Study on the Optimization and Development of Remote Sensing Science and Technology Programs in Industry-Specific Higher Education Institutions

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Abstract: Industry-specific universities, as a distinct institutional form differentiated from comprehensive universities, are characterized by their explicit mandate to serve corresponding industrial sectors, constituting a vital component of China's higher education system. The disciplinary structure of these institutions typically reflects foundational industry-oriented features. In recent years, driven by industrial demands and institutional development, many industry-specific universities have established emerging disciplines such as Remote Sensing Science and Technology (RSST). Addressing the question of how to optimize the development of RSST programs within such universities, this study first examines the opportunities and challenges associated with their establishment and growth. Building on this analysis, and considering the unique characteristics of non-core discipline development in industry-specific institutions, the paper proposes a series of approaches and methodologies to enhance RSST programs. The findings provide a valuable reference for the advancement of RSST education in industry-specific universities.

Keywords: Industry-Specific Universities; Remote Sensing Science and Technology (RSST); Program Development

1. Introduction

In the early years of the People's Republic of China, a cohort of industry-specific universities (e.g., institutions specializing in mining, geology, metallurgy, textiles, transportation, and agriculture) was established to address the urgent demand for skilled personnel in national economic reconstruction. These institutions played a pivotal role in cultivating high-level talent, thereby making profound contributions to the nation's industrialization and modernization.[1] Over decades of practice, they have developed a distinctive educational tradition characterized by industry anchoring, industry orientation, and industry service, providing intellectual, technological, and cultural support to their respective sectors.[2]

However, with the ongoing evolution of disciplinary systems, the deepening and diversification of industrial scopes—particularly due to the penetration and empowerment of new information technologies—and the intrinsic need for institutional advancement, many industry-specific universities have recently launched numerous new academic programs beyond their traditional core disciplines. While these programs maintain broad linkages with the institutions' foundational industry-focused specialties, they face significant challenges, including short establishment history, inadequate infrastructure, and faculty shortages.[3][4] Investigating optimized pathways for such programs is therefore critical, not only to address immediate pedagogical demands but also to enhance the overall competitiveness of industry-specific universities in China's evolving higher education landscape.

2. Opportunities and Challenges in the Development of Remote Sensing Science and Technology Programs

Remote Sensing Science and Technology (RSST) is an emerging interdisciplinary field, classified under the first-level discipline of Surveying and Mapping Science and Technology in China's higher education system, with graduates awarded a Bachelor of Engineering degree. As a cutting-edge

discipline integrating geomatics, aerospace engineering, electronic information, and image processing, RSST is distinguished by its powerful data acquisition capabilities and extensive spatial coverage, enabling broad applications in fields such as geology, land resources, agriculture, environmental protection, meteorology, and transportation. Consequently, many industry-specific universities have established RSST programs in recent years. Currently, nearly 70 Chinese universities offer undergraduate degrees in RSST, the majority of which are industry-oriented institutions.[5]

Leveraging their established industry connections in student recruitment, graduate employment, and scientific research, these universities provide RSST programs with strong foundational support in admissions, career placement, and research funding. Furthermore, as numerous industries in China transition from large-scale construction to refined management, from quantity-driven to efficiency-driven models, and from output-focused to profit-oriented operations, RSST—as a representative of high-end technology—faces even greater developmental prospects.[6][7]

3. Analysis of Challenges in Remote Sensing Science and Technology Program Development at Industry-Specific Universities

Despite significant progress in recent years—supported by institutional efforts and external resources—the development of Remote Sensing Science and Technology (RSST) programs at industry-specific universities still faces several critical challenges. A systematic analysis of these issues is essential for targeted quality improvement and optimized program advancement.

3.1 Ambiguous Program Positioning

Program positioning defines a discipline's objectives in teaching, research, and talent cultivation, typically categorized as either research-oriented or application-oriented. Given the current faculty capacity, infrastructure, institutional history, and student profiles at most industry-specific universities, an application-oriented approach would be more appropriate for RSST programs. However, many institutions persist in pursuing a research-oriented model, while those adopting an application-oriented framework often fail to design concrete talent cultivation plans. This misalignment results in vague program positioning, ultimately compromising both educational outcomes and disciplinary development. After the talent cultivation objectives are established, it is necessary to construct a comprehensive talent cultivation system. First, based on the defined objectives, thorough research should be conducted on peer institutions, employers, and graduates to identify the required competency system—also referred to as graduation requirements—for achieving these objectives. Subsequently, the curriculum system should be designed in alignment with this competency system, ensuring that each course supports one or more competencies, which serves as the fundamental rationale for its inclusion.[8]

3.2 Insufficient Synergy with Core Industry Disciplines

Core disciplines are the foundational pillars of industry-specific universities. Secondary programs like RSST should align closely with these core disciplines, leveraging their strengths while reciprocally supporting their evolution—a logical developmental pathway for RSST in such institutions. In practice, however, despite theoretical recognition of this approach, most RSST programs exhibit weak synergy with core disciplines. They neither fully utilize the core disciplines' advantages to propel their own growth nor contribute effectively to the transformation and upgrading of those core disciplines. The integration into core disciplines can adopt a "mutual empowerment" approach, leveraging the distinctive strengths of Remote Sensing Science and Technology to enhance the development of traditional core disciplines.[9]This enables their optimization in terms of informatization and intelligentization, while simultaneously expanding the application domain for Remote Sensing Science and Technology.

3.3 Deficiency in High-Impact Achievements

For any academic discipline, high-level achievements—such as top-tier publications, major research projects, and prestigious awards—serve as critical metrics of scholarly influence. Due to factors like limited

institutional heritage, short establishment history, and ongoing capacity-building, RSST programs at industry-specific universities generally underperform in generating such outputs. This shortfall weakens their societal impact and technology transfer potential.

4. Pathways and Methods for Optimizing Remote Sensing Science and Technology Programs in Industry-Specific Universities

To address the common challenges faced by Remote Sensing Science and Technology (RSST) programs in industry-specific universities, this study proposes the following optimization strategies based on institutional characteristics and disciplinary attributes, supported by empirical research.

4.1 Scientifically Defining Program Objectives

The talent cultivation objective serves as the overarching guideline for educational processes. For RSST programs in industry-specific universities, these objectives must align with undergraduate education standards while incorporating industry demands and institutional realities. The goals should balance workforce needs with achievable outcomes. In practice, institutions should articulate their objectives by leveraging the conceptual frameworks of "application-oriented talent" and "excellent engineers" to develop scientifically grounded, institution-specific cultivation targets.

Once the curriculum system is developed, course standards should be formulated based on their respective competency support. These standards should encompass the knowledge system, teaching methods, achievement assessment methods, and continuous improvement mechanisms. During the course delivery process, these standards should serve as the guiding framework to ensure consistency in achieving teaching objectives, even when instructors are replaced.

4.2 Active Integration with Core Disciplines for Synergistic Development

A defining advantage of industry-specific universities lies in their historical collaboration with target industries, yielding robust foundations in disciplinary development, R&D, technology transfer, industry-academia partnerships, and graduate employment. As emerging programs, RSST disciplines should adopt a "borrowing vessels to navigate seas" strategy—actively embedding themselves within core disciplines to capitalize on existing strengths while developing distinctive features. This synergistic approach accelerates growth by transforming existing advantages into new competitive edges.[10]

4.3 Enhancing Government-Industry-Academia-Research Collaboration

The modern university's tripartite mission—talent cultivation, scientific research, and societal service—requires integrated fulfillment.[11] For program development, strengthening partnerships with government agencies, industries, and innovative R&D institutions is indispensable. Such collaboration fosters faculty development, curriculum enhancement, student employability, and entrepreneurial outcomes. RSST programs in industry-specific universities possess innate advantages for industry integration, making government-industry-academia-research synergy both a strategic imperative and a developmental necessity.[12]

The discipline of Remote Sensing Science and Technology should actively collaborate with academic institutions to seek government support and promote the formulation of relevant policies that encourage enterprise-school partnerships. For instance, special funds could be established to provide financial support for industry-university-research collaboration projects. Additionally, a robust intellectual property protection system should be established to safeguard the rights and interests of all stakeholders. Meanwhile, the government should act as a bridge by organizing matchmaking events to facilitate collaboration and build platforms for exchange and cooperation.

Remote Sensing Science and Technology should also optimize its curriculum system. Strengthening communication with enterprises to jointly develop talent training programs and incorporating real-world projects and case studies into teaching are essential steps. Furthermore, universities can collaborate with enterprises and research institutions to establish joint laboratories and training bases, providing students with practical experience while creating opportunities for the

commercialization of research outcomes.

Enterprises can actively participate in the talent cultivation process by assigning technical experts as adjunct faculty to deliver lectures and provide practical guidance. Offering internship opportunities and employing graduates are also effective measures. Moreover, universities and enterprises should jointly engage in scientific research projects, co-applying for research grants at various levels to accelerate the transformation and application of scientific and technological achievements.

This structured approach ensures a synergistic relationship between academia, industry, and government, fostering innovation and practical skill development in Remote Sensing Science and Technology.

4.4 Cyclic Cultivation through Teaching, Learning, Competition, and Practice

With the introduction and widespread adoption of modern pedagogical concepts such as Outcome-Based Education (OBE) and Conceive-Design-Implement-Operate (CDIO), as well as the advancement of the "Emerging Engineering Education" initiative and reforms in applied talent cultivation, engineering disciplines—including Remote Sensing Science and Technology (RSST)—have undergone continuous optimization in teaching and training processes. As a discipline that emphasizes the integration of theory and practice, with a strong focus on applied competencies, RSST programs should prioritize a cyclic cultivation model encompassing faculty instruction, student learning, discipline-specific and innovation/entrepreneurship competitions, practical coursework, and graduation internships. Adopting a problem-oriented and output-driven approach ensures that students' competencies align with industry demands.

The curriculum should be closely aligned with industry demands, with enterprise experts invited to participate in syllabus design to incorporate cutting-edge technologies and real-world case studies. Theoretical instruction should be integrated with project-driven teaching methods to encourage active thinking and hands-on practice among students.

Students should be encouraged to form study groups to collaboratively complete course projects, fostering teamwork and communication skills. A wealth of learning resources, such as online courses and academic lectures, should be provided to broaden their perspectives.

A multi-tiered competition system should be established, ranging from basic skill contests to comprehensive innovation challenges, catering to students at different learning stages. Pre-competition training and post-competition reviews should be conducted to translate competition outcomes into teaching materials.

Collaborative internship bases should be established with enterprises, enabling students to engage in regular internships and participate in real-world project development. Intensive practice weeks or short semesters should be organized to focus on project-based training, enhancing students' engineering and practical skills.

Teaching provides the foundation for learning and competitions, while learning outcomes inform instructional improvements. Competitions serve as a means to evaluate the effectiveness of teaching and learning, and practical training consolidates knowledge and skills. This multi-faceted virtuous cycle enhances students' comprehensive competencies, ensuring a well-rounded educational experience.

4.5 Active Participation in Specialized Development Initiatives

In recent years, the Ministry of Education has launched high-impact disciplinary development initiatives, such as the "Golden Course Development", alongside association-led programs like "Engineering Education Accreditation". These initiatives have significantly propelled the advancement of disciplines and curricula in higher education institutions. By engaging in such programs, universities leverage evaluation-driven improvement to enhance educational components, including curricula, teaching resources, faculty, and students, leading to substantial progress. For RSST programs in industry-specific universities, which often lack historic (accumulated experience), these initiatives present a strategic opportunity to address weaknesses, strengthen core competencies, and achieve rapid disciplinary advancement.

In practical implementation, it is essential to align with the evolving trends in information-

related disciplines and address critical teaching challenges. Efforts should focus on integrating cutting-edge technologies such as artificial intelligence and big data into the curriculum, as well as exploring innovative approaches to enhance practical teaching quality.

Furthermore, a high-caliber team should be assembled by combining core faculty members from information-related disciplines within the institution, instructors with industry experience, and educational technology experts to form a multidisciplinary and complementary group. Team members should possess diverse strengths in teaching, research, and industry practice, ensuring comprehensive support for the project.

A solid preliminary foundation must be established by conducting prior investigations and exploratory studies to accumulate relevant data and preliminary results. Feasibility and potential efficacy should be demonstrated through pilot teaching interventions, collecting student feedback, academic performance metrics, and other empirical evidence.

5. Conclusion

As a next-generation information technology discipline within industry-specific universities, RSST bears dual responsibilities: fulfilling its own developmental requirements and supporting the traditional industries it serves in achieving "old-to-new kinetic energy conversion". To meet these demands, RSST programs must capitalize on their distinctive strengths, forge deep integration with their target industries, and adopt the "from the industry, for the industry" approach to realize symbiotic growth between the discipline and its associated sectors.

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