ISSN 2663-8169 Vol. 8, Issue 8: 39-43, DOI: 10.25236/IJNDE.2026.080805

Innovation and Practice of the "Dual-Wheel Drive and Six-Dimension Integration" Postgraduate Cultivation Model

Lili Zhang[a], Wei Wei[b], Jing Li[c], Wentao Wu[d], Ge Wang[e]

College of Information Engineering, Beijing Institute of Petrochemical Technology, Beijing, China
[a]zhanglili@bipt.edu.cn, [b]weiwei@bipt.edu.cn, [c]bipt_lijing@bipt.edu.cn, [d]wuwentao@bipt.edu.cn, [e]wangge@bipt.edu.cn
**Corresponding author*

Abstract: *Against the background of classified development of academic and professional degree postgraduate education in China, municipal universities with industry characteristics commonly face three problems: academic-degree and professional-degree postgraduates are cultivated along "two parallel lines" with little interaction; professional-degree training tends to be reduced to superficial internships; and regional industry advantages are not fully transformed into cultivation strengths. To address these problems, this paper proposes the "Dual-Wheel Drive and Six-Dimension Integration" postgraduate cultivation model. A flywheel architecture of "theory engine (academic degree) + application carrier (professional degree)" is constructed, three integration interfaces of joint research projects, mutual course opening and mixed faculty teams are established, a five-layer full-stack practical ability training path is designed for professional-degree students, a PDCA closed-loop quality improvement mechanism is built, and two practical proving grounds—capital city safety operation and low-altitude economy—are developed. The model realizes a symbiotic evolution of "theory supplying blood and practice generating blood", and provides a replicable and promotable reform paradigm for postgraduate cultivation in municipal industry-characteristic universities.*

Keywords: *Postgraduate education; Classified cultivation; Industry-education integration; Full-stack ability; Quality assurance*

1. Introduction

Postgraduate education constitutes the pinnacle of China's higher education system and serves as a crucial support for the nation's high-level self-reliance in science and technology. With the issuance of the Opinions on Further Promoting the Classified Development of Academic Degree and Professional Degree Postgraduate Education by the Ministry of Education in 2023, the classified development and classified cultivation of the two types of postgraduates has become a clear national policy orientation[1-3]. Academic degree postgraduates are expected to highlight the orientation of scientific research and innovation, while professional degree postgraduates are expected to highlight the orientation of professional practice; however, how to make the two types mutually reinforcing rather than mutually isolated remains an open question in the reform practice of most universities[4-5].

For municipal industry-characteristic universities, this question is particularly acute. On one hand, such universities generally possess stable industry cooperation resources and distinctive disciplinary features; on the other hand, constrained by disciplinary platforms, faculty scale and financial investment, they can hardly replicate the cultivation models of "double first-class" universities[6]. How to transform industry characteristics into cultivation advantages under resource constraints, and how to build a sustainable closed loop between academic research and engineering practice, are the key issues that determine the quality and distinctiveness of postgraduate cultivation in these universities[7-8].

Taking the College of Information Engineering of Beijing Institute of Petrochemical Technology as the carrier, and relying on the academic master's program of Control Science and Engineering and the professional master's programs of Electronic Information and Control Engineering, this paper proposes and practices the "Dual-Wheel Drive and Six-Dimension Integration" postgraduate cultivation model. The model takes "academic postgraduates should not be hollowed out, and professional postgraduates should not be reduced to interns; the two must form a symbiotic relationship of theory supplying blood

ISSN 2663-8169 Vol. 8, Issue 8: 39-43, DOI: 10.25236/IJNDE.2026.080805

and practice generating blood" as its core philosophy, and systematically reconstructs the cultivation scheme, the integration mechanism, the practical training path and the quality assurance system. The remainder of this paper is organized as follows: Section 2 analyzes the prominent problems of traditional cultivation models; Section 3 elaborates the dual-wheel drive architecture; Section 4 presents the six-dimension integration mechanism and the five-layer full-stack training path; Section 5 describes the PDCA closed-loop quality improvement mechanism; Section 6 introduces the two practical proving grounds; Section 7 concludes the paper.

2. Prominent Problems in Traditional Postgraduate Cultivation Models

(1) The "Two Parallel Lines" Dilemma of Academic and Professional Degree Cultivation

In most universities, the cultivation schemes of academic and professional degree postgraduates are designed independently of each other: curriculum systems, scientific research activities and thesis requirements each form their own closed systems[3]. Academic postgraduates devote themselves to theoretical research and paper publication, and their algorithmic achievements often stay at the level of simulation verification; professional postgraduates shuttle between enterprises and laboratories, but the engineering problems they encounter in practice can hardly be refined into scientific topics and fed back to academic research. As a result, the achievements of academic postgraduates are difficult to transform into engineering applications, while the practical problems of professional postgraduates are difficult to nourish theoretical innovation, and the two types of resources cannot be shared effectively[5][8].

(2) The "Internship-ization" Tendency of Professional Degree Cultivation

Professional degree education has achieved leapfrog development in scale, but its connotation construction has lagged behind[2]. In practice, the cultivation of professional postgraduates is prone to superficialization: enterprise practice is simplified into routine internships, engineering training is confined to simulation and parameter tuning, and students "only dare to simulate but dare not go to the site". Lacking complete training across the whole chain of "algorithm–system–deployment–operation and maintenance", graduates are often jokingly called "parameter-tuning engineers", whose comprehensive engineering ability cannot meet the actual needs of the industry[6-7].

(3) Insufficient Transformation of Industry Characteristics into Cultivation Advantages

For municipal universities, industry characteristics are the most valuable endowment, yet also the most easily wasted one. On one hand, the cooperation between universities and enterprises often stays at the level of internship bases and honorary titles, lacking deep mechanisms such as joint research topics, mutual course opening and mixed faculty teams; on the other hand, cultivation schemes are updated slowly and cannot keep pace with the iteration of industrial demands, and a sustainable closed-loop quality improvement mechanism is absent. The consequence is that regional industrial safety demands and industry characteristics fail to be converted into real cultivation competitiveness[4][9].

3. The "Dual-Wheel Drive" Architecture: From Parallel Lines to Symbiosis

(1) The Flywheel Model of "Theory Engine + Application Carrier"

Breaking through the traditional architecture of "two parallel lines", the model constructs a flywheel of "academic degree as the theory engine and professional degree as the application carrier". Academic postgraduates focus on deep research in frontier directions such as intelligent control theory, industrial information security mechanisms and multimodal fusion fundamentals, and are required to produce engineering-ready algorithm modules complete with code, data sets and test reports. Professional postgraduates, oriented to real scenarios such as petrochemical intelligent operation and maintenance, urban safety Internet of Things, industrial control system security and low-altitude management and perception, carry out system development and field deployment. Through the mechanism of joint research groups, algorithm prototypes produced by academic postgraduates are verified by professional postgraduates in real scenarios, and field data and engineering problems are in turn fed back to drive theoretical iteration, thus realizing the symbiotic evolution of "theory supplying blood and practice generating blood"[5][10].

(2) Three Integration Interfaces: Joint Projects, Mutual Courses and Mixed Faculty

To make the flywheel rotate continuously, three institutional interfaces are established. First, the

ISSN 2663-8169 Vol. 8, Issue 8: 39-43, DOI: 10.25236/IJNDE.2026.080805

joint research project mechanism requires that the algorithm modules in academic theses must be verified by professional postgraduates in real scenarios, forming a closed loop of "algorithm–system–data"; meanwhile, the "unmeasurable and uncontrollable" problems discovered in professional practice are refined into the research topics of the next cohort of academic postgraduates. Second, the mutual course opening mechanism stipulates that academic postgraduates must take engineering case analysis courses to cultivate engineering thinking, while professional postgraduates must take intelligent algorithm courses to avoid degenerating into "parameter-tuning engineers", with mutual recognition of credits. Third, the mixed faculty mechanism forms joint supervisor teams in which academic supervisors focus on theoretical breakthroughs, professional supervisors focus on technology development and enterprise supervisors focus on requirement definition, with regular "theory–application docking meetings" to ensure that research directions do not deviate from the main channel of the industry[7][9].

(3) Institutional Guarantee: Outcome Recognition and Credit Mutual Recognition

The operation of the dual-wheel architecture depends on supporting institutional design. A "technology transformation" indicator is added to the graduation requirements of academic postgraduates: in addition to publishing papers, each student must complete at least one engineering-ready algorithm module that has passed scenario verification. For professional postgraduates, the deliverables include complete systems, deployment documents and operation manuals. Rules on topic selection procedures, division of labor, outcome recognition and credit mutual recognition for joint projects are formulated, so that cross-type collaboration is no longer a voluntary act of individual supervisors but a standardized cultivation institution.

4. The "Six-Dimension Integration" Mechanism and the Five-Layer Full-Stack Training Path

(1) The Six-Dimension Integration Framework

On the basis of the dual-wheel architecture, the model integrates six key dimensions of the cultivation process into a coherent whole: project-based enrollment, mutual-opened curriculum, joint research projects, mixed faculty teams, full-stack practical training and closed-loop quality assurance. At the enrollment stage, professional degree directions are set according to real industry demands—the urban safety Internet of Things direction and the low-altitude intelligent perception direction—so that talent cultivation is anchored to real projects from the very beginning. The six dimensions are not simply juxtaposed but mutually embedded: courses provide knowledge support for projects, projects provide real scenarios for courses, mixed faculty operates the joint projects, and the quality loop dynamically feeds the other five dimensions.

(2) The Academic Side: "Deep Dive + Pre-research + Supply" Empowerment System

For the academic master's program of Control Science and Engineering, a three-dimensional empowerment system is constructed. Basic theory deepening faces the large-lag and strong-coupling characteristics of petrochemical plants and carries out advanced control theory research; frontier technology pre-research focuses on weak signal detection, small-sample target recognition, infrared-visible cross-modal fusion and industrial control system information security; and the theory ammunition depot requires that every thesis form a deliverable algorithm module verified through scenario reports by professional postgraduates. In this way, academic cultivation is prevented from being "hollowed out" and theoretical results are endowed with engineering vitality.

(3) The Professional Side: The Five-Layer Full-Stack Ability Training Path

Aiming at the "internship-ization" drawback of professional degree cultivation, a five-layer full-stack ability training system is designed, covering the perception layer (sensor selection, calibration and fusion), the cognition layer (target detection and fault diagnosis), the decision layer (control strategy and safety interlock), the execution layer (embedded and edge computing) and the deployment layer (system integration and field debugging). Taking the "low-altitude inspection UAV" project as an example, professional postgraduates must complete the whole chain of sensor selection and calibration, on-site optimization of the visual recognition model based on the algorithm packages of academic postgraduates, edge deployment on the RK3588 platform, and field joint debugging with operation manual compilation. Such end-to-end training ensures that graduates possess the composite ability of "algorithm + embedded system + industry norms" and grow from "parameter-tuning engineers" into genuine intelligent engineers[6][10].

ISSN 2663-8169 Vol. 8, Issue 8: 39-43, DOI: 10.25236/IJNDE.2026.080805

5. The PDCA Closed-Loop Quality Improvement Mechanism

To ensure that the cultivation model can be continuously iterated with industrial demands, a spiral quality improvement mechanism of "Plan–Do–Check–Act" is established. In the Plan stage, individualized cultivation schemes are customized according to students' foundations and industry demands; enterprise supervisors participate in the formulation and define the level of engineering problems that must be solved upon graduation. In the Do stage, a rhythm of "course study (the first semester) → laboratory research or enterprise practice (the second to third semesters) → thesis research (the fourth to sixth semesters)" is implemented, in which academic postgraduates complete algorithm prototypes in the laboratory while professional postgraduates complete system deployment in enterprises, with joint group meetings synchronizing progress. In the Check stage, a "on-site defense" is introduced into the mid-term assessment in the fourth semester: professional postgraduates must bring their equipment to the college for demonstration or connect to the operating site via video, and enterprise supervisors hold a veto power over unqualified practical outcomes. In the Act stage, excellent projects are incorporated into the case base, while failed projects enter the "problem base" to drive the next round of theoretical research, forming a complete and sustainable closed loop of "industry demand → cultivation scheme → project practice → thesis outcomes → employment feedback → scheme iteration".

6. Development and Verification of the Two Practical Proving Grounds

(1) Proving Ground One: Capital City Safety Operation

The first proving ground is anchored to the safety operation of the capital city and develops the Beijing gas management and operation-maintenance practice project. Academic postgraduates carry out algorithm research such as data analysis and knowledge graph construction, while professional postgraduates develop data analysis systems for concrete engineering applications. Through this proving ground, the gene of the energy industry is transformed into an irreplaceable cultivation advantage, and students' ability to serve the safe operation of the megacity is cultivated in real engineering contexts.

(2) Proving Ground Two: Low-Altitude Economy

The second proving ground is oriented to the low-altitude economy and develops the UAV-borne multimodal inspection system practice project. Academic postgraduates conduct research on multimodal target recognition algorithms, while professional postgraduates, facing the actual inspection demands of government commissions and bureaus, carry out system development with edge deployment on the RK3588 platform. The two proving grounds inherit the industry characteristics, connect with the capital's demands, and face the future industries, providing real engineering ranges and sufficient enterprise supervisor resources for the "project-based + full-stack" cultivation of professional postgraduates.

7. Conclusion

The "Dual-Wheel Drive and Six-Dimension Integration" postgraduate cultivation model reconstructs the relationship between academic and professional degree postgraduates from "parallel development" to "integrated symbiosis". Through the flywheel architecture of "theory engine + application carrier", the three integration interfaces of joint projects, mutual courses and mixed faculty, the five-layer full-stack training path, the PDCA closed-loop quality mechanism and the two practical proving grounds, the model is expected to achieve outcomes at three levels: at the cultivation model level, a replicable and promotable paradigm for municipal industry-characteristic universities is formed; at the student ability level, academic postgraduates acquire interdisciplinary research ability of "control + AI" and produce engineering-verified algorithm modules, while professional postgraduates acquire the full-stack ability of "algorithm + embedded system + industry norms"; and at the cultivation mechanism level, the scheme can be dynamically iterated with industry demands. The exploration demonstrates that, under resource constraints, the deep integration of the two degree types and the systematic transformation of industry characteristics are the realistic paths for municipal universities to improve the quality of postgraduate cultivation, and this issue deserves continued in-depth investigation by graduate education administrators and supervisors alike.

ISSN 2663-8169 Vol. 8, Issue 8: 39-43, DOI: 10.25236/IJNDE.2026.080805

Acknowledgement

This work is supported in part by General Project of Beijing City Higher Education Society in 2025 (Project Number: 125) and Educational and teaching reform and research project funding of Beijing University of Petroleum and Chemical Technology (Research on Innovation and Practice of the Postgraduate Training Model of "Two-wheel Drive·Six-dimensional Connection": 24033981001/027).

References

[1] Ding, X. M., Zhen, L., Song, P., et al. Implementing Classified Cultivation and Building a Quality Assurance System for Applied Talents. Academic Degrees & Graduate Education, 2010, (02): 1-4.
[2] Bao, S. M., Gu, H. Q. Professional Degree Postgraduate Education: The Embarrassment behind Leapfrog Development and Its Resolution. China Higher Education Research, 2011, (09): 41-45.
[3] Wu, Z. J., Li, Y., Cao, J., et al. Exploration of the University-Enterprise Joint Cultivation Model for Full-Time Professional Degree Postgraduates in the Field of Vehicle Engineering at Tongji University. Academic Degrees & Graduate Education, 2012, (08): 36-39.
[4] Shen, J. R., Zhang, J. H. Construction and Practice of the University-Enterprise Collaborative Cultivation Mechanism for Professional Degree Postgraduates. Journal of Graduate Education, 2016, (02): 80-84.
[5] Li, W., Yan, G. F. Theoretical Analysis and Practical Re-orientation of the Professional Degree Postgraduate Cultivation Model: From the Perspective of Classification. Journal of Graduate Education, 2021, (05): 51-57.
[6] Shi, Y., Wang, X. What Kind of Cultivation Environment Do Professional Degree Master's Students Need: An Empirical Study Based on a Survey of Master's Students. China Higher Education Research, 2021, (11): 35-41.
[7] Zhao, D. X., Wang, M., Lu, H. B. Exploration and Practice of a Multi-Agent Collaborative Cultivation Model for Engineering Professional Degree Postgraduates. Academic Degrees & Graduate Education, 2021, (12): 9-19.
[8] Ma, Y. H., Ma, W. L. Where Should the Boundary Lie: A Study on the Cultivation Differences between Engineering Master and Engineering Science Master Students. Academic Degrees & Graduate Education, 2022, (11): 9-18.
[9] Peng, X. B., Wu, J., Zu, J. W. Research on the Interdisciplinary Postgraduate Cultivation Model under the Background of High-Quality Development: A Case Study of the Intellectual Property Major. Journal of Graduate Education, 2022, (06): 59-65.
[10] Zhang, J., Zhang, B. B., Bu, D. H., et al. Exploration and Practice of the "Project-Based" Reform in the Cultivation of Agriculture-Related Professional Degree Master's Students. Academic Degrees & Graduate Education, 2023, (10): 22-27.