Article

Development and Practice of a Micro-Major in Intelligent Manufacturing of New Energy Vehicles under the "Electric Guizhou" Strategy

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Abstract: In response to China's dual-carbon strategy and the Ministry of Education's "Double-Thousand Plan," and to address the mismatch between the shortage of talent across the new energy vehicle (NEV) industry chain under Guizhou's "Electric Guizhou" strategy and the limitations of conventional single-discipline education, Guizhou University of Commerce has developed a micro-major in Intelligent Manufacturing of New Energy Vehicles through its School of Big Data and Intelligent Engineering. From the perspective of industry-education integration, this paper systematically examines the policy, industrial, and educational rationales for the micro-major. It proposes an interdisciplinary talent-development philosophy in which technology forms the foundation, artificial intelligence provides leverage, and application remains the focus. A six-component, progressively structured curriculum is established around foundational cognition, design communication, process fundamentals, digital enablement, specialized manufacturing, and design and testing. The paper also details an implementation pathway based on university-enterprise collaboration and joint instruction by academic and industry faculty. The study argues that the micro-major model can effectively break down disciplinary barriers and align the education and talent chains with the industrial and innovation chains, thereby providing a replicable and scalable model for cultivating new-engineering talent at local application-oriented universities.

Keywords: Electric Guizhou; new energy vehicles; micro-major; industry-education integration; curriculum system

1. Introduction

As the global energy transition accelerates and China's dual-carbon goals advance, the new energy vehicle industry has become a strategic emerging industry through which the country seeks to gain a competitive advantage in automotive development. In March 2025, the Ministry of Education launched the "Double-Thousand Plan" for improving university students' employability. The plan called for the nationwide establishment of 1,000 micro-majors, or specialized course clusters, and 1,000 vocational competency training courses to help graduates remedy gaps in their knowledge and skill structures and improve their employability. Characterized by a small number of credits, a narrow focus, carefully selected courses, interdisciplinarity, and flexibility, a micro-major generally consists of three to ten core courses completed over one to two years [1]. This policy initiative marks the elevation of micro-major development from bottom-up institutional innovation to top-down policy embedding and provides local universities with a clear route for responding proactively to industrial transformation [2]. The Ministry of Education has further specified that micro-majors should focus on fields facing acute shortages, including artificial intelligence and the low-altitude economy.

At the same time, Guizhou Province has responded to national priorities by leveraging its abundant phosphate, aluminum, manganese, and other mineral resources

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to advance the "Electric Guizhou" development strategy. The province has established an industry-chain ecosystem encompassing ore, materials, batteries, and complete vehicles. In 2025, its new energy battery capacity reached 55 GWh, lithium-ion traction-battery output increased by 90%, and NEV production exceeded 250,000 units, representing growth of 147.7% [3]. Guizhou's 15th Five-Year Plan calls for accelerating and upgrading the "Electric Guizhou" initiative and integrating the entire NEV industry chain [4]. Rapid industrial expansion, however, has increasingly exposed a structural mismatch between industrial demand and the supply of qualified personnel. Guizhou faces an acute shortage of high-level, locally trained NEV specialists; firms often recruit from other provinces at high cost and with limited employee retention.

Furthermore, the talent needs of the "Electric Guizhou" initiative cannot be met simply by increasing the number of engineering and technical personnel in a particular field; rather, they require the optimization and restructuring of the talent profile. On the one hand, the new energy vehicle industry chain encompasses R&D, design, manufacturing, quality assurance, supply chain operations, and production management, with strong technical interdependence among these functions. On the other hand, the increasing integration of production equipment, industrial software, data acquisition, and artificial intelligence into manufacturing is gradually blurring the boundaries between technical and managerial roles. Consequently, regional industrial development increasingly demands an integrated combination of engineering knowledge, digital proficiency, and organizational and managerial capabilities, rather than isolated professional skills.

Against this background, Guizhou University of Commerce has established a micro-major in Intelligent Manufacturing of New Energy Vehicles by drawing on the province's first undergraduate program in New Energy Vehicle Engineering and combining the university's established strength in business education with its emerging engineering programs. The rationale for the micro-major can be summarized as policy guidance, industrial demand, interdisciplinary integration, and industry-education collaboration. It is grounded in the Ministry of Education's Double-Thousand Plan, oriented toward the needs of the Electric Guizhou industry, distinguished by the integration of engineering and management, and supported by university-enterprise collaboration. The program seeks to establish a flexible, precise, and efficient pathway for applied talent development. By integrating engineering knowledge, artificial intelligence, and managerial competence, it aims to cultivate interdisciplinary graduates capable of adapting to complex industrial settings.

2. Background to the Micro-Major

The micro-major did not emerge in isolation; it resulted from several interacting forces. Public policy provides institutional space and strategic direction, industry supplies authentic talent requirements and technical contexts, and the university draws on multidisciplinary resources to translate industrial needs into courses and teaching activities. Student competency development ultimately serves the regional industry's growth.

2.1. Policy Dimension: Responding to the National Double-Thousand Plan

The Ministry of Education's Double-Thousand Plan, introduced in 2025, provides strong policy support for micro-major development. Focusing on optimizing the knowledge and skill structures of graduates in fields with relatively weak labor-market demand, the plan guides universities to develop micro-majors around urgent industrial needs and employment opportunities. The supply logic of a micro-major is to derive the curriculum from industrial demand, directly converting learning content into job skills and learning outcomes into employability [5]. With its short cycle and rapid responsiveness, the micro-major functions as a talent-supply interface between university education and industry. In implementing the Double-Thousand Plan, Chongqing further classified micro-majors into three types: programs addressing acute shortages, programs

emphasizing applied skills, and interdisciplinary programs [6]. The present micro-major combines the first and third attributes: it addresses the talent gap in a regional pillar industry while breaking down boundaries among engineering, science, and management. By July 2025, Chinese universities had established 2,654 micro-majors for the graduating class of 2025, enrolling 74,000 graduating students.

2.2. Industrial Dimension: Addressing the Talent Bottleneck in the Electric Guizhou Strategy

Although Guizhou's NEV industry is developing rapidly, a pronounced structural mismatch remains between the supply of talent and industrial demand. On the one hand, the province has formed a complete industry chain extending from mineral resources and battery materials to core components and complete-vehicle manufacturing. Leading enterprises such as CATL, BYD, Geely, and Chery have established production capacity in Guizhou. On the other hand, the development of locally trained technical personnel has lagged far behind capacity expansion. More importantly, industry no longer needs only narrowly trained technicians; it requires interdisciplinary personnel who understand intelligent manufacturing technology and possess production-management awareness. Highly automated NEV production lines require employees who can understand production processes while also managing work on the shop floor. By promoting "local education for local employment," the micro-major directly addresses the staffing needs of complete-vehicle manufacturers such as Geely's Guiyang facility and Chery's Guizhou facility.

From the perspective of the supply--demand relationship in talent development, there is a significant time lag between the pace of technological iteration in the new energy vehicle industry and the cycle of university program adjustments. Traditional undergraduate programs are generally built around relatively stable knowledge systems, while curriculum revisions typically require processes such as program review, revision of talent development plans, and teaching organization. As a result, their responsiveness to emerging technologies, new occupations, and new forms of industry development is relatively limited. Micro-credential programs, guided by industry scenarios and job competencies, can enhance the responsiveness of talent development to changing industry needs by reducing the scale of coursework, focusing on core competencies, and strengthening practical instruction. For Guizhou, which is currently experiencing accelerated industrial development, this "small-scale, rapid-response" approach can serve as an important complement to traditional undergraduate education, providing students with new opportunities to develop the competencies needed to expand into industrial fields beyond their primary disciplines.

2.3. Disciplinary Dimension: Breaking Down Barriers through Interdisciplinarity and Industry-Education Integration

The NEV industry is inherently interdisciplinary, encompassing mechanical engineering, electrical engineering, materials science, computer science, management science, and related fields. Conventional university programs are often divided too narrowly: engineering students may lack managerial thinking, management students may lack an engineering foundation, and science students may lack exposure to applied contexts. Such segmentation makes it difficult to meet industrial demand for interdisciplinary talent [7]. Guizhou University of Commerce combines a distinctive tradition in business education with Guizhou's first undergraduate program in New Energy Vehicle Engineering, giving it a foundation for integrating engineering, management, artificial intelligence, and other disciplines. The micro-major is therefore primarily offered to senior students in management-related majors. It draws on this distinctive disciplinary ecosystem to cultivate well-rounded graduates with multidisciplinary perspectives who differ from those trained in conventional engineering-only institutions.

3. Development Pathway and Talent-Development System

3.1. Reconstructing Program Objectives: From Discipline-Based to Competency-Based Education

The objectives of a micro-major differ substantially from those of a conventional major. Whereas a conventional major emphasizes the systematic and comprehensive nature of disciplinary knowledge, a micro-major places greater emphasis on occupational orientation and competency-based education [8]. On this basis, the present program translates its training objectives into observable and assessable learning outcomes organized in three dimensions: knowledge, ability, and professional attributes.

In the knowledge dimension, students are expected to acquire systematic knowledge and skills concerning NEV construction, engineering materials and the fundamentals of mechanical manufacturing, automotive artificial intelligence, digital modeling, manufacturing processes, and design and testing technologies. In the ability dimension, they should be able to apply this knowledge to the digital modeling of NEV components, manufacturing-process design, and basic performance testing, thereby developing an initial capacity for technical management in production settings. In the professional-attributes dimension, students should demonstrate sound professional ethics, teamwork, awareness of production safety and quality, and innovative thinking, enabling them to adapt to the rapid development of intelligent manufacturing and the NEV industry. These objectives reflect the short-cycle, focused, and application-oriented nature of micro-major education and closely align with the Double-Thousand Plan's central goal of improving employability and promoting high-quality, adequate employment.

Building on these objectives, the micro-major organizes student competence into six progressive levels: recognition, communication, design, manufacturing, analysis, and collaboration. Recognition means understanding NEVs and their intelligent manufacturing contexts. Communication refers to the ability to communicate through engineering drawings, digital models, and technical documentation. Design entails applying fundamental engineering knowledge to develop a solution. Manufacturing means understanding and participating in manufacturing processes and quality control. Analysis is the use of digital tools and AI methods to conduct basic analyses of production or test data. Collaboration is the ability to complete tasks in teams spanning disciplines and job roles. These six levels correspond to the progressive curriculum and express the program's logic of transferring disciplinary learning into occupational competence.

3.2. Curriculum Design: A Modular Architecture for Progressive Competency Development

The curriculum is the core of micro-major development [9]. Moving beyond a conventional discipline-centered knowledge structure, the program adopts a work-process-oriented competency structure. It establishes a six-part progressive curriculum chain comprising foundational cognition, design communication, process fundamentals, digital enablement, specialized manufacturing, and design and testing. The curriculum simultaneously follows three developmental threads: foundational cognition, production application, and integrated management. It comprises 12 credits and 192 contact hours, of which 50% are practical. Table 1 presents the curriculum structure.

Table 1. Curriculum Structure of the Micro-Major in Intelligent Manufacturing of New Energy Vehicles

No.	Course	Credits	Total hours	Contact-hour distribution		Assessment	Semester
				Theory	Practice		
1	New Energy Vehicle Construction Engineering	2	32	16	16	Coursework	1
2	Materials and Fundamentals of Mechanical Manufacturing	2	32	16	16	Coursework	1

3	Automotive Artificial Intelligence	2	32	16	16	Coursework	1
4	Automotive Digital Modeling Technology	2	32	16	16	Coursework	2
5	New Energy Vehicle Manufacturing Technology	2	32	16	16	Coursework	2
6	New Energy Vehicle Design and Testing Technology	2	32	16	16	Coursework	2
	Total	12	192	96	96	/	1 academic year

Course organization further strengthens project continuity across modules. In the first semester, a foundational project organized around "Understanding a New Energy Vehicle" connects New Energy Vehicle Construction, Engineering Materials and Fundamentals of Mechanical Manufacturing, and Automotive Artificial Intelligence. In the second semester, an integrated task organized around "Designing and Manufacturing an NEV Component" links Automotive Digital Modeling Technology, New Energy Vehicle Manufacturing Technology, and New Energy Vehicle Design and Testing Technology. The progressive implementation of a single project across different courses reduces fragmentation and allows knowledge, skills, and professional attributes to develop together as task complexity increases.

The curriculum follows three principles. The first is selectivity: six carefully selected courses totaling 12 credits satisfy the defining micro-major features of a small credit load and focused content. The second is integration. In addition to the dedicated Automotive Artificial Intelligence course, AI elements are embedded in every other course. Examples include AI-based quality inspection in New Energy Vehicle Manufacturing Technology and AI-assisted data analysis in Design and Testing Technology. All courses also incorporate values and ethics education to help students develop sound values, strengthen engineering ethics, pursue craftsmanship and continuous improvement, and cultivate a sense of responsibility to contribute to national scientific and technological development. The third principle is application. Practical work accounts for 50% of contact hours, enabling students to learn by doing and do while learning, strengthen hands-on ability, and complete practical projects designed around enterprise needs.

The 50% practical component secures sufficient time for competency development, but the quality of practical teaching also depends on the authenticity and progression of the tasks. The program therefore goes beyond software exercises and confirmatory experiments by introducing integrated tasks. During digital modeling, students construct a model based on component functions and dimensional requirements. During manufacturing technology, they analyze materials, process routes, and quality-control requirements. During design and testing, they use test data to determine whether a design should be adjusted. The continuity among these tasks allows students to experience the basic engineering cycle of requirements, design, manufacturing, testing, and improvement.

3.3. Building a Dual-Qualified Teaching Team

A capable teaching team is essential to educational quality. The micro-major has established a jointly staffed team in which university faculty members and senior enterprise engineers share teaching responsibilities.

The university-based group consists of five core faculty members, all of whom hold the rank of associate professor or above, and 80% of whom hold doctoral degrees. They are responsible for theoretical instruction and foundational laboratory work and possess strong theoretical backgrounds and extensive teaching experience in NEV construction, digital modeling, and manufacturing processes. The industry-based group consists of three senior engineers from organizations including Chery's Guizhou facility (Guizhou Ruiqi New Energy Vehicle Co., Ltd.), Guizhou Changjiang Automobile Co., Ltd., and the Beijing Huizhihuizhong Automotive Technology Research Institute. These engineers participate extensively through classroom teaching, specialist lectures, practical-course supervision, and project mentoring, ensuring that course content remains aligned with industrial advances. Their long-term experience across the NEV industry chain enables them to bring front-line technologies and job requirements from the Electric Guizhou initiative into the classroom, supporting the program's objective of precisely cultivating interdisciplinary applied talent.

4. Implementation Pathway and Operating Mechanisms

4.1. Admissions and Academic Management

The micro-major uses an open admissions process for full-time undergraduates across the university, with particular emphasis on senior management students. The inaugural cohort consists of 25 students. Selection follows the principles of voluntary application and merit-based admission, with comprehensive consideration given to academic performance in the primary major, learning potential, and the personal statement. Motivation, interest in interdisciplinary study, and the capacity to commit sufficient time are also important criteria.

In academic management, the program strengthens documentation of the learning process by establishing an individual portfolio for each student. Course grades, practical work, project performance, enterprise evaluations, and evidence of skills are archived to create an increasingly complete competency profile. The micro-major certificate thus indicates more than course completion: project outputs and practical evidence make the student's actual competence visible and improve the connection between learning outcomes and employment. Classes are scheduled on weekends, during short terms, and over winter and summer breaks to avoid conflicts with primary-major courses. Students who complete all courses with passing grades receive a standardized micro-major certificate issued by the university.

4.2. Developing a University-Enterprise Practice Platform

4.2.1. Practice Platforms

On-campus: vehicle cutaway display; traction-motor test bench; BMS training platform; digital modeling laboratory.

Off-campus: Chery Guizhou Facility; Guizhou Hankes; Beijing Huizhihuizhong Automotive Technology Research Institute.

4.2.2. Three-Stage Process

Stage 1 - Cognition: site visits and understanding of industrial processes.

Stage 2 - Training: disassembly, digital modeling, and manufacturing-process simulation.

Stage 3 - Workplace Practice: enterprise practice guided by industry mentors.

Assessment: formative evaluation + project outcomes + industry-mentor evaluation.

Practical teaching is critical to the quality of micro-major education [10]. The program has established a dual-track system combining on-campus training with enterprise practice. On-campus work will use the forthcoming Experimental and Training Base of the New Energy Vehicle Industry College at Guizhou University of Commerce. Planned facilities include a complete-vehicle cutaway display area, a traction-motor test bench, a battery-management-system training platform, and a digital modeling laboratory, enabling the base to support the experiments, computer-based exercises, and practical

teaching required by all courses. Off-campus practice bases have been jointly established with Chery's Guizhou facility (Guizhou Ruiqi New Energy Vehicle Co., Ltd.), Guizhou Hankes Intelligent Technology Co., Ltd., the Beijing Huizhihuizhong Automotive Technology Research Institute, and other enterprises. These firms provide opportunities to observe complete-vehicle manufacturing processes, learn about intelligent chassis and digital manufacturing technologies, and undertake specialized technical training.

On this foundation, the micro-major adopts the three-stage progressive practical teaching model shown in Figure 1. The first, cognition, involves factory visits through which students develop an intuitive understanding of the complete NEV manufacturing process. The second, training, uses the on-campus base for integrated exercises in digital modeling and manufacturing-process simulation. The third, workplace practice, places students on enterprise production lines, where industry mentors supervise authentic projects or job-based practice.

PRACTICE PLATFORMS
On-campus: vehicle cutaway display; traction-motor test bench; BMS training platform; digital modeling laboratory.
Off-campus: Chery Guizhou Facility; Guizhou Hankes; Beijing Huizhihuizhong Automotive Technology Research Institute.
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Stage 1 - Cognition: site visits and understanding of industrial processes.
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Stage 3 - Workplace Practice: enterprise practice guided by industry mentors.
Assessment: formative evaluation + project outcomes + industry-mentor evaluation.

Figure 1. Process of the Practical Teaching System

4.3. A Diversified Assessment System

The micro-major replaces the conventional single-examination model with a diversified system combining formative assessment, project-based assessment, and enterprise participation. Formative assessment focuses on routine performance, including classroom participation, laboratory operations, and group discussions. In project-based assessment, Automotive Digital Modeling Technology primarily evaluates the modeling work submitted by students, whereas New Energy Vehicle Design and Testing Technology requires students to complete and report on an integrated design-and-testing project. In practice-intensive courses such as New Energy Vehicle Manufacturing Technology, enterprise mentors participate in grading, with particular attention to engineering practice, professional conduct, and production-safety awareness. This system embodies competency-based education by directly linking learning outcomes to occupational competence.

4.4. Establishing Quality Assurance Mechanisms

Quality assurance is essential for moving the micro-major from project development to sustainable operation. The program has established a four-party quality assurance structure involving the university, the school, the program team, and partner enterprises. The university is responsible for policies, student records, and resource support. The school manages teaching organization, faculty coordination, and process administration. The program team oversees course content, practical projects, and learning assessment. Enterprises provide feedback on occupational standards, industrial demand, and practical conditions. Regular development seminars, course review meetings, and enterprise-needs consultations are used to identify discrepancies between the training scheme and industrial change in a timely manner.

5. Expected Outcomes and Transferability

5.1. Expected Outcomes

After systematic study in the micro-major, the inaugural cohort is expected to develop three core capabilities. First, in engineering practice, students will be proficient in digital design software, understand the complete NEV manufacturing process, and possess basic process-design and shop-floor operational skills. Second, in interdisciplinary integration, students will develop a combined "technology + AI" perspective, adapt to technical roles in intelligent manufacturing, and understand how digital and intelligent technologies are applied in manufacturing. Third, in employability, the program's close alignment with the Electric Guizhou strategy will enable graduates to target positions such as manufacturing process technician, shop-floor technician, and quality-inspection assistant in partner enterprises, thereby linking local education effectively with local employment.

In addition to individual student development, outcomes will be examined at the course, faculty, university, and industry levels. At the student level, evaluation will focus on professional understanding, practical skills, AI application, and employment fit. At the course level, it will examine alignment between content and occupational demand and the quality of project-based teaching. At the faculty level, it will consider improvements in industrial experience and interdisciplinary teaching. At the university level, it will assess the micro-major's contribution to program-portfolio optimization and industry-education integration. At the industry level, it will examine the depth of enterprise participation and students' adaptation after entering relevant positions. This multilevel approach avoids evaluating micro-major performance solely by enrollment or certificate counts.

To make outcomes observable, the program will progressively establish both process and result indicators. Process indicators include the course-completion rate, completion of practical hours, participation of enterprise instructors, completion of project tasks, and quality of student work. Result indicators include the micro-major completion rate, proportion of students interning in relevant positions, enterprise evaluations, alignment between study and employment, and graduates' continuing learning.

5.2. Transferability

The micro-major model has substantial potential for replication and wider adoption. First, its three-dimensional rationale of policy, industry, and disciplinary drivers is broadly applicable; other application-oriented universities can adapt it to their regional industries and disciplinary strengths. Second, the integrated philosophy of "technology + AI + application" corresponds to the demand for interdisciplinary talent in new-engineering education and can inform similar institutions. Third, the joint teaching model comprising core university faculty and enterprise engineers, together with the progressive three-stage system of cognition, training, and workplace practice, is operationally feasible and readily transferable.

Transfer does not, however, mean simply copying the six courses. It requires adapting the program's underlying rationale and operating mechanisms and depends on a suitable regional industrial foundation and institutional resources. Other local application-oriented universities can adapt the model through a sequence of industry identification, job analysis, competency reconstruction, curriculum modularization, practice-platform development, enterprise collaboration, and quality evaluation, while adjusting course content to the structure of the local industry chain.

At a deeper level, the value of the Micro-Major in Intelligent Manufacturing of New Energy Vehicles lies in its exploration of a talent development mechanism through which local application-oriented universities and regional industries can grow together. Traditional universities often organize curricula and allocate faculty resources around established disciplinary and professional structures, whereas rapidly changing industries require universities to develop new combinations of competencies in a timely manner in

response to regional economic development. The Micro-Major provides a flexible mechanism for connecting these two domains.

Overall, as a new form of educational organization characterized by a short development cycle, focused competencies, and strong practical orientation, the Micro-Major is becoming an important approach for universities to break down disciplinary barriers and cultivate innovative talent. The development experience of this Micro-Major demonstrates that such programs can effectively address the limitations of traditional talent development, including long cycles, slow adjustments, and weak alignment with industry needs, thereby enabling more rapid alignment between talent development and evolving industrial demands.

6. Conclusion

The development of the micro-major in Intelligent Manufacturing of New Energy Vehicles is a concrete initiative through which Guizhou University of Commerce is responding to industrial transformation, deepening industry-education integration, and implementing the Ministry of Education's Double-Thousand Plan. Through the focused vehicle of a micro-major, the university has responded to the Electric Guizhou strategy's substantial demand for locally trained technical personnel while exploring a new model of interdisciplinary talent development. The program's flexibility, precision, and efficiency can break down disciplinary barriers and align the education and talent chains with the industrial and innovation chains.

The practical significance of this study lies not only in developing a micro-major for intelligent NEV manufacturing but also in exploring a sustainably iterative mechanism for talent development. Future work will center on student learning outcomes and enterprise-defined occupational competence. The curriculum, practical projects, faculty collaboration, and assessment mechanisms will undergo periodic evaluation, while graduate tracking and enterprise feedback will be used to verify whether program objectives are achieved. These measures will gradually form a closed-loop mechanism of demand pull, curriculum response, practice-based validation, evaluative feedback, and dynamic iteration, providing continuing talent support for the Electric Guizhou industry.

Looking ahead, the university will deepen collaboration with leading enterprises such as Chery's Guizhou facility and Hankes, dynamically adjust course content and teaching methods, and continue to refine the talent-development model in which technology forms the foundation, AI provides leverage, and application remains the focus. In doing so, it will contribute expertise and capacity to accelerating and upgrading the Electric Guizhou strategy while offering useful experience for new-engineering education at local application-oriented universities.

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