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Course Design of Automotive Transmission Disassembly and Mapping Experiment for the Training of "New Engineering" Talents

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Abstract: Under the new engineering background, talent cultivation places greater emphasis on the interdisciplinary and comprehensive nature of course knowledge. Firstly, in response to the issue of insufficient hands-on training for students in the traditional teaching model of the automotive transmission disassembly and surveying laboratory course, an innovative and systematic design of the course content was made. This includes a chain of experimental segments such as transmission disassembly, part surveying, 3D printing, and transmission assembly, combined with the simulation of automotive simulation software, group defense, and problem-solving tests to cultivate students' abilities to analyze and solve complex engineering problems. Secondly, based on the characteristics of new engineering talent cultivation that focus on the combination of theoretical knowledge and engineering practice, a comprehensive course evaluation and assessment system was proposed, which includes student classroom performance, teamwork, hands-on ability, and experimental reports. Suggestions and ideas for the continuous improvement and perfection of the course implementation were also provided. Finally, to cultivate high-end composite talents with multidisciplinary integration, the course integrates theories such as mechanical design, automotive construction, mechanical drawing, and automotive electronic control technology, using the disassembly and surveying of automotive transmissions as the main line for practical teaching. This approach has effectively completed the experimental teaching tasks and achieved good teaching results, providing an effective reference and innovative exploration for the cultivation of new engineering talents.

The Ministry of Education puts forward the construction of "new engineering", which specifies the ideas and requirements of education reform such as "three questions, three constructions" and "five more emphasis" [1-3]. This course provides a practice and platform for exploring the new path and direction of 'new engineering' talent cultivation in the context of 'Made in China 2025 ' [4-5]. It is evident that the prevailing pedagogical approach in the context of automotive transmission

disassembly and mapping experimental courses in general colleges and universities is predicated on a single teaching method, predominantly comprising PowerPoint lectures and demonstrations by the faculty. Students are predominantly engaged in mechanically repeating the simulation, a practice that lacks innovation and interest. Consequently, there is a conspicuous deficiency in practical courses that are both innovative and engaging, thereby hindering the cultivation of students' aptitude for analysing and resolving practical problems [6]. There is also a single way of assessment, there is the problem of repeating the only score is the lifeblood, the lack of comprehensive and objective evaluation methods, it is difficult to meet the purpose of practice for learning [7]. With the national “One Belt and One Road” and intelligent manufacturing emerging industry development plan for social development of talent demand, the need to cultivate innovative ability, combined with engineering practice to train students' core competitiveness, to participate in the upgrading and transformation of enterprises of high-end talents [8]. Automotive transmission as an important automotive parts, its structure and working principle is more complex, through the simulation teaching transmission disassembly learning can strengthen the students’ sense of cooperation and independent exploration learning [9]. Colleges and universities serve as the primary entities in the construction of "new engineering." To enhance students' innovative thinking and practical abilities, higher demands are placed on the design of experimental practice courses, such as automotive transmission disassembly and mapping. In response, our university has adopted a new vision under the "new engineering" framework. We have systematically designed the experimental course for automobile transmission disassembly and mapping to align with the direction of educational reform in the new era [10].

The experimental course integrates knowledge from comprehensive mechanical design, automobile structure, mechanical drawing, automobile electronic control technology, and other theoretical courses. It focuses on the structure of automobile transmission as the main theme, aiming to cultivate students' ability to connect theory with practice and to guide practice through theory. By enhancing students' hands-on practical skills through the disassembly and mapping of automobile transmissions, the course fosters their ability to analyze and solve problems. Throughout the experimental process, students can gradually achieve the transition of theoretical knowledge into professional skills.

1. General design of the laboratory course

Automotive transmission disassembly and mapping experiments is a professional experimental course for vehicle engineering majors, the course uses on-site experimental lecture method, case study teaching method, deductive method and multimedia teaching method comprehensive experimental teaching method. The main content of this course for a Santana sedan manual transmission disassembly, the specific content is the scene to disassemble the entire transmission to get most of its parts, based on the disassembly of various parts to learn to understand the working principle of the automobile transmission, personal perception of touching the characteristics of automotive parts and design guidelines method, to understand the performance of automotive parts and components of the manufacturing process, to master the requirements of the automotive transmission assembly and the process [11].

The implementation process of this experimental course is shown in Figure 1 below.

(1) First of all, a Santana 2000 sedan manual transmission is disassembled to obtain the decomposition parts of the transmission, and record and organize the marking of each part and its characteristics;

(2) The decomposed parts according to the experimental requirements for parts mapping, through the ruler, vernier calipers, angle ruler and other measuring tools for sketching and mapping,

for the key dimensions need to be considered for its disassembly and assembly process;

(3) Based on the parts sketched above, use Solid works and CAD software for 3D modeling and 2D design, and mark according to parts machining and assembly requirements;

(4) Select the drawn Solid works 3D model for 3D printing, and verify the accuracy of the mapping and 3D model design according to the 3D printed parts; (5) Finally, assemble this gearbox, and learn to master the assembly process and installation tools by using Yulong automobile simulation software simulation.

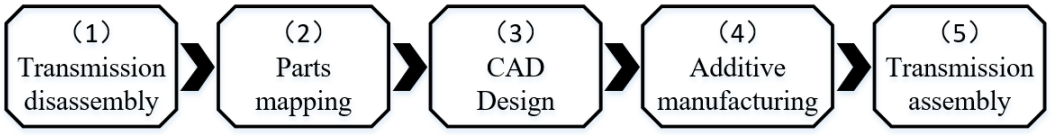

Figure 1: General design of the course.

Through the study of this experimental course, students are trained to analyze complex engineering problems and solve practical problems, and the experimental process can gradually realize the migration of theoretical knowledge to professional skills, and realize the following three course objectives of this course:

Course Objective 1: To understand and master the basic composition and working principle of automobile gearbox construction, master the disassembly and assembly methods of the gearbox, and have the ability to design the disassembly and assembly program and select the disassembly and assembly sequence.

Course Objective 2: To be able to work in a team to disassemble and assemble an automotive transmission, to work independently in a team to carry out disassembly and assembly, and to demonstrate the ability to organize, coordinate or direct teamwork.

Course Objective 3: To master the use of mechanical drawing knowledge to accurately map the key a transmission, to master the use of two-dimensional and three-dimensional drawing software, and to master the use of three-dimensional software for the secondary design of automotive transmission components.

2. Disassembly of automotive transmissions

Considering the complexity of the automotive transmission and the disassembly process there are certain difficulties and safety precautions, first through the PPT explain the principle of the Santana 2000 transmission and the structural composition, including the transmission gears and synchronizers and other key knowledge points; and then learn to use the "Yulong Automotive Maintenance Simulation Software" to master the disassembly precautions and the use of disassembly tools through the simulation tool to simulate software disassembly to avoid damage to the parts in the process of irregular operation. Simulation tools for simulation software disassembly, to avoid damage to parts in the disassembly process of non-standard operation, fully grasp the disassembly process of each process step.

To ensure the safety of students during the disassembly of an automobile transmission, it is necessary to watch a video of the instructor performing the disassembly before the actual operation. This video explains the key points of disassembly and safety precautions. In the video, the instructor demonstrates the critical steps and precautions, especially for those steps that are difficult or potentially hazardous. This allows students to fully understand the process in advance, thereby avoiding safety accidents during the subsequent hands-on disassembly.

3. Mechanical parts mapping and CAD design

Parts mapping process includes parts analysis, drawing parts sketches, measuring parts dimensions, determine the technical requirements of the parts and complete the parts working diagram and other links. The process needs to train students to master the transmission of the correct mapping methods and steps for professional courses and work to lay a solid foundation, can be comprehensively applied to the knowledge learned in the textbook for parts sketching, CAD parts drawing and assembly drawing, so that the knowledge has been consolidated, deepened and developed.

Which drawing parts sketch, to maintain the proportion of each part of the component, not only to consider the relationship between parts and components in the component, but also to consider the relationship between parts and components, components and assemblies or parts. Students should correctly use various measuring tools, select the length, width, and height dimensions, and mark the dimensions of the datum. Students are required to mark the necessary dimensions and technical requirements. Through sketching, students will familiarize themselves with ruler and instrument drawing, as well as practical computer-aided drawing. Additionally, students will develop proficiency in both freehand sketching and computer-based sketch drawing. Considering that the sketches are students' on-site mapping, the mapping time is relatively limited, and the sketches do not necessarily express the most reasonable and accurate, and need to be proofread and organized before designing the formal drawings of the parts sketches.

Automotive transmission parts mapping and design is an important part of this course, the comprehensive ability of students have certain requirements, through the link to strengthen the knowledge of students to learn, can be applied to the application of the learned professional theory to the actual operation of the process, to enhance students' interest in learning. Finally, based on the part design model, generate 3D printing format for 3D reverse manufacturing learning.

4. Parts 3D Printing Manufacturing

With the advent of Industry 4.0, 3D printing technology has become increasingly important in modern industrial systems. Introducing 3D printing into educational practice is highly significant for students to understand reverse engineering. This course incorporates the 3D printing process into the experimental teaching system. Based on the 3D models designed by students, several deformable parts, such as gears, coupling sleeves, and synchronizers, are selected and converted into formats recognizable by 3D printers. After pre-processing in 3D printing software, these models are printed. Students can actually operate the 3D printer to produce the transmission parts they designed. Since the 3D printing process is time-consuming and usually takes several hours to complete, students can simultaneously work on 3D printing and part design.

This 3D printing session has played a good role in enhancing students' interest in learning the part manufacturing process, allowing them to manufacture the parts designed by hand mapping, and also to have a first-hand experience in understanding the product reverse design and manufacturing. However, because the 3D printing process takes a long time, it is not possible to print every part in the transmission, so only a few representative parts can be selected for printing, which also puts forward the corresponding requirements for the subsequent improvement of laboratory equipment, i.e., the laboratory needs to add more 3D printing equipment and more multi-functional 3D printers, in particular, the current more advanced metal 3D printing. Each group can ensure that all parts are printed for self-assembly, this process not only learns the entire reverse manufacturing process, but also reflects the results of group learning and practice, which will greatly help to improve the learning effect and motivation.

5. Assembly of automotive transmissions

The assembly process of a transmission is more challenging than disassembly because it requires not only an understanding of the characteristics and installation positions of each component but also a grasp of their working principles and assembly techniques. This is especially true for the three synchronizers in the transmission, which consist of numerous and complex parts. To prevent students from misplacing or losing small components such as sliders and retaining rings during synchronizer assembly, the experimental course has designed a synchronizer installation competition. The competition evaluates proficiency based on the time each student takes to complete the task. This activity significantly enhances students' enthusiasm for learning theoretical knowledge and adds enjoyment to the experiment, while also providing a basis for their classroom performance and overall grades. Through this competition, students become familiar with and understand the composition and working principles of synchronizers. By referencing the simulation process in the Yulong Automotive Repair Simulation Software, each group of students assembles their transmission. Through group discussions and teacher guidance, the course ensures that no parts are missing or incorrectly installed during the assembly process.

Transmission assembly process usually requires three students teamwork 4-5 hours to complete the actual operation process students can personally experience the hands-on fun and the role of theoretical knowledge, but also in-depth understanding of the importance of teamwork for the future of professional knowledge and work to lay a practical foundation. In the entire experimental process, to train students to correctly use tools and organize the habit of placing tools, after each experiment needs to be experimented with a variety of tools to the designated location and placed neatly, the installation of this experimental course requires the completion of the automobile Santana 2000 transmission assembly, so that students can fully experience the whole transmission disassembled and installed the fun and knowledge system.

6. Course Teaching Evaluation System and Improvement Measures

Automotive transmission disassembly and mapping experiment as an independent experimental course for cultivating engineering excellence, 32 hours, 2 credits. The experimental course content covers the mechanical system, automobile structure, automobile theory, geometric tolerance and measurement, mechanical manufacturing foundation, CAD drawing and other professional backbone courses, which plays an important role in linking the students' course knowledge system and subsequent extension of learning content. Since the course includes a complete reverse manufacturing process of disassembly - mapping - design - 3D printing - transferring, and the experimental course does not set up an examination, and assesses the performance of each student by inspection, it is necessary to take into account all aspects of the performance of the students and the team (group), and to give a more objective grade to enhance the students' participation in the classroom and play a key role in the improvement of the course. This requires the entire teaching team to develop a more objective grade for each student. This requires the entire teaching team to develop a more reasonable course grading standards, as shown in Table 1 below, the total grade of this course consists of the usual grades and report grades, the usual grades include four respectively: classroom performance, teamwork, hands-on ability and completion of the situation, which accounted for 20%, 15%, 15% and 20%, respectively; the laboratory report accounted for 30% of the total 100%. Throughout the 32 credit hours teaching process, the teacher according to the course grading standard appropriate organization assembly competition session and defense session to give each student objective evaluation score.

Table 1 Grading criteria for automobile disassembly and mapping experiments

Course Objective 1	marking scheme				Weight (%)
	(90-100) A	(80-89) B	(60-79) C	(0-59) D	
classroom performance	Excellent Mastery	Good Achievement	Satisfactory Performance	Needs Improvement	20%
Teamwork	Excellent Mastery	Good Achievement	Satisfactory Performance	Needs Improvement	15%
manual dexterity	Excellent Mastery	Good Achievement	Satisfactory Performance	Needs Improvement	15%
Completion	Excellent Mastery	Good Achievement	Satisfactory Performance	Needs Improvement	20%
Lab Report	Excellent Mastery	Good Achievement	Satisfactory Performance	Needs Improvement	30%
add up the total	Excellent Mastery	Good Achievement	Satisfactory Performance	Needs Improvement	100%

The experimental course encompasses numerous practical elements, assimilates a substantial portion of the curriculum typically covered in professional courses, and demands proficiency in hands-on skills from students. Consequently, the school, the college, the department, the teachers, and the students have all attached significant importance to the course, and have proposed elevated expectations and anticipated outcomes. The course's practical nature has exposed deficiencies and highlighted the necessity for further enhancement. For instance, experimental transmission equipment components have been dismantled, and it has been observed that certain components, such as needle bearings and circlips, are prone to breakage or loss. The necessity for ongoing improvement of equipment and the procurement of new components is paramount to ensure the validity of experimental results. Furthermore, the duration of 3D printing is a contributing factor to the current number of 3D printers and printing sites. The current number of 3D printing and printing sites is inadequate in meeting the needs of each group for the transmission of each part of the 3D printing, especially with regard to some cylindrical and rod parts, which require more advanced 3D printers to achieve, thereby placing higher requirements on The necessity for 3D printing equipment and sites is paramount. Finally, a group is established to assist students in completing their work, ensuring both the completion of tasks and the quality of work. This involves numerous experimental links, necessitating the involvement of teachers.

The quality of experimental teaching is paramount in nurturing exceptional engineers, thereby contributing to the advancement of society and the nation as a whole [12].

7. Summary

The following conclusions have been drawn for the cultivation of talents in "New Engineering":

1) Through the automotive transmission disassembly and mapping experimental course learning, students can deepen their understanding of the practical role and interrelationship between the knowledge of various professional courses, for the students' practical hands-on ability and innovative thinking training provides a way to continue to explore and improve the solution, but also for the teachers to enhance the quality of teaching in the practice of teaching and theoretical teaching with the assistance of the platform.

2) Students in this experimental course, you can directly learn to understand and practical operation of related knowledge, such as transmission casting shell materials, casting process characteristics and machining requirements, etc., learning to master a variety of tools and CAD software to complete parts mapping and reverse design, learning to use 3D printer on their own

design parts additive manufacturing, learning Yulong automotive simulation software with the actual disassembly of the transmission.

3) Due to the experimental course tasks, workload, links, especially need to group teamwork ability, but also for students to develop teamwork provides a platform for exhibition. The whole experiment multiple links, a student is difficult to complete, often need to cooperate with other students to assist, which requires students to have a good teamwork spirit, but also an important aspect of the course learning training.

4) This course aims to cultivate all-round and compound talents of "engineering, innovation and internationalization". In the subsequent teaching process, more cases will be introduced, political education will be added, problems will be raised according to the reality, experiments will be designed according to the basic theories, and engineering and technological phenomena and problems will be analyzed through the intuitive experimental results, and the direction from "problem discovery" to "independent innovation" will be extended. "Problem discovery" extends to "independent innovation".

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