Research on the Integration Path of Talent Cultivation in "Fixture Design and Application" under Digital Transformation

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Abstract: With the development requirements of new quality productivity and the rapid advancement of Industry 4.0 and intelligent manufacturing technologies, digital transformation has put forward higher demands on mechanical professionals. Based on the demand and development trends of fixture design positions in the mechanical industry, this paper takes the "Fixture Design and Application" course as an example to study the integration path between the course and the talent cultivation in the mechanical industry, explore its integration path with the professional talent cultivation, and propose a curriculum reform plan based on digital technology to enhance students' practical and innovative abilities and meet the industry's demands. Taking occupations as the carrier, a curriculum system closely aligning with the demands of digital economic development is constructed. The teaching model of introducing real project tasks from enterprises and the teaching method driven by 3D digital technology provide new ideas for cultivating high-quality, compound technical and skilled talents in the mechanical industry.

Keywords: Digital transformation; Fixture design; Talent cultivation; Teaching reform; 3D digital technology

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Quotation

Digital transformation is the core trend in the current development of the manufacturing industry. As an important support for the manufacturing industry, the talent cultivation model of the mechanical design, manufacturing and automation major urgently needs to adapt to this change. As a core course of this major, "Fixture Design and Application" has seriously lagging teaching content, insufficient integration of industry and education, and a lack of deep integration with digital technology. These issues have led to its inability to meet the automotive industry's demand for cultivating new quality productivity talents. Therefore, this paper explores the integration path of the course and professional talent cultivation by combining industry demands and educational practices. It aims to cultivate high-quality, compound technical and skilled talents.

1.The demand and development trends of fixture design positions in the automotive industry

1.1 Requirements for the Position of Tooling Fixture Design

The demand for fixture design positions in the automotive industry mainly involves welding fixture design and tooling fixture design. Different types of fixtures have significant differences in design, function and technical requirements.

Welding fixtures are key equipment in the manufacturing process of automotive bodies. Through positioning devices (such as pin positioning and profile positioning), they accurately position the workpiece, control welding deformation, and ensure that the three-dimensional coordinate dimensions of the body assembly meet the requirements of the drawing. Their core function is to achieve precise positioning and clamping of stamping parts, assemblies, and assemblies. Ensure that the relative positions and fit of each part during the welding process meet the design requirements, while controlling the welding deformation. Ultimately, this guarantees the shape, dimensional accuracy and welding quality of the vehicle body, reduces labor intensity, and provides support for mass production, assembly lines and automated production.

Tooling fixtures are the general term for various tools used in the manufacturing process. They can quickly

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fasten the workpiece, keep the machine tool, cutting tool and workpiece in the correct relative position, which is conducive to ensuring the technical requirements such as the size, geometric shape and mutual position accuracy with other surfaces of the workpiece, and reduce the clamping time. For large-scale production and processing of workpieces, the use of tooling fixtures can significantly improve processing efficiency. It is conducive to improving the working conditions of workers and ensuring safe production. Tooling fixtures are not only applied in welding and assembly, but also widely used in key national industries such as aerospace, railway locomotives, automotive manufacturing, shipbuilding, sheet metal and hardware, heavy equipment, medical devices, and oil pipelines.

1.2 Development Trends

With the rapid expansion of China's new energy vehicle industry, the demand for tooling fixtures in production automation and intelligence has significantly increased. The production of new energy vehicles is highly dependent on high-precision and flexible fixtures. For instance, in the assembly of battery packs and the processing of motor stators/rotors, customized fixtures are required to meet the demands of precise assembly. Robot custom fixtures have become a mainstream trend due to their adaptability to various components (such as irregular-shaped battery casings and lightweight body structural parts), driving the transformation of the tooling fixture position from traditional mechanical design to intelligent, modular and standardized design. As a key tool in the manufacturing production process, the job development of tooling fixtures shows trends such as increased technical requirements, expanded market demand, and optimized salary structure, especially demonstrating strong growth potential in the new energy vehicle industry chain. The application of tooling fixtures in the new energy vehicle industry chain covers sub-sectors such as mechanical/equipment manufacturing, automotive parts, and electronic technology. The development of the new energy vehicle industry has injected new vitality into the tooling and fixture positions, promoting their transformation from traditional mechanical design to intelligent, modular and standardized design.

2.Problems existing in the course of Fixture Design and Application

2.1 Lack of application of digital technology

Most courses in colleges and universities still focus on theoretical explanations, with relatively insufficient integration with digital means. There is a lack of organic integration of digital technologies such as 3D modeling of parts, simulation analysis, finite element calculation, computer-aided technology (CAD), and computer-aided engineering (CAE). The course has not integrated multiple disciplines. Digital design, intelligent design and the course content have not formed a closed loop. Under the influence of this structural defect, students' understanding of the digital design of tooling fixtures is weak, and they have not formed a digital thinking and design system, making it difficult for them to meet the requirements for compound technical and skilled talents in the context of new quality productivity.

2.2 The course content is seriously lagging behind

The traditional fixture design curriculum system lags behind. It mainly covers the knowledge framework related to traditional mechanical disciplines, which cannot match the current development trends of automotive intelligence, electrification and networking. With the rapid rise of new energy vehicles, Robot custom fixtures, robot handling grippers, battery fixtures, flexible fixtures, quick-switching fixtures, AGVs, RGVS and other fixtures are developing rapidly. However, these contents have not been included in the current teaching scope and cannot cover emerging industries such as new energy. This directly leads to the knowledge system being unable to meet the industrial demands, and students face huge challenges after graduation. The lack of the ability to integrate knowledge and technology fully exposes the problems of the traditional teaching mode being single and seriously disconnected from industrialization. Students' engineering practice ability, innovation ability and ability to solve practical problems are relatively poor.

2.3 Insufficient integration of industry and education

The current course teaching overly relies on theoretical explanations, with relatively little engineering practice content. There is a lack of actual production project simulation exercises, and cutting-edge technologies of intelligent manufacturing production lines such as battery fixtures and flexible fixtures are not equipped. As a result, students are unable to come into contact with the latest new technologies, new processes and new methods of enterprises. Although some colleges and universities have already launched project-based teaching, it only stays at the surface level. First, they lower the requirements and standards for enterprise projects, which deviate greatly from the actual project parameter requirements. Second, it is not fully controlled in accordance with the enterprise's quality system, and thus cannot truly meet the quality standards of the enterprise's projects. Third, the lack of digital verification methods such as virtual simulation makes it impossible to verify the rationality of interference situations, production line rhythms, and offline programs. The above-mentioned teaching deficiencies will directly lead to the mismatch between students' design capabilities and the requirements of enterprises, and there are problems such as large errors and low efficiency between the fixture design standards and the requirements of enterprises.

2.4 The evaluation system is not perfect

The course evaluation system is not perfect and there is a serious disconnection from the industry. The main manifestations are that the dimensions of the course evaluation system are single, still mainly focusing on the basic structure design tasks and theoretical knowledge assessment, and the key indicator parameters of enterprises have not been included in the assessment and evaluation system. Enterprise projects focus on indicators such as the compliance of technical process design schemes, equipment selection, energy consumption analysis, investment estimation, and financial risk analysis. However, the course evaluation system does not cover these core demands of enterprises adequately, resulting in a systemic disconnection between the course evaluation system and enterprise standards. This may affect the cooperation between schools and enterprises. Enterprises may question the teaching quality of schools, thereby reducing cooperative projects and internship opportunities, leading to an imbalance between supply and demand of talents, with serious consequences.

3.Research on the Integration Path of Curriculum and Industry Talent Cultivation

3.1 Take occupations as the carrier and build a curriculum system that closely aligns with the demands of digital economic development

Deepen the cooperation between schools and enterprises, with enterprises participating in design, training and reception. In accordance with the concept of "three-person progressive", from cultivating "technical people" and "professional people" to cultivating high-quality technical and skilled "complete people". While emphasizing professional basic theories, it integrates professional direction module courses, aligns with the latest industrial demands, and implements modular course design. It organically combines three-dimensional digital technologies such as scheme design, finite element analysis, virtual simulation, and motion simulation with theories. The course system pays attention to the integration of theory and practice, as well as the fusion of core elements with occupations, and dynamically matches industry demands. Promote the alignment of specialties with industries, facilitate the connection between the teaching process and the production process, enhance students' professional competence in adapting to the demands of digital economic development, and improve the effectiveness of talent cultivation quality. Therefore, it is urgently necessary to break the traditional model and build a composite course content system that integrates mechanical engineering design, digital design technology and intelligent control technology.

3.2 Centered on students, expand the horizons of digital manufacturing

To meet the needs of talent cultivation in the digital age, we highlight the students as the main body, and integrate resources such as enterprise development, technical service projects, horizontal research topics, digital teaching materials, and enterprise training materials. The teaching content is cross-disciplinary and integrated, and cutting-edge digital and intelligent production technologies are added to deeply integrate the teaching content with the advanced technologies urgently needed by enterprises. Form a knowledge loop with traditional course content, integrate digital technologies such as 3D modeling, simulation analysis, finite element analysis, computer-aided technology (CAD), and computer-aided engineering (CAE) into the curriculum, and form a digital design thinking and system. Enable students to complete the practical teaching tasks of the course in a real environment, and effectively improve students' practical abilities. Build a full-process training system covering theory, design modeling, simulation analysis, computational verification and structural optimization, and enhance students' engineering practice ability and broaden their digital vision through engineering projects.

3.3 Improve school-enterprise cooperation, deepen the integration of industry, academia and research, and innovate working mechanisms

In terms of enhancing the depth, breadth and validity of industry-education integration, we have conducted in-depth cooperation with enterprises such as FAW-Volkswagen, Hongqi Factory, Prosperity Factory, FAW Jiefang, BYD and Geely. We have introduced actual project cases from these enterprises, equipped them with cutting-edge technologies such as battery fixtures, AGVs and RGVS, and learned about their new technologies, new processes and new methods. Teaching is carried out strictly in accordance with the actual project parameters, project standard requirements and procedures of the enterprise, following the enterprise's project quality management system. Virtual simulation, production line rhythm and offline program verification and other means are added to enable the enterprise to participate in professional construction, the formulation of talent cultivation plans, the joint construction and sharing of equipment bases, and the collaborative solution of technical and process problems between the school and the enterprise. Coordinate the interests between the industrial and educational sectors well and innovatively establish a working mechanism for mutual benefit and long-term development for both sides.

3.4 Construction of a "Dual-Qualified and Dual-Capable" digital Teaching Team

First, enhance the teaching staff of institutions by introducing teachers with digital skills and qualities. Second, organize teachers to participate in various digital skills training and learning exchange activities to enhance their digital skills and qualities. Third, through school-enterprise cooperation, teachers should be involved in the digital projects of enterprises to enhance their application and innovation capabilities of digital technologies. Fourth, conduct joint discussions and formulations with enterprise technical experts. Teachers implement an enterprise practice system to learn the latest technologies, new processes and new methods from enterprises, enhance their dual-teacher capabilities, and invite enterprise experts to give lectures on campus. A dual-mentor system between the school and enterprises is implemented, featuring dual training and integration of work and study. At the same time, School-enterprise cooperation can transform the digitalization demands of enterprises into specific innovative projects, providing students with opportunities to learn in enterprises.

3.5 Optimize the digital and diversified evaluation system and strengthen the guarantee mechanism

Supported by data and guaranteed by supervision, promote the informatization of the new educational ecosystem. On the basis of emphasizing theoretical assessment and evaluation, increase students' professional abilities such as fixture structure design ability, social abilities such as teamwork ability and professional ethics ability, and methodological abilities such as problem-solving ability and innovative thinking ability. Set up scoring scales for social abilities and methodological abilities Comprehensive evaluation is conducted through methods such as mutual assessment of group projects and enterprise internship appraisals. In the process evaluation, enterprise engineers are invited to assess the process feasibility, economy and other important indicators and parameters of the enterprise project of the students' design plans, and provide feedback on improvement suggestions. At the same time, the technological development of the manufacturing industry is tracked, and cutting-edge contents such as 3D printing fixtures and digital factory integration technology are included in the evaluation scope to ensure that the evaluation standards are in step with industrial upgrading. Taking the career growth of students from "technical people", "professional people" to "complete people" as the main line, an "Internet +" digital information platform is established, and the evaluation system is optimized with the help of digital technology. Realize a new digital evaluation system for all-round and full-process education, explore the construction of a guarantee system featuring "total quality management with a focus on process control", and through the three-dimensional synchronization of "supervision of teaching, supervision of learning, and supervision of management", and the simultaneous progress of "guidance of teaching, guidance of learning, and guidance of correction", form a quality supervision and guarantee mechanism with supervision, assessment, feedback, and acceptance.

4.Conclusion

By deeply empowering with digital technology and taking occupations as the carrier, a curriculum system closely aligning with the demands of digital economic development is constructed. Student-centered, expand the horizons of digital manufacturing; Improve school-enterprise cooperation, deepen the integration of industry, academia and research, and innovate working mechanisms; The construction of a "dual-qualified and dual-capable" digital teaching team Optimize the digital and diversified evaluation system, strengthen the integration path of the guarantee mechanism, and provide a reference model that can be referred to and promoted for the digital transformation and upgrading of tooling and fixture design in the automotive industry.

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