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Research on the Multidimensional Integration of Talent Cultivation in the Field of Electronic Information

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Abstract: *To adapt to the trends of the electronic information technology industry in the new era and meet the demands of the national strategy for revitalizing the country through science, technology, and education, a comprehensive analysis was conducted on the issues in the talent cultivation system for electronic information in universities. The problems identified included the insufficient integration of government, industry, academia, and research, as well as the lack of diverse collaborative practical platforms. In response to the challenges posed by the new era and the new economic context, new requirements for the qualities of talent in the information industry were explored. As a result, a "three-stage + six-module + N bases" model for talent cultivation in the electronic information engineering field, emphasizing the collaboration between government, industry, academia, and research, was proposed. Through practical teaching collaborations with leading electronic information enterprises such as 360 Group and ZTE Corporation, it was demonstrated that the construction of a diverse and collaborative talent cultivation system in the electronic information field can effectively integrate advantageous resources and provide a variety of collaborative practical platforms. This approach leads to a significant improvement in students' professional competence and innovation ability, playing a proactive role in cultivating high-level engineering talents that align with the national development needs of the era.*

Keywords: *Multivariate Collaboration; Electronic Information Engineering; Talent cultivation; System building*

1. Introduction

In the year 2020, during the initial commercialization phase of 5G technology, the outbreak of the COVID-19 pandemic demonstrated how 5G technology combined with smart healthcare could contribute to epidemic prevention and control. In the new normal of epidemic prevention and control, cutting-edge information technology played a crucial role in various aspects, such as resuming work and production, unmanned smart factories, remote work, and precise epidemic prevention and control.

5G technology, in particular, served as a fundamental infrastructure supporting the development of future industries in the new era, including autonomous driving, artificial intelligence, and intelligent manufacturing. At present, a new round of technological revolution and industrial transformation is reshaping the global innovation landscape and economic map, with electronic information engineering being a core driving force behind the transformation towards information technology.

Universities play a vital role in achieving major breakthroughs and disruptive innovations in critical technologies. To proactively respond to the changes in economic development in the new era, integrate into the global wave of information technology innovation, and meet the needs of national major strategies, it is urgent for universities to reform electronic information engineering education.

Henan University of Science and Technology, School of Information Engineering, has addressed the existing issues in the talent cultivation system for electronic information engineering. They have undertaken reforms to create the "three-stage + six-module + N bases" model for cultivating professionals in this field. The challenges they aimed to tackle included insufficient integration of government, industry, academia, and research in the current talent cultivation process, a lack of diverse collaborative practical

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platforms during comprehensive professional course teaching, students' inadequate practical skills during actual electronic information engineering practices, and insufficient innovation capabilities in engineering education. Through their reform efforts, the university has established a new talent cultivation model that focuses on three stages of development, six core modules, and the establishment of multiple bases to foster electronic information professionals with comprehensive skills, strong practical abilities, and enhanced innovation capabilities.

The "Three Stages" training objective divides the students' four-year tenure into three intersecting and progressive levels of professional competence. This step-by-step approach guides students towards their learning directions and clarifies the kind of electronic information talents that should be cultivated in the context of the new era, new economy, and emerging industries. The "Six Modules" collaborative practice scheme complements the "Three Stages" training objectives by providing a series of training programs. These programs focus on steadily improving the practical skills of electronic information talents, offering a pathway for discipline construction. The "N Bases" represent diverse and cross-disciplinary practice platforms, serving as crucial resources to support the "Six Modules" collaborative practice scheme. These bases effectively integrate the strengths of government, industry, academia, and research to ensure the successful implementation of the training objectives. By combining the "Three Stages," "Six Modules," and "N Bases," the institution is able to nurture electronic information professionals who are grounded in practical knowledge and continuously enhancing their professional competence. This approach also provides a clear roadmap for discipline development and guarantees the effective realization of the training objectives by integrating various resources from government, industry, academia, and research.

The "Three Stages + Six Modules + N Bases" talent cultivation system for electronic information professionals, with its multi-dimensional collaboration among government, industry, academia, and research, effectively harnesses the advantages of various resources in these sectors. It takes a proactive approach in strategically planning and optimizing the setup to serve the needs of the country's strategies and industries. Through this system, the nation can nurture and cultivate a group of exceptional engineering and scientific talents who possess the ability to innovate, undertake entrepreneurial endeavors, integrate knowledge across disciplines, and exhibit high-quality skills. This comprehensive approach to talent cultivation aligns with the nation's strategic goals and industry demands. By fostering a diverse and collaborative environment involving government, industry, academia, and research entities, it paves the way for the development of outstanding and cross-disciplinary electronic information professionals. These talents will be equipped with the capabilities to drive innovation, create new ventures, and contribute significantly to the advancement of engineering and technology fields.

2. Insufficiencies in the Current Talent Development System for Electronic Information Engineering

The electronic information-related disciplines have distinct characteristics, including broad knowledge coverage, fast iteration of cutting-edge technologies, high industrial demand, and close integration with advanced social production. The discipline of electronic information engineering is extensive, encompassing multiple fields in engineering education, such as computer science, communication engineering, control engineering, information technology, and electronic engineering. Breaking the boundaries between different disciplines and promoting the organic integration of knowledge systems from various fields are crucial in advancing the educational process. It is essential to cultivate students with a holistic mindset that transcends disciplinary boundaries and assists them in establishing personalized technical knowledge systems based on their individual development plans. This issue deserves significant attention in higher education for electronic information engineering.

Electronic information technology is the fastest-evolving technological force in human history. In 1958, Jack Kilby invented the integrated circuit, which marked the beginning of the 20th-century information revolution and heralded the arrival of the era of informatization. Following Kilby's invention, Robert Noyce developed commercially producible integrated circuits, propelling the semiconductor industry from the "invention era" to the "commercial era." Over the past six decades, the development of semiconductor chips has adhered to Moore's Law, driving the progress of the entire information technology industry.

In 1986, the first-generation mobile communication system was born in Chicago, using analog signal transmission for voice messages, but lacked global roaming capabilities. Thirty-five years later, the fifth-generation mobile communication technology has been commercially deployed, enabling the Internet of

Things. It has significantly advanced industrial intelligent manufacturing, networked collaboration, personalized customization, extended service capabilities, and digital management. It has facilitated the digitalization, networking, and intelligent transformation of industrial enterprises, becoming the infrastructure for advanced production in human society and directly contributing to the development of the Fourth Industrial Revolution.

Higher education in electronic information engineering needs to continuously consider how to design courses that keep pace with the rapid development of cutting-edge technologies and provide students with advanced technical practice platforms. Currently, electronic information technology has permeated various aspects of social production practices, bringing significant changes to the relationships between laborers, objects, and tools. It represents advanced productive forces and intelligent production has become a trend. Therefore, it is crucial to focus on cultivating students' ability to apply theoretical knowledge to practical situations, enhance their flexibility and innovation in applying electronic information technology, and use it to solve real-life production and living problems.

The current traditional talent cultivation system for electronic information engineering, which revolves around the discipline's knowledge structure, has several shortcomings that can be highlighted in the following aspects:

(1) The current talent cultivation process for electronic information engineering lacks a close integration of government, industry, academia, and research, falling behind the demands of the evolving era. In the new era and new stage, higher education should serve and support the country's major projects and development plans. It should actively collaborate with enterprises to conduct joint research and enhance the capacity for technology transfer and commercialization. However, the existing talent cultivation model, which revolves around the discipline's knowledge structure, is outdated and unable to meet the forward-looking requirements of the industry's development and technological exploration. As a result, the collaboration between universities and enterprises in scientific research is not well aligned, leading to a mismatch in meeting the current talent demand of the information industry [1-3].

(2) In the teaching process of comprehensive professional courses, there is a lack of diverse collaborative practical platforms, which fails to meet the practical needs of the interdisciplinary nature of electronic information. Electronic information engineering integrates theoretical foundations and engineering practices from various fields, such as information acquisition, signal processing, communication, control systems, and computer science [4]. However, currently, most practical courses offered by universities primarily focus on basic theoretical validation, and the practical platforms lack comprehensiveness, engineering relevance, and advanced capabilities. The equipment used in experimental courses is also outdated compared to the industry's development, leading to a disconnect between talent cultivation and industry demands [5,6].

(3) In actual electronic information engineering practice, students may lack solid technical skills and proficiency, and their innovative abilities might be inadequate to keep up with the rapidly changing market and industry demands. The field of electronic information engineering experiences rapid technological iterations and has a high degree of intelligence [7]. Compared to traditional engineering disciplines, the electronic information industry requires talents with strong practical and innovative abilities, who can compete internationally [8,9]. Enhancing students' innovative and practical capabilities is crucial to meet the talent demands for future emerging industries and the development of the new economy in the country [10].

3. "Three-Stage" Talent Development Objectives for Electronic Information Engineering

The "Three Stages" cultivation objectives divide students' four-year learning and practice into three progressive and interconnected levels, aiming to continuously enhance their expertise and innovation capabilities. The first stage focuses on foundational validation in the first and second years, followed by the second stage in the second and third years, which aims for comprehensive improvement. Finally, the third stage in the third and fourth years aims for expansive innovation.

The "Three Stages" talent cultivation objectives in electronic information engineering adhere to the guiding principles of "solid foundation, broad caliber, emphasis on practice, pursuit of innovation, and strong competence." It aligns with the Party's basic line, implements the new development concept, emphasizes moral education and the development of the whole person. The talent cultivation is oriented towards serving the electronic-empowered technology service industry and other related fields.

The objective is to cultivate well-rounded talents with comprehensive development of moral,

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intellectual, physical, and artistic qualities. These talents should possess a solid foundation in mathematical and physical sciences, a systematic understanding of professional theories, and knowledge of the trends, status, and frontiers of the discipline. They should be able to analyze key problems and technical challenges in electronic information engineering, effectively communicate and collaborate in multidisciplinary and multicultural research teams, and have a forward-looking international perspective and an exploratory spirit.

These talents are expected to have a clear understanding of engineering ethics, shoulder social responsibilities, uphold professional ethics, and continuously enhance their professional proficiency and innovative thinking through lifelong learning. They should be in sync with the country's long-term strategic demands and possess advanced application-oriented research skills in advanced electronic information technology.

3.1 Foundation and Validation Level

The foundational validation stage requires students to grasp the fundamental knowledge of electronic information engineering, which can be divided into two main parts: engineering fundamentals and professional fundamentals. Engineering fundamentals include basic mathematical courses such as calculus, matrix theory, and complex analysis. Professional fundamentals encompass courses such as analog electronics, digital electronics, information theory, signals and systems, and computer organization principles.

This stage aims to help students establish a solid theoretical foundation in the field, deeply understand the fundamental theorems and principles presented in the textbooks, and build a knowledge framework for electronic information engineering. It emphasizes cultivating students' engineering literacy. Through this stage of learning, students will master the essential theoretical knowledge related to the profession and be able to validate these theories through practical applications. This will lay a solid foundation for enhancing their comprehensive application capabilities in subsequent practical courses.

3.2 Comprehensive Improvement Level

The comprehensive improvement stage requires students to organically integrate the knowledge and skills acquired in the foundational validation stage and further study topics such as communication networks and systems, signal analysis and processing, and coding theory.

This stage places emphasis on cultivating students' engineering practical abilities, including comprehensive practical skills and design improvement capabilities. Students are expected to apply the theoretical knowledge they have learned to solve practical problems in the development and production of electronic information products and related industries. They should familiarize themselves with the production standards and technical specifications of electronic information products and be able to identify key issues and technical challenges in engineering projects. Based on existing technologies, they should propose feasible solutions to address these challenges.

3.3 Expanding and Innovative Level

The expansive innovation stage requires students to conduct research on complex engineering problems related to electronic information systems using scientific principles and methods, and to propose independent technical insights. This stage focuses on cultivating students' independent thinking and innovative consciousness, including comprehensive ability training and innovation and entrepreneurship training. Students are expected to have the ability to track cutting-edge technologies and maintain a lifelong learning mindset. They should be able to introduce new ideas, technologies, and methods in response to new demands arising from technological developments and industrial applications in the new era.

Students should actively embrace new concepts and be willing to explore across disciplines, specialties, and fields. They should be able to consider comprehensively the technological, social, economic, environmental, and other relevant factors that exist in electronic information engineering.

4. "Six Modules + N Bases" Talent Development System for Electronic Information Engineering

Henan University of Science and Technology, School of Information Engineering, has constructed a

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"Six Modules + N Bases" practical training system based on the requirements of the "Three Stages" cultivation objectives, which include the foundational validation stage, comprehensive improvement stage, and expansive innovation stage. This practical training system is guided by the multi-party collaborative practice plan and supported by diverse and cross-cutting practical platforms.

The "Six Modules" consist of the Engineering Fundamentals Training Module, Professional Fundamentals Training Module, Comprehensive Improvement Training Module, Design Improvement Training Module, Comprehensive Ability Training Module, and Innovation and Entrepreneurship Training Module. The Engineering Fundamentals Training Module and the Professional Fundamentals Training Module serve the objectives of the foundational validation stage. In the Engineering Fundamentals Training Module, students are provided with practical equipment and facilities for courses such as physics, analog and digital electronics, communication principles, and microcomputer principles, aiming to cultivate students' perceptual understanding of fundamental courses and the operating criteria for relevant engineering experiments, thus laying a solid foundation for the development of their comprehensive practical abilities.

The Comprehensive Improvement Training Module and the Design Improvement Training Module are designed to achieve the objectives of the comprehensive improvement stage. They undertake the curriculum design and training tasks for courses such as Electronics and Electrical Engineering Practice, Professional Comprehensive Practice, Embedded Systems, DSP, and Circuits. Through a series of electronic information engineering-related practical training, hands-on experiences, and course design, these modules assist students in integrating relevant knowledge, understanding the process of engineering project management, and gradually establishing their own technical research direction based on their interests.

The Comprehensive Ability Training Module and the Innovation and Entrepreneurship Training Module serve the objectives of the advanced expansion stage. Through practical activities such as scientific competitions, research projects, graduation designs, and corporate internships, they strengthen the collaboration between the university and enterprises, enhance students' innovative application abilities, and improve their employability and competitiveness in the job market.

To support the practical implementation of the "Six Modules," the university has established a diverse and cross-disciplinary practice platform for electronic information engineering. The "N Bases" mainly consist of the university's public practice teaching platform, comprehensive professional laboratories, industry-academia-research cooperation bases, as well as national, provincial, and university-level diversified collaborative practice and innovation platforms for talent cultivation.

The university's public practice teaching platform provides practical teaching resources for engineering fundamental courses. The comprehensive professional laboratories and industry-academia-research cooperation bases introduce advantageous engineering resources from relevant industries, serving as practical platforms for the three training modules: Engineering Fundamentals, Comprehensive Improvement, and Design Improvement in electronic information engineering.

Moreover, the national, provincial, and university-level diversified collaborative practice and innovation platforms offer resources such as corporate internships, scientific competitions, research projects, and innovation and entrepreneurship practices for the Comprehensive Ability Training Module and the Innovation and Entrepreneurship Training Module, creating a platform to explore and combine research, competitions, and learning for fostering talent.

4.1 Multi-party Collaborative Practical Program

Based on the training objectives of the Engineering Fundamentals, two major basic training modules have been established: the Engineering Fundamentals Training Module and the Professional Fundamentals Training Module. The Engineering Fundamentals Training Module is responsible for the experimental verification of common basic courses for engineering students and includes physics experiments, circuit experiments, electrical engineering experiments, computer practices, and metalworking internships. The Professional Fundamentals Training Module provides experimental verification for the core courses of electronic information engineering, such as electromagnetic field experiments, communication principles experiments, microcomputer principles experiments, DSP experiments, and mobile communication experiments. Through the practical training in these basic modules, students will develop a more intuitive understanding of the fundamental theories of electronic information engineering. They will be able to apply the learned theories through related experiments and gain a clear understanding of the relevant theoretical knowledge applied in engineering projects.

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Based on the training objectives of the Comprehensive Improvement, two major improvement training modules have been established: the Comprehensive Improvement Training Module and the Design Improvement Training Module.

The Comprehensive Improvement Training Module includes comprehensive professional experiments, electronic and electrical engineering practices, awareness internships, and production internships. Through these practical activities, students will gain an understanding of the technical requirements and operating standards in the actual development process of electronic information-related projects. They will also develop a deeper understanding of the production processes of relevant products.

The Design Improvement Training Module focuses on course design and includes embedded system course design, circuit course design, and DSP course design. Through this module, students will gradually enhance their research and development capabilities in electronic information engineering projects. They will be able to comprehensively analyze project requirements, establish critical technologies needed for the project, and implement the design based on the project's objectives and solutions.

Based on the training objectives of Expanding and Innovating, two major training modules have been established: the Comprehensive Ability Training Module and the Innovation and Entrepreneurship Training Module.

The Comprehensive Ability Training Module includes graduation design, graduation internship, research papers, and enterprise internships. This module focuses on enhancing students' comprehensive literacy in theory, practice, and application. It aims to cultivate students who not only possess the professional expertise in developing electronic information engineering projects but also have the ability and methods to showcase their development plans and technical concepts.

The Innovation and Entrepreneurship Training Module includes projects in innovation and entrepreneurship, participation in technology competitions, study of cutting-edge topics in the field, involvement in faculty research projects, and hands-on experience in innovation and entrepreneurship. Through diverse and multi-level academic activities and technology competitions, this module helps students to understand the cutting-edge developments in the discipline, enhances their enthusiasm for scientific research, and stimulates their creativity. It effectively encourages students to embrace the ideals and beliefs of lifelong learning, innovation, entrepreneurship, and service to society.

4.2 Multi-dimensional Cross-disciplinary Practice Platforms

The Public Practice Teaching Platform primarily undertakes the practical tasks of the Engineering Foundation Training Module. It is equipped with various laboratories for subjects like physics, circuits, electrical engineering, and computer science, providing support for the teaching of common foundational courses. In these laboratories, instructors lead students to conduct experiments, verifying their intuitive understanding of the fundamental theoretical knowledge from the textbooks, familiarizing them with the experimental procedures, and enhancing their practical hands-on skills. This lays a solid foundation for their subsequent studies in specialized courses.

The Professional Comprehensive Laboratory and the Industry-University-Research Cooperation Base support the practical requirements of the Professional Foundation Training Module, Comprehensive Enhancement Training Module, and Design Enhancement Training Module.

The Professional Comprehensive Laboratory provides students with experimental resources related to electromagnetic fields, communication principles, mobile communications, and other relevant courses. Through practical experiences, students gain a deep understanding of the theoretical foundation of electronic information engineering, discover the beauty of the discipline, and cultivate research interests in electronic information engineering.

The Industry-University-Research Cooperation Base is jointly established by the university and related enterprises in the field of electronic information engineering. It provides students with guidance for practical training, production internships, embedded system course design, DSP course design, and other specialized courses. Through in-depth collaboration with enterprises, students are led to visit exhibition halls, research centers, and production workshops, and invited to receive explanations from research and development personnel about the production process, industry development status, and future directions of electronic information products. Students are recommended to participate in production internships and training to acquire production skills within cooperating enterprises. This allows them to combine their theoretical knowledge with practical production, gain in-depth insights into electronic information industry products, and receive guidance from engineers and course instructors in completing course designs. Through these experiences, students develop comprehensive abilities and realize the transformation of theoretical knowledge into practical project engineering.

The national, provincial, and university-level diversified and collaborative practice innovation platforms focus on scientific research innovation training and technology competitions. They carry out explorations and innovations in areas such as mobile communications and signal processing, intelligent collaborative control, and big data analysis and mining techniques. The aim is to enhance students' comprehensive abilities and innovation levels. The platform provides students with electronic information engineering-related scientific research projects, cutting-edge lectures, and various academic competitions.

To increase students' enthusiasm for participating in mentor-led research projects and to stimulate their curiosity and exploratory spirit, the university has established the SRTP (Students' Research Training Program) fund. Students can also apply for SRTP projects to explore the path of scientific research based on their interests and innovative ideas. The output and experience gained from these projects can assist students in completing their graduation design and scientific research papers.

The university has continuously organized the "College Student Science and Technology Culture Art Festival" for sixteen sessions, and has held a series of professional-related competitions such as "Internet+" Innovation and Entrepreneurship Competition, "Challenge Cup" National College Student Extracurricular Academic Science and Technology Works Competition, "National College Student Mathematical Modeling Competition," "Energy Equipment Competition," "National College Student Electronic Design Competition," and "Freescale Smart Car Competition" for many years. By promoting research through competitions and enhancing learning through competitions, the university encourages students to think creatively and fosters an innovative environment.

To support students in these competitions, the university has established various electronic information project competition laboratories, including the "Intelligent Car Laboratory," "Robot Laboratory," and "Intelligent Control Laboratory." These laboratories provide students with competition projects, experimental materials and environments, funding, and technical support, helping them implement new ideas and designs, and enhancing their innovative drive and practical skills. This forms a positive cycle of knowledge discovery, exploration, implementation, and rediscovery.

The university regularly invites renowned scholars and experts in electronic information, communication, computer science, and the Internet of Things to conduct lectures, broadening students' horizons and understanding the forefront of electronic information technology and the current development of the industry. The university also organizes innovation and entrepreneurship exchange meetings, inviting engineers, founders, and distinguished alumni from relevant companies to discuss industrial layout, technological applications, and national policy trends. This provides students with career guidance and helps them smoothly transition from graduation to employment.

5. Conclusion

This article addresses prominent issues in the existing electronic information engineering talent cultivation system, such as the insufficient integration of government, industry, academia, and research; the lack of diverse collaborative practical platforms in comprehensive professional course teaching; and the inadequate practical skills and innovation abilities of students in engineering practices. In response to these challenges, it proposes a multi-faceted and collaborative model for cultivating electronic information engineering talents called "Three Stages + Six Modules + N Bases."

The "Three Stages" set new goals for the cultivation of electronic information engineering talents, clarifying the direction for talent development in the new era. The construction of "Six Modules + N Bases" brings together diverse collaborative resources from government, industry, academia, research, and applications. This creates practical platforms that are seamlessly integrated into teaching, providing vital support for the cultivation of electronic information talents in the new era.

Recent teaching practices have shown that the establishment of a multi-faceted collaborative talent cultivation system in electronic information engineering can effectively increase students' interest in research and learning, enhance their professional expertise, practical capabilities, and innovative potential. Furthermore, it can bridge the gap between talent cultivation in universities and the needs of society. This model has the potential to nurture a group of outstanding electronic information engineering talents that align with the development requirements of the country's new era economy, industry, and

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politics.

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