

“Plus One” Teaching Method on Mechanical Innovative Design Course

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Abstract. In the undergraduate teaching on mechanical innovative design course, authors introduced “plus one” teaching method in order to guide students in accordance with the engineers’ design thinking and creative thinking approach to mechanical design work. On the one hand, the selection principles and methods for the practical engineering cases in “plus one” teaching method were discussed, on the other hand, the practical engineering cases in teaching were introduced. Then, students were required to conduct a small research project to consolidate the teaching contents on this basis. Authors also explored implementation methods and evaluation mechanisms of the research project. Practice shows that: “plus one” teaching method can inspire students’ innovative thinking ability, train students’ engineering thinking mode and team cooperation ability and improve students’ comprehensive ability to use knowledge.

Introduction

In traditional classroom teaching, the interpretation of practical engineering cases are usually lacked. It’s difficult for students to put what they have learned in classroom into use and their innovative ability can’t be developed. In order to solve this contradiction, “plus one” teaching method is introduced, which takes out one credit (16 hours) from the traditional theory of teaching to mainly analyze and explain the practical engineering cases. There are two points on the research projects. First, we provide opportunities for juniors to come into contact with practical engineering and scientific cases, train students’ problem-analyzing and problem-solving ideas, and develop their creative thinking. Second, students can creatively study and apply the knowledge points from the textbook through the learning of practical engineering cases, and their ability of engineering design and innovation can be cultivated by the design of research project in person^[1].

This paper first introduces “plus one” teaching method and discusses its selection and design principles of relevant practical engineering cases. Then, students’ small research projects are arranged and their specific evaluation mechanism are given. Finally, it shows the students’ work which has been done under the implement of “plus one” teaching method when authors work at Beijing University of Posts and Telecommunications over the years.

Implementation of “plus one” teaching method not only improves students’ interest in learning and enriches the knowledge of classroom teaching, but also helps to enhance students’ ability of innovative design.

Implementation of “Plus One” Teaching Method

1 Selection Principles of Practical Engineering Cases.

To effectively select the contents of the practical engineering cases, we develop three selection principles

Pertinence. The selected contents of the practical engineering cases must accord with the requirement of mechanical innovation design course and reflect the thinking and methods of the course in order to achieve the goal of the teaching.

Inspiration. The selected contents of the practical engineering cases should be able to inspire students’ thinking and guide students to think deeply in order to cultivate students’ creative ability.

Comprehension. The selected contents of the practical engineering cases should involve

different fields of mechanical design and be able to fully reflect ideas and methods of mechanical innovation course in order to satisfy different students' needs.

2 The Contents of Practical Engineering Cases.

Authors have collected, collated and interpreted the practical engineering cases in Beijing University of Posts and Telecommunications for several years. These cases are widespread and have a strong teaching and demonstration function. Some of them are shown as Table 1.

Table 1. Part of the practical engineering cases

1	Mechanics analysis of palletizing robot end executor
2	The working cycle diagram design of Palletizing robot and 4 cylinder engine
3	The design and evaluation of electric door solutions
4	The design method and key points of palletizing robot end executor
5	The detailed design solution of XX camera lens' automatic assembly line

The interpretation of the practical engineering cases can help students understand and verify innovative design theories and methods so as to grasp the theories and methods of mechanical innovation design. For example, The mechanics analysis of palletizing robot end executor can guide students to learn mechanical analysis, design and optimization on the mechanical parts. The working cycle diagram design of Palletizing robot and 4 cylinder engine can guide students to learn the design and points of the mechanical system cycle diagram. The design and evaluation of electric door solutions can guide students to learn solution selection and evaluation on the mechanical system. The detailed design solution of XX camera lens' automatic assembly line can guide students to learn the system integration methods.

Implementation of the research projects

1 Project Arrangement.

The schedule of the research projects is as follows: after the 2th teaching week, students are required to find, analysis and design their own research projects by themselves. They can choose two to four people in a group, with free combination (suggesting in bedroom units)., in the 17th teaching week, we will arrange a day to conduct research project respondent;

2 Assessment and Evaluation.

In the 3th week after choosing research subjects, Students are required to make a reply in groups and show progress. This will be done in a lesson(45 minutes).Results of research projects are determined by mutual evaluation of the students, which is divided into two parts: overall evaluation (S_1) and member assessment (S_2), as shown in Table 2^[3]. Overall evaluation S_1 is the grade of overall impression of the reply group which includes six aspects: innovation ability, theoretical analysis, design thinking, design means ,total work and reply expression^[3]. Member assessment S_2 is mainly determined by the contribution of the project team and the workload^[4]. Based on the overall evaluation S_1 , The group members determine the subtraction of their members' scores, ranging between -10 to +10^[5]. The individual whole score S is the sum of S_1 and S_2 .

Table 2. Students' scoring sheet of research projects

Evaluation Type	Evaluation Content	Weights	Scores
S ₁	1. innovation ability,	30	100
	2. theoretical analysis	20	
	3. design thinking	10	
	4. design means	10	
	5. total work	20	
	6. reply expression	10	
S ₂	Contribution and Total Work		

Students' innovations

Part of the work of students is shown below:



Fig. 1 Multifunctional automatic supporting bed leg

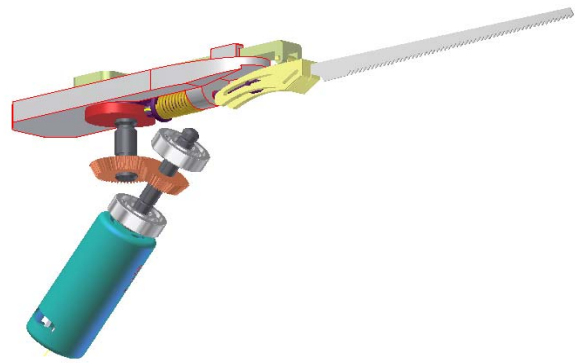


Fig. 2 Reciprocating hand saw

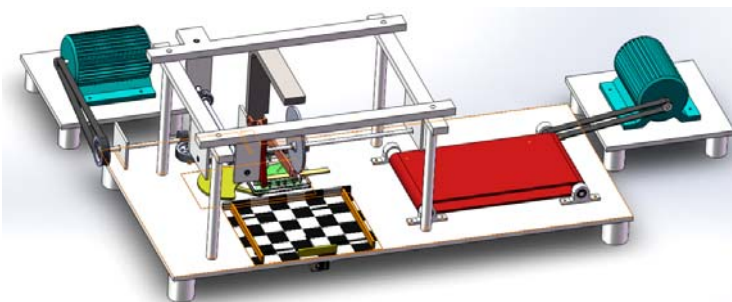


Fig. 3 Automatic stapler

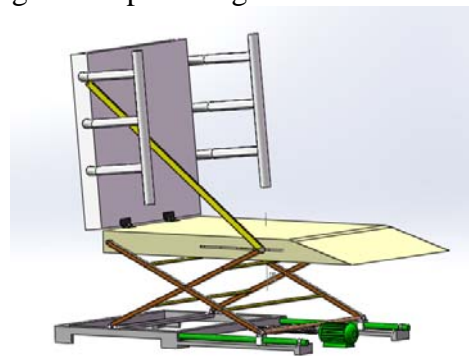


Fig. 4 Barrier-free system platform

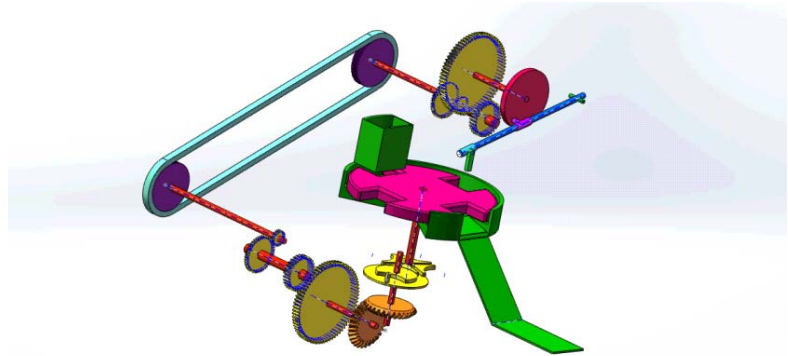
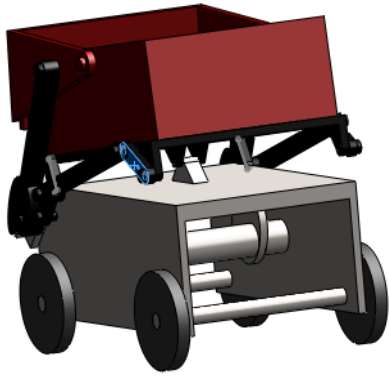


Fig.5 The 3-D assembly drawing of dump truck Fig. 6 Automatic seal machine
 These innovations have been obtained for the reason of the correct implementation of “plus one” teaching method, which has inspired students’ creative thinking and improved innovation capability.

Summary

This paper described “plus one” teaching method which was introduced in the undergraduate teaching on mechanical innovative design course by authors and discussed its background and concepts. This paper also discussed the selection and design principles of relevant practical engineering cases and assessment and evaluation of research projects. The implementation of “plus one” teaching method can make up for the lack of practical engineering cases in classroom teaching. Students can learn theoretical knowledge combined with practice in the classroom by the analysis and presentations of practical engineering cases. The practice of research-oriented projects in the classroom will be easily turned into analysis, design, operation and other practical skills. Years of classroom practice shows that “plus one” teaching method consolidates the theoretical knowledge students have learned in classroom ,cultivates students' practical ability, inspire students' creative thinking, strengthen the ability of teamwork, improves students' comprehensive ability to use knowledge.

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