Adult and Higher Education (2024)
Clausius Scientific Press, Canada

DOI: 10.23977/aduhe.2024.060801
ISSN 2523-5826 Vol. 6 Num. 8

Research and Practice on Intelligent Transformation and Upgrading Path of Traditional Automation Specialties in the Context of Engineering Education

Junmei Guo[a], Fei Lin[b,*]

School of Ocean Technology Science, Qilu University of Technology (Shandong Academy of Sciences), Jinan, Shandong, China
[a]84254456@qq.com, [b]122745081@qq.com
[*]Corresponding author

Keywords: New engineering; automation major; intelligent transformation; educational reform; practical exploration

Abstract: With the concept of new engineering science, automation majors are facing the opportunities and challenges of intelligent transformation. This paper discusses the necessity of intelligent upgrading and transformation for the current situation of automation professional education, combining with the ongoing professional certification of engineering education, and proposes corresponding transformation strategies, with a view to providing reference for relevant institutions and enterprises. It has been proved that the upgrading of automation majors improves students' innovative ability and practical ability, enhances the ability to solve complex engineering problems, and enables students to better adapt to future career needs.

1. Introduction

Engineering colleges and universities in developed countries in Europe and America have a long history of practical engineering education and a relatively perfect system. In the 1980s, the concept of "return to engineering" was put forward, emphasizing the importance of practical engineering ability and innovation, with a high proportion of practical teaching in the curriculum and close contact with industry. The Massachusetts Institute of Technology (MIT) launched the Gordon Engineering Leadership Program as early as 2007, putting forward the concept of "engineering leadership" and emphasizing the importance of cultivating students' practical engineering ability. [1] The report of the 20th Party Congress profoundly elaborated the core position of innovation-driven development strategy and emphasized the strategic significance of talents as the first resource, especially the higher requirements for the cultivation of applied and innovative talents.In April 2021, during his visit to Tsinghua University, The main leaders of the country emphasized "promoting the 'four new' constructions such as the new engineering discipline", and the spirit of this important speech indicates that the new engineering discipline is closely related to the fusion of industry-academia-research and application and the cultivation of engineering ability. [2]

The concept of new engineering discipline aims to adapt to the needs of scientific and

technological progress and industrial transformation, emphasizing students' interdisciplinary integration, innovation ability cultivation and practical ability enhancement. As an important part of engineering disciplines, traditional automation majors must be closely integrated with industries and undergo intelligent transformation and upgrading in order to cultivate high-quality, innovative and applied talents who can adapt to future development. This paper will analyze the current challenges facing the automation profession, discuss the necessity of intelligent transformation, and put forward the corresponding implementation plan.

2. Current status of domestic and international research

2.1. Status of research abroad

Internationally, many countries and regions have conducted in-depth research on the intelligent transformation of the automation profession, mainly focusing on the following aspects:

In terms of curriculum, many colleges and universities in Europe and the United States have incorporated emerging technologies such as artificial intelligence, the Internet of Things, and big data into the curriculum of automation majors. For example, colleges and universities such as the Massachusetts Institute of Technology (MIT) and Stanford University have offered courses related to intelligent manufacturing and machine learning, emphasizing the combination of theory and practice. Studies have shown that this curriculum significantly improves students' employment rate and career adaptability. [3] In terms of industry-university-research cooperation, many foreign universities have established close cooperative relationships with enterprises to enhance students' practical ability and employment competitiveness through the joint development of curricula and internship programs. For example, Germany's "dual system" education model combines theoretical learning with internships in enterprises, cultivating a large number of high-quality technical talents. In terms of scientific research and innovation, Europe and the United States are in a leading position in the research of intelligent manufacturing and automation technology, and many research institutions and universities have carried out research in the fields of intelligent manufacturing system and industrial Internet, which has promoted the rapid development of technology. [4]

2.2. Status of domestic research

With the promotion of the concept of new engineering science, domestic universities have conducted relevant research for the intelligent transformation of automation majors. Many colleges and universities have introduced new courses such as artificial intelligence and data analysis into the curriculum system of automation majors to promote the updating and optimization of the course content, and combined with the development of the industry to enhance the hands-on ability and practical experience of the students through the establishment of laboratories and internship bases. For example, universities such as Tsinghua University and Zhejiang University have added courses such as intelligent control and machine learning in automation majors to meet the needs of the industry; Harbin Engineering University has carried out the construction of a multi-dimensional innovation and practice platform for new engineering talents; [5] Xi'an Jiaotong University has taken Huawei - "Intelligent Base" as an example to carry out the exploration and practice of the integration path of the production and teaching of electronic information majors. Xi'an Jiaotong University has taken Huawei-"Smart Base" as an example, and explored and practiced the integration path of electronic information specialty. [6]

3. The need for intelligent transformation

The cultivation of new engineering talents needs to develop students' vision, establish the view of full-cycle system engineering of technical products, and cultivate students' integration ability and innovation and practice ability. Under the background of industrial upgrading, the mismatch between the supply side of talents and the demand side of industries is increasingly prominent. [7] At present, the engineering majors of local universities still have the problems of weak mathematical and scientific foundation of some students, insufficient logical thinking ability, lack of engineering literacy and humanistic literacy, insufficient lifelong learning ability, insufficient innovation and practice ability, as well as weak ability to comprehensively consider multiple factors to solve complex engineering problems, etc., and there is a certain disconnect between the quality of the students' cultivation and the industry's demand for innovative and practical talents. Taking the automation major of the Department of Electronics, Electricity and Control of Qilu University of Technology (Shandong Academy of Sciences) as an example, the reasons are analyzed as follows:

3.1. Insufficient linkage between training programs and industry needs

In the context of industrial change, automation talents need to have the knowledge structure and content to keep pace with the times. However, some colleges and universities are still limited to a single discipline in automation courses, and the content is slow to update, failing to fully consider the actual needs of enterprises and technology development trends, resulting in a disconnect between the knowledge students learn and industry standards and cutting-edge technology. This disconnect not only affects the competitiveness of students' employment, but also restricts the investment and participation of enterprises in talent training, and makes it difficult to reflect the needs of major national industries and the development of regional new economy and new industries. The revision of training program needs to be oriented to industrial demand, but at present, the participation of industrial enterprises in the development of training program is low, and the training objectives and graduation requirements fail to fully reflect the industrial demand; in the curriculum system, the content of some courses overlap, and in the limited number of hours, it squeezes out the hours and credits of the practical classes, resulting in a waste of hours and credits; the courses in the curriculum system are fewer than the courses that cultivate the students' logical thinking ability and analytical problem ability. In the curriculum system, there are few courses that cultivate students' logical thinking ability and analyzing ability.

3.2. The practical teaching platform for industry-teaching integration has not yet functioned in depth

The automation program has actively promoted school-enterprise cooperation in recent years, and has established several school-enterprise cooperation bases, which provide students with opportunities to contact enterprises and promote the combination of theory and practice. However, there are still some urgent problems in the current cooperation mode, which leads to students failing to fully recognize and master the full life cycle management of products, systems and processes in actual learning.

First, the integration of resources between schools and enterprises is inadequate. Despite the establishment of school-enterprise cooperation bases, the resources and technological advantages of many enterprises have not been brought into full play, and the teaching resources and scientific research achievements of the schools have not been effectively transformed into practical applications for enterprises. This one-sidedness and asymmetry of resources make the effect of cooperation greatly reduced, and the ability of students to solve complex engineering problems is

not much improved.

Secondly, there is a single form of enterprise participation in practical teaching. When participating in school-enterprise cooperation, many enterprises mainly focus on short-term interests and employment demand, but fail to really participate in the curriculum, teaching content and project development; most of the students' internships in enterprises are in the form of visits. This kind of superficial cooperation relationship leads to insufficient learning experience for students in practice, and they are unable to deeply understand the industry demand and technology application.

3.3. Inadequate engineering background and practical skills of some teachers

The automation program has certain advantages in terms of faculty strength, the number of teachers can meet the teaching demand, and there are experts from enterprises or industries serving as part-time teachers to provide students with diversified learning perspectives and practical experience. However, the professional experience of some new young teachers mainly focuses on academia, and they have no practical experience in engineering, which is lacking in cultivating students' ability to solve complex engineering problems.

In the field of automation, the engineering problems faced by students are often multidimensional and systematic, requiring the integrated use of multiple knowledge and skills to analyze and solve. However, the knowledge structure of new young teachers is relatively homogeneous. Although they have a strong theoretical foundation and research ability in academic research, their lack of direct contact with industrial sites and experience in actual engineering projects has led to a relatively superficial understanding of the actual production process, industry standards and technology applications, and a poor ability to solve complex engineering problems. In addition, young teachers who fail to contact the actual production process, and then in the course of teaching, it is difficult to provide students with real cases and practical experience, which affects the cultivation of students' professionalism and practical ability.

4. The implementation path of intelligent transformation

4.1. Improve students' comprehensive abilities

Based on the concept of OBE and keeping up with the needs of the industry, the theoretical curriculum system is reconstructed to consolidate the fundamentals and enhance students' logical thinking ability and their ability to analyze problems with comprehensive consideration of multiple factors.

The engineering basic and professional basic courses of automation majors have a large number of applications of mathematics and natural science knowledge, so the mathematical and scientific foundation of students is crucial to the learning of professional courses. In the cultivation program, the course of Discrete Mathematics is added to cultivate the abstract discrete thinking ability and strict logical reasoning ability of automation majors; the course of Operations Research and Introduction to System Engineering is set as a limited elective course to cultivate the ability of students to analyze and obtain the optimized decision-making plan under the situation of multi-objective, multi-stage decision-making and multi-evaluating factors, so as to solve the problem of the automation majors' weak ability of logical thinking and analyzing problems. Problems. Courses such as "Engineering Project Management", "Engineering Ethics" and "Environmental Protection and Sustainable Development" are added to cultivate students' engineering and humanistic qualities. These courses are taught by teachers of automation majors in conjunction with actual engineering projects to provide students with a theoretical knowledge base for solving complex engineering

problems by combining non-technical factors in their specialized courses of study.

4.2. A three-dimensional and progressive practical teaching system

To build a progressive practice teaching system of "basic practice, professional practice, comprehensive practice and innovation", and to cultivate students' three abilities of "engineering cognition, engineering practice and engineering innovation". It cultivates students' ability of "engineering cognition, engineering practice and engineering innovation", and guides students from "solving problems" to "problem solving". The automation program is oriented to solving complex engineering problems in the field of automation, and adheres to the talent cultivation concept of "foundation as the root, practice as the body, and innovation as the soul", and has constructed the practice teaching system by top-level design. Through the practice teaching links closely linked to industrial reality, the knowledge of specialized courses is applied to solve practical engineering problems, to comprehensively cultivate students' engineering practice ability and innovation ability, and to realize the transformation of students' ability from "solving problems" to "solving problems". The practice system is shown in Figure 1.

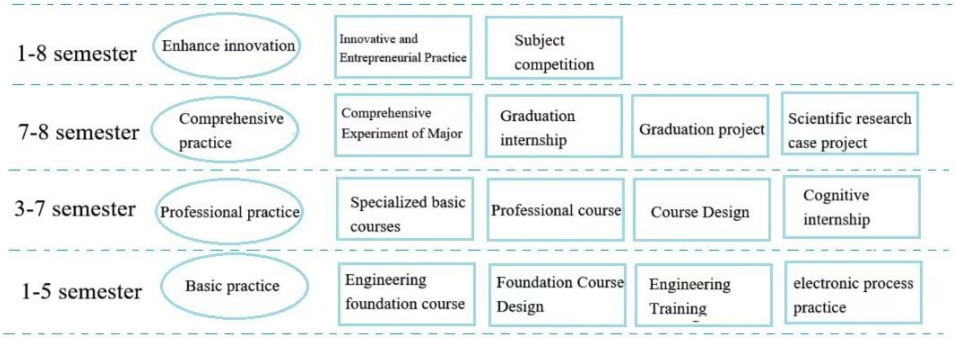

Figure 1: The practice system

4.3. Tripartite linkage of science, technology and industry to build a "dual-teacher, dual-capability" teaching force

Firstly, young teachers are encouraged and supported to participate in enterprise internships and engineering projects to enhance their practical working ability and engineering literacy. By regularly arranging teachers to go to enterprises for attachment or participate in project cooperation, we can help them better understand the industry demand and technology application, so as to enrich their knowledge structure. Secondly, establish communication and cooperation mechanisms both inside and outside the university, invite more industry experts and engineers to participate in teaching activities and share their practical experience and industry dynamics. This can not only provide students with richer learning resources, but also help young teachers expand their horizons and improve their teaching quality. In addition, professional development and training of teachers, especially in engineering practical skills and project management, are promoted to improve their overall quality and teaching ability. Through regular trainings and seminars, teachers are helped to update their knowledge and improve their skills so as to better serve the learning and growth of students. Finally, young teachers are encouraged to adopt project-driven and case-based teaching in their teaching, so as to involve students in actual engineering problem solving. In this teaching mode, teachers can take the role of guides to help students learn, think and innovate in practice, and cultivate their comprehensive ability and ability to solve complex problems. Through these measures, the teaching quality of automation majors can be effectively improved to cultivate talents with more practical ability and innovative spirit.

5. Effectiveness of professional upgrading

Based on the concept of international engineering education, combined with the characteristics of local institutions, we have constructed a chain progressive automation professional talent cultivation model based on the concept of OBE, which strengthens the cultivation of students' knowledge, ability and quality, and promotes the enhancement of students' engineering practice ability and innovation ability. The popularization and application of the results have achieved remarkable results.

5.1. Significant enhancement of students' engineering practice and innovation ability

Automation students have participated in many national, provincial and ministerial level college students' science and technology competitions, such as "Intelligent Vehicle Competition", "Siemens Cup Intelligent Manufacturing Challenge", "China Robotics and Artificial Intelligence Competition" and so on. China Robotics and Artificial Intelligence Competition", etc. A good learning atmosphere of encouraging hands-on and focusing on practice has been established among students, and the enthusiasm of automation students to participate in all kinds of science and technology competitions is high, with the participation rate exceeding 80%, and the practical application ability of most of the students has been effectively improved. Teachers of automation major have guided students to win 60 national awards, more than 300 provincial awards, 40 innovation and entrepreneurship program projects above the university level, and 30 excellent graduation designs above the university level.

5.2. Social recognition of graduates has increased dramatically

In the past five years, the overall recognition of the graduates by the society and enterprises has increased significantly, with the average employment rate reaching 90% and the proportion of admitted postgraduates reaching 35%; well-known enterprises such as Shandong Luneng Intelligent Information Technology Co. Ltd., Shandong Bosuo Automation Technology Co. Ltd. and Shandong Aotai Electric Co. Ltd. gave satisfactory evaluations on the students' ethical cultivation, engineering ability, teamwork ability, competitiveness in employment, lifelong learning ability, innovation ability and The ability and level of serving the society gave a satisfactory evaluation.

5.3. Effective professional development and teaching reform

The automation program has achieved remarkable results in professional construction, approved as a national first-class undergraduate program construction site, and passed the application for entry to the university for professional certification of engineering education. In terms of faculty construction, the academic and title structure of the faculty has become more reasonable, and the proportion of teachers with engineering background has been raised to 70%, forming a full-time and part-time combined faculty team with high moral character and excellent quality. Teachers' vitality has also been effectively stimulated, and the team has participated in and presided over more than 30 teaching, research and reform projects, achieved a number of provincial teaching honors, and constructed a number of online courses. In addition, the program has published a series of course ideology guidebooks covering five core courses, and the professional knowledge mapping has been basically completed. The quality of student resources has been greatly improved.

The automation program in Shandong Province has been improving its enrollment position for years. the lowest admission position in 2021 was 93881, the lowest admission position in 2022 was 90234, which is 3647 positions higher than in 2021; the lowest admission position in 2023 was

76353, which is 13881 positions higher than in 2022.

6. Conclusions

This paper centers on the development of automation industry on the new demand for innovative and applied personnel training, to establish moral character as the fundamental task, based on local institutions, in the face of automation professional cross-fertilization, strong engineering applicability, for the local automation of first-class professional engineering personnel training prevailing "logical thinking ability is not strong", "lack of engineering literacy and humanistic literacy", "practice and innovation ability", "ability to solve complex engineering problems" and other issues based on OBE exploration and practice, "engineering literacy and humanistic literacy", "insufficient practice and innovation ability", "insufficient ability to solve complex engineering problems", etc. Based on OBE, we have explored and practiced the upgrading path for automation majors, which will provide a good opportunity for other universities. Based on OBE, we explored and practiced the upgrading and transformation path of automation specialty, which provides a reference for other institutions.

Acknowledgements

Fund Project:

1) 2022 Research and Practice of Intelligent Transformation and Upgrading of Automation Specialties in the Context of New Engineering Subjects, a Special Topic for Higher Education Research of Shandong Higher Education Society

2) Qilu University of Technology (Shandong Academy of Sciences) 2024 School-level Teaching Research Project "Digital Intelligence Empowerment, Industry-Education Integration: Exploration of Multiple Collaborative Educational Models for Automation Majors in the Context of New Engineering Science ".

3) Qilu University of Technology (Shandong Academy of Sciences) School level Teaching Achievement Award "Exploration and Practice of Practical Teaching System for Electronic Information Majors in Innovative and Applied Local Colleges with Demand Orientation and Multi party Collaboration" (No. CGPY2405).

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