Construction of Field Engineer Competency Framework in Diverse UI Scenarios - Taking UI Design as An Example

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Abstract. With the advancement of digital and intelligent transformation, the working environment of field engineers is increasingly characterized by diverse UI scenarios. Using CNKI and WoS literature as data sources and VOSviewer for keyword analysis, this study reveals a disconnection between China's policy-driven field engineer training and UI design competencies. Subsequently, it examines the capability requirements for field engineers in diverse UI scenarios from three perspectives: talent positioning, design dimensions, and design processes. Finally, a competency framework for field engineers, focused on UI design roles, is constructed across five layers: fundamental skills, core integration, innovative application, multi-dimensional collaboration, and advanced thinking. This framework aims to provide theoretical reference and practical guidance for talent development in modern industries.

Keywords: diverse UI scenarios, field engineers, competency framework, UI design

1 Introduction

The continuous advancement of industrial digital transformation is driving the development of emerging fields such as smart manufacturing. This transformation also turns user interfaces (UIs) into diverse information media, giving rise to the concept of diverse UI scenarios. The Chinese government has introduced policies focusing on the development of a "field engineer" training system to help enterprises adapt to complex transformations[1]. However, existing training systems have not fully adapted to these changes, especially in integrating UI design capabilities with field engineering competencies.

Therefore, this study aims to address the following research questions from a UI design perspective:

RQ1: What are the current research and knowledge structures regarding field engineers in diverse UI scenarios?

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RQ2: What competency requirements do field engineers need to meet in diverse UI scenarios?

RQ3: How can a structured and actionable competency framework be constructed to support talent cultivation in vocational education?

2 Current Research of Field Engineer Training in Diverse UI Scenarios

2.1 Data Sources and Analysis Software

To enhance the comprehensiveness and reliability of the analysis, the study combines Chinese literature from China National Knowledge Infrastructure (CNKI) and international literature from the Web of Science (WoS). The search period was set from January 1, 1996 to November 23, 2025, because the earliest relevant Chinese literature in CNKI appeared in 1996. The same time range was applied to the WoS search for consistency. VOSviewer (1.6.18) was used for keyword co-occurrence and overlay visualization.

2.2 CNKI-based Analysis

Using the Chinese topic term "field engineer", CNKI data show a sharp increase in publications after 2022, following national policies, with annual output rising further by 2025. A separate search combining the Chinese topic term "field engineer UI" also shows growth (see Figure 1).

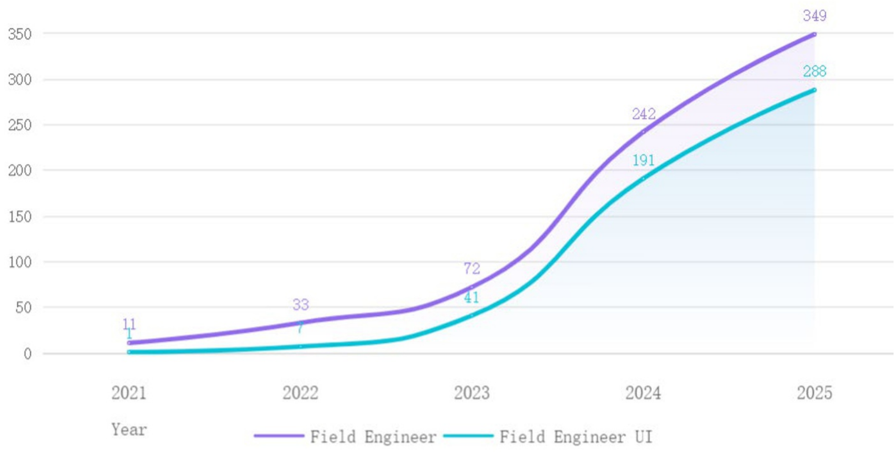


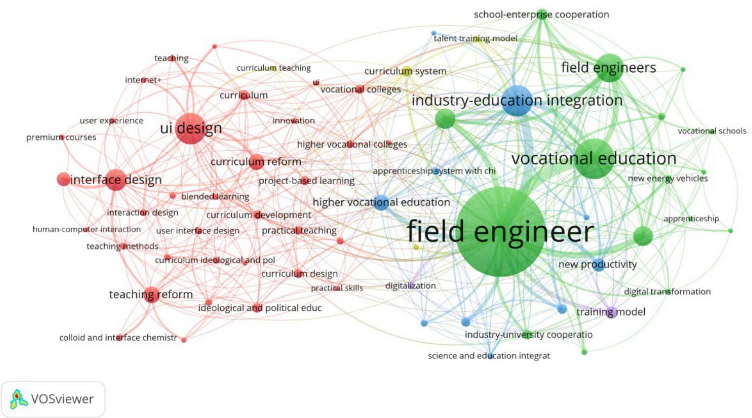
Fig. 1. Trend of CNKI Literature from 2021 to 2025

A total of 567 papers were retrieved with "field engineer UI". To broaden the search, a second query was used: (Topic: UI Course) OR (Topic: UI Enterprise Requirements) OR (Topic: Interface Course) OR (Topic: Interface Enterprise Requirements), all in Chinese except "UI". Because of the Chinese context, where the terms "UI" and "Interface" are often used interchangeably, both were retained in the search query to ensure comprehensive coverage of relevant studies. After removing irrelevant items, 461 relevant papers were retained from 791. The combined corpus for keyword analysis is 1,028 papers (567+461), including all 21 conference papers.

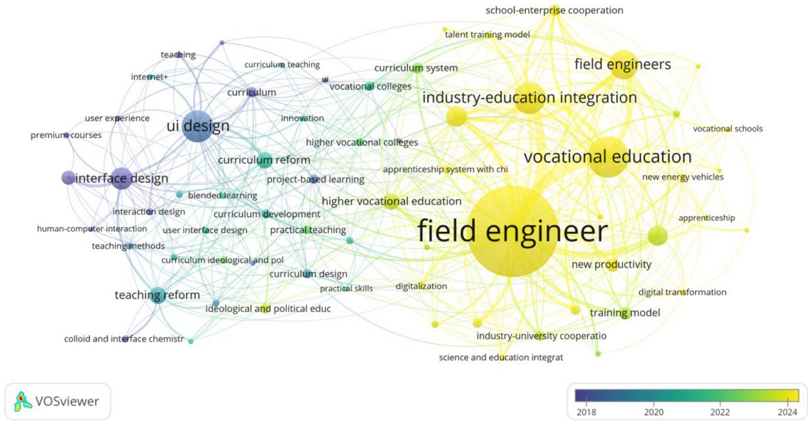
To determine an appropriate threshold, multiple minimum occurrence values (4-12) were tested. The results show that when the threshold is below 7, the network becomes fragmented. When the threshold is set between 7 and 12, the clustering structure stabilizes at five clusters. Therefore, a threshold of 7 was selected as the minimum stable value, ensuring both structural robustness and sufficient information retention.

As shown in Figure 2-a, the research landscape comprises five clusters defining the vocational design education ecosystem. The red cluster focuses on teaching reform and UI design fundamentals, while the green cluster centers on industry-education integration and the cultivation of "field engineers" to meet "new productivity" demands. The blue cluster acts as a strategic bridge for innovation in cultivation models and school-enterprise cooperation. Notably, the yellow and purple clusters, though smaller and more dispersed, represent curriculum systems and digital transformation. Collectively, this indicates a shift from traditional skill-based instruction toward a technologically-integrated, field-oriented model.

As illustrated in Figure 2-b, the bright yellow cluster signifies a highly active research frontier, where the "field engineer" training system is rapidly converging with emerging domains such as "digital transformation" and "new energy vehicles." In contrast, UI-related nodes remain largely situated in the earlier, "cooler" blue-purple zone. This spatial-temporal disparity suggests a pedagogical lag: while industry demands are shifting toward diverse, high-tech UI scenarios, the existing UI education paradigm remains relatively static, indicating a growing mismatch between traditional training models and the evolving needs of the modern market.



(a) keyword co-occurrence network



(b) keyword overlay visualization

Fig. 2. VOSviewer Keyword Analysis on CNKI data

2.3 International Literature Analysis

For international literature, the following query was applied in the WoS: (Topic: field engineer) OR (Topic: onsite engineer), yielding 48 publications. A total of 275 keywords were extracted and analyzed with a minimum occurrence threshold of 1. As shown in Figure 3, the clustering results demonstrate that international research on field engineers is highly domain-specific and technically oriented, primarily embedded within specific engineering or environmental contexts. Across all clusters, no keywords related to "UI design", "human-computer interaction" or "design competency" were identified.

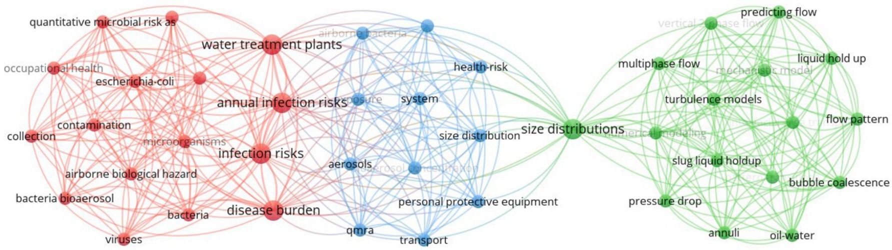


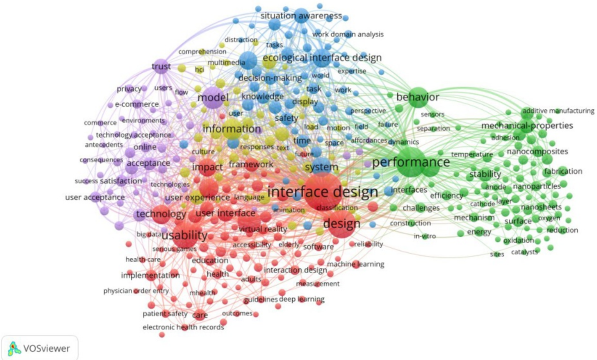
Fig. 3. VOSviewer Keyword Analysis on international literature about "field/onsite engineer"

To compensate for the limited number of field engineer studies, a broader search on (Topic: UI design) OR (Topic: interface design) was conducted in the WoS, yielding 5,082 publications.

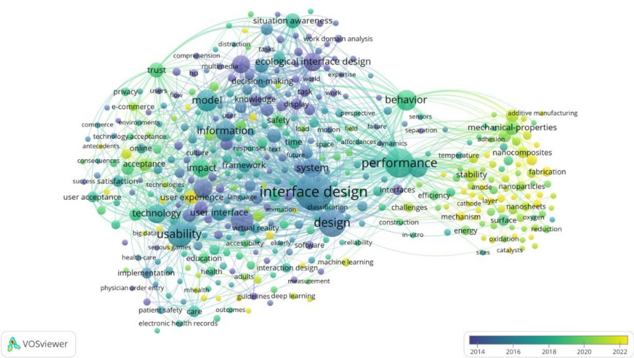
Based on comparative testing, a minimum keyword occurrence threshold of 10 was selected, as it produced a stable clustering structure (five clusters), while lower or higher thresholds resulted in structural fragmentation.

The resulting network (Figure 4-a) reveals five major knowledge domains with clear structural differentiation from a comprehensive research framework spanning from "base materials" to "high-level psychology": red serves as the central hub, focusing on engineering foundations such as UI design and usability; blue extends outward to situational awareness and decision support within complex systems; yellow acts as the cognitive mediator, exploring the logic of information processing and mental workload; purple delves into social behavior to examine user trust and technology acceptance; while green crosses into the physical realm, focusing on the mechanical properties and performance of smart materials. These five clusters show a highly interdisciplinary convergence.

According to Figure 4-b, the emergence of frontier topics is relatively uniform across all clusters, primarily encompassing fields such as Artificial Intelligence and Novel Materials. Notably, the integration of Artificial Intelligence (e.g., machine learning and deep learning) has become a ubiquitous driver for optimizing user interfaces and system performance.



(a) keyword co-occurrence network



(b) keyword overlay visualization

Fig. 4. VOSviewer Keyword Analysis on international literature related to UI design

2.4 Comparative Analysis

Based on the above analysis, significant differences exist between domestic and international research.

In China, driven by policies, there is a substantial body of research focusing on "field engineers". However, its connection with UI design and competency cultivation systems remains weak—the two research areas of UI design and field engineers are relatively separate in knowledge clusters, and have not yet formed an effective integration.

In contrast, international research focusing specifically on "field engineer" or "onsite engineer" is extremely limited, and rarely links curriculum systems directly with UI design. This reflects differences in national contexts regarding industrial demands, educational systems, and talent development pathways. Nevertheless, international research in the field of UI design exhibits systematic and comprehensive characteristics: its knowledge structure spans multiple levels from engineering fundamentals to higher-order psychological cognition, with frontier topics (such as artificial intelligence and novel materials) evenly distributed across different clusters, indicating relatively balanced and interdisciplinary development.

In summary, China urgently needs to systematically integrate UI design competencies into the existing policy-driven field engineer training framework, in order to build a composite talent cultivation system for diverse UI scenarios.

3 Analysis of Capability Requirements for Field Engineers in Diverse UI Scenarios

The comparative analysis in Section 2 reveals that while China's policy-driven field engineer research lacks integration with UI design, international UI studies exhibit systematic, multi-layered competency structures. This gap calls for a domestically grounded competency model tailored to diverse UI scenarios. Accordingly, this section analyzes the required capabilities from three perspectives: talent positioning, design dimensions, and design processes.

3.1 Ability Requirements for UI Talent Positioning

According to national policies[2], field engineers are expected to possess craftsmanship, skilled operation, process understanding, management, collaboration, and innovation. This positioning demands a cross-border knowledge system and ability structure for UI domain engineers.

Multi-dimensional Extension Ability of Job Responsibilities.

Multi-dimensional extension ability is a key characteristic of the role. Field engineers are required not only to complete visual design work but also to engage at the front line, actively perceiving and accurately understanding user needs. They must transform abstract requirements into concrete UI solutions to manage interactive design tasks in unexpected scenarios. Additionally, they need to interpret product managers' requirement documents efficiently and collaborate with development engineers to ensure smooth project processes under rapid iteration or sudden changes.

Flexible Application Ability of Knowledge System.

The ability to flexibly apply an integrated knowledge system underpins the scientific rigor of design decisions. UI design synthesizes knowledge from design, psychology, and human-computer interaction. Field engineers must master core principles of graphic composition and visual communication, while also understanding how color psychology and cognitive psychology influence user perception and behavior. Their design decisions must simultaneously adapt to target users' cultural and aesthetic preferences and align with brand strategic positioning.

Rapid Transfer Ability of Tool Skills.

The rapid transfer ability of tool skills is crucial for adapting to a volatile technological landscape. In the information age, tools evolve rapidly, and different enterprises adopt distinct tool sets. Field engineers, therefore, must not be limited to proficiency in a single software but should cultivate a tool-agnostic mindset by extracting the underlying logic common to UI design tools. During vocational education, fostering the ability to discern patterns across similar software and quickly adapt to new tool environments is more valuable than mastery of any specific tool, which will determine their adaptability and collaboration efficiency directly in diverse projects.

Human-AI Collaborative Creativity.

Intelligent technologies are reshaping design tools for UI field engineers. Beyond mature UI tools, new-generation tools such as AI-generated prototypes, automatic layout, and intelligent color matching are emerging. Visual aids like graphics and videos also serve as useful resources for inspiration, mid-term design assistance, and post-design reflection. Field engineers must master efficient communication with AI tools, convey design intentions through precise prompts, and professionally evaluate, screen, and optimize AI outputs, thereby transforming AI into a collaborative design partner that improves efficiency.

3.2 Ability Requirements for UI Design Dimensions

In the new era, UI presents new characteristics in four design dimensions: visual design, logical framework, feedback methods, and interaction ways[3], influenced by the development of intelligent and digital industries, which put forward new capability requirements for field engineers.

Cross-media Communication Ability in Visual Dimension.

The diversification of visual dimensions defines diverse UI scenarios, stemming from the proliferation of information media enabled by digital intelligence. As China promotes manufacturing digital transformation through innovation[4], UI media now extend beyond phones and tablets to include smart homes, interactive displays, robots, virtual spaces, wearable devices, and IoT factories. This shift brings varied screen sizes and a transition from 2D to 3D and fully virtual environments. Therefore, field engineers must master visual transformation and expression from two-dimensional to three-dimensional, and design UIs for carriers of different spatial dimensions. Meanwhile, 5G and digital technologies have made dynamic graphics more accessible, shifting UI visuals from static presentation to dynamic expression to intuitively convey product logic and state.

The Intuitive Descriptive Ability of Logical Frameworks.

Information technology places users in a complex ecosystem of numerous information devices. Although users are generally familiar with electronic screen interaction, they subconsciously demand simpler and more intuitive UI logic. In diversified information media, users expect to start using interfaces without excessive learning costs for higher efficiency. Thus, the core challenge for field engineers is to construct clear, consistent, and intuitive cognitive paths and operational logic under rich visual elements and interactive forms. This requires robust capabilities in information architecture and process organization to ensure a coherent and efficient user experience.

Multi-modal Emotional Expression Ability of Feedback Methods.

In the era of product saturation, user experience competition increasingly focuses on emotional value, raising dual requirements for emotional and intelligent feedback in UI. Feedback methods are no longer limited to conventional visual prompts and sound effects; they integrate visually dynamic effects rich in fun and brand personality, and may incorporate IP or emoji design and cute voice interaction systems. These jointly form a multi-modal, emotional feedback system that enhances users' sense of participation and control, meets their need for spiritual comfort, and increases retention. This requires field engineers to integrate brand, user psychology, and professional skills, and to possess empathy to design more emotionally resonant feedback methods.

Data Understanding and Conversion Capability under New Interaction.

Intelligent technology has given rise to new interactions, reflected in operational methods. In new industrial forms such as virtual spaces, field engineers need to design personalized processes that respond to and understand users' natural behaviors (gestures, voice, expressions, body language). This calls for a certain understanding of information science and technology: learning to use sensors to capture user behavior data, as well as possessing the logical ability to convert data into images or audio. Consequently, UI design training in vocational colleges should strengthen students' mathematical and logical transformation abilities, preparing them to adapt to advanced interaction modes in new business contexts and meet the demands of richer UI scenarios.

3.3 Ability Requirements for UI Design Processes

In diverse UI scenarios, field engineers need systematic execution across the product life-cycle—from research to iteration—entailing deep user understanding, efficient implementation, and continuous optimization. Full immersion in the UI design process enables engineers to embody "precise operation, craftsmanship, management, collaboration, and innovation", aligning with China's talent requirements.

User Insight and Demand Conversion Capability.
The core competency in the initial phase is user insight and demand translation. Field engineers must directly engage in user research, employing professional methodologies to identify user pain points and behavior patterns, then translate these into specific functional definitions and interaction frameworks. This process calls for deep user experience understanding and strategic product thinking to ensure alignment between design direction and business objectives.

Cross-disciplinary Communication Skills.
Working on the front line, engineers need to produce varied prototype designs based on specific scenario needs, enabling them to communicate effectively with different types of collaborators in the design process. Therefore, field engineers are required not only to possess professional skills in design annotation, component-based delivery, and dynamic demonstration, but also to comprehend technical implementation boundaries and master common terminology across disciplines. This allows them to strike an effective balance between design and technology when working alongside development teams.

4 Field Engineer Competency Framework in Diverse UI Scenarios

Drawing on the capability requirements identified in Section 3 and addressing the disconnection between UI design and field engineer training revealed in Section 2, this section constructs a competency framework tailored to China's vocational education context. The framework comprises five progressive modules: fundamental skills, core integration, innovative application, multi-dimensional collaboration, and advanced thinking.

4.1 Fundamental Skills

This layer strengthens students' professional foundation in design software operation, UI design specifications, and front-end basics. It covers proficient use of Adobe tools (Photoshop, Illustrator, After Effects, XD) for visual design and animation, as well as standardized production of visual and component systems. Students also learn basic

HTML to facilitate future team collaboration. Foundational theories—design psychology, brand design, and dynamic graphics—are integrated to prepare engineers for diverse user groups and enterprise positioning.

4.2 Core Integration

The Core Integration layer serves as a crucial bridge, enabling students to progress from possessing basic skills to developing comprehensive problem-solving abilities. It focuses on the systematic integration and flexible application of learned knowledge through three core dimensions.

First, multidimensional extension ability of job responsibilities: students move beyond UI design tasks to engage in user research, interaction design, and product definition, mastering user profiling, requirement sorting, and function transformation. Second, flexible application ability of the knowledge system: students learn to use various design tools collaboratively to create targeted, differentiated UI solutions for diverse UI scenarios. Third, rapid transfer ability of tool skills: by understanding common rules of design tools, students quickly adapt to different software environments and learn new tools independently. Together, these three dimensions form the core competencies collectively that allow field engineers to sustain their competitiveness in a diverse work environment.

4.3 Innovative Application

The Innovative Application layer enables students to create adaptable, experiential UI solutions across four dimensions.

First, cross-media visual communication ability in visual dimensions: students master responsive layout principles, designing for screens from mobile to industrial size, and for 3D virtual spaces. Second, intuitive descriptive ability of the logical frameworks: students design clear information hierarchies and user-centered processes that make UI expressions easy to understand. Third, multi-modal emotional expression ability of feedback methods: students use animation and sound effects to construct feedback that evokes emotional resonance. Fourth, data understanding and transformation under new interaction: students learn data visualization and information presentation, structuring the link between data transformation and visual application to enhance competency in diverse UI scenarios.

4.4 Multi-dimensional Collaboration

The layer encompasses two dimensions: collaboration with AI and with people.

In terms of human-AI collaborative creativity, students should have the ability to use AIGC to empower data research[5] and design practice in the early and middle stages, such as combining tools like Doubao and Jimeng. In the early stage, they can combine professional knowledge to obtain reliable research data sources and promote inspiration generation. In the practical design stage, AI can assist in generating IP image designs quickly that fit the product's positioning and enhance the product's emotional expression through efficient collaboration.

For cross-disciplinary communication with people, students learn to use precise terminology when working with product managers and developers. They also produce detailed diagrams and annotations to advance design implementation effectively.

4.5 Advanced Thinking

The layer focuses on enhancing students' user thinking and product awareness, enabling them to understand design value from a business perspective, including the ability to analyze and transform user needs, demonstrate design decisions, and interpret product data. By cultivating these advanced product thinking abilities, not only can students better understand the business logic behind design when performing UI related tasks, but also can develop the thinking abilities of managers and entrepreneurs in diverse UI scenarios gradually, providing broader possibilities for their career development role transformation and helping students build and improve their core and thinking levels.

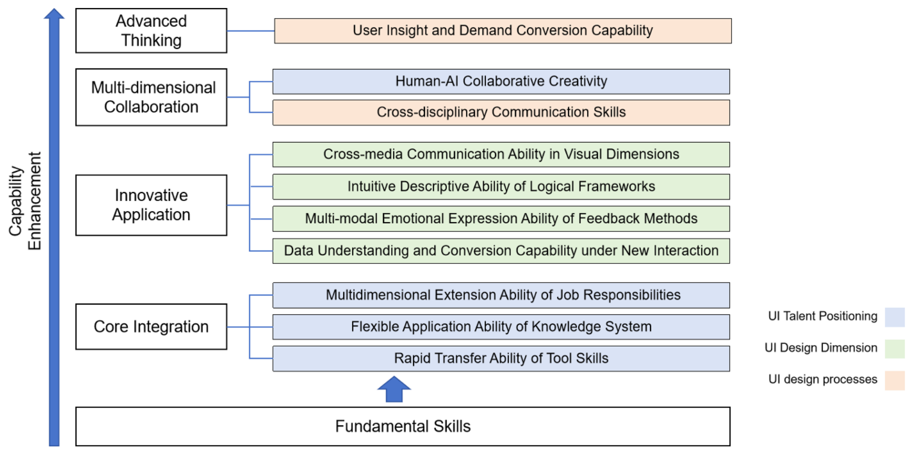


Fig. 5. Field Engineer Competency Framework in Diverse UI Scenarios

The above five modules form a progressive and mutually supportive competency framework (see Figure 5). In the process of teaching implementation, project practice should be taken as the main line, and the cultivation of various levels of abilities should be integrated into specific teaching links. Through the integration of industry and education, situational teaching and other methods, theoretical knowledge should be transformed into practical work abilities, and ultimately practical technical talents that meet industry needs should be cultivated.

4.6 Operationalization of the Competency Framework

To make the above framework actionable in teaching and to clarify the specific training paths and evaluation criteria for each layer, this study further maps each competency module to example courses, assessment methods, rubrics, and expected student outcomes, as shown in Table 1.

Table 1. Operationalization of the Competency Framework

Level	Competencies	Course Examples	Assessment Methods	Rubric	Expected Student Outcomes
Fundamental Skills	① Adobe software operation (PS, AI, AE, XD) ② UI design specifications & component systems ③ Basic HTML/CSS	① UI Design Tools ②Front-end Basics	Software tests + UI tasks	①Excellent: full compliance + top 20% efficiency ②Pass: main tasks completed	Independently complete a high-fidelity mobile UI
Core Integration	① User research & requirement translation ② Flexible application of knowledge system ③ Rapid tool transfer	① User Research ②Interaction Design	Project report + review presentation	①Excellent: complete requirement-to-function mapping ②Pass: major workflows covered	Complete an interactive prototype for a real scenario and pass user testing
Innovative Application	① Cross-media visual communication ② Intuitive logical framework design ③ Multi-modal emotional feedback ④ Data visualization	① Responsive Design ②Data Visualization	Multi-scenario design projects	①Excellent: adaptation to ≥3 media types + clear data storytelling ②Pass: adaptation to 2 media types	Design UIs for mobile/large screen/VR and explain design decisions
Multi-dimensional Collaboration	① Human-AI collaboration (AIGC) ② Cross-disciplinary terminology & deliverables	① AIGC in Design Practice ②Team Collaboration	Teamwork + AI-assisted tasks	①Excellent: ≥30% efficiency gain via AI tools ②Pass: successful handover	Use AI to generate drafts and refine them; communicate effectively with developers
Advanced Thinking	① User insight & business translation ② Design justification ③ Data-driven iteration	① Product Mindset ②Design Management	Case analysis + design reports	①Excellent: measurable improvement in business metrics ②Pass: logical coherence	Explore new products or business models from market and user perspectives.

5 Conclusion

This paper responds to the gap between China's policy-driven field engineer training and the systematic UI competency structures observed internationally. By integrating UI design into field engineer development, the study constructs a five-layer competency framework: fundamental skills, core integration, innovative application, multi-dimensional collaboration, and advanced thinking. Each layer is operationalized, making the framework actionable for vocational education.

The main contributions are threefold: (1) revealing the disconnection between UI design and field engineer training through bibliometric analysis, (2) identifying competency requirements from talent positioning, design dimensions, and design processes, and (3) providing an operationalized competency framework.

A limitation is the lack of empirical validation; future research should implement the framework through industry-education collaboration and evaluate its effectiveness in real training programs.

Acknowledgments

Construction and Practice of a Capability Improvement System for On-site Engineers in Diverse UI Scenarios (2023JG070).

Reference

1. Yuan Xiaohua, Xu Han. The dilemma and countermeasures of field engineer training in vocational education: based on the perspective of organizational sociology[J/OL]. Higher Education Development and Evaluation,1-10[2025-11-23].
2. Xu Lan, Mei Yanghan, Wang Zhiming. Realistic Dilemmas and Path Optimization of Field Engineer Training under New Application Scenarios of Intelligent Manufacturing, Chinese Vocational and Technical Education, 2024, (14): 13-21.
3. Zhong X, Cao M, Han T. Research on Application Model of Unconsciousness in User Interface [J]. Advances in Intelligent Systems and Computing, 2020:324-332. DOI:10.1007/978-3-030-19135-1_32.
4. Su Yaotian, Wang Ke, Bai Jingyuan. Cultivation Pathways for Field Engineers in Intelligent Manufacturing from the Perspective of Industry-Education Integration[J]. Higher Vocational Education Exploration, 2025, 24(05):52-58.
5. Wang Xiwei, Li Mali, Zhao Yang, Fan Zhewei. Service Innovation of Knowledge and Intelligence Enabled by AIGC under the New Quality Productive Force Strategy: New Mechanisms, New Risks and New Paths[J]. Journal of Modern Information,2024,44(12):3-14.