

Intelligent Innovation for the Future: Exploring Pathways for Teaching Reform in University Product Design Courses in the AI Era

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Abstract:

This paper examines how artificial intelligence (AI) reshapes product design education through systematic curriculum innovation. It proposes a “trinity” talent cultivation framework with three strategic dimensions: pedagogical evolution from “product creation” to “intelligence control” via AI-native thinking; three-tier curriculum restructuring (foundational AI literacy, core AI-driven processes, and ethical sublimation); OBE-supported project-based human-machine collaboration. Case studies show AI technologies like AIGC and large language models transform design paradigms from “form follows function” to “form follows data”. The evaluation system prioritizes process (70% weight for AI application records) over output. Challenges include teacher knowledge gaps, resource disparities, and AI over-reliance risks. The study concludes that future education must integrate technology, business, and humanity to advance social progress.

Keywords:

AI-Driven Design Education, Curriculum Restructuring, Human-Machine Collaboration, Teaching Evaluation Reform, Interdisciplinary Innovation

1. Changes and Opportunities – AI Drives Teaching Innovation

With the rapid advancement of technology, artificial intelligence (AI) has been widely empowering various industries, emerging as a key force driving industrial transformation and innovation. In the field of design, the transformation is particularly pronounced: AIGC (AI-Generated Content) is unleashing creative visual expression with unprecedented efficiency; large language models are redefining the boundaries of human-computer interaction through deep semantic understanding and generative design can explore massive optimal solutions under complex constraints. These core technologies have not only revolutionized the workflow of the design industry but also reshaped its core connotation and underlying paradigm, propelling design from “experience-driven” manual work to “intelligence-driven” human-machine

collaboration. Against this backdrop, the traditional teaching framework of university product design curricula is facing severe challenges and urgent needs for innovation.

Currently, university product design programs have established a relatively comprehensive curriculum system covering three modules: basic, core, and elective courses. However, the inherent issue of “curriculum isolation” remains prominent. There is often a lack of effective horizontal connection and vertical support between courses. Absence of integration weakens the synergistic effect that the curriculum system should have generated, making it difficult for students to integrate scattered knowledge points into organic and comprehensive design capabilities. As a result, their knowledge system becomes fragmented, leading to “subjective and arbitrary” designs that fail to meet real market demands in later-stage product development.

The traditional product design curriculum system has long centered on three pillars: expression techniques, design thinking, and specialized fields, with its teaching focus anchored on “hard skills” such as hand-drawing, modeling, and prototype making, as well as design thinking based on experience and intuition. Nevertheless, this educational paradigm rooted in the industrial age has significantly lagged behind the iteration speed of intelligent technologies. As the industry moves toward a new paradigm centered on data-driven and AI-collaborative workflows, over-reliance on traditional teaching models will leave students unable to adapt to modern design processes characterized by rapid generation, iteration, and verification, thereby posing the risk of students being disconnected from industry practices [1].

To address the changes of the times, product design teaching requires top-level design and systematic restructuring. The goal is to cultivate a new generation of designers with “trinity” composite capabilities: they should possess solid traditional product design skills, excel in mastering AI tools, and simultaneously have creative thinking to define human-computer interaction rules.

2. Reshaping Teaching Philosophy: From “Creating Objects” to “Controlling Intelligence”

Throughout the development of the design field, the concept of “form follows function” has long occupied a core position, profoundly influencing the creative logic of architecture, industrial design, product design, and other fields. For many years, the teaching philosophy of university product design programs has focused on cultivating “creators of products.” However, with the popularization and application of AI and big data technologies, the design paradigm is undergoing a fundamental shift - from “form follows function” to “form follows data, algorithms, and experience.” Consequently, the role of designers is undergoing a disruptive transformation. Therefore, the teaching philosophy of university product design programs should evolve from cultivating “product creators” to nurturing “multi-role professionals” who can define human-computer interaction rules, AI behavioral logic, and user experience processes.

In traditional product design skill teaching, students often passively receive skill training as “tool users.” Even though there are preliminary theoretical courses such as “Design Psychology” and “Introduction to Design,” the time gap between these courses and practical training means that when students apply skills like “modeling and rendering” to design projects, they rarely analyze the essence of design problems, resulting in “unreasonable” designs [2]. In the current context where AI deeply penetrates the design process, designers can leverage AI to easily extract valuable

information such as product development insights, generate user portraits, and conduct user data analysis. Thus, the teaching goal of product design programs needs to realize the in-depth integration of the “skill layer” and “strategy layer” through AI technology. Students should not only proficiently use design tools to complete basic creation but also develop the ability to define design problems and understand the boundaries of AI collaboration.

Massive homogeneous design solutions often put designers in a dilemma. This requires a further upgrade of teaching goals: guiding students to transform from “content creators” to “content curators and editors,” and cultivating their ability to critically screen and deeply edit content. In practical teaching, real project cases can be used for student practice: when faced with hundreds of small household humidifier appearance design schemes generated by AI, students need to establish screening criteria based on product positioning, usage scenarios, manufacturing costs, and other dimensions, eliminating schemes that do not meet safety standards, conflict with brand positioning, or are difficult to mass-produce. At the same time, they should further refine the retained high-quality schemes – for example, adjusting the arc of the mist outlet to improve safety, optimizing the texture of the body material to enhance grip comfort, and adding night soft light design to adapt to bedroom scenarios. This not only helps students accurately identify high-quality content from massive information but also cultivates their ability to control design details and innovative thinking.

3. Restructuring Teaching Content: Building an Integrated Knowledge System of “AI + Design”

In the field of product design, AI technology has evolved from an auxiliary tool to a core production factor. The traditional teaching content system centered on “hand-drawing – modeling – rendering” can no longer meet the ability requirements of product designers in the AI era. Therefore, teaching content needs to be systematically restructured around the entire process of “AI + product design,” forming a three-tier knowledge structure from basic cognition to core practice and then to thinking sublimation. This enables students to master the dual capabilities of “using AI for product design” and “designing AI-native products.”

3.1. Foundation Layer: AI Literacy and Tool Proficiency – Building the Capability Base for Product Design

The foundation layer of teaching aims to eliminate students’ unfamiliarity and fear of AI technology, ensuring that technical cognition and tool application are deeply adapted to product design scenarios, and avoiding disconnection between general knowledge and practice.

In terms of theoretical teaching, courses such as Introduction to AI Design are offered as the cornerstone of disciplinary general education [2]. These courses explain core concepts related to design, such as machine learning, natural language processing, and computer vision, helping students demystify the “black box” of AI technology. Meanwhile, a large number of cases should be integrated into the teaching content to visualize abstract concepts for easier student understanding. For example, when explaining the concept of “machine learning,” the user behavior learning function of smart home appliances can be used to illustrate how algorithms optimize product interaction logic by analyzing user usage frequency and operating habits. When

introducing “computer vision,” the face recognition technology of smart door locks can be taken as an example to break down processes such as image collection, feature extraction, and matching verification, allowing students to understand how technical parameters (e.g., recognition accuracy, response speed) affect product user experience. Additionally, knowledge about the “AI product development cycle” should be supplemented to help students understand the connection logic of links such as demand analysis, technology selection, and prototype testing, laying a theoretical foundation for subsequent practice.

In practical teaching, courses on concept visualization using tools like Midjourney/Stable Diffusion can be offered. Students learn to generate multi-dimensional concept sketches by combining product usage scenario keywords (e.g., “portable coffee machine for outdoor camping, minimalist style, waterproof material, compatible with car power supply”), enabling them to quickly explore possibilities in form, material, and function. They are also guided to use ChatGPT for user research and copywriting – generating user interview outlines, organizing survey data, and assisting in writing product manuals and function introduction copy.

3.2. Core Layer: AI-Driven Design Process and Methodology Reconstruction

Traditional product design research relies on questionnaires and interviews, which have limited data volume and long analysis cycles. AI technology enables a dual breakthrough of “big data + precise insight.” Therefore, courses can be offered on using AI for big data user portrait analysis, sentiment analysis, and market trend prediction. Through such courses, students are guided to use AI tools to analyze public datasets, such as Baidu AI Sentiment Analysis and Google Trends combined with AI algorithms.

Teachers can introduce the concept of “generative exploration” into traditional design courses, using AI for unlimited program brainstorming. AI takes on the role of “mass program generation,” while students focus on “value identification and creative integration.” For example, in designing a smart desk lamp, students first define core functions (e.g., “eye-protection dimming,” “mobile APP linkage,” “timed reminders”), then use AI tools to generate hundreds of schemes (covering dimensions such as form, light color, and operation method). They then establish screening criteria (e.g., “whether it meets ergonomics,” “whether manufacturing costs are controllable,” “whether it is compatible with existing supply chains”), eliminate impractical schemes (e.g., overly complex mechanical structures that are difficult to mass-produce), and integrate and optimize the retained schemes (e.g., combining “touch dimming” with “APP remote control” while retaining the minimalist lamp body form). This link cultivates students’ critical thinking and prevents blind reliance on AI-generated results – for instance, identifying “aesthetic but impractical” issues in AI schemes (e.g., an overly heavy lamp base causing instability) and adjusting the design to balance aesthetics and functionality.

AI technology can upgrade product testing from sampling inspection to full-scale data analysis, improving the objectivity and comprehensiveness of evaluation. In courses such as product optimization and improvement, content can be added on using AI tools to track user operation behaviors and identify experience pain points in prototypes. At the same time, AI is used to automatically generate usability reports, convert test data into visual charts, and propose optimization suggestions.

3.3. Sublimation Layer: AI-Native Thinking and Design Ethics – Establishing Vision for Product Design in the AI Era

The sublimation layer of teaching goes beyond technology and process, cultivating students' innovative thinking to “design AI-native products” while establishing their awareness of technical risks, ensuring that designs are both forward-looking and ethically sound.

Teachers need to guide students to break free from the mindset of “adding AI functions to traditional products” and instead conceive products and services that “exist because of AI,” making AI the carrier of the core value of products. For example, when explaining “adaptive UI” design, smart in-vehicle systems can be used as an example to illustrate how products use AI to dynamically adjust interface display content (e.g., hiding non-essential information and only retaining navigation and speed data when driving at high speed) by real-time analyzing driving scenarios (e.g., vehicle speed, road conditions, driver attention status).

Teachers can add thematic discussions on “algorithmic bias, data privacy, and sustainable development” to cultivate students' responsible design concepts. By focusing on real ethical dilemmas in product design and avoiding vague moral preaching, students can develop a responsible design perspective through case analysis. For example, discussions on algorithmic bias, data privacy, and sustainable development help cultivate the original intention of “technology serving humanity” in design. Taking smart bracelet design as an example, students can discuss how to balance data collection (e.g., heart rate, sleep data) and user privacy protection (e.g., clearly informing users of data usage purposes, providing data deletion functions) to avoid over-collection of sensitive information. In combination with “sustainable development,” they can explore the full-life-cycle environmental design of AI products (e.g., modular design of smart home appliances to facilitate component replacement and reduce scrapping; AI algorithm optimization to reduce energy consumption during product use).

4. Innovation in Teaching Methods and Models: Project-Driven Learning and Human-Machine Collaboration

Project development is guided by real product design needs, abandoning the misunderstanding that “AI replaces human labor” and emphasizing the collaborative relationship between students (as “design leaders”) and AI. At the project initiation stage, the “human-machine collaboration plan” submitted by students must elaborate on the entire product design process. Taking the project “Designing an AI-Powered Health Management App for the Elderly” as an example, in the user research phase, roles should be clearly defined: AI is responsible for capturing public medical data and analyzing user reviews of similar products to initially identify pain points in user needs, while students focus on offline interviews to gain in-depth insights into the elderly's understanding of health data and their operational preferences; in the creative design phase, AI generates multiple interface layout schemes based on demand keywords, and students then screen schemes that align with logical operation principles and optimize details such as button size and font color, taking into account the elderly's visual cognition characteristics; in the prototype testing phase, AI assists in collecting user operation data and marking high-frequency error paths, while students analyze the causes of these errors and adjust the interaction process accordingly. This clear division of labor not only improves design efficiency but also

ensures students maintain control over the design direction, preventing passive reliance on AI-generated results.

In addition, teaching teams can develop a “deep online-offline integrated” hybrid teaching model based on the concept of OBE (Outcome-Based Education). By leveraging AI technology to build an intelligent teaching platform, this model enables bidirectional empowerment between online theoretical learning and offline practical innovation [2,3]. With “outcome orientation and competency progression” as its core logic, the online module focuses on “concise theoretical explanations + intelligent case analysis”—relying on AI to generate personalized learning paths, it is supported by a structured video course library, a dynamic case database, and a real-time intelligent Q&A system, all designed to help students independently master knowledge frameworks and cutting-edge cases; the offline module, on the other hand, emphasizes “project-driven learning + multi-dimensional interaction,” including advanced case workshops, interdisciplinary project practices, teacher-student collaborative creation workshops, and achievement showcase salons. Through hands-on practice, students deepen the application of theoretical knowledge; through face-to-face discussions with teachers and peers, they enhance critical thinking; and through public evaluation of their works, they strengthen their ability to deliver tangible outcomes. The platform uses AI algorithms to track learning behaviors and generate competency profiles, dynamically adjusting the allocation of online and offline resources to form a closed loop of “learning-practice-evaluation-creation.” Ultimately, it achieves full-chain training from knowledge input to competency output, ensuring students systematically master basic theories while highlighting practical training for advanced skills, and truly establishing a modern teaching system characterized by “diversified resources, flexible paths, and scientific evaluation.”

The implementation of product design requires the integration of knowledge from multiple fields, including design, technology, and data. Therefore, teachers need to build an interdisciplinary cooperation platform in teaching, where product design students form project teams with students majoring in computer science and data science. For instance, in the “Smart Office Chair Product Design” project, product design students take charge of user experience design and appearance innovation; computer science students focus on the selection of AI sensors and the implementation of functions, ensuring the feasibility of features such as sitting posture detection and automatic adjustment for the chair; and data science students design schemes for collecting and analyzing user behavior data to provide data support for subsequent product iterations. During the collaboration, students from different majors are required to hold regular demand communication meetings: product design students need to convey design concepts to technical majors in plain language, while technical majors must explain the feasibility boundaries of technical implementation to design students. This interdisciplinary collaboration not only helps students understand the full-chain logic of product design but also cultivates their cross-field communication skills, laying a solid foundation for their future participation in industry team collaboration.

5. Reform of the Teaching Evaluation System

Teachers need to increase the evaluation weight of AI application in AI-related courses. For example, in the “Smart Home Appliance Design Project” submitted by students, the final product rendering only accounts for 30% of the weight, while the design thinking process, AI prompt engineering, and optimization records account for

70%. By reviewing these process materials, teachers can determine whether students truly understand the essence of design rather than simply relying on AI to generate high-quality results, thereby guiding students to value the integrity of design logic and the depth of thinking.

Product design teachers can use AI systems to evaluate students' various abilities [3], generate preliminary scores and problem lists, and then the teaching team focuses on evaluating indicators that require human aesthetics and empathy, such as "emotional design" and "user experience." In addition, AI systems can generate personalized feedback reports based on evaluation results, including "strengths," "areas for improvement," and "learning resource recommendations." For students with weak performance in a certain ability, relevant online courses, case libraries, and AI-assisted design tools are recommended. Finally, teachers can build an online work display platform and introduce "AI review + public voting" mechanism, combining qualitative evaluation by professional judges to form a "professional-public" dual-perspective evaluation. For example, AI analyzes public voting data to identify the "market acceptance" and "emotional resonance" of design works, assisting teachers in evaluating students' "user insight ability."

6. Challenges and Prospects

As product design education is deeply integrated with cutting-edge technology, multiple practical challenges are restricting the improvement of teaching quality. First, there is a lag in the update of teachers' knowledge structures. Currently, the industry's demand for product design has shifted from traditional appearance design to composite capabilities of "design + technology + business," covering emerging fields such as AI interaction design, sustainable material application, and user experience data analysis. However, the knowledge system of most teaching teams still focuses on traditional design theories and skills, lacking systematic mastery of new technologies and tools. Although some teachers attempt to learn cutting-edge content, they struggle to effectively integrate technical logic with design thinking due to the lack of corporate practical experience and continuous training support, resulting in a clear gap between classroom teaching and actual industry needs [4].

Second, there is an imbalance in teaching resources and hardware support. Product design is highly dependent on practical teaching, requiring continuous capital investment and equipment iteration for resources such as 3D printing equipment, interaction design laboratories, and virtual reality (VR) design tools. However, there are significant differences in resource allocation among universities in different regions and at different levels.

Third, there are dual risks brought by the application of AI technology: over-reliance on AI and homogenization of creativity. Excessive reliance on AI to generate creative schemes and visual effects leads to neglect of core links such as preliminary user research, demand analysis, and creative divergence, resulting in the gradual degradation of design capabilities and failure to meet the industry's demand for personalized and innovative designs.

Product design education is undergoing a profound transformation from "traditional skill-oriented" to "technology integration-oriented." This transformation is not only an inevitable result of technological iteration but also a direct reflection of the industry's demand for composite design talents. In the future, product design education will further break down disciplinary barriers, promote in-depth integration

of design with fields such as AI, big data, the Internet of Things, and sustainable science, and form a new teaching system “supported by technology, targeted at business, and centered on humanity.” Ultimately, design will become an important force driving social progress and improving the quality of human life.

Conflicts of Interest

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