

Research article

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Development Pathways for Low-Altitude Technology and Engineering Disciplines under the Perspective of “Extraordinary” Deployment

Yue Chen ^{a,b}, Qian Liu ^a, Guopei Chen ^{a,*}, Dejun Hu ^a, Li Dong ^a^a Beijing Advanced Innovation Center for Future Urban Design, Beijing 100044, China^b Beijing University of Civil Engineering and Architecture, Beijing 100044, China

KEYWORDS

*Discipline Construction;
Low-Altitude Technology and
Engineering;
Talent Cultivation*

ABSTRACT

As a national strategic emerging industry, the low-altitude economy boasts a vast market scale and promising industrial prospects. However, it lacks a compatible disciplinary system. Therefore, in June 2025, the Office of the Academic Degrees Committee of the State Council launched a pilot program for the extraordinary deployment of cross-disciplinary degree-granting points in low-altitude technology and engineering, aiming to systematically cultivate high-caliber talent for the sector. This paper reviews the current status of low-altitude economic development at home and abroad, examines the establishment of relevant academic programs in higher-education institutions, and analyzes the requirements for this degree-point deployment. Based on the official list released by the Academic Degrees & Graduate Education Development Center of the Ministry of Education, 131 universities have applied to establish or rename 136 first-level interdisciplinary disciplines, second disciplines outside the catalog, or self-initiated interdisciplinary programs. To support the trillion-yuan market and the safe, sound development of the low-altitude economy, the study proposes policy breakthroughs, disciplinary restructuring, and regional collaboration.

INTRODUCTION

The low-altitude economy, a strategic emerging industry with a strong radiation effect, covers manufacturing, infrastructure, operation, services and support systems in its industrial chain and has entered a rapid development stage. Per China's Civil Aviation Administration, its market size is estimated to hit 1.5 trillion yuan in 2025 and 3.5 trillion yuan by 2035. Currently, over

19,000 Chinese enterprises are engaged in low-altitude economy-related sectors, but the demand for high-quality talents keeps rising – the gap of high-level talents in low-altitude engineering technology is expected to reach 200,000 in 2025 alone.

To address this talent gap, boost talent reserves and enhance organized high-level talent training, China's Office of the Degree Committee of the State Council issued a notice on June 11, 2025, launching a pilot for

* Corresponding author. E-mail address: chenguopei@bucea.edu.cn

the extraordinary layout of interdisciplinary degree programs in "Low-altitude Technology and Engineering". This pilot innovatively sets up a "green channel" for discipline construction, which fuels the innovative development of the low-altitude economy industrial chain and fosters virtuous interaction between talent training and industrial upgrading. It is China's first extraordinary discipline/major layout for the low-altitude economy field.

CURRENT DEVELOPMENT STATUS IN CHINA

Policy Support

In February 2021, the Central Committee of the Communist Party of China and the State Council issued the "Outline of the National Comprehensive Three-dimensional Transport Network Plan"^[1], proposing to "develop platform economy, hub economy, corridor economy, and low-altitude economy in transportation", which was the first time the concept of "low-altitude economy" was written into the national plan. In May 2023, the State Council and the Central Military Commission promulgated the "Interim Regulations on the Management of Unmanned Aircraft Flight"^[2], which came into effect on January 1, 2024. In December 2023, the Central Economic Work Conference clearly identified the low-altitude economy as a national strategic emerging industry^[3]. In March 2024, the low-altitude economy was written into the "Government Work Report"^[4] for the first time, proposing to actively create new growth engines such as the low-altitude economy. In March 2024, the Ministry of Industry and Information Technology, the Ministry of Science and Technology, the Ministry of Finance, and the Civil Aviation Administration of China issued the "Implementation Plan for Innovation and Application of General Aviation Equipment (2024-2030)"^[5], proposing to "promote the formation of a trillion-yuan market size of the low-altitude economy by 2030" and "support universities in strengthening the construction of general aviation-related disciplines and majors, and build a number of characteristic colleges. Deepen the integration of industry and education around the cutting-edge emerging interdisciplinary fields of general aviation, and promote joint and precise talent cultivation by universities, research institutions, and enterprises". In July 2024, the Third Plenary Session of the 20th Central Committee of the Party was held in Beijing, and the meeting wrote "developing general aviation and low-altitude economy" into the "Decision of the Central Committee of the Communist Party of China on Further Comprehensively Deepening Reform and Promoting Chinese Modernization"^[6]. In December 2024, the National Development and Reform Commission officially established the Department of Low-altitude Economic Development^[7], and held a number of meetings such as the "Special Symposium on the Construction of Low-altitude Intelligent Network System"^[8], the "Special

Meeting on the Safe and Healthy Development of the Low-altitude Economy"^[9], and the "Symposium on Promoting the Safe and Standardized Development of the Low-altitude Economy"^[10]. In 2025, the low-altitude economy was once again included in the "Government Work Report"^[11], proposing to promote the safe and healthy development of emerging industries such as the low-altitude economy.

Major Establishment Situation

In response to the national strategy, the Ministry of Education has seen six "Double First-Class" universities successfully add the major of "Low-altitude Technology and Engineering" in the second half of 2024. The first undergraduate students will be welcomed in September 2025. This major falls under the category of interdisciplinary engineering within the field of engineering, with a four-year duration, and graduates will be awarded a Bachelor of Engineering degree. This move significantly enhances the talent supply to the industry.

Beihang University^[12]: Integrates five key disciplines, including aerospace and unmanned systems, and partners with industry to create a multidisciplinary platform for cultivating talent in low-altitude technologies. Beijing Institute of Technology^[13]: Enrolls up to 100 students, led by 7 academicians. Focuses on aircraft design and low-altitude traffic control, with strong industry-academia collaboration. Beijing University of Posts and Telecommunications^[14]: Combines strengths in ICT, AI, and control to train talent in intelligent low-altitude systems, navigation, and communication. Nanjing University of Aeronautics and Astronautics^[15]: Offers a curriculum covering aircraft design, control, and airspace management. Provides drone pilot training, integrating degree education with professional licensing. South China University of Technology^[16]: Emphasizes hands-on learning through aircraft and system design projects to cultivate versatile talent for the low-altitude economy. Northwestern Polytechnical University^[17]: Focuses on infrastructure, aircraft, and operations to train future engineers for urban air mobility, logistics, and emergency services.

EXTRAORDINARY LAYOUT WORK

Basic Requirements and Suggestions on Disciplinary Directions.

Firstly, the institution must have at least one corresponding degree-granting point in relevant first-level disciplines such as Mechanical Engineering, Electronic Science and Technology, Information and Communication Engineering, Control Science and Engineering, Computer Science and Technology, Transportation Engineering, or Aerospace Science and Technology. Secondly, the institution must have strong faculty in the relevant directions of the above first-level disciplines, possess high-level research platforms, and have sufficient

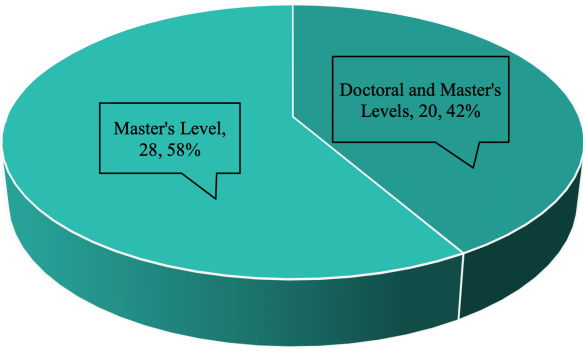


Figure 1 | Distribution of Degree Authorization Point Levels

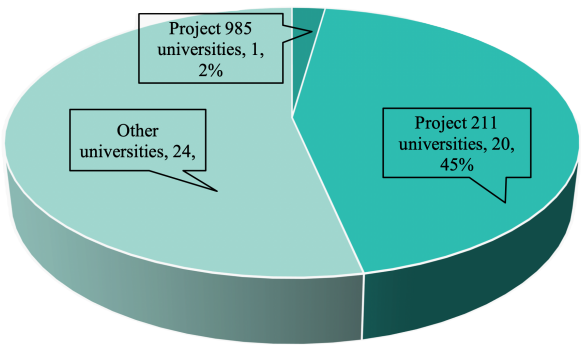


Figure 2 | Distribution of University Categories

research funding and projects as support. Thirdly, the institution must have a certain scale of talent cultivation in the direction of low-altitude technology and engineering, with an average of more than 30 doctoral and master's degrees awarded per year in the past three years.

The "Guidelines for the Setting of Disciplinary Directions in Low-altitude Technology and Engineering" suggest five disciplinary directions: Low-altitude Carrier System Engineering, Low-altitude Intelligent Navigation Technology, Low-altitude Security Assurance Technology, Intelligent Three-dimensional Traffic Engineering, and Low-altitude Airspace Planning and Management. These disciplinary directions are intercrossed, integrated, and supportive of each other.

Suggestions on Disciplinary Directions.

Firstly, universities that meet the pilot conditions and have the authority to independently review degree authorization, in combination with the development needs of the low-altitude economy and their own disciplinary construction plans, may voluntarily argue for the addition of interdisciplinary subjects managed as first-level disciplines, or independently set up second-level disciplines or interdisciplinary subjects outside the directory according to actual conditions. If a new interdisciplinary subject managed as a first-level discipline is added, it will not be subject to the annual limit on the number of new degree-granting points added through independent review. Secondly, universities that meet the pilot conditions but do not have the authority to independently review degree authorization may independently set up second-level disciplines or interdisciplinary subjects outside the directory.

The low-altitude economy industry, from intelligent equipment manufacturing and application scenario design to flight support systems and standard construction, especially in the core technology research and development of low-altitude intelligent networking, and in the construction of security facilities such as surveillance and identification, interception, and counter-measures, urgently needs to accelerate the cultivation of a group of high-level talents with research and de-

velopment capabilities and innovative spirit to provide talent security for the sustainable development of the low-altitude economy. This layout work is the first extraordinary layout of disciplines and majors in China facing the field of low-altitude economy. Firstly, it opens a "green channel" for the establishment of disciplines. Compared with the traditional process of adding disciplines, which needs to follow a fixed application cycle and go through a lengthy process of multi-layer approval, this work simplifies the approval levels, optimizes the allocation of resources, and significantly shortens the preparation cycle for disciplinary construction. Secondly, it accurately matches industry needs, helping universities to quickly connect with national strategic needs and respond in time to the urgent demands of industry talents and scientific research. This is achieved through building a disciplinary innovation ecosystem, deepening the integration of industry and education, and strengthening policy coordination. Thirdly, it focuses on core technology breakthroughs. Facing the national strategy of the low-altitude economy, it conducts basic theory and key technology research in low-altitude technology and engineering, breaks through the core foundations of low-altitude technology and engineering, and leads the development of the national low-altitude technology and engineering system.

LAYOUT SITUATION

According to the results displayed by the Ministry of Education's Degree and Graduate Education Development Center (as of June 30, 2025), 131 universities plan to add or rename 136 first-level interdisciplinary subjects, second-level subjects outside the directory, and self-established interdisciplinary subjects, including 77 doctoral degree authorization points and 136 master's degree authorization points.

First-Level Disciplinary Doctoral Points.

Tsinghua University, Chongqing University, and Harbin Institute of Technology have already publicized their independent review and addition of doctoral de-

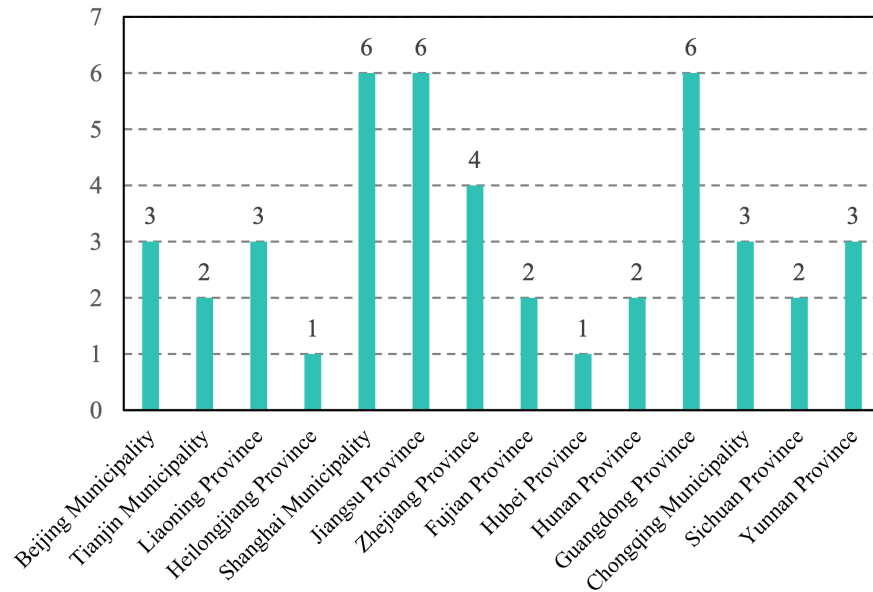


Figure 3 | Distribution of Provinces

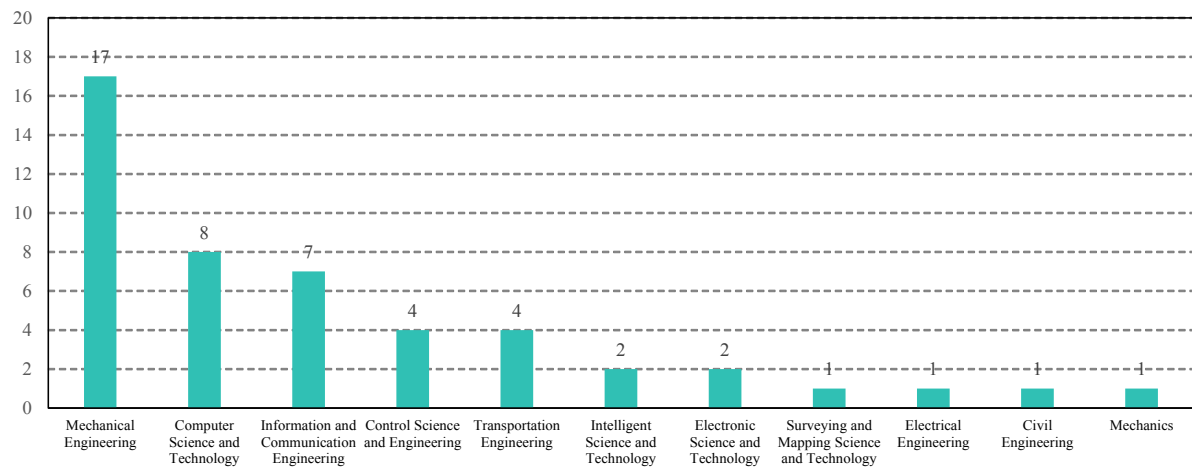


Figure 4 | Distribution of Disciplines

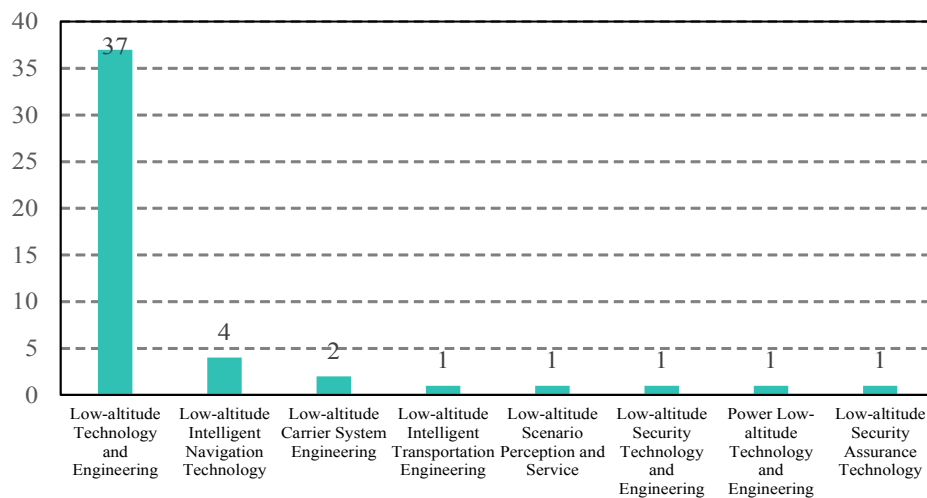


Figure 5 | Names of Second-level Disciplines

gree authorization points for the first-level interdisciplinary subject of Low-altitude Technology and Engineering.

Second-Level Subjects Outside the Directory.

In terms of degree authorization point levels: 48 second-level subjects in low-altitude technology and engineering are planned to be added by universities such as Southwest Jiaotong University and Beijing University of Civil Engineering and Architecture, including 20 doctoral and master's level subject points and 28 master's level points.

In terms of university categories: There is 1 "Project 985" university, which is Nankai University, and 8 "Project 211" universities, including Nankai University, Soochow University, China University of Geosciences (Wuhan), Southwest Jiaotong University, Hunan Normal University, Jinan University, Yunnan University, and Liaoning University.

In terms of provincial distribution: Universities in Shanghai, Jiangsu Province, and Guangdong Province have the highest number at 6 each, accounting for 13.64%.

In terms of disciplinary distribution: Most universities have set up second-level subjects under the recommended 7 first-level disciplines according to the notice. Among them, the number of second-level subjects set up under Mechanical Engineering is the highest at 17, accounting for 35.42%, followed by Computer Science and Technology and Information and Communication Engineering, which account for 16.67% and 14.58% respectively. Control Science and Engineering and Transportation Engineering each account for 8.33%, and Electronic Science and Technology accounts for 4.17%. It is worth noting that currently no university has set up second-level subjects related to the low-altitude field under the first-level discipline of Aerospace Science and Technology. Four universities have set up second-level subjects under the first-level disciplines of Surveying and Mapping Science and Technology (Beijing University of Civil Engineering and Architecture), Electrical Engineering (Shanghai University of Electric Power), Civil Engineering (Suzhou University of Science and Technology), and Mechanics (Southern University of Science and Technology) in combination with their own disciplinary characteristics.

In terms of second-level subject names: 37 subjects use the name of the undergraduate major "Low-altitude Technology and Engineering" as the second-level subject, accounting for 77.08%. Four subjects use the disciplinary direction names suggested in the "Guidelines for the Setting of Disciplinary Directions in Low-altitude Technology and Engineering," namely "Low-altitude Intelligent Navigation Technology" and "Low-altitude Carrier System Engineering." Four universities have set up second-level subject names in combination with their own characteristics: Low-altitude Intelligent Transportation Engineering (Beijing University of Civil Engineering

and Architecture), Low-altitude Scenario Perception and Service (Beijing University of Civil Engineering and Architecture), Low-altitude Security Technology and Engineering (Civil Aviation University of China), Power Low-altitude Technology and Engineering (Shanghai University of Electric Power), and Low-altitude Security Assurance Technology (Shanghai Institute of Technology).

Self-Established Interdisciplinary Subjects.

In terms of degree authorization point levels: Universities such as Beijing Jiaotong University and Beijing University of Technology plan to add 85 second-level subjects in low-altitude technology and engineering outside the directory, including 54 doctoral and master's level subject points and 31 master's level points.

In terms of university categories: There are 2 "Project 985" universities, namely Fudan University and East China Normal University, and 17 "Project 211" universities, including Beijing Jiaotong University, Beijing University of Technology, University of Science and Technology Beijing, Beijing University of Posts and Telecommunications, Beijing Forestry University, North China Electric Power University (Beijing), Donghua University, Fudan University, East China Normal University, Nanjing University of Aeronautics and Astronautics, Nanjing University of Science and Technology, Hohai University, Jiangnan University, Nanjing Agricultural University, Wuhan University of Technology, Xidian University, and Chang'an University.

In terms of provincial distribution: Universities in Jiangsu Province have the highest number at 15, accounting for 17.86%, followed by Shaanxi Province and Beijing with 10 (11.90%) and 7 (8.33%) universities respectively.

In terms of disciplinary distribution: Most universities have self-established interdisciplinary subjects in combination with the recommended 7 first-level disciplines according to the notice. Among them, the number of second-level subjects set up under Mechanical Engineering is the highest at 49, accounting for 14.20%, followed by Computer Science and Technology at 13.04%, Control Science and Engineering at 9.86%, Information and Communication Engineering at 8.41%, Transportation Engineering at 4.35%, and Electronic Science and Technology at 3.77%. Aerospace Science and Technology only appears in self-established interdisciplinary subjects, with a total of 5 universities accounting for 1.45%.

More universities have self-established interdisciplinary subjects in combination with their own characteristics under the first-level disciplines of Urban and Rural Planning (Xi'an University of Architecture and Technology), Grassland Science (Beijing Forestry University), and Marine Science (Shanghai Ocean University).

In terms of second-level subject names: 80 subjects use the name of the undergraduate major "Low-altitude Technology and Engineering" as the second-level sub-

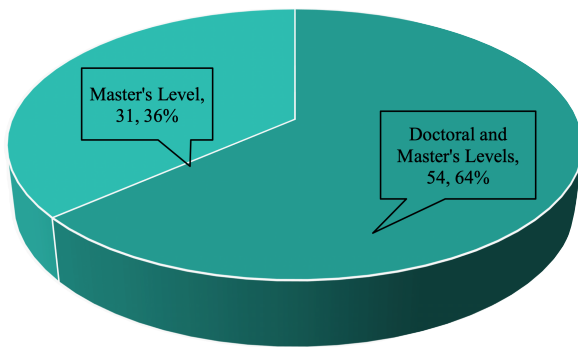


Figure 6 | Distribution of Degree Authorization Point Levels

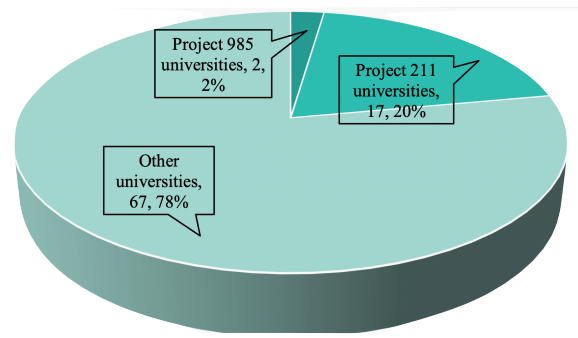


Figure 7 | Distribution of University Categories

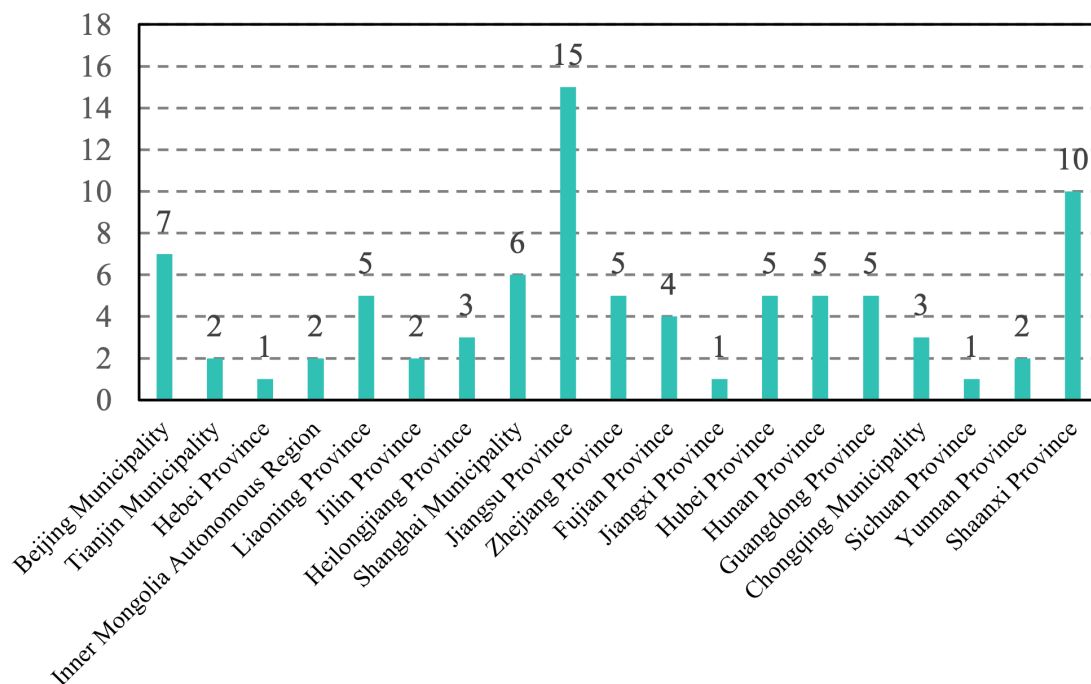


Figure 8 | Distribution of Provinces

ject, accounting for 94.12%. One subject uses the disciplinary direction name "Low-altitude Intelligent Navigation Technology" suggested in the "Guidelines for the Setting of Disciplinary Directions in Low-altitude Technology and Engineering." Four universities have self-established interdisciplinary subject names: Low-altitude Technology and Intelligent Transportation Engineering (Xi'an University of Architecture and Technology), Low-altitude Carrier Technology and Engineering (Ningbo University), Low-altitude Intelligent Technology and Engineering (Chongqing University of Technology), and Low-altitude Intelligence and Safety (East China Normal University).

RELEVANT SUGGESTIONS

Establish a "Region-Industry-Scenario" Three-Dimensional Training System.

Disciplinary construction should be adapted to the development needs of local economic and social development^[18]. Disciplines related to low-altitude technology and engineering should be combined with the local low-altitude industry's resource endowment, industrial foundation, and innovation capability to build a talent training system that matches regional characteristics. According to the distribution of provinces, the five provinces of Jiangsu, Guangdong, Beijing, Shaanxi, and Zhejiang account for 47.66% of the second-level disciplines and self-established interdisciplinary subjects. Based on the industrial foundation, policy orientation, and resource characteristics of the low-altitude econo-

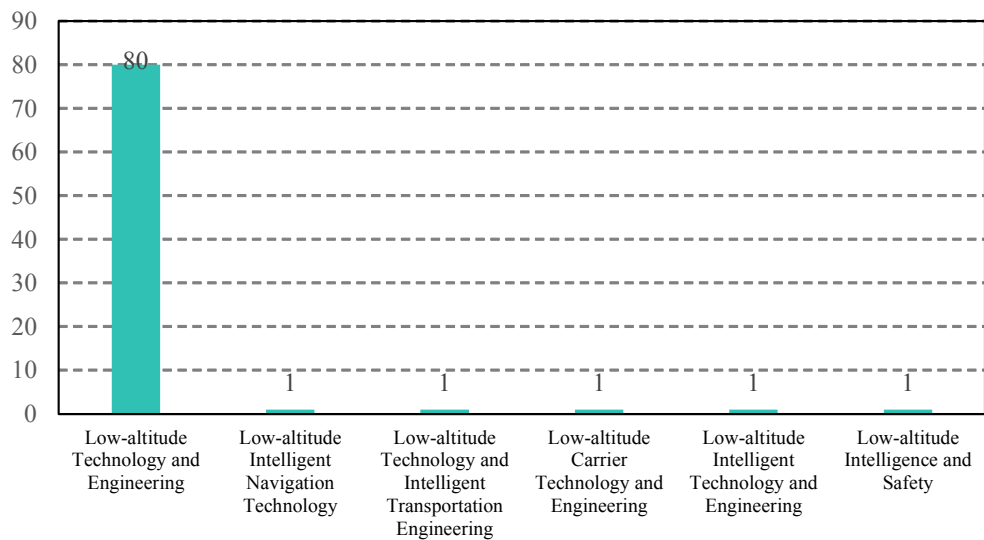


Figure 10 | Names of Second-level Disciplines

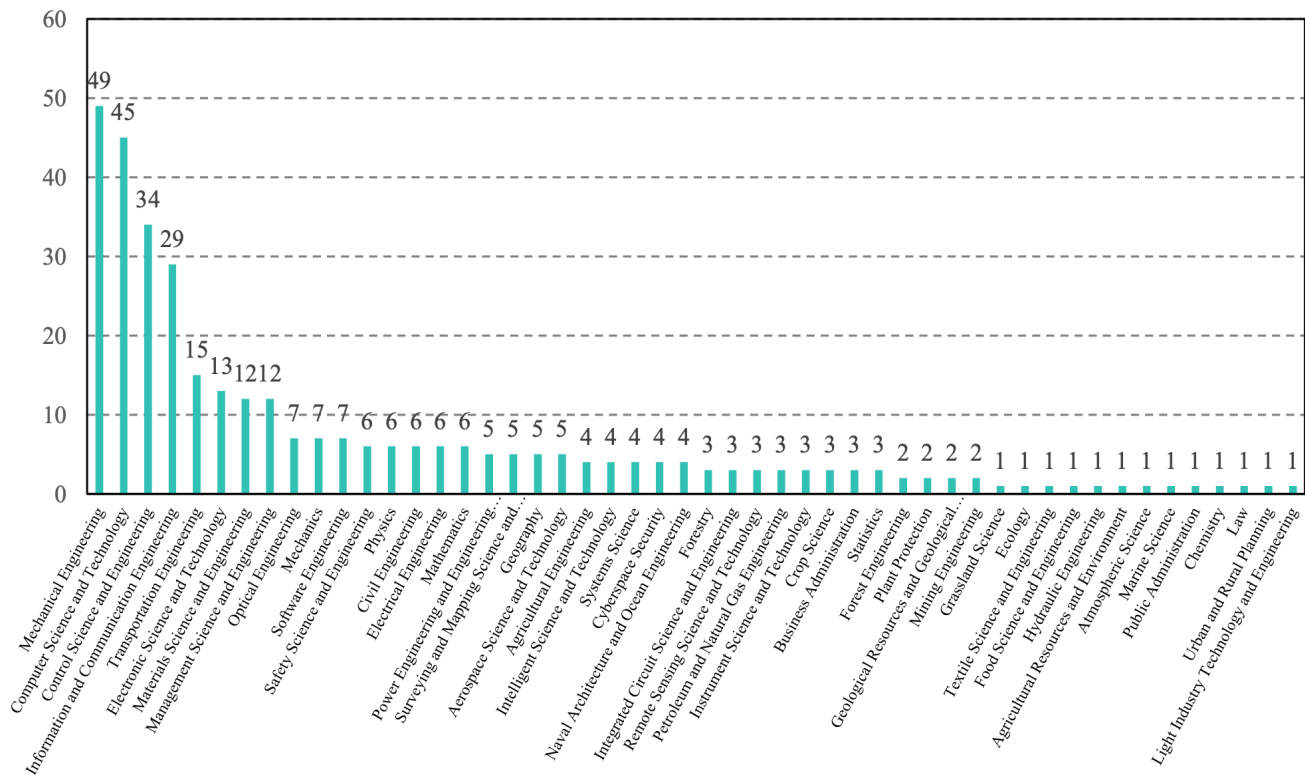


Figure 9 | Distribution of Disciplines

my in the same province, they are divided into three types of regions: industry-leading regions, technology-supporting regions, and scenario-characteristic regions.

Industry-leading regions: Jiangsu Province has a strong manufacturing base and leads in the fields of drone research and development and aerospace parts manufacturing. Guangdong Province is home to a large number of drone companies (such as DJI and EHang). Zhejiang Province has an active private economy and

has an urgent need for low-altitude logistics (such as Cainiao Network drone delivery).

Technology-supporting regions: Beijing, as the core of the national strategic scientific and technological forces, gathers scientific research institutes (such as Aviation Industry Corporation of China and China Aerospace Science and Technology Corporation) and leading enterprises in the field of aerospace.

Scenario-characteristic regions: Shaanxi Province has strong aerospace universities such as Northwest-

ern Polytechnical University, and the demand for national defense-related scenarios promotes the deep integration of disciplines with local military industry and manufacturing. The colleges and universities in these provinces have natural advantages in the establishment of disciplines related to low-altitude technology and engineering. The application scenarios of the low-altitude economy have strong industry specificity (such as safety^[19], agriculture^[20,21], logistics^[21], urban governance^[22], etc.). It is necessary to take specific applications as the guidance, deeply integrate general technology with industry knowledge, and cultivate compound talents of "low-altitude technology + industry scenario".

Construct a Low-Altitude Characteristic Interdisciplinary Integration Training System.

Building an interdisciplinary integration system with low-altitude characteristics must be guided by the core needs of the low-altitude economy. As analyzed, disciplines related to low-altitude technology and engineering are most closely linked to mechanical engineering, computer science and technology, control science and engineering, information and communication engineering, and transportation engineering. By breaking traditional disciplinary barriers and applying the four-layer structure of "target anchoring - content reconstruction - platform support - mechanism guarantee," cross-domain integration of knowledge, technology, and talents can be achieved.

First, focus on problem-oriented low-altitude scenarios. The low-altitude economy industrial chain includes four links: R&D design, core manufacturing, operation and service, and support systems. For R&D design, disciplines like low-altitude carrier system engineering and intelligent navigation technology cultivate high-end R&D talents. For core manufacturing, it connects to first-level disciplines such as mechanical engineering and electronic science and technology to train talents in precision manufacturing, supply chain management, and quality inspection. For operation and service, centering on scenarios like low-altitude logistics and urban air mobility, it cultivates talents in airspace planning, scheduling management, and market operation. For support systems, it corresponds to low-altitude security assurance technology and intelligent 3D traffic engineering to train talents in airworthiness certification, security monitoring, and emergency response.

Second, build a curriculum system with low-altitude characteristics, forming a three-level structure of "basic layer - integration layer - expansion layer." The basic layer, based on core engineering literacy, integrates low-altitude technology logic, core courses, and cutting-edge modules. The integration layer sets interdisciplinary courses, adopts MIT case teaching and project-based experimental models, and requires students to complete practical projects. The expansion layer offers electives, and jointly builds school-enterprise sci-tech and educational platforms with leading

enterprises to launch workshops, using real scenarios for teaching and turning corporate pain points into teaching cases.

Improve the Long-Term Operation and Guarantee Mechanism.

First, build an interdisciplinary elite team. As faculty is key for long-term support, integrate multi-disciplinary expert resources to form an interdisciplinary teaching team covering mechanical engineering, computer science and technology, and other core fields. Learn from foreign universities: hire corporate experts as industry mentors and corporate mentors as university technical consultants, and establish a "dual appointment - dual secondment - dual evaluation" mechanism. In-house teachers must hold CAAC or enterprise-recognized UAV/airworthiness qualification certificates to teach, and spend at least 3 months annually working in leading enterprises. Enterprise chief engineers and professor-level senior engineers, after approval by the university's degree evaluation committee, can become part-time professors and must undertake teaching tasks. Establish a "discipline - industry" joint professional title evaluation system, and include corporate project achievements, technical patents, and teaching performance equally in promotion criteria to keep faculty updated on frontline industry technologies.

Second, establish a "diversified investment, open sharing" support system. It is suggested that the State Council Degree Office continue the "extraordinary" layout policy to simplify approval and help universities add discipline programs quickly. The government should set up a "low-altitude education special fund" for school-enterprise co-construction and sharing of integrated experimental-training-flight training platforms, adopting a "school construction, corporate donation, industry co-management" model, with equipment update cycles synchronized with industrial technology iteration. Build a national open low-altitude engineering course cloud, integrate tool chains, and implement credit recognition, faculty exchange, and case sharing to realize cross-school and cross-regional flow of hardware and data resources.

Third, implement a multi-dimensional evaluation system based on industry alignment, international certification, and dynamic feedback. For discipline evaluation, break traditional single academic standards, integrate "low-altitude characteristics" into indicators. Introduce third-party evaluation agencies, cooperate with low-altitude economy industry associations, refer to AABI aviation certification standards to launch international certification for flight technology majors and conduct course quality evaluation. Regularly release reports on the alignment of talent training with industry demand. Establish a dynamic feedback mechanism focusing on quality tracking and risk warning, and include enterprises' evaluation of graduates' skills and the contribution of scientific research results to low-altitude technology

breakthroughs in teacher evaluation, forming a "teaching - practice - industry" closed-loop evaluation to ensure talent training meets low-altitude economy development needs.

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