

Original Research Article

Research on the master's training model of mechanical engineering for the development of Guangxi industrial clusters*Yunze Yang, Hucheng Chen, Yubing Gong**School of Mechanical and Electrical Engineering, Guilin University of Electronic Technology, Guilin, Guangxi, 541004, China*

Abstract: To solve the bottleneck problem of the disconnect between the supply of high-level applied talents in the field of mechanical engineering in Guangxi and the demand for regional industrial clusters, this study focuses on Guangxi's characteristic industrial clusters such as automobiles, engineering machinery, and agricultural equipment, and proposes strategies to optimize the master's training mode of mechanical engineering in Guangxi. On the demand side, through research on 52 enterprises such as Liugong and Yuchai, the core competency gaps for master's talents in the field of mechanical engineering in Guangxi were identified, such as intelligent equipment research and development and cross-border technology adaptation; On the supply side, a three chain collaborative training model of "industry chain innovation chain education chain" is constructed, and a three in one training framework of "characteristic courses+industry education practice+international expansion" is designed to provide a systematic solution for the western region to solve the dilemma of "talent supply lagging behind industrial upgrading".

Keywords: Mechanical engineering education; Industrial clusters; Integration of industry and education; Strategy optimization

1. Introduction

As a forefront window for China's open cooperation with ASEAN, Guangxi is accelerating the construction of a billion dollar industrial cluster centered on automobiles, engineering machinery, and agricultural equipment^[1-2]. Against the backdrop of promoting industrial intelligence and green transformation in the 14th Five Year Plan, the mechanical engineering field in Guangxi is facing dual challenges of insufficient core technology research and development capabilities (such as lightweight design of new energy vehicles, intelligent sugarcane harvesting machinery, etc.) and structural shortage of high-level applied talents^[3-4]. Although universities in the region, such as Guangxi University and Guangxi University of Science and Technology, have initially formed a "school enterprise collaboration, industry education integration" framework for mechanical engineering master's training, there are still significant shortcomings in adapting to regional industrial needs: the curriculum system lags behind the pace of technological iteration such as intelligent equipment and digital twins; The internationalization training content for the ASEAN market is weak^[5]; The depth of collaborative innovation between schools and enterprises is insufficient, and the conversion rate of scientific research achievements is lower than the national average^[6-7].

2. Current situation of industrial cluster development in Guangxi**2.1. Regional characteristics of industrial cluster development in Guangxi**

Guangxi's agricultural industry cluster is leading in the country and is China's "sugar jar" and "fruit plate".

Guangxi's sugar cane production has long ranked first in the country, forming a complete industrial chain from planting to deep processing^[8-9]. The output value of the sugar industry cluster exceeds 100 billion yuan. Guangxi's fruit production has been among the top in the country for many consecutive years, with characteristic fruits such as citrus and mango being grown on a large scale. The vegetable industry covers the entire season, creating an important base for the transportation of southern vegetables to the north. The output value of freshwater fisheries in Guangxi has exceeded 100 billion yuan, and the proportion of large-scale breeding of high-quality livestock (such as pigs and beef cattle) has increased, promoting the national influence of the "vegetable basket" project. At the same time, Guangxi's forestry economy implements a three-dimensional composite management and green engine strategy. Guangxi relies on the model of "planting under the forest, cultivating in the forest, harvesting on the forest, and traveling in the forest", with an economic output value of over 130 billion yuan under the forest, benefiting nearly 12 million forest farmers. Special planting such as eucalyptus intercropping under the forest to promote intelligence and promote rural revitalization in mountainous areas.

Guangxi actively promotes the upgrading of traditional industries, and Laibin City promotes the transformation of the sugar industry towards comprehensive utilization, building clusters of over 10 billion yuan in metal new materials, calcium based new materials, and other industries; The non-ferrous metal industry has extended to the field of high-end alloy materials. Liuzhou is centered around the automotive industry, accelerating the research and development of new energy vehicle models (such as the SAIC GM Wuling "One Two Five" project), and increasing the local matching rate of mechanical equipment to over 60%. Marine economy and clean energy have become representatives of emerging industries in Guangxi. The first batch of offshore wind power units in Fangchenggang have been connected to the grid for power generation, the Huadian Blue Water project has been put into operation, promoting the construction of deep-sea aquaculture platforms, and the growth rate of marine engineering equipment manufacturing has exceeded 200%. The Yuchai pure electric commercial vehicle project has landed, and the application of industrial robots has increased by 39.7%. Nanning has laid out unmanned aerial vehicle and intelligent robot industrial parks.

Regionally speaking, Nanning focuses on emerging industries such as new energy vehicles and drones, and is building an ASEAN market hub. Liuzhou strengthens the collaboration between automobile and construction machinery clusters to promote the transformation of intelligent manufacturing. Border cities such as Chongzuo and Baise have developed port economies, promoted cross-border industrial chain collaboration, and led the region in import and export scale for 18 consecutive years.

2.2. The demand for Master's degree in mechanical engineering for the development of industrial clusters in Guangxi

Guangxi has listed the machinery and high-end equipment manufacturing industry as one of the nine key industrial clusters for cultivation, with the goal of achieving a total output value of 415 billion yuan for enterprises above designated size by 2025, with a focus on enhancing competitiveness in areas such as intelligent equipment and new energy vehicles. The 14th Five Year Plan for the Development of Guangxi Machinery and High end Equipment Manufacturing Industry Cluster clearly proposes the direction of "digitalization and intelligence" transformation, promoting a significant increase in demand for high-end talents in mechanical engineering. The policy requires that R&D investment in the mechanical equipment industry account for more than 2% of sales revenue, and two new national level manufacturing innovation platforms have been added, directly driving the demand for mechanical engineering master's degrees (with R&D capabilities). The automotive industry clusters in Guangxi, such as Dongfeng Liuqi and SAIC GM Wuling, are accelerating their transformation towards new energy. In 2024, the proportion of positions in the mechanical manufacturing industry, such

as new energy vehicle battery testing and intelligent driving system development, will increase. Leading enterprises such as Liugong Group and Yuchai Machinery are laying out new energy engineering machinery (such as electric loaders), which requires master's degree talents to solve problems such as tropical environment adaptability design and cross-border technical standard docking. The demand for intelligent equipment and robots is strong, involving the intelligent transformation of agricultural machinery (such as sugarcane harvesters), industrial robot system integration, and other fields. By 2025, Guangxi's machinery manufacturing industry is expected to add positions such as intelligent equipment research and development, new energy engineering machinery testing, etc. The demand for master's degree talents is expected to grow at an annual rate of over 15%. It can be seen that the upgrading of industrial clusters in Guangxi presents the characteristics of "high-end, cross-border, and intelligent" demand for mechanical engineering master's degree. It is necessary to improve the quality of talent supply through industry education collaborative innovation and policy empowerment (such as special funds and cross-border platforms), and support the regional industrial chain to climb to the high-end of the global value chain.

3. Current status of master's degree training mode in mechanical engineering

Guangxi currently adopts a hierarchical and progressive ability training system, which includes four gradient training processes: engineering cognition, basic training, design application, and innovative practice. For example, Guilin University of Technology has established a "four step" capability advancement system, which gradually strengthens practical abilities through courses such as theoretical mechanics and electromechanical control system internships. In addition, some universities in Guangxi adopt a research and industry project driven approach to cultivate master's degrees in mechanical engineering. For example, Guangxi University relies on a national experimental teaching demonstration center to integrate enterprise technology research and development (such as intelligent agricultural machinery research and development) into graduate projects, promoting the transformation of scientific research achievements. Guangxi also emphasizes the use of the school enterprise collaborative education model, where on campus mentors and enterprise mentors jointly guide the training of mechanical engineering master's students. There are over 100 enterprise mentors at Guangxi University of Science and Technology, covering areas such as intelligent equipment and robotics. Guangxi Autonomous Region jointly builds three autonomous region level bases (such as Liugong Base), providing internship and research and development scenarios in the fields of engineering machinery, new energy vehicles, etc

4. Adjustment strategy for the training mode of mechanical engineering master's degree oriented towards the development of industrial clusters

4.1. Clearly define the training positioning and objectives

The training mode for mechanical engineering master's degree with the goal of serving regional industrial clusters should be clearly defined. With Guangxi's pillar industries such as automobiles, engineering machinery, and agricultural equipment as the core, we aim to cultivate high-level applied talents with engineering practice and technological innovation capabilities, and support the upgrading needs of the regional industrial chain. The training mode should emphasize the integration of industry and education and regional adaptation^[10-11], combine enterprise practice with scientific research and innovation, and strengthen the mission of graduate students to serve the local economy. The training objectives should also be guided by composite abilities, covering core competencies such as mechanical design, intelligent manufacturing, and intelligent equipment development^[12-13], while integrating interdisciplinary knowledge such as artificial intelligence and digital technology to enhance students' ability to solve complex engineering problems.

4.2. Integrating regional characteristics into curriculum design

Construct course modules guided by regional industrial demand. Based on the needs of the Liuzhou automobile industry cluster, courses such as new energy vehicle power system design and intelligent welding technology for engineering machinery will be offered^[12], combined with technical research cases from companies such as SAIC GM Wuling and LiuGong, to enhance students' understanding of local industrial technology pain points. Integrating optimization technology for shovel loading machinery operation devices into basic courses such as "Mechanical Manufacturing and Automation" to achieve synchronous updates between teaching content and actual needs of enterprises. In response to the demand for agricultural mechanization in Guangxi, courses such as the design of intelligent sugarcane harvesting machinery and the research and development of cassava processing equipment are designed to transform the research and development achievements of sugarcane pre cutting equipment in cooperation between Guangxi University and ASEAN into teaching cases, and cultivate the application ability for regional characteristic industries.

4.3. Interdisciplinary integration and regional cultural infiltration

Add modules such as intelligent equipment control algorithms and digital twin technology applications to traditional mechanical courses, combined with research results on robot control algorithms, to cultivate the ability to develop intelligent equipment. Inviting enterprise representatives to give lectures on topics such as "The Contribution of the Construction Machinery Industry to Guangxi's Economy" to enhance students' sense of professional identity rooted in Guangxi. In courses such as "Mechanical Device Design and Manufacturing", real enterprise projects such as Dongfeng Liuzhou Automobile Body Structure Optimization and Yuchai Group Intelligent Agricultural Machinery Equipment Design are introduced, requiring students to complete the complete process from scheme design to prototype production.

5. Conclusion

This study is based on the development needs of billion level industrial clusters such as automobile manufacturing, engineering machinery, and agricultural equipment in Guangxi. Through theoretical analysis and practical verification, we visited leading enterprises such as Yuchai Group, Liugong Machinery, and Dongfeng Liuqi, focusing on the research and development of new energy power, intelligent sugarcane harvesters, and cross-border technology standard adaptation needs to clarify the technical needs and talent gaps of the three billion level industrial clusters in Guangxi (automobile manufacturing, engineering machinery, and agricultural equipment), and diagnose the key contradictions between the existing mechanical engineering master's training mode and regional industrial adaptability. We have established a master's program in mechanical engineering that combines demand driven education with industry integration and cross-border collaboration, breaking through the limitations of traditional mechanical engineering education that emphasizes knowledge transmission over industry adaptation. This provides methodological support for universities in the western region to serve regional industrial clusters.

Acknowledgements

This research is supported by the Innovation Project of Guangxi Graduate Education (Grant No. JGY2025153, JGY2024158)

References

- [1] Zeng Q, Wang L. Exploration on the Reform of "Integration of Theory and Practice" Teaching Mode of Professional Undergraduate Curriculums--Taking the Example of Undergraduate Majors in Vehicle Engineering[C]//2018 International Conference on Education Reform and Management Science (ERMS 2018). Atlantis Press, 2018: 71-75.
- [2] Wang C, Xie J. [Retracted] Research on Application Adaptability of Big Data and IoT in Discipline Construction of Mechanical Engineering Specialty in Universities[J]. Security and Communication Networks, 2021, 2021(1): 3130841.
- [3] Weiguang Z. Research on Curriculum Reform of Mechanical Manufacturing Equipment Design Based on Engineering Awareness Training[C]//IOP Conference Series: Earth and Environmental Science. IOP Publishing, 2019, 358(4): 042011.
- [4] Li Z, Yu X. Data Mining Technology for Mechanical Engineering Computer Test System[J]. Mechanical systems and signal processing, 2020, 141: 106628.
- [5] Gao M, Wang Q, Wang N, et al. Application of Green Design and Manufacturing in Mechanical Engineering: Education, Scientific Research, and Practice[J]. Sustainability, 2021, 14(1): 237.
- [6] Li X, Wei J, Ding S, et al. Teaching Mode of Mechanical Design Course Based on Simulation Analysis Technology[J]. International Journal of Emerging Technologies in Learning (Online), 2017, 12(7): 112.
- [7] Yang W, Chen P. Research on the Maker Learning Experiences of Engineering College Students Majoring in Mechanical Engineering in China[J]. Scientific Reports, 2025, 15(1): 11285.
- [8] Shen J, Li T, Wu M. The New Engineering Education in China[J]. Procedia Computer Science, 2020, 172: 886-895.
- [9] da Silva L, Seabra J, Lopes A. Reformulation of the Integrated Master in Mechanical Engineering (MIEM) at FEUP in Two Cycles of Studies (bachelor and master)[J]. U. Porto Journal of Engineering, 2021, 7(1): 48-62.
- [10] Hąbek P, Palacz M, Saeed F. Embedding Sustainability into Mechanical Engineering Master Programs—a Case Study of the Top Technical Universities in Europe[J]. Sustainability, 2024, 16(2): 941.
- [11] Soares J, Paiva J M, Cruz M, et al. Impact of COVID-19 on the Integrated Master of Mechanical Engineering of the University of Porto[J]. Journal on Teaching Engineering, 2022, 2(1): 14-37.
- [12] Wang Z, Liu C, Tang Z, et al. Exploration of Talent Training Models in Mechanical Engineering for Future High-end Manufacturing Demands[J]. Frontiers in Educational Research, 2025, 8(1).