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# *Reform Path of 'Numerical Control Technology' Course of Mechanical Specialty in Universities under the Background of 'Intelligent Manufacturing'*

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***Abstract:*** With the rapid development of intelligent manufacturing technology and the rapid iteration of knowledge, the problems of traditional teaching methods, teaching contents and evaluation methods have become increasingly prominent for Numerical Control Technology course, and the new teaching mode reform needs to be carried out urgently. First, focusing on the professional training direction under the background of intelligent manufacturing, the goal of curriculum construction and strengthen the construction of engineering connotation should be established. Following the principle of keeping up with the frontier and advancing appropriately, engineering knowledge, highlight practical teaching and pay attention to the cultivation of innovative ability should be renew. Information-based teaching assistant platform and innovating autonomous learning mode and integrating curriculum ideology, politics to improve the quality of education should be built, and school-enterprise cooperation and implementing the training mode of integration of production, teaching and research were carried out.

## 1. Introduction

In 2021, China's Ministry of Industry and Information Technology and other eight departments jointly issued the 14th Five-Year Plan in Intelligent Manufacturing Development, indicating that "China Intelligent Manufacturing" and "Intelligent Manufacturing" have become the inevitable trend of the future development of China's manufacturing industry [1]. Its implementation will promote the new scientific and technological revolution and industrial transformation, and also provide unprecedented opportunities and challenges for the cultivation of talents in colleges and universities. "Numerical Control Technology" course is the core professional course of mechanical specialty, which takes CNC machine tools as the representative, and comprehensively expounds the application theory and application knowledge of computer numerical control technology in mechanical manufacturing equipment. However, with the rapid development of intelligent manufacturing technology and the rapid iteration of knowledge, the problems of traditional teaching methods, teaching contents and evaluation methods have become increasingly prominent[2], which are manifested in the outdated knowledge system, poor practical ability, inadequate innovation ability, weak engineering awareness and lack of self-learning ability of the training objects, and the

new teaching mode reform needs to be carried out urgently.

## 2. Focusing on the professional training direction under the background of intelligent manufacturing, we should establish the goal of curriculum construction and strengthen the construction of engineering connotation

Establishing reasonable curriculum objectives is the first step of curriculum reform. Under the background of intelligent manufacturing industry, the traditional content of CNC Technology should be deeply transformed with the knowledge, theory and concept of intelligent manufacturing, and deeply introduced into the traditional CNC machining process design, CNC programming and machine tool operation, taking full account of artificial intelligence, AI and big data technology. Content of courses should keep up with the needs of the times and the industry, penetrate the theory of intelligent manufacturing into every link of CNC technology, and master CNC technology. At the same time, it is also necessary to cultivate students' engineering ability in line with the needs of the industry and the requirements of the industry, such as establishing an advanced and output-oriented teaching mode around multi-axis processing, high-end precision manufacturing and special processing, and having the ability to design and manufacture key components of high-end CNC equipment and solve complex engineering problems and project management. On this basis, we should cultivate students' engineering qualities of concentration, patience and meticulousness, good humanities and social sciences literacy, professionalism, craftsmanship and social responsibility, communication, team consciousness, innovative ideas and innovative consciousness, and lifelong learning ability.

According to the professional training objectives and engineering certification requirements, in order to meet the development needs of the intelligent manufacturing industry and follow the principle of "forward design, reverse construction", the author develops the connotation training system of intelligent manufacturing engineering from three dimensions of knowledge, ability and quality, in accordance with the principle, technology, engineering management, humanistic quality and lifelong learning. The connotation system construction of intelligent manufacturing engineering is put forward, starting from the construction of characteristic brand, and six training objectives are constructed through the training system and the innovative training mode with three forces. (See Table 1)

Table 1 Engineering Connotation and Objectives of Numerical Control Technology

| Engineering connotation | Course objectives |
|---|---|
| Engineering knowledge | Basic knowledge of artificial intelligence, concept and principle of intelligent machine tool, design of intelligent machine tool |
| Engineering capability | Machining process formulation, NC automatic programming and NC machining capability |
| | Have the ability to design and manufacture key components of high-end CNC equipment and solve complex engineering problems |
| | Have the management ability to engage in intelligent manufacturing related projects |
| Engineering quality | Good humanities and social sciences literacy, professionalism, craftsmanship and social responsibility |
| | Have communication, team consciousness, innovative ideas and innovative consciousness and lifelong learning ability. |

## 3. Renew engineering knowledge, highlight practical teaching and pay attention to the cultivation of innovative ability

Following the principle of keeping up with the frontier and advancing appropriately, the

engineering knowledge structure of the course is adjusted and optimized. In addition to retaining the basic knowledge points necessary for classics, the outdated teaching content is eliminated, the new knowledge of intelligent manufacturing is added, and the basic knowledge of artificial intelligence, intelligent machine tools, automatic programming and knowledge base is added to meet the needs of the development of intelligent numerical control technology and lay the foundation for the cultivation of engineering practice ability.

The NC process planning and automatic programming of complex parts are the core engineering ability of NC technology course. Around the ability training, we set up and carry out special NC automatic programming homework, and increase the project inquiry and autonomy of the course homework, adopt the open way of independent topic selection, carry out personalized education, and improve the sense of innovation. In addition, the national or regional college students' innovation and entrepreneurship competition is used as a platform to carry out various forms of innovative experiments and scientific and technological innovation activities to promote students' mastery and application of numerical control knowledge, and to carry out innovative practice attempts to solve practical engineering problems for enterprises, so as to gradually improve the application design and innovation ability. Students should be guided to participate in the cooperative research and development of intelligent equipment manufacturing projects and the practical training of characteristic engineering projects, to promote the innovation and transformation of intelligent mechanical products, and to train students' scientific and rigorous thinking attitude, engineering concept of excellence and innovative spirit of pursuing excellence. In order to meet the current requirements of new engineering construction and OBE engineering education certification, professional engineering management practice, engineering optimization design, complex manufacturing process, equipment optimization debugging, intelligent control training, cultivate students' knowledge transfer ability and engineering comprehensive application ability should be strengthened.

## 4. Building an information-based teaching assistant platform and innovating autonomous learning mode

Educators should change the traditional classroom teaching mode of one-way knowledge inculcation, give full play to the advantages of modern information tools such as online learning platform and MOOC classroom, promote the deep integration of modern information technology and teaching, complete the construction of information-based teaching environment, and establish an online and offline hybrid autonomous learning mode of "pre-class guidance", "in-class research" and "after-class practice" [3]. The specific design contents are as follows:

Pre-class: Teachers use video guidance to guide students to use the learning platform for inquiry and personalized learning in the form of tasks, to clarify concepts and form suspense, so as to trigger learning problems and complete pre-class guidance.

In class: the teacher explains the theoretical knowledge according to the problems caused by the pre-class learning, and explains the problems in combination with the theoretical knowledge and course cases. In the teaching process, the teacher strengthens the interaction and cooperation between teachers, students and students, internalizes the important and difficult knowledge in class, and stimulates the students' interest in learning and professional interest to complete the in-class research.

After class: The teacher uploads the homework and test questions to the online learning platform for stage test, consolidates the stage learning situation and feeds back the learning situation. Based on the feedback of learning situation, teachers complete teaching reflection, re-integrate the knowledge points of teaching content and upload them to the learning platform, which is convenient for students to review after class, check leaks and fill vacancies, so that students can gradually develop their own post special ability in the learning process to complete after-school practice.

Through "pre-class guidance", "in-class research" and "after-class practice", students are given sufficient space to think independently and develop their abilities, and are encouraged to find new methods and open up new ideas, so as to achieve the integration of theoretical knowledge. Educators also should break the conventional classroom teaching mode, try students' autonomy and inquiry learning, and form a new teaching mode of student-centeredness autonomous learning, which integrates pre-class, in-class and after-class.

## 5. Integrating curriculum ideology and politics to improve the quality of education

In the blended teaching mode of numerical control technology course, combining with the knowledge framework of the course, we should dig deeply into the ideological and political elements, skill design the ideological and political content, organically integrate it into the course teaching, and guide students to continuously improve their post ability and professional accomplishment through a series of films such as "Super Power", "Big Power Heavy Equipment" and "Big Power Intelligent Manufacturing". Educators will understand the connotation of "core technology and key technology must be firmly grasped in their own hands", vigorously promote the spirit of craftsmen, cultivate skills to serve the country, and firmly establish the responsibility and responsibility of building a strong manufacturing country.

Through the integration of ideological and political courses, on the one hand, it promotes students to better accept the education of patriotism and the edification of mainstream values, cultivates students' correct values, stimulates students' patriotism, enables students to better internalize the spirit of craftsmen and product awareness, and forms good humanities and social sciences, and engineering quality is improved [4].

On the other hand, teachers can also better enhance the awareness of educating people in curriculum teaching, laying the foundation for more systematic planning of curriculum construction in the later period. Through the construction of engineering quality and ability, the identity of teachers has also changed, and teachers have changed from a traditional educator to a thoughtful educator, which can better realize the return of educational value in teaching.

## 6. Deepening school-enterprise cooperation and implementing the training mode of integration of production, teaching and research

Teachers of course should give full play to the advantages of technological research and technological reserve of university research teams, help enterprises upgrade their productivity, and closely integrate the advantages of intelligent control and intelligent detection technology of manufacturing equipment with the strong demand of digitalization and intellectualization of production enterprises, so as to realize the seamless transformation from university technology to enterprise productivity. Educators also should explore the new mode of joint training of talents by universities and enterprises, provide enterprises with integrated solutions for tackling key technical problems and customized training of talents, and better adapt to the new format of the development of China's intelligent manufacturing industry in the new era [5].

Through the deep integration of schools and enterprises, the latest research results of numerical control technology are combined with the development needs of intelligent manufacturing enterprises, the motion control technology of numerical control technology, the precision detection of numerical control machine tools, the error compensation technology and the high-end intelligent equipment needs of enterprises are combined, and the latest research results are transformed into productive forces, at the same time, the characteristics of intelligent manufacturing are condensed. We will carry out the reform of personnel training mode and teaching content that integrates production, learning, research and application.

On the other hand, on this basis, school-enterprise joint construction of "intelligent manufacturing industry-education integration" practice innovation base, to build "go out, bring in"

cross-border integration of engineering practice mode. Starting from the demand point of the training program for applied CNC talents, this paper provides more abundant and perfect digital practice conditions for college students, integrates the intelligent equipment and technology of enterprises into practical teaching, provides guarantee for students to participate in various practical teaching and training links of the course, and enables students to have a deeper understanding of CNC equipment in the realization of intelligent manufacturing. The practice and innovation base not only gives full play to enterprise resources through various channels, but also organizes students to visit the production line of various enterprises from time to time in the teaching links of professional cognition, professional comprehensive experiment and professional practice, so as to get close contact with intelligent equipment and production lines, broaden professional thinking and learn new technologies. Students' professional knowledge and skills are constantly improved in the work scene, creating certain value for intelligent manufacturing enterprises and tapping their own potential, as well as making a good talent reserve for the sustainable development of enterprises, so as to achieve "win-win" for both sides [6].

## 7. Conclusions

In a word, under the background of "intelligent manufacturing", the curriculum reform of "numerical control technology" should first grasp the "new demand" of manufacturing industry development and the "new quality" of personnel training, and construct the teaching content and evaluation method of "numerical control technology" course from multi-directional, diversified and multi-angle. In addition, according to the development needs of the industry, knowledge, ability, quality of the three dimensions of the engineering connotation training system is established, and based on the three dimensions of the requirements to build six major personnel training objectives, combined with intelligent manufacturing teaching platform, students' learning ability and professional interests are to stimulated. Through the university-enterprise cooperation, the motion control technology, precision detection of CNC machine tools and error compensation technology of CNC technology are combined with the high-end intelligent equipment needs of enterprises, and the latest research results are transformed into productivity. At the same time, the classic teaching cases with intelligent manufacturing characteristics are condensed, the case-based classroom teaching method is explored, and the case-based teaching is carried out. We will carry out the reform of personnel training mode and teaching content that integrates production, learning, research and application.

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