

Reform and practice of undergraduate graduation design based on *Outstanding Engineers Training*

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ABSTRACT: Graduation design is the most important comprehensive practice for engineering students in China. The quality of graduation design is a direct reflection of the quality of engineering education in engineering universities and colleges. In view of the problems of graduation design for process equipment and control engineering, the authors have put forward a new teamwork model and an innovative subject as a graduation design topic for the graduation design programme. Through the reform and practice, graduation design quality has improved significantly. It has improved the students' engineering consciousness, innovation ability and team spirit, and has demonstrated an effective way to improve the quality of engineering education.

INTRODUCTION

It is an important practical teaching task for undergraduate graduation design teaching in engineering colleges and universities in China to train and develop students' comprehensive application of the theory of professional knowledge, to improve the students' basic skills, and to improve their practical and innovative ability. At the same time, it is also important to cultivate students' skills through engineering practice, in order to improve their ability to analyse and solve problems. This will lay a good foundation for the practice platform for entering the workforce, and it is also important to cultivate students' creative ability and team spirit through practice.

Graduation design directly affects the quality of the talent training plan, and also directly reflects the quality of engineering education in colleges and universities. Hence, improving the quality of graduation design is an important matter and a real challenge for engineering educators.

In graduation design, the scientific research topic is the key; it determines the content of the graduation design, and is a prerequisite for the smooth completion of graduation design. The authors have analysed the graduation design for the Northeast Petroleum University process equipment and engineering in recent years, and have found that there are problems in the graduation design process. These problems have led to a decline in the quality of graduation design, and have made it more difficult to achieve the goals and requirements of engineering education personnel training. Therefore, the teachers engaged in teaching process equipment and control engineering put forward a new model of teamwork for graduation design, combined with scientific research and the topic selection for actual production. In 2015, graduate practice shows that the quality of graduation design has increased significantly in the process of the completion of graduation design. This has enhanced the students' engineering consciousness, innovation ability and the team spirit [1-3].

PROBLEMS OF GRADUATION DESIGN FOR PROCESS EQUIPMENT AND CONTROL ENGINEERING

Back in 2011, the process equipment and control engineering as defined by the authors was approved as part of the *Excellence Initiative* put forward by the Ministry of Education in China. Solid progress has been made after four years' exploration and practice with the *petrochemical mechanical excellent engineers* talent training goal, through the formulation of the *excellence initiative* talent training scheme. Certain teaching effects have been observed, and achievements have been made, but the graduation design as a practical teaching link with the management of the teaching process is not as strict as the management of classroom teaching. Throughout the engagement in the teaching practice of graduation design for process equipment and project engineering in recent years, the authors have experienced certain problems that are outlined below.

TOPIC SELECTION

Because of the student source expansion in recent years and the increase in the number of students under the guidance of teachers, the phenomenon of repeating topics has arisen. The scope of some subjects is very narrow with low workloads, but some topics are very big, and the level of difficulty and the time frame extend far beyond students' ability. Some successive graduation design projects concern similar topics, so that the design content has changed little. Some topics are not closely related to professional practice, for example.

PROCESS MANAGEMENT

The graduation design semester is the peak period for graduates looking for jobs. For some students, the second-round examinations are also scheduled in this period, so that there is a time conflict, and the students have less time and energy to dedicate to graduation design. At the same time, graduation design lacks the fixed physical location that would facilitate the focus on the design, and the place where the students carry out their graduation design is more dispersed. There is also a lack of communication with teachers and classmates, and the teachers have difficulties in monitoring the process of graduation design effectively.

REFORM OF GRADUATION DESIGN IN PROCESS EQUIPMENT AND CONTROL ENGINEERING

In view of the existing problems, teachers of process equipment and control engineering have explored and devised a new teamwork model for graduation design and practice. In order to remedy the situation, the general colleges and universities graduation design work has now been arranged in the eighth semester, mostly to avoid the conflict for second-round examinations of graduate students and searching for jobs. However, the designers arranged for the graduate design projects to commence in the seventh semester. In the seventh semester, two weeks are dedicated to the selection of design topics that are listed by the teachers. These topics all consist of scientific research and production practice, and must first undergo a proper discussion with, and approval by a teachers' team, before they can be offered to students.

At the same time, in order to improve the students' innovative consciousness and motivation, these all topics for projects must strongly exhibit innovative ideas and concepts. Because, the completion of graduation design requires a team effort and cooperation of a group of three or four members, each group must have a moderate and equal workload. Teachers mostly provide group guidance instruction, with each group having two teachers assigned to monitor the project throughout its duration. Students are obliged to present a report on the progress of their project every two weeks.

The students have been allocated a designated office for graduation design and the teachers can timely solve the problems existing in the graduation design projects, so the teachers are fully aware of the progress of graduation design. For example, there are 26 students in Class 1, and the students are assigned to seven innovation subjects. Students are free to select an appropriate topic according to their interests out of the seven projects offered and, then, form seven groups. The choice of group members is mostly to mobilise the initiative of students during the graduation topic. The project titles, student groupings and assigned tutors are presented in Table 1.

Table 1: Student groups.

No.	Title	Student	Tutor
1	Design and development of remote control on-line NDT experimental station.	Xiang-Chun Cong, Yi Yu, Tian-Yu Wang.	Wei Cui - lecturer, Ying Zhang - professor
2	Device prising type three-phase separator design.	Qiao-Hui Yu, Zhen-Yu Liu, Zhong-Yi Wu.	Hai-Feng Zhao - lecturer, Jun-Ru Zhao associate professor
3	Research on driving devices for industrial pipe detection.	Li-Na Yang, Han Gao, Zhao-Lun Zhang, Tao-Wen Zhao.	Zi-Ming Feng - associate professor, Peng Jiang - lecturer
4	Development of a flat-weld automatic vacuum leak detector.	Chang Liu, Bing-Bing Shao, Ji-Feng Ma, Li-Fan Ma.	Yu-Juan Lin - professor, An-E Qiu - lecturer
5	The compressor performance test based on a virtual instrument and intelligent analysis system.	Li-Xue Liu, Jing-Bo Zhang, Jun-Yi Na, Yu-Qi Zhang.	An-E Qiu - lecturer, Min Li - professor
6	The outer wall of pipeline leakage magnetic scan variable diameter testing method and instrument design.	De-Hui Kong, Gang Luan, Yu-Bo Gao, Ji-Ting Li.	Ying Zhang - professor, Peng Jiang - lecturer
7	A measuring instrument based on the ultrasonic bolt fastening force.	Jia Li, Tian-Qi Yang, Yun Bai, Xiao-Feng Liu.	Wei Cui - lecturer, Zhi-Jun Yang - associate professor

REFORM OF THE GRADUATION DESIGN OF PROCESS EQUIPMENT AND CONTROL ENGINEERING PROFESSIONALS

As shown in Table 1, each team has two teachers assigned to guide them all the way through the project. Group 1, for example, consisting of Xiang-Chun Cong, Yi Yu, Tian-Yu Wang, was formed through an independent choice in the seventh semester, and they selected a topic entitled the *Design and Development of a Remote Control on-line NDT (non-destructive testing) Experimental Station*.

This innovative project is the result of the teaching process. Based on its particular significance to engineering, most colleges and universities carry out NDT experimental lessons. However, their devices mostly exhibit only a single function, such as only one testing can be done.

Moreover, the existing devices do not operate well and they are fabricated in a way that they perform inefficiently. Also, the traditional devices may demonstrate hidden dangers. For example, some experiments require compression using the hands, hence, once faults appear in the vessels, students may be exposed to danger. It is for this and other reasons that an innovative design was sought, as well as other innovative topics arranged for this group.

The new station can realise NDT and ultrasonic testing and pressure testing experiments. The new design also solved the single function problem in the old device. Compared with the traditional manual compression device, an electric pump is used in the new station to improve its efficiency.

Using HD (high definition) Webcam to improve security is the most prominent feature of the new station. A remote observation through PC can solve potential vessel breaks. At the same time, the station can be used to conduct many experiments. It cuts down the expense and improves the operability and security of the experiments. NDT learning can provide a constructive role for students, thus, fostering the acquisition of a student's ability in NDT technology.

Early in the graduation design process, the guide teachers of Group 1; namely, Wei Cui - lecturer and Ying Zhang - professor, have required students tackling this topic to carry out a literature review and collect data relevant to the topic. Students were advised to learn about the advanced technology and the development trends both at home and abroad, and research on possible solutions of the topic in the design link. Then, the guide teachers put forward the overall planning and subject requirements, according to the requirements of project design, whereas the students devised and presented the project's design scheme.

The main content and process of the design of the *Design and Development of Remote Control On-line NDT Experimental Station* can be accomplished in three stages. The first stage is the design and selection of hardware and equipment. The paramount task of this stage is to complete the design structure of the project, with the selection of hardware for the experimental station. This mainly includes four parts that are the pressure vessel and quick dismantling structure, safety valve and other ancillary components design are selected, such as an experiment table and a water tank.

Other tasks in this stage include the experimental station's installation design, the piping layout, the pressurised pump selection and the selection of monitoring devices.

The second stage is the design phase of the software control system of the experimental station. The tasks of this stage are to complete the selection of the experimental station and the preparation of the control software, it includes the choice of the type of control system, the design of the software function and the preparation of the control software. The last stage is the completion of the experimental station manufacturing and testing, and the design and operation of the experimental programme. It includes the operation tests of the station, the improvements test and the check on the performance of its work.

DESIGN OF THE HARDWARE AND EQUIPMENT SYSTEM FOR A REMOTE CONTROL ON-LINE NDT EXPERIMENTAL STATION

The hardware system design includes experiment platform design, pressure vessel design, quick release structure design, selection of the pump, relief valve selection, experimental equipment and piping layout design, etc. This is a critical stage at which team members have to demonstrate a clear division of responsibilities.

For instance, Xiang-Chun Cong was mainly responsible for the experiment platform design, pressure vessel design and quick release structure design; Yi Yu was mainly responsible for the selection of the pump and the relief valve; Tian-Yu Wang was mainly responsible for designing the experiment equipment and the piping layout design.

The entire design is illustrated by the prefabricated defects fission structure of the pressure vessel design (Figure 1), the experimental station whole structure design and piping layout (Figure 2), the overall design of remote control on-line NDT experimental station (Figure 3), and the NDT experimental station entity diagram shown in Figure 4.

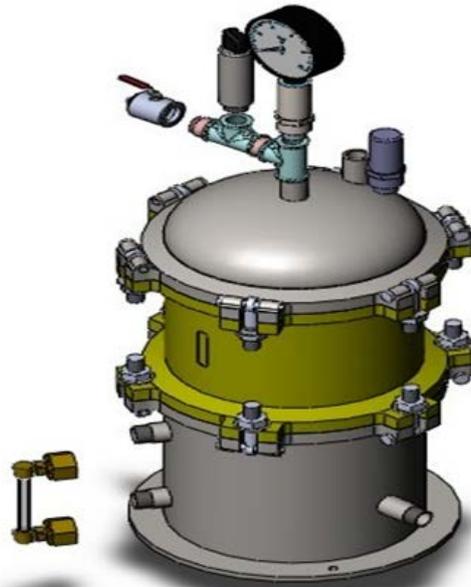


Figure 1: The prefabricated defects fission structure of pressure vessel design.

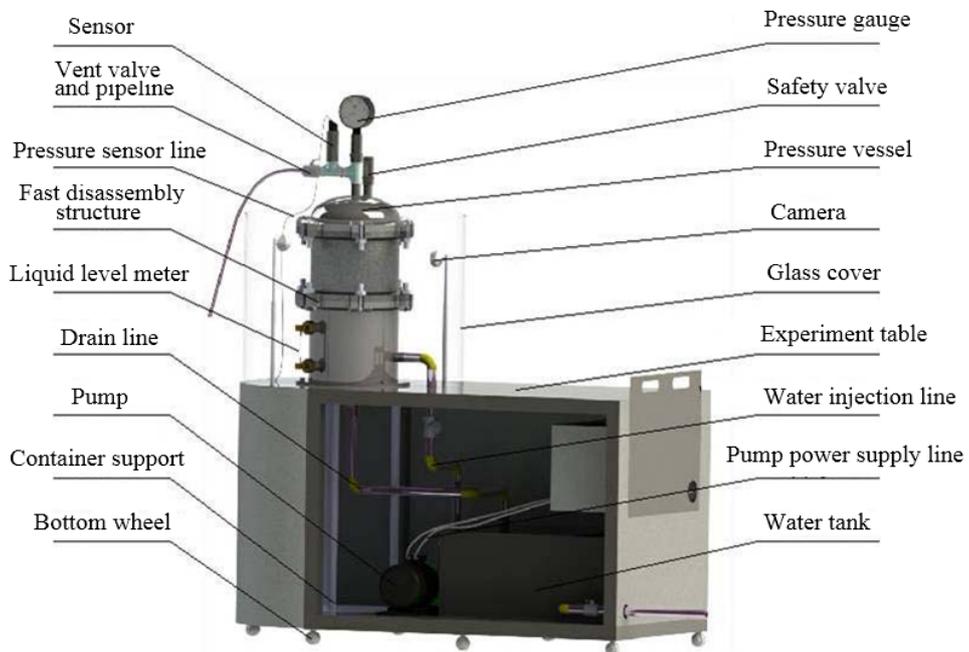


Figure 2: Experimental station whole structure design and piping layout.

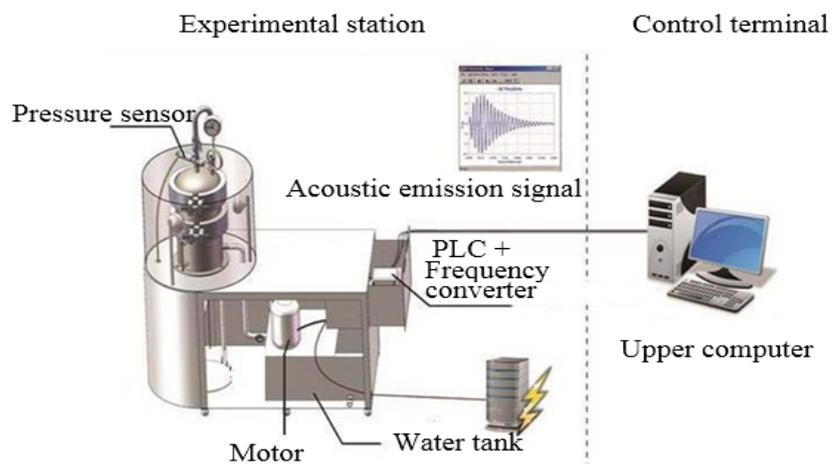


Figure 3: The overall design of the remote control on-line NDT experimental station.



Figure 4: NDT experimental station entity diagram.

APPLICATION OF THE REMOTE CONTROL ON-LINE NDT EXPERIMENTAL STATION

On completion of the manufacturing of experimental machine parts in the factory, group members Xiang-Chun Cong, Yi Yu and Tian-Yu Wang assembled the test bench, then, they applied the test bench. Because the experimental station is equipped with a camera, including a real-time monitor screen, the process can be monitored through a control-end monitoring window to observe and detect the defect of deformation, the pressure gauge's reading variations and monitoring of the container seal sealing status. The station possesses a high degree of automation, hence, it can be used for on-line and long-range monitoring of the variation and potential defects of the prefabricated elements. Such facilities offer enhanced performance and ensure improved safety. The availability of this station has enriched experimental teaching and learning when compared with traditional experiments.

CONCLUSIONS

Through reform and practice, the time allocated to graduation design has been extended, and following nearly a year of research and exploration, the depth and breadth of research is higher than when only one semester was given to complete the graduation design. Through team work and collaboration in this subject, it has been observed that the students' practical ability, innovation ability and cooperative spirit have all improved. In particular, Group 1 has designed and developed this innovative experiment platform for practical teaching and experimental work, thereby, bringing a lot of experience, convenience and confidence for the developers, and creating experimental equipment more conducive to student learning in the future. The three classmates in Group 1 (Xiang-Chun Cong, Yi Yu and Tian-Yu Wang) have completed the graduation design and have demonstrated outstanding performance. As a result, the three students with this innovative research took part in the Student Technology Innovation Competition (STIC) at the 14th International Conference on Pressure Vessel Technology (ICPVT).

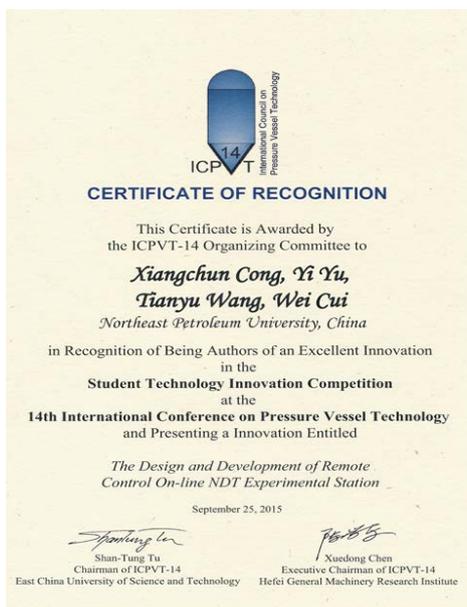


Figure 5: The ICPVT award certificate.

Through the comprehensive review and the project reply, six innovative works were listed on the STIC outstanding innovation team. This team ranked second and, together with their teacher Ms Wei Cui, were issued the *ICPVT Certificate of Recognition* by the General Assembly. The Certificate is shown in Figure 5. They also received a prize money of \$1,000.

This experience proves that through the reform and practice of graduation design, one can develop innovative professional skills, stimulate students' motivation and enthusiasm for graduation design and improve the quality of graduation design. Although the higher engineering education reform is a complex and complicated process with many challenges and opportunities, it still requires continues exploration of new avenues to improve students' practical abilities and skills, their ability to carrying our innovative research and professional practice to the advantage and satisfaction of the general population.

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