Students' Graduation Project Training for Mechanical Design Specialty Based on Light Industries Transformation

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Abstract. For cultivating students' ability to solve problem using theoretical basis, professional knowledge and skills, a professional talent training knowledge system has been carried on the reform, which blends advanced technology specialty curriculums and the requirements of graduation design in the light industry machinery specialty of Zhengzhou University of Light Industry, according to the requirements of light industry transformation. Through the student's actual graduation project, the key knowledge points and student's exercise are discussed in this paper for an excellent graduate design which blends advanced technology curriculum knowledge. Reform Practice has proved that establishing advanced technology courses based on modern industry transformation are very useful to cultivate students' specialty ability. The work provides a reference for the similar professional teaching reform.

1. Transformation requirements of Chinese light industry equipment

In the economic and social development, the light industry plays an important role. The light industry machinery is the equipment which is used to produce the light industrial products. The operation quality and performance of the light industry machinery have direct relationship for the quality and performance of light industrial products.

"Made in China 2025" clearly puts forward the manufacturing is the main body of the national economy, is the foundation for building and developing country. Through 30 years effort, China will be build into a manufacturing powerful country which leads the world manufacturing industry since the founding of the People's Republic of China one hundred years.

"Made in China 2025" specifically puts forward to enhance scientific and technological innovation ability, to promote the depth fusion for informatization and industrialization, to establish base database of national industrial. Therefore, talents cultivation of colleges and universities must follow the national strategy, and we must make strategic planning and thinking for the key technology problems in field of light industry equipment[1].

After years of development, China's light industry equipment has made some progress in many aspects such as digital design and service-oriented manufacturing technology. However, compared with the country's transformation and upgrading requirements, there is a significant gap, mainly in:

1. Enterprise production digital design level is not high. At present, mostly enterprise stay in the CAD design drawing level, a few companies can do with CAE engineering. Few enterprises can integrate the vibration analysis, optimization design and reliability engineering of the key components into the design process.
(2) Take not enough attention to virtual manufacturing technology. At present, most enterprises still use the traditional design and test methods, the product development cycle is too long, and the market is seriously out of line.

(3) The development and promotion of light industrial robots started relatively late. The current industrial robot began to be applied in light industry of our country, but the distribution is uneven, and some industries have a big gap. The market potential of robots in manufacturing based light industry is enormous.

2. The characteristics of light industry machinery professional direction talent training about Zhengzhou University of Light Industry

At present, under the impetus of scientific and technological achievements, the world is changing very fast, and the cycle of industrial technology upgrading is becoming shorter and shorter. Science and technology innovation are playing an increasingly important role in the social development. School of Mechanical and Electrical Engineering whose aim is to cultivate light industrial machinery equipment design and research talents must follow the direction of technology development, adjust the personnel training mode.

The characteristics of light industry machinery is significantly different from the general machinery and engineering machinery, precise motion, novel mechanism, and complex control are its main features, the requirement of integrated application of machine, light, electricity, gas and other disciplines is becoming more and more high for light industry machinery. College of mechanical and electrical engineering, Zhengzhou University of Light Industry always take the teaching, research and talents cultivation for light industrial machinery as its target, which have cultivated a large number of talents on light industrial machinery researching, manufacturing, management and application for the industry. Although on the aspect of training talent, college of mechanical and electrical engineering, Zhengzhou University of Light Industry carries on a great deal of exploration and gains remarkable achievements, talent training still cannot meet the needs of social and economic development[2-4].

In the practice of teaching reform, the knowledge system of "mechanical design" specialized personnel training under the background of light industry transformation is studied. Around the light industry equipment development goals: The deep integration of informatization and industrialization; to realize intelligent manufacturing and green manufacturing; Deepen the Internet application in the field of manufacturing, Establishing virtual and real innovation platform, etc. According to the target of construction of characteristic specialty under the background of light industry transformation, the curriculum should be integrated and reconstructed, and the core curriculum system of cultivating professional talents is constructed. According to talents training target and training pattern, it emphasizes the intersection and integration of mechanical discipline and related extension knowledge in curriculum and knowledge structure, and emphasizes the training of knowledge application and innovation ability.

3. Curriculum design and graduation project training

In light industry machinery professional direction, with the aim to cultivate mechanism innovation design ability, the four curriculum is used as main line to carry on the curriculum establishment, the four curriculum is shown as following: automatic machinery (packaging machinery) design skills and modern design methods, machine, electricity, gas, hydraulic control technology and application, the application of robot technology, light industry machinery manufacturing skills and modern manufacturing methods. In the curriculum offered, combined with the direction of the development of the industry, to establish advanced technology courses[5], mainly include:

(1) Light industry machinery CAE engineering: research and promotion the application of CAD/CAM/CAE in product development deepen the computer aided design and computer aided
manufacture, highlight the role of virtual manufacturing technology in light industry equipment design and development. Through the integration of interdisciplinary theory, make the students deepen cognition and practice of light industry equipment industry science and technology innovation base supporting role.

(2) Light industry (packaging) mechanical development frontier: track light industry (packaging) machinery development trend, strengthen the light industry equipment design, development, application and manufacture, maintenance and management and other characteristics of the industry. To deepen students understanding and grasping of light industry equipment industry as a whole.

(3) Signal detection and fault diagnosis, intelligent logistics technology: for light industry equipment and the concept of intelligent manufacturing and green manufacturing in light industry, supplementary light industry whole life cycle of equipment database data model building, big data knowledge mining technology, the equipment running status monitoring method, the performance of product processing control and prediction method and related content.

(4) Light industry robot technology: light industry market potential is very huge in the manufacturing. Make the students understand the robot technology.

As an important part of university practical teaching link, graduation project (paper) is the last teaching link in the university stage, which serves as an important task for graduates to learn more knowledge. In the process of graduation program for light industry machinery professional direction in Zhengzhou University of Light Industry, the students should enrich knowledge based on the requirements of professional development direction; the students should also learn and integrate advanced technology.

4. Graduation design training of integrating advanced technology course knowledge

"The design of three degree of freedom handling robot" is from the actual project of enterprise, which is a good graduation design by integrating advanced technology curriculum knowledge.

4.1 The actual needs of enterprise, stimulating the students' creative potential.

This topic is derived from Henan Yellow River Cyclone Co., LTD. The requirements are in order to achieve the pyrophyllite's pallet movements in automatic production line, to design a transfer robot.

Specifically, one of the parts required for artificial diamond—graphite column in Fig. 1. The graduation program is to design a robot to complete transshipment after pack.

![Figure 1. A three-dimensional model of the graphite column.](image)

Because of the particularity of the structure and the requirements of the parts, it needs to put the bottom column and the above bottom of the pyrophyllite ring together, at present in the enterprise. The realization of parts and components together is mainly rely on artificial. Manual workers work very hard and perform mechanical assembly operations every day. When the students go deep into the enterprise, it motivates the students' creative potential.

4.2 Refer to Domestic and foreign literature, tracking the forefront of the subject

In the graduation project, the students carried out a more detailed study of the transfer robot at home and abroad. Realizing that China attaches great importance to develop robot industry, especially
in 2017, the tragedy is vigorously developing industrial robot, service robot, surgical robot and military robots, promoting the development of artificial intelligence technology in the field of commercial has been included in the 13th Five-Year key project planning. A three-dimensional model of six degree freedom robot is construct using design software SolidWorks by Beijing Institute of Petrochemical Technology, ADAMS software is used to do dynamic simulation, and verified by MATLAB software. These investigations broaden the horizons of students and it is also a good exercise for students to learn to consult the literature.

4.3 Application of professional knowledge to determine the overall program of transfer robot.

(1) Classification and comparison of transfer robots
By comparing the main features and application areas of articulated robot and Cartesian coordinate manipulator, it is determined that the structure adopted in the design of the robot is the rectangular coordinate type.

(2) Overview of composition and the relations among various parts of the robot
When making the detailed design, in the design of mechanical system, driving system and control system of robot, it is also very important to grasp the connection between them so that the whole robot can work harmoniously and cooperate closely, so as to realize each action accurately.

(3) Brief calculation and preliminary selection of the driving device.
According to the function need, consider using the mechanism that can achieve rectilinear motion, to design the principle and method of achieving the rectilinear motion.

(4) Design of transfer robot
Through the above analysis, the design idea of the moving robot is basically clear, that is using two linear modules to achieve linear motion in two directions, the left and right movement realizes the transport of the finished parts, and the upand down movements realizes the scraping of the parts. It is necessary to have a linear motion module in the vertical direction and horizontal direction, and it also needs to consider some connecting parts and some supporting structures to complete the design of the moving robot.

(5) Design of other structural schemes
Just rely on handling robot is not enough, it also need to design the supporting equipment with coordination to complete the relevant actions better. Therefore, it is necessary to design other structures to meet the functional requirements of the moving robot.

4.4. Application of professional basic knowledge, the parameter design and verification of key structures
In the parameter design and check of the key structure, Curriculum knowledge such as mechanical principles, mechanical design, theoretical mechanics, material mechanics, electro-mechanical control, and other curriculum knowledge were used. We need to design and check key institutions and components. It mainly includes: check and calculation of electromagnetic sucker; design of other structures in the linear module. Check and calculation of ball screw; check and calculation of belt drive in conveyor.

4.5. Motion simulation and animation design
Practical computer aided design; computer aided manufacturing and other advanced modern design manufacturing technology and light industrial equipment design and development integration. Learning the role of virtual manufacturing technology in the design and development of light industrial equipment. Eventually form the overall structure as shown in Fig. 2.
4.6. The inspiration of graduation project for students

(1) In the reading process of the literature, students have realized that the application of other industrial robots such as transporting robot is more common, which has great market value and application value.

(2) In the comparison of carrying robot, we have learned some cutting-edge technologies of the handling robot, and learned about the structure and technological development of the robot.

(3) In the specific design of the robot, students have mastered the cartographic method of 3d modeling software SolidWorks and familiar with the process of the linear coordinate robot design using linear motion module.

(4) In the overall scheme design, it cultivates the students’ ability of overall coordination, especially in the specific design of the manipulator; it needs the type choice depending on the type of product.

(5) When making the parameters design and check of the key structure in the design of the scheme, it enables students to master the method and train thought of belt drive and ball screw.

(6) In the process of using SolidWorks, the specific movement of the robot motion simulation and animation design, Students have mastered the method of using SolidWorks to carry out motion simulation and animation design, which is helpful to observe the coordination work of the whole scheme.

5. Conclusion

According to the requirements of light industry transformation background, light industry machinery knowledge system has been reformed for college, make curriculum offered meet the requirements of industry transformation.

In the students’ graduation design, advanced technology curriculum knowledge can be fused; can make the student to obtain very good exercise.

The effect of teaching reform is obvious. The learning enthusiasm and the ability of experiment studying are all improved. In addition, the innovation of students is enhanced, and the manipulative ability is got some exercise.

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7. References


