

# Discussion on the Training Mode of Excellent Engineers in Conditions with Industry University Research Cooperation

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**Abstract**—For solving problems such as dislocation of talent training objectives and social demands, the difficulties of developing China's "Excellent Engineer Education and Training Program", this paper aims to establish a training system for engineering and technical personnel in research oriented university in conditions with engineering practice training, and discusses some problems related to the "Education and Training Program for Excellent Engineers" with cooperation between industry, university and research. Next, this paper mainly describes how to make full use of the existing enterprise resources of university, how to construct a talent cultivation scheme in conditions with industry, university and research cooperation, and how to strengthen practice training through combining the first and second classes closely. At last, some methods to reform the talent cultivation mode, enhance students' engineering accomplishment, practical ability, innovation ability and comprehensive competitiveness are proposed, these methods will help to find a practical and feasible way to train engineering and technical personnel during conditions of industry and enterprises' deeply involving in the training process.

**Keywords**—*Excellence program, Industry university research cooperation, Personnel training mode, Engineering and technical personnel, Improving students' ability*

With the rapid development of science and technology, the speed of knowledge updating is faster and faster. The long-standing Soviet higher education system in China has been unable to meet the needs of today's national economic development because of its narrow specialty range and narrow specialty division. In order to train a large number of high-quality engineering and technical personnel with strong innovative ability to meet the needs of economic and social development, the state launched the "Excellent Engineer Education and Training Program" (abbreviated as "Excellence Program") in June 2010. The plan of excellence has three characteristics: The first is the deep participation of industry and enterprises in the training process. The two is to train engineering talents according to general standards and industry standards. Three is to strengthen students' engineering ability and innovation ability.

In the process of advancing the "Plan of Excellence", we can not completely copy the American model or the European model, but should closely integrate with China's national conditions. It must be clearly recognized that China's "Excellence Plan" is only starting, experience is still less, and the enthusiasm of enterprises to participate in is not high, coupled with personnel training industry standards are difficult to unify, the employment system of engineering teachers has not yet been established and a series of problems have not yet been solved, so there will be a long way to go. At this stage, colleges and universities shouldering the important mission of personnel training, especially the key construction of the "985 Project" and "211 Project" must not "wait, depend on, and want". They should find the key to the problem and set a good example. We should seize the opportunity to further clarify the training orientation of engineering and technical personnel and improve the personnel training system. We should further promote the cooperation between industry, University and research institute, make full use of all kinds of resources, and serve the training of engineering and technical personnel in schools.

## I. PROMOTING THE "EXCELLENCE PROGRAM" REQUIRES CLEAR KEY ISSUES

### A. The Problem of Educating People

What enterprises need is an engineer who integrates knowledge, ability and experience. What they need is different levels and different types of manufacturable talents who possess considerable engineering literacy. To improve the quality of engineering and technical personnel training, "what to teach, how to teach" is a different issue facing colleges and universities at different levels. Different types of enterprises, even the same enterprise in different periods of the same professional students are not the same requirements. This requires that we avoid the cultivation of engineering talents with thousands of schools and ability convergence. Therefore, in order to carry out the plan of excellence, we should set up the idea that we can't simply carry out the training of talents according to a certain standard. We should emphasize the integration of engineering practice and literacy education into the whole process of engineering and technical personnel training.

### B. The Problem of Universal Participation

Talent cultivation is a social problem, and the role played by families, schools, enterprises and society in the process of students' talents can not be ignored. Enterprises are pursuing economic interests, fearing no return on investment, and are not enthusiastic about fully participating in the training of talents. Parents, due to the pressure of work and their own knowledge, devote little energy to the study and success of College students. Society has no time to take into account the Ivory Tower of College students. Schools are naturally defined as cradles of talent development, the implementation of the "excellence

program", universities are naturally pushed to the forefront of the storm. But schools that have a bearing on the interests of millions of households are obliged to work with the government to arouse people's awareness and create an atmosphere of universal participation, concern and support for education.

### *C. The Problems of Teacher Development*

Our university teachers are basically from school to school, engineering teachers are the same, even if the "985 Project" and "211 Project" key construction university engineering teachers, although they have high academic qualifications, academic ability, but the most lacking is still engineering practice knowledge, experience and accomplishment. At the same time, no matter what kind of colleges and universities, there are still some problems, such as the weak experimental technical team, the lack of talents, the lack of attention to the training and improvement of teachers. All these affect the quality of our engineering and technical personnel training, are the crux of our implementation of the "excellence program".

### *D. Linking Practical Problems*

At present, it is an indisputable fact that talent training in Colleges and universities is divorced from the needs of enterprises and society. There are three reasons for this: Professional setup and curriculum content are divorced from production practice. The input of experimental equipment mainly depends on administrative appropriation, which is difficult to synchronize with technological progress. Teacher training itself is a long-term process, coupled with the existing problems in the system, resulting in the lack of actual production experience of teachers as the main body of teaching. As a result, it will inevitably bring about a series of problems, such as serious disconnect between theory teaching and practice, emphasis on theory, light practice, practice course can not be strictly checked and so on. These problems are particularly prominent in the performance of Engineering specialty, which is an important problem we must solve in the implementation of the "Excellence Program".

## II. PROMOTING THE "EXCELLENCE PROGRAM" REQUIRES SEVERAL IMPORTANT ASPECTS THAT UNIVERSITIES SHOULD GRASP

Although it is a matter of the whole society to carry out the "Plan of Excellence", there are still many unresolved relations and many problems that can not be solved, all colleges and universities should start from themselves, actively promote the reform of various systems, make full use of existing resources, and actively participate in the implementation of the "Plan of Excellence", especially it is the responsibility of universities and colleges that focus on the "985 Project" and "211 Project" to strive to be the pioneer in leading the implementation of the "Plan of Excellence".

### *A. Clear Educational Objectives*

The diversity of talent demand determines that the quality of different types of personnel training can not be measured by the same standard, so different types of universities and different types of engineering and technical personnel training objectives should be different. Therefore, in the process of advancing the plan of excellence, colleges and universities at all levels should accurately orientate their educational objectives. The national key construction of "985 Project" and "211 Project" should aim at cultivating excellence in "broad foundation, strong adaptability, high comprehensive quality and long life cycle".

### *B. Updating Teaching Contents*

On the basis of defining professional training objectives, relying on the advantages of industry-university-research cooperation and discipline specialty, and combining with the actual adjustment of teaching syllabus and teaching content, this paper explores an effective method of "on-demand teaching" according to the needs of enterprises, which is suitable for the training and management of engineering and technical personnel. First of all, in the formulation of personnel training programs and syllabuses, we should fully listen to the opinions of the cooperative enterprises, clarify the role of each course in the personnel training program, allow the dynamic adjustment of professional basic courses, backbone courses on the basis of general education, curriculum content should be broad and comprehensive, in order to be more comprehensive. Effectively realize the integration of theory and practice, knowledge, ability and quality, and adapt to the flexible changing market demand. Secondly, to improve the structured description of each course, according to the choice of the course content and its arrangement order, through describing the course topology map to reflect the primary and secondary relationship, the hierarchical relationship, and the internal relationship and coordination between the courses, relying on the classification construction of the large series of courses, all kinds of quality courses at all levels. Reorganizing and integrating the curriculum contents to achieve the overall optimization of the whole teaching process. Thirdly, we should timely increase the content of production front-line on-site teaching, and allow the students who have passed the industry-related certification to exempt the relevant courses or increase the score of their courses.

### *C. Pay Close Attention to Team Building*

First class engineering teaching management and teaching staff are the foundation of cultivating first-class engineering and technical personnel. Under the present situation of system obstacle and inconspicuous salary advantage, it is not possible to employ large-scale enterprise engineers as the main lecturer of school engineering courses. Therefore, the foothold of strengthening the construction of the teaching staff should also be the training and training of teachers in our school. Enhance the engineering quality of our school teachers: On the one hand, we can send teachers to universities both at home and abroad for further studies, and we can also send teachers and laboratory technicians to enterprises for training, and encourage on-the-job teachers to enter the post-doctoral mobile station. On the other hand, we can set up a teaching team and a scientific research team composed of teachers and enterprise engineering technicians. Enterprise engineering technicians and old, middle-aged and young teachers and staff cross-link each other to form a closely related teaching team and a scientific research team, in the form of project cooperation, through the role of "transmission, help and guidance", so that teachers The practical

experience and comprehensive quality of the project can be improved continuously, and the purpose of infiltrating the teaching process into the whole process of improving the level of teachers and training engineering and technical personnel can be realized with the minimum investment. In addition, we should do a good job in the construction of experimental technical team, further increase the strength of the introduction of teaching staff, and boldly try to employ enterprises to come to the school station postdoctoral personnel as teaching or experimental teaching tasks. Of course, engineering practice and related work should also be included in the evaluation and assessment system in the process of building up the qualified engineering education teachers.

#### *D. Enrich Teaching Form*

To enrich the teaching form, we should focus on improving students' self-study ability, ability to analyze and solve problems, ability to innovate and engineering literacy. On the one hand, we should clearly identify the key and difficult points of each professional course, as well as the cross-fields and possible integration with other courses, and then consider how to use modern teaching technology to vividly and properly express the course content and the relationship between courses. At the same time, it emphasizes the close combination of theoretical teaching and intuitive teaching, the close combination of systematic teaching and thematic teaching, and the close combination of teaching and scientific research. On the other hand, we should adopt the teaching methods of discussion, question, participation and on-the-spot lecture to cultivate students' professional skills and team spirit. In the teaching process, we should pay attention to the cultivation of professional orientation and ability, and explore the methods of teaching, case analysis, on-site research, heuristic and seminar teaching combined with school teachers and enterprise engineering technicians. A more reasonable assessment system for engineering and technical personnel training should be established, and a comprehensive assessment and evaluation system for engineering and technical personnel with dynamic adjustment and distributed implementation should be gradually established. Curriculum examination can replace traditional single examination mode by design, field operation and so on.

Adjusting and optimizing the connecting form of theory teaching and practice teaching can increase the form of students' active practice after class besides the form of theory before practice in class. By reducing the total class hours, increasing the extra-curricular class hours, giving students more independent time, providing students with the possibility of active practice, practice or practice-related credit settings accounted for more than one-third of the total credits of students' professional courses. By giving the following theoretical questions which need to be considered, arousing the enthusiasm and initiative of students' extracurricular practice, and constructing a multi-level practice model, the multi-level practice links mainly include four levels: basic experiment, professional series experiment, comprehensive experiment and research and practice series which combine with the actual situation of enterprises. Level by layer, theory combined with practice runs through the whole stage of professional learning. Through collective arrangement of off-campus practice and students' independent contact with off-campus practice, students' practice opportunities will be increased.

In the process of exploring the training scheme of "Plan of Excellence", our school has reformed the existing curriculum system and set up a "Freshman Seminar" for all students in the first semester. The class system is less than 30 students. The course is taught by subject leaders and teachers at or above the level of professors. The main contents are professional engineering application and professional direction guidance. After a small amount of teaching, a large number of in-class discussions, supplemented by papers for guidance of extra-curricular learning, to promote students' macro-understanding of professional content and engineering applications, so as to enable students to define their future work areas and determine the direction of learning and course selection content, for the next three years to play a guiding role in learning. Before the graduation of the fourth grade, the frontier courses should be offered to introduce the frontier research of the current major and its application in industry with fewer class hours so as to guide the students to understand the direction of professional development and the frontier development of Engineering application, so that they can meet the needs of enterprises for the frontier knowledge to guide industrial production after taking part in the work. At the same time, according to the principle of "Excellence Program" in our school, for some outstanding students, the school has established the center of innovation and Practice for college students as a long-term platform for engineering practice, set up two forms of innovation and practice class and innovation team, to study and continue to participate in research in engineering, and create an all-round project.

#### *E. Pay Attention to the Second Classroom*

In college, students spend less time in the second classroom than in the first classroom, but almost all colleges and universities in the second classroom focus on humanistic quality education, in fact, relying on the second classroom to enhance students' engineering literacy is also very important. Under the situation that the appointment and assessment system of engineering teachers has not been established and perfected, and it is difficult for engineering teachers to enter the first classroom, it is necessary to rely on the second classroom education with more flexible time, space and form for enterprises to participate in the whole process of training.

To design the second classroom closely combined with the first classroom, to create the second classroom closely combined with the requirements of the industry and enterprises, and to employ enterprise engineers and technicians as the instructors of the second classroom or student associations can make the time of both teachers and learners more flexible, improve the attractiveness and effectiveness of the second classroom, and make up for the learning effectively. The first class education in school is not closely integrated with the reality, cultivating students' basic engineering literacy and interest in learning, and extending the scope of Industry-University-Research cooperation. At the same time, we should give more support to the professional literacy education and innovation education activities in the second classroom, and encourage teachers to enter the second classroom. In addition, we should also vigorously promote the interaction between the first and second classes,

construct a "learning-practice-relearning" model, so that students' interest in learning, comprehensive sense of competition and engineering literacy, in the first and second classes in the blend of continuous improvement.

At present, the second classroom of our university relies on the innovation and practice center of College students, takes all kinds of practical projects at all levels as the carrier, and takes the students' science and technology competition as the impetus to improve the learning of engineering practice in the second classroom. According to the current needs of enterprises, industry hotspots and students' interests, engineering teachers guide students to apply for practical projects at all levels. After students enter the project team, they complete the project under the guidance of engineering teachers to achieve the purpose of engineering practice learning and cultivate basic engineering literacy. Through the student engineering science and technology competition to further select outstanding students into the actual engineering design, enhance students' comprehensive competitive consciousness. As the second class of our university has been promoting the cultivation of students' engineering literacy, we have achieved many good results in the National University Electronic Design competition, the University mechanical innovation design competition and other engineering science and technology competitions.

#### *F. Rational use of Human Resources in Enterprises*

Postdoctoral enterprisers, Engineering Masters and all kinds of personnel entrusted by enterprises for school training are valuable resources provided by enterprises to schools. They have rich experience in engineering practice and are basically technical backbones. Making rational use of these resources will effectively promote the training of engineering and technical personnel in schools. For postdoctoral entrepreneurs, in addition to the teachers mentioned above, we can also choose to send outstanding teachers and experimental technicians to join their research teams. For the master of engineering, on the one hand, we require them to conscientiously fulfill their responsibilities of "three assistants" to serve the school's teaching, experiment and second-class education, on the other hand, we can also allow full-time students to join their research team, as research assistants, so that students can enhance their engineering literacy in actual research projects. For all kinds of trainers, we can boldly try a certain number of professional courses and undergraduate teaching mixed class teaching, in order to enhance the interactive teaching.

#### *G. Further Deepening Industry University Research Cooperation*

Promoting the "Excellence Plan" and putting forward that enterprises should participate in the whole process of personnel training in an all-round way, and creating a new mechanism of cooperation between industry, University and research, which puts forward higher and newer requirements for universities to promote the work of industry, University and research. Under the new situation, colleges and universities should not only pay close attention to the main bodies of "production", "learning" and "research", but also consider the stakeholders involved, and organically "tie" the main stakeholders of Engineering Education - schools, enterprises, governments and research institutions, so as to mobilize the whole people. The enthusiasm of participating in personnel training. At the same time, in the process of promoting cooperation between industry, University and research, we should not only attach importance to the expansion of students' practice bases outside school, but also to the construction of engineering centers and laboratories inside school. We should make full use of the opportunity that multinational enterprises, which are leading the trend of the industry, are willing to invest and publicize in key national universities and jointly build engineering centers and laboratories with them. This not only makes up for the shortage of school equipment investment, but also facilitates the use of teachers and students. There is no fixed form of Industry-University-Research cooperation, so long as it can fully mobilize the enthusiasm of all walks of life in society and enable schools to make full use of domestic and foreign resources for engineering and technical personnel training services, it is worth universities to try boldly.

It is a long-term problem that the training of engineering and technical personnel lags behind the society and market demand. Promoting the "Excellence Plan" and letting enterprises participate in the whole process of personnel training is an inevitable way for colleges and universities to enhance the ability of engineering and technical personnel demand forecasting, to clarify social needs, and to ensure that personnel training is as appropriate as possible to the industrial restructuring and technological updating of enterprises in China. In the early stage of the implementation of the "Plan of Excellence", relying on its own advantages in teaching reform and enterprise cooperation, the state should take the lead in setting an example and boldly try to find a feasible way to cultivate engineering and technical personnel for cooperation between industry, University and research. We should guide other types of colleges and universities at all levels to diversify and develop their own characteristics.

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