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Bridging the Industry-Academia Gap: An Independent Engineering Institute within a Comprehensive University

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Abstract Engineering educators face a persistent dilemma: universities and industries operate under fundamentally different missions. Academic institutions prioritize knowledge creation and theoretical advancement, while industrial partners seek practical solutions and market readiness. Traditional collaborative models often favor one perspective over the other, resulting in inherent tensions that limit efficiency. This study explores whether a structurally independent engineering college—an institution that maintains neutrality between academic and industrial demands—can offer a viable alternative to traditional partnership models. This paper presents findings from an exploratory study of an engineering college operating within a large research university while maintaining autonomy from both traditional academic departments and direct industrial control. The core research question addresses how this unique positioning enables the institute to navigate three long-standing friction points in university-industry collaboration: the persistent gap between classroom learning and workplace practice; complex disciplinary boundaries that complicate real-world problem-solving; and incompatible reward structures that hinder meaningful engagement across sectors. The investigation employed semi-structured interviews with ten stakeholders—including program administrators and graduate students at both master's and doctoral levels—representing multiple cohorts of the focal institute. To enhance interpretive validity, the study analyzed twelve complementary documents from institutional records, public-facing platforms, and media sources. Through systematic qualitative coding, the research identified recurring patterns in the institute's operations, outcomes, and challenges. The institute addresses each friction point through purposeful structural design:

Rather than compelling students to choose between academic depth and practical relevance, the college creates a dedicated space where both coexist. Students focus on authentic industry problems valued by corporate partners, yet do so within a framework that maintains academic rigor and encourages critical reflection.

Learning is organized around major projects led by senior technologists rather than departmental affiliations. Disciplinary barriers naturally diminish when students from mechanical, electrical, and software engineering backgrounds must collaborate to solve complex challenges.

This work enriches our understanding of university-industry collaboration by documenting a functional alternative to the binary "academic vs. industrial" framework. The independent institute model demonstrates how deliberate organizational design can respect the distinct missions of university and industry while achieving authentic synergy between them. For engineering educators and administrators considering deepening industry collaboration, our findings suggest specific structural elements worthy of replication. We also provide a candid discussion of implementation challenges and sustainability issues that merit continued attention. We hope this investigation sparks productive dialogue within the engineering education community on reimagining collaborative infrastructure to better serve students, universities, and industrial partners simultaneously.

1. Introduction

Global engineering educators face a persistent and increasingly acute dilemma: the structural misalignment of fundamental missions between universities and the industrial sector. While various global initiatives strive to cultivate adaptable 'excellent engineers,' they frequently struggle to reconcile this inherent tension. Traditional collaborative models often fail because the logic of modern research universities prioritizes knowledge production and disciplinary specialization , whereas industry demands rapid, cost-effective solutions to complex, interdisciplinary problems.

The fundamental logic of modern research universities prioritizes knowledge production and disciplinary specialization, measuring success primarily through high-impact publications[2]. Conversely, the industrial sector is driven by market competition and practical problem-solving, demanding talent capable of rapid, interdisciplinary system integration. This endogenous conflict between "Academic" and "Industrial" logics often renders traditional cooperative models superficial. When academia dominates, industrial engagements—such as internships and corporate mentorships—become nominal. Conversely, when industry dominates, education risks devolving into mere vocational training devoid of theoretical depth.

This dilemma is increasingly urgent amid the current technological revolution, where complex challenges—such as intelligent manufacturing and carbon-neutral systems—demand cross-disciplinary knowledge fusion[14]. However, the rigid, siloed organizational structures of traditional university departments severely hinder the cultivation of such interdisciplinary talent. Furthermore, as data-intensive paradigms empower corporate R&D to outpace universities in certain frontier fields, the traditional linear technology transfer model is rendered obsolete, necessitating a novel mechanism for deep integration and bidirectional empowerment.

Facing these challenges, this study focuses on a radical and unique organizational innovation scheme: the establishment of a "substantively independent" Engineers College within a research university. This model attempts to create a neutral "Trading Zone" within the university through organizational and institutional design changes. It enjoys the university's academic resources and degree-granting authority while possessing relatively independent administrative, personnel, and financial powers to flexibly align with industrial needs. This study selects Zhejiang University Engineers College (ZJU-EA) as the core case. Established in 2016, it is China's first graduate-level engineers college with substantive operations. As an upgraded explorer of the national "Plan for Educating and Training Excellent Engineers," [15][16]the college aims to explore a path for cultivating world-class engineers with Chinese characteristics by breaking disciplinary barriers, industry-education barriers, and singular evaluation criteria. This case is not only typical but, due to its "Special Zone" nature, provides an excellent window for observing how structural reform can resolve the difficulties of industry-education integration.

This study focuses on a single case study centered on the question: "How does a structurally independent engineers college effectively bridge the long-standing rift between universities and industry in talent cultivation through its unique organizational positioning and operational mechanisms?" This research transcends micro-level discussions of specific teaching methods in engineering education, ascending to the macro-level of organizational sociology and institutional

design. It attempts to provide a systemic solution framework based on "substantive institutions" for global engineering education reform, possessing significant theoretical and practical implications.

2. Literature Review

This chapter reviews relevant literature on university-industry collaboration (UIC), institutional logics, and boundary spanning to construct the theoretical framework for this study.

2.1 Elements and Frameworks of University-Industry Collaborative Engineering Education

Although the government-industry-university "Triple Helix" model has long been regarded as the theoretical cornerstone of industry-education integration, recent research has focused more on operational elements at the micro-level. Vuoriainen and Rikala[10]proposed the "Six C" framework for successful higher education-industry collaboration through a systematic review of the past decade's literature: Clarity, Communication, Commonality, Commitment, Continuity, and Confidence. Shah and Gillen[7], in their systematic literature review, noted that the breakdown of many partnerships stems from ambiguous definitions of goals, intellectual property ownership, and role division in the early stages. Since academia pursues public knowledge and long-cycle theoretical breakthroughs while industry pursues proprietary technology and short-cycle market applications, this conflict of institutional logics must be reconciled through high-frequency, transparent communication mechanisms. Pellinen et al.[5]found that collaboration resilience is significantly enhanced when partners identify a common vision beyond short-term interests (e.g., solving global challenges like climate change). This commitment is reflected not only in strategic agreements by senior leadership but also in daily interactions between frontline faculty and corporate engineers. Steinmo and Rasmussen[8], and later through an extensive review, pointed out that trust is key to reducing transaction costs. Long-term, repeated games allow for the accumulation of relational social capital, making knowledge transfer—especially tacit knowledge transfer possible. In contrast, one-off project collaborations often fail to reach deep technological innovation.

2.2 Barriers to University-Industry Collaborative Engineering Education

Ankrah and AL-Tabbaa[1] updated their classification of UIC barriers, emphasizing the persistence of the cultural divide. First is the misalignment of time horizons. Academic research often follows a linear logic of "discovery-verification-publication" with long cycles; conversely, enterprises operate in fierce market competition, following a circular logic of "agile development-iteration-launch." This mismatch in rhythm often leads to corporate disappointment with university response speeds. Second are disputes over intellectual property and benefit distribution. Ismail et al. [4] showed in their study of UIC in developing countries that rigid IP policies are a primary factor deterring Small and Medium-sized Enterprises (SMEs) from participating in school-enterprise cooperation. SMEs lack the legal resources of large multinational corporations to conduct lengthy IP negotiations with universities and often retreat. Furthermore, insufficient incentives for technology transfer within universities make faculty more inclined to publish papers than to apply for patents or engage in technology transfer. Third is the difference in absorptive capacity. Rossoni et al.[6] pointed out that even if universities produce high-quality research results, collaboration fails to generate economic value if enterprises lack

corresponding technological absorptive capacity. This is particularly evident in the transition of traditional manufacturing to Industry 4.0; enterprises urgently need digital talent but lack the infrastructure to interface with frontier university technologies.

2.3 Institutional Logic Conflict and Boundary Spanning

Theoretically, the tension between university and industry can be examined through the lens of Institutional Logics. Friedland and Alford's [3] Institutional Logic Theory provides a powerful tool for explaining barriers to UIC. In engineering education, two distinct dominant logics exist: Academic Logic and Industrial Logic. Academic Logic pursues truth, theoretical contribution, peer review, and long-cycle verification, with reputation and publicity of knowledge as core assets[9]. Industrial Logic pursues profit, efficiency, applicability, and agile iteration, with patents and exclusivity of knowledge as core assets. Ankrah and AL-Tabbaa[1] emphasize that these differences manifest as misalignments in time concepts and incompatible reward structures. Without structural intervention, academic logic tends to dominate within universities, transforming engineering education into "applied science" rather than "engineering practice."

3. Research Design

3.1 Research Methodology

This study employs a Single Case Study method. Case studies are suitable for exploring "How" and "Why" questions, particularly when the boundaries between the research object and its context are blurred and complex organizational behaviors are involved. ZJU-EA, as a completely new entity established through "incremental reform" within a "Double First-Class" university, serves as a highly revealing extreme or paradigmatic case, capable of uncovering the deep logic of structural reform.

3.2 Case Selection

Case Object: Zhejiang University Engineers College. Rationale for Selection:

Pioneering Status: Established in 2016, it is the first graduate-level engineers college in the nation, possessing seminal significance.

Substantive Nature: Unlike general virtual coordination agencies, ZJU-EA possesses an independent campus (Hangzhou headquarters and branch campuses in Ningbo, Quzhou, and Taizhou), independent admissions codes, independent budget, and independent authority for professional title review. This makes it the optimal sample for testing the effects of "substantive reform."

Scale: With over 4,000 enrolled graduate students (including over 680 engineering doctoral students) and 1,167 enrolled in the single year of 2022 covering 8 professional engineering degree categories, the large-scale operational data excludes the potential randomness of small-scale pilots.

Effectiveness: The model was awarded the First Prize of the 2022 National Teaching Achievement Award and was selected into the first batch of "National Excellence Engineer Colleges," indicating dual recognition from official bodies and academia.

3.3 Data Collection and Analysis

This study uses triangulation to collect data, ensuring the reliability and validity of research

conclusions., as shown in Table 1.

Table 1: Date source

Data Type	Specific Content	Source/Description
Documentation	12 key institutional documents	Includes the "Exploration and Practice of Excellence Engineer Education and Training Reform" report, college annual reports, talent cultivation schemes, title review regulations, and school-enterprise cooperation agreement templates. These provide the original blueprint for institutional design.
Interview Data	In-depth interviews with 10 key stakeholders	Administrative Managers (3): College Dean and Academic Affairs heads, regarding top-level design and strategic intent. Academic & Corporate Mentors (3): Includes internal doctoral supervisors and corporate chief experts, exploring the actual operation and evaluation of the "Dual-Mentor" system. Graduate Students (4): Covers full-time Master's and Engineering Doctoral students, regarding learning experience, project participation, and employment competitiveness.
Statistical Data	2016-2022 Operational Data	Covers annual enrollment numbers, student source structure, graduate employment rates and distribution, patent application and authorization numbers, number of corporate cooperation bases, and equipment investment amounts.

The study employed the coding strategy of Grounded Theory to analyze qualitative data. To ensure coding reliability and minimize subjective bias, two researchers independently coded the interview transcripts and institutional documents. Discrepancies were resolved through iterative discussions until a consensus was reached. During the open coding stage, the research team identified initial concepts such as 'resource conflict,' 'forced boundary spanning,' 'identity confusion,' and 'evaluation differences'.

4. Research Findings

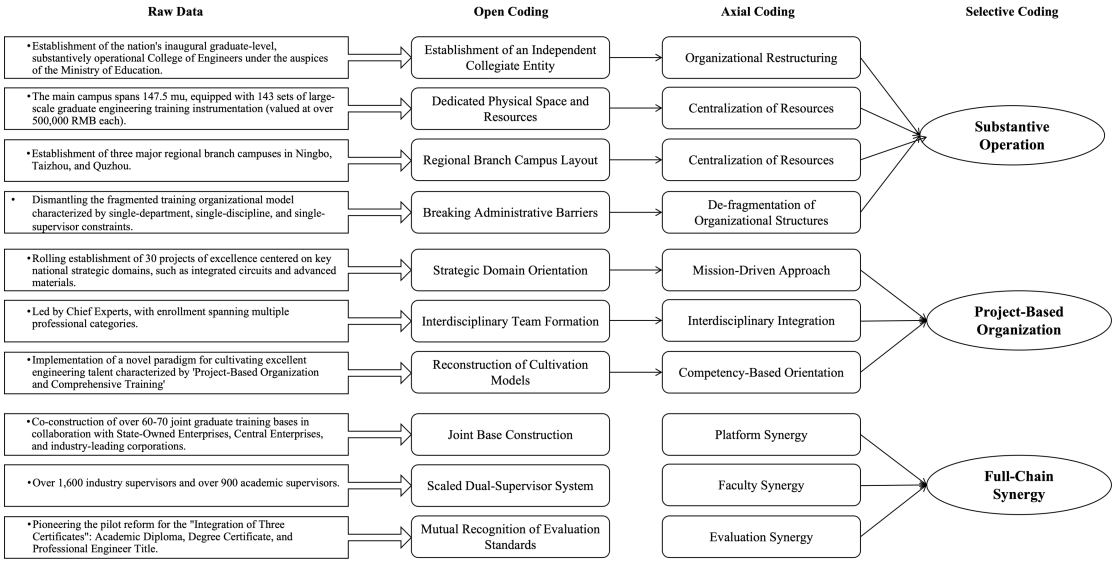

Figure 1 research coding process

Through an in-depth analysis of ZJU-EA, this study finds that the college does not attempt to simply eliminate the differences between academia and industry. Instead, through "Structural Hybridity"—establishing an entity with independent physical space and administrative power—it creates a venue within the university where both logics are allowed to coexist and effectively exchange, as shown in Figure 1. The mechanism for resolving conflicts is analyzed below from

the three dimensions of resources, organization, and incentives.

4.1 Feature 1:Substantive Operation——Breaking Administrative and Resource Barriers

Traditional professional degree education often "parasitizes" academic departments, facing the predicament of resource crowding. The most significant feature of ZJU-EA is its "Entity-based" operational model.

- Independent Space and Resources: The college has built an independent main campus covering 147.5 mu and has invested heavily in constructing an Engineering Innovation and Training Center. Data shows the college has installed 143 sets of large-scale graduate engineering training equipment (valued at over 500,000 RMB each), with a total investment exceeding 400 million RMB. This equipment is not used for basic scientific experiments but interfaces with real industrial production and R&D environments, such as intelligent manufacturing production lines and automotive powertrain test benches.

- Administrative and Admissions Independence: The college possesses independent admission quotas and degree-granting authority. In 2022, the college enrolled 1,167 students covering 8 engineering professional degree categories such as Electronic Information, Mechanical Engineering, and Energy and Power. This independence allows the college to adjust its enrollment structure based on industrial needs rather than disciplinary inertia.

A college administrator mentioned in an interview: "If we were just a center attached to the School of Mechanical Engineering, we would never be able to buy an industrial-grade five-axis machining center worth millions, because in the academic evaluation system, this is not as useful as buying an electron microscope to publish papers. Being a substantive entity gives us the power to define 'what is an important resource'."

4.2 Feature 2:Project-Based Organization—Breaking the Barriers of Disciplinary Silos

Addressing problems caused by disciplinary segmentation, ZJU-EA abolished the traditional "Department-based" student management model and innovatively implemented a "Project-based" cultivation model.

- Interdisciplinary Projects Oriented to Industry Needs: The college does not have an "Electrical Department" or "Chemical Engineering Department." Instead, it has established 30 excellence training projects oriented toward key national domains, such as "Smart Energy," "Integrated Circuits," and "High-end Equipment and Intelligent Manufacturing." These projects possess inherent interdisciplinary attributes. For example, the "Smart Energy" project recruits not only students from Electrical Engineering but also those from Control Science, Thermal Engineering, and even Computer Science, who study and tackle key problems together within the same project.

- Chief Expert Responsibility System: Each project is led by an Academician or top industry expert acting as the Chief Expert, responsible for formulating cultivation schemes and curriculum systems. (Table 1 in the source data illustrates project configurations).

This organizational method forces students of different backgrounds to collaborate within the same project. In an interview, a graduate student participating in the "Robotics and Intelligent Manufacturing" project stated: "Previously in the college, I only knew how to write code. In this project, I have to debug servo motors with classmates from mechanical backgrounds and discuss algorithm implementation with classmates from control backgrounds. This forced 'cross-over' made me truly understand what systems engineering is."

4.3 Feature 3:Full-Chain Synergy

The college has constructed a "Full-Chain Synergy Ecosystem," characterized by deep synergy across three dimensions: platforms, faculty, and evaluation standards.

- Platform Synergy: Base Co-construction. The college transcends the casual internship model by establishing 60-70 joint training bases with State-Owned Enterprises and industry giants. These are not merely visiting points but shared R&D facilities where students live and work. This physical embedding ensures the "classroom" is indistinguishable from the "workshop" .

- Faculty Synergy: Scaled Dual-Mentorship. The college has institutionalized industrial participation by hiring over 1,600 corporate mentors, a number significantly exceeding the 900+ internal academic mentors. Unlike honorary roles, these corporate mentors possess veto power in four key stages: recruitment, cultivation plan formulation, topic selection, and defense.The college established specific "Engineering Education Innovation Posts," where faculty assessment is based on technological impact rather than SCI papers, thereby establishing the legitimacy of industrial expertise within the university.

- Evaluation Synergy: Mutual Recognition of Standards. Students may submit product R&D reports, engineering design schemes, or technical standards to replace traditional academic theses. This policy perfectly aligns student motivation of obtaining a degree with industrial motivation of solving practical problems. A measurable indicator of this model producing better-prepared engineers is the 'Three Certificates in One' pilot. Unlike traditional models where graduates must accrue years of industry experience post-graduation to prove their practical competence, ZJU-EA aligns its degree requirements directly with national professional qualification standards. As empirical evidence of this success, 129 graduate students in a single cohort directly obtained Intermediate Engineer titles upon graduation. This tangible outcome demonstrates that the independent college model successfully accelerates the professional readiness of its engineers compared to conventional academic pathways.

5. Conclusions and Implications

5.1 Research Conclusions

Using Zhejiang University Engineers College as an extreme case, this study explores how to resolve the structural dilemma of industry-education integration through organizational innovation within a research university. The research indicates that traditional "additive" reforms (such as establishing joint centers or adding internship credits) are insufficient to meet the complex

engineering talent demands of the Industry 4.0 era.

We developed a conceptual framework for bridging the industry–academia gap through an independent engineering college, as shown in Figure 2.The core conclusions are summarized below.

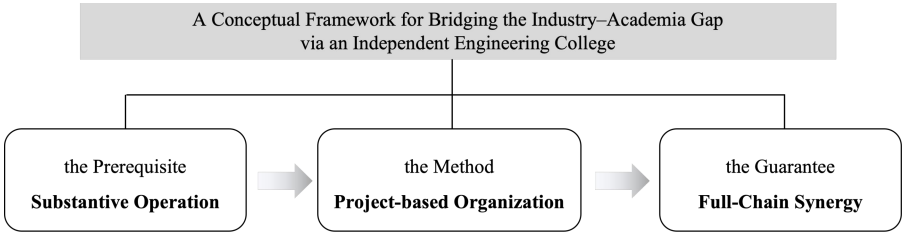

Figure 2 Research conceptual framework

Substantive Operation is the Prerequisite: Only by establishing a substantive entity with independent physical space, administrative power, and budget systems can a "Institutional Special Zone" be created within the university to resist the isomorphic pressure of a singular academic evaluation system.

Project-based Organization is the Method: By abolishing traditional departmental structures and implementing "Project-based" organizational forms guided by national strategic needs, disciplinary barriers can be forcibly broken, realizing a transformation in knowledge production from discipline-oriented to problem-oriented.

Full-Chain Synergy is the Guarantee: Only when the industry possesses substantive decision-making power (e.g., veto power) throughout the full lifecycle of recruitment, training, and evaluation, and achieves mutual recognition of evaluation standards (e.g., Three Certificates in One), can industry-education integration shift from "transactional" to "symbiotic."

5.2 Theoretical Contributions

This study expands existing literature on engineering education and organizational management in two aspects. One is enriching the substantive expression of "Third Space" theory in engineering education. Existing literature often views the "Trading Zone" or "Third Space" as a metaphor or a temporary interactive venue . This study, through the ZJU-EA case, confirms that "Structural Hybridity" is key to maintaining the long-term existence of the Third Space[11][12]. As an entity that is neither purely academic nor purely corporate, ZJU-EA proves that through careful institutional design, a university can endogenously generate a new organizational form compatible with both logics, thereby avoiding the fate of one party being assimilated by the other in traditional collaborations[1][12]. Another one is revealing the mechanism of organizational structure as a "Buffer" for institutional logic conflict[3]. Based on Institutional Logic Theory , this study finds that "Substantive Operation" is not merely a resource allocation method but an institutional defense mechanism. Independent college boundaries act as a "Buffer," filtering excessive academic publication pressure from the parent university while introducing the legitimacy of market logic through the "Dual-Mentor System" and "Three Certificates in One." This finding explains why "virtual" agencies often lead to superficial industry-education

integration—because they lack structural barriers capable of protecting the survival of heterogeneous logics.

5.3 Policy and Management Implications

For university administrators and policymakers attempting to deepen engineering education reform, this study proposes the following recommendations.

Shift from "Addition" to "Special Zones": Reform cannot stop at the curriculum level. Universities should grant engineering education institutions relatively independent control over "personnel, finance, and assets," allowing them to establish evaluation systems independent of science departments, fundamentally establishing the academic legitimacy of engineering practice.

Reconstruct the Power Structure of Industrial Participation: Corporate mentors cannot be mere honorary titles. Institutional design must grant industrial partners substantive veto power in talent selection and quality control. Only when enterprises transform from "passive sponsors" to "active co-educators" can the misalignment between education supply and industrial demand be corrected.

Promote Interconnection and Mutual Recognition of Evaluation Systems: It is recommended that education authorities promote the "Academic Degree + Professional Qualification" interconnection model. Breaking barriers between the education system and the human resources system allows the training process of engineering masters/doctors to interface directly with professional engineer qualification standards, serving as the strongest baton guiding students to value engineering practice[17].

5.4 Limitations and Future Prospects

Although this study provides profound insights, limitations exist. ZJU-EA relies on the resource endowments of a top-tier research university and received massive initial investment. While the replicability of this high-cost model in resource-constrained local universities requires further verification, its structural design has already proven scalable among major institutions. Recognized for its effectiveness, the ZJU-EA model informed the Chinese Ministry of Education's recent rollout of the 'National Excellence Engineer Colleges' initiative, which has officially selected a first batch of top-tier universities to replicate and adapt this independent college framework. Future studies should investigate how these newly established institutes adapt the model to their specific regional and industrial contexts.

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