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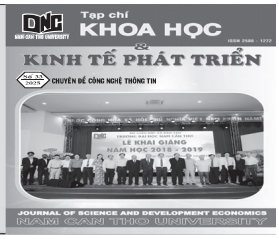

Collaboration in the field of electrical, electronic, and semiconductor technology engineering training

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ABSTRACT

In response to the increasing demand for skilled professionals in the fields of electrical, electronic, and semiconductor circuit engineering technology, many universities and academies are now offering training programs in these areas. This article aims to analyze the necessary requirements, capabilities, and methods for cooperation between universities and academies in order to ensure high-quality training and continuous development. Collaboration can take place between institutions offering similar or related majors, within a specific region or nationwide, between institutes, schools, and businesses, and even with foreign educational institutions. In particular, this article highlights the benefits of collaboration in the current era of technology, with the use of new forms and methods.

TÓM TẮT

Trước những yêu cầu cao về nguồn nhân lực cho ngành công nghệ kỹ thuật điện, điện tử và vi mạch bán dẫn, có nhiều trường đại học và học viện triển khai mở các ngành đào tạo này. Bài viết này sẽ phân tích các yêu cầu, khả năng, phương thức hợp tác giữa các trường đại học, học viện nhằm bảo đảm chất lượng đào tạo và không ngừng phát triển. Việc hợp tác có thể thực hiện giữa các trường có đào tạo cùng ngành hoặc các ngành gần; hợp tác theo từng khu vực, trong toàn quốc; hợp tác giữa các viện, trường và các doanh nghiệp; hợp tác với các cơ sở giáo dục nước ngoài; đặc biệt là những thuận lợi của sự hợp tác trong kỷ nguyên thông minh với những hình thức và phương thức mới.

1. INTRODUCTION

Resolution No. 23-NQ/TW, dated March 22, 2018, by the Politburo, on the direction of developing national industrial policies until 2030, with a vision towards 2045, indicates that "A harmonious combination of both extensive and intensive industrial development should be prioritized, with an emphasis on depth to achieve breakthroughs in productivity, quality, and competitiveness in industrial products. Taking full advantage of Vietnam's demographic dividend, leveraging the Fourth Industrial Revolution, and commercial benefits to rapidly and intensively develop strategic foundational industries with competitive advantages is vital. The primary focus should be on developing information technology and electronics industries, with a central emphasis on processing and manufacturing industries, and breakthroughs in smart manufacturing, emphasizing green industry development." By 2030, the goal is for high-tech industrial products to account for at least 45% of the processing and manufacturing sector's value, meeting the demands of the Fourth Industrial Revolution to create a digital technology foundation for other industries [2].

The recent upgrade in the Vietnam – U.S. bilateral relations to a Comprehensive Strategic Partnership is expected to boost Vietnam's economic development, especially in science, technology, and innovation cooperation as a breakthrough. Vietnam's high-tech economic development focus aligns with the U.S. strategy of supply chain formation in Southeast Asia.

In Resolution No. 124/NQ-CP, concluding the Government's regular meeting in July 2023, the Vietnamese Government assigned relevant ministries to promptly build and implement a project to develop a workforce of 30,000 to 50,000 in the semiconductor electronics fields by 2030 to supply personnel for Vietnam's high-tech industries [5].

The demand for training in electrical engineering, electronics, and semiconductor technology is clear. Many universities and academies (hereafter referred to as universities) have planned to introduce these majors in the upcoming academic years. In the Mekong Delta region, several universities, including Nam Can Tho University, have also planned to open these programs and begin admissions for the 2024-2025 academic year.

Given the specific requirements of electrical engineering, electronics, and semiconductor technology sectors, workforce training demands robust training institutions with substantial facilities, modern and synchronized lab equipment, advanced training programs, a qualified faculty, and an effective collaboration network. Collaboration between domestic and international educational institutions and enterprises is a key factor in boosting research and training capacity. This study focuses on the areas and methods of collaboration in training, especially in the fields of electrical engineering, electronics, semiconductor technology, and electronic circuit design.

2. RESEARCH METHODS

In this study, we rely on the current regulations of the Government and the Ministry of Education and Training on the training of human resources for the Engineering Technology industry, especially in the fields of Electrical, Electronics, Computer, and Semiconductor IC Design. Legal documents such as Resolutions, Circulars, and Decisions will be used to clarify

the groups of training professions, the requirements for the capacity of educational institutions, the quality of training, and the development orientation. We also refer to school-business cooperation models, training ecosystem theory, in order to clarify the roles and relationships between stakeholders, combine to learn about the cooperation situation of schools and domestic agencies, the cooperation situation between schools and businesses, etc. , the ability to cooperate between domestic and foreign schools. From there, it determines the requirements and cooperation methods in training human resources for majors in electrical, electronic, semiconductor engineering technology and semiconductor IC design; cooperation between schools with training in the same major and close majors in the group of disciplines; the cooperation between schools that are geographically close to each other; cooperation between schools and businesses; the coordination between domestic educational institutions and foreign training institutions; Cooperation methods in the intelligent era. To determine the requirements and cooperation methods, we have analyzed the documents including: Training programs at major universities at home and abroad, especially in Electrical and Electronic Engineering, Computers and Semiconductor ICs; reports on cooperation between schools and businesses in Vietnam; guidance and orientation from international organizations on cooperation in training and human resource development. We think that, in the context of limited facilities and human resources of many universities, training institutions, especially newly opened schools majoring in Electrical Engineering Technology, Electronics and Semiconductor Circuits, to ensure the quality of training, Comprehensive cooperation is an urgent requirement. In order to fully exploit the potential of training institutions, cooperation is not only limited to majors but needs to be expanded to nearby majors. Therefore, it is necessary to study training programs to identify specialties that are close to determine the ability and level of cooperation. To strengthen cooperation, we also need to strengthen cooperation between training institutions that are geographically close to each other.

3. RESULTS AND DISCUSSION

3.1 Demand for collaboration in human resource training for electrical and electronic technology, semiconductor engineering, and semiconductor design

As mentioned, the fields of Semiconductor Engineering Technology, Semiconductor IC Design along with the disciplines of Electrical Engineering Technology, Electronics, and Computer Engineering in Vietnam have great opportunities to participate deeply in the value chain and supply chain of high-tech industries. Decision No. 1017/QD-TTg dated September 21, 2024 has approved the Program "Human resource development in the semiconductor industry to 2030, orientation to 2050". This program affirms that human resources in the semiconductor industry are "breakthroughs of breakthroughs" in training high-quality human resources, are prioritized for development. The common goal is to develop quality human resources in the semiconductor industry, in which at least 50,000 human resources with a university degree or higher are trained to serve the semiconductor industry in all stages of the value chain in the

semiconductor industry. Following the development of the Semiconductor Industry, we realize that Electrical and Electronic Engineering Technology is both the foundation and the application environment of Semiconductor Technology. In Vietnam, the training disciplines of Electrical and Electronic Engineering Technology, Computer Engineering have had a long development process with many universities, strong lecturers and adequate facilities. Meanwhile, Semiconductor Engineering Technology and Semiconductor IC Design have only been invested in training in recent years and especially many schools will open this major from the 2024-2025 academic year. Of course, there will be many schools that lack lecturers and practical facilities, both hardware and software. In this context, the issue of training cooperation between domestic and foreign schools, between schools and enterprises is a decisive factor for the quality of training and development. In the new era, the intelligent era, also opens up new possibilities and modes of cooperation [1],[7],[8],[9].

3.2 Collaboration between universities with the same or similar fields

As of the 2024-2025 academic year, there are more than 15 universities in Vietnam that have implemented training programs related to IC design and the semiconductor industry (Hanoi University of Science and Technology, University of Technology - Hanoi National University, University of Information Technology - Vietnam National University Ho Chi Minh City, University of Da Nang, University of Science and Technology - Can Tho University, Dai Nam Can Tho University, Can Tho University of Engineering and Technology, University of Science and Technology, Phenikaa University, FPT University, Ho Chi Minh City University of Science and Technology, Ho Chi Minh City University of Natural Sciences, CMC University, Saigon International University,…

This number is likely to increase. Formal and comprehensive cooperation between universities in the disciplines of Electrical and Electronic Engineering Technology, IC Design and Semiconductor Technology is currently not popular and is mainly through visiting lectures [1]. Therefore, in order to ensure the Government's training targets under the program "Developing human resources in the semiconductor industry by 2030, it is first necessary to strengthen cooperation between schools with training in the same industry. However, in order to take advantage of resources, cooperation can and should also be carried out between schools with training in "close disciplines". Because in the training program, there are many modules that are similar or equivalent. Therefore, they can support each other according to modules. We have pintegrate the existing curricula of domestic educational institutions to identify majors that are close to the majors of Electrical and Electronic Engineering, IC Design and Semiconductor Technology, thereby, identifying majors that can be linked and cooperated in training. Cooperation also needs to be carried out comprehensively, in terms of lecturers, laboratories, learning materials, in the development of training programs, in scientific research and in accreditation.

According to Circular No. 09/2022/TT-BGDĐT, the Circular on the List of Higher Education Training Programs, the Electrical, Electronics, and Telecommunications Engineering Technology Group (Code 75103)

includes the following specializations: Electrical and Electronics Engineering Technology (Code 7510301); Electronics and Telecommunications Engineering Technology (Code 7510302); Automation and Control Engineering Technology (Code 7510303). The Electrical, Electronics, and Telecommunications Engineering Group (Code 75202) encompasses: Electrical Engineering (Code 7520201), Radar-Navigation Engineering (Code 7520204), Acoustic Engineering (Code 7520205), Marine Engineering (Code 7520206), Electronics and Telecommunications Engineering (Code 7520207), Biomedical Engineering (Code 7520216), and Automation and Control Engineering (Code 7520216). The Computer Science Group (Code 74801) includes majors such as Computer Science (Code 7480101), Computer Networks and Data Communications (Code 7480102), Software Engineering (Code 7480103), Information Systems (Code 7480104), Computer Engineering (Code 7480101), Artificial Intelligence (Code 7480107), and Computer Engineering Technology (Code 7480102). The Information Technology Group (Code 740802) includes specializations such as Information Technology (Code 74080201) and Information Security (Code 7480202). Typically, departments or faculties select closely related majors for training purposes. We have examined the training programs of domestic universities, compared these programs, and identified closely related majors based on two criteria: they are taught within the same department or faculty and have approximately 60% similar foundational and specialized courses in the curriculum.

From the aforementioned specialization groups, we have identified related majors in the fields of electrical, electronics, and semiconductor technology, as follows: Electrical and Electronics Engineering Technology (Code 7510301), Electronics and Telecommunications Engineering Technology (Code 7510302), Automation and Control Engineering Technology (Code 7510303), Electronics and Telecommunications Engineering (Code 7520207), Automation and Control Engineering (Code 7520216), Computer Engineering (Code 7480101), and Semiconductor Technology or Semiconductor Circuit Design. Currently, the Ministry has not assigned a code for Semiconductor Engineering Technology, so universities often introduce semiconductor courses as an elective direction within programs such as Computer Engineering, Electrical Engineering Technology, and Telecommunications [6].

Currently, the training of circuit design and semiconductor engineers is only concentrated in a few universities in Vietnam, mainly at specific institutions such as Ho Chi Minh City University of Technology (around 26%), University of Science – Vietnam National University Ho Chi Minh City (18%), Ho Chi Minh City University of Technical Education (12%), Hanoi University of Science and Technology (9%), Can Tho University (7%), and University of Information Technology – Vietnam National University Ho Chi Minh City (6%). Formal partnerships between universities are minimal, primarily involving individual guest lectures and invitations to conferences and seminars [1],[4]. It should be emphasized that collaboration between universities with closely related majors is not limited to faculty exchange, laboratory resources, materials, or textbooks. Rather, it is

comprehensive cooperation, including mutual support in developing training programs, accreditation, scientific research, and more.

3.3 Cooperation among geographically close universities

Although in today's smart era, there are many advanced technologies that support remote cooperation, both domestically and internationally, in various collaborative forms, universities located near each other have certain special advantages. First, it is easier to provide *direct support* in terms of faculty and facilities, saving costs. Universities in the same area often have a good understanding of each other, a friendly relationship, and a tradition of cooperation in training and scientific research aimed at regional development, with support from local authorities. VNUR (Vietnam's University Rankings) has classified universities into six economic regions: the Northern Midlands and Mountains, the Red River Delta, the North Central and Central Coast, the Central Highlands, the Southeast, and the Mekong Delta [12].

On the morning of March 17, 2024, at the Department of Science and Technology in Can Tho City, a ceremony was held to sign a cooperation agreement for training human resources in electronics and semiconductor fields between the Department of Science and Technology of Can Tho City, Polytechnic School - Can Tho University, Can Tho University of Engineering and Technology, and Sun Edu International Education Corporation [4]. We hope this model will be expanded to other universities with training programs in electrical, electronics, and semiconductor engineering technology in the Mekong Delta region, such as Tra Vinh University, Vinh Long University of Technology Education, and Nam Can Tho University.

3.4 Cooperation between universities and enterprises

Students who graduate without finding employment, while businesses are unable to recruit workers who meet their needs and therefore must retrain employees, are common issues. To address this challenge, it is necessary for universities and businesses to "join hands" in training students. The cooperation between universities and enterprises is a demand from both sides. From the perspective of universities, businesses are not only places for student visits and internships but also contribute to setting the objectives and content of training programs to meet practical requirements. Businesses participate in accreditation, quality assessment, and serve as real-world environments for faculty and researchers through research and product development collaboration. Skilled employees from enterprises can also be invited as visiting lecturers, participate in academic activities, contribute funding for training, and provide facilities to support training, as well as improve the material life of university staff and lecturers.

From the perspective of enterprises, through internship supervision, businesses have the opportunity to monitor and accurately evaluate students' work attitudes, knowledge, and capabilities to make informed recruitment decisions. By engaging in scientific research collaborations, enterprises gain access to the latest research outcomes, enabling them to apply these advancements quickly in their business operations. Businesses can also commission high-quality and practical research from universities to improve their products.

Additionally, the government offers tax incentives for enterprises that actively contribute to training.

Socially, cooperation between universities and enterprises helps reduce the burden on the state budget, thereby contributing to economic development, creating jobs, and reducing the unemployment rate among recent graduates. The ultimate goal is to benefit students, who gain access to an optimal learning environment, an updated knowledge system, training in professional and soft skills, and increased employment opportunities upon graduation [7].

Currently, in Vietnam, numerous foreign companies, such as Intel, Amkor, Marvell Technology, Faraday Technology, Renesas Corp., Synopsys, Cadence, Keysight Technology, Global Foundries, and the U.S. Semiconductor Industry Association, will collaborate with the National Innovation Center to establish training and research centers, advancing to the design of chip and semiconductor products in Vietnam. This presents an opportunity for cooperation in training fields related to electrical, electronics, and semiconductor design engineering.

3.5 Collaboration between domestic educational institutions and foreign training institutions

In the context of globalization, international cooperation in education and training is an inevitable trend for all nations and universities. Following the Party's policies and the State's laws, in recent years, Vietnamese universities have achieved significant outcomes in international education and training cooperation, contributing to Vietnam's international integration and helping train a high-quality workforce for national industrialization and modernization. In addition to national, ministerial, provincial, and city-level projects, universities have also collaborated with many reputable foreign training institutions to improve training quality and boost their institutional rankings.

On the morning of December 16, 2022, the G7 Group, consisting of seven technical universities, signed a cooperation agreement in the field of educational internationalization, focusing on international accreditation and ensuring quality standards that meet the requirements for an internationally competitive workforce. The universities in this group include Ho Chi Minh City University of Technology, Hanoi University of Science and Technology, Danang University of Technology, Hanoi University of Civil Engineering, University of Transport and Communications, Thuyloi University, and Hanoi University of Mining and Geology. Joint activities organized by the group include self-assessment, accreditation, external evaluation; sharing documents for internal quality assurance systems; providing resources to implement quality assurance efforts, improving training quality; implementing quality assurance processes; digital transformation in quality assurance and accreditation; and measurement, evaluation, forecasting, and improvement efforts. The G7 model serves as an exemplary initiative in practice.

Currently, all universities in Vietnam are particularly interested in cooperation with foreign educational institutions. It can be said that this is a general trend, with an increasing demand for international training cooperation in terms of scale and complexity, as well as diverse methods,

accompanied by rising quality expectations, requiring Vietnamese partner universities to invest in both infrastructure and human resources. The semiconductor engineering technology training major, in particular, is a newly emerging field in Vietnam, with few universities offering programs in this discipline. Infrastructure is newly developed, faculty members are limited in number and experience in curriculum development and teaching methods. Thus, it is essential to strengthen cooperation, particularly with foreign training partners [3],[10],[11].

3.6 New collaboration methods in the smart era

We are now in the smart era. The development of artificial intelligence, big data, the Internet of Things, and other advanced technologies has significantly changed how we live and work, creating a strong, promising digital environment. Technology has deeply penetrated many fields, from industrial production to services, education, healthcare, transportation, and more. Therefore, collaborative training among universities now takes on many new forms, overcoming spatial and temporal barriers. Teaching, conferences, and seminars can be conducted online in cases where physical gatherings are not feasible. Learning materials and references can be stored in digital libraries as e-books or videos, which can be exchanged and accessed via the Internet. Equipment, tools, and lab facilities (software or hardware) can also be virtualized and optimized, supporting remote learning and research. Geographical distance no longer hinders collaboration, even internationally. These new technologies are particularly well-suited for training in electrical, electronics, and semiconductor engineering fields. Smart-era technologies such as Virtual Reality (VR), Augmented Reality (AR), Extended Reality (XR), and generative AI, integrated into cloud computing and the 3D Metaverse, enable training collaboration between educational institutions domestically and internationally, free from spatial, temporal, and physical infrastructure limitations. Collaboration between universities and enterprises in the smart era also becomes more convenient, flexible, and adaptable with the support of new technology.

4. CONCLUSION AND RECOMMENDATIONS

In response to the government's project of developing a workforce of 30,000 to 50,000 people by 2030 in the semiconductor electronics fields, many universities have announced plans to launch specialized training programs in electrical engineering, electronics, semiconductor technology, and semiconductor circuit design. Many universities are just beginning to invest in these areas, so they still face limitations in human resources and facilities. To ensure training quality, universities offering similar or related majors must collaborate, as well as partner with enterprises. These collaborations could be within regions, nationwide, or with international training institutions, which is crucial. If these partnerships are led by the government or local, provincial, or municipal authorities, they are certain to be more effective. The training collaboration model in electronics and semiconductor technology between the Department of Science and Technology of Can Tho City, Can Tho University of Technology and Engineering, and Sun Edu International Education Corporation is an exemplary model and should include more

universities in the Mekong Delta region offering these majors in the coming academic year, such as Tra Vinh University, Vinh Long University of Technology Education, and Nam Can Tho University. This model should also be expanded nationwide. The G7 model of seven major universities is also exemplary in collaborative efforts toward internationalizing education. Collaboration goes beyond sharing human resources and equipment and includes comprehensive cooperation in program development, accreditation, scientific research, and technology transfer. In the smart era, new technologies enhance cooperation efficiency, overcoming space and time constraints and reducing reliance on physical facilities and financial resources.

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