# Exploration and Practice of Module Joint Engineering Training Open Mode---Based on 3D Printing and Casting Technology

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**Keywords:** Module union; open experiment; teaching mode; 3D printing; investment casting; reverse engineering

**Abstract:** This article aims to cultivate students' comprehensive innovation and practical ability, exploring the application prospect of the teaching mode of 3D printing-casting module combined, including the curriculum system, operating mechanism and training effects, etc. 3D printing-casting two-module joint training uses various techniques including 3D modeling, 3D printing, and investment casting ,it can improve students' engineering practice ability and stimulate students' comprehensive innovation ability. This move effectively promoted the module construction and training reform of the engineering training center.

## 1. Introduction

The module cross-opening training course started by the Engineering Training Center is based on students. Through the expansion and transformation of the two-module of 3D printing and casting technology in the training process, a teaching mode is created which is conducive to the improvement of students' ability. In the process of training, a diversified teaching evaluation method is implemented, and students change from passive acceptance to active exploration, and discover and acquire relevant knowledge in exploration [1-3]. With the increase of individual behavior and the increase of mobility, students' willingness to freely arrange their learning methods is more and more intense. The open training mode is still the only way for the education reform of college engineering training centers [4-5]. In the past, the development of a single module open innovation training, the Jilin University Engineering Training Center actively explored the teaching model of cross-open training, and implemented a flexible open training model based on the existing teaching resources of each module of the integration center [6].

## 2. Module cross-training curriculum system

The perfect curriculum system is based on the social development, which determines the construction of the training talent knowledge system, and is also the key to guarantee and improve the quality of engineering training [7]. The teaching content implemented by students of different majors is integrated by the teacher and the design scheme, technical points and operational norms of the students in the training process are clarified, and finally the multi-level and multi-disciplinary practice teaching is realized. To implement the specific experimental project, it is necessary to comprehensively consider the factors of different training grades and different majors, and design a training system that can meet the requirements of students at different levels, and establish a multi-level, modular and comprehensive curriculum system. The teaching documents such as the experimental outline, the experimental instruction book and the experimental report are prepared for the feedback of the student training.

The evaluation link of the 3D printing-casting technology module cross-training is based on the student's assessment results, which runs through the entire module cross-training teaching. The

evaluation of the assessment results controls the orderly conduct of the teaching activities, which is mainly determined by the students' training design plan, the training classroom performance, and the training report writing. The proportion of the three parts is adjusted according to the type of training students. At the same time, according to the completion of the students' training works, an interactive evaluation system combining students' self-evaluation, mutual evaluation and teacher evaluation is established.

## 3. Operating mechanism

For students who participate in the training, they can make online appointments, and implement the “white + black” and “7*12” training venues and equipment maximization open plan during the experiment time, which realizes the coverage of students and the flexible opening time. In addition, the training program is unconstrained, students can learn about the project in advance, such as the basic knowledge of 3D printing and casting technology, the basic process of wax mold 3D printer and lost foam casting technology, and the basic principle of reverse equipment, operation Matters such as matters needing attention. The practice teaching mode consists of three categories: cognitive perception-basic operation-integrated innovation, with a gradient in content and level, and cross-integration of learning content, which challenges students' ability to control knowledge flexibly.

## 4. Training effect

First of all, the teacher simply explains the 3D printing, the theoretical knowledge of the casting technology, the students carry out the equipment operation exercises, randomly grouped, and practice the crafts for different materials. The initial prototype provided by a group of training is a variety of materials, the crafts "Ding", as shown in Figure 1. The process from the original crafts to the final casting into the metal "Ding" is shown in Figure 2:

Fig. 1 Craft prototype

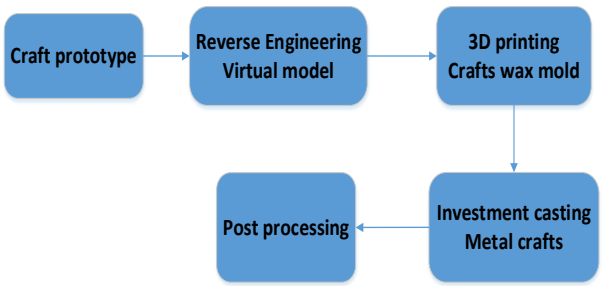


Fig. 2 Open internship process

### 4.1 Reverse engineering technology to obtain virtual model

Students use the creamform 3D scanner - Go! Scan 300 to scan the craft "Ding", get its point cloud data in a 1:1 ratio, and use the post-processing installed in the workstation with the shape scanner. The software "VX element" processes the scanned point cloud data, and saves the processed point cloud data into a file of "STL" format.

### 4.2 Wax printer printing model

The basic principle of 3D printing is layered printing, layer by layer. Before printing, students need to import the “STL” file of “Ding” into the software of the wax pattern printer to perform a series of parameter settings as needed, such as setting support and layering. The layered data is transferred to the 3D printer, the 3D printer is operated to perform the printing task, and the wax pattern "Ding" with support is obtained by printing, as shown in FIG. 3, to remove the supporting material on the wax pattern.

Fig. 3 Wax pattern printing model

Fig. 4 Casting model

### 4.3 Investment casting metal "Ding"

Instruct students to use the 3D printed wax mold "Ding" to obtain metal crafts by investment casting technology. The soldering iron is used to bond the fusible resin to the wax casting system. The bonding surface is generally non-important or processed. In the practice process, the three legs of the wax "Ding" are welded together with the wax riser to form the pouring system and the riser. Finally, the students post-processed the metal molds of the investment mold casting, including cleaning the gypsum, cutting the pouring system, ultrasonic cleaning, grinding, sandblasting and other processes. The metal crafts obtained are shown in Figure 4.

## 5. Conclusion

Based on reverse engineering - 3D printing - advanced casting technology, Jilin University Engineering Training Center has implemented an open training method of 3D printing and casting multiple modules, and explored and implemented cognitive training for different levels of training objects. By participating in open training, it not only enables students to have a clearer understanding of the complete product production process, but also to stimulate students' enthusiasm for knowledge, improve students' practical skills, and strengthen their professional foundation. Knowledge. The open training provides reference for the introduction of multi-module cross-training in 3D printing-laser processing, intelligent manufacturing-CNC technology in engineering training, and the cross-training of engineering training from the previous single training to the new engineering background. Engineering practice provides a foundation.

## Acknowledgements

Jilin University undergraduate teaching reform research project (2019XZC047, 2019XYB067)

## References

[1] Pi Zhijun, Li Jianhai,Yu Min, et al.2010. Research and Exploration of Open Experimental Teaching Mode. Experimental Technology and Management, Vol. 27(05): 27-29.

[2] Han Tong, Liu Zhiming, Zhang Ruoda, ET al.2016.Exploration of open engineering training teaching mode. Experimental Technology and Management, Vol. 33(07): 8-10+13.

[3] Song Guoli, Gai Gongqi, Su Dongmei, ET al.2010. Research and Practice of Open Experimental Teaching Model. Laboratory Research and Exploration, Vol. 29(02): 91-93+132.

[4] Lu Wei. 2015.The Scientific and Technological Innovation Mechanism of the National Laboratory of American Research Universities. University Education Science, Vol. (01): 110-115.

[5] Wang Aihua, Yu Yan, Huo Guoliang, et al. Exploration and Innovation of the Teaching Model of Full-open Engineering Training. Laboratory Research and Exploration, Vol. 37(10): 171-175.

[6] Zheng Zhijun, Xiang Cong, Cao Xueyu, ET al.2015. Construction and Management of Open Engineering Training Center. Laboratory Research and Exploration, Vol. 34 (07): 147-150.

[7] Zheng Zhi. 2016. The Connotation and Path of the Cultivation of Students' Innovative Ability in Applied Undergraduate College. Social Scientist, Vol. (12): 114-118.