

The Main Mode Analysis of University-Enterprise Cooperation on Engineering Education

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INTRODUCTION

Enterprises play an important role in cultivating engineering talents for having following advantages which universities lack: (1) accurately grasp the social demand for engineering talents; (2) have the most advanced manufacturing equipment and techniques; (3) have a group of experienced engineers and technicians; (4) offer real environment of engineering practice and innovation; (5) provide concentrated atmosphere to learn the progressive enterprise culture. Thus, enterprises involving in university-enterprise cooperation and engineering education becomes the key to cultivate engineering talents.

The cooperation modes to be chosen by universities and enterprises include: systematic and comprehensive cooperation mode, modular cooperation mode, project-based cooperation mode, ordering cooperation mode, cooperation mode of substitution internship, cooperation mode of learning and working alternation, multi major joint cooperation mode, and course replacement cooperation mode. Their characteristics, advantages and disadvantages, as well as applicability will be analyzed as follows.

1. SYSTEMATIC AND COMPREHENSIVE COOPERATION MODE

Systematic and comprehensive cooperation mode refers to one type of the university-enterprise cooperation education mode that essentially implemented and systematically completed in an enterprise or a corporate group. An effective way to carry out this kind of cooperation mode is to jointly build a national, provincial or collegial engineering practical training center, or off-campus practice base in one enterprise by universities and enterprises together as an integrated platform to systematically cultivate talents.

Systematic and comprehensive cooperation mode has remarkable advantages. First, universities and enterprises are able to thoroughly and deeply discuss the design and implementation of study plan in enterprises, in order to ensure its continuity, systematic, integrity and effectiveness. In this way, the issues on work efficiency, implementation effects, teaching arrangements and student management, which resulted from separate implementation of study plan, are minimized. Second, considering the long-term cooperation, both universities and enterprises are more likely to focus on investments in money, facilities and human resource, and state and governments may provide more funds and policy support, to jointly promote the development of cooperation. Third, tripartite training agreement signed by the enterprises, universities and students in accordance with the principles of equality, voluntariness and consensus helps enterprises to select and employ talents, and also provides students a new employment channel. Last but not least, university and enterprise can establish a long-term and stable strategic partnership, which helps them to expand cooperation to other fields beyond talents cultivation, including product development, research program, technology development, patented invention, collaborative innovation, and so on; such all-aspect cooperation will in turn support and contribute to engineering talents development, especially for the high level engineers' development.

The disadvantages of systematic and comprehensive cooperation mode result from the requirements to enterprises, including (1)the enterprise's scale and business scope must be large enough to cover different educational practice; (2)enterprises need to provide special places, facilities, money and staff, and to occupy some manufacturing facilities. Therefore, systematic and comprehensive cooperation mode is mainly carried out in large enterprises and corporate groups. Considering the differences of fields and areas, this kind of cooperation mode is not suitable for every university, especially those local universities which are located in industrial underdeveloped areas and lack of industry background.

2. MODULAR COOPERATION MODE^[1]

The modular cooperation mode is based on certain teaching modules of study plan in enterprises. In accordance with overall design, targeted and progressive principles, and by modularly designing and organizing learning and teaching plan, enables each module to have a clear objective function. In this way, the modules can be sorted in the right order and be implemented progressively in different enterprises on the basis of the law of knowledge learning and capacity development, as well as interdependence between modules.^[1]

Modular cooperation mode makes learning plan of enterprise can be implemented in different companies, which not only reduces the university's pressure for looking for "large-scale" enterprises but also allows universities to choose suitable enterprises with proper hardware and software to implement modular cooperation and to complete teaching tasks, to make sure that each module of the whole learning programs can be implemented in enterprises with superb conditions. Therefore, the modular cooperation mode is a practical university-enterprise cooperation mode for

universities in small cities with few large companies.

The engineering education for lower degree relatively has larger quantity and more extensive educational activities implemented in enterprises, which makes them need more cooperative enterprise partners to provide enough practice bases and educational positions. From this perspective, the engineering talents cultivation of undergraduate is more suitable for modular cooperation model than master-level graduates, and doctoral level students are least suitable.

3. PROJECT-BASED COOPERATION MODE

Project-based cooperation mode refers to the mode in which university-enterprise cooperation is based on a particular project. In this mode, based on the needs of learning plan of enterprises universities and enterprises organize students to involve in the actual projects, and enable students to apply theoretical knowledge in the project practice, cultivate students' sense of engineering, train and improve their ability of solving practical engineering problems, in order to meet the training standards prescribed in learning plan of enterprises.

The projects of this kind of cooperation mode are mainly enterprises' actual projects, aiming at solving specific issues related to enterprises' production, design, research and development, innovation, operation and management, etc. Thus, the projects can be those that are being implemented or about to be started in company, and can also be research projects jointly developed by university and enterprise, and other university' research projects commissioned by enterprises.

The competitive advantage of this mode is mutually beneficial and win-win mechanism between universities and enterprises. On one hand, the implementation of the projects requires a lot of investment in human resources, and the universities' participation not only reduces the cost of human resource in research and development, but also provides talents with theoretical advantages to be complementary, which gives companies high motivation to cooperate. On the other hand, the projects cooperation allows faculty and college students, especially students not only to get true experience of participating in engineering projects, but also to have opportunities to solve practical engineering problems. This kind of experience and opportunities are really needed in engineering talents cultivation.

Universities need to pay attention to two aspects to use this mode. First, make sure that the projects can meet the current need of university's talents cultivation. In other words, on one hand, avoid the students being treated as labor or elementary technicians and participating in the projects with no ability improvement; on the other hand, avoid the projects to be unsuitable for educational practice and not in accordance with progress of learning plan of enterprises, like problems that repeating the same projects or implementing extremely difficult projects. Second, universities should organize the students well and pay attention to the ability development of team work, communication, organization and coordination, in order to not only improve students' engineering ability, but also train students' social skills and integrative competence.

4. ORDERING COOPERATION MODE

Ordering cooperation mode is one type of cooperation mode that university and enterprise cultivate engineering talents on purpose to meet enterprises' future development needs or industry market demands for engineering talents. The main features of this university-enterprise cooperation mode are as follows. First, the engineering talents cultivation is target-oriented, in which students are trained to acquire proper knowledge, capability and quality to meet employers' need and get to work directly after graduation. Second, the cooperative enterprises are highly motivated and supportive, willing to arrange students to practice in companies, and implement learning plan of enterprises, as well as to provide pre-employment job positions and instructors. Third, cooperative enterprises have clear responsibilities and obligations, and universities make cooperative enterprises actively participate in the whole process of training engineering talents by signing directional training agreement, which contributes to quality improvement of talents cultivation.

Ordering cooperation mode brings two main advantages apart from other cooperative modes. First, the cooperation between university and enterprise is more systematic and more in-depth, and enterprise will hold an open and positive attitude on talents cultivation for its own sake to meet talents demands. They not only provide students with advanced equipment for practical training and create a good learning environment that allows students to have access to advanced engineering technology, but also cooperate closely with universities on various items of engineering talents cultivation. This is conducive to improving the quality of engineering talents cultivation. Second, students can easily adapt and actively fit in companies' living and working environment. Given relatively clear employment objectives, students are willing to learn enterprises' management style, operation mechanism and corporate culture, and get preparation for working in them. In this way, students' transition from school to company is shortened. Thus, students cultivated through ordering cooperation mode will be competitive in talent market.

Universities that adopt ordering cooperation mode need to pay attention to two relationships. The first is relationship between enterprises' requirement based on their own needs and basic requirements of universities for training engineering talents. If these two requirements are contradictory, universities, on the premise of keeping the basic standards, should accommodate themselves in a certain degree to accord with enterprises' requirements. The second is relationship between students' employment expectation and enterprises' jobs which can be offered. To deal well with this relationship, universities should arrange those students to take part in ordering cooperation mode, who are willing to work in cooperative enterprise after graduation. All in all, the design and implementation of learning plan of enterprises must be subject to general requirements for engineering talents cultivation, and meet the needs of university services for the area and industry.

5. COPERATION MODE OF SUBSTITUTION INTERNSHIP

Cooperation mode of substitution internship refers to the cooperative education mode that universities arrange for the students to practice in the working sites or posts

provided by the cooperative enterprises. The main feature of this mode is that students could systematically operate production activities around the jobs, in relatively fixed production posts, and under the co-guidance of both experienced engineers from enterprises and teachers from universities. During the substitution internship, the students are directed by both full-time teachers from universities and delegated engineers with rich experience in engineering practice, and are required to engage in production activities as same as the enterprise staffs, accomplish production tasks as stipulated in the working posts, and take the same responsibilities as the enterprise staffs. These requirements result in the most outstanding difference of this cooperation mode from other cooperation modes, and bring the students unprecedented environments and working pressure. Also, they accelerate the cultivation of students' abilities and comprehensive qualities in the following three aspects.

First, the requirement to engage in the production activities same as the enterprise staffs will familiarize the students with the internship environment and make the adjustment as soon as possible. It also helps them to be clearer with the characters of their majors and the abilities required, to be familiar with the production activities in which they are engaged in, to handle the basic skills needed in the work, and enable them to carry out the production activities same as the enterprise staffs.

Second, the requirement to accomplish production tasks as stipulated in the working posts will encourage the students to learn hard from those experienced engineers from enterprises, to be familiar with the production process and pace, to handle the skills that they need when accomplish their tasks, and to coordinate the partnership with the enterprise staffs. In this way, they can accomplish the production tasks with quantity and quality guaranteed.

Third, the requirement to take the same responsibilities as the enterprise staffs urges the students to have the sense of the responsibility for the work rapidly, to acquire the knowledge and abilities when performing duties in the posts as quickly as possible, and to cultivate the abilities to work independently and be qualified for the posts. In this way, they can take the same responsibilities as the enterprise staffs.

In a word, cooperation mode of substitution internship provides students with the real enterprise and engineering environment, in which they can systematically and comprehensively understand and familiarize with the internship posts, learn and acquire production knowledge and working skills rapidly, cultivate and improve all kinds of engineering abilities efficiently. During the processes above, they are under the pressure from production activities, working tasks and responsibilities. Also, they can gain many opportunities to cultivate overall comprehensive competencies to be qualified for the posts, which are helpful to students' fast growth.

Besides, cooperation mode of substitution internship supplies a good chance for students and enterprises to know and select each other mutually.

Universities need to pay attention to four problems that may occur in cooperation mode of substitution internship. First, as the internship posts are scattered and the number of full-time teachers is limited, the guidance from university teachers may not enough. Second, the responsibility and enthusiasm of instructor from enterprises

have great influence on the effect of students' internship. Third, the intern posts given by the enterprises may be simple and basic as due to worries of disturbing normal production activities. Thus, the effect of students' practice education is affected. Last but not least, the effect of the internship depends on students' consciousness. Once the supervision is deficient, those students with low motivation might make the internship become formalistic.

6. COOPERATION MODE OF LEARNING AND WORKING ALTERNATION

Cooperation mode of learning and working alternation means practice education for engineering talents in enterprises is replaced by working in enterprises, on the premise of keeping the basic school system. In this way, education mode of university-enterprise cooperation is formed when learning in school and working in enterprise is alternated. The fundamental difference between this mode and other cooperative education modes is that practice education in enterprises is replaced by working experience. When working in enterprises is arranged more than one time during the cultivation, three aspects of main advantages are as follows.

First, by reasonably designing and arranging the time of learning in schools and working in enterprises of each alternation, students could put the theories and knowledge learnt in school into practice during working in enterprise, reinforce the purposiveness, selectivity, initiative and positivity of their learning. The alternation of theories and practice are not only accordance with people's understanding of objective things, but also with the education law of talent cultivation.

Second, relative to the student identification in the enterprise practice of other university-enterprise cooperative mode, they will work as the regular staffs in the enterprise. This turning from a guest into a host requires students to obey the rules and regulations, be strict with themselves as the regular staffs, take the relevant responsibilities, and adjust to the working conditions of enterprise. These requirements not only are helpful to foster students' professional dedication, occupational ethics, and social responsibility of engineers, but also bring great conveniences and opportunities for students to learn better.

Third, the dual identity of students in school and staff in enterprise, makes the students become important links of communication and cooperation between universities and enterprises. This students' function and enterprises' expectation for graduates are useful to mobilize the motivation of enterprise to carry out cooperative education with universities, and prompts enterprises to take part in the cultivation of engineering talents. Through this, the professional training program and the quality of talent cultivation are improved.

Cooperation mode of learning and working alternation is especially suitable for the cultivation of engineering talents in graduate student level, in particular master of engineering and doctor of engineering. For instance, doctoral students spend the first year in university on completing the courses together, the next half to one year in enterprise on working and topic selection of doctoral dissertation, then half to one year on literature analysis, dissertation proposal and early stage research work in university, and about one year on completing doctoral dissertation while working in enterprise. In

this way, it may cost 3 to 4 years to complete the cultivation of engineering talents in doctoral level, during which the time spent in university learning and enterprise working is half and half.

There are problems need to be focused in the cooperation mode of learning and working alternation. The first one is the management of students' dual identity during working in enterprise. As enterprise staffs, students must receive the same supervision as other regular ones. But, their student identity makes their universities to take the responsibility for their behaviors when they are in enterprises. Thus, universities, enterprises and students need to sign a valid agreement in which students' responsibilities and obligations when working in enterprises are clearly identified. The second one is that the feature of learning and working alternation makes enterprises usually arrange flexible positions for students, so that when they leave, the normal operation will not be affected. This kind of arrangement brings some difficulty to those enterprises that emphasize performance and teamwork. This may make some enterprises reluctant to accept this kind of university-enterprise cooperative education mode.

7. MULTI MAJOR JOINT COOPERATION MODE

Multi major joint cooperation mode refers to the university-enterprise cooperative education mode in which students from more than one engineering majors are organized and arranged to the same enterprise to practice. Apparently, the main objective of this cooperation mode is to improve the efficiency of university-enterprise cooperative education. Considering the total number of students of certain majors is too small to arrange practice alone, these students could be organized together to carry out study plan of practice education in enterprises.

There are two ways of major joint in multi major joint cooperation mode. One is the joint of similar or related majors, and another is the joint of complementary majors. Which way to be selected depends on the specific conditions and requirements of the practice activities in which the students will take part. For the practice activities which could hold more students, the joint majors should be similar or related, to have the possibility to carry out enterprise learning together. Also, the timing should be the former stage of enterprise learning plan, so that the contents of practice education are basically the same. For those practice activities that need cooperation of students from different majors, the joint majors should be complementary, so that students from different majors can cooperate to carry out enterprise practice activities. And the timing usually is the latter stage of enterprise learning plan, so that students from different majors could use the basic engineering abilities they gained in former stage to better support the cooperation of different majors.

Considering the student number, this cooperative education mode is more suitable for graduate-level cultivation of engineering talents. For example, for doctorate level graduate students of related majors in engineering disciplines, as the number of student in each major is limited, therefore, students from several similar majors could be organized, to participate in some basic practice activities together in cooperative enterprises. If some large engineering projects need graduate students to participate in the research, development and design, then university could organize doctoral,

graduate and even undergraduate students from different engineering disciplines or several majors of the same discipline, to play their own part in the cooperation and accomplish the task.

8. COURSE REPLACEMENT COOPERATION MODE

As one way of training and cultivating of college students' career abilities, some vocational skills training institutions or certification accrediting centers usually set up specific practice courses to train and develop college students' special vocational skills. Therefore, except the seven university-enterprise cooperative education modes above, universities could consider a new cooperation mode that replacing some practice courses or teaching parts in undergraduate level by vocational skill courses of vocational training institutions out of school.

To adopt the course replacement cooperation mode or not depends on the quality and conditions that vocational skills training institutions or certification accrediting centers have. Universities should consider those who have training qualification, good faculty, professional training conditions, a good reputation, and have been approved or recommended by government departments, industry associations, or other international professional organizations. Cooperation should be conducted after careful choice and discussion. On one hand, the courses for replacement should meet the need of engineering talents' cultivation, and be able to replace some specific practice course in the professional training program; on the other hand, universities should design the course contents together with these institutions, and raise clear standards and requirements, and even process certification and cultivation of students' vocational skills together with them. Only in this way could universities approve the vocational certificates that students gain in these institutions, so as to replace the specific practice part that students should complete in university or in enterprise, achieving the replacement of courses and credits.

Course replacement cooperation mode is a new way to take the advantage of social resource to cooperative education. This mode is not able to solve the problems of universities' practice education in large scale, and usually only suitable for some practice part of undergraduate level engineering talents' cultivation. University should specially pay attention to avoid cooperating with those who only care making money, accredit certificates irregularly, and have low quality.

SUMMARY

Above modes are not exclusive but inclusive. Several modes could be used comprehensively, or a main mode with other modes as a supplementary, so that the task of practice education could be accomplished more efficiently.

REFERENCE

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