# Experience in Building Comprehensive School-Enterprise Cooperation Model for "Double First-Class" Universities

Xinyu Pang

***Abstract*—In order to give full play to the scientific leading role of "Double First-class" universities in the energy revolution, Taiyuan University of Technology has made a thorough exploration in school-enterprise cooperation in recent years. Under the background of "Double First-class" construction, universities and large coal machinery enterprises cooperate in depth combining with the characteristics of the industry. A variety of cooperation modes have been constructed, such as co-cultivation of talents, co-development of projects, co-construction of platforms and resource sharing. On the basis of these cooperation modes, school-enterprise cooperation has been further developed to achieve an effective integration with the "Double First-class" construction.**

***Index Terms*—"Double first-class" university, excellent engineer, Internet +, school-enterprise cooperation.**

## I. Introduction

Along with the trend of science and technology development, the open reform of higher education in China is becoming much further, so is the interaction between university development, industry enterprises and regional development [1]. Especially under the strategic deployment of the national overall promotion of the "Double First-class" construction, the strategic development of universities concentrates on strengthening the collaborative innovation of industry-university-research cooperation and improving the innovation ability [2]. Focusing on the construction of applied disciplines, it is the inevitable choice for local "Double First-class" universities to improve the ability to actively serve the local economic and social development [3].

From the perspective of discipline development, the only criterion for evaluating the development level of applied disciplines lies in whether they play a service, support and even leading role in regional economic and social development [4]. The important way to realize this function is to promote the deep integration of local universities with local governments and enterprises, that is, to solve the major problems in the process of regional development through school-enterprise cooperation, and to realize the effective integration of academic value and application value in the construction of first-class disciplines. Of course, school-enterprise cooperation also has new intrinsic requirements under the new situation of "Double First-class". These requirements are mainly reflected in two aspects: one is to truly serve the local economic development; the other is to systematically cooperate between schools and enterprises. School-enterprise cooperation itself is a systematic project. This project is based on the construction of university-enterprise collaborative innovation platform and the transformation of scientific research achievements. It not only considers the establishment of professional talent training system for docking industry chain, but also considers the institutional mechanism for supporting industry enterprises to participate in cooperation.

In recent years, Taiyuan University of Technology has paid great attention to the industry-university-research cooperation. The school vigorously promotes the development of industry-university-research to serve the local economy. Since 2017, cooperation agreements have been signed with more than 50 enterprises. The school has built a good integrated cooperation system in school-enterprise cooperation, including excellent engineers, Double tutors, scientific research team, and practice training base, etc. Taking "Double First-class" universities and large-scale energy enterprises as the research objects, this paper proposes a new mode of all-round synergistic integration of industry-university-research by highlighting characteristics and integrating resources. This paper explores the intrinsic motive force of current industrial technological innovation, and strives to achieve the win-win goal of joint development of first-class disciplines and industry enterprises.

## II. Cooprativing Training of Talents

### A. Excellent Engineering

With the deepening of higher education reform, especially the full implementation of the education and training plan for excellent engineers, the role of school-enterprise cooperation in the personnel training system has become increasingly prominent [5]. The "Education and Training Plan for Excellent Engineers" aims to train a large number of high-quality engineers with strong innovative ability. They have solid professional theory knowledge, engineering technology knowledge and a certain degree of humanistic literacy, through the practice of system engineering training to meet the needs of economic and social development. In accordance with the training objectives and requirements of the Plan, the "Excellent Engineer" of mechanical design, manufacturing and automation specialty adopts the "3+1" training mode, that is, students study in school for 3 years and practice and graduate design in enterprises for 1 year. The excellent engineer education training plan brings us new

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challenges. To implement training plan, we must establish a long-term cooperative relationship with enterprises. Enterprises participate in the training of students. The school trains excellent mechanical engineers for enterprises.

Excellent engineers are trained for practice in the last year of undergraduate. Enterprise is the main base for training excellent students. Enterprises provide first-class practice site, and undertake the practical tasks of cognition practice, production practice, graduation practice and graduation design for excellent class students. Students are guided by school and enterprise tutors to complete practical tasks. Students can go into the workshop at any time and communicate with the technical personnel of the enterprise. The graduation defense section consists of enterprises and schools to form a defense group to evaluate design works of the students.

Excellent engineers trained by the school-enterprise cooperation have excellent academic performance. The average grade of the class is much higher than that of other classes in the same grade. Postgraduate enrollment rate is more than 85%. Students' practical ability and professional practice ability are also significantly better than those of other students. Especially in some national competitions, it has made remarkable achievements.

### B. Graduate Students and Young Teachers

In terms of training objects, the joint training of schools and enterprises is not only for undergraduates, but also for graduates, postdoctoral students and young teachers. The "Double First-class" discipline puts forward higher requirements for the training of postgraduates. Postgraduates should have good professional competence, the ability of team work, the ability of analyzing and solving problem. Professional master should pay more attention to the transformation of academic achievements and the cultivation of practical ability of subject knowledge. In the process of joint training postgraduates, universities and enterprises jointly build postgraduate innovation centers to train students through the "Double-tutor system". At the same time, the "Double First-class" university also provides a platform for enterprise engineers to study for master's degree and help them improve their theoretical knowledge level. Professional postgraduates must complete the training of science and technology in enterprises. Some postgraduate projects are also completed in enterprises. Through these joint training, students' engineering practice ability is greatly enhanced. Many students are directly absorbed by enterprises into the R&D Departments of Science and Technology after graduation.

In order to improve the professional practice level and scientific research ability of young teachers, the university actively explore how to better play the advantages of school-enterprise cooperation. Both university and enterprises have jointly expanded their functions in the training of talents and built a more conducive practice platform for young teachers. Enterprises provide various channels for young teachers to practice and accept them to do skills training in enterprises. For example, many young teachers began to enter the enterprise postdoctoral research workstation. Similarly , the university also organizes their teachers to visit enterprises in a planned way to improve their practical teaching ability and professional level.

### C. Enterprise Tutors

In the construction of “Double First-class”, the guidance of practice ability of students is mostly based on Double-tutor system. Students have both school tutors and enterprise tutors. Therefore, the quality requirement of the tutor team is getting higher and higher. In order to improve the teaching ability of enterprise tutors and enhance their theoretical knowledge and the ability to guide students, the school provides various forms of training for enterprise technicians. At the same time, opportunities are increasing for learning and communicating between schools and enterprises. University invites technical talents from enterprises to participate in school teaching activities, and carry out professional construction and curriculum design according to their reasonable suggestions. Each department establishes a teaching team with the professionals and enterprise personnel. Their tasks include formulating curriculum standards, implementing curriculum development and design, undertaking relevant teaching tasks, and supervising the implementation of major teaching.

## III. Project Cooperation

It is of great significance to carry out school-enterprise cooperation around the goal of scientific and technological innovation and achievement transformation. Promoting the effectiveness of school-enterprise cooperation will help accelerate the construction of "Double First-class" research universities. The overall goal of the national "Double First-class" strategy is to "improve the teaching level and innovative ability of universities, so that a number of universities and disciplines can reach or approach the world first-class level". For research universities, the key to the construction of "Double First-class" is to build first-class quality and reach the first-class level. In order to focus on the first-class cooperation between universities and enterprises in research universities, it is necessary to distinguish them from applied universities and vocational skill universities in terms of main cooperation contents and cooperation levels [6]. Besides general technology development, training of general technical personnel and innovation consultation of conventional management, more attention should be paid to the basic core technology of the industry. School-enterprise cooperation has played a promoting role in completing various scientific research projects and solving practical problems, but in the construction of "Double First-class", more think tanks should be provided for enterprises to solve more core technical problems. For example, the technological innovation of enterprises in the field of coal machinery can not be separated from the intellectual support of universities. Teachers and experts from enterprises form scientific research teams to select relevant topics according to the production needs of enterprises. They jointly tackle key problems and carry out research and development and transformation of applied technology.

Taiyuan University of Technology and enterprises have carried out cooperative research activities on some major projects, such as the key projects of the National Science and

Technology Support Plan, the provincial industry chain project, the National Natural Science Foundation project, the provincial science and technology major special projects, and won the Provincial Natural Science Prize and the provincial science and technology progress prize.

## IV. Construction of Practice Base and Platform

In the process of mutual cooperation, schools and enterprises should fully integrate school resources and enterprise resources, and build practice bases and platforms. On the one hand, enterprises and schools jointly build key laboratories so as to students and enterprise technicians can choose different laboratories to carry out experiments according to their needs. On the other hand, network and computer technology are used to build various platforms to realize the simulation of production process and equipment operation. Some courses offered by universities are taught within enterprises. Through the deeply cooperation between schools and enterprises, the interoperability of teaching and production is realized.

### A. Distance Education Platform Based on Internet +

In the traditional experiment teaching process, the time and space of the experiment are relatively limited, so the demonstration method can only be used in the experiment teaching for large-scale equipment. Students can not form a full understanding of the operation structure and principle of the equipment. For example, in order to realize the real-time monitoring and diagnosis of the operation of the main parameters of the lifting equipment, students must stay at the experimental site for a long time, and can not monitor the operation of the equipment remotely anytime and anywhere. Through on-site experimental teaching mode, students can have a preliminary understanding of the working principle and operation structure of lifting equipment, and understand the changes and trend curves of the main parameters of each system of lifting equipment. In view of the shortcomings of traditional experimental teaching platform, a network experimental teaching platform for condition monitoring and fault diagnosis of large-scale equipment is constructed on the basis of on-site experimental teaching equipment and Internet technology through the joint efforts of universities and enterprises, so as to realize remote monitoring and diagnosis of large-scale equipment operating conditions.

Fig. 1 is a network experimental teaching platform for improving equipment condition monitoring and fault diagnosis. On the one hand, the industrial computer on the spot develops the teaching platform of field test through configuration software, which provides the traditional experimental teaching platform for teachers and students. On the other hand, the signals collected by sensors and PLC are transmitted to the local area network server through the local area network, and then the data are transmitted to the server of the remote diagnosis center in real time by remote data transmission technology [7]. The remote diagnosis center is based on Web. Technologically, a network experimental teaching platform for monitoring and diagnosis of lifting equipment has been developed. According to the different learning terminals, network experimental teaching platform is divided into Internet experimental teaching platform and mobile Internet experimental teaching platform. Students, teachers and enterprise personnel can choose the appropriate network platform through their own learning terminals, which can remote real-time monitor the condition detection and fault diagnosis of lifting equipment.

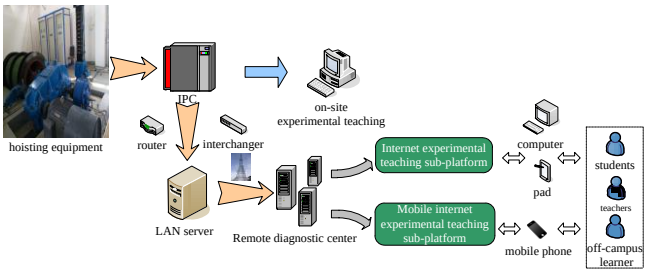


Fig. 1. Network experimental teaching platform.

### B. Virtual Simulation Platform

Under the background of "Industry 4.0", "Made in China 2025" and "Internet +", automation, informatization and intellectualization have begun to merge deeply with the production process. This makes it possible to automate, intellectualize and unmanned the production and processing of some heavy industries and large equipment. Virtual reality technology is widely used in industrial field because of its intuitive, immersive and interactive characteristics. Under the virtual reality engine Unity3D, Taiyuan University of Technology has studied the key technology of virtual collaboration in fully mechanized coal mining face, and established the panoramic fully mechanized coal mining virtual reality scene [8], as shown in Fig. 2. The motion simulation model of mechanical equipment is established to show the movement of each part in the process of coal mining. It is of great significance to further realize the safe production of fully mechanized mining face and the production of few people or unmanned ones. The virtual reality system can vividly and truly reproduce the dynamic matching relationship, attitude and performance of the three machines in the fully mechanized mining face, and can plan the haulage speed of the shearer and the distance between the hydraulic support and the machine according to different working conditions. The digital design level of virtual reality of fully mechanized mining has been improved, which can provide sufficient technical support for planning, analysis and decision-making of fully mechanized mining face.

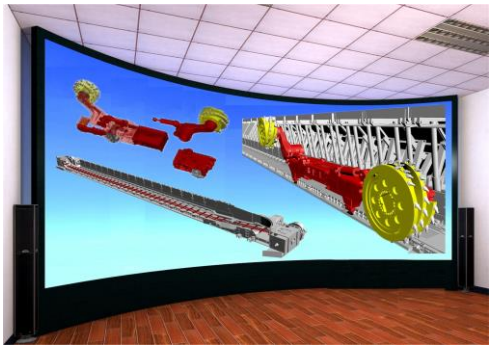

Fig. 2. Virtual simulation teaching platform.

In the early stage of the project, the whole project can be analyzed and judged to improve the level of digital design of

fully mechanized mining equipment and effectively expand the teaching and training functions of virtual reality technology in the industrial field. Realize the visual planning of three-machine operation condition in fully mechanized mining face. Under different working conditions, the shearer traction speed, the dynamic matching relationship of the three machines, attitude and performance are accurately simulated. It can realize the virtualization and digitalization of the whole fully mechanized mining process, and grasp the whole fully mechanized mining process from the overall point of view.

Considering the coupling of the parameters of other related equipment, environmental state and equipment's state, the proper algorithm is adopted to realize the accurate planning of the three machines in fully mechanized mining face, which provides a reliable basis for the operation decision of fully mechanized mining.

### C. Digital Design Platform

At present, the design method of large-scale equipment is gradually transforming from the traditional design method based on the experience of designers and existing production data, with the help of category and trial-and-error method, to the practice of relying on advanced technical means such as computers. Especially, it has important practical significance for parametric design of parts and components of fully mechanized mining equipment in coal mine. Using ANSYS, ASP. NET, WebGL and other technologies to develop parametric design system for large-scale equipment parts can provide a platform for technical exchange for designers, reduce the investment of enterprise funds and R&D personnel, and speed up product design and development. Fig. 3 is a digitized design system developed by universities for coal machinery enterprises.

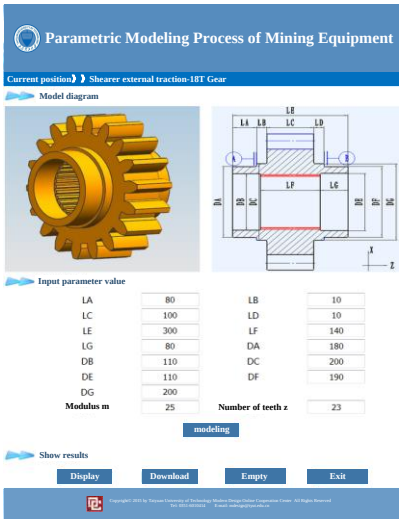


Fig. 3. Digital design system.

In the process of deep cooperation between universities and enterprises, relying on their own academic advantages, the university has developed several parametric design systems for enterprises. After enterprise designers input the parameters of spare parts in the web page, the system can combine the each dimension parameters with the APDL parametric command flow of spare parts, form the final parametric command flow document. Technicians realize parametric design of equipment parts by remotely calling the modeling module of ANSYS software [9]. The system can easily change the size of parts and quickly parameterize the design of parts. This not only improves the efficiency of product design, but also reduces the professional requirements of users, which is very convenient for enterprise personnel to use. In the parametric design system, university researchers also integrate reasoning model into the design of the system. They integrate the design experience and knowledge rules of enterprise designers for decades into the conceptual design of products, and further standardize the design of products. The new knowledge processed by the fusion reasoning model has high credibility. It not only reduces the dependence on domain experts, but also shortens the time of product conceptual design, and realizes the inheritance and sharing of knowledge.

## V. Ideological and Political Construction

In the deep cooperation with enterprises, in addition to focusing on personnel training and scientific and technological development, university also combines their own educational characteristics to strengthen cooperation with enterprises in Ideological and political aspects. Teachers and students are regularly organized to visit enterprises and learn from the advanced figures and deeds of enterprises to stimulate their entrepreneurship and struggle spirit. For example, the teachers visited the "Liu Hulan Group" exhibition room of the Enterprise and listened to the group leader talk about their advanced deeds. The sisters of Liu Hulan's group set Liu Hulan's heroic example, devoted to work and selfless dedication, and made extraordinary achievements in the extremely ordinary position of lathe workers, which played a great role in stimulating teachers and students in universities. Through this form of activity and practical learning, not only understand the production process of enterprises, but also promote teachers and students to better play a leading role.

## VI. Conclusion

Under the environment of “Double First-class” construction, universities and enterprises have broken through the original cooperation framework. School-enterprise cooperation has developed an comprehensive mode and deepened the cooperation in depth. Through mutually beneficial cooperation, schools, enterprises and students have benefited a lot. The pace of industry-university-research cooperation should be speeded up so that school-enterprise cooperation can truly take root and bear fruit. In the process of promoting the construction of "Double First-class", higher education should pay attention to the connotative development, so that the construction of "Double First-class" plays an important role in promoting economic-social development and enhancing comprehensive national strength.

## Conflict of Interest

The author declares no conflict of interest.

## AUTHOR CONTRIBUTIONS

X. Y. Pang conducted the research, wrote the paper, and had approved the final version.

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