Construction of an Inter-disciplinary and Cross-integration Compounding and Innovative Talent Training System

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Abstract. Changes in demand for new engineering talents for new trends such as Internet+ and China Manufacturing 2025, we constructed a new training system for inter-disciplinary and innovative talents with integration of four top-notch majors. This new training system comprehensively considered the interrelationship between professional knowledge and striving spirit, research type and skill type. Furthermore, in the aspects of general education module, subject basic module, professional basic module, professional course module and practical teaching module, we have considered the similarities and differences between the four majors and the division of labor in the knowledge system that China manufacturing 2025 talents should have, for these needs, we devised specific platform and special courses.

Foreword

Industry 4.0 indicates a new round of scientific and technological revolution and industrial transformation represented, this revolution is a fully integration of information technology and industry, contains three cores including digitalization, networking and intelligence of manufacturing, also the revolution is triggered by Internet of Things and Internet of Services with a further breakthrough in AI, new energy and new materials, this revolution would profound impact on the industry around the world, thus deeply affecting the closely related higher education of engineering. The information technology, intelligent manufacturing related technologies, Internet of Things technologies, Internet technologies, innovative design methods, big data analysis and other related technologies involved in the transformation belong to many traditional first-level disciplines and majors, while these technologies were trained separately in the past. The training of talents for Internet+ and China Manufacturing 2025 needs to break through the traditional obstacles in the discipline setting, innovative education training mode, reform the talent training mechanism and platform, and innovatively build a comprehensive practical platform integrating relevant technical knowledge.

Analysis of the Knowledge Structure Needs of Talent Cultivation under the Perspective of Internet+ and China Manufacturing 2025

Internet+, Industry 4.0, and China Manufacturing 2025 are not only a new round of industrial revolution, they are manifested in national policies and industrial sector, also promote development of higher education of engineering, its technical requirements mainly involve mechanical engineering, automation, testing technology and instruments, logistics engineering, computer science and other majors and disciplines, all these majors are integrated with information technology, and the degree of integration is getting higher and higher, as a result, more and more people agree that it is because of Internet+, Industry 4.0, and China Manufacturing 2025 that they have the meaning of new engineering.

From the perspective of Internet+, Industry 4.0, and China Manufacturing 2025 on the knowledge structure of talents, it emphasizes the integration of multidisciplinary knowledge, requires a good
engineering foundation, and highlights the characteristics of information technology and various professions. The knowledge structure requirements for talent training are shown in Figure 1.

![Diagram showing the knowledge structure for China Manufacturing 2025]

Figure 1. Talents’ knowledge structure for China Manufacturing 2025.

The demand of talent’s knowledge structure for Internet+, Industry 4.0 and China Manufacturing 2025 is not a simply addition of these professions or disciplines, but an intimate integration of various professions. Among these professions, mechanical engineering is the skeleton and torso, measurement and control is tactile and sensing, automation is the brain, logistics is the planning and management of the operation within the system, and the communication between the various parts is information technology, the support of information technology is computer technology and electronics technology, all these parts have interaction and influence with each other.

When devising a talent development plan for each major, the following two issues must be considered seriously:

1. Internet+ and China Manufacturing 2025 need to absorb relevant content from various discipline systems gradually and continue to integrate in engineering practice before having their own structure and needs. Therefore, when developing a plan for each major, it is necessary to extract directly related content from relevant majors and disciplines, then determine the core curriculum;

2. The Internet+ and China Manufacturing 2025 involve a long chain of knowledge and a wide range of content. It’s difficult for a student to read and learn everything in the four years of university life. At the same time, if all the knowledge points of the same profession are involved, it’s also hard for a student to master everything, thus the goal of mastering knowledge learned deeply cannot be achieved, and the top-notch talents cannot be cultivated.

When developing training plans, students from relevant majors should select some of their main specialty courses according to their respective foundations to achieve proficiency level, another part of the cross-integration course should reach the general mastery level.
The Status of Talent Training in School of Automation in BUPT

The School of Automation, Beijing University of Posts and Telecommunications has four majors with mechanical engineering, automation, measurement and control technology and instrumentation, and logistics engineering, after years of operation, its training system and teaching operation mode have performed well, graduates from four professions have achieved good results in their respective professional fields and have been recognized by the employers.

There is some cooperation in the construction of four majors in the college for many years. For example, there are several professional and experimental platform courses in the general education, and a small number of professional courses and experimental courses are reused. However, because of the division of the first-level disciplines, the professional training systems still have a relatively fragmented and insufficient degree of integration. Particularly, there is no professional positioning and training objectives for the various systems in general, and there is no unified construction of a multi-disciplinary professional knowledge training system.

Constructing a Professional Knowledge Training System with Integration of Interdisciplinary

After many investigations and arguments, the School of Automation, Beijing University of Posts and Telecommunications believes that the college's multi-disciplinary talents’ training system should implement a new type of 1+1 education system, the 1+1 education has two meanings as following:

(1). The systematic professional education of New Engineering Major should not only educate professional knowledge, but also cultivate the spirit of courage in work and study, strive to develop and strive to develop, and cultivate talents with professional knowledge and hard-working spiritual power.

(2). Other than cultivating the theoretical research ability of talents, the systematic professional education of New Engineering Majors should also cultivate the practical skills of talents to solve comprehensive practical problems, that is, to cultivate research-type and skill-based compound talents.

Constructing a Multi-Factor Talent Training and Collaboration System from the Perspective of Interdisciplinary Integration

From the perspective of multidisciplinary integration, the talent training model is a multi-factor support system. The training program, teaching model, incentive mechanism and guarantee mechanism constitute a cohesive system. The curriculum system of each major should emphasize systemic and scientific features. The construction of teaching material system should emphasize normative and unified features, and the integration of multidisciplinary knowledge should also be emphasized in the construction of teaching staff. In addition, the teaching mode, practical teaching mode, quality mechanism and incentive mechanism of each professional theory should also be coordinated with each other.

Guiding Ideology and Basic Principles for the Formulation of Professional Knowledge Training Programs from the Perspective of Interdisciplinary Integration

For guiding ideology: Carry out the spirit of the plenary session since the 18th National Congress of the Communist Party of China, thoroughly study and implement the spirit of the important speech of General Secretary Xi Jinping, and lead the five development concepts of innovation, coordination, sustainable, openness, and sharing, fully implement the spirit of the Communist Party's National Medium- and Long-Term Education Reform and Development Plan (2010-2020), fully implement the Communist Party's education policy, follow the development law of higher education, and learn from the advanced educational concepts and teaching reform achievements of universities at home and abroad, adhering to the excellent educational traditions and characteristics of the BUPT, also focusing on the development plan of the 13th Five-Year Plan of BUPT, adhering to the principle of teaching reform of strengthening the foundation, broadening the profession, attaching importance to practice,
cultivating ability, stimulating innovation, developing individuality, paying attention to comprehensiveness, and improving quality, establish the concept of talents with all-round development and diversification of various professions, establish the concept of actively serving the national strategic requirements, and actively serve the needs of enterprises in the industry, actively adapt to the new requirements of the development of Industry 4.0, China Manufacturing 2025, Internet+, etc. Focus on the needs of employers and develop training standards and implementation matrices from the actual needs of China Manufacturing 2025 and international engineering education professional certification, so as to formulate training programs to adapt to the new situation.

For basic principles: (1). Considering the advantages of coexistence of multiple majors in the college, the system will create an interdisciplinary professional training platform and strengthen the professional foundation of the discipline.

(2). Do fully research and take the training programs of relevant majors in domestic universities the needs of enterprise talents as reference, clarify the professional positioning and training objectives, and highlight the professional characteristics.

(3). Keep the theoretical teaching and practice teaching continuous for four years, strengthen the theoretical analysis of practice, and emphasize the way of thinking in engineering practice.

(4). Optimize the innovation industry education system, strengthen the practice of educating people, deepen the innovation industry education reform, integrate the concept of innovation and entrepreneurship into talent training, focus on students' self-study and promote individualized training.

(5). Deepen the reform of teaching mode and accelerate the process of internationalization.

Construction of a Multi-disciplinary and Interdisciplinary Curriculum System

Although the four majors set up by the School of Automation span a discipline rank in first-level, they meet the common knowledge needs of Internet+ and China Manufacturing 2025, thus building a multi-disciplinary and interdisciplinary curriculum system is needed, which is shown in figure 2.

(1). Construction of general education module
The general education platform is mainly composed of ideological and political modules, English modules, sports modules, quality education modules, mathematics and natural science modules, and computer basic modules. Among all these modules, the ideological and political module, the English module, the sports module, and the quality education module can achieve a completely consistent training requirement. While the main points of knowledge and requirements involved in the mathematics and natural science modules and computer basic modules are also basically the same, therefore, the main courses in these two modules are consistent, thus consideration of very few courses of the particularity of professional requirements and do not pursue complete consistency. The above-mentioned modules have jointly constructed an interdisciplinary general education platform, which laid a good foundation for interdisciplinary training.

(2). Construction of subject basic course module
The basic course of the subject is a basic course that supports the whole subject and is the basis for the basic and professional courses of the major. The four majors of the Automation College span a first-level discipline, and the subject-based courses have certain commonalities and differences. As shown in figure 2. From a systemic perspective, the module has four professional unified platform classes. Such as engineering graphics, engineering management. There are also platform courses shared by more than 3 majors, such as: basics of circuit analysis, analog electronics, digital electronics, signals and systems and engineering mechanics and materials, etc. There are also two professionally shared courses, such as the principle of automatic control. In addition to these shared platform courses, each major should set its own special courses in consideration of the needs of its own professional needs.

The proportion of the four majors subject-based courses in the total credits is basically close about 14.5%.
## Figure 2. Talents’ knowledge structure for China Manufacturing 2025.
Construction of Professional Basic Course Module

The professional basic course is a base that supports the direction of the major and lays the foundation for the following-up professional courses. Professional basic courses in four majors are set up to meet the needs of both Internet+ and China Manufacturing 2025, as well as special courses for their respective basic education needs. Do not insist on the consistency of the four professional courses is not strictly demand but focus on the possibility of opening more than two professional shared platform courses, such as detection technology and signal processing, basics of controlling engineering, each major should set an introductory course for it.

The proportion of the professional basic courses in these four majors is basically close to 10% in total.

Construction of Professional Course Module

The professional course is a key characteristic curriculum designed to meet the needs of professional engineering practice. It is a comprehensive application of a variety of knowledge related to subject basic course and professional basic course that can be used to solve practical professional and technical problems. Although there are big differences in the overall professional course setting of the four majors, there are still platform courses shared by 4 majors, 3 majors and more than 2 majors. Also, as shown in figure 2, the proportion of the professional courses in these four majors is basically about 8% in the total credits.

In the design of the professional course module, the following features are highlighted:

1. Construct a core technical knowledge module system of this major. Considering the characteristics and needs of each major, set up technical theories and comprehensive application modules that can represent the core of the profession and the featured professional direction of subdivision.

2. Coordinate the construction of a professional curriculum knowledge module system across the first-level disciplines. Coordinate the consideration of the distribution of knowledge points of the four professional courses, so that it can basically cover the overall knowledge needs of Internet+ and China Manufacturing 2025.

3. Add a curriculum that reflects the trend of multi-disciplinary integration of new engineering. The influence of computer technology and information technology on the majors of traditional engineering is huge. On the one hand, we appropriately add new technology courses that can represent new trends and new directions of engineering, such as artificial intelligence and data mining, machine learning, etc. On the other hand, the professional course modules for various specialties tries to consider setting up a multi-disciplinary platform course to reflect the integration trend of knowledge systematization and professionalism.

Construction of Practice Course Teaching Module

The construction of the practical curriculum system meets the requirements of continuously studying procedure for four years: from cognitive internship to special engineering training, from comprehensive training to professional internship, and finally comprehensive training and improvement are carried out through the graduation design to complete all the training process.

At present, the main part of the practice links of various professions has been tested by many years of practice. In the new scheme, the subject remains unchanged, new comprehensive and design practice links are added, and the thinking mode of training hands-on ability and engineering practice is emphasized.

The School of Automation plans to add a comprehensive experimental platform for intelligent production lines that can reflect Industry 4.0 and China Manufacturing 2025. Through this intelligent production line, it can integrate the comprehensive and design experiments of four majors of machinery, measurement and control, automation and logistics, further embodying the systematization and integration of the four professional practices.
Construction of Practice Course Teaching Module

Beijing University of Posts and Telecommunications has always attached great importance to college students with innovation and entrepreneurial activities. With the help of the platform of the school, the School of Automation constructs a four-in-one innovative education system in combination with its own actual situation, specifically referring as following instructions.

1. The school offers a public elective course on innovation and entrepreneurship in various forms, such as massive open online courses (MOOC) for students to learn.
2. The school sets up a platform for university students to innovate and start a business. The platform sets up many innovative and entrepreneurial projects each year for students to apply for. While at the same time, students can also set up their own innovative entrepreneurial projects to apply. The school is funded after the application is approved.
3. Innovative design courses are offered in each professional development program to guide students in all majors to learn and apply innovative methods.

Overall Situation of the Curriculum System

Based on the specific conditions of the schools and colleges, the total credits in each professional curriculum system are determined to be 160+6 points, of which 6 points are innovative and entrepreneurial credits for compulsory courses.

The proportion of each component in the curriculum system is set as follows: general education counts about 45%, professional education counts about 51%, and innovation and entrepreneurship education section set close to 4%. Among them: humanities and social sciences general education credits count more than 15%; mathematics and natural sciences credits count more than 15%; subject basic, professional fundamental and professional credits count more than 30%; engineering practice and graduation design credits count more than 20%. What’s more, compulsory courses ratio should be set less than 75%, elective courses ratio should be set more than 25%.

Conclusion

With the rise of the knowledge economy such as Internet+ and China Manufacturing 2025 and the development of information technology, multi-disciplinary integration has become an inevitable trend in the development of higher education in China. In the innovation of talent training system, the School of Automation in Beijing University of Posts and Telecommunications systematically considers and clarifies the objectives of each major construction and the needs of talent knowledge structure and gives full play to the advantages of multidisciplinary cross-infiltration, constructed a 1+1 composite top-notch innovative talent training system across the first-level disciplines. At the same time, we constantly optimize the curriculum system and teaching methods, improve the quality of teachers and multidisciplinary nature, improve the teaching system, and cultivate compound talents that truly meet the needs of the society.

References