

Construction of School Enterprise Win-Win Mode — Off Campus Engineering Practice Base for Excellence Plan

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Abstract. Strengthening school enterprise cooperation and establishing a series of high-quality, stable and reliable off campus engineering practice bases are the solitary way and effective means to improve students' engineering practice ability. Based on the analysis of domestic current situation and existing problems of off campus engineering practice in colleges, the positive experience of relevant colleges and foreign higher engineering education should be drawn. Taking talent training as the core and enterprise demand as the guidance, this paper discussed the construction idea of school enterprise win-win off campus engineering practice teaching base.

Keywords: Practice teaching base; excellence program; school enterprise win-win

1 Introduction

In order to cultivate a group of high-quality engineering and technical talents of all types who are oriented to future industry, and have strong innovation ability, the Ministry of Education launched the "Excellent Engineer Education and Training Plan" (referred as "Excellent Plan") (Ke Jiangfeng, 2019), (Yan Weiyong, 2018), (Wang Jianhua, Dong Tingxu, Li Hui, Yang Peihua & Zhang Xinhe, 2021), (Xu Xiangzheng, 2021) in June 2010. The outstanding feature of the "Excellent Plan" is the implementation of the "3+1" talent training mode, emphasizing the cultivation of comprehensive quality, especially the engineering practice ability.

Western developed countries have always attached great importance to cultivation of college students' engineering practice ability (Zhong Dongjie, 2021), (Wang Jie, Liang Yuehua, 2020), (Sun Yinghao, 2021), emphasizing that students must start comprehensive engineering training earlier. The main method is to bring practical engineering problems into the classroom through practical curriculum or project development. The learning is jointly guided by enterprise engineers and college teachers: students complete a series of work such as problem analysis, design, processing and manufacturing. During this period, student carry out one-year practical operation skill training in the enterprise and carry out engineering necessary training for division post ability (Ge Jianjie, Wang Ge, 2020), (Liu Changming, Wang Zhigang & Yu Zhen, 2020), (Wang Zhaohui, Zeng Liangcai & Yu Zhen, 2021). So far, developed countries have successfully established the five-in-one system of the state, schools, enterprises, teachers and students, which played an important role in the teaching process of various countries (Fan Xiaoping, Li Yang & Hou Jingjun, 2020), (Liu Hai, Zheng Genwen & Yan Yongbin, 2020).

From the successful experience of developed countries, one can realize that strengthening school enterprise cooperation and establishing a series of high-quality off campus engineering practice base is an effective means to improve students' engineering practice ability (Gao Zhongke, 2019), (Wang Di, Gan Lu, 2019), (Xu Weijiong, Yang Qiuyue, 2019). As the second batch of pilot majors selected into the national "excellence plan" in 2012, Wuhan University of science and technology "Mechanical Engineering" (referred as "Mechanism") is in the talent training system and practical teaching mode. A series of innovative

reforms and explorations have been carried out in the construction of off campus engineering practice base.

2 Present Situation and Existing Problems of Off Campus Engineering Practice

2.1 Lack of Win-Win Mechanism between Schools and Enterprises

At present, colleges are mainly concerned about how to use the resources of cooperative enterprises to cultivate students' comprehensive quality and engineering practice ability, and emphasize the obligation of enterprises to support higher education (Luo Wei, 2020), (Xue Meng, 2019), (Wang Rui, 2020). People rarely consider the needs of enterprises in the training and selection of reserve talents, technical support and services. There is no reasonable mutual benefit and win-win mechanism in the process of cooperation between each other (Xu Yunxia, 2019). Therefore, it is difficult for enterprises to have enough interest to actively cooperate with colleges to build the engineering practice teaching base.

2.2 The Knowledge Structure of Students Does Not Meet the Expectations of Enterprises

Due to the tendency of emphasizing theory and neglecting practice in the traditional training mode, there is a big gap between the knowledge structure of students and the actual needs of enterprises. Enterprises need to spend a lot of energy and financial resources on retraining students. In addition, because of the short practice time and rigid practice content, enterprises believe that accepting students to practice in enterprises is not only unable to promote the improvement of economic benefits, but also an additional burden.

2.3 The Effect of the Existing Practice Mode Is Not Good

The traditional practice of off campus engineering is to arrange the whole specialty to a large state-owned enterprise for production practice for 2-3 weeks. Although this centralized practice mode has low cost and simple management, due to the large number of students and short time, students can only visit each workshop of the enterprise under the guidance of teachers, and cannot deeply participate in the enterprise design, manufacturing, management and other specific links, causing the effect of practice is limited.

3 Thoughts on the Construction of Off Campus Engineering Practice Teaching Base

During the construction of off campus engineering practice teaching base, one should learn from the successful experience of relevant colleges and foreign higher engineering education, taking talent training as the core and enterprise demand as the guidance, in order to realize the deep integration of schools and enterprises, as shown in Figure 1.

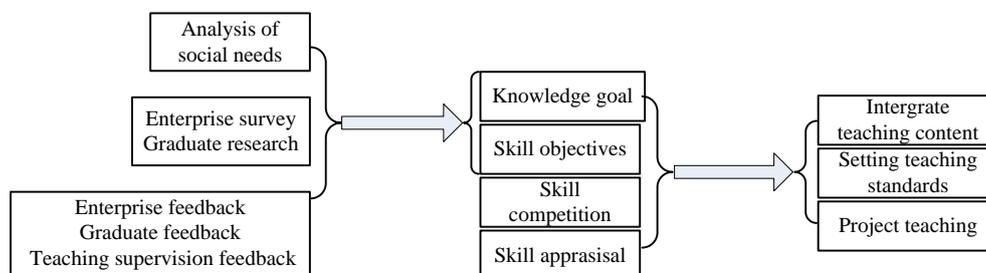


Figure 1. Thoughts on the execution.

3.1 Select Cooperative Enterprises in Combination with Industry Background

The construction of off campus engineering practice teaching base cannot be implemented without the support of enterprises. Therefore, enthusiasm and motivation is the prerequisite for selecting cooperative enterprises. Meanwhile, the core function of off campus engineering practice teaching base is to cultivate talents, therefore, a sound talent training system is also an important index for selecting cooperative enterprises. In addition, in order to improve the effect of practice teaching, one should comprehensively consider the technical strength, scale, advanced level of production technology and equipment, etc.

3.2 Optimize the Curriculum System of "Excellent Talents" in Combination with the Needs of Enterprises

Based on the training characteristics of mechanical talents and the specific needs of cooperative enterprises, through investigation and demonstration, enterprises requirements for talent knowledge structure are integrated into the "excellent talents" curriculum system. Students can integrate into the enterprise working environment as soon as possible in the engineering practice link, to improve the practical effect and create certain value for the enterprise.

3.3 Build a Win-Win Engineering Practice Teaching Base for Schools and Enterprises

Win-win cooperation and benefit sharing are the cornerstone of long-term cooperation and the source of cooperation driving force between each other. Improving the training quality of talents is the fundamental goal for colleges, and it is an eternal pursuit to obtain excellent talents and create more economic value for enterprises. Therefore, only by fully considering the win-win cooperation needs of each other, can we establish a high-quality off campus engineering practice teaching base.

3.4 Establish and Improve the Evaluation System of Engineering Practice Teaching

According to the training objectives and standard requirements of excellent talents, combined with the characteristics of different internship positions of cooperative enterprises, one should take the level of engineering practice ability as the assessment core to establish an "excellent talents" practical teaching assessment system, so as to ensure the effective implementation of the talent training mode of college enterprise combination.

4 Construction Practice of Off Campus Engineering Practice Teaching Base

The college officially launched the construction of the professional "Excellent Plan" in 2011 and selected one class as the pilot of the "excellence plan" (referred as the "Excellence Class"). So far, the college signed with Baowu group, Dongfeng Motor Corporation, MCC south company and other 30 enterprises the "agreement on off campus engineering practice teaching base of Wuhan University of science and technology".

From 2014 to 2020, the college sent 116 students to carry out two stages of enterprise engineering practice in three enterprises, which achieved complete success and won unanimous praise from students and enterprises. Through the development and exploration of a series of enterprise engineering practice activities, the college has a deeper understanding and understanding of the construction ideas and processes of off campus engineering practice teaching base.

4.1 Selection of Cooperative Enterprises

The college sent an expert group to each contracted enterprise to discuss with relevant personnel about the purpose and expectation of participating in the "excellence program", the detailed process, post and specific task of internship, how to guide and train students, as well as students' accommodation, food, internship salary, life accident insurance and other aspects. After about one year of repeated screening, in line with the guiding ideology of "prefer shortage to abuse and mature one to build one", Baowu group, Dongfeng Motor Corporation, MCC south company are the first batch of "excellent class". Through

communication and exchange, two sides have reached the following consensus on students' engineering practice in enterprises:

(1) Compared with directly recruiting fresh graduates through a resume and a short interview, absorbing some excellent students for one year's engineering practice in the enterprise can not only enable the enterprise to fully understand the quality and ability of students in all aspects, so as to find and cultivate the excellent reserve talents required by the enterprise, but also the students have fully adapted to the enterprise's culture, been familiar with the work flow of the enterprise and mastered various necessary skills, which can save the training process of new employees for about half a year, so as to save a lot of time and economic cost for the enterprise.

(2) The number of interns, internship positions and specific internship contents absorbed by the enterprise each year are dynamically adjusted according to the actual situation of the enterprise each year, so as to ensure that each person has a clear post responsibility and task.

(3) In order to better select the reserve talents needed by the enterprise, the enterprise changed the traditional mode of passive acceptance of students. In May and June of each year, the enterprise sends a special recruitment team to college to recruit the students of the "excellent class" separately. The enterprise announces the recruitment positions and number in advance and holds an on-site publicity meeting. The students submit their resumes according to their own interests, and the enterprise recruitment team determines the interns of each post through rough selection, on-site interview and other links. The remaining "excellent class" students who have not been recruited will automatically transfer to the parallel class and complete their senior studies in school.

(4) The internship arrangement of interns after entering the enterprise shall be independently formulated by the enterprise according to the work nature and work content of each post, and the school shall be responsible for review and supervision, so as to meet the actual needs of each post of the enterprise as far as possible on the premise of meeting the requirements of talent training.

(5) The working conditions and daily assessment of interns in the enterprise are consistent with those of regular employees. Students need to abide by various reward and punishment systems of the enterprise. The enterprise also needs to pay a certain internship salary, arrange accommodation and ensure the personal safety of students.

4.2 Reform of Curriculum System

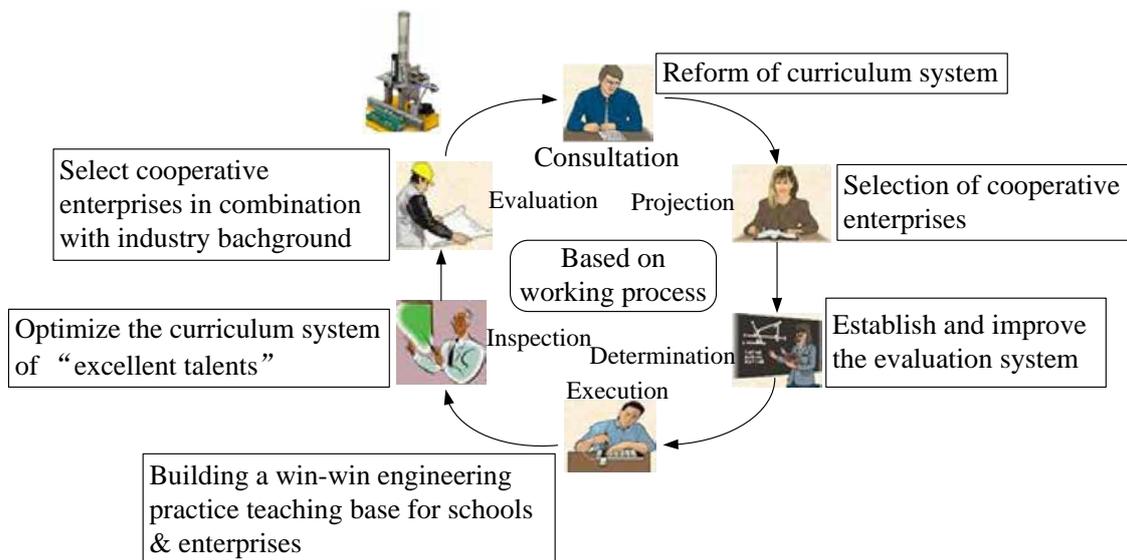


Figure 2. Process implementation.

Table 1. Personalized course module.

Category	Course nature	Course number	Course name	Credit	Class hour allocation				Seme	
					Total class hours	Teach.	Exper.	Comp.	Pract.	1st year
									1	2
Elective	Direction 1	02010149b	Advanced manuf. technology	1.5	24	20	4			
		02010318b	Special processing technology	1.5	24	20	4			
		02010358b	CAD/CAM	1.5	24	12	4	8		
		Subtotal		4.5	72	52	12	8		
Elective	Direction 2	02010359b	Robotics	1.5	24	20	4			
		02010360b	Artificial intelligence	1.5	24	20	4			
		02010070b	Image recognition technology	1.5	24	20	4			
		Subtotal		4.5	72	60	12			
Elective	Direction 3	02010388b	Metallurgical equipment	1.5	24	12	4	8		
		02010389b	Equipment maintenance	1.5	24	12	4	8		
		02010390b	Structural mechanics	1.5	24	12	4	8		
		Subtotal		4.5	72	36	12	24		

The curriculum system is the program of talent training. The college proposes to build an integrated curriculum system with the combination of theory and practice, in and out of school, based on the cultivation of engineering ability and quality. It includes five organically connected engineering education platforms, including comprehensive quality education, engineering design, engineering manufacturing, engineering management and engineering innovation, including basic, professional personality class and other course modules, as shown in Figure 2.

On the basis of fully investigating the requirements of cooperative enterprises on students' knowledge structure, considering the integrity and generality of knowledge system, combined with professional and industrial characteristics, the college summarizes and refines the individual needs of different enterprises, forming the individual course module as shown in Table 1. Students can choose a corresponding individual course module according to the enterprise to be interned, or take some courses in other modules according to their interests.

4.3 Practice Process Management and Assessment

The management of the practice process adopts the mode of enterprise oriented and school supplemented. After arriving at the enterprise, each student first carries out one week's factory education and corporate culture training, then carries out one to two weeks of production site practice, and enters the scheduled department. The department head arranges 4-6 weeks of training related to specific posts as appropriate, and assigns an engineer to guide the whole process.

The work and rest time and office conditions of students in the enterprise are the same as those of regular employees, and they also need to strictly abide by the rules and regulations of the enterprise. For each enterprise, the college appoints a tutor with rich engineering experience. The tutor usually keeps communication with students through QQ and WeChat. The tutor goes to the enterprise once a month to communicate with students and corresponding personnel of the enterprise, understand students' practice and ideological trends, and solve various problems in time.

When the first stage of practice is completed, each student will submit a summary report. The guidance engineer and department head will also score and give corresponding comments on each student's practice. The instructor will synthesize the two situations and finally give the practice results of the first stage.



Figure 3. Graduation defense.

Before the second stage of internship, the instructor and the enterprise engineer negotiate and jointly determine the graduation thesis topics of each student in combination with the specific work of each internship post. The second stage of internship is carried out simultaneously with the graduation project, using the dual tutor system mode. The enterprise engineers are mainly responsible for the specific guidance, and the college teachers instruct through the network. Every month, the instructor goes to the enterprise to have a discussion with students and engineers to understand the progress and difficulties of the graduation project and give face-to-face guidance. When the graduation project is completed, the college specially establishes a defense team composed of professors, enterprise engineers, enterprise department directors and instructors to conduct the graduation project defense in the student internship enterprise, Figure 3 shows the scene of graduation defense in Dongfeng Motor Corporation.

5 Evaluation and Improvement of Practical Effect of Off Campus Engineering

5.1 Practical Effect Evaluation

In view of the enterprise engineering practice, the college distributed questionnaires to the students, enterprise engineers and department managers participating in the internship. A total of 15 student questionnaires and 9 enterprise questionnaires were recovered. 6 students reflected very good and 9 students reflected good. 5 engineers reflected very good, 3 reflected good and 1 reflected general. In the graduation design link, 1 of the 15 students was school excellent, 4 were excellent, 9 were good and 1 was medium. Correspondingly, among the students who did not participate in the practice, the proportion of excellent results was 7%, and the proportion of good results was 20%. After the practice, 6 students signed employment agreements with the enterprises they practiced, and the starting salary of the other 9 students were also higher than the average level.

5.2 Existing Problems and Improvement Measures

The collected questionnaires and discussions with students and relevant personnel of enterprises also reflect that there are still some places worthy of further improvement and adjustment.

(1) The practice time needs to be optimized. The first stage of practice starts in mid-July, while the entry time of new employees in some enterprises is early July, which makes enterprises need to arrange two induction education and training. The improvement measures are to advance the final examination of the sixth semester to the end of 18 weeks (end of June), so that enterprises can arrange according to their own time. There is a 3-month interval between the two stages of internship. The enterprise reflects that the time interval is too long, which affects the normal development of work. In view of this problem, the college has conducted many discussions and believes that from the perspective of ensuring the integrity of students' knowledge system and the connection between the front and back courses, it is unable to complete all courses in the first 6 semesters. Therefore, the improvement measures are: adjusting the curriculum system and arranging the courses in the first 6 semesters as far as possible. The course schedule of the 7th semester is completed in the first 6 weeks. Some courses in the 7th semester are allowed to be completed in the internship enterprise. In this way, the enterprise will centrally arrange various education and training in July & August and form a continuous practice cycle from mid and late October to June of the second year.

(2) Students' communication ability needs to be improved. Enterprises reflect that although some students work hard, they are not good at communicating with colleagues. The improvement measures are to revise the teaching plan and exercise students' communication and teamwork ability by adding team projects, group discussions, on-site reports and other links in the course.

(3) The ability of students to start, analyze and solve problems needs to be strengthened. The improvement measures are to further improve the curriculum system, improve the proportion of practical ability and quality expansion links, and introduce discussion, case and project teaching methods in professional course teaching to cultivate students' autonomous learning ability.

6 Conclusion

Based on the establishment of school enterprise cooperation mechanism and combined with the needs of enterprises, building a school enterprise win-win engineering practice teaching base to meet the training needs of "excellent talents" is the key to the training of "excellent talents". According to the standard requirements of "Excellent Plan", college has explored the construction ideas of off campus engineering practice teaching base. At the same time, the optimization of cooperative enterprises, the course system reform and practice process management have been carried out, and the first batch of students have been sent to successfully complete the first enterprise engineering practice link. The overall evaluation of the practice effect is excellent, and the students' comprehensive quality and engineering practice ability have been greatly improved.

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References

1. J. F. Ke (2019), "A Research on the Quality of Regular Organization Activity in the Colleges Under the New Circumstances," *Journal of Nanping Teachers College*, Vol. 38, No.2, pp. 92-96.
2. W. Y. Yan (2018), "Improvement of Teaching Efficiency of Ideological and Political Theory Course in Private Colleges under the New Situation," *Journal of Anhui Agricultural University (Social Sciences)*, Vol. 27, No. 3, pp. 135-140.
3. J. H. Wang, T. X. Dong, H. Li, P. H. Yang, X. H. Zhang (2021), "Exploration and Practice of Practical Teaching Base for Training Applied Talents Jointly Built by Schools and Enterprises", *Journal of Mianyang Normal University*, Vol. 40, No. 8, pp. 116-120.
4. X. Z. Xu (2021), "Innovation, Reform and Practice of Talent Training of Excellence Program for Electrical Engineering and Automation Specialty", *Chinese Journal of Multimedia and Network Teaching*, Vol. 26, No. 7, pp. 109-111.
5. D. J. Zhong, Z. Dang (2021), "Structural Analysis of Quality Problems in Training Excellent Engineers and Exploration of Operation Mechanism", *Modern Manufacturing Technology and Equipment*, Vol. 57, No. 6, pp. 215-217.
6. J. Wang, Y. H. Liang (2020), "School Enterprise Cooperation to Build "Excellent Engineer" Education and Training System", *Sichuan Architecture*, Vol. 40, No. 6, pp. 276-279.
7. Y. H. Sun (2020), "Research on the Training Mode of Excellent Talents in Business Administration based on the Excellence Plan", *Business News*, Vol. 31, No. 1, pp. 185-186.
8. J. J. Ge, G. Wang (2020), "Research on the Training Mode of Excellent Engineers under the Background of Applied Education", *Journal of Taiyuan City Vocational and Technical College*, Vol. 46, No. 10, pp. 84-86.
9. C. M. Liu, Z. G. Wang, Z. Yu (2020), "The New Mode Based on Theory-Practice-Competition Three-in-One Pattern", *Journal of Advances in Education Research*, Vol. 5, No. 2, pp. 70-76.
10. Z. H. Wang, L. C. Zeng, Z. Yu (2021), "Research on Advantaged Discipline Group of Green Steel Intelligent Equipment and System", *Journal of Advances in Education Research*, Vol. 6, No. 1, pp. 9-15.
11. X. P. Fan, Y. Li, J. J. Hou (2020), "Problem Analysis and Countermeasures of School Enterprise Cooperation Based on the Cultivation of Excellent Engineers", *Modern Vocational Education*, Vol. 40, No. 1, pp. 164-165.
12. H. Liu, G. W. Zheng, Y. B. Yan (2020), "Discussion on the Collaborative Education and Training Mode of "Jingchu Excellent Talents" under the Background of Engineering Education Professional Certification", *Science, Technology and Economy Guide*, Vol. 28, No. 21, pp. 156.
13. Z. K. Gao (2019), "Analysis on the Training Mechanism of Integrating Excellent Agricultural and Forestry Talents into Regional Development in Local Colleges and Universities", *Industrial Scientific and Technological Innovation*, Vol. 1, No. 34, pp. 40-42.
14. D. Wang, L. Gan (2019), "Construction of Excellent Talent Training Mode Based on "Studio System"

- Environment Design of Industry Education Integration”, *Housing and Real Estate*, Vol. 33, No. 1, pp. 228.
15. W. J. Xu, Q. Y. Yang (2019), “Review and Prospect of Research on Education and Training Plan for Outstanding Engineers -- Visual Analysis Based on CiteSpace”, *Exploration of Higher Vocational Education*, Vol. 18, No. 6, pp. 59-67.
 16. W. Luo (2020), “Discussion on Practical Education of School Enterprise Cooperation under the Cultivation of Excellent Accounting Talents”, *Industry and Technology Forum*, Vol. 19, No. 6, pp. 191-192.
 17. M. Xue (2019), “Research on the Assessment Methods of Learning Achievements in Private Universities -- Based on the Education and Training Mode of 'Industry Education Integration and School Enterprise Cooperation'”, *Modern Communication*, Vol. 24, No. 3, pp. 150-151.
 18. R. Wang (2020), “Exploration of Higher Vocational Education Industry Education Integration and School Enterprise Collaborative Education Mode -- Taking BIM Application Technology Specialty as an Example”, *Journal of Liaoning Higher Vocational College*, Vol. 22, No. 7, pp. 28-32.
 19. Y. X. Xu (2019), “Analysis of School Enterprise Cooperation Mode under the Background of 'Double First Class' -- Taking the School of Design and Creativity of Tongji University as an Example”, *Educational Modernization*, Vol. 6, No. 84, pp. 36-37.