Engineering Education Review

PERSPECTIVE

Reform and practice of the training system for top innovative talents in aerospace mechanics based on creativity and leadership

Mingqiang Luo*, Zilong Zhao, Xianglin Zhang*

School of Aeronautic Science and Engineering, Beihang University, Beijing 100191, China

ABSTRACT

In view of the core problems in the cultivation of top-notch innovative talents in space and space mechanics, this research takes Beijing University of Aeronautics and Astronautics as the practice carrier, and puts forward a "knowledge capability accomplishment" coordinated-oriented high-quality talents cultivation system. Through the analysis of capability elements, the study of training system, and the study of implementation strategies, the system constructs the training framework with creativity and leadership as the core, and realizes the "three upgrades" of students' knowledge system, capability system, and literacy system. The study uses case analysis, questionnaires and longitudinal tracking methods to reveal the key capability elements and training path of top talent growth. The practice shows that the system has promoted students' innovative practical ability, sense of mission of serving the country through air and space, and interdisciplinary literacy. Its innovation lies in combining mission-driven and capability-oriented deeply, guiding top students to set up great projects and take on the responsibility of the era, providing theoretical paradigm and practical reference for top talents training under the background of new engineering.

Key words: top talent program, aerospace mechanics, innovative talents, training model

INTRODUCTION

The report of the 20th National Congress of the Communist Party of China emphasizes: "We must uphold that science and technology are the primary productive forces, talent is the primary resource, and innovation is the primary driving force. We must thoroughly implement the strategy of rejuvenating the country through science and education, the strategy of strengthening the country with talent, and the strategy of innovation-driven development, opening up new fields and new tracks for development, and continuously shaping new development momentum and new advantages." Talent, especially top-tier innovative talents and their autonomous cultivation, is a core task that must be tackled in the construction of a strong educational nation (Zhong, 2023). After launching the "Top Talent Program" 1.0 in 2009, the Ministry of Education initiated the 2.0 version of the program in 2019, which emphasizes that the "Top Talent Program" should "strengthen mission-driven approaches" and "be oriented to bear the national mission" (Yang & Jin, 2021). However, the current situation of talent loss in China remains severe, with the number of talent outflow ranking first in the world, and the retention rate of those studying abroad reaching as high as 87% (Sheng, 2013). Therefore, it is urgent for "Double First-Class" universities, which gather top-tier talents, to deepen the

***Corresponding Author:**
Mingqiang Luo, School of Aeronautic Science and Engineering, Beihang University, 37 Xueyuan Road, Beijing 100191, China. Email: luomingqiang_buaa@163.com. https://orcid.org/0000-0003-2039-1363
Zhang Xianglin, School of Aeronautic Science and Engineering, Beihang University, 37 Xueyuan Road, Beijing 100191, China. Email:zxlin727@buaa.edu.cn. https://orcid.org/0000-0002-1958-5753
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reform of talent cultivation systems and enhance the innovation-driven training of "top-tier talents." This is of strategic significance for strengthening talent cultivation, responding to the new era's requirements for building a strong educational nation, solving the "Qian Xuesen's Question", and achieving breakthrough development in fundamental discipline research (Luo, 2023).

This paper begins with the background of cultivating top-tier innovative talents in China, using aerospace mechanics, guided by creativity and leadership, as an entry point. It constructs a high-quality, competency-oriented talent development system based on the complementary relationship of "Knowledge, Skills, and Competencies" (Figure 1). The goal is to stimulate students' creativity and initiative, guide top students to set ambitious goals, shoulder the responsibilities of the times, and provide references and suggestions for the development of high-quality talent under the new era's "Top Talent Program" 2.0.

OVERVIEW OF CREATIVITY AND LEADERSHIP

American psychologist J. P. Guilford believed that creativity is not a singular ability, but a composite of various skills. For top-tier innovative talents, creativity manifests as the ability to generate new, unique, and creative ideas, perspectives, or solutions when facing problems or challenges. Leadership, on the other hand, refers to the ability to achieve goals at minimal cost while improving the overall efficiency of a group. It is a crucial driving force for maintaining the excellent growth and sustainable development of an organization. For top-tier innovative talents, leadership is demonstrated through the ability to maintain a clear strategic vision, strong team cohesion, and excellent stress resistance when leading complex tasks and projects.

An approach guided by creativity and leadership not only encourages students to meet the strategic demands of the country with "innovative power", but also helps students cultivate strong internal motivation, thus developing "action power". Universities, particularly "Double First-Class" universities, must focus on achieving major breakthroughs in original innovation and overcoming foundational theoretical and key technological challenges related to critical issues (Yang & Jin, 2021). Students' capabilities are best developed through the process of problem-solving (Zhang *et al.*, 2019) By integrating creativity and leadership orientation into the development of top-tier students, we enable them to challenge conventional knowledge with a questioning attitude and provide opportunities to engage in solving "bottleneck" problems. This approach fosters higher-order thinking, encouraging students to independently design and create solutions (Shen *et al.*, 2019). It also helps students set lofty ideals, establish long-term goals, enhance their interest in learning, and develop into the top-tier talents required by the country and society (Zhang *et al.*, 2019).

Faced with the two major priorities and the Chinese Dream of national rejuvenation, top-tier innovative talents must possess both creativity and leadership to contribute wisdom and strength in the construction of a shared future for mankind. They are expected to tackle challenges in the process of building a strong aerospace nation and demonstrate their talents in the journey of national revitalization (Li, 2023).

OVERVIEW OF AEROSPACE MECHANICS AT BEIHANG UNIVERSITY

The Engineering Mechanics program at Beihang University has always focused on national needs, aiming to cultivate leading talents in the fields of aerospace mechanics, engineering technology, and fundamental sciences. Through the persistent efforts of several generations, the program has produced a group of industry elites and academic masters, represented by model chief designers and academicians, establishing Beihang's leading and supporting role in the national aerospace field.

Since the beginning of this century, the competition in aerospace technology has intensified. "Major Aerospace Mechanics Issues" has been listed as one of the ten fundamental research areas addressing national strategic needs. The initiation of the large aircraft project marked the entry of China's aerospace industry into a new stage of independent innovation and forward engineering development. This has presented new challenges for the cultivation of aerospace mechanics talents: the need to break down disciplinary and professional barriers horizontally to cultivate interdisciplinary talents; the need to integrate experimental and practical systems vertically to foster innovative talents; and the need to inherit the red gene and cultivate mechanics talents with a strong sense of national responsibility toward aerospace.

In response to these challenges, since 2006, Beihang's Engineering Mechanics program has proactively planned for the country's urgent demand for future aerospace mechanics talents. The program has strengthened its curriculum by integrating mathematics, physics, and mechanics, while optimizing courses in aerospace and space technology. By merging education with scientific research and collaborating with enterprises to gather advantageous resources, the program has sparked

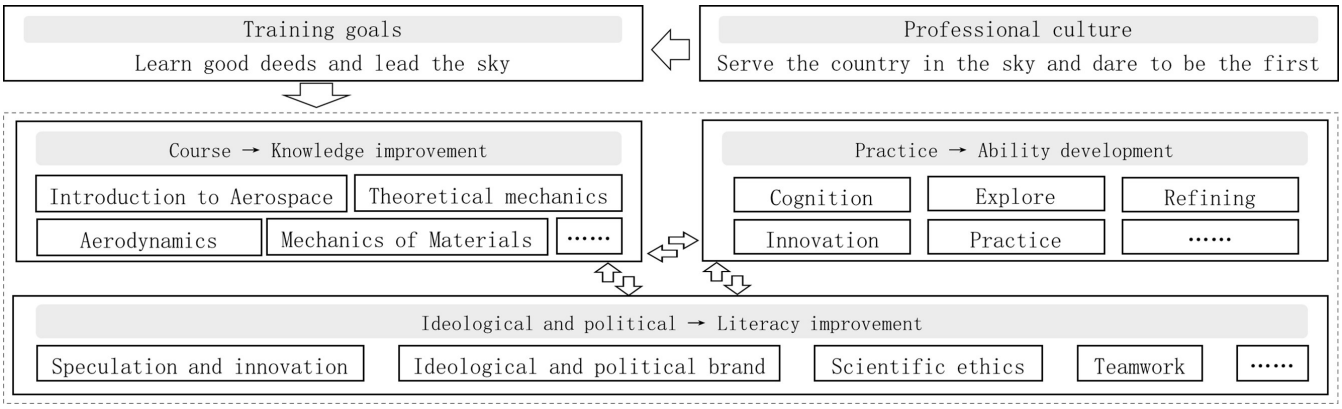

Figure 1. Integration framework of knowledge, skills, and competencies.

students' internal motivation through space-related issues and missions. Moreover, through multidimensional evaluation and positive feedback, the program has enhanced the quality of teaching. These efforts have achieved significant results, such as the selection of Beihang's Engineering Mechanics program as one of the first national-level "First-Class Undergraduate Programs", as well as its designation as a key program under the "Strengthening the Foundation Plan" and the "Top Talent Program 2.0" base. It has become a primary supporting program for the Ministry of Education's first batch of "Future Aerospace Technology Colleges". Undergraduate students have consistently ranked first nationwide in the "National Zhou Peiyuan College Student Mechanics Competition" for three consecutive years, and won the first prize in the team competition for two years in a row. The undergraduate-led "Fengru No. 3" long-endurance Unmanned Aerial Vehicle (UAV) team has set two world records and won the Grand Prize in the "Challenge Cup". Furthermore, the employment and further education rate of graduates in the aerospace and defense sectors has been increasing year by year, reaching 80% in 2020.

CHALLENGES IN THE CULTIVATION OF TOP-TIER TALENTS IN AEROSPACE MECHANICS

General Secretary Xi Jinping emphasized at the Central Talent Work Conference that the talent evaluation system must be improved, with the acceleration of establishing an evaluation system oriented toward innovation value, capability, and contribution. The goal is to form and implement an evaluation system that is conducive to scientific and technological talents dedicating themselves to research and innovation (Xi, 2021). Top-tier talents are the epitome of human wisdom and ability. Integrating a competency-oriented approach into the cultivation of top-tier talents clarifies the cultivation objectives (Lu, 2022), enhances the objectivity of evaluation (Liu, 2016), and increases the relevance of assessments (Fu *et al.*, 2023) By establishing and refining a talent development system based on creativity and leadership orientation, a more scientific, objective, and accurate talent evaluation system can be created (Sheng *et al.*, 2016), providing strong support for the discovery, cultivation, and selection of top-tier talents (Figure 2).

It is evident that, both at the national level and from the perspective of student development, it is imperative for universities to assume a historical mission. There is a pressing need to establish a competency-oriented talent development system for top-tier innovative talents in aerospace mechanics (Hao, 2022). However, this effort faces the following challenges:

(1) The interdisciplinary nature of engineering mechanics problems in aerospace is constantly increasing. How can we design a curriculum system that integrates education and science to help students acquire multiple skills, thereby elevating these skills into a sense of patriotism and national responsibility?

(2) Aerospace technology is highly practical and develops rapidly. How can we create an immersive environment that fosters innovation and leadership in students, while aligning social value goals with individual development needs?

(3) The difficulty of mechanics courses and the long time required for talent development are significant challenges. How can we construct a multi-dimensional, collaborative talent development mechanism that aligns with the country's science and technology strategy, ensuring the implementation of a competency-oriented system for cultivating top-tier aerospace mechanics talents?

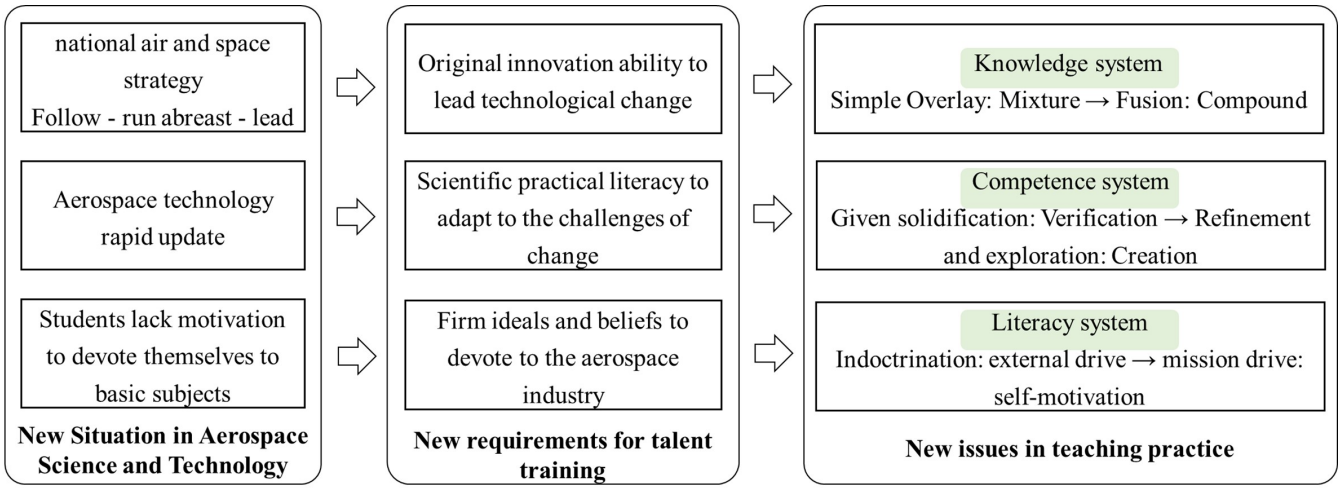

Figure 2. Framework for the process of cultivating top talents in aerospace mechanics.

NEW CONCEPTS AND MEASURES FOR CULTIVATING TOP-TIER TALENTS IN AEROSPACE MECHANICS

Analysis of capabilities of top-tier innovative talents in aerospace mechanics

Based on a systematic case study of leading talents and top students, this research delves into the experiences and stages during students' academic years that contribute to their proactive learning and outstanding achievements. It further explores the career paths of students who have demonstrated exceptional performance and whether they continue to excel after entering the workforce. Additionally, the study investigates which experiences and factors in the workplace motivate individuals to strive for excellence and achieve high performance. By comparing these two aspects, we explore the correlation between students' academic performance and their professional success, the extent to which the skills developed during their academic years are transferred to their work, and the influence of these experiences. Ultimately, we aim to identify the types of abilities that should be cultivated during students' academic years and the methods through which these abilities can be sustained and applied in their professional careers, helping top students evolve into industry leaders.

Collection of Typical Cases of Top-tier Innovative Talents

The cases of top-tier talent development can provide strong support for current talent cultivation efforts. These cases help to better analyze the competency systems constructed during the growth of top-tier talents, promoting the discovery of hidden potential. Internationally, cases of figures like Theodore von Kármán and Elon Musk are analyzed, while domestically, the cases of Qian Xuesen and Guo Yonghuai are studied. The research also includes case studies and analyses of top students who have won Beihang University's highest honor, the "Shen Yuan Medal" (formerly the "Beihang Gold Medal").

Research on the Growth Path of Top-tier Innovative Talents

By collecting the growth paths of senior scientists such as Qian Xuesen and Guo Yonghuai, as well as chief designers of various aerospace models, this study uses comparative and dynamic analysis methods to compare and contrast the growth trajectories of top-tier innovative talents with different backgrounds. The goal is to explore commonalities and differences in their growth paths and summarize both general and special patterns. The study pays close attention to the dynamic development of top-tier talents and explores the changes and evolutionary laws throughout their growth processes.

Analysis of Competency Elements for Top-tier Innovative Talents

Based on the conclusions of the research on the growth paths of top-tier innovative talents, this study integrates the common and distinctive elements of their competency systems, and develops personalized training plans. Common elements can be cultivated through general education and core courses, while distinctive elements can be developed through specialized courses and practical projects. The growth and competency development of different types of top-tier talents are a dynamic process, requiring continuous evaluation and adjustment. Training plans and resource allocation can be flexibly adjusted based on students' performance and development, better meeting their growth needs.

Research on the talent development system for top-tier innovative talents in aerospace mechanics

For students selected under the "Top Talent Program" 1.0 and 2.0, this study traces and tracks the development process of their training systems. It investigates the competencies students feel they have acquired during the training and analyzes the relationship among their knowledge system, capability system, and competency system through horizontal analysis (comparing different students within the same system) and vertical analysis (tracking the development of the same student across different stages).

Knowledge System—Curriculum Construction

By studying students from the same professional field but with different training plans under the "Top Talent Program" 2.0, this research tracks students' overall performance and surveys their understanding of what they wish to "learn" and "do". By comparing the new and old curricular systems, the study explores how different curriculum factors influence the cultivation of students' abilities. The study also examines data from past students and earlier training plans to identify areas for improvement in the curriculum. Additionally, the research explores the impact of elective courses, such as expert seminars, laboratory classes, and professional introduction courses, on students' ability development. It also investigates how students utilize their autonomous time to explore and achieve outcomes in areas left open by the curriculum.

Capability System—Practical System Construction

This research focuses on project-driven redesigns of research-oriented courses for top students, allowing them to enter laboratories and use real-world problems as their textbooks. In the process of solving practical problems, students engage in knowledge acquisition and ability enhancement. By investigating the learning conditions and actual outcomes of students in both the old and new research-oriented classrooms, and through surveys, this study seeks to understand the new capabilities students have acquired after participating in experimental and practical activities. For platforms and bases that fail to meet expectations, an overall adjustment of the training process should be made, taking into account faculty resources and course arrangements.

Competency System—Ideological and Political Education Construction

By sharing the stories of three generations of mechanics professionals who have served the country through aerospace engineering, this initiative aims to enhance students' awareness and confidence in contributing to the aerospace field. The study explores a new model for integrating top-tier innovative talents with dual-degree flight students. Using social practice, field courses, and other activities during holidays, top students are guided to visit institutions like the Naval Aviation University of the People's Liberation Army (PLA) and participate in specialized training courses for pilots. Feedback from students on how these activities assist in their personal competency development will be gathered and used for further refinement.

Research on operational models and implementation strategies

This research tracks students participating in the "Top Talent Program" 1.0 and 2.0 over a long period, collecting data on the process and effects of the program. A questionnaire survey will be conducted among program students, frontline instructors, mentors, counselors, and administrators of platforms and bases. The survey will focus on gathering feedback on the practical effectiveness of the competency-oriented talent development system for top-tier innovative talents in aerospace mechanics, including suggestions for improvement. The research combines literature analysis, comparative studies, and case investigations to summarize the shortcomings and major issues of the current system and propose solutions based on survey findings.

Building Supply for Training Elements

Personalized courses will be developed, with flexible organizational models and management systems, offering a variety of course choices. Discussions and problem-oriented learning and practice will be incorporated into the curriculum. Improving the quality of top-tier talent cultivation requires strengthening textbook development. Textbook construction should be integrated with teaching reforms, continuously optimizing textbook structure and content to meet the goals and requirements of training top-tier innovative talents. Collaborative platforms for education and scientific research will be built to create a vertically and horizontally connected curriculum system.

Faculty Development

The teaching staff for students in the "Top Talent Program" 2.0 consists of advisors, instructors, and research mentors, drawn from various colleges, research institutes, and external organizations. It is essential to integrate these three types of faculties to foster students' research-oriented thinking and stimulate their innovative capabilities. The study will focus on whether the synergy of these diverse faculty members can help students build their personal competency systems and embark in academic exploration.

Institutional Construction for Integrated Undergraduate and Graduate Education

Using the aerospace mechanics talent development base

as an example, undergraduate students from the 2021 cohort will begin the process of applying for recommendation-based admission to master's and doctoral programs in 2024. The study will focus on examining whether the integrated undergraduate and graduate education system fosters deeper and more coherent talent development, improving the quality and efficiency of top-tier talent cultivation and ensuring the continuity and specificity of research activities during the talent development process.

PRACTICAL ACHIEVEMENTS IN CULTIVATING TOP-TIER TALENTS IN AEROSPACE MECHANICS

Achievements in developing the talent cultivation system

Optimization of the Curriculum System

The curriculum system has been optimized by organically combining general education with specialized education. By strengthening practical components, introducing top-tier resources and research outcomes, the learning experience for students has become richer and more diverse. Additionally, personalized needs of students are considered through flexible course scheduling and the offering of tailored courses, allowing students to better manage their energy and time. This not only meets the demand for students' holistic development but also enhances the quality and effectiveness of the teaching process.

Development of a Capability-Oriented Course Selection Mechanism

A capability-oriented course selection mechanism has been developed, where the competencies that need to be cultivated serve as the basis for course selection. This mechanism aims to enhance students' creativity and leadership skills, fostering their overall development. It also grants students more freedom to choose courses based on their personal interests and career aspirations. This approach not only stimulates students' enthusiasm and initiative but also improves the relevance and practicality of the courses.

Exploration of the Feasibility of Course Gaps and Flexible Adjustments

By leaving certain gaps in the curriculum, faculty can flexibly adjust the courses based on academic development and students' needs, ensuring the timeliness and relevance of the curriculum. At the same time, students can personalize their learning schedule according to their pace and interests, enhancing learning efficiency. This approach ensures the flexibility of the curriculum while promoting independent learning and personalized development for students.

Building a Capability System Driven by Projects

The program focuses on creativity and leadership development by engaging students in major projects, allowing them to hone their professional skills, stimulate innovation, and enhance teamwork capabilities. This initiative effectively promotes the comprehensive development of students' qualities.

Implementation of the "Trinity" Research Classroom Plan

The "Trinity" Research Classroom Plan includes mentorship from research advisors, participation in open lab days, and in-depth exploration of mini-projects, and has been effectively implemented at Beihang University. This provides students with valuable opportunities to interact with top mentors and engage in real-world scientific research, further enhancing their research abilities and innovative spirit.

Adjustment and Enhancement of Top-tier Talent Cultivation Processes

The cultivation process for top students has been adjusted, focusing on optimizing the curriculum system, strengthening practical teaching, and improving the mentorship system. These measures have enhanced the quality of aerospace mechanics top-tier talent cultivation. The improvements not only support personalized development but also make the training process more targeted and effective.

Building a Competency and Ideological System

The competency and ideological systems have been integrated to deeply embed the mission of serving the country through aerospace engineering into students' daily learning and lives. By vividly sharing the stories of three generations of mechanics professionals, the program has not only enhanced students' awareness and confidence in contributing to aerospace but also strengthened their commitment to the great rejuvenation of the Chinese nation. This has significantly promoted students' ideological and political development, laying a solid foundation for cultivating top-tier talents with noble character and firm beliefs.

Exploration of New Models for Integrating Top-tier Innovative Talents and Dual-degree Flight Students

By implementing special holiday courses and pilot training programs, students have been provided with richer learning and practical opportunities. This not only helps enhance students' professional expertise and practical skills but also lays a solid foundation for their future careers. This exploration represents an innovative attempt in higher education talent cultivation, with significant practical implications and potential for widespread application.

Development of a Platform for Cultivating Top-tier Innovative Talents Integrating Red Education, Theoretical Learning, and Innovation Practice

By integrating high-quality educational resources, the program enables students to receive red education while also deeply engaging in theoretical knowledge and innovation practice. This approach has enhanced students' overall qualities and innovative abilities, providing valuable experiences and insights for talent cultivation in higher education.

Establishment of Teaching Teams Led by Eight National and Beijing Teaching Masters

A teaching team has been established with eight national-level and Beijing teaching masters at its core, forming national-level teaching teams such as the "Fundamental Mechanics Course Teaching Team" and the "Aerospace Introduction Undergraduate Education Team". Thirteen courses, such as "Introduction to Aerospace", "Aircraft Design", "Aerodynamics", "Theoretical Mechanics", and "Material Mechanics", have been developed into national first-class courses. Additionally, the program has recruited high-end academic mentors, including four academicians, one national-level master, twelve national talents, and four main contributors to national scientific achievements. Through mentorship, these experts inspire students to establish academic ideals and scientific literacy. Over the past decade, the employment rate in the national defense system for graduates from the College of Aerospace Engineering has increased by 20%, reaching 80% in 2020, with more than 90% working in research and design, with the spirit of serving the country through aerospace deeply embedded in each graduate.

Achievements in cultivating top-tier innovative talents

Innovation Teams Breaking World Records

Innovation practice teams such as the "Fengru No. 3" have broken world records and won prestigious awards like the Challenge Cup Grand Prize and the Society of Automotive Engineers (SAE) International Aero Design Competition three times in a row. By focusing on the four core drivers—institution establishment, mechanism guarantee, base construction, and project support—students' enthusiasm for scientific innovation, sense of achievement, and honor have been stimulated. The participation rate of students in scientific research has remained around one-third, with over 100 research training projects. Through encountering, analyzing, and solving problems in scientific and technological innovation projects, students have gradually developed a resilient spirit of exploration and innovation.

High-level Achievements in Competitions

Top-tier aerospace mechanics talents have participated in high-level national and international competitions, winning over 20 individual and team championships. Notable honors include the SAE International Aerospace Design Competition Advanced Group Championship, the Aircraft Construction Committee (ACC) European Student Aircraft Weight Challenge Design Group Championship, and the British Model Flying Association (BMFA) International University Aircraft Design Competition Weight Project Championship. In the Challenge Cup National College Students' Academic Science and Technology Competition, they won three Grand Prizes, seven First Prizes, two Second Prizes, and two Gold Medals in the Entrepreneurship Competition. In Beihang's "Fengru Cup" Student Science and Technology Competition, students won two championships, five second places, two third places, and 27 first prizes.

Collaboration with Major National Aerospace Projects

Starting in 2022, aiming to meet national strategic needs and improve innovative and practical capabilities, the program has deepened industry-education integration with organizations like the China Aerospace Research Institute and Commercial Aircraft Corporation of China (COMAC) North Research Center. By co-designing engineering projects such as digital aircraft, interdisciplinary team-based graduation projects have been explored, which have received awards such as the Beijing Excellent Graduation Design (Team Category) for two consecutive years. This has provided a new approach for cultivating interdisciplinary top-tier innovative talents in aerospace mechanics, and has contributed to the national aerospace development.

Enhancement of Students' Commitment to Serving Aerospace

Over the past five years, students' sense of mission to "serve the country through aerospace" has continued to strengthen, with an increasing number of students choosing specialties critical to national strategic needs. The number of students selecting aerospace-related majors as their top choice has risen from less than 70% to near full enrollment. Furthermore, the overall employment rate of graduates in the defense system has significantly improved, with 62% of master's graduates and 53% of doctoral graduates employed in the aerospace, information, and other related systems. At the College of Aerospace Engineering, more than 70% of graduates have chosen to work for organizations like the China Aviation Industry Corporation and China Aerospace Corporation, contributing to the national aerospace industry and gradually becoming the backbone of these organizations. Graduates are highly praised for their professionalism and dedication, with employer satisfaction reaching over 95%.

Promotional proposals and outlook

The promotion of the top-notch innovative talents training mode of aerospace mechanics needs to be based on the national strategic needs and the reality of universities to build a differentiated and sustainable practical path.

For universities of science and engineering, we can deeply integrate "discipline intersection + engineering practice", rely on university enterprise joint laboratory and interdisciplinary curricula to break the fragmentation of knowledge system; Comprehensive universities should give full play to the advantages of multiple disciplines, and strengthen the coordination of humanities and technology through courses such as "innovation of science and technology and social responsibility"; Local universities can focus on regional industry characteristics (such as general aviation, UAV applications), and combine local enterprises to customize practical projects to achieve two-way empowerment of talent training and local economy.

At the mission-driven level, colleges and universities need to dig deep into their own red genes or subject missions to visualize values such as "serving the country by air and space" and "building a strong country by sea" into curriculum, practice and campus culture to inspire students' endogenic motivation.

In addition, it is necessary to further perfect the "university enterprise government" collaborative ecology, reduce the resource threshold and promote resource sharing through virtual simulation platforms, open-source case bases and regional innovation alliances.

At the policy level, the education department can pilot the system of flexible schooling, interschool credit mutual recognition and so on.

In the future, it is suggested that the "Top Program Demonstration Area" be constructed in sub-regions, and a continuous iterative training model be established through dynamic monitoring and third-party evaluation, eventually forming a national top talent training network featuring "mission leadership—ecological support—institutional innovation", providing a solid talent foundation for the strategy of space power and global science and technology competition.

CONCLUSION

The opportunities and challenges brought by the goal of becoming a "strong aerospace nation" are unprecedented, and the country urgently needs top-tier innovative talents who possess interdisciplinary knowledge and capabilities. Based on this, the top-tier talent cultivation team at Beihang University, focusing on the cultivation objectives for the new phase of aerospace development, has proposed a talent development system oriented toward high-quality innovation and leadership. This system integrates "knowledge-capability-literacy", with these components complementing each other. Through years of accumulation and development, a new paradigm for cultivating top-tier talents has been formed, achieving a harmonious and mutually reinforcing relationship between students' knowledge, capabilities, and literacy. This system provides practical value and serves as a reference for the current cultivation of top-tier aerospace mechanics talents as well as the national cultivation of innovative talents and outstanding engineers in the new era of engineering education.

DECLARATIONS

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Author contributions

LUO MQ developed research questions, proposing an overall framework for the manuscript. Zhang XL reviewed the literature, analyzed it and wrote the manuscript. Zhao ZL collected the data, revised and proofread the manuscript content. All authors have read and approved the final version of the manuscript.

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Ethics approval

Not applicable.

Informed consent

Not applicable.

Conflict of interest

The authors declare no competing interest.

Use of large language models, AI and machine learning tools

None declared.

Data availability statement

No additional data.

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