Journal for Geometry and Graphics
Volume 23 (2019), No. 2, 269–274.

Project-Based Integrated Practice of Engineering Graphics under Different Task Systems

Yunhui Zhang, Xiuzhi Zhang*, Jun Li, Siyuan Liu

Dept. of Eng'g & Computer Graphics, School of Mechanical & Aerospace Eng'g, Jilin University
No. 5988, Renmin Street, Changchun, Jilin Province, China
email: xiuzhi@jlu.edu.cn

Abstract. This paper presents the integrated practice section of Engineering Graphics at Jilin University, China. Under the guidance of the concepts of Engineering Education Professional Certification, this section experienced reform and construction. Adjusted in objectives, contents and procedures, it had been updated to be a project-based integrated practice under different task systems.
The main objectives of the integrated practice of Engineering Graphics are cultivating students' ability of representing machine parts and components, and the ability of analyzing and solving basic engineering problems. In addition, the innovating ability and team-cooperating spirit of students are supposed to be trained through integrated practice.
Students were divided into small groups, and were given different assemblies. The task of each group was doing a project based on integrated measuring and drawing a given assembly. The whole process of the project mainly included experiments in the sequence of decomposing and composing an assembly, experiments in measuring dimensions of machine parts and components, drawing freehand sketches, making instrument drawings, 3D modeling, and virtually assembling machine parts and components. The overall work was made up of the work of groups and of individual persons. At the end of integrated practice, the students were required to answer adviser's questions in groups. They were also encouraged to make powerpoint files (PPTs) and give presentations, make animations and conduct 3D printing to show the compositions and principles of the assemblies. Advisers give grades for each student according to his/her performance.

Key Words: Engineering Graphics, different task system, project-based, integrated practice.

MSC 2010: 97G80

ISSN 1433-8157/$ 2.50

1. Installation

In recent years, the concept of *Engineering Education Professional Certification* (EEPC) has been widely recognized in the field of higher education, which has produced a far-reaching impact on improving the quality of education and promoting the development of higher education. EEPC emphasizes the concepts of student-centered and outcome-based education, and continuous improvement of the education quality [3, 1]. Then, the cultivating objectives of majors, the qualifying standards for graduation, and the curriculum system have been rebuilt according to quality criteria of talent cultivating. The quality criteria of talent cultivating were divided into detail graduation requirements. Each requirement will be satisfied by corresponding course(s). Then, the objectives of a certain course will correspond to one or more graduation requirements. Further, the syllabuses and specific contents of a certain course should be set according to the course objectives. So, designing courses according to the cultivating objectives of students is the basic requirement of *"student-centered"*.

In 2012 and 2018, the major of mechanical engineering at Jilin University passed smoothly two rounds of EEPC. Guided by the concept of EEPC, the course of Engineering Graphics has been continuously improved at Jilin University. The core contents of Engineering Graphics was set corresponding to one of the graduation requirements of engineering major students, that is, cultivating the ability of the students to distinguish, represent, and describe complex engineering problems. So, the main contents of Engineering Graphics was set to include projection theories, views and dimensions of objects, relevant provisions on representations of mechanical drawings in national standards, drawing, and visualizing detail drawings and assembly drawings. In addition, modern advanced drawing technology and innovative ability was set as contents of higher level and innovative [5, 4]. As known, to deal with complex engineering problem is a challenging job for students of lower grade [2, 7]. Moreover, in order to be qualified in modern era, students should also have team work spirit. In order to satisfy the cultivating requirements of students, *project-based integrated practice under different task systems* was conducted.

At Jilin University, the Engineering Graphics course is set for the freshmen of engineering major. The whole contents of Engineering Graphics are divided into two stages.

- The first stage concerns projection theories and the basic knowledge of representation skills of commonly used parts and components, and
- the second one consists of project-based integrated practice. This second stage is arranged in a classroom, after a test of knowledge concerning the first stage, and takes two weeks. The project-based integrated practice of Engineering Graphics has been conducted for more than 20 years. With the diversification of the mapping assemblies, the project-based integrated practice under different tasks become possible.

At Jilin University, there are more than 1600 students each year, who take this practice stage. The students are divided into two time period to take this course stage. Students are divided into groups, and each class generally includes about 6 groups of four to five students each, and each adviser guides about 10 groups in each time period.

2. Contents of project-based integrated practice of Engineering Graphics

Integrated practice of Engineering Graphics is a comprehensive practical project, which includes the representation of machine parts and components, application of national standards, and flexible usage of computer aided design software. Students are divided into groups, and their tasks are projects based on measuring and drawing assemblies, which mainly includes experiments of decomposing and composing given assemblies, measuring and representation of machine parts and components, hand drawing, computer aided drawing, and modeling a virtual assembly.

The overall work is made up of the work of groups and that of individual persons. Students are going to complete the whole task according to the following steps.

1) Through accessing the reference material [6] and conducting a decomposing and composing experiment, be familiar with working principles, the motion transmission process, the application occasions, the sequence of composing and decomposing a given assembly, and also assembling relationship of parts and components.

2) From analyzing the shape and measuring the dimensions of the standard parts, make sure the types, specifications, and codes. Make a list of standard parts.

3) Other than standard parts and components, the work concerns general parts shared by group members. Measure dimensions and make drawings of all general parts. Make sure reasonable representation schemes, show a suitable layout, give overall dimensions, specify surface roughness and size tolerances, and describe other technical requirements. Draw sketches of general parts and components on graph paper. And then, make virtual models of the parts and components according to the sketches with 3D CAD software. Make 2D CAD drawings in the AutoCAD drawing environment, or generate 2D draftings from 3D virtual models.

4) Produce an instrumental assembly drawing with hand drawing equipment. Make an assembly drawing of AutoCAD style. Create an axonometric exploding drawing of the virtual assembly, and save it as AutoCAD file.

5) After the adviser's reviewing, print out the drawings on an AutoCAD file into paper drawings, print out the virtual 3D models into solids.

6) After finishing the above tasks, students are required to compile a design specification, in which they record the whole process of integrated practice and what they learned from this work. In order to enlarge the benefit of students, they were also encouraged to make PPTs, animations, videos, and give presentations to introduce the assembly they worked with, and to express their understanding of the overall work they had done.

7) At last, answer adviser's questions in groups.

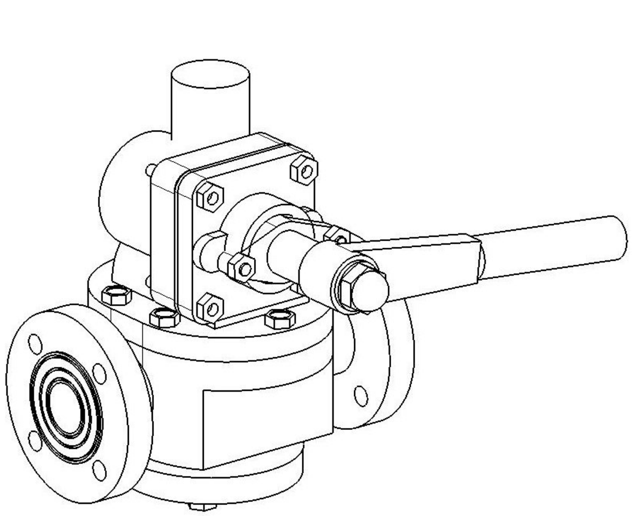
3. An example

An assembly of a fast valve was given to a group of students. The pictures in Figure 1 show the 3D virtual assembly, its explosion style, and the 2D drawings.

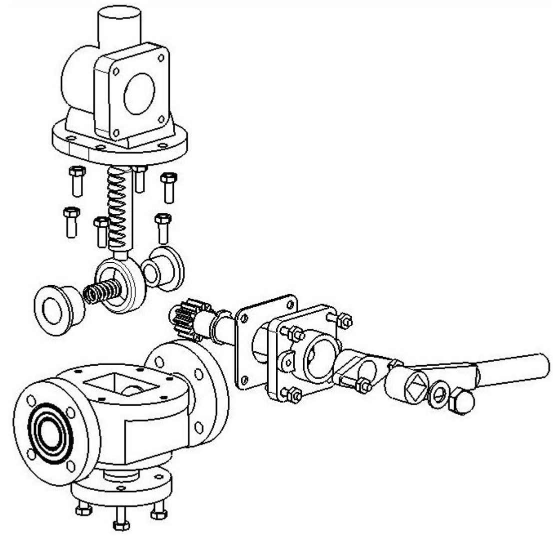
4. Abilities that students developed after the integrated practice

Through the project-based integrated practice of Engineering Graphics under different task systems, students not only understood the breadth and depth of knowledge related to Engineering Graphics, but also developed the practical ability.

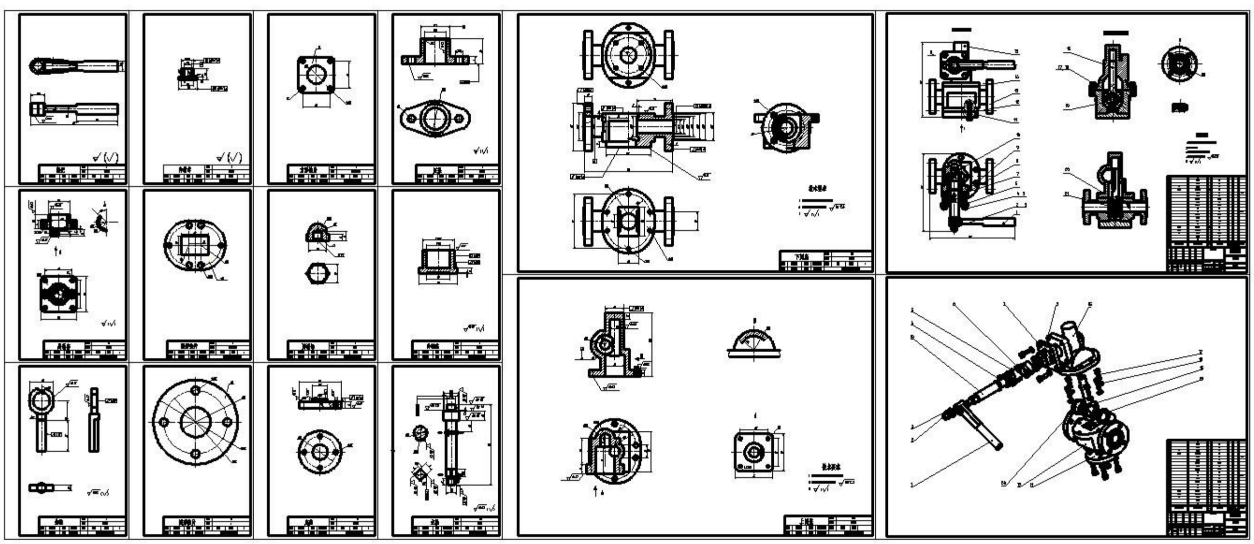
1) In order to know the working principle and applying occasions of the given assembly, students had to search related material from books, or got reference of different style from



a. Virtual assembling experiment



b. Virtual disassembling experiment



c. AutoCAD drawings

Figure 1: Fast valve

different channels. Through the process, the reference material retrieval ability of students was improved, and the outlook of students was broadened.

2) In the course of making sure the specifications and codes of standard parts and components, or the shapes and sizes of standard features on machine parts, students should be familiar with commonly used measuring tools and methods of measurement. On the basis of the dimensions they got from a real assembly, students needed to consult national standards. Thus, the students developed the consciousness of following national standards, with which they could communicate smoothly with other engineers and technicians. Meanwhile, the engineering consciousness could also be cultivated in the process.

3) A detail drawing, just according to its name, shows all details of machine parts. Since the structure of a part can be simple or complex, the ability to make a reasonable representation

scheme is very important for students. Through the integrated practice under different task systems, students had the chance to come into contact with many parts having different shape styles and various features, so that the students' ability of representing machine parts could be greatly improved. 3D modelling is a very useful process in integrated practice. Through modelling machine part on the basis of the dimensions they measured from real parts, or indirectly according to the sketches they drew, students could grasp advanced mapping technology, and they could reversely check the correctness of the sketches and the dimensions made by themselves.

4) Students could not only make AutoCAD drawings directly under AutoCAD environment, they could also obtain AutoCAD drawings from resaving draftings, which are generated by projecting and editing projections from the models they made in 3D CAD modelling environment. Through the process, students could be familiar with the conversion of data formats between different softwares, and would become experts in the flexible usage of commonly used CAD software.

5) In the course of measuring dimensions and making drawings of parts and components, and also in the process of modelling and constructing AutoCAD drawings, students of the same group should cooperate with each other, they share the data and reference materials, discuss the details of each work section, and make related shapes, sizes, and dimensions coincident. Each student was required to conduct virtual assembling and draw assembly drawing by himself. In this section, students experienced serving and being served, thus, the sense of responsibility, service, and cooperation could be rooted in the heart of students.

6) For passing the defense smoothly, students themselves would communicate and discuss with group members and classmates of other group, and also discuss with advisers. Through communication and discussion just before the defense, the foundation of the range and depth of students' knowledge related to Engineering Graphics could be much more solid. Arranging and taking part in discussions is an interaction process between advisers and students. Through the process, advisers could master the attitudes, capabilities, levels, and benefits of students, and could also promote a knowledge extension of students.

5. Conclusions

Through conducting integrated practice of Engineering Graphics under different task systems, the abilities of students including the representation of parts and components, problem analyzing and solving were trained, and their engineering consciousness was constructed. Through defensing and giving presentations in groups, the abilities of students including oral description, expression, and communication were reinforced. In addition, the team work spirit of students was cultivated.

As the tasks of different groups are different, the students have to do hard in their own job, and the phenomenon of overstudying from others was greatly reduced. Since students of different groups work in the same classroom, they come into contact with several different assemblies, so that their outlooks are broadened.

After rounds of practice, reformation, and improving, the integrated practice has already developed into a project-based integrated practice under different task systems, in which innovative design and 3D printing were combined. Through the practice, students not only understand the breadth and depth of knowledge related to Engineering Graphics, but also develop the practical ability. This course is proved having outstanding effectiveness, and is highly approved by students. In addition, this course is designed to be combined with 3D printing and discipline related competition, so that the innovation ability of student is improved meantime. One of the byproducts are several excellent achievements at national awards in the National College Students Advanced Mapping and Innovation Competitions in recent years.

References

[1] Yali Chen, Zhen Liu: *Teaching Reform of Engineering Graphics Education in terms of Engineering Education Professional Certification in Guangzhou, China*. Proceedings of 2018 IEEE International Conference on Teaching, Assessment, and Learning for Engineering, TALE 2018, 2019, pp. 596–601.

[2] D.F. Kuchkarova, D.A. Achilova: *Quality management of engineering graphics teaching*. Adv. Intell. Syst. Comput. **809**, 1624–1630 (2019).

[3] Zhiyi Li: *Analyze Outcome-based Concept in Engineering Education Professional Certification*. China Higher Education **17**, 7–10 (2014).

[4] Guodong Lu: *Govern "Water Course", Create "Golden Course"*. China University Teaching, **337**/09, 25–27 (2018).

[5] Yan Wu: *Construct Chinese "Golden course"*. China University Teaching 12, 4–9 (2018).

[6] Yunhui Zhang, Shuzhang Pan: *Engineering Design Drawing*. Science Press, 2014.

[7] Xiuzhi Zhang, Xiangbao Meng, Yunhui Zhang: *Attempts on Improving Students' Comprehensive Qulities through Engineering Graphics Course*. 17th International Conference on Geometry and Graphics (ICGG), Beijing 2016, pp. 353–354.

Received November 1, 2019; final form November 28, 2019