EACHING PRACTICE OF SECOND LEVEL CDIO PROJECT IN A MACHANICAL COURSE

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ABSTRACT

The second level CDIO project of the mechanical manufacturing technology and fixture design is designed on the basis of CDIO educational idea and the requirements of undergraduate educational goal in machine design manufacture and automation specialty. According to the capacity requirements of a qualified machinery manufacturing engineer, the project is centered to process designs and the processing of the typical machinery parts. It includes: parts analysis, process planning, fixture design, design and analysis of the machining process, parts manufacturing and machine assembly. Students' capacities of conceiving, designing, implementing, and operating can be well trained through the above activities. The guideline of the project is cooperating with a due division of labor; different faculty is in charge of different tasks covering fixture design, engineering drawing audit, cost budget, fixture manufacturing, and etc. The faculties try their best to improve the guiding quality of the project. Students participate in the project as a team; tasks like parts analysis can be completed by a student independently, while the other tasks like fixture design, design and analysis of the machining process, part manufacturing and machine assembly need to be completed by the cooperation of the whole group. Students improve not only the capacity of organization and management, communication and cooperation but also the sense of responsibility. In order to ensure the implementation effect of the project, four evaluation codes are set up to evaluate comprehensively the completion situation. Through the practice of this CDIO project, we turn the boring theoretical knowledge into a vivid engineering practice. We got very positive feedbacks from students. The project consolidates the theoretical teaching achievements, enhances the engineering practice training and highlights the feature specialty. Students grasp the pleasure and significance of design for manufacturing.

KEYWORDS

CDIO, Engineering Education Reform, Project, Manufacturing Technology, Standards: 2, 3, 5, 8, 9, 10, 12

1. INTRODUCTION

Facing to the new situation of popularization of higher education and the new need of building an innovation-oriented country, colleges and universities are deficient in those aspects such as talent training goal and training method. As a local undergraduate universities, the biggest difficulty of training mode reform of Yanshan university lies in the

disparity between the educational concept and the requirements of modern education, the talents training scale is large while the teaching resources is limited. For Yanshan University, how to achieve the scale training of engineering talents with high quality under with the limited resources is the main direction of its engineering talent training mode reform.

Yanshan University, based on the national innovation experimental area whose talents training mode is to cultivate the entrepreneurial talents through the interaction between the learning-research-industrialization of mechanical engineering and the concept of learning by doing and also based on the National-level features professional, the national comprehensive reform pilot all included accounting 11 national undergraduate teaching quality construction projects and 7 undergraduate teaching quality project of Hebei province, has made remarkable achievements when it adopted the majors in mechanical engineering as its pilot and carried out a series of explorations and practices in engineering talent training mode reform since 2007. This paper takes the students major in machine design manufacture and the automation specialty as an example and at the same time focuses on second level project to introduce the engineering training model teaching reform.

2. ABILITY ORIENTED PROJECT SYSTEM

According to the requirements of mechanical manufacturing engineer training goal and following guidance of paying equal attention to knowledge learning and ability training and using the professional capacity and industry demand as the background, we construct an integrated curriculum system centered to post technology demands, aimed at improving engineering abilities and focusing on the project implementation and concerning professional capacity and industry demand. The curriculum system is centered to closely related projects with different levels. It includes: (1) the third level projects, based on application of the basic knowledge in one single course (or combination of two courses). The third level projects are set in basic professional courses and specialized courses, can also be subprojects of first level projects or second level projects. Most of the projects' titles are derived from faculty's scientific research project aimed to strengthen students' understanding of core knowledge or skills; (2) the second level projects, based on the contents of core courses and related with the third level projects, include the whole or main process of conception, design, implantation, operation of the projects, and aim at organically fusing knowledge of different courses. The foundations of the second level projects are a series of professional research projects and many courses aimed to strengthen the cultivation of the students' professional core competency. (3) The first level projects, with the purpose of enlarging the comprehensive application and innovation of professional knowledge. There are two kinds of projects in the major of machine design manufacture and the automation specialty---the innovation and specialty education and the graduation project. The innovation and specialty education, which set up in the first semester is designed to make students initially build the concept of mechanical engineering and cultivate the interest and innovative awareness. Through the graduation project, students can participate in the faculties' project including new product development, product upgrading and technical transformation. The comprehensive ability and quality of students is improved through the using of professional knowledge and skill.

The three level projects listed above are all have their independent research designs, evaluation codes, the evaluation criteria, project and demo report. They are closely related and locked with the each teaching link. The contents of the three parts are designed from easy to difficult and cover the professional basics and core knowledge.

3. DESIGN OF THE SECOND LEVEL PROJECT

3.1 Project objective

This project named mechanical manufacturing technology and fixture design is set up to the students major in machine design manufacture and the automation specialty. The project is centered to process designs and the processing of the typical machinery parts. It can consolidate the theoretical teaching achievements, enhance the engineering practice training and highlights the feature specialty and thus lay a solid foundation for the graduation project and future careers. Figure1 is the knowledge structure of the second level project.

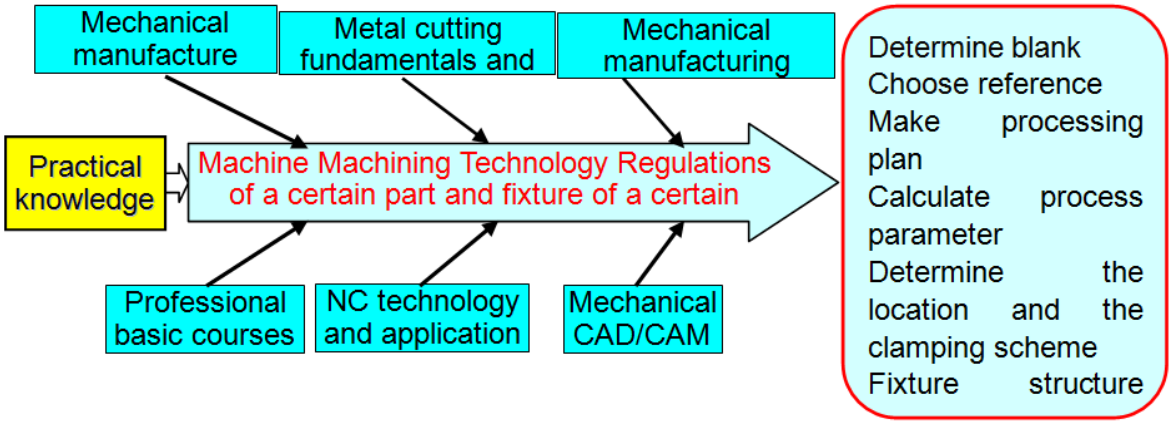


Figure1 Knowledge structure of the second level project in the course of mechanical manufacturing technology and fixture design

Concrete objectives of the project:

(1) To further understand the relationship of the courses such as mechanical manufacture technology, metal cutting fundamentals and cutting tools, mechanical manufacturing equipment and their application in practical production to investigate the whole process of the mechanical manufacturing.

(2) To preliminarily grasp the basic research ways like document retrieval, information query, and using the modern information technology to obtain relevant information, skillfully using the manual and figure materials.

(3) To cultivate the awareness of applying theory into practice and preliminarily use the obtained knowledge to make machine machining technology regulations and the design ways of a relevant fixture. At the same time, students preliminarily have the ability to analyze and solve the problems related with the machine machining technology in practical production.

(4) To training the ability in structure design and practical operating manufacturing.

(5) Students improve not only the capacity of organization and management, communication and cooperation but also the sense of responsibility.

3.2 Project Content

The content includes: technology formulation, structure design and object-making. The main content is listed as follows:

(1) Machine machining technology regulations formulation of a certain part. (Group cooperation) the main task of this phase is to exercise the ability in conceiving and designing. Things need to commit: after the determination of the optimal project, students have to fill in the process card and operation flow card.

(2) Fixture design of a part's certain process (One student commits one design, non-repeat), the main task of this phase is to exercise the ability in conceiving and designing. Things need to commit: completed fixture assembly graph (2D, proportion: 1:1, map sheet: A0/A1)

(3) Virtual assembly of a specific fixture. (One student commits one design, non-repeat). According to the formal graph of fixture structure, students need to complete the virtual assembly of 3D model and dynamic display of the assembly process. The main task of this phase is to exercise the ability in implementing. Things need to commit: completed 3D model of the fixture.

(4) The object-making of a specific fixture. (Large group cooperation) The main task of this phase is to exercise the ability in implementing and operating. Things need to commit: material object of the fixture and photograph.

(5) Writing design instruction and making reply PPT. The main task of this phase is to exercise the ability in implementing and designing. Things need to commit: the paper design description and electronic PPT edition.

3.3 Project Capability Matrix

According to the objective of the second level project, we make the project capability matrix, as shown in Table 1, We cultivate all kinds of capabilities in the process of the implementation.

4. AN IMPLEMENTATION EXAMPLE OF THE SECOND LEVEL PROJECT

4.1 The Implementation Plan of Project.

Figure 2 shows the implementation plan of project.

To ensure the implementation effect of the project, four evaluation codes are set up to evaluate comprehensively the completion situation, code 1 weighs 15% including the part analysis, processing plan, blank design, and etc. Code 2 weighs 25% including the fixture sketch design, final drawing design, and the fixture virtual assembly. Code 3 weighs 20% whose main content is the fixture processing and manufacturing. Code 4 weighs 40% including the writing manual and reply.

Table 2 shows the concrete steps of the mechanical manufacturing technology and fixture course design and the evaluation codes.

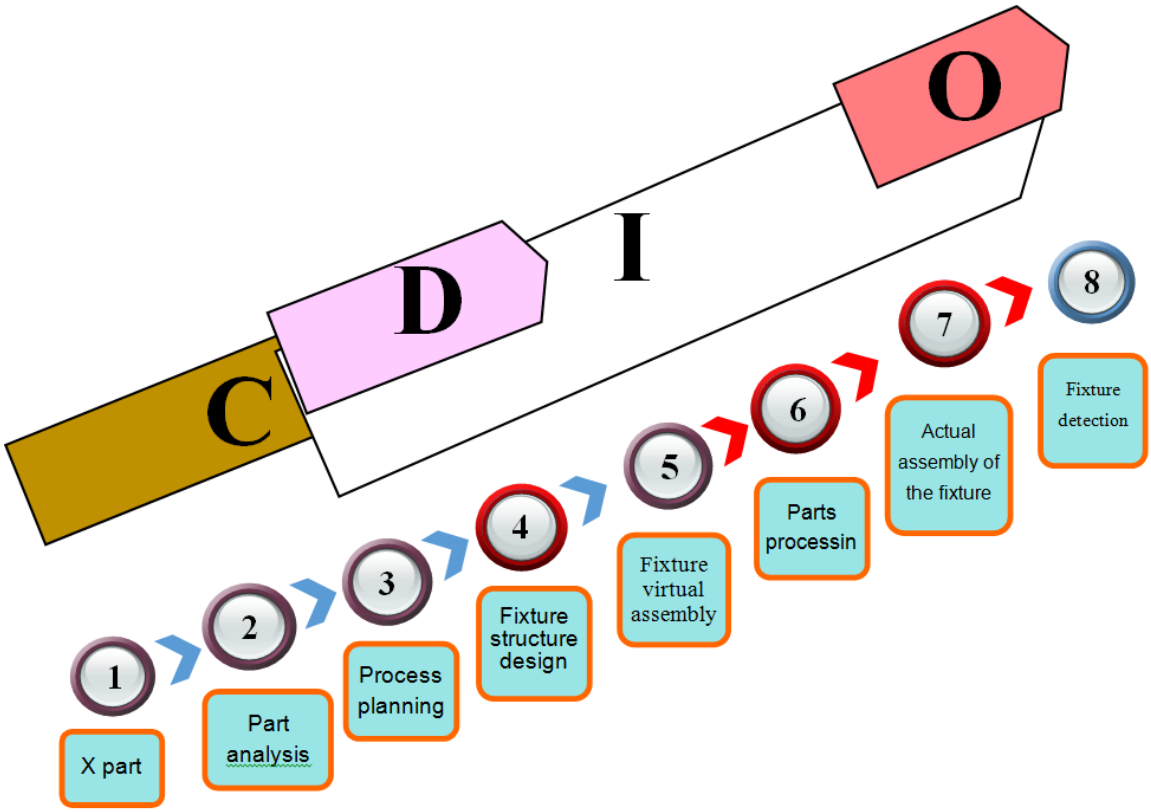
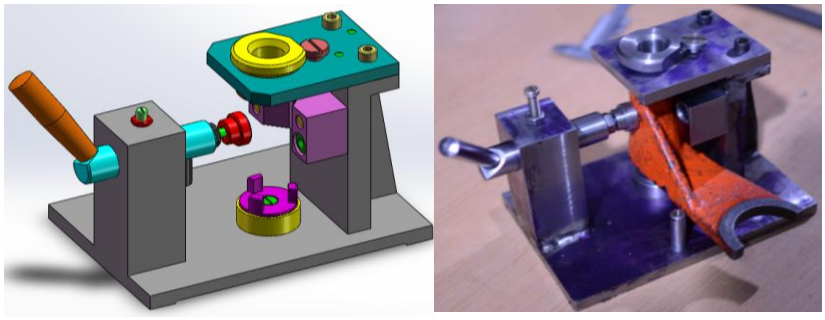


Figure 2 The CDIO process of the mechanical manufacturing technology and fixture design

4.2 Project Implementation Effect.

Figure 3 shows a real object of the students' project. The involved professors express that: They get very positive feedback from students. The project consolidates the theoretical teaching achievements, enhances the engineering practice and highlights the feature specialty with the relatively complete training of manufacture process technology. Students' capacities of conceiving, designing, implementing, and operating can be well trained through the above activities. The project pays more attention to application of the technology knowledge meanwhile emphasizes the quality audit of the fixture design. Students grasp the pleasure and significance of 'design for manufacturing'. Two groups of students undertake the same technological task to design one typical part, and only make a set of fixture object, thus the interest and the sense of competition can be improved.



a) the assembly model of a fixture b) Complete fixture object

Figure 3. An example of project achievement

The involved students also express their opinions that:" as an engineer technician, each dimension of the part must be accurate, we should have those engineering spirit: rigorous, diligent, and courageous enough to delve into the research. In the process, we should communicate with our classmates and professors so that we can do every step of the project steadfastly, we believe that, through our continuous efforts, we can do better and make progress and we are sure that we are closer to the goal-become an excellent engineer.

5. CONCLUSION

Years of teaching reform practices have proved that using the project as a carrier, the talent training mode which pays equal attention to knowledge learning and ability training and ability oriented project system are successful, they turn the boring theoretical knowledge into a vivid engineering practice. Students improve not only the capability of organization and management, communication and cooperation but also the sense of activeness. Though the implementation of the three level projects, students can furtherly master the professional basic and core knowledge and improve their engineering practice ability. In the year of 2010~2013, the employment rate of graduates major in machine manufacture and the automation specialty of Yanshan university amounted more than 97%, a large number of graduates signed with international and national famous enterprises. Graduates' comprehensive ability gets general recognition from the employers.

Though the teaching reform practice won initial success, there are also some problems:

(1) The standards of the top-level design in some projects need to be enhanced, especially in the implementation part and operation part and the ways of evaluation need to be careful design to satisfy the excellent engineer training requirements.

(2) The project connotation needs to be further enriched. Try to avoid flashy form, and meet the practical requirements of the engineering, and students need truly act on what they learn.

(3) Owing to the limitation of the manufacturing setting, the quality and the scope of the object need to be improved.

(4) The effort of training students' working attitude and team cooperation spirit is insufficient. Try to pay more attention to improve the work attitude and the team spirit of the students and make students realize the importance to improve those things through the relevant links.

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APPENDICES

Table1. Project Capability Matrix

NO.	Capability	Degree	Machine Machining Technology formulation			Structure design and virtual assembly of a fixture			Fixture –making assembly, and detection			Project report and reply	
			Data retrieval	Analysis diagram of the parts	Making the technological regulation	Structure design of the fixture	Diagram of the fixture parts	Fixture virtual assembly	Fixture making	Fixture assembly	Detection of the fixture accuracy	Project report	Reply
1	Investigate the current status, development trend of mechanical manufacture technology and the mechanical manufacturing equipment. Preliminarily grasp the basic ways of document retrieval, information query, and using the modern information technology to acquiring relevant information.	Cognize and understand											
		Initially master	+									+	
		Comprehensive application											
2	Use the professional knowledge skilfully and through the locating, clamping, and process routine to ensure the quality of the parts. Can analyze and solve the problems related with technology and technological equipment appearing in the production.	Cognize and understand											
		Initially master											
		Comprehensive application		+	+	+		+	+	+	+	+	+
3	Master the methods, the steps and the main points of designing fixture. And master the manufacture and assembly technology. Initially have the ability to design reasonably-structured and efficient fixture. Know the innovative way of design.	Cognize and understand											
		Initially master											
		Comprehensive application			+	+	+	+	+	+	+	+	+
4	Preliminarily have the ability to make, evaluate the accuracy of the parts and know how to use and operate the gauge and the measuring instruments.	Cognize and understand											
		Initially master							+	+	+	+	
		Comprehensive application											
5	Have the outstanding ability of using computer, basic grasp the mechanical design and the usage of simulation software such as CAD, PROE, the basic capability of modeling and simulation, finally students can analyze and virtually assemble the fixture.	Cognize and understand											
		Initially master		+		+	+	+				+	+
		Comprehensive application											
6	Understand the design, production, development of the mechanical manufacturing industry and the related environmental protection laws and regulations, students can correctly understand the influence of the mechanical engineering to the whole world and society.	Cognize and understand											
		Initially master	+		+	+			+		+		+
		Comprehensive application											

7	Develop the habit of active learning and life-long learning. Improve the capacity of organization and management, and ability of communication, competition and cooperation, and the sense of responsibility, professional ethics.	Cognize and understand											
		Initially master	+	+	+	+	+	+	+	+	+	+	+
		Comprehensive application											

Table 2. Concrete Steps of the Mechanical Manufacturing Technology and Fixture Course Design and the Evaluation Codes.

Steps	Contents	Requirements	Schedule	Evaluation time
1.Analyze the parts	Analyze the function, structure and technological characteristics of the parts.	Parts drawing	0.25days	The first week on Wednesday
2.Make processing plan	Choose the blank reference and surface machining method, determine the process order, and compare different schemes. Determine the machining allowance, process dimensions and tolerance, cutting dosage and the hour norm.	Fill in a process sheet and a operation schedule	2.5days	
3.Determine the size of the blank	Determine the type, shape and size of the blank.	List the size of the blank	0.25days	
4.Fixture sketch design	Determine the location, cutter guidance and clamping scheme; draw the structure sketch; make corresponding calculation; determine the main structure size	Analyze and calculate the positioning error and clamping force, complete the structure sketch of the fixture.	1day	The third week on Tuesday
5.Formal drawing design of fixture structure	According the manufacturing position and the fixture state to complete fixture assembly drawing, and the proportion is 1:1; mark the dimensions, tolerance and fit, and technical requirements; fill in the part list.	Fixture assembly drawing(A0/A1)	3days	
6.Virtual assembly of the fixture	Complete the virtual assembly of 3D model and the dynamic display of the assembly process	A set of part model and fixture assemble model	5days	
7.Fixture manufacturing	Disassemble the parts drawing, modify scheme and the engineering drawing , order standard parts and purchased parts , parts acceptance and the fixture assembly and inspection	Fixture assembly drawing, parts drawing, standard parts and purchased parts procurement specification	5days	The fourth week on Tuesday
8.Writing the design manuals	Analyze, calculate and design the manual.	No more than 5000 words	2days	The fourth week on Friday
9.Prepare the PPT and reply	Make the PPT and reply	Use PPT to support ones reply	2days	