

# *The practice of Mechanical CAD/CAM Course for Applied Undergraduates*

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**Abstract**—This paper analyses the function and development status of CAD/CAM course for the mechanical specialty of applied undergraduate, and puts forward the teaching reform and implementation method based on the cultivation of application ability. In practice, experimental links, curriculum design, numerical control practice, graduation design, and theoretical teaching are organically integrated, and practical teaching is the focus. It effectively improves students' skills and engineering literacy in CAD/CAM engineering area.

**Keywords**—CAD/CAM; Course Reform; Practice;

## I. INTRODUCTION

Since the 1950s, the CAD/CAM technology (Computer Aided Design and Computer Aided Manufacturing), has been rapidly developed and widely used in the world, which has brought revolutionary changes to the field of design and manufacturing. Therefore, it has been rated as one of the most outstanding engineering and technical achievements in the 20th century. Now CAD/CAM technology has become an indispensable basis for technological innovation[1,2] in advanced manufacturing system. With the gradual deepening of digitalization technology in the transformation of traditional machinery manufacturing industry, economic globalization and informationization have posed severe challenges to China's manufacturing industry. In order to realize the leapfrog development of China's manufacturing industry, digitalization and informationization of manufacturing industry should be implemented to drive industrialization by informationization, developing advanced manufacturing technology and promote tradition. The structural adjustment and optimization and upgrading of manufacturing industry have become an important task at present. This also contributed to the development of the mechanical CAD/CAM course from the previous elective course to the important position of the main professional course. Our college opened this course in the mid-1990s. With the help of the construction of FMS flexible manufacturing automation production line, our college has a higher starting point at the beginning of the course construction. At the beginning of this century, our

university applied for the establishment of Jiangsu Digital Manufacturing Technology Key Construction Laboratory, which provided a platform for the rapid development of this course. Previously, the teaching of CAD/CAM was mainly based on the introduction of basic concepts. The teaching methods and hours arrangement in practice were basically the same as those in traditional professional courses, neglecting the correspondence with other professional courses, and it was difficult to achieve the teaching effect of learning for application. This is particularly prominent in local undergraduate colleges and universities which mainly train applied technical talents. The teaching of mechanical CAD/CAM in key colleges and universities mainly focuses on theoretical teaching, emphasizing the principle analysis and explanation of CAD/CAM technology in teaching, and training students at the level of development of CAD/CAM technology [3]. However, in some higher vocational colleges, the basic theory teaching of mechanical students is relatively few, and the teaching focus is generally on specific operational skills, which makes the training of students' engineering literacy deficient[4]. Aiming at the training objective of Applied Undergraduate Mechanical specialty, this paper puts forward the teaching mode of practice-oriented teaching in the course of CAD/CAM, and explores the reform idea aiming at the training of engineering ability and literacy, which has achieved remarkable results.

## II. OBJECT AND GUIDELINES

At present, digital technology has become the focus of manufacturing industry development. The teaching of CAD/CAM course aims at cultivating students' basic skills in digital manufacturing and is characterized by strengthening students' engineering ability in CAD/CAM. It mainly includes two-dimensional drawing, three-dimensional modeling and motion simulation, CAPP, CAM and numerical control programming, and operation of numerical control equipment [5]. In the course of curriculum reform, the theoretical course teaching system and the practice teaching system are constructed to meet the requirements of enterprises for CAD/CAM skilled personnel. In the course of implementation,

the teaching guiding ideology of concurrent theory teaching and practice teaching and focusing on practice is carried out.

#### A. Principle of theory teaching

Theory teaching is based on the principle of "practicality and sufficiency", highlighting the characteristics of application and advancement of curriculum. Modular integration of the original curriculum content, such as the theory teaching part of the matrix transformation principle of graphics processing as the teaching focus, and encourage students to prepare two-dimensional and three-dimensional graphics transformation of the small program.

#### B. Principle of practical teaching

Practical teaching mainly focuses on students' hands-on teaching, which is completed in the computer room. By learning the software of CAD/CAM, we can further deepen the understanding of the basic concepts and principles of CAD/CAM technology in theoretical teaching. Practical teaching should not only give full play to students' enthusiasm but also guide students to grasp it emphatically. Emphasis is laid on improving students' practical working ability through practical links. To improve students' innovative skills and comprehensive qualities, so that students can master the relevant CAD/CAM skills and so-called "know-how" through the teaching sequence of "practice-theoretical learning-practice". It embodies early practice, multi-practice and targeted practice in teaching.

#### C. Combination theory and practical teaching

In teaching practice, the application of CAD/CAM skills runs through every link of professional course teaching. Encouraging and requiring students to use CAD/CAM software in the course design and graduation design of relevant professional courses (such as mechanical design, mechanical manufacturing technology, numerical control processing technology, etc.), so as to ensure that students' ability of CAD/CAM is continuously developed in the whole professional learning stage.

### III. METHOD OF TEACHING

The content of the mechanical CAD/CAM course is complex and the operation of software is difficult. Due to the high technology and large amount of information, the traditional teaching method is difficult to adapt during the teaching work. It is undoubtedly one of the key points of teaching reform that how to enable students to grasp relevant skills quickly in a relatively short period of time and to enter the brand-new field of design and manufacturing as early as possible. For this reason, we have made some attempts mainly from the following aspects [6, 7].

#### A. Multimedia courseware

Firstly, in the process of teaching theory and practice of CAD/CAM technology, multimedia courseware is applied to make the teaching content vivid. Making full use of the advanced teaching conditions of our college's CAD/CAM laboratory, using video, animation and on-site operation and

other forms of teaching, the teaching effect has been significantly improved. Multimedia courseware matched with textbooks is selected in teaching, and network courseware is self-developed. It is currently in the trial stage. In teaching, through multimedia courseware, on-the-spot explanation and demonstration software, the function and operation essentials of each functional module, students complete the design task of teachers' arrangement on-the-spot; at the same time, through practical teaching such as curriculum design, students further strengthen the software modules (including three-dimensional design and assembly of parts, two-dimensional engineering drawing). At the same time, in the graduation design stage, students with higher application levels and interest in CAD/CAM software, combined with practical research or application projects, complete the graduation design.

#### B. Teaching and training

To realize the seamless connection between traditional theoretical teaching and practical training. In the course of teaching, experiment and theory are carried out simultaneously. After the course is finished, CAD/CAM course design and numerical control practice are arranged. Combining the practical teaching of CAD/CAM software application with the teaching of advanced NC programming technology organically, every student can use CAD/CAM software to complete the whole process of parts from design, modeling to generating NC processing program and machine tool processing, and solve students' problems in the operation process in time through teachers' on-site guidance. The problem improves learning efficiency. It forms an interactive classroom atmosphere between teachers and students, stimulates students' enthusiasm for learning, and exercises students' practical ability.

#### C. Continuity teaching

To ensure the continuity of the training of CAD/CAM ability in the learning stage of specialized courses. In the lower grade, two-dimensional engineering drawings are the focus of training, and students are encouraged to participate in three-dimensional CAD interest groups; in the higher grade, three-dimensional CAD/CAM is the main teaching method. In the higher grade, UG, ProE, Mastercam and other elective courses are widely offered. In view of the fact that most of the mainstream CAD/CAM software used by enterprises are English interfaces, a bilingual teaching experiment has been carried out. Promote students' active learning and encourage them to participate in the national three-dimensional digital innovation design competition and other mechanical design innovation competitions organized by the province. In production practice, teaching and skill assessment are organically combined, and students are encouraged to take part in a three-dimensional modeler qualification examination and numerical control craftsman certification examination.

#### D. Skill training and teaching

We should adjust the teaching contents and organically combine knowledge imparting with skill training. The teaching reform of the curriculum must be clear about the

training objectives and specifications. The training goal of our school is to master advanced CAD/CAM manufacturing technology and high-tech talents in the whole process of product design, engineering analysis, processing and manufacturing. We have streamlined a large number of conceptual content in the original curriculum, content that can be mastered through reading, and other professional courses have involved. The multi-level practical teaching is highlighted through the combination of experimental teaching of CAD/CAM course, curriculum design of CAD/CAM course, numerical control practice and graduation design. At the same time, the use of CAD/CAM software in relevant professional courses is encouraged. To cultivate students' comprehensive ability to solve practical engineering problems by using high-end CAD/CAM software. Achievement evaluation adheres to the practice assessment, which combines teaching with engineering application and technology development. It is an effective way to extend the teaching process from classroom to production and realize the organic combination of theory and practice, teaching and production.

#### IV. CONSTRUCTION OF TRAINING BASE

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##### A. Metalwork training base

Traditional metal processing theory and practical skills are still the basis of learning advanced manufacturing technology of CAD/CAM. Modern manufacturing technology is developed on the basis of traditional technology. Automated CNC machine tools are inseparable from traditional turning, milling, planer and grinding technology. A CAD/CAM technician can not become a qualified application-oriented talent unless he knows the tool angle, cutting parameters and manufacturing technology. Therefore, in building a modern manufacturing technology training base, we should also pay attention to the construction of a traditional metal processing technology training base.

##### B. CAD/CAM training center

CAD/CAM is the direction of manufacturing technology development. Through CAM/CAM teaching software, students can carry out mechanical drawing and part process analysis on computer, and master the processing programming method skillfully. Software simulation and actual machine tool processing often can not be organically linked, students can not be sure whether the knowledge they have learned is effective. Therefore, it is necessary to establish a certain scale of CAD/CAM technology training base to carry out practical teaching. The base should include CNC lathe, CNC milling machine, machining center, EDM machine tool, WEDM machine tool and other CNC processing equipment. It should

be equipped with small CNC machine tools as the main equipment, and select high-end machine tools appropriately to handle the practice well. The primary and secondary relationship between skill operation training in teaching and on-site observation teaching. CNC system should have most of the functions of foreign main systems. G, M, T codes and PLC instructions are abundant, and the system parameters, axis parameters and compensation parameters can be set abundantly. It can support different control modes such as open-loop, semi-closed-loop and full-closed-loop. It is better to have three-dimensional graphics simulation verification and dynamic display of machining trajectory, secondary development and expansion interface, so as to realize the organic unity of curriculum teaching and technology development.

##### C. CAD/CAM software

At present, most CAD/CAM software has motion simulation, finite element analysis and machining simulation modules. This can not only reduce the cost of teaching operation, give students more opportunities to simulate practice, but also improve the structural design of parts and deepen the understanding of process optimization. These software systems can not only run independently on a single computer, but also simulate on-line production operations. The simulation operation of NC machine tools is carried out on the simulation panel of the display, and the cutting process of parts is demonstrated by the three-dimensional animation of the machine tool model, using the computer and relevant special hardware to form a real scene to experience a real feeling, mastering the CAD/CAM technology skillfully in a large number of simulation exercises, so it can go further. Training operators' practical working skills.

#### V. SUMMARY

The whole teaching of CAD/CAM course insists on the idea of ability cultivation and reforms teaching methods and means. The teaching process is from two-dimensional to three-dimensional, from simple to complex. It adopts the teaching mode of theory and practice, the two-way parallel between classroom and field, determines the teaching mode of the course in the form of case and simulation, innovates the teaching content, assessment criteria and teaching implementation methods, etc. Expanding students' learning space and providing strong support and guarantee for cultivating students' autonomous learning ability. Insist on learning knowledge and skills in practice, students can skillfully use 1-2 kinds of CAD/CAM software before graduation, master the NC processing methods of conventional mechanical parts, and some have taken the qualification certificate of the three-dimensional modeler and NC craftsman certificate. To enable students to apply what they have learned in the course of CAD/CAM greatly improves their engineering literacy and also promotes their employability.

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