation System of Mechanical Manufacturing Process

Mechanical manufacturing process design virtual simulation training project relies on open virtual simulation training system, which is based on computer simulation technology, multimedia technology and network technology, and adopts service-oriented software architecture development, integrating physical simulation, innovative design, intelligent guidance, automatic correction of virtual practical training results and teaching management. It has good autonomy, interactivity and expansibility. Students can access it anytime, anywhere through the browser, and through the user-oriented intelligent guidance provided by the virtual simulation system, as far as possible to help students realize independent practical training.

As shown in Figure 1, the virtual simulation system architecture is divided into five layers, and each layer provides services for its upper layer until the construction of the specific virtual simulation training teaching environment is completed. The specific functions of each layer will be described in the order from bottom to top.

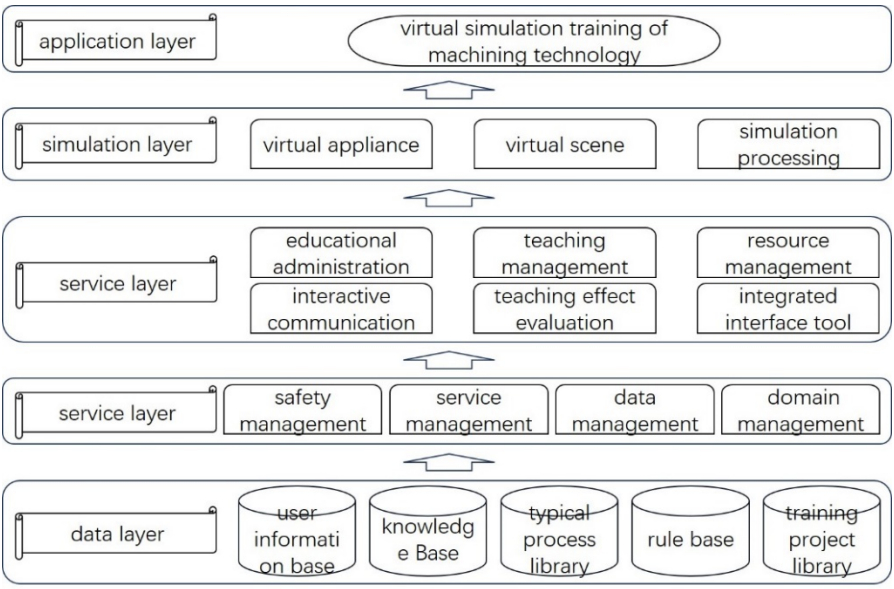

Fig. 1. Overall architecture diagram of the system.

2.1 Data Layer

Mechanical manufacturing process virtual simulation training project involves many types of virtual training components and data. Here, the user information database, knowledge base, typical process database, rule database and training project database of virtual training are set respectively to realize the storage and management of corresponding data.

2.2 Support layer

The support layer is the core framework of virtual simulation practical training teaching and open sharing platform, and is the basis for the normal open operation of practical training projects. It is responsible for the operation, maintenance and management of the entire basic system. The supporting platform includes the following functional subsystems: security management, service container, data management, domain management and so on.

2.3 Service Layer

The service layer is the open virtual simulation training management platform, which provides some general support components of the virtual training teaching environment, so that users can quickly complete the virtual simulation training in the virtual training environment. The general services include: practical training teaching administration management, practical training teaching management, practical training

resource management, interactive communication, teaching effect rating, and provide corresponding integrated interface tools, so that the platform can easily integrate the third-party virtual training software into the unified management.

2.4 Simulation Layer

The simulation layer mainly carries out the corresponding practical training scene construction, virtual equipment display, and parts simulation processing for the project, and finally provides the formatted output of the practical training result data for the upper layer.

2.5 Application Layer

Based on the service of the bottom layer, finally realize the virtual simulation of mechanical manufacturing process training project. The application layer of the framework has good expansibility. Training teachers can design various typical practical training projects according to the teaching needs, using various tools provided by the service layer.

3 Key Functions of Virtual Simulation System

3.1 Understand Machining Process Equipment in Virtual Simulation System

The virtual simulation system simulates the construction of the real factory environment, and places the actual equipment and tools in the factory. There are many kinds of equipment in the factory, including CNC lathes, CNC grinding machines, CNC boring and milling machining centers, gear hobbing machines, gantry planers, high-frequency quenching machines, etc. Each equipment has a variety of general fixtures and tools. Students can rotate, translate, enlarge, shrink and other operations on the three-dimensional model of equipment such as the keyboard and mouse to understand the specific structure and principle of equipment and tools.

3.2 Establish a Shared Process Example Library

The virtual simulation system is not only a practical training system, but also allows students to study and learn typical examples of machining technology in the system. Typical examples are the latest processing cases of typical parts collected by enterprises, stored in the typical process library, which can be updated from time to time, including shaft parts, shaft sleeve parts, box parts and gear parts. Students can choose to view the parts of the processing process file, you can also watch each process of simulation processing, as well as the parameters of the parts after processing. Through such learning, students can learn the process characteristics and process of various parts more intuitively.

3.3 Realize the Virtual Simulation Training of the Whole Process of Mechanical Manufacturing

The virtual simulation system of mechanical manufacturing process based on the teaching objectives of mechanical processing technology has established a virtual practical training teaching system of the whole process of mechanical parts processing. Teachers can store the practical training projects in the training project library in advance according to the teaching requirements. Each practical training project should be entered including parts drawings, key points and solutions of the process analysis of the parts drawings, and the blank selection range. A variety of process route reference schemes and each step of the design of the theoretical knowledge points and other content. In the practical training, students can according to the guidance of the system, in the system to carry out parts drawing process analysis, blank selection and process development, for each process to select the appropriate machine tools, fixtures, tools and measuring tools, and determine the cutting parameters and process size. In each link of the operation, the system will link the knowledge points needed to present on the interface, and students can learn the knowledge points at any time. Students each completion of a process, the system can according to the selected equipment, tools, fixtures, etc. according to the selected cutting amount of simulation processing, and finally give parts after processing size, roughness and tool wear and other data, students can according to the data given by the system repeatedly adjust the process and parameters, and finally get the parameters are qualified parts. Figure 2 takes a drive shaft part as an example to illustrate the whole process of simulation training.

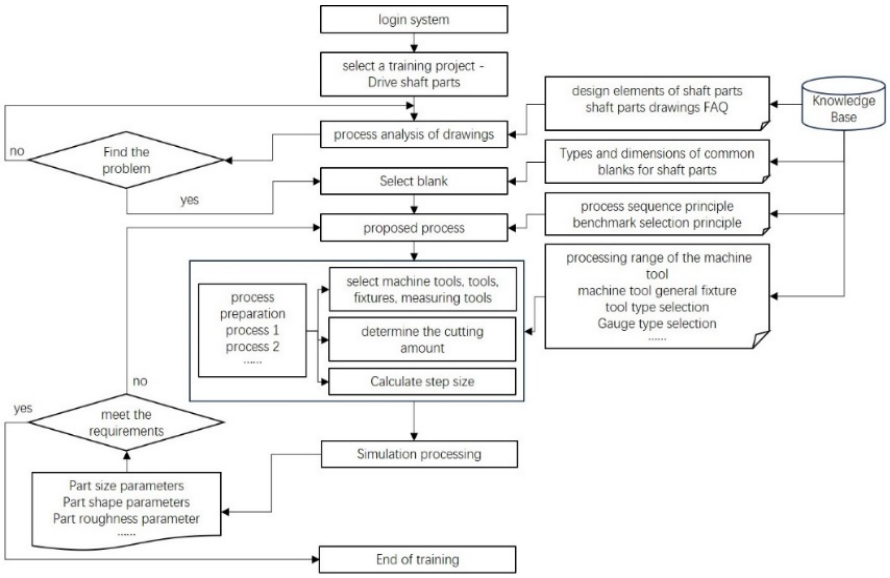

Fig. 2. Transmission shaft parts simulation training process diagram.

4 Conclusion

The application of virtual simulation technology in the practical training of mechanical manufacturing technology course provides a practical scheme to solve the difficult problems of traditional teaching. The virtual simulation practical training system of mechanical manufacturing technology simulates the real factory environment, so that students can fully understand the process equipment, not limited by the actual equipment and site, Establish a rich shared process example library, provide students with the latest and most typical cases, expand the learning resources, The virtual simulation training of the whole process is realized, which closely combines theoretical knowledge with practical operation to enhance students' comprehensive ability.

Through the virtual simulation and practical training system of mechanical manufacturing process, students can understand and master the knowledge and skills of mechanical manufacturing process more deeply and intuitively on the basis of reducing costs and saving time.

References

1. Zhu, Y. X. (2019) "Mechanical Manufacturing Technology" practice case overall through teaching model exploration. Education Modernization., 92: 50-53.
2. Zhu, J. H., Tang, J. H. (2023) Teaching reform and practice of "Mechanical Manufacturing Technology and Fixture Design" course. Equipment Manufacturing Technology., 10: 106-109.
3. Gao, F. (2022) Inquiry into the improvement of teaching effect by informatization teaching - taking the course of machinery manufacturing and craft compilation as an example. The Light & Textile Industries of Fujian., 7: 27-29.
4. Safikhani, S., Keller, S., Schweiger, G., et a1. (2022) Immersive virtual reality for extending the potential of building information in architecture, engineering, and construction sector: systematic review . International Journal of Digital Earth.,15:503-526.
5. Kousi, N., Aivaliotis, S., Giannoulis, C., et al. (2019) Digital twin for adaptation of robots' behavior in flexible robotic assembly lines. Procedia Manufacturing., 28:121-126.