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# Innovative Approaches to Talent Development in Optoelectronic Information Science and Engineering under the Emerging Engineering Perspective

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**Abstract:** In the context of the accelerated evolution of scientific and technological revolutions and industrial transformations, the development of emerging engineering education has become a key direction for reforms in higher engineering education. As a frontier discipline, Optoelectronic Information Science and Engineering has been widely applied in fields such as communications, healthcare, and energy. However, traditional training models can no longer meet the innovation-driven and practice-oriented talent requirements of emerging engineering. Thus, exploring innovative pathways for talent cultivation in this discipline has become imperative. Focusing on this issue, the present study examines innovative approaches to talent cultivation in the field. It analyzes the new requirements posed by emerging engineering education, and proposes pathways such as curriculum system optimization, enhanced practical teaching, and strengthened faculty development. The aim is to offer references for cultivating high-quality talents in Optoelectronic Information Science and Engineering who can meet the needs of emerging engineering, thereby promoting the sustainable development of the discipline and responding to the urgent societal demand for qualified professionals.

**Keywords:** emerging engineering, Optoelectronic Information Science and Engineering (OISE), talent cultivation pathways, innovative research

## 1. Introduction

Against the backdrop of rapid scientific and technological development, the concept of emerging engineering has gradually gained prominence, emphasizing interdisciplinary integration, the cultivation of practical competencies, and adaptability to emerging technologies. As a highly advanced and application-oriented discipline, Optoelectronic Information Science and Engineering is experiencing new developmental demands under the framework of emerging engineering. Traditional talent cultivation pathways can no longer meet the societal needs for professionals in this field under the emerging engineering paradigm. Therefore, exploring innovative approaches to talent cultivation in Optoelectronic Information Science and Engineering holds significant practical value. This paper conducts an in-depth analysis of the current status of talent cultivation in this discipline and explores innovative pathways that align with the development of emerging engineering.

## 2. New Requirements of Emerging Engineering for Talent Cultivation in Optoelectronic Information Science and Engineering

### 2.1 Strengthening the integration of interdisciplinary knowledge

Emerging engineering emphasizes interdisciplinary integration, and Optoelectronic Information Science and Engineering is one of the typical interdisciplinary fields. It requires breaking traditional disciplinary boundaries and establishing a

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knowledge system centered on optics and electronics while integrating computer science, materials science, and related disciplines (Qin & Li, 2024). On the basis of understanding the properties and fabrication processes of optoelectronic materials, students must not only master the fundamental theories of physical optics and engineering optics but also acquire essential skills in electronics and computing, such as circuit design, signal processing, and embedded system development.

This complex knowledge structure calls for the incorporation of interdisciplinary course modules into the training program, such as "Optoelectronics and Computer Interface Technology" and "Optoelectronic Materials and Device Design." Additionally, it is necessary to promote the dynamic updating of course content to ensure alignment with the latest developments in optoelectronic technologies.

### 2.2 Emphasizing the cultivation of engineering practice and innovation capabilities

Emerging engineering is proposed with the intention of responding to future changes and shaping technological development, thus requiring the cultivation of innovative talents capable of addressing complex engineering problems. In this regard, the Optoelectronic Information Science and Engineering program needs to establish a stepwise training model of "theory–practice–continuous innovation."

In practical training, multiple platforms—such as laboratories and engineering training centers jointly built by universities and enterprises—can be utilized to strengthen students' hands-on abilities in optoelectronic device testing, optoelectronic system integration, and related operations. The innovation component can adopt a research project–driven model to encourage students to participate in supervisors' research projects or conduct self-designed optoelectronic innovation projects, thereby cultivating their ability to identify problems, design solutions, and tackle technical challenges (Liu et al. , 2025).

Moreover, integrating innovation and entrepreneurship education into the curriculum is essential. Courses such as "Introduction to Entrepreneurship in Optoelectronic Technology" and "Intellectual Property Management" can enhance students' awareness of technological commercialization and business operations.

## 3. The Value of Innovating Talent Cultivation Pathways for Optoelectronic Information Science and Engineering under the Perspective of Emerging Engineering

### 3.1 Promoting discipline development through deep alignment with industry needs

The innovation of talent cultivation pathways under the emerging engineering framework can drive the Optoelectronic Information Science and Engineering program to more accurately align with industrial demands. By establishing a demand-oriented curriculum system, such as offering frontier courses like "Intelligent Optoelectronic Systems" and "Fiber Optic Sensing Technology," students are equipped with core skills urgently needed by the industry. Furthermore, through joint development of training programs and co-construction of practical training bases with enterprises, the synchronization between teaching content and the latest industry technologies can be ensured (Wu et al., 2025).

This integrated model of industry–academia–research–application not only enhances the discipline's capacity to serve local economic development, but also provides the optoelectronic industry with interdisciplinary talents who possess strong engineering practice and innovation capabilities, thus supporting regional industrial upgrading.

### 3.2 Enhancing students' employment competitiveness and career development potential

Innovative cultivation pathways under the emerging engineering paradigm—by strengthening interdisciplinary integration, engineering practice, and innovation capabilities—significantly enhance students' employability. For example, students with a combined background in "optoelectronics +

computer science" have strong advantages in emerging fields such as artificial intelligence and autonomous driving; similarly, students proficient in optoelectronic system integration and debugging can more readily meet the job requirements of optoelectronic manufacturing enterprises (Liu & Wang , 2025).

In addition, integrating innovation and entrepreneurship education with internationalized training helps students develop lifelong learning abilities and a global perspective, laying a foundation for career advancement from technical positions to managerial or research roles, and ultimately extending their professional career cycle.

### 3.3 Driving the transformation of educational models from "Knowledge Transmission" to "Capability Development"

Traditional education in optoelectronic-related disciplines has primarily emphasized theoretical instruction, whereas emerging engineering requires the reconstruction of educational models with capability cultivation as the core. The adoption of interactive methods such as project-based teaching and case-based teaching can stimulate active learning and critical thinking among students. Moreover, by constructing a multi-tier experimental system consisting of basic experiments, comprehensive design experiments, and innovation practice, students can progress from verification-based experiments to exploratory, innovative experiments.

This transformation not only enhances students' problem-solving abilities but also cultivates essential soft skills such as teamwork and communication, enabling them to better meet the future workforce's demand for "T-shaped talents" who possess both deep expertise and broad interdisciplinary perspectives.

## 4. Methods for Innovating Talent Cultivation Pathways in Optoelectronic Information Science and Engineering under the Perspective of Emerging Engineering

### 4.1 Constructing an interdisciplinary curriculum system

Building an interdisciplinary curriculum system is a key approach to innovating talent cultivation pathways for the Optoelectronic Information Science and Engineering major under the emerging engineering framework. Traditional curricula are often confined to single-discipline knowledge, making it difficult to meet the current demand for cultivating versatile, interdisciplinary talents.

An interdisciplinary curriculum breaks through disciplinary barriers and achieves the organic integration of optoelectronics with computer science, materials science, physics, and other fields. At the foundational level, new interdisciplinary courses—such as Quantum Physics and Information Technology and Fundamentals of Materials Science and Optoelectronic Applications—provide students with a broad knowledge base, enabling them to understand and solve problems in optoelectronic applications from multiple disciplinary perspectives (Wang et al., 2025)

For example, Quantum Physics and Information Technology introduces students to core concepts of quantum mechanics and their applications in optical communication and quantum computing, thus broadening their academic horizons.

At the professional level, interdisciplinary modules—such as Optical System Design and Simulation, combining optical design with computer-aided design—teach students to apply software tools to design and optimize optical systems (Han et al., 2024). Modules such as Artificial Intelligence and Optoelectronic Signal Processing further train students to apply AI algorithms in optoelectronic data analysis.

Through such a curriculum system, students develop interdisciplinary knowledge and innovative problem-solving abilities, better meeting the demand for versatile talents under the emerging engineering context.

### 4.2 Deepening industry–academia–research collaborative education

Deepening collaboration among industry, universities, and research institutes is a crucial measure for innovating talent cultivation pathways in the emerging engineering era. This model integrates university training with industry needs, helping students access the latest technologies and develop problem-solving and practical abilities. To achieve this, universities and enterprises must establish long-term, stable partnerships and co-develop talent training programs (Shu & Chen, 2024).

Enterprises can provide suggestions based on industrial trends, while universities adjust curricula accordingly. For instance, if enterprises propose new technical requirements in optical communications, universities can incorporate updated content into related courses to keep teaching aligned with industry developments.

Joint practice bases serve as important platforms for collaborative education. Through internships and participation in real enterprise projects, students gain exposure to production processes and management models, enhancing their operational skills. Meanwhile, enterprise engineers may serve as part-time instructors, offering hands-on guidance.
Collaborative innovation also promotes the transformation of research achievements. Joint university–enterprise research projects allow students to participate in R&D processes, cultivate research abilities, and develop an innovative mindset. For example, universities and enterprises conducting research on new optoelectronic materials provide students with opportunities to learn fabrication methods and performance testing, laying a solid foundation for future study and work.

### 4.3 Implementing Project-Based Learning (PBL)

Introducing project-based learning is an effective approach to innovating talent cultivation in the emerging engineering context. PBL uses real-world projects as carriers, enabling students to acquire knowledge and skills through solving practical engineering problems, thereby developing autonomy, collaboration, and creativity.

Teachers must carefully design PBL projects to ensure comprehensiveness and challenge (Hao et al., 2024) For instance, a project centered on optoelectronic sensors may integrate optical principles, sensing technologies, signal processing, and microcontroller programming into the development of an intelligent environmental monitoring system.

Teachers should clearly define project objectives, tasks, and requirements while providing necessary guidance and resources. Students then work collaboratively in groups, dividing responsibilities based on individual strengths to complete research and development tasks.

Throughout the project, students engage in literature review, system design, experimentation, and testing. For example, in the monitoring system project, some students may focus on sensor selection and calibration, others on signal-processing algorithms or system integration.

During the problem-solving process, students inevitably encounter challenges—such as inaccurate sensor readings—which prompt them to consult literature, analyze causes, and explore improvement methods. This model encourages active learning, enhances problem-solving abilities, and strengthens teamwork and communication skills.

### 4.4 Applying virtual simulation in practical teaching

The application of virtual simulation represents an important pathway for innovating practical teaching in Optoelectronic Information Science and Engineering under the emerging engineering paradigm. Through advanced computer technologies and simulation software, virtual simulation replicates realistic experimental environments and engineering scenarios, providing a safe, efficient, and flexible approach to practical training.

Given the high cost of optoelectronic equipment, strict laboratory requirements, and potential safety risks, many experiments are difficult to conduct within traditional teaching. Virtual simulation effectively addresses these limitations.

For instance, in optical experiments, high-precision instruments are often too expensive for large-scale use. Through virtual simulation platforms, students can conduct experiments such as optical imaging and optical interference and observe principles more intuitively.

Virtual simulation also offers diverse practice scenarios. In optical communications teaching, students can simulate network topologies, signal transmission, and modulation–demodulation processes to understand system principles and performance.

The high repeatability of virtual experiments allows students to practice extensively until mastering required skills. Meanwhile, simulation software can be updated according to technological developments; for example, models for modern optical communication systems can be continuously upgraded to reflect the latest advancements.

**4.5 Expanding international exchange channels**

Expanding international exchange channels is a key component of innovating training pathways for optoelectronic information–related majors under the emerging engineering framework. With the deepening of globalization, international collaboration in optoelectronics is becoming increasingly frequent. International exchange enables students to access cutting-edge theories, research achievements, and industrial developments, fostering global vision and cross-cultural competencies.

Universities can collaborate with overseas universities and research institutions to establish student exchange programs, selecting outstanding students to study abroad for short or long terms. Such experiences expose students to different teaching methods, research approaches, and academic environments. Students may also participate in foreign research projects, broadening research perspectives and enhancing academic competence.

Inviting international experts and scholars for lectures and seminars is another effective approach. Regular international workshops and academic events expose students to frontier developments, stimulate research interest, and enable interaction with global experts.

Encouraging faculty participation in international conferences and cooperative research enhances the academic level and global influence of university teachers. Faculty engagement in international collaboration also allows them to bring advanced pedagogical and research methods back to domestic classrooms.

Moreover, involving students in international cooperative projects—guided by their instructors—enables them to develop research skills, global communication abilities, and international competitiveness through hands-on experience.

**5. Conclusion**

Under the perspective of emerging engineering, innovating talent cultivation pathways for the Optoelectronic Information Science and Engineering major is an inevitable response to the evolving demands of the era. By optimizing the curriculum system, strengthening practical teaching, and enhancing faculty development—supplemented with appropriate support mechanisms—it is possible to cultivate high-quality professionals equipped with interdisciplinary integration capabilities, practical and innovative competencies, and an international outlook.

Such efforts not only contribute to improving the overall quality of talent cultivation in this field but also provide strong human resource support for the development of China’s optoelectronic information industry, thereby promoting the continuous advancement of emerging engineering education.

Moving forward, it remains essential to closely monitor developments in emerging engineering and to continuously refine and adjust talent cultivation pathways so they can better accommodate changing societal needs.

**Conflict of Interest**

The author declares that he has no conflicts of interest to this work.

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