

# Project Teaching Method Based on the Application of CAE Software

Lihua Li<sup>1,\*</sup> Jin Wang<sup>1</sup>

<sup>1</sup> School of Mechanical Engineering, Qingdao Technological University, Qingdao 266033, China

\*Corresponding author. Email: lilihua9393@163.com

## ABSTRACT

The technical courses of university require students not only to establish a complete knowledge system, but also to have the ability to solve practical problems and innovation ability. The project teaching method based on the application of CAE software described in this paper combines traditional classroom teaching and project teaching method organically, and uses CAE software to verify and evaluate the project scheme, forming a closed-loop scheme demonstration process. Students can comprehensively process theoretical knowledge while building a relatively complete knowledge system, so as to analyze and solve practical technical problems. After that, it is analyzed and verified by CAE software, and reasonably modified according to the result feedback, which effectively improves the students' method ability and professional ability.

**Keywords:** Project teaching method, CAE software, closed-loop scheme demonstration process

## 1. INTRODUCTION

Design and Manufacture of Plastic Mold is a typical technical course. The teaching purpose of this kind of course is not only to enable students to establish a knowledge system, but also to have the ability to apply relevant laws to solve practical problems. That is, they need to master the law of plastic mold design, to complete the design of plastic molds with medium complexity independently, to select plastic molding equipment reasonably, to analyze and solve the technical problems of product quality and molds in production, so as to lay a solid foundation for future work related to plastic molds.

At present, the teaching methods of technical courses are usually divided into traditional classroom teaching method and project teaching method <sup>[1]</sup>. Classroom teaching method is a kind of traditional teaching method. Its advantage is that the teaching of theoretical knowledge is more systematic. But students usually lack training and have poor ability to use knowledge to solve practical problems. Project teaching method is a novel teaching method. Students can use their knowledge to think and formulate design schemes, and then complete the project, so as to exercise the ability to solve practical problems. However, the deficiency of project teaching method is that the students lack intuitive and specific cognition of the actual effect of their design scheme.

Therefore, in fact, their engineering practice ability cannot be effectively improved <sup>[2-3]</sup>.

Physical verification is the most intuitive verification method. That is, the mold is processed according to the scheme made by the students and installed on the injection molding machine for practical use. Students can directly find out the problems in the implementation of their own design scheme. However, the method of processing real molds is not only has the disadvantages of high cost, time-consuming and labor-consuming, but also difficult to intuitively and comprehensively observe the change process in each link of plastic forming when the design scheme is changed <sup>[4-5]</sup>.

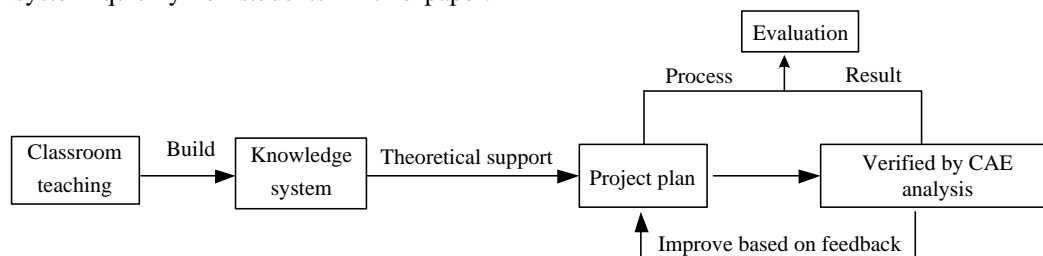
Combination of classroom teaching and project teaching was adopted, and the method of numerical simulation was introduced to evaluate the project. Classroom teaching method is convenient to build a systematic knowledge framework for students. The project teaching method arouses students' learning enthusiasm and improves their ability to solve practical problems. The introduction of CAE software helps to evaluate the project scheme more comprehensively and reasonably, and guide students to correct the project scheme effectively. So, a closed loop formed in the scheme demonstration process. Especially for the verification of the rationality of non-structural design schemes, such as the determination of forming

parameters, the design of gating system and the design of temperature regulation system, the method of using CAE software for evaluation can be better than using real molds.

## 2. IMPLEMENTATION METHODS

Classroom teaching was used to build an overall knowledge system quickly for students in this paper.

Then students were guided to give project plans based on this system. After that, CAE analysis software was used to verify the project scheme, according to the feedback of which, students can also correct and improve their project scheme. Finally, the overall evaluation of the project was carried out according to the process and the final improved results. The flow chart of course flow chart implementation is shown in Figure 1.



**Figure 1** Course implementation flow chart

### 2.1 Classroom teaching

Using classroom teaching method, teachers can convey a large amount of new knowledge to students in a short time. The teacher can help students build a more systematic knowledge framework in a purposeful and planned way according to the idea of careful preparation, so that students can firmly grasp the basic theoretical knowledge. However, the disadvantages are that the transmission mode is one-way, training of creativity is missing. As a result, students lack initiative in learning, and their speculative ability is weak.

Therefore, in the process of classroom teaching, the "single player" teaching method should be avoided as far as possible, and the constructive teaching mode should be appropriately adopted to make students have a certain leading position in the learning process. That is, when the new knowledge is introduced, attention should be paid to interaction and inspiration of students to construct a new knowledge system on the basis of the original knowledge structure.

### 2.2 Project Teaching

The classroom teaching introduced constructive teaching ideas can only help students establish their knowledge system by their own. For the professional technical courses, how to comprehensively apply the knowledge to analyze and solve the technical problems of product quality and mold in production and make a reasonable design scheme is the ultimate goal. The project teaching method takes the project as the main line. Students must comprehensively process the theoretical knowledge to apply it to the project scheme design. Therefore, it can greatly improve students' method ability and professional ability, mobilize their awareness of active participation, and stimulate their creativity and learning enthusiasm.

Before the teaching of this course, students would select typical products firstly in daily life as projects, such as plastic cups, lunch boxes, scanning gun shells, etc. The teaching sequence was arranged according to the actual working idea of completing the project, and guide students to establish knowledge system. After the teaching of each chapter was completed, the corresponding project requirements are arranged to promote the students to realize the ability objectives while thinking about completing the project, as shown in Table 1.

**Table 1.** Teaching content arrangement and project requirements

| Title of chapters   | Content of courses  | Project requirements   | Capability objectives  |
|---|---|--|--|
| Material selection design   | Composition and process characteristics of plastics   | To choose plastic reasonably according to the purpose and performance of the products  | To master the composition and properties of plastics   |
| Structural manufacturability analysis   | Structural manufacturability of plastic parts   | To complete the design of plastic parts according to the product purpose   | To master the analysis method of structural manufacturability of plastic products  |
| Forming principle   | Injection principle and process characteristics   | To select injection molding process parameters reasonably  | To master injection principles and process , and the design method of process parameters   |
| Cavity arrangement, parting surface design and selection of injection machine | Selection of injection machine, design of cavity arrangement and parting surface                        | To design parting surface and parting surface ,to select injection machine according to the product size and structure                 | To master the method of designing cavity arrangement and parting surface, and the method of selecting and verificating injection machine |
| Design of gating system   | Composition and design of gating system   | To design gating system reasonably according to the structure of injection machine and products  | To master the design method of gating system   |
| Design of cooling system  | Significance and design of cooling system   | To design cooling system reasonably according to the structure of products   | To master the design and calculation method of cooling system  |
| Design of working parts   | Structural design and calculation of working parts  | To make structural design and calculate the size and accuracy working parts according to product structure and appearance requirements | To master the structural design and calculation methods of working parts   |
| Design of ejection mechanism  | Composition and design of ejection mechanism  | To design ejection mechanism reasonably according to the product structure and using requirements                                      | To master the design method of ejection mechanism  |
| Design of structural components   | Type and selection of mold base, design of supporting and connecting, guiding and positioning mechanism | To select mold base, supporting and connecting, guiding and positioning mechanism reasonably   | To master the selection method of mold base and standard parts   |

### 2.3 Scheme verification and improvement

Firstly, 3D modeling software was used for modeling. Then, the model would be imported into the CAE software, such as MOLDFLOW. After the grid is divided

and repaired, different functional modules can be used to analyze and verify the project scheme,

and guide students to improve the project scheme according to the analysis results, as shown in Table 2.

**Table 2.** Verification contents and improvement direction

| Analysis sequence       | Contents of analysis and verification   | Improvement method  |
|-------------------------|---|---|
| Forming window analysis | To verify the influence of process parameters on molding, and whether the product can be filled smoothly by the selected injection machine  | Material selection design<br>Process parameter design<br>Injection machine selection                      |
| Filling analysis        | To simulate the whole process from the beginning of injection molding to the completion of filling, and predict the filling behavior of products in the mold cavity   | Gating system design<br>Process parameters design<br>Venting system design<br>Injection machine selection |
| Cooling analysis        | To simulate the cooling process and analyze the cooling balance and cooling efficiency  | Cooling system design   |
| Packing analysis        | To continue the analysis in the pressure holding stage to reduce the volume shrinkage difference, reduce the residual stress, improve the warpage, reduce the clamping force and save energy consumption ,based on the filling analysis above | Material selection design<br>Process parameter design<br>Injection machine selection Gating system design |
| Warp analysis           | To simulate the deviation between the overall dimension and the cavity dimension after injection molding  | Cooling system design<br>Calculation of working parts   |

## 2.4 Teaching effect

According to the final examination results, students' ability to master comprehensive application topics has been significantly improved. According to the performance of students in the follow-up teaching link, the ability to analyze and deal with practical problems has been improved. The statistical results of the questionnaire also show that students have a high degree of recognition of the curriculum objectives.

This is because the scheme demonstration process forms a closed loop after the CAE simulation verification link is added. Students have a clear understanding of the implementation effect of their own project scheme, and can reasonably modify, explore and think about improvement methods according to the result feedback, so as to ensure that idea has good practical effect. It can improve their method ability and professional ability effectively, and stimulate their creativity and learning enthusiasm.

## 3. CONCLUSION

In this paper, the implementation process of plastic molding process and mold design was introduced, by combining classroom teaching with project teaching method organically, and using CAE software to verify and evaluate the project scheme.

In the process of classroom teaching, the idea of constructing teaching mode was added, which made full use of the efficient and systematic advantages of classroom teaching methods, so that students could establish a complete knowledge system soon. By

combining with the popular project teaching method, students can comprehensively process the theoretical knowledge and apply it to analyze and solve the technical problems of product quality and mold in production, so as to greatly improve their method ability and professional ability. Using CAE software for project verification and evaluation, students can intuitively find the problems in the implementation of their design scheme, verify the rationality of their idea, and get closed-loop feedback results, so as to really improve their ability to solve practical problems.

Teaching practice shows that the teaching method described in this paper can enable students to build a relatively complete knowledge system, exercise and improve their ability to solve practical problems and innovation, and the teaching effect is good.

## REFERENCES

- [1] S. Huang, Teaching Reform of Design and Manufacture of Plastic Mold Course, Mold manufacturing, 2021(2), pp. 90-92, in Chinese. DOI: 10.12147/j.cnki.1671-3508.2021.02.025
- [2] H. Zhang, Y. He, Research on teaching reform of "design of mould for plastic" course in higher vocational education, Mold industry, Vol.47 (4), 2021, pp. 81-83, in Chinese. DOI: 10.16787/j.cnki.1001-2168.dmi.2021.04.019
- [3] Guoliang Fan, Hongyong Tong, Xinhua Xu, Curriculum construction and teaching reform in higher vocational colleges based on OBE-Taking the course of "plastic mould design and

manufacturing” as an example, *Mold industry*, Vol.47 (6), 2021, pp. 89-94, in Chinese. DOI: 10.16787/j.cnki.1001-2168.dmi.2021.06.018

- [4] R. Peng, Application of CAE Technology in plastic mold design , *Chinese Equipment Engineer* , Vol.14(2), pp. 166–167, in Chinese.
- [5] Kaiyuan Chen, Ying Wang, Jirui Ou, Curriculum reform and practice of "plastic forming technology and die design" based on project teaching. *Mold industry*, Vol.42(1),2016, pp.71-75, in Chinese. DOI:10.16787/j.cnki.1001-2168.dmi.2016.01.020