Exploration and Practice of the Talent Training Model of Mechanical and Electrical Majors Based on the Integration Project Empowered by Artificial Intelligence

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Keywords: Artificial Intelligence (AI) Empowerment, New Computer Technology, Integration Project, Mechanical and Electrical Major, Curriculum System, The Vocational Ability of The Post.

Abstract: Nowadays, the correspondence between the professional curriculum system and the talent training objectives is not close enough, talent training lacks effective project support. Therefore, with the help of new modern computer technology such as artificial intelligence, intelligent and personalized management software system is designed for training mechanical and electrical professionals. Through developing professional integration projects covering professional knowledge and vocational ability of the post and adapting to teaching and practice, training program formulation, teaching process implementation, and teaching result assessment are organically integrated into the professional curriculum system, which not only effectively supports the realization of the talent training objective, but also makes the learning goals of students clearer, the teaching contents of teachers to be more carrier-based, and the curriculum to be coherent and systemic. Moreover, the curriculum system turns into an organic whole, and curriculum management and assessment get more intelligent, efficient, and accurate. The introduction of professional integration projects empowered by artificial intelligence can overcome the shortcomings of the discipline system in the traditional professional teaching model. If the advantages of modern computer information technology can be fully used to exert the systematic and complete advantages of the discipline system and emerge with the practice and teaching of the integration project, professional talents training objective will be effectively supported to realize the "top-down" design and implementation of professional talent training and improve the quality of talent training due to the supplementation between theory and practice.

1 INTRODUCTION

Talent training according to professional classification is an ordinary way of modern higher education, and professional education is to shape and develop the vocational ability of the post and comprehensive quality of people in a certain field. The school sets up majors according to the needs of social and industrial development, formulates professional talent training objectives, develops a professional curriculum system, and decomposes the knowledge and skills required by vocational posts into different courses. Through implementing the curriculum system, students will finally have the vocational ability to meet the needs of vocational posts and the needs of enterprises for talents. Therefore, when training talents, the market demand must be focused to establish clear goals. The construction of a professional curriculum system, teachers' teaching, students' learning knowledge, and training skills should be carried out around the training objectives.

From the current situation, the specialty has described the objective of talent training when developing talent training programs and has established a talent training curriculum system with a logical relationship. However, the logical progression

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of these courses is limited to the accumulation and transmission of knowledge, as well as a certain increase in vocational ability. It can not systematically shape students' vocational ability, because there is no effective and consistent teaching project support in the specific implementation process of the curriculum system, and there is no organic connection between courses. Most of the different courses are the personal behavior of teachers, and there is no project to take charge of the talent training in the whole process. In addition, there is also a lack of specific standards for talent training, and the assessment of professional courses and vocational abilities is devoid of standards and basis. As a result, an objective and fair assessment of the quality of professional talent training cannot be made. In addition, problems occurring in talent training cannot be fed back to the talent training program, which is also the reason why the State Council issued the *National Vocational Education Reform Implementation Plan* in 2019 to implement the pilot 1+X certificate system.

With the development of society and industry towards lean optimization, the professional counterpart rate and employment quality of students' employment have become more important indicators to measure the quality of professional talent training compared with the employment rate of professional students that were paid more attention to before. The training quality of professional talents and the professional counterpart rate after employment are positively correlated. In other words, only premium talent training quality can ensure a high employment counterpart rate. On the contrary, poor talent training quality inevitably leads to a low professional counterpart rate. In addition, the current talent training system is short of a customized, intelligent, efficient, and accurate information management system in the whole process in terms of talent training plan formulation, teaching process implementation, and teaching result assessment, which makes each teaching link seriously disconnected and profoundly restricts the upgrading of the talent training system and the quality of talent training.

2 TRADITIONAL TEACHING MODEL AND EFFECT

Taking the compulsory course "Fundamentals of Mechanical Design" for mechanical and electrical majors as an example, the teaching model and effect of the traditional knowledge architecture course are illustrated in this paper. This course is an important professional course for mechanical and electrical majors, mainly teaching various basic concepts, knowledge, commonly used components, mechanical structures, and design methods used in mechanical design. The traditional course materials and teaching models are conceived and arranged according to the knowledge system structure (as shown in the block diagram in Figure 1). How can students acquire the practical ability of "mechanical design"? According to the knowledge points taught in the course *Fundamentals of Mechanical Design*, it is difficult for students to obtain design ability, because knowledge is scattered in the teaching process, and mechanical design is an application of comprehensive ability. Therefore, the general practice is to design the curriculum twice or so in the professional curriculum system, and the practice project adopted is the well-known reducer design (from the design of primary to secondary gear reducers, etc.). The reducer is a typical project case suitable for mechanical design, which can cover loads of mechanical design knowledge. However, this project has been a routine design process without too much change, from which students can gain little training in creative thinking and ability. Moreover, a big problem of this project is that it can only stay on the drawings. Due to the complexity of the component structure and the particularity of the processing technology (casting, gear processing) and other problems, it is difficult to turn the design results into real works and present them in front of students. At the same time, for electromechanical majors, the project also lacks the application of knowledge and skills related to electrical control.

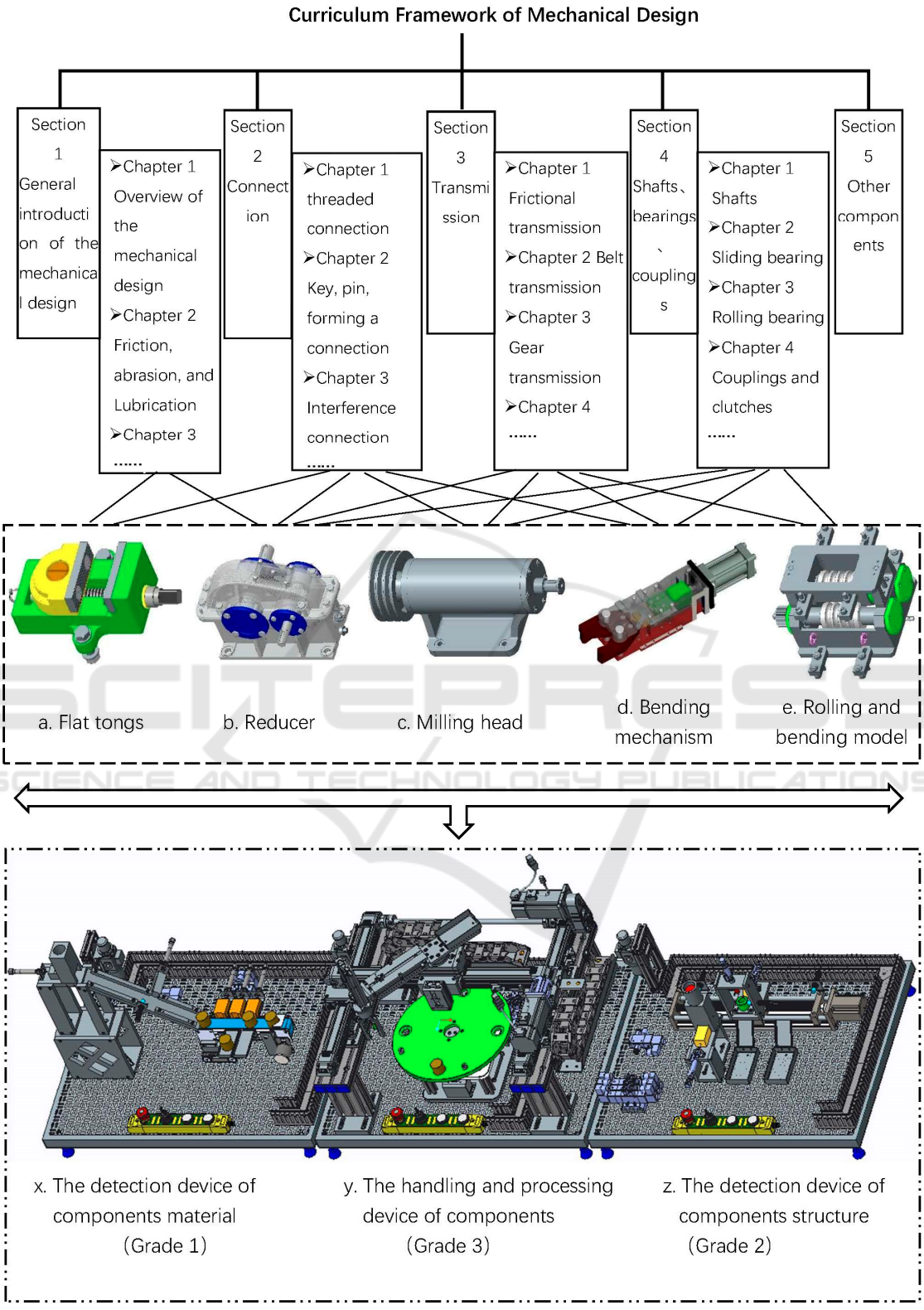

Figure 1: Project teaching reform of curriculum system

3 PROJECT REFORM OF CURRICULUM AND CURRICULUM SYSTEM

To improve the quality of professional talent training, higher vocational education has been continuously reformed for more than 20 years. As an important field of teaching reform in higher vocational education, project teaching presents the main exploration direction and effective way to reform the teaching of the discipline system in higher vocational education. Over the years, much literature has summarized the reform and effect of project teaching of the curriculum. For example, Zhang Anfu put forward the transformation from the indoctrinated CPE teaching logic to the project PTI teaching method (Zhang 2019, Yao 2020, Ding 2019, Wu 2015, Yu 2015). Duan Yongkang proposed that "project teaching has played an important role in improving the quality of higher vocational education, but there are some constraints when implementing the project, such as higher requirements for teachers' ability and inadequate allocation of resources," and suggested to "build a teaching coordination mechanism" (Yan 2018). The author of this paper also deeply believes that. Some literature also further proposed to "develop a penetrating project teaching system to improve students' comprehensive application ability and innovative consciousness towards knowledge" (Duan 2019).

To improve the teaching quality and effect, the projected reform of the course is carried out in the process of teaching reform. In the teaching field of mechanical and electrical specialty, the so-called teaching project should refer to some teaching carriers with independent and complete functions, which should be defined from the function of the carrier, rather than the knowledge system. Therefore, the first stage of the teaching project reform is to develop some teaching carriers suitable for mechanical design as teaching projects, such as the design of flat tongs, reducers, milling cutter heads, etc. (as shown in the dashed frame of Figure 1), integrating the original knowledge points of the mechanical design course into these projects. By implementing these projects, knowledge is acquired and curriculum skills are trained. This projected curriculum reform has made great strides and progress compared with the teaching model based on the knowledge system. However, these projects are called "granular" teaching projects because they are decentralized and not systematic although some knowledge of the curriculum is covered.

To further improve the teaching effect, several comprehensive projects (as shown in the double dotted line frame of Figure 1) are developed as the carrier, and the curriculum in the professional curriculum system is decomposed into these projects so that the training objectives of professional knowledge and skills are realized through implementing the projects. In this way, many "granulation" projects in the original different courses can be unified into a professional integration project to implement the mechanical design in the whole process, components processing and manufacturing, electrical control system design, mechanical and electrical installation, and adjustment. In this process, the knowledge system in the course is no longer the main content of teaching, but the content of learning to complete the project. Knowledge can be acquired through implementing the project, rather than taking project training to acquire knowledge. The active and passive relationship of teaching has been transformed, realizing the "project" design and implementation of the curriculum system.

4 CLOSED-LOOP MODEL OF TALENT TRAINING

In this paper, it is proposed to construct a closed-loop control model for professional talent training based on artificial intelligence empowerment (as shown in Figure 2), which mainly includes two aspects. One is to systematically design and develop integration projects that run through the professional talent training in the whole process according to the objectives of professional talent training. Through these projects, the courses in the professional curriculum system are organically connected. When implementing talent training, guided by ability and achievements, the quality of professional teaching is evaluated and guaranteed through the "X certificate" to achieve closed-loop control of the quality of professional talent training. The other is to customize or research and develop the management system of professional talent training empowered by artificial intelligence in the whole process, providing intelligent, efficient, and accurate technical support in curriculum system design, teaching process implementation, training system effect assessment, and other links, and serving the entire professional talent training system.

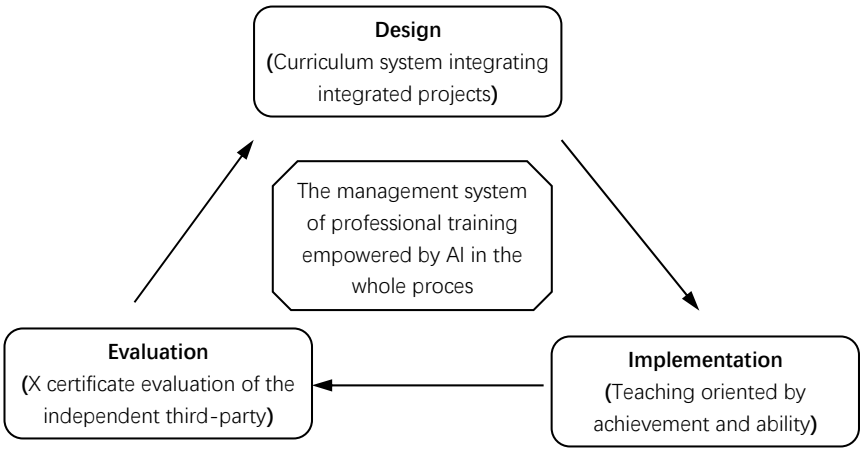

Figure 2: Closed-loop model of talent training empowered by artificial intelligence

In the closed-loop control model shown in Figure 2, the design module, implementation module, and evaluation module at the time $t+1$ are $D(X_t)$, $I(X_t)$, $E(X_t)$ respectively. The closed-loop control model can be expressed as follows:

$$Y(X_{t+1}) = F(X_t) \bullet \left(D(X_t) I(X_t) E(X_t)\right) \quad (1)$$

$$F(X_{t+1}) = F(X_t) + Y(X_{t+1}) \quad (2)$$

$F(X_t)$ refers to the input transformation function. It can be seen from the above formula that Formula 1 represents the output obtained X_t at the current time t as input through the closed-loop model at the time $t+1$. Formula 2 represents the feedback module. By introducing the system output feedback at a time $t+1$, the output of the entire closed-loop model is optimized.

As for the management system of professional talent training empowered by artificial intelligence in the whole process in Figure 2, its main responsibility is to serve the implementation of the design module $D(X_t)$, implementation module, $I(X_t)$ and evaluation module $E(X_t)$, which are realized by three artificial intelligence (AI) models respectively. For the design module $D(X_t)$, by introducing the professional curriculum settings of other schools and the professional curriculum settings and teaching evaluation of one's school, the professional curriculum training system can be automatically recommended with the help of the artificial intelligence algorithm. The formula is as follows:

$$Y_{t+1}^D = AIModel1(Y_t^D, Y_O^D) \quad (3)$$

Among them, Y_{t+1}^D, Y_t^D, and Y_O^D respectively refer to the professional talent training curriculum system optimized by the AI model, the professional talent training curriculum system of the school before the optimization, and the professional talent training system of corresponding majors of other schools.

For the implementation module $I(X_t)$, AI empowerment mainly completes the intelligent arrangement of course progress, phased effect evaluation, etc. Its formulaic description is as follows:

$$Y_{t+1}^I, Z_{t+1}^I = AIModel2(Y_t^I, Z_t^I) \quad (4)$$

Among them, Y_t^I and Z_t^I respectively refer to the schedule of professional talent training courses and the phased effect evaluation plan before optimization in the school. Y_{t+1}^I and Z_{t+1}^I represent the optimized schedule of the professional talent training courses and the phased effect evaluation plan in the school. For the evaluation module $E(X_t)$, AI empowerment, mainly for the student-centered multi-dimensional talent training effect evaluation, evaluates the training effect of professional talents in the school, including innovation ability, engineering practice ability, critique ability, enterprise adaptability, and so on. Its formulaic expression is as

follows:

$$Y_{t+1}^{E} = AIModel3(Y_{t}^{E}) \quad (5)$$

Among them, Y_{t}^{E} refers to the effect evaluation data of the professional talent training system before optimization in the school, and Y_{t+1}^{E} represents the multi-dimensional effect evaluation results of the professional talent training after AI optimization in the school.

5 VOCATIONAL POST AND CURRICULUM SYSTEM CONSTRUCTION

The typical vocational posts corresponding to the major and the vocational ability of the post are the basis for formulating the professional curriculum system, and also the direct embodiment of the training objectives of professional talents. Therefore, the professional curriculum system is the core to support the training objectives of professional talents (as shown in Figure 3). In the article "Reconstruction of electromechanical curriculum system based on the international engineering education professional certification standards", the author summarized the methods and processes of constructing the electromechanical curriculum system in detail. According to such methods and processes, the author constructed a disciplinary curriculum system structure with logical relations. The curriculum system structure is complete and logical. Evaluated from the normative and scientific aspects, the professional curriculum system built in the way the author proposed has made much more progress than that constructed by the traditional way. However, from the perspective of the implementation process, there are still problems as described in Section "one". There is only a logical relationship between functions and knowledge among the courses in the curriculum system, lacking cohesion and coherence in skills training and promotion. There is no unified common goal between courses as a teaching guide. Therefore, to strengthen the logical connection between courses, the curriculum system and courses must be integrated to serve the training objectives of professional talents through the professional integration project, so that the integration project can become the link connecting courses and the information center of professional talents training (as shown in Figure 4).

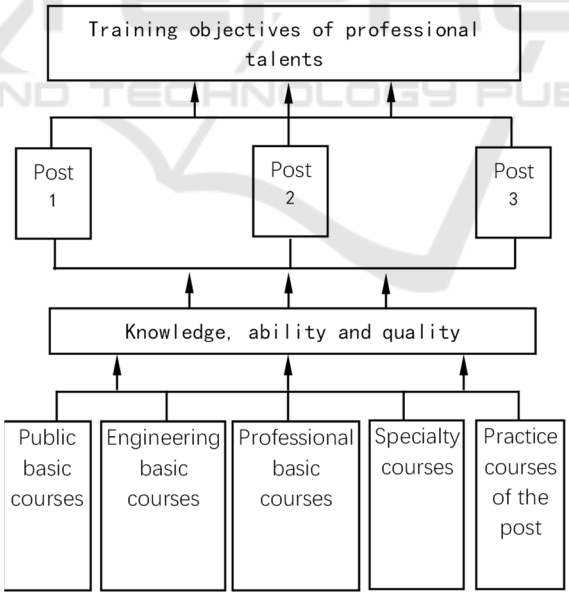

Figure 3: Professional curriculum system supporting talent training objectives

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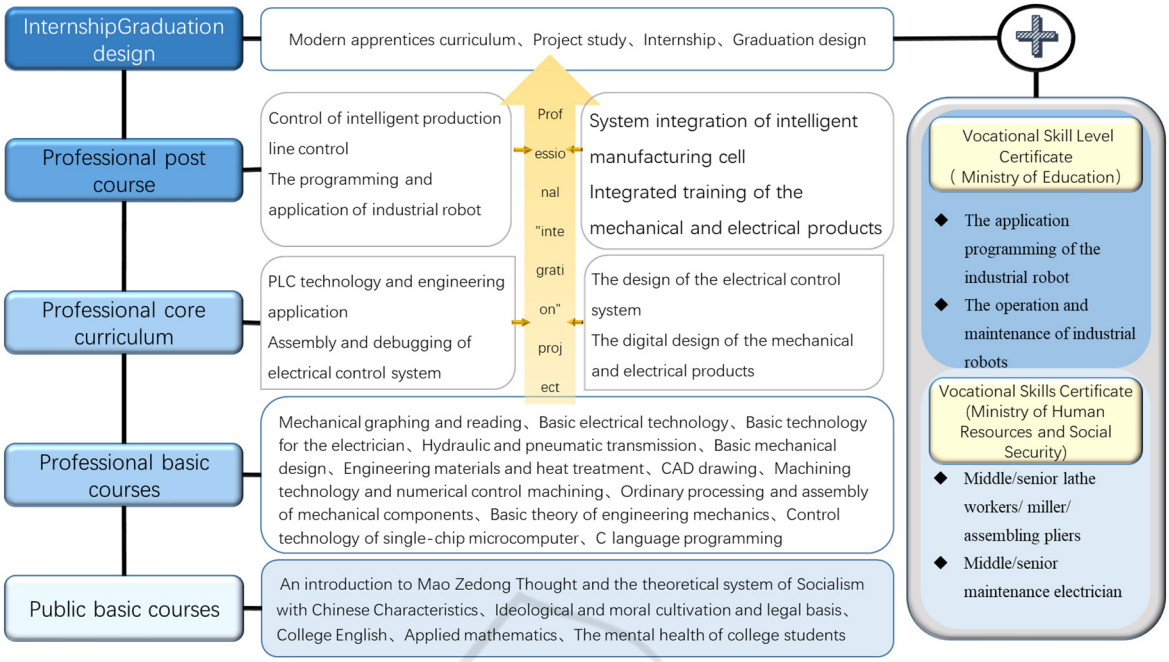

Figure 4: Curriculum system architecture of electromechanical specialty

6 IMPLEMENTATION OF THE INTEGRATION PROJECT OF THE PROFESSIONAL CURRICULUM SYSTEM

The integrated teaching project refers to a comprehensive teaching project that can guide professional knowledge and professional skills, including electromechanical specialty. The integrated project should cover the knowledge and skills of mechanical graphing and reading, mechanical design (including CAD, digital design of electromechanical products), machining technology and numerical control machining, the design of hydraulic or pneumatic transmission system, the design of electrical control system, PLC technology, and engineering application, the installation and debugging of the electrical control system, intelligent equipment application, and other aspects. By developing several integrated teaching devices that can cover the professional knowledge and professional skills of electromechanical specialty, and running the integrated project through the talent training of electromechanical specialty in the whole process, the courses in the professional curriculum system will be organically connected, so that the course is no longer an independent one, but a necessary link to complete the project. Each course in the curriculum system is to complete a specific function in the whole project. All courses aim to complete several specific projects (as shown in Figure 5). Students gradually form corresponding vocational abilities through various stages of the course. Finally, Students can complete the whole project and form specific teaching works, so that teachers' teaching and students' learning can be more targeted.

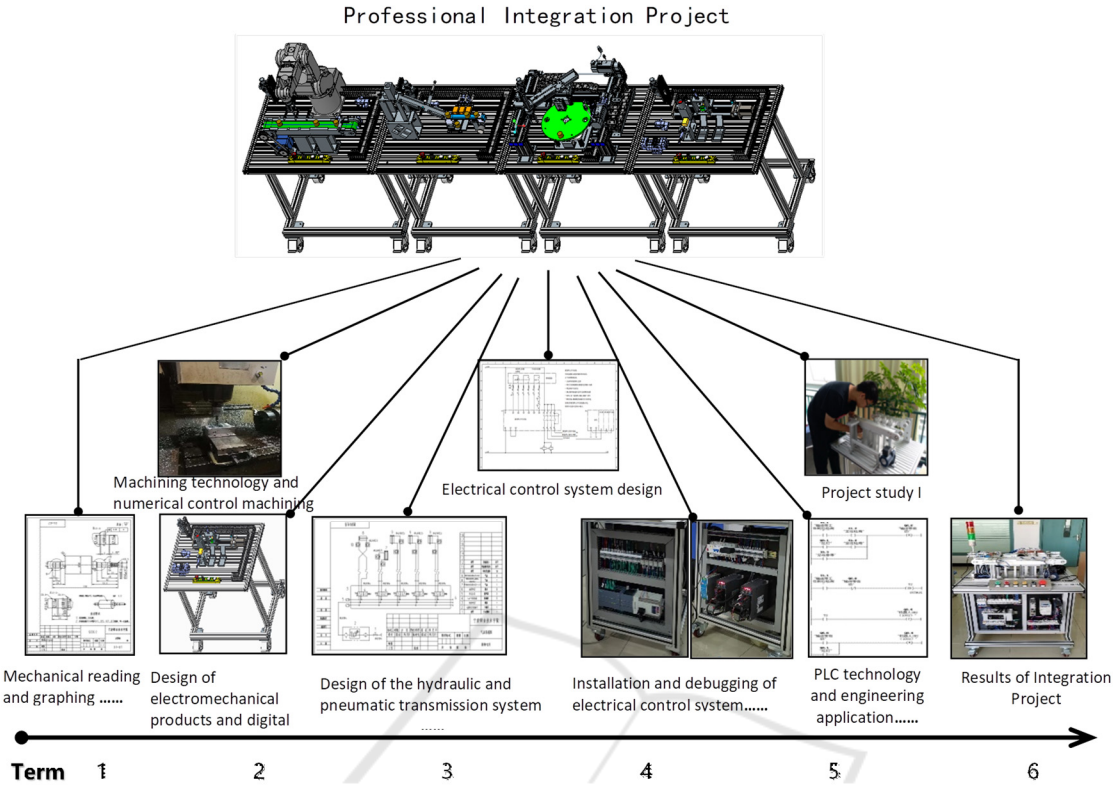

Figure 1: Professional integration project and curriculum system

7 CONDITIONS FOR IMPLEMENTING INTEGRATION PROJECTS

7.1 The Development of the Project

The primary condition for implementing the professional integration project is to develop several projects that can cover the core knowledge and skills of the profession, and form a complete teaching kit of the integration project, from which the teaching materials of each course in the professional curriculum system can be obtained. Organized by professional teachers, the materials can become the project carrier of the curriculum teaching. On one hand, taking the mechanical and electrical specialty as an example, according to the professional characteristics, the integration project must be able to cover the knowledge and skills of mechanical, electrical, liquid (gas), control technology, and other aspects. On the other hand, the integration project should be a comprehensive project suitable for teaching rather than directly gaining from the actual project of the enterprise. Since the actual project completely from the enterprise is ever-changing, with complex project processes and high development costs, and the students lack the process cognition and accumulation of the enterprise project, the actual project completely from the enterprise cannot be transformed into actual products and are difficult to implement in the school. Therefore, the integration project must be suitable for professional teaching. The project can come from the enterprise, but it must be sorted, optimized, and refined.

7.2 The Configuration of Teachers

Another important condition for carrying out professional integration teaching is that the teaching team with rich practical experience must be able to integrate knowledge and skills into the implementation process of the project, and can quickly solve the problems proposed by students when completing the project, which is a test for professional teachers. On the one hand, the teaching content should be transformed into actual results and works, which can avoid the disconnection between theory and practice. On the other hand, through implementing professional integration projects, the

professional skills of professional teachers will also be greatly improved.

7.3 The Complement of Funds

The curriculum and curriculum system is transformed and implemented with project orientation, which ultimately aims to complete the actual product. Therefore, consumables cost is a real problem that must be considered. Taking the *Z* device shown in Figure 1 as an example, the cost of main components such as mechanical components, electrical control cabinets (including S7 1200 PLC), and pneumatic components is about 75 thousand (The cost details are shown in Table 1.), which is completed by a project team composed of three students. Therefore, the average cost per student's shoulder is 25 thousand yuan. If the secondary or multiple uses of electrical control components, pneumatic components, and other components in the original device are considered, the cost can be controlled within one thousand yuan per person. Therefore, doing actual projects will not greatly increase the cost of teaching. In addition, the project transformation and implementation of the curriculum and curriculum system also involve the management system for the professional talent training empowered by artificial intelligence in the whole process. There are two solutions. One is to develop a set of management systems with complete intellectual property rights for intelligent and professional talent training in the whole process in the form of curriculum design or graduation design. The other is to entrust an IT company to develop a set of management systems empowered by artificial intelligence in the whole process of professional talent training. The system is about 100,000-150,000 yuan. It is worth noting that the system can be applied to the management of each different professional talent training in the whole process in the whole school, and the cost averagely shouldered by each student is also acceptable.

Table 1: The project cost of the device *Z* (Figure 1)

Number	Major categories of the components	Details of spare components	Amount	Cost (ten thousand yuan)
1	Mechanical components	machining fitting	One batch (20)	0.01 (only material cost concerned)
2		Heat treatment on components (blackening)	One batch (20)	0.01
3		Grid of 304 stainless steel	1 piece	0.045
4	Electrical components	Screw module (including stepper motor)	1 piece	0.04
5		S7 1200 and I/O extended module	1 piece	0.4
6		Electric control cabinet and low-voltage electrical components, etc	1 set	0.1
7	Pneumatic components	Pneumatic cylinder	3 pieces	0.015
8		Reversing valve	4 pieces	0.02
9		Gas source processor and other pneumatic accessories	1 set	0.015
10	Others	Accessories	1 set	0.1
Total				0.755

8 CONCLUSION

The integration project transformation of the professional curriculum system aims to connect and integrate the courses teaching professional knowledge and training ability for students in the curriculum system through integration projects. Through the management system of professional talent training in the whole process, the talent training is empowered from the beginning to the end, supplementing the shortcomings of systematic ability while giving full play to the systematic advantage of knowledge in the curriculum system. The dispersed “granular” ability training is changed to “continuous” and “systematic” ability training, integrating theory and practice teaching, and forming the talent training model of “integration project leading, ability and

result guiding". From the practice of electromechanical specialty for about 3 years, the effect is remarkable. The engineering practice ability of the students has been significantly improved, with a shorter cycle of adapting to professional posts. The students are welcomed by enterprises, and the professional counterpart rate of students has been significantly promoted. In the future, this model will be integrated with the "X" vocational skill level certificate which is vigorously promoted and continuously improved by China, realizing the third-party assessment of teaching quality. The training quality of higher vocational education professionals in China will be significantly improved. On this basis, the exploration and practice of the specialty in the training model of innovative talents, the cultivation of the professional skills, engineering expertise, and literacy of the students will be paid attention to. Meanwhile, more attention will be paid to training the creative thinking and innovation ability of the students. Students will be truly cultivated into compound high-skilled talents with sustainable development potential.

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