

Case study of university-industry partnerships on training outstanding petroleum engineers

Jingyuan Zhao, Yuxue Sun, Mingxing Bai, Jihong Zhang & Shibin Li

Northeast Petroleum University
Daqing, Heilongjiang, People's Republic of China

ABSTRACT: Petroleum engineering education is tied directly to the needs of the petroleum industry. Graduates with experience in engineering practice are more popular with employers. *The Plan for Educating and Training Outstanding Engineers* (PETOE) of China began in 2010. The plan emphasises deep participation of corporations in the education process of engineering students. After completing three years' university study and a one-year internship programme, the first graduates of PETOE majoring in petroleum engineering at Northeast Petroleum University graduated in July 2014. This article highlights challenges faced by teachers and students within a varying curriculum and environment, such as dual-tutor system-building for teachers and capacity-building for students. The goal of this article is to summarise experiences related to complementary advantages from cooperation between university and enterprise, and improve quality of graduate training in the future.

INTRODUCTION

Because of a downturn in the domestic and international economic environments, Chinese university graduates are facing a difficult employment situation. In recent years, the growth of oil consumption has been slowing down, while many oil service companies, and even exploration and development companies have started staff layoffs. Large Chinese oil companies including PetroChina and Sinopec have raised the recruitment criteria and reduced the numbers being recruited. Petroleum engineering education is tied directly to the needs of the petroleum industry.

From about 2003 to 2015, the demand for petroleum engineering graduates has experienced the same boom-to-bust cycle as the petroleum industry. In the difficult employment situation, companies have higher expectations of graduates. Graduates with strong hands-on ability and experience in engineering practice are more popular with companies, and it is easier for them to get good jobs. The new situation has posed new requirements for the manner in which colleges and universities train students majoring in petroleum engineering.

For a long time, the world's petroleum universities have paid quite a lot of attention to the students' practical training, pursuing better training cooperation with the relevant enterprises. From as early as 1987, Von Gonten promoted the opinion of strengthening the cooperation relationship between petroleum universities and enterprises, and increasing numbers of laboratories, and supplying more practice opportunities for students [1]. During the cooperation, the cooperating enterprises may not be limited to domestic firms, but may also extend to foreign enterprises. By building long term and stable cooperation relationships, both the universities and enterprises will benefit [2]. Problems about how to train more adaptable graduates and higher overall quality, so as to deal with the more and tougher job market, are key points of concern to both universities and enterprises [3].

By inviting specialists or professional engineers to the university to give lectures to the students, to act as course tutors, and to discuss practical engineering cases in the lectures, students will come into contact with practical engineering problems, as well as being exposed to the issues about economics and policies. Meanwhile, providing opportunities for university teachers to participate in the practice tasks, will not only help the teachers to obtain better understanding about the courses they teach, but will also increase the teachers' contact with the staff from the enterprises.

The students may participate in practical engineering projects, thereby, combining the knowledge they have learned at university with practice. Through practical working together with the field engineers, the students can acquire more practical engineering knowledge [4]. In such cooperation relationships, both the university and the enterprise greatly increase the management experiences for both parties, through data and information sharing during the cooperation. Of more importance for the enterprise is that the products by cooperation of university and enterprise - the students, will become potential employees of the enterprise [5].

University-industry partnerships are recognised as a major contribution to better prepare professionals [2][6][7]. In June 2010, the Ministry of Education in China officially launched the *The Plan for Educating and Training Outstanding Engineers* (herein referred to as the Outstanding Plan) to intensify the training of a variety of innovative engineering and technical personnel that are able to adapt to economic and social development needs for the purpose of solving practical issues and enhancing innovation in higher engineering education. The plan emphasises deep participation of corporations in the education process of engineering students [8].

Many universities and corporations carried out significant work on university-industry interactions and have made fruitful achievements [9-11]. Petroleum engineering education is facing the serious challenge of preparing versatile engineers who can adapt to the rapidly changing needs of the petroleum industry and technological innovations [12]. Northeast Petroleum University has long since been focusing on training innovative individuals and actively exploring an innovative model under the new training plan. With the guiding ideology of *...serve the local economy and promote enterprise development*, Northeast Petroleum University has partnered with the Daqing Oilfield Exploration and Development Research Institute, the Oilfield Construction Design Research Institute, the Production Engineering Research Institute, the Refining and Chemical Company, the Drilling Engineering Technology Research Institute, the Anton Petroleum Technology (Group) Co., Ltd., and other companies. Along with these companies, Northeast Petroleum University has established a basis for innovation training and has cooperatively cultivated appropriately-innovative graduates in high demand in industry.

The second batch of undergraduate students has completed the Outstanding Plan, which seeks to train professionals in the petroleum engineering field. The Petroleum Engineering Department of Northeast Petroleum University implemented national energy development strategies, revitalised an old industrial base in northeast China, and created training goals in line with the Outstanding Plan. As an on-campus instructor for the outstanding engineer class, after more than a year of exploration and practice, the authors have achieved milestones in teaching practical content.

MUTUAL ADVANTAGES OF UNIVERSITY-INDUSTRY PARTNERSHIPS PROMOTE THE IMPLEMENTATION OF THE OUTSTANDING PLAN

- The university provides theoretical training for students to lay the foundation:

The specialisation is intended for professional engineers training through four-year undergraduate education, in accordance with the 3 + 1 training mode. That is, students complete three years of university and a total of one year of corporate practice, internships and senior design. During the three years in university, students complete basic courses and specialised courses that allow students to master the fundamentals of advanced mathematics, physics, chemistry, mechanics, English and topics within other basic courses, as shown in Figure 1.

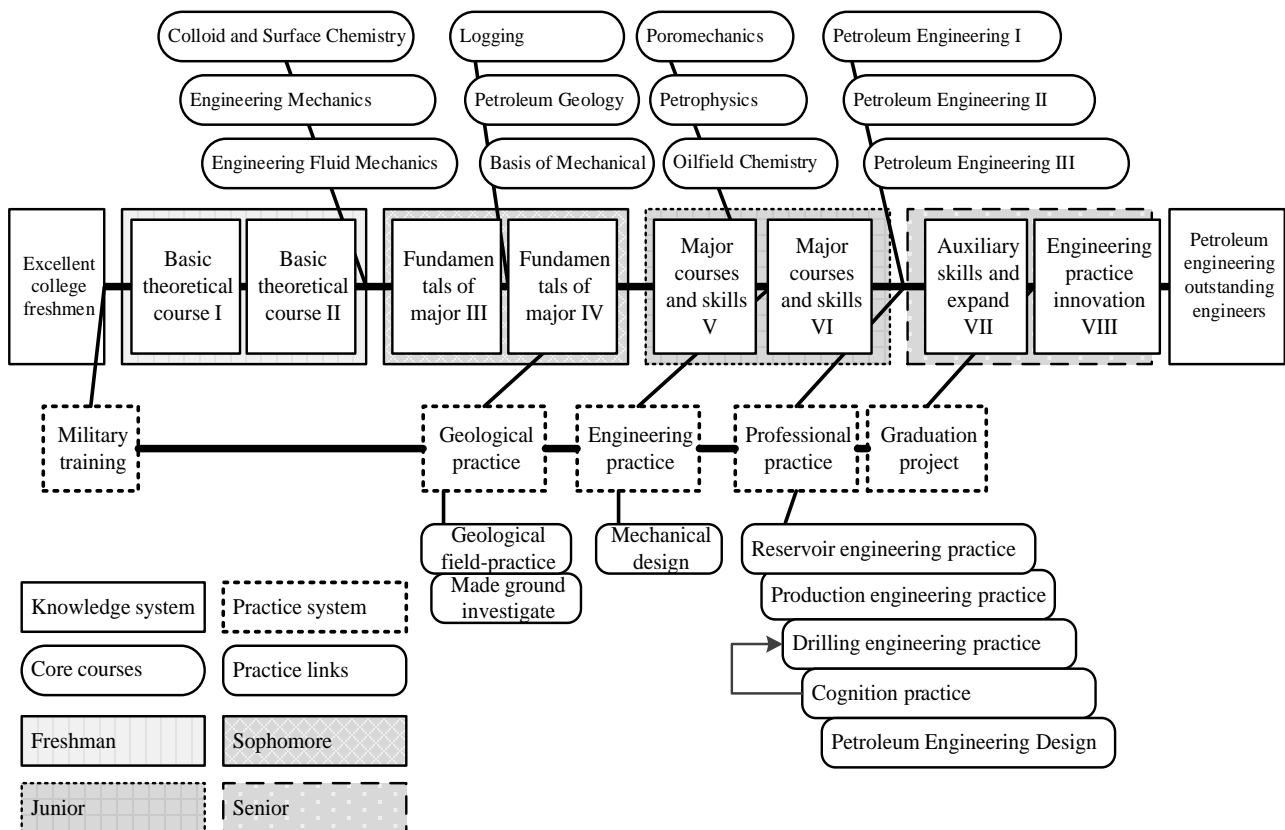


Figure 1: Structure of petroleum engineering core courses and practice training.

Through these courses, students develop knowledge of reservoir physics, seepage mechanics, rock mechanics and other topics within other professional basic courses to lay a solid theoretical foundation for an internship the following year.

- Industry experience provides students with real world engineering training and introduces them to corporate culture:

For example, drilling engineering training is divided into draining crew training and drilling engineering research training. From design to construction drilling, the content covers all aspects of a drilling project. First, students apply the basic knowledge they acquired at university to the drilling design process. Then, they practice construction aspects with a drilling crew, implementing their design results into the construction process. Students receive training throughout the entire design and construction process.

UNIVERSITY-INDUSTRY PARTNERSHIPS PROMOTE LEARNING, EXPERIENCE AND SKILLS TRAINING OF STUDENTS

For example, the courses in the drilling engineering programme apply knowledge and curriculum design of petroleum engineering as the junction point. Combining the application of theoretical knowledge from various related courses and drilling practice allows students to analyse and resolve the main problems encountered in the actual construction process.

Through this process, students are also able to consolidate and deepen their theoretical knowledge, which enables them to participate in design training and on-site drilling practice. One successful example in the on-site drilling practice is shown in Figure 2. The courses mainly train students in the following areas:

- Integrating theory with practical analytical skills through on-site drilling practice and actual drilling site design.
- Using theoretical knowledge in accordance with objective laws to analyse and solve problems, such as the actual drilling problems encountered on site.
- The overall concepts of modern engineering, including awareness of quality, environment, occupational health, safety, engineering as a service and other basic qualities of an outstanding engineer.
- Developing innovative ideas around the drilling process, drilling equipment and environmental constraints through practical training with a drilling crew, in addition to design, technological and innovation skills.
- Communication, adaptability and teamwork through practical on-site training, alongside a relatively large group of field workers, while working and living together in small groups for four weeks.
- Dealing with crises and emergencies with flexibility through field engineering training, as the risks associated with drilling operations are often hidden and unexpected, potentially causing harm in the form of personal injury, property damage, ecological destruction, etc.
- Mastering practical skills through on-site training, such as filing drilling reports; inspection, positioning, measurement, and maintenance of slings, rope clamps, drilling assemblies and casings; filing drilling records and casing records; identifying and matching drilling assembly connectors; wellhead tools and operations; handling rope; management and use of wellhead fire-fighting tools, wellhead operations, racking operations, cementing, casing, well-completing and other operations; and drilling design software operation.



Figure 2: On-site drilling practice.

UNIVERSITY-INDUSTRY PARTNERSHIPS STRENGTHEN THE HERITAGE OF THE PETROLEUM CULTURE AND THE DAQING *IRON MAN* CULTURE

The main cooperative enterprises are located in the Daqing oilfield, which has a deep historical and cultural heritage around petroleum promoted by the Iron Man Museum, Petroleum History Museum, Petroleum Science and Technology Museum, and other cultural and scientific museums. Additionally, there have been teams led by *Iron Man* Wang Jinxi,

such as *Iron 1205*, *Sharp Knife 1202* drilling crew, *Heroic-Workover Iron Army* team 107, and so on. These gold-medal teams have excellent skills and strict disciplines, and they have their own team history exhibitions, which serve as an outstanding cultural heritage base of the spirit of Daqing and the *iron man* culture. A visit to the museums and the gold-medal team exhibitions as a part of the learning process provides students with a better understanding of the Daqing spirit and the *Iron Man* spirit, encouraging students to embrace these spirits as shown in Figure 3.



Figure 3: Visiting history museum of *Iron 1205* drilling crew.

UNIVERSITY-INDUSTRY INSTRUCTOR QUALIFICATION SYSTEM PLACES NEW DEMANDS ON THE FACULTY

Building a Competent Engineering Faculty for the Outstanding Plan Contributes to the Success of the Project

The establishment of a cooperative system between full-time university academics and part-time corporate staff can create a complementary system, with each learning from the other and improving together. On the one hand, the full-time university academics can develop experience in handling and solving practical engineering problems by working with the part-time corporate staff. On the other hand, the part-time corporate staff can learn teaching methods from the full-time academics.

Full-time university academics join with their industry counterparts and participate in the actual work of production, design, development and management. In the industry environment with advanced equipment and technology, under the guidance of engineers with rich corporate experience and strong engineering skills, full-time university academics learn practical engineering skills, engineering design and development skills, and technical innovation skills.

Part-time corporate staff receive further education in colleges and universities. This arrangement allows them to update their professional knowledge and improve their theoretical knowledge in the field of engineering in order to promote the integration of their practical experience and theoretical knowledge.

Full-time university academics and part-time corporate staff participate in domestic and foreign conferences to learn about the latest developments in the industry, and new changes in domestic and foreign corporate advanced technology and talent needs. This arrangement widens the vision of all staff involved.

PROBLEMS ENCOUNTERED DURING THE COOPERATION PROCESS

At the beginning of the cooperation between universities and enterprises, some problems were exposed, including:

- Lack of the active instruction and effective operations from the government department, which is necessary to help the universities and the enterprises to build up the long-term and stable cooperation relationship. At the very beginning of the cooperation, the connection and negotiation between the enterprise and the universities were only through the relationship between the university fellows, and there was a lack of support and help from the government.
- Although the university has made detailed and completed plans for training outstanding engineers through the cooperation between universities and enterprises, during the practicing process, the enterprise had no detailed management plan for the students. There were no proper prevention and handling mechanisms for emergency incidents during the cooperation process.
- The flexible cooperation mode, different from the systematic management and complete regulation for the students when they study in the university, makes the management of the students more complex and random;

therefore, monitoring the rate of incidents of various emergencies, including student safety needs to increase substantially. Thus, it is necessary for the university and the enterprise to work together to establish an effective prevention and quick action mechanism to ensure safety cooperation processes, as well as smoothness of the cooperation.

CONCLUSIONS

In the process of training outstanding petroleum engineers through university-industry partnerships, the teaching and learning environment of the university and the engineering environment of industry should be utilised, so that students can experience the corporate work environment in combination with the theoretical knowledge learned in university and apply their theoretical knowledge to practical work. The content of courses and skill training should not only cover the topics necessary for working in the petroleum engineering industry, but also contribute to raising student awareness in the areas of teamwork, innovation, safety and environmental concerns.

Additionally, the deep petroleum history and culture of the Daqing Oilfield, as captured in the exhibition halls, and a variety of advanced collectives are used to allow students to profoundly experience the petroleum culture and the *Iron Man* spirit, promoting student dedication. The method described to enhance the qualifications of instructors is a new exploration model for the Outstanding Plan, requiring full-time university faculty and part-time corporate staff to collaborate and learn from each other to continuously improving their engineering ethics and conduct a good student training plan.

The cooperation between the university and enterprises will need the government to provide better policy and funding support on policies. During the training process for the students, the enterprises need to continue to make more complete and detailed training plan with corresponding improvements to management mechanisms and the safety regulations.

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