



Study on Teaching of Engineering Design Course with 3D Modeling Software and 3D Printer in International Training Course

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Abstract. Engineering design is one of the most important major courses for students in international training course. The goal for them is mastering professional comprehensive knowledge and applying it into the professional work projects. The content of engineering design and the international requirements was introduced. In order to improve the shortcoming of traditional teaching, novel teaching integrated with 3D modeling software and 3D printing technology was studied. For specific designing task, 3D modeling could make it more convenient to calculate the parameters of the designing. 3D printing could get the designed products rapidly and directly to help students to measure the precisions of the products. It is helpful to evaluate the designing scheme and to improve the quality of the products. The new teaching methods make it improved that the designing quality and efficiency. The comprehensive ability of students has been improved by combining 3D printing technology with the engineering designing work in the practice of the students.

Keywords: Engineering design · 3D modeling · Teaching · Internationalization

1 Introduction

Engineering design is an important course for students majoring in electromechanical specialty in international training course. The course includes two parts of knowledges. This first part of the course in engineering design introduces the students to concepts, procedures, data, and decision analysis techniques necessary in modern design applications. Power transmission components including gears, belts, chains, bearings, couplings, and shafts are studied in detail, and incorporated into a significant term-end project. The second part of the course continues the directions started in the first part, using similar methods to introduce new topics. A major project, including calculations and production drawings, will involve a linkage mechanism and a welded structure. The teaching methods were researched on the basis of the traditional teaching methods and study [1, 2].

In the processing of the design work, 3D modeling software is necessary for students to understand the designing model. 3D modeling was a popular research topic in design fields [3–9]. Integrating 3D modeling established with a software into the designing process is a helpful teaching method to get better effect in class. 3D modeling is to build a model with three-dimensional data through virtual three-dimensional space through three-dimensional production software.

While 3D printing technology is a novel manufacturing technology which is rapid and direct to get the designed real parts, and it is facilitate to evaluate the design scheme. 3D printing could be applied in many engineering fields [10–14]. The 3D printing technology will be more and more popular and is researched by many methods [15–17]. The principle of 3D printing is that the materials needed such as metal or plastic are overlaid and bonded layer by layer through printer. The technology could help students to get the designed products rapidly from the 3D printer instead of numerical control machining of multiple processes.

Integrating the international knowledges with the 3D modelling and 3D printing technology is a novel teaching method for teachers and an interesting experience.

2 Requirements and Teaching

For students in international training course, the knowledges they mastered should adapt to the internationalization. The comprehensive ability corresponding to the specialty knowledges is important for students to continue the study and work in Canada or Britain. So the internationalization and the combining knowledges are both necessary key requirements for students.

2.1 Internationalization of Knowledges and Abilities

Internationalization is a way of designing and producing products that can be easily adapted to different locales. This requires extracting all language, country/region and culturally dependent elements from a product. In other words, the process of developing an application whose feature design and code design do not make assumptions based on a single locale, and whose source code simplifies the creation of different local editions of a program, is called internationalization.

With the developing of the globalization, the knowledges for students should be generalization and internationalization to meet all of the job positions in the specialty.

Engineering design is an important specialty course for students in mechanical major. The mainly contents of the course are composited of two parts. The first part of the course includes concepts, procedures, data, and decision analysis techniques necessary in modern design applications. Power transmission components including gears, belts, chains, bearings, couplings, and shafts are studied in detail, and incorporated into a significant term-end project. The skills required are shown in Table 1.

Table 1. Skills required in Engineering Design 1

Employability	Essential Employability Skills addressed in this course
Communication	<ul style="list-style-type: none"> Communicate clearly, concisely and correctly in the written, spoken, and visual form that fulfills the purpose and meets the needs of the audience Respond to written, spoken, or visual messages in a manner that ensures effective communication
Numeracy	<ul style="list-style-type: none"> Execute mathematical operations accurately
Critical Thinking and Problem Solving	<ul style="list-style-type: none"> Apply a systematic approach to solve problems Use a variety of thinking skills to anticipate and solve problems
Information Management	<ul style="list-style-type: none"> Locate, select, organize, and document information using appropriate technology and information systems Analyze, evaluate, and apply relevant information from a variety of sources
Interpersonal	<ul style="list-style-type: none"> Show respect for the diverse opinions, values, belief systems, and contributions of others Interact with others in groups or teams in ways that contribute to effective working relationships and the achievement of goals
Personal	<ul style="list-style-type: none"> Manage the use of time and other resources to complete projects Take responsibility for one’s own actions, decisions, and Consequences

Computer aided design is encouraged in the processing of solving the problems in homework for students. Figure 1 is a calculation example for students to solve problems in the processing of designing project.

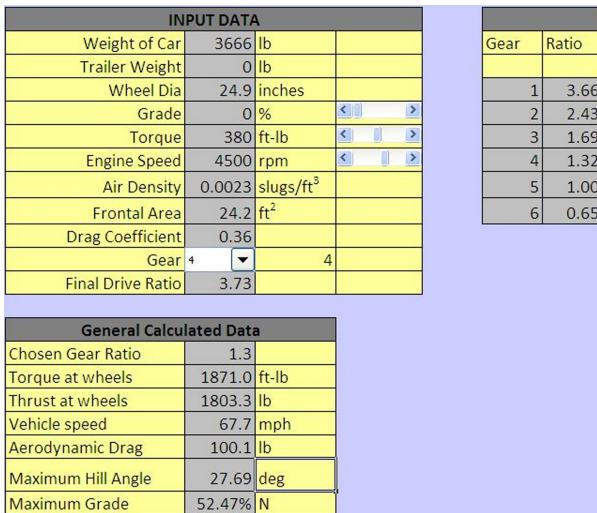


Fig. 1. Calculation software example for students

The second part of the course will enable the student to: 1) Describe the wide range of mechanisms already designed and be able to research for suitable means of obtaining a required motion. 2) Construct linkage displacement diagram to determine overall motion. 3) Develop force analyses for linkages. 4) Select suitable hydraulic, pneumatic, or electric linear actuator. 5) Check column strength of actuator. 6) Design plain bearings and select suitable propriety units. 7) Select suitable brake and clutch units for given loads and acceleration. 8) Design welded joints. 9) Define the considerations of strength and rigidity in welded frames and structures. 10) Integrate the design of the above elements into an overall machine design and produce assembly and detail drawings.

Figure 2 is an example for students to get design an mechanism. The question enhanced the calculation ability and broaden the design thinking of students.

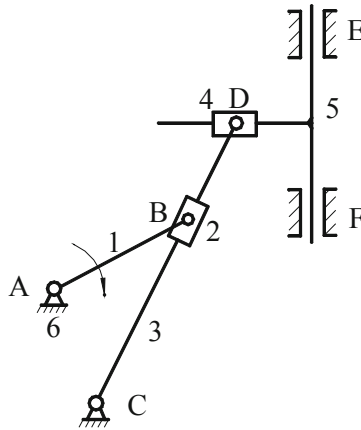


Fig. 2. An example for designing to get the required motion

2.2 Integrate 3D Modeling Software

The designing projects in the course is an important part for students to attain the designing ability. The designing projects are required and arranged in teaching plan for students to practice the software. At school, the designing homework were required to apply 3D modeling software for modeling and other software for calculating. It is also encouraged for students to use office software to write the design specification.

In the processing of designing mechanism, the mechanical drawing is the key work. While in the mechanical drawing, 3D modeling is a necessary work for understanding the designing objects except 2D drawing. Integrate 3D modeling software into the designing work is a helpful work.

With 3D modeling software, we could evaluate the products from each view to help the designing projects. Figure 3 shows the 3D models of parts and assemble drawing made by 3D software which could help students to check the feasibility of the design. (a) shows a shaft of a reducer designed for outputting the rotation. (b) shows a gear designed by a 3D software to match with a shaft. (c) shows the assemble reducer. Assembling by

using the 3D modeling software could check that whether the assembly between parts is reasonable. From the example, integrating 3D modeling software with the designing could help students to practice designing the required model directly and visually.

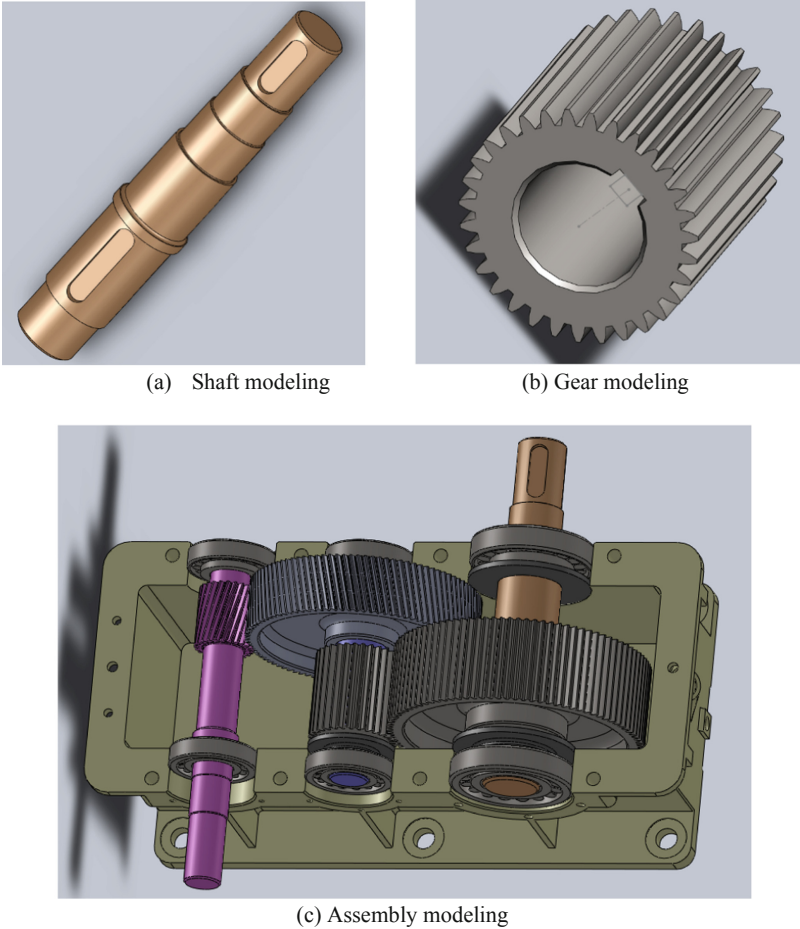


Fig. 3. 3D modeling for designing example

2.3 Integrating 3D Printing

3D printing is novel manufacturing technology which could convert the data in the computer designed by software to the signals in the printer, to overlaid and bond the metal or plastic materials layer by layer through the printer. In the course of Engineering Design, 3D printing technology could follow up the 3D modeling to realize the transfer from the modeling to the real products. It could help students to understand the designing model and evaluate the real quality of the products designed in the process. In the 3D

printing class, students could realize their designed plan by 3D printer which could initiate their innovation ideas and innovative thinking. Then the interesting of designing and innovation could be inspired in the class.

Students could study from the modeling library and design their objective by their innovative ideas by talking with their teammate. The group cooperation could train students' ability of teamwork. Figure 4 shows the models and products for students to practice and design.

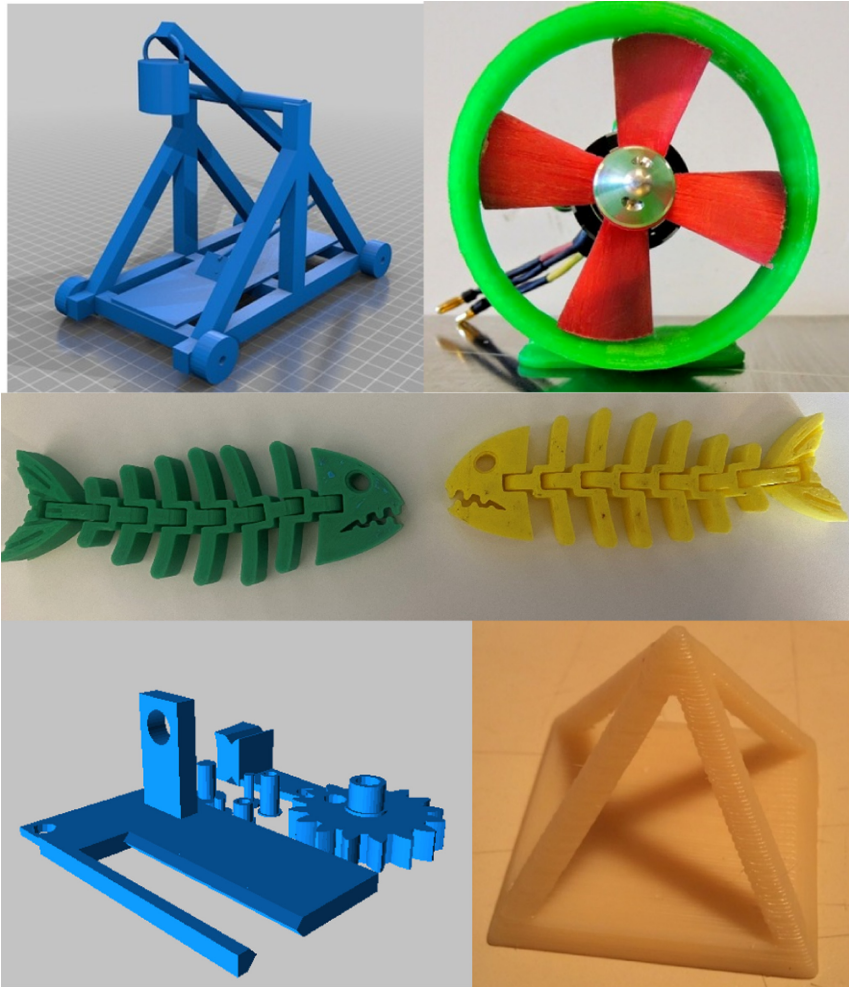


Fig. 4. Modeling and products for students to practice

In the 3D printing class, the divergent thinking is important for students to generate innovative ideas. So combination of free play in thinking and group cooperation in

realizing the design is necessary. Teacher statements the requirement conditions and the other time leaved for students to free thinking, talk and cooperate with the teammates.

Combining 3D printing and 3D modeling could attain good teaching effect in the studying process of the course. Integrating 3D printing technology and 3D modeling software into the teaching class is an effective and popular teaching mode for students in the international training class.

3 Summary

Engineering design is a key specialty course for students in international training class. In the paper, the internationalization was introduced. The requirements of the course were studied and made. The content of Engineering Design was summarized. In teaching method, establishing 3D modeling for students is an important progress to understand and express their design ideas. Integrating the 3D modeling software into the course is necessary and helpful for students. 3D printing technology is a novel manufacturing which could get the real products designed in class rapidly and directly. Combining 3D printing with 3D modeling is effective and helpful for students to view and evaluate the design plan, which is helpful for students to improve the designing work.

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