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REVIEW ARTICLE

PRACTICE RESEARCH ON VOCATIONAL EDUCATION OF MECHANICAL MAJORS BASED ON DIGITAL DESIGN AND 3D PRINTING TECHNOLOGY

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ABSTRACT

In order to make the graduates of mechanical majors not only understand the profession but also adapt to the career requirements of graduates in the new era,the integration of digital design and 3D printing technology into the vocational education of undergraduates have been discussed in this paper. The digital design professional skills platform has been built around the construction of digital design basic professional courses; The vocational education platform of 3D printer technology has been built around the activities of curriculum development training, discipline competitions and science and technology club activities. These platforms are important for cultivating innovative and technical talents that meet the needs of modern manufacturing.

KEYWORDS

Mechanical majors Digital design and 3D printing Vocational education Platform construction

1. INTRODUCTION

In recent years, the number of college graduates in China has increased year by year, and the employment situation of college students is very severe. Vocational education is an important part of the national education system and human resources development, and an important way to train diversified talents, inherit technical skills, and promote employment and entrepreneurship. In 2005, “the Decision of The State Council on Vigorously Developing Vocational Education” put forward that the purpose of vocational education was to train applied talents and socialist laborers and builders with a certain level of culture and professional knowledge and skills. Vocational education focuses on the cultivation of practical skills and practical working ability.

At present, Ying Zhang et al. studied that practical teaching plays an important role in applied undergraduate vocational education (Zhang et al., 2012). Shiwei Yan studied the dual-track system of "attaching equal importance to skills" in professional education of environmental art design (Yan, 2010). Chunyan He et al. studied the vocational teaching reform centered on "professionalization" (He and Xu, 2010). Yongjin Shi et al. studied vocational education in ordinary colleges and universities and put forward some measures for your reference (Shi, 2010). In order to adapt to the needs of economic and social development and changes in the labor market, western developed countries have long taken important measures to develop vocational education and established an open lifelong vocational education system (Ren and Li, 2021). Therefore, in order to make the graduates of mechanical majors not only understand the profession but also adapt to the career requirements of graduates in the new era quickly, and construct their practical teaching links scientifically and reasonably, the integration of digital design and 3D printing technology into the vocational education of undergraduates have been discussed in this paper. To guide and train innovative and technical talents who meet the needs of modern manufacturing industry and can highly use computers to identify, understand, express, analyze and solve complex engineering problems.

2. SYSTEMATIC STRUCTURE OF VOCATIONAL EDUCATION

3D printing technology is a new type of integrated manufacturing technology involving multiple disciplines, and it is a new type of technology that emerged after the 1980s. It is the bridge between product design and mass production. Through 3D printing, the design concept of the product can be quickly expressed, feedback information of the product can be obtained, and the feasibility of the product can be evaluated and demonstrated. Vocational education focuses on cultivating students' practical ability and practical working ability. Therefore, in order to improve students' practical ability and professional quality, digital design and 3D printing are integrated into the undergraduate vocational education of mechanical majors, that is, digital design is integrated into the construction of professional courses, and 3D printing technology is integrated into professional curriculum development training, discipline competitions and science and technology community activities.

3. CONSTRUCTION OF PROFESSIONAL SKILLS PLATFORM FOR DIGITAL DESIGN

The professional course "Digital Design Basics" adopts digital design software CATIA or Siemens NX. By learning 3D digital design technology, students can use it to model parts, assemble parts and generate engineering drawings; To enable students to master the use of computer technology for product design and expression methods, with preliminary mechanical design and analysis ability. It provides students with basic modeling skills for innovative entrepreneurial activities such as 3D printing etc.

3.1 Course Content

The teaching content of the Digital Design Basics course includes sketch design, part modeling, assembly design, engineering drawing and mechanism motion simulation. Many of the cases in the course come from the production practice, the national college student discipline competition questions, and some cases are full of interesting. Depending on the course, students can complete the conversion between two-

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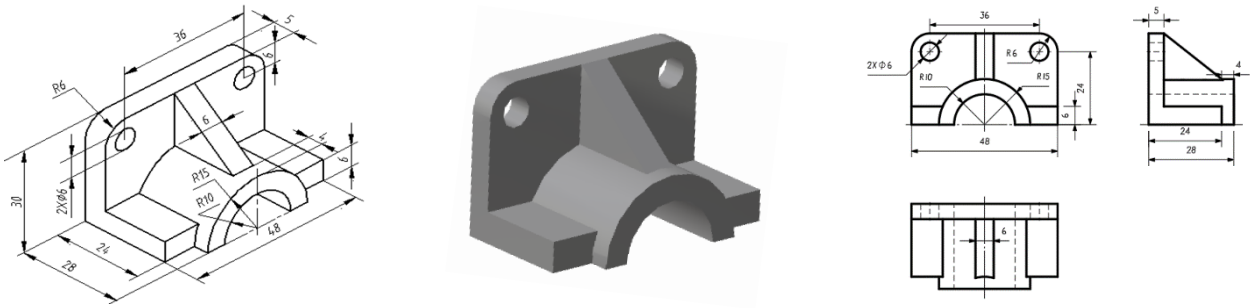
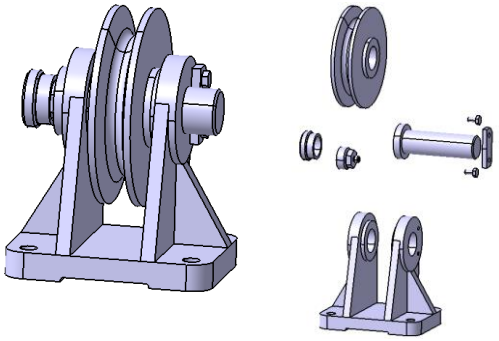
dimensional and three-dimensional models, as shown in Figure 1; Depending on the course, students can complete the product part modeling and product assembly according to the design drawings, and generate the product decomposition diagram, as shown in Figure 2. The study of professional skills courses provides students with basic modeling skills for innovation and entrepreneurship activities. Students participate in discipline competitions based on courses, and can design innovative products according to design requirements, and can express their innovative ideas with digital design methods for improvement and promotion. This course provides important design tools for students to participate in mechanical innovation design competition, engineering training Comprehensive ability innovation competition, industrial design competition, Internet + and other competitions. The main competition projects and competition plans related to digital design are shown in Table 1. The students' professional skills and professionalism are improved by participating in the competition.



(a) Axonometril drawing (b) 3D modeling (c) 2D engineering drawing

Figure 1: Conversion between engineering drawing and 3D models



(a) Assembly of the product (b) Decomposition of the product

Figure 2: Assembly and decomposition diagram of the product

Table 1: Main competition projects and participation plans related to "Digital design"

Case	Competition name	Competition level	Competition time	Participating student
1	College students Advanced Mapping technology and Product information Modeling innovation competition	university-level	March/year	Freshman, Sophomore, Junior
2	Industrial Design Competition for university students	university-level	April / 2 years	Freshman, Sophomore, Junior
3	Jilin Province College Students Advanced Mapping Technology and Product Information Modeling Innovation Competition-Digital innovation design track	Provincial level	May / year	Sophomore, Junior
4	Jilin Province college students industrial design Competition	Provincial level	July /2 years	Freshman, Sophomore, Junior
5	National College Students Advanced Mapping Technology and Product Information Modeling Innovation Competition and digital innovation design track	National level	July / years	Sophomore, Junior
6	National College Students Industrial Design Competition	National level	October /2 years	Sophomore, Junior

3.2 Course Assessment

The assessment method of the course is process assessment, and the score consists of five parts: normal performance (including attendance and homework (8-10 times)), two in-class tests, midterm tests and final exams. The score ratio of each part is 15:5:5:25:50. The usual homework content is the examples explained by the teacher in class, exercises after class, and the basic modeling problems and modeling challenges assigned by the teacher in the PPT. Basic questions require all students to complete, modeling challenges require all students to complete at least 60% of the amount of questions, teachers should record the number of questions completed by students, and pay attention to quality.

4. Platform Construction of 3D Printer Technology Vocational Education

Professional skills in 3D printing technology need to be familiar with and master the technical principles of 3D printers, assembly, debugging, design of 3D printing data, process optimization of 3D printing manufacturing products and post-processing of 3D printing products. In order to train students to have solid professional and vocational abilities, it is far from enough to rely on conventional classroom teaching, and it is necessary to expand and improve students' professional skills and professional literacy through the way and method of carrying out the second classroom. The digital design basic professional curriculum

development training, discipline competition and community activities are the three commonly used means of development in colleges and universities, which have been tested and proved in the practice process over the years.

4.1 Platform Construction Based on Curriculum Development Training

Digital design basic professional course Extension training is selected from each class 2-3 students, the whole grade selected about 30 students. The full-time teacher will organize students to study 3D printing, a total of 10 class hours. Outward development training mainly cultivates students' professional and vocational abilities in product modeling, 3D printing molding, and comprehensive literacy. That is, 3D printing model preparation (according to the given product design drawings, three-dimensional modeling and assembly of the components of the product), equipment debugging, 3D printing data design, rapid prototyping, model output and post-processing and other professional capabilities; Complete the assembly of printed parts, and analyze the intuitiveness, functionality, and assemblability of products. The teacher gives the corresponding grades according to the performance of the 3D printed product, that is, excellent, good, medium, pass and fail. The product 3D modeling and 3D printing extended training projects are shown in Table 2.

4.2 Platform Construction Based on Discipline Competition

As an important platform of domestic competition in recent years, discipline competition has been paid more and more attention by government departments and colleges and universities. The annual discipline competition "National College Students Advanced Mapping Technology and Product Information Modeling Innovation Competition-Additive Manufacturing Track" has pushed the 3D printing competition to a new stage. Through the accumulation of experience in competitions over the years, our school has built a competition system of "school competition, provincial competition and national competition". The establishment of the school and provincial events is guided by the competitive content of the national events. Through the school competition selection, provincial competition and national competition sprint, the students' professional skills are effectively improved. The competition projects and participation plans related to the professional ability of "3D printing" for students majoring in mechanical engineering are shown in Table 3. Through the development of the system science competition plan, students have the opportunity to participate in the skills competition related to 3D printing during their undergraduate study career.

Table 2: Expansion projects of 3D modeling and 3D printing of products

Case	Data source	Project name
1	Forward design	Vise modeling and 3D printing
3	Forward design	Manual air valve modeling and 3D printing
3	Forward design	Globe valve modeling and 3D printing

Table 3: Competition projects and competition plans related to 3D printing

Case	Competition Name	Competition Level	Competition Time	Participating student
1	College students 3D printing digital design Competition	university-level	November/year	Freshman
2	College students mechanical innovation design Competition	university-level	December/year	Freshman, Sophomore, Junior
3	Jilin Province College Students Advanced Mapping Technology and Product Information Modeling Innovation Competition-Additive manufacturing track	Provincial level	May/year	Sophomore, Junior
4	Jilin Province college students mechanical innovation design competition	Provincial level	May /2 years	Freshman, Sophomore, Junior
5	National College Students Advanced Mapping Technology and Product Information Modeling Innovation Competition-Additive manufacturing track	National level	July/year	Sophomore, Junior
6	National college students mechanical Innovation design Competition	National level	August /2 years	Sophomore, Junior

Through the participation of the above competitions at all levels, the students' learning interest and enthusiasm are fully mobilized, the internal motivation of the students is tapped, and the learning atmosphere of "comparing, learning, rushing, helping and super" is created. The results over the years show that the competition can not only effectively improve the professional skills of students, but also cultivate the quality of perseverance and hard work of students, and temper the spirit and will of students, so that students can better adapt to the corporate culture and working atmosphere after graduation, and improve the employment ability of students.

4.3 Platform Construction Based on Science and Technology Society

As an important platform to exercise college students' scientific and technological ability, science and technology associations not only enrich their spare time life, but also play a significant role in expanding their professional knowledge and skills (Xu and Zhu, 2011). Our school has a "3D Maker" club, which has been in existence for 5 years, and the scientific and technological activities carried out by the club can fully meet the personalized development of students. In the comprehensive implementation of quality education, the science and technology association takes student activities as the main body, focusing on the cultivation of students' scientific and technological interests and hobbies in "digital design and 3D printing". Through activities to tap students' innovation, creative talent and self-inquiry potential; The members of the community enhance their professional skills and innovative ability by working in groups and competing with each other. In recent years, the innovative design and 3D printing projects organized by the "3D Makers" science and technology community are shown in Table 4.

Table 4: Innovative design and 3D printing projects organized by the "3D Maker" science and technology society

Item 1	Construction machinery and 3D printing
Item 2	Give a beloved gift and 3D printing
Item 3	3D printing creative design with Marine life as the theme
Item 4	Creative timepieces and 3D printing

5. Conclusion

In view of the increasingly severe employment situation of students majoring in machinery, the simultaneous problems of employment difficulty and talent shortage have put forward challenges to the training mode, course setting, course content and especially the practical teaching system of machinery majors in colleges and universities. This paper discusses the integration of digital design and 3D printing into undergraduate professional education, and builds a digital design professional skills platform around the construction of digital design basic professional courses; The vocational education platform of 3D printer technology has been built around the activities of curriculum development training, discipline competitions and science and technology societies. These platforms are of great significance for cultivating innovative and technical talents who meet the needs of modern manufacturing industry and can identify, understand, express, analyze and solve complex engineering problems with a high degree of computer ability.

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