

# Research on the Construction of Localized Course Teaching System of Mechatronics Major in High Vocational Colleges Based on German AHK Graduation Examination

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**Abstract:** Through understanding the process of organizing the AHK graduation examination, this paper focuses on the analysis of the connotation of the AHK examination, and constructs a localized course teaching system of the mechatronics major in high vocational colleges based on the German AHK graduation examination, which has strong practicability and conforms to China's national conditions. After practice, the students who are cultivated are welcomed by enterprises and have a strong sense of self-identity. On the one hand, the AHK examination with vocational action ability as the core promotes the improvement of students' comprehensive vocational quality. While improving their practical skills, they have obtained corresponding vocational qualification certificates, obtained employment skills and improved their ability. On the other hand, it also promotes the improvement of teachers' teaching methods, attaches importance to the cultivation of vocational ability, and stimulates students' learning motivation and interest. Therefore, a win-win situation among students, schools and enterprises is formed.

## 1. Introduction

The root cause of Germany's strong economy lies in a unified and excellent vocational education and vocational continuing education. At present, many countries in the world are learning German vocational education, and China is no exception. The Overseas Chamber of the German Commerce and Industry Chamber (Abbreviation AHK) is a foreign institution with a global presence. At present, it has cooperative relations with many provinces in China. AHK's vocational education system includes the introduction of German professional standards from a strategic level, the localization design in China through the establishment of the Vocational Education Committee, the quality management of the vocational education process, and the establishment of an examination committee that performs tests in full accordance with German professional standards to guide the assessment. The vocational qualification certificate obtained after passing the AHK examination is currently issued by the Overseas Chamber of the German Commerce and Industry Chamber. The AHK examination is also an effective process evaluation method of the Sino-German dual-system education, which has played a good reference role in promoting the construction of the curriculum system of talent training in high vocational colleges. The Sino-German cooperative education has just proved the effectiveness through the graduation of the first mechatronics students in our college[1][2].

## 2. AHK examination

The purpose of the graduation examination is to determine whether candidates have acquired vocational action ability. Candidates are required to prove in the graduation examination that whether they have mastered the necessary professional skills, whether they have the necessary vocational theory knowledge and general ability, and whether they are familiar with the key

teaching contents that are taught in the teaching of vocational colleges and are essential to vocational training.

The AHK examination for mechatronics students is divided into two parts: Graduation examination 1 (AHK1) and graduation examination 2 (AHK2). AHK1 is the mid-term examination, which accounts for 40%. Generally, it is the fourth semester of the three-year system in China. AHK2 is the final exam, which accounts for 60%. It is in the sixth semester.

### 3. Graduation examination 1 and mechatronics curriculum setting

The composition and completion time of test questions in the graduation exam 1 are shown in Figure 1.

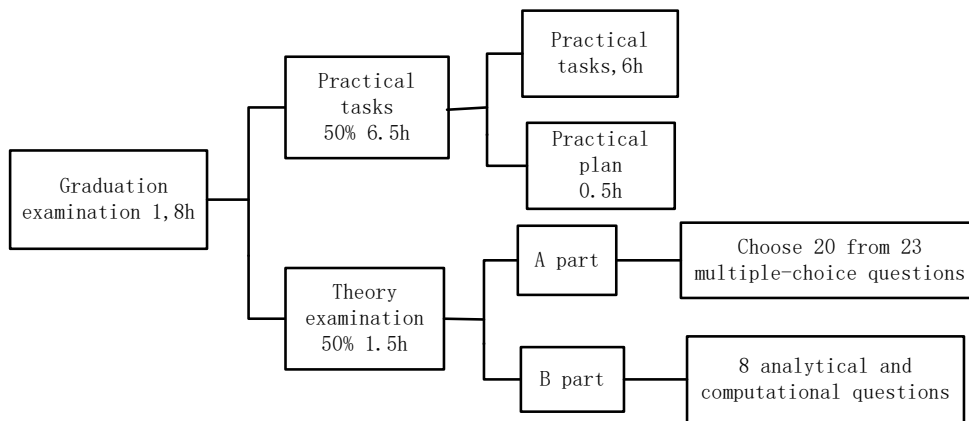


Figure 1. Composition and completion time of test questions in the graduation examination 1

The scope of the partial exam covered in the graduation examination 1 is called "working on the electromechanical subsystem". Candidates are required to demonstrate the following abilities: (1) Be able to collate and analyze the technical data, determine technical parameters, formulate and adjust the workflow plan, process materials and tools. (2) Assemble modules and components, wire, connect and configure, comply with safety rules, safety technical specifications and environmental protection regulations. (3) Judge the safety of electromechanical subsystems, check mechanical and electrical protection measures. (4) Analyze subsystems, check functions, set and measure operation values and implement functional capabilities. (5) Hand over and interpret systems, record the implementation of orders, and compile technical data (including checking records). Candidates are required to do a task including situational professional dialogue and theoretical examination. The examination time is 8 hours, including the situational professional dialogue (up to 10 minutes), and the theoretical examination time is 90 minutes.

According to the content covered by the examination, it is mainly to complete the mechanical manufacturing, installation, electrical, pneumatic and hydraulic circuit planning, installation and debugging, program linkage debugging of a complete electromechanical subsystem, and each part should reflect the vocational action ability. By referring to the "Regulations on the Vocational Training for Mechatronics workers" of the German Federal Economy and Technology Ministry in 2011 and the "Teaching Standards for Mechatronics Technology Major of High Vocational Colleges" of the Department of Vocational Education and Adult Education Department of the Education Ministry in 2012, The knowledge and skill level are listed in the talent training program and teaching training syllabus developed by them for senior high school graduates and high vocational college graduates, which are guided by the students' action ability in the vocational career, requires students to complete the courses for vocational ability, knowledge and skills needed

in the AHK 1 examination and requires the training tasks to achieve the purpose. At the same time, it requires students to achieve the vocational theoretical knowledge and practical skills required for the vocational talent training in China. By combining with the practical dual-system of Germany, the curriculum setting of the first three semesters is shown in Table 1[3].

Table 1 Curriculum setting according to the AHK1 examination

No.	Theoretical knowledge learning field	Class hour	Semester	Professional skills training module	Class hour	Semester
1	Cognition of mechatronic system	24	1	Computer-aided mechanical design	60	1
2	Reading and drawing of mechanical drawings	66	1	Manual processing, cutting and forming	120	1, 3
3	Manufacturing and assembly of mechanical subsystems★	72	1	General milling machine processing	60	2
4	Installation and debugging of electronic circuits	54	2	Computer-aided electrical design	30	2
5	Layout, installation and debugging of electrical components and modules I	72	2	Design, installation and debugging of electronic circuits	60	2
6	Installation and debugging of electrical, pneumatic and hydraulic control systems	60	3	Electrical installation planning and implementation★	90	2
7	Programming of control program for mechatronic system	72	3	General lathe processing	60	3
8	Layout, installation and debugging of electrical components and modules II	72	3	Assemble modules and components into mechanical systems	60	3
9				Installation and debugging of electrical, pneumatic and hydraulic control system	60	3
10				Electromechanical system programming	60	3
	Total	492		Total	660	

#### 4. Graduation examination 2 and mechatronics curriculum setting

The composition and completion time of test questions in the graduation exam 2 are shown in Figure 2.

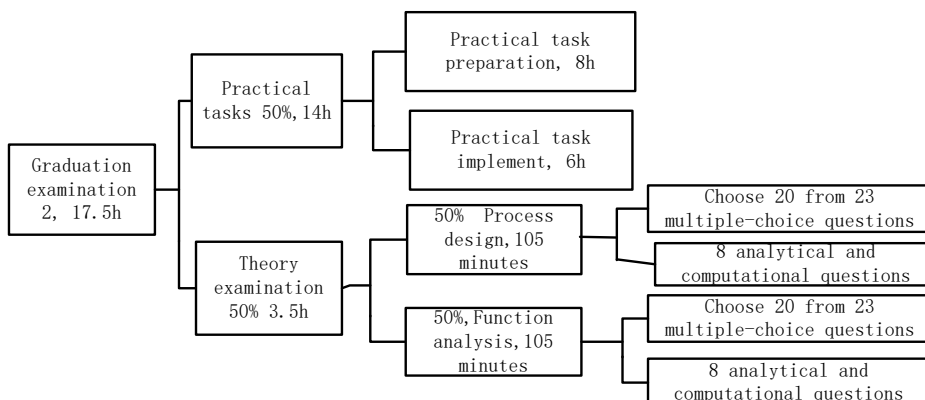


Figure 2. Composition and completion time of test questions in the graduation examination 2

The part of the graduation examination 2 examines the professional skills and theoretical knowledge described in the corporate training syllabus, and examines the key teaching content of vocational training that is taught by vocational schools according to the requirements of the syllabus.

The graduation examination 2 consists of the following examinations: (1) work order (practical examination); (2) process design (theoretical examination); (3) functional analysis (theoretical examination); (4) economic sociology (This part is not examined in China)

Two examination forms of "work order"

(1) Make a business order within 20 hours, record it with practice-related information, and conduct a professional dialogue on the order (up to 30 minutes). The professional dialogue is based on information about the practical information of the business order that has been made. The professional dialogue for the order is designed to assess the important ability of the candidate in the process of making an order with reference to relevant practice data. Before making a business order, the task list must be submitted to the examination committee for approval (including the time period plan for processing the order).

(2) "Work order" in the form of a unified examination paper, prepare, implement and post-process a work task within 14 hours, and record and conduct a professional dialogue (up to 20 minutes) with the special information of the order. The implement time of the task is 6 hours. By observing the implementation situation, assess the important process-related abilities of the candidates according to task-specific information and professional dialogue. At present, the second form is adopted in China.

During the examination of "work order", candidates are required to install or maintain the electromechanical system, then modify or retrofit and debug the system functions. The work order is already a real vocational practice, which requires students to apply flexibly in the theoretical knowledge modules that they have learned. The unknown module has appeared in the examination, which requires students to have comprehensive order analysis and processing abilities. It is more challenging than the AHK1 examination. If the student doesn't have the ability to assemble and debug, it will be very difficult for him to complete independently[4].

There are two examinations in the AHK2 theoretical examination, namely process design and functional analysis, including electrical, electronic, electric, hydraulic and pneumatic system, sensor, frequency converter, automatic control system, mechanical manufacturing and process, CNC machining, industrial robot, mechanical and electrical product delivery and other aspects of professional knowledge, the examination questions are also professional ability knowledge that need to be mastered for the work order. They are all choice questions and analysis questions, which also have corresponding calculations, such as analog-to-digital conversion, circuit and current, hydraulic flow rate, heating temperature of bearing installation, etc., drawing reading and drawing identification, standards and specifications, the content is various and extensive, by referring to the knowledge and skills involved in the examination questions, and also referring to the "Regulations on the Vocational Training for Mechatronics workers" of the German Federal Economy and Technology Ministry in 2011 and the "Teaching Standards for Mechatronics Technology Major of High Vocational Colleges" of the Department of Vocational Education and Adult Education Department of the Education Ministry in 2012, to achieve the professional theoretical knowledge and practical skills required for the professional talent training in China, by combining with the practical dual-system of Germany, the curriculum setting of the last three semesters is shown in Table 2.

Table 2 Curriculum setting according to the AHK2 examination

No.	Theoretical knowledge learning field	Class hour	Sem ester	Professional skills training module	Class hour	Semester
1	Installation and debugging of typical automation production lines	72	4	Electro-mechanical system manufacture I ( including AHK examination 1)	150	4
2	Installation and debugging of industrial robots	54	4	Installation and debugging of mechatronics system★	120	4
3	Connection and debugging of industrial network and configuration control system	32	4	Connection and debugging of industrial network control system	30	4
4	Fault diagnosis and maintenance of mechatronics system	54	5	Operation, installation and debugging of industrial robots	90	5
5	Handover of mechatronics system to customers	54	5	Fault diagnosis and maintenance of typical electro-mechanical equipment ★	60	5
6	German communication and application	32	5	Design and handover of Mechatronics systems	150	5
7	Programming for NC machining of typical parts	36	5	Electro-mechanical system manufacture II ( including AHK examination 2)	180	6
8	Embedded system design and application (optional)	54	4	Post internship (Vocational post-internship)	360	6
	Total	334		Total (excluding post-internship)	780	

## 5. AHK graduation examination and mechatronics major curriculum system

With the progress of the examination, we revise the curriculum teaching plan of talent training every year. When students enter the school, they should make clear their professional orientation, complete the study and training of the basic module of vocational ability in the first two years of their studies, and implement four stages of vocational education according to the growth rules of high-skilled talents, that is, the cognitive stage of vocational ability, the formation stage of vocational ability, the promotion stage of vocational ability and the vocational post-training stage. The AHK graduation examination 1 is based on the manufacture of an electromechanical system to solve the problems in the cognitive and formation stages of vocational ability. The AHK graduation examination 2 needs to complete a complete work order, which mainly reflects the improvement of vocational ability and job training, which is equivalent to a complete process of vocational behavior. According to the requirements of the core ability of mechatronics technology profession, the curriculum system should reflect not only the cultivation of students' vocational technical skills, but also the vocational action ability, which is different from the traditional curriculum. Based on China's actual national conditions, the vocational basic module of the major is added to the curriculum teaching system of the major to form a complete localized curriculum system of mechatronics major, which has strong practicability. The specific course teaching system is set up as shown in Figure 3 [5][6].

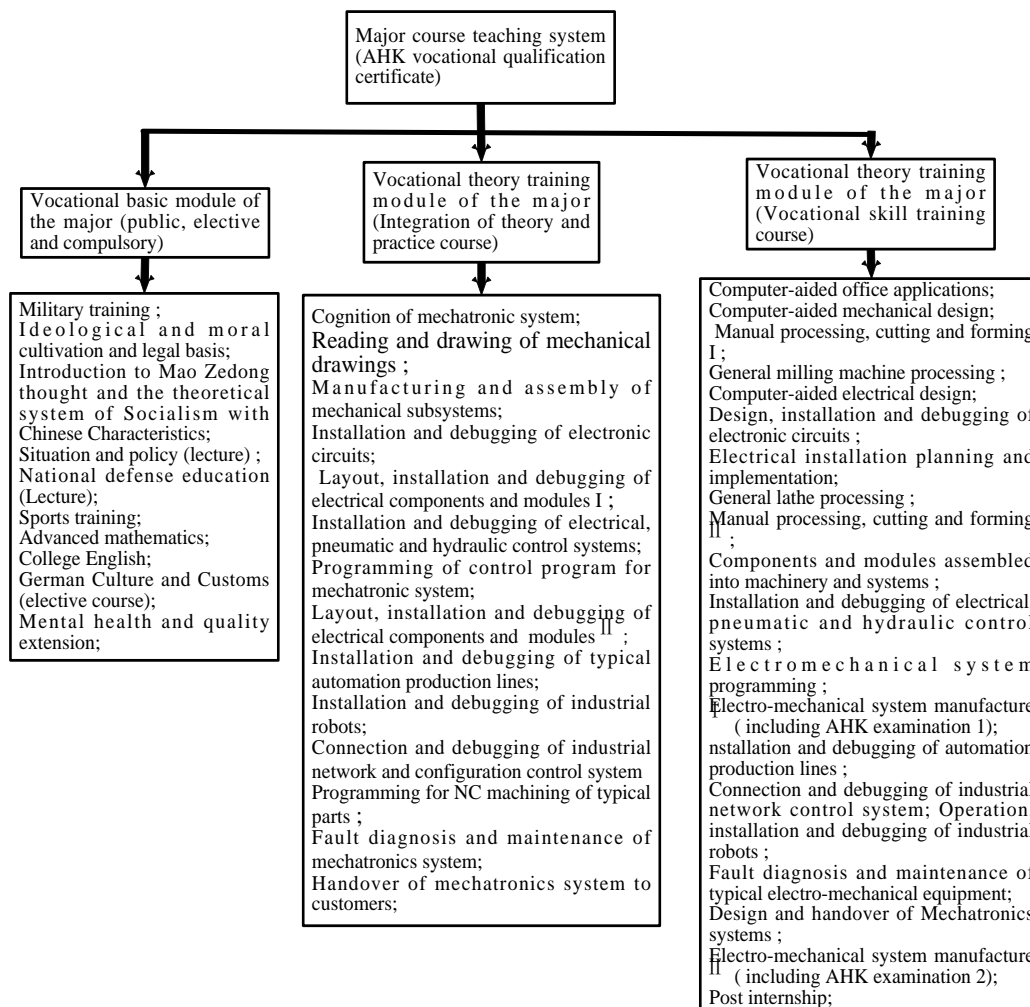


Figure 3. Course teaching system of mechatronics major

## 6. Implement effectiveness of dual-system education for mechatronics major based on German AHK examination

The comprehensive ability of the students in the dual-system class is much higher than that of the students in the general high vocational class. In order to test the training effect of the high vocational dual-system class, in December 2017, we selected 10 students with better learning from the 2016 mechatronics class (ordinary high vocational class) and conducted a comparative simulation test with 10 students from the 2016 Sino-German dual-system class. From the analysis of the examination results, the students in the dual-system class are far higher than those in the ordinary high vocational class in both theoretical knowledge and practical skills.[7]

From the year of 2015 to now, the first graduates of the Sino-German class in our college have all completed their studies and employment. Among them, 16 students successfully entered EU high-tech manufacturing enterprises. 18 students chose to enter a large number of large-scale precision processing and high-end intelligent manufacturing enterprises at home and abroad according to their professional interests and personal reality. 7 students majoring in mechatronics technology were recruited by the design institute of large state-owned institutes to engage in automation-aided design work after a series of selections. The feedback given to us by the enterprises shows that the students who are cultivated in the dual system have obvious advantages in the ability to adapt to the post, self-learning ability, hands-on ability and work initiative.

## 7. Summary

Starting from the AHK graduation examination, the localization construction of the curriculum system of mechatronics major in high vocational colleges by our college based on the German AHK examination was discussed in this paper, which has strong practicability and conforms to China's national conditions. Through practice, the students trained are welcomed by enterprises and have a strong sense of self-identity. On the one hand, the AHK examination with vocational action ability as the core promotes the improvement of students' comprehensive vocational ability. While improving their practical skills, they have obtained corresponding vocational qualification certificates, obtained employment skills and improved their ability. On the other hand, it also promotes the improvement of teachers' teaching methods, attaches importance to the cultivation of vocational ability, stimulates students' learning motivation and interest, and forms a win-win situation among students, schools and enterprises.

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