

# *A Study of the Course Teaching Reform of Basic Mechanical Design*

—Based on Cultivating Project Application Ability and Highlighting Specialized Characteristics

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**Abstract**—Nowadays the undergraduate, especially who are from those application-oriented universities, become more and more concerned with the interconnectedness between their major and their career goal. To better harmonize the contradicts about how to combine the common shortage of the traditional teaching of Basic Mechanical Design and the professional needs and project reality, those aspects like teaching contents, teaching approach, teaching method and test mechanism are all explored in the paper, from the perspective of highlighting specialized characteristics and project application ability. Considering the development tendency of the subjects and oriented towards the cultivation goal of application-oriented graduate, application and integration should be emphasized in theoretical knowledge teaching according to the teaching content of the specialized courses. The students are supposed to learn in an active, practical and interconnected way to strengthen their ability of problem analyzing and projects handling in real cases. This should be carried out by optimizing the teaching method and teaching approach. The exploration and academic achievements in the reform of teaching approach and teaching method in the paper can also be used for paving the way for similar study in other specialized basic course teaching from the aspect of cultivating application-oriented graduate.

**Keywords**—specialized characteristic; specialized basic course; application-oriented; Basic Mechanical Design; teaching reform

## I. INTRODUCTION

Basic Mechanical Design is quite an important and indispensable specialized basic course for Petroleum Engineering students, which is a national specialty of our university. It shows the main theoretical foundation of all the supporting subjects in this major, provides systematic and wide theoretical knowledge for the students, occupying an irreplaceable position in widening specialized theories. The construction of specialized basic course should be given top priority in order to highlight the characteristics of our

university and cultivate qualified application-oriented personnel in the field of petroleum and petroleum chemistry. However, enforcing the construction of the specialized basic course does not mean only the enforcement of theoretical knowledge but more consideration over how to cater to the professional needs in teaching, how to highlight specialized characteristics and cultivate the application ability of the students. Therefore, more attention should be given to the specialty and application-orientation in the specialty basic course teaching process.

However, Basic Mechanical Design being taught now cannot highlight the specialized characteristic of our university, with great weakness in cultivating the project application ability of the students. Taking the newly increasing need for application-oriented personnel in petroleum and petroleum chemistry, to better make use of the supporting function of Basic Mechanical Design in cultivating application-oriented personnel in petroleum and petroleum chemistry and deepen the teaching reform in this course, the authors exploration and academic achievements in teaching content, teaching approach, teaching method and test form, etc. are introduced in the paper by introducing the characteristics and specialty of our university, paving the way for similar study in other majors and courses.

## II. INTEGRATING AND OPTIMIZING TEACHING CONTENT TO SHOW SPECIALIZED CHARACTERISTICS

### A. *Setting in Petroleum Engineering and Optimizing Teaching Content*

Nowadays the undergraduate, especially who are from those application-oriented universities, become more and more concerned with the interconnectedness between their major and their career goal[1]. The traditional teaching of Basic Mechanical Design attaches too much importance to the

instruction of theoretical knowledge and its independence and completeness, and owns great shortage in professional teaching content and combination of project and specialized needs. In order to coordinate these contradict, specialized characteristics should be taken into consideration and the original teaching content also needs improvement. Teaching content should be a highly developed summary of basic knowledge and theory of mechanical design, and fully stands for the latest achievement and development trend of that subject, especially the latest fruits and development in the academic field of petroleum engineering. Based on a thorough study of relevant course books and references, the leading development in the field of petroleum engineering equipment should be tracked and teaching content be continually enriched, thus helping the students get access to more information in a limited time.

#### *B. Increasing Case Study of Petroleum Engineering Equipment according to the Professional Needs*

In the present teaching of Basic Mechanical Design, the number of case study is far from enough. Though there are cases studies, they are outdated without on-time updating, and there is almost none case study that reflects modern petroleum engineering practice. Besides, the cases studies are not well combined with the specialized needs. The teaching of Basic Mechanical Design includes two parts: mechanical principles and mechanical design. In the teaching of structural analysis of mechanical principles, combination, mechanical movements and parts of mechanical design, a great many project cases will be studied according to the specialized characteristics of petroleum engineering, which makes the teaching full of vivid characteristics of petroleum industry.

### **III. BASED ON SPECIALIZED CHARACTERISTICS, STRENGTHEN THE ORGANIC CONNECTION BETWEEN NOW-TEACHING COURSE AND SUBSEQUENT COURSE, HIGHLIGHTING APPLIED INTEGRATION OF THEORETICAL KNOWLEDGE**

#### *A. Strengthen Communication and Cooperation among Teachers of each School*

By a thorough analysis of the personnel cultivating plan of the petroleum engineering, it is found that there are two courses related to mechanics: Basic Mechanical Design in the fourth semester and Drilling Machinery in the fifth semester. Drilling Machinery is a specialized course for students majoring in petroleum engineering, mainly including the basic composition, type, basic parameters, drive and rotation mode of the oil rig, and the structural principle, function parameters, basic property, maintenance, relevant calculation of the parts of the rig. This course helps the students develop their acquisition of the fundamental theory and initial ability in correct selecting, using and maintaining the drilling equipment, thus they can better tackle the real problems in operating the equipment. These two courses are scheduled at different semester, but the connection between them is quite close. However, the teachers in charge of these two courses only pay attention to their responsibility but pay no attention to the relevant course teaching, thus ignoring the connection among the course system. Consequently, the students cannot acquire a complete and clear knowledge system, and also cannot be cultivated qualified enough to cater

to the needs for application-oriented personnel. In addition, the course teaching discussion section of Basic Mechanic Design and Drilling Machinery is not open enough to the other resources and faculty, leading to a shortage of necessary cooperation and communication and the limited and one-fold teaching content. Thus the specialized characters cannot be highlighted well. Above all, it is extremely necessary to strengthen the communication and cooperation among the teachers from relevant schools, hold more teaching discussions among all the schools, in order to enhance the teachers overall consciousness and provide a healthy environment for cultivating application-oriented graduates in the field of petroleum engineering.

#### *B. Realize the Organic Integration of Present-teaching and Subsequent Courses*

Based on the goal of cultivating the students project application ability, combining the specialty of our university, the theories and application abilities of the students majoring in petroleum engineering in the fundamental mechanical design should be analyzed and ensured. Only in this way, the cultivation plan and knowledge points of the course can be identified and the fundamental theoretical knowledge can well serve the specialized knowledge. In details, concrete teaching cases can be carried out in the teaching of the basic courses of mechanical design by referring to the contents of the drilling machinery teaching, to better explain the application of relevant mechanical knowledge in specialized practice. A closely interconnected course group will come out by this type of course teaching. And each teacher in the course group should be required to teach by integrating the contents of both the present teaching course and subsequent course and try to enrich the content of each course [2]. By this, the theoretical knowledge acquired by the students is integrated and more professional and specialized. They will adapt to the social needs better after graduation.

### **IV. OPTIMIZE THE TEACHING METHOD AND TEACHING APPROACH; DEVELOP THE ABILITY OF ACTIVE LEARNING OF THE STUDENTS**

Basic Mechanical Design focuses mainly on practice. The students learn little about real projects before selecting this course, and they have a shortage of practical knowledge about machinery. Thus they cannot be well aware of the importance of the course, let alone how to apply the taught knowledge in the class in specific projects problem solving, greatly weaken the students confidence in learning this course.

#### *A. Adopt the Approach of Project Case Study, Highlighting Specialized Characteristics and Inspiring Students Knowledge Desire*

Since the content in each chapter of Basic Mechanical Design is very systematic and independent with large amount of and spread knowledge, the students usually find it difficult to grasp the main point in the course [3]. Typical projects case study teaching can connect the independent chapters and help the students directly try projects application which is intimately related to their major. And they will find the knowledge they

learned are specialized and oriented when their interest is inspired.

*B. Make Full Use of and Explore Multi-media Teaching and Design a Series of Courseware in Fundamental Mechanical Design Teaching Which Can Highlight Specialized Characteristics*

The study of application-oriented undergraduate education starts its way in China just for a short time period. There are not many suitable course books in Basic Mechanical Design, let alone those which can highlight the specialty of the petroleum. To improve this shortage, we can make full use of multi-media. The teacher can put the necessary content in the multi-media courseware and send it to the students as reference learning. Besides, since there are not enough chances for the students to participate in practices, and they cannot get a complete knowledge system of petroleum equipment's application. The author specially shoot the live working process of all institutions and drive equipment in some petroleum and petroleum chemistry companies, which can be integrated into the multi-media courseware with detailed instruction, thus increasing the students specialized and practical knowledge. Combine the theoretical and practical knowledge, and the students can better enhance their practical skills and realize the importance of their learning in class. This way of teaching plays an important role in activating the students' initiative.

*C. Integrate Theory and Solid Model Teaching, Making the Teaching Practical and Visualized*

At present, Basic Mechanical Design is usually taught in multi-media classroom, and the teachers always adopt spoon-feeding approach in their teaching by playing PowerPoint to directly explain the content of the course book. However, it is very hard for the students of petroleum engineering from lower grades to imagine the solid model of the machine just via the PowerPoint and to put the knowledge into practice since they seldom practice in real case and have no complete awareness of the mechanical equipment. Therefore, in the process of teaching, the single mode of teaching in the multi-media classroom should be improved and changed to the lab when it is necessary for key chapters learning and teaching [4]. In this way, solid model can be shown and introduced to the students in class. The students' sense cognition can be well enforced by specific case analysis. When the teaching content is taught in a visible way closely related with daily life, the students will find it easier to acquire the application of the general machine in common institutions. This way of teaching makes the theory teaching more practical, visualized and fully activates the students' initiative in study, and also widens their sense of space. What's more, a series of common machine models of petroleum should be equipped in the labs by combining the specialized characteristics. It will help the students a lot in cultivating their specialized consciousness.

**V. STRENGTHEN THE ENGINEERING APPLICATION ABILITY OF THE STUDENTS**

It is widely accepted the common problems in the process of training application-oriented talents including the lack of

engineering consciousness, the deficiency in the engineering application-related knowledge and the ability of boosting the technology transformation into productivity[5]. Most of the petroleum engineering graduates still stay at the level of book knowledge and have lots of problems in actual operation under the guidance of expertise. The traditional teaching methods which focus on classroom teaching even are unable to adapt to the request of enterprises who value the practical ability more [6]. Based on the questions, the following teaching reform should be imperative.

*A. Adding modern engineering awareness to the classroom teaching*

Rearrange the teaching content. Ignoring the role of practical knowledge which used in mechanical design, current Basic Mechanical Design courses emphasis on the details of theory makes the students in the dark of the actual designing works, especially in the determine of parameters [7]. Therefore, the training of students' designing capacity should replace the teaching model which overemphasized on the complex formula manipulation and perfect theory. To use design as the basic roles, depend on the specific demanding of design project, select the right parameter to complete each unique design problem. The application of design methods, empirical formula, data tables, etc. should be increased; the purely theoretical conceptualizations which just have little significance to improve the design level must be given up. Furthermore, the design ideas and methods, the development status of engineering knowledge should be as the key tasks. In short, the basic theory just needs to be enough for the use, the cultivation of students' engineering awareness, improvement of students' ability to solve engineering design problems should be pay more attention to. The learning in doing should be as the principle part in the classroom teaching.

A variety of methods such as pictures and video recordings of professional application can be used in the classroom teaching. They could be newly developed products, significant economic benefits projects, and even the most failed design cases. Such lessons could motivate the students and lift their mode in the practicing of design. The aim of teaching could be complete in the relax interaction between teachers and students.

In addition, the true experienced engineers may be popular in the classroom teaching; they could share the engineering practice case with students and point out the problems in the process of designing. Teachers also can learn more engineering experience which could be useful in their design teaching.

*B. Adopt the "Learning for practice" test mechanism*

The assessment of basic concepts and theoretical calculations were used in the traditional Basic Mechanical Design test. Student with the top scores may be the one who learn by rote of the theory; the innovative thought and active thinking were not motivated during their process of learning. Meanwhile, the actual level of practicing ability of students may be hard to evaluate. So the ratio of subjective questions could be added to assess the true level of the mechanical design capacity, the answers could be more flexible in solving problems.

## VI. CONCLUSION

This paper picked the engineering application abilities as the key point of engineering design teaching, which combines the specialized basic course and subsequent professional closely. The students are supposed to learn in an active, practical and interconnected way to strengthen their ability of problem analyzing and projects handling in real cases. Meanwhile, the discussing of teaching contents, methods, skills and test mechanism may supply the references for similar study in other specialized basic course teaching, and other universities in cultivating application-oriented talents area.

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