

# Exploration and Practice of Industry-University-Research Cooperation in Production Practice

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**Abstract**—The production practice is a very important program of mechanical engineering, but it is not easy to implement and even become a mere formality, the phenomenon is more common. By taking advantage of talents in colleges and universities and cooperating with enterprises to establish an industry-university-research practice base, many problems in practice can be solved and good results can be achieved. The industry-university-research base can enhance the strength of leading teachers and provide an open internship environment for students. The base is fully open to students in terms of technical data, production practice and technical guidance. The base's graduate students teach by example, not only enrich the internship guidance force, but also inherit the fine tradition of solid internship. The cooperation with the base ensures the internship effect and provides a good opportunity for enterprises to select talents.

**Keywords**—*mechanical engineering; Production practice; industry-university-research cooperation; Internship base; Learning transfer*

## I. INTRODUCTION

Production practice is very important for mechanical engineering students. In the planned economy era dominated by state-owned enterprises, it was basically an obligation of enterprises to accept production practice, and it was relatively easy for schools and enterprises to connect. In the 1990s, in order to improve production efficiency and ensure production safety, enterprises with increasingly obvious characteristics of market economy gradually adopted some restrictions on production practice, which led to difficulties in deepening production practice, maintaining school-enterprise relationship and mobilizing students' enthusiasm [1]. As a result, some internships become the formalism, a cursory internship is more common, and some schools cannot even find internship factories. Some enterprises with insufficient production capacity even develop a new way to make profit by accepting the internship student. Being charged fees, students can visit the factory areas that have not been started or start symbolically, which cannot play the role of internship. After 2000, the university enrollment expansion policy made the problem worse. Some colleges and universities encourage students to independently contact the practice units as a supplement to the unified practice in schools [2, 3]. Some

universities also arrange students with good grades to enter scientific research institutes for internship [4]. Some colleges and universities have set up in-house practice bases and even considered setting up virtual simulation practice bases. Some colleges and universities have found new ways to develop deep cooperation with enterprises to draw on each other's strengths and establish long-term cooperation bases with enterprises. The Sunward Intelligent Equipment Co., Ltd. created by Qinghua He, a professor of electrical and mechanical engineering of Central south university, is a global engineering machinery enterprise 50 [5], as well as the top 20 excavator enterprises in the world [6]. The central south university has the talent advantage, while the company has the industrial advantage. Professor Qinghua He is not only an entrepreneur, however, is also a professor of central south university. With profound education complex, it is natural to build the production, learning and research base. Over the years, the practice base has trained a large number of talents for our college, and some students have become the backbone of the company technology after graduation.

## II. THE TRAINING EFFECT OF THE INDUSTRY- UNIVERSITY-RESEARCH BASE ON THE TEACHING STAFF

### A. The Characteristics of the Industry-University-Research Practice Base

Both the school and the company leaders attach great importance to the construction of the production, learning and research base. As the base, Sunward Intelligent Equipment Co.,Ltd. adheres to the integration of production, learning and research, and has now developed into a group company with Equipment manufacturing as its main business and radiating from home and abroad. Group total assets of 14 billion yuan, more than 5,000 employees. Focusing on equipment manufacturing and developing engineering equipment, special equipment and aviation equipment simultaneously, the company has been ranked the 34th among the top 50 construction machinery enterprises in the world, the top 20 excavator enterprises in the world and the top 3 regional aircraft leasing enterprises in the world. The company has been awarded the titles of "National Certified Enterprise Technology Center", "National Postdoctoral Research Station", "National innovative Enterprise", "National Technological Innovation

Demonstration Enterprise”, “International Scientific and Technological Cooperation Base”, “National 863 Achievement Industrialization Base” and so on. Party and state leaders have personally inspected the company, guidance. The base company is a company born in Central South University. The leading backbone teachers were also the core technical force during the incubation period of the company, participating in the product development and production process of the company. They are very familiar with the design and manufacturing process of the main products of the company, such as hydraulic static piling machine, rotary digging drill, subsurface drilling machine and excavator. The internship is mainly about engineering equipment, and also about special equipment and aviation equipment.

#### *B. Rooted in the Base of Industry-University-Research, Train the Teachers*

The practice in the production, study and research base is mainly guided by the teachers of our college, during which the technical personnel of the company are invited to carry out several special lectures. To ensure safety, each practice group is also equipped with postgraduate assistant guidance. Each year, the graduate students have had one-year internship in the Sunward Company and participated in some research projects of the company, so they are familiar with the design, processing and assembly of these products. Teachers of our school can visit and study in the company conveniently and apply for participating in product r&d. Leading the backbone teachers used to be the backbone of the company’s main product r&d. In order to expand the team of leading teachers, new teachers will participate in the practice team every year. Under the leadership of the backbone leading teachers, these teachers will get familiar with the characteristics of the company’s main products and their production and processing processes one week in advance. Therefore, the number of interns in the base also increases year by year. From the initial two classes of engineering equipment major, six classes of other major directions including mechanical design, mechanical electronics and so on have been added.

### III. BASED ON THE CHARACTERISTICS AND LEARNING RULES OF THE PRODUCTION, STUDY AND RESEARCH BASE, MAKE A REASONABLE INTERNSHIP PLAN

#### *A. Use Practice to Promote the Positive Transfer of Knowledge, Lay a Solid Foundation and Cultivate Innovation Ability*

Production internship is held at the beginning of the first semester of senior year. Students already have basic professional knowledge, and internship can promote the positive transfer process of knowledge. Due to the recessive and inert characteristics of students’ previous knowledge, positive transfer cannot be carried out spontaneously [7-9], which is why students without guidance will feel bored and idle in the workshop, while students with proper guidance will be full of interest and gain a lot. Through knowledge transfer, students can consolidate and achieve mastery through a comprehensive study has studied the theory of mechanics, material mechanics, mechanical drawing, mechanical

principles, mechanical design, metal material and heat treatment, tolerance matching and measuring technology, metal cutting machine tool, fixture design, principles of metal cutting and cutting tools, machinery manufacturing technology, and curriculum knowledge. The practice process can help the students to master machining technology, assembly technology and mechanical design method, understand the structural characteristics and design method of construction machinery, understand the production organization, production management and equipment application methods in the process of product manufacturing. It also can help them to establish the basic concept of professional technology application, lay the foundation for the follow-up professional course learning and practical teaching, cultivate the interest of further learning professional knowledge, and cultivate the thinking mode of connecting theory with practice. And enable the students understand the current situation of domestic industrial production, improve the basic skills of observing, analyzing, proposing and solving problems, and lay a foundation for innovative design.

#### *B. Make a Reasonable Internship Plan*

In order to achieve the goal of promoting the positive transfer of knowledge, laying a solid foundation and cultivating innovation ability, we have made thorough arrangements for the internship process. According to the knowledge students have mastered and the needs of subsequent courses (including graduation design), we have formulated the internship outline, compiled the internship instruction book and completed the internship plan. The internship outline clearly puts forward the purpose and requirements of the internship as well as the work to be completed, and guides students how to observe and analyze. In order to carry out the practice purpose, the adviser have prepared a lecture based on the outline of the internship and they will call a practice mobilization meeting to announce the practice discipline and practice requirements. The lecture also help the students to learn the working principle and the structure of the practice product, such as hydraulic excavator, the rotating drill, DTH drill, hydraulic static piling machine. In order to ensure the learning effect, the students were asked to answer questions about the product. During the internship, we emphasized that students should collect first-hand data on site and draw the structures they saw with freehand drawing to illustrate the principles. This not only cultivates the students’ habit of careful observation and attention to details, but also trains the students’ basic skills as an engineer and technician. Because the syllabus gives very specific job objectives, students are very fulfilled throughout the internship.

### IV. THE TECHNOLOGICAL OPENING ADVANTAGES OF THE INDUSTRY-UNIVERSITY-RESEARCH BASE

#### *A. Integrate into the Actual Production Process, Make Good Internship Records and Internship Summary*

In order to guarantee the practice effect, the adviser divide each class into two practice group. Each group will take turn in different workshops, such as in machining and cylinder assembly workshop, the riveting and welding workshop, excavator assembly workshop, down-hole drill, rotary digging

drill assembly shop, electric controller and hydraulic static piling machine production workshop respectively. Each group will stay in every workshop for a week. They can have a look at the machine process, measure the size of the workpiece, sketch the parts and record the craft process. In this way, the students can have a good understanding on three aspects, the machine, the electricity, and the liquid. Internship instructors are very familiar with the design, machining and assembling of these products. The assistant graduate students have also been at the base for one year, and participated in some research projects of the company. So the instructors can introduce the equipment structure, working principle, process technic, and assembly process, etc. of every workshop to the students. In addition, there are technicians or skilled workers to cooperate with the students to answer the questions in the internship. Do in the whole practice process, there are teachers, technical personnel, technical workers explain the whole process, guidance, answer questions.

The internship at the base also made us deeply realize the advantages of the integration of production, education and research. Since Sunward Intelligent Equipment Co., Ltd. is the production, learning and research base of our college, and also the excellent practice base of our school, the company leaders attach great importance to it and make careful arrangements. During the internship, the company is open to students without reservation. Students can read the company's technical documents and measure the size of the structure at will. Teachers can take students to the technical center to consult the drawing materials and explain the design method and drawing method to students in detail. Technical backbones and experts were specially arranged to give lectures on machinery, electricity and hydraulics, and to discuss with students the problems arising from the development to the market. The internship instructor is also the product r&d personnel of the company. The graduate students who assisted the internship also participated in the product r&d work of the company, so they are very familiar with the company's products and production and have rich practical experience. The advantage that the integration of production, study and research brings to us is quite outstanding, make the students benefit a lot, and guaranteed the quality of practice practically.

During the internship, the students will finish the homework every day. The home work related to the content of what they practice in the day. The need to remember what they see or what they learn in the workshop. Vast majority of students can observe carefully and record carefully. After work, they can sort out the recorded content and consult relevant materials to deepen their understanding and complete the internship diary. Teachers read the diary every day and point out problems.

Through internship, students understand the structure of a typical engineering machinery products, working principle, parts processing, parts and assembly process of the machine, the production of the enterprise organization process, etc. they can also learn many practical applications in the process of mechanical product manufacturing knowledge. The instructors also teach the students some design skills accumulated over the years by the instructors. For example, how to select the sealing ring for a hydraulic cylinder, how to choose the fit tolerance,

buffer, and so on. Some of these is not written in the books and cannot learn or experience from the school. Through the internship, students have a perceptual understanding of the production and design of mechanical products, which lays a solid foundation for the next stage of learning and future design work.

### *B. Carry out Special Lectures and Master the Latest Trends*

In order to strengthen the connection between theory and practice and grasp the latest development trend of the industry, we usually organize three special lectures in three different major, structural design of construction machinery, mechanical electrical and control system and hydraulic system design technology. Because these discipline is the key problem of the construction machinery products, and they were also the key professional knowledge of the mechanical and electrical engineering. The purpose of the lecture is to let the students understand the advanced technology and design method in mechanical, electrical and hydraulic aspects, understand the frontier dynamics of engineering practice, and advanced production management mode, and pass on the valuable experience accumulated in the design and production process of the company to the students.

One of the characteristics of construction machinery is the extensive use of structural parts. So the structure design seminar focuses on the layout of the weld, the setting of stiffened plate, and the interpretation of welding process, help students to understand the structure of the process, the weld types, and how to reduce the stress concentration from the perspective of design and processing technology, so as to guarantee the quality of welding parts. Actually, the metal structure design is very important, because if the structure of the machine is failure and fracture, it will cause an accident, sometimes will cost huge economic loss and the death of people.

Most modern construction machinery is integrated with advanced electrical control system or monitoring system to improve performance, collect data of working conditions, and realize remote monitoring and remote fault diagnosis and troubleshooting. Through the special lecture of mechanical, electrical and control system, help students to better master the basic methods of electrical circuit design, understand the design ideas of controllers, and the functions and applications of advanced controllers. The student's interest in electrical control was stimulated and some of them devote themselves to the electrical control.

Another characteristic of modern construction machinery is that its transmission mode adopts hydraulic transmission system, which is composed of "machine, electricity and hydraulic integration" system with machinery and electricity. Taking typical excavator hydraulic system as an example, the seminar analyzed and introduced the cutting-edge knowledge of hydraulic system design to help students understand the performance of advanced hydraulic components and key issues of hydraulic circuit design.

The special lecture helps students better understand the practical problems observed on site. The students have no practice experience so they do not understand why the craft

process is carried or how to solve a problem in the machine process. After the lecture, students return to the site to combine production practice and theory to improve the practice effect. Most of the knowledge the student learned from the book and the class is the classical theory and knowledge, while the information of the lecture includes the frontier knowledge, some of is the key technology of the company.

#### V. SUMMARY

Since the establishment of the industry-university-research base, we have a good practice environment for the students to improve their skills and theory. It becomes the stable internship base for our college. It provides a unique opportunity to improve the practical ability of the intern teachers, provides good practice conditions for students, and provides a good channel for enterprises to select talents. The improvement of teachers' practical ability promotes a good internship atmosphere, improves the value of students' internship, and cultivates talents with solid foundation and strong innovation ability for enterprises and the society. All aspects enter a virtuous cycle and promote each other, which just as it said "the river is always keeping clean, since there is inflowing water from its source."

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