

OVERVIEW OF TEACHING AND MANAGEMENT MODELS FOR THE UNIVERSITY COURSE 'COMPUTER-AIDED DESIGN' IN THE CONTEXT OF ARTIFICIAL INTELLIGENCE IN PRODUCT DESIGN EDUCATION

Zou Yiyao

Nor Saidi Mohamed Nasir

Gao Jiaxin

Xia Yingying

Zhu Renjie

Faculty of Business Innovation and Technology,
Universiti Melaka,

Corresponding Author's Email: a18296666866@gmail.com

Article History:

Received : 10 September 2023

Accepted : 23 November 2023

Published : 31 December 2023

ABSTRACT

The 'Computer-Aided Design' course in product design education emphasizes creative design, cultivating students' ability to use design software to showcase product effects through extensive practical exercises. In today's digital era, CAD has evolved from a mere tool to an engine driving innovative design. However, traditional CAD courses often focus on technical operations, neglecting students' creative thinking and problem-solving skills. With rapid technological advancements, AI has integrated into various fields, including design. This paper aims to explore how integrating AI into university CAD courses can enhance teaching methods, fostering students' engagement, creative thinking, and design abilities, ultimately driving course innovation and reform.

Keywords: *Product Design, Computer-Aided Design, Artificial Intelligence, Higher Education, Pedagogical Management*

Introduction

In product design, Computer-Aided Design (CAD) is the technique of generating static or dynamic images of three-dimensional product models using computer software such as Photoshop, Rhino, Blender, etc. This technology simulates realistic effects like light reflection, shadows, textures, providing highly realistic and lifelike images. CAD-generated product renderings serve to present

design concepts, communicate ideas, and showcase outcomes, enhancing designer efficiency, reducing costs, and minimizing errors, thereby elevating design quality and accuracy. As the sophistication of CAD visuals increases, so does the learning curve and complexity. Hence, educators need to balance professional and creative case studies with considerations of students' cognitive levels and learning abilities. This paper aims to explore how teaching and management can emphasize students' proficiency in CAD-related design software, integrating AI development with CAD courses to explore changes in teaching methodologies, enabling students to master the use of digital tools for design expression, enhancing design efficiency, and visual impact.

Literature Review

The advancements in information and communication technology have ushered in a new era in all aspects of life (Mambang et al., 2022). One of the professional fields significantly influenced by the progress in computer system technology is product design, with profound implications from the advancements in artificial intelligence (AI). John McCarthy, one of the pioneers of AI, defined AI as a statistical method system aimed at understanding and simulating human thought processes. AI systems are used to design machines or neural networks capable of emulating human behavior and making ethically sound decisions and actions. The emergence of AI has been a remarkable phenomenon and continues to be a hot topic as it assists designers and students in managing information related to two-dimensional and three-dimensional aspects. Moreover, it enhances work efficiency from simulating product design analysis to the visualization design phase.

In the realm of higher education, as the rapid proliferation of AI application tools has occurred, scholars such as Lakshmi, Chen, Holme and Zhang (Lakshmi et al., 2023) have conducted studies on the application of AI in higher education. Crompton and Burke (Crompton & Burke, 2023) provided unique findings and recent research outcomes regarding the application of artificial intelligence (AI) in higher education from 2016 to 2022. They employed a priori coding and data-driven coding methods to thoroughly review 138 relevant articles. This review revealed existing research gaps, including exploration of new tools like the generative AI tool Chat GPT, providing valuable insights for researchers interested in the intersection of higher education and artificial intelligence. Enjellina et al. (Enjellina et al., 2023) explored the emerging trends in text-to-image-based generative artificial intelligence (GAI) or AI image generation technology. This technology has garnered attention due to its ability to create images based on natural language messages in a short time.

Additionally, it has raised discussions and viewpoints, including its impact on the field of architecture. Escotet (2023) discussed the immense potential of AI technologies in higher education, such as ChatGPT, MidJourney, or Codex, falling under the category of generative artificial intelligence (GenAI). These technologies offer both opportunities and potential risks, and the article maintains an optimistic outlook on their application in higher education. Lee et al. (Lee et al., 2022) emphasized the importance of envisioning and designing future human-AI interactions for HCI designers, especially in light of the prevalence of AI in daily life. They conducted immersive experiences using high-fidelity illustrations to elicit potential users' perceptions, expectations, and concerns about future technologies. Lively et al. (Lively et al., 2023) discussed the disruptive potential of AI in education across various levels, including the emergence of chatbots, AI art generators, and large language models. These advancements have altered the workflow for artists and

designers and prompted discussions regarding creativity and the role of humans in the creative process. Newton and Dhole (Newton & Dhole, 2023) explored the impact of AI art generation tools like Dall-E and Midjourney on art and design development. They demonstrated how integrating AI tools into the web design and development workflow resulted in improved productivity and creativity among students. Yu and Guo (Yu & Guo, 2023) provided a comprehensive overview of the development and technical principles of generative artificial intelligence. They highlighted the information revolution brought about by the emergence of ChatGPT and analyzed its current applications in education. The paper also discussed future trends in generative AI, including personalized education, intelligent teaching, collaborative education, and virtual teaching. The study conducted by Wang et al. (Wang et al., 2023) in 2023 underscores the pivotal role of teachers in the realm of AI-enhanced education. It emphasizes the necessity for teachers to be adequately prepared for the integration of AI into education, ensuring a seamless implementation of AI in the educational domain. This research serves as a significant point of reference for the formulation of effective policies and strategies aimed at fostering successful AI-enhanced education. Southworth et al. (Southworth et al., 2023) have noted the impact of artificial intelligence (AI) technology on addressing educational equity issues. They argue that a fundamental understanding of AI should be a crucial component of student education. Their research describes a potential path to bridge the gap in AI education and integrate AI into traditional research university curricula.

In summary, the aforementioned literature provides a comprehensive exploration of the applications of artificial intelligence (AI) technology in the domains of product design and higher education. Within the realm of product design, the continuous advancements in AI technology have significantly elevated operational efficiency, streamlining tasks such as research analysis and visual design within the product development process. In the higher education sector, the widespread integration of AI tools has engendered novel research avenues, particularly highlighting the transformative impact of generative AI technologies in the spheres of personalized and specialized education. These developments underscore the substantial potential of AI across various domains, while also shedding light on the associated challenges.

Overview of the Pedagogical Landscape of the "Computer-Aided Design" Course

As an indispensable and ubiquitous tool in the field of product design, Computer-Aided Design (CAD) plays a multifaceted role in facilitating the presentation of design concepts, the exchange of design ideas, and the exhibition of design outcomes. In the educational landscape focused on design, institutions across the board have universally incorporated the "Computer-Aided Design" course into their curriculum, leveraging it as a conduit to augment students' proficiency in design practice and innovation.

Regarding the structuring of the curriculum, universities typically divide the "Computer-Aided Design" course into two distinct segments: two-dimensional representation and three-dimensional representation, with each segment assigned to different academic terms. The initial phase revolves around two-dimensional creative presentation, guiding students in comprehending the essence of computer-aided product design. This phase involves assimilating foundational knowledge in computer-aided design and acquiring mastery over key attributes, prevalent commands, and editing tools within software platforms like Photoshop and Corel Draw. The primary aim here is to cultivate students' foundational competence in utilizing two-dimensional design software to vividly portray

product outcomes. Subsequently, the second phase endeavors to deepen students' understanding of computer-aided concepts by exposing them to the intricacies of three-dimensional model design. This entails inculcating familiarity with the intricacies of the workflow, design principles, and methodologies inherent in computer-aided three-dimensional design visualization. Proficiency in software applications such as Rhino, Keyshot, and Blender is also imparted to facilitate modeling and rendering techniques, enabling the production of high-quality three-dimensional representations of products.

Regarding instructional mode management, the "Computer-Aided Design" course typically employs a predominantly in-class teaching approach. During these sessions, instructors expound on theoretical concepts and demonstrate operational procedures. Following this pedagogical delivery, students actively engage in practical exercises, wherein they apply and consolidate their knowledge. However, due to variations in instructional time allocation and student aptitude, the course content primarily focuses on rudimentary tool commands and simplified design cases. This phenomenon often results in a course curriculum characterized by relatively shallow knowledge complexity and constrained teaching progression. The practical hands-on component is further constrained by the temporal limitations of the classroom setting, thereby impeding the fulfillment of students' practical learning requisites.

An analysis of students' course assignments reveals that traditional computer-aided software instruction tends to foster an approach where students mimic mechanical steps. Consequently, students often limit their engagement to executing predefined procedures without proactively considering how computer-aided design tools could effectively materialize their unique design concepts. This dynamic frequently leads to a situation wherein students continue to grapple with integrating computer-aided design as a proficient tool for their individual design projects. Ultimately, this gap between theoretical understanding and practical application undermines the intended instructional outcomes, drifting away from the cherished pedagogical objectives.

In response to the aforementioned scenario, the question emerges: How can the application of the "Computer-Aided Design" course be orchestrated to not only facilitate students' mastery of foundational professional skills but also expand their horizons? How can creative thinking be effectively integrated into practice, enhancing students' practical abilities, igniting innovative thinking, and elevating professional acumen? In essence, how can students be nurtured into becoming exemplary design professionals?

Overview of the Application and Development of Artificial Intelligence in Design

The domain of product design inherently encompasses processes such as design positioning, creative ideation, design representation, model construction, manufacturing, and iterative refinement. In the contemporary landscape of burgeoning technological advancement and computational prowess, the integration of artificial intelligence technology into computer-aided design has unequivocally become an indispensable facet of the design paradigm.

Artificial Intelligence (AI) technology spans a diverse spectrum aimed at endowing machines with the capability to simulate human intelligence. This field encompasses the enabling of computer systems to execute tasks akin to human cognition, encompassing areas such as speech recognition, image recognition, natural language processing, and decision-making, among others. Within this

purview, Generative AI systems emerge as a subset of artificial intelligence, endowed with the capacity to learn from existing data and generate novel information, thereby mirroring human creative faculties. Generative AI has witnessed widespread application across multiple domains, including music composition, image synthesis, text generation, and more.

i. Introduction to Image Generative

Image Generative Artificial Intelligence Technology (Generative Adversarial Networks, GANs) stands as a profound and pivotal deep learning methodology. At its core, GANs adhere to the fundamental principle of engendering data that exhibits a striking semblance to real-world counterparts. This feat is achieved through the orchestration of a dynamic interplay between two neural networks: the generator and the discriminator.

The role of the generator within the GANs framework is to shoulder the responsibility of data generation. It commences its creative endeavor by ingesting random noise, which serves as its creative palette. In response to this stochastic input, the generator endeavors to fashion samples that bear an uncanny resemblance to authentic data, thereby blurring the boundary between synthetic and genuine data. Conversely, the discriminator assumes the contrasting role within this adversarial duet. Its task entails an evaluation of the likelihood that a given set of input data truly emanates from the realm of reality. Armed with this evaluative prowess, the discriminator embarks on a relentless pursuit of distinguishing the authentic from the synthetic. It strives to refine its acumen, enhancing its ability to discern the nuances that delineate real data from its artificially crafted counterparts. This captivating synergy between the generator and the discriminator engenders a relentless competition and cooperative spirit. The generator, driven by an innate creative impulse, relentlessly seeks to transcend its previous accomplishments in the pursuit of crafting data that is ever more indistinguishable from the real. Concurrently, the discriminator evolves to become a discerning connoisseur, refining its ability to identify even the subtlest distinctions that betray the origin of the data. The ultimate aspiration within the realm of GANs is for the generator's output to reach a zenith of realism. The litmus test of this achievement lies in the discriminator's inability to reliably distinguish between the synthetic and the authentic.

The inception of GANs can be attributed to the visionary work of Ian Goodfellow and his dedicated team in the year 2014. Since their inception, GANs have embarked on a journey of continuous evolution and refinement. The relentless march of deep learning technology, coupled with the relentless drive for hardware improvement, has ushered in a new era for GANs. This era is characterized by heightened generation quality and an expansive application domain. Noteworthy is the proliferation of GAN variants and enhancements that have enriched this landscape. These include but are not limited to conditional GANs (cGANs), CycleGANs, StyleGANs, and an array of other innovative iterations. These variants serve as catalysts, broadening the horizons of GANs' application potential. They enable GANs to gracefully handle a diverse spectrum of data types, spanning from images and text to audio and beyond. Across a multitude of domains, GANs have been wholeheartedly embraced as transformative tools. They have made significant inroads in the domains of image generation and enhancement, video synthesis and editing, medical image analysis and processing, artistic and creative expression, immersive virtual reality experiences, and the dynamic realm of game development.

In summation, GANs epitomize a revolutionary technological paradigm within the expansive

domain of deep learning. Their profound impact resonates across diverse fields, offering unprecedented possibilities and ushering in an era of innovation and scientific exploration. GANs, with their capability to enhance data generation quality and expand the frontiers of artificial intelligence, stand as potent instruments for driving progress and catalyzing transformative change.

ii. Introduction to Stable Diffusion

Stable Diffusion, introduced in 2022, is a deep learning text-to-image generative model that emerged from a collaborative effort involving the startup companies StabilityAI, CompVis, and Runway, with the support of EleutherAI and LAION. Built upon the foundational concept of the Latent Diffusion Model (LDM), Stable Diffusion operates as a technology bridging textual descriptions to image synthesis. The methodology involves iteratively denoising random Gaussian noise to progressively generate images, with each step incorporating an increasing magnitude of noise.

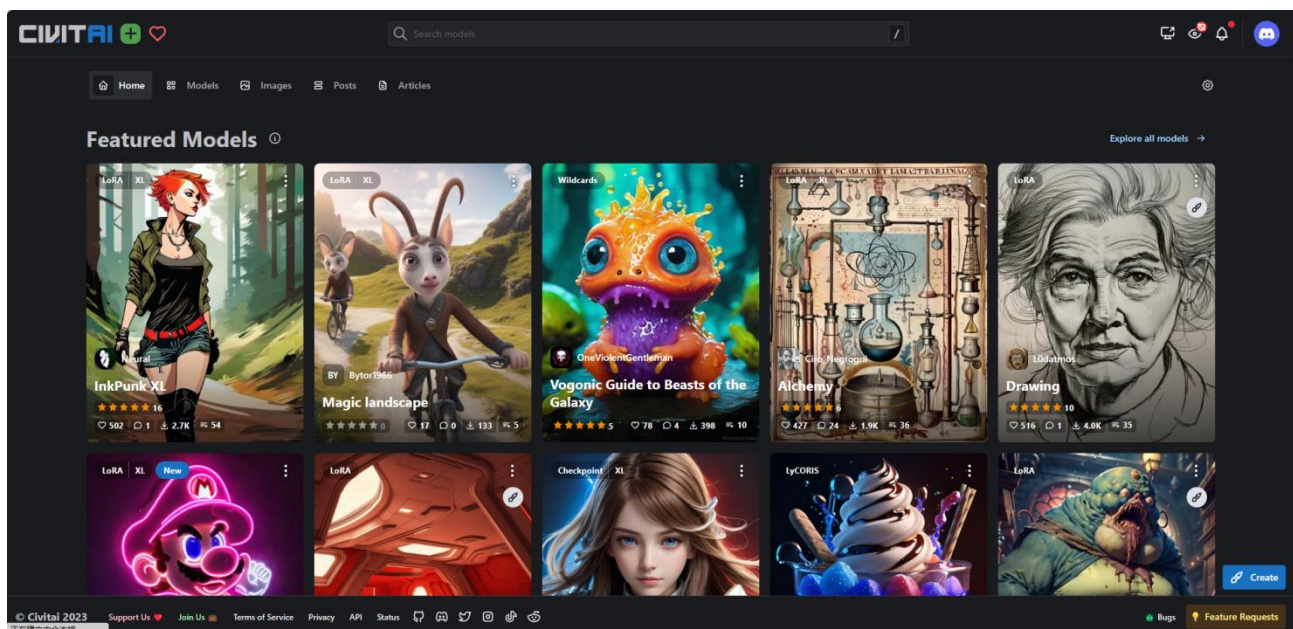


Fig (1): From Stable Diffusion official website

Stable Diffusion finds extensive application, primarily focusing on the generation of intricate images based on textual descriptions. It extends its utility to diverse tasks, encompassing tasks such as inpainting and extrapolation, as well as translating prompt-guided image synthesis. Notably, Stable Diffusion excels in its capacity to yield highly accurate and remarkably authentic images, a feat enabled by its adept image rendering engine. Additional salient attributes of Stable Diffusion include:

Gratuitous Usage: Users benefit from unrestricted image generation without the need for subscription purchases or supplementary charges.

Local Deployment Support: Users can employ the tool in offline settings, obviating dependence on network connectivity.

Plurality of Open-Source Models: Users enjoy the prerogative to select from a spectrum of open-source models that best align with their distinct preferences and requirements for graphic composition.

Agile Update Cadence: Users are facilitated with prompt access to the latest software iterations

and newly integrated functionalities.

Facilitation of Tailored Commercial Applications: Users can undertake the development and training of models in alignment with their specific exigencies and contextual demands, thereby realizing bespoke and personalized graphic rendering effects.

iii. Introduction to Mid journey

Mid journey, developed by a research laboratory of the same name, entered the public testing phase on July 12, 2022. This AI painting tool possesses the capability to generate corresponding images based on user-input text descriptions, achieved through the utilization of Generative Adversarial Network (GAN) technology for text-to-image transformation. With vast application potential in artistic creation, game development, film effects, and beyond, Mid journey symbolizes the continual breakthroughs and innovations of artificial intelligence technology in the realms of image processing and creativity. Users can engage Mid journey by transmitting messages to a bot within the Discord chat application, circumventing the need for programming. The laboratory behind Mid journey is spearheaded by David Holz, one of the founders of Leap Motion, and is dedicated to the development of AI tools capable of emulating human creativity.

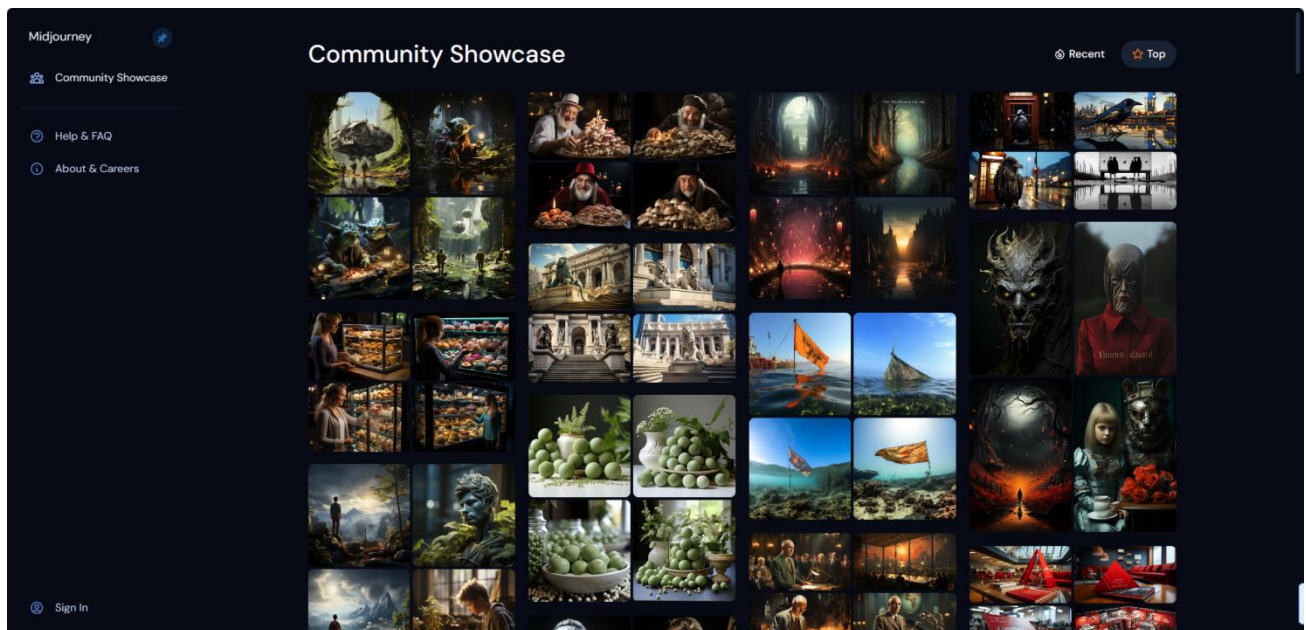


Fig (2): From Mid journey official website

Mid journey stands as a potent AI painting tool, its chief advantages encompassing:

Highly Realistic Imagery: The images generated by Mid journey exhibit remarkable realism, akin to works of photographic quality. This characteristic proves particularly enticing for users seeking rapid generation of authentic scenes and characters.

Versatile Styles and Techniques: Mid journey can engender an array of distinct styles and techniques, spanning oil painting, watercolor, and sketching, thus rendering it versatile across diverse design domains.

Text-to-Image Conversion: Mid journey has the faculty to transform text descriptions furnished by users into corresponding images, proving exceedingly valuable for individuals rich in imagination yet less adept in artistic drawing.

Broad Application Scope: Mid journey's application scope is expansive, encompassing artistic creation, game development, film effects, and more, thus rendering it a pivotal instrument for many designers and developers.

User-Friendliness: The usability of Mid journey is remarkably straightforward, with users merely required to convey messages to the bot within the Discord chat application—obviating the necessity for programming acumen.

Summary

In conclusion, image generative artificial intelligence (AI) exhibits several notable advantages over traditional computer-aided tools:

Speed and Efficiency: Image generative AI leverages advanced technologies such as deep learning and convolutional neural networks to swiftly produce high-quality images. Within the iterative design process, the laborious computations and iterative time required by traditional 3D rendering are significantly reduced. This allows designers to realize creative concepts more rapidly and achieve satisfactory visual presentations within limited timeframes.

Flexibility and Real-time Capability: The real-time image generation capacity of image generative AI empowers designers to instantaneously evaluate diverse styles and representations within an interactive environment. This flexibility enables designers to intuitively adjust design elements and refine stylistic details, effectively realizing visual intentions.

Automation and Intelligence: Image generative AI, employing algorithms like Generative Adversarial Networks (GANs), can autonomously learn style features from data and subsequently generate images without manual intervention. This automated process notably diminishes the intricate parameter adjustments inherent in traditional 3D rendering, imbuing the creative process with increased intelligence and enhancing creative efficiency.

Diversity and Innovation: The inherent nature of image generative AI lies in its ability to generate diverse images through randomness and variable control, thereby furnishing designers with an expanded creative space. This aids in examining design issues from various angles and exploring novel visual effects, thereby stimulating innovative design thinking.

Reduced Technical Barrier: While traditional 3D rendering techniques often demand a high level of technical expertise, image generative AI minimizes this requirement. Through user-friendly interfaces and automation functions, designers can achieve impressive image generation without needing to master intricate rendering pipelines, thereby expediting the realization of creative concepts.

Cost Savings: Image generative AI imposes relatively modest infrastructure demands. In contrast to traditional 3D rendering, the need for expensive dedicated hardware and substantial licensing fees is diminished, providing a more cost-effective option for project development and design.

However, despite the remarkable performance of image generative AI across various dimensions, its efficacy may be constrained by data samples and training algorithms, potentially yielding suboptimal results in complex scenarios. In practical applications, designers must thoroughly assess the suitability of chosen tools, ensuring generated images align with design intentions while remaining cognizant of algorithm limitations. Consequently, in the practical application of design projects, the selection of suitable design solutions should be guided by design objectives and positioning, ultimately ensuring the creation of exceptional design works by students.

Findings

In the preceding sections, a comprehensive overview of the current state of "Computer-Aided Design" (CAD) courses in higher education institutions and the utilization of AI-driven computer-aided design tools has been presented. Within the context of practical teaching in CAD for product design, traditional educational management methods encounter certain limitations due to students' limited learning capacities, cognitive levels, and practical abilities. This section primarily focuses on three aspects: curriculum design, teaching methodologies, and integration across specialized courses, proposing directions for optimizing the teaching and management model.

i. Curriculum Design

In the realm of curriculum design, it becomes imperative to address the intricacies of software applications such as Photoshop (PS) and Rhino, which have found substantial traction within the domain of product design. These applications offer a robust array of functionalities capable of yielding near-realistic, professional-grade visual representations of products. However, the intricacies of their feature designs impose a prolonged learning curve, necessitating extensive practical training to attain a proficient skill level. This culminates in an escalated learning complexity.

Given the practical constraints of students, a prudent strategy for mitigating the initial apprehensions associated with mastering complex software lies in the integration of AI-driven design tools as supplementary content. These tools can be introduced in the form of preparatory courses, harmonizing with the traditional pedagogical content. Such an approach serves a dual purpose: it alleviates the trepidation of novices and, concurrently, fosters a genuine curiosity to actively delve into the realm of product visualization through computer-generated imagery.

The realm of Image Generative AI, encompassing a potent array of artificial intelligence technologies, is intrinsically geared towards autonomously generating lifelike images and visual content through the conduit of machine learning and deep neural networks.

This technological frontier has rippled across an array of sectors, encompassing artistic endeavors, design ventures, medical image analysis, and beyond. Within the context of product design, the pivotal contribution of Image Generative AI lies in its ability to channel an unprecedented degree of design creativity and productivity to both designers and creators.

Notably, the software entities of Stable Diffusion and Mid journey conspicuously leverage natural language inputs to orchestrate the operation of their respective models, engendering the generation of bespoke design creations. Within the spectrum of curriculum design, the critical juncture emerges where instructional guidance steps in to educate students on the judicious deployment of AI tools, enabling the swift conceptual ideation and three-dimensional rendering of a plethora of design propositions.

The impetus behind these pedagogical augmentations is underpinned by the aspiration to seamlessly integrate AI-driven design tools into the educational landscape. This integration not only augments students' agility in navigating advanced technologies but also nurtures an organic proclivity for innovative design ideation. Ultimately, this avant-garde educational paradigm empowers students with the prowess to seamlessly oscillate between conventional and AI-facilitated design paradigms. This, in turn, forges a holistic and adaptable cohort of prospective designers, impeccably poised to traverse the ever-evolving design milieu.

Conceptual Ideation and Design: Through the utilization of Image Generative AI, students can harness an expeditious avenue to yield an array of diverse conceptual designs. This pedagogical praxis engenders a milieu conducive to the exploration of manifold design trajectories, thereby serving as a crucible for the kindling of creative stimulus. The instrumental Image Generative AI tools, exemplified by Stable Diffusion and Mid journey, proffer an interface for governing model generation, enabling the inception of rudimentary design sketches through the conduit of natural language inputs.

Employing lexicons such as "sketch," "industrial design sketching," "sketching," and their akin, furnishes the modality to orchestrate the synthesis of incipient design frameworks. The resultant corpus of creative renditions duly encapsulates the essence of product morphology and compositional congruity. Illustrated in context, envisage the creation of a men's wristwatch design, wherein an intricate textual delineation, synonymous with the design at hand, is tendered through natural language conduits, eliciting the materialization of a meticulously conceived, high-caliber conceptual sketch manifesting sound logical structuring. It is noteworthy that this subdomain of AI tools accentuates an augmented level of deterministic manipulation, thereby bequeathing students the wherewithal to further ameliorate the output design, engendering a symbiotic harmony with their proprietary ideations pertaining to product functionality, form, and configuration. Via the strategic infusion of terminologies resonant with their conceptual schema, students can iteratively refine the design's trajectory until it impeccably aligns with their envisaged artistic vision.

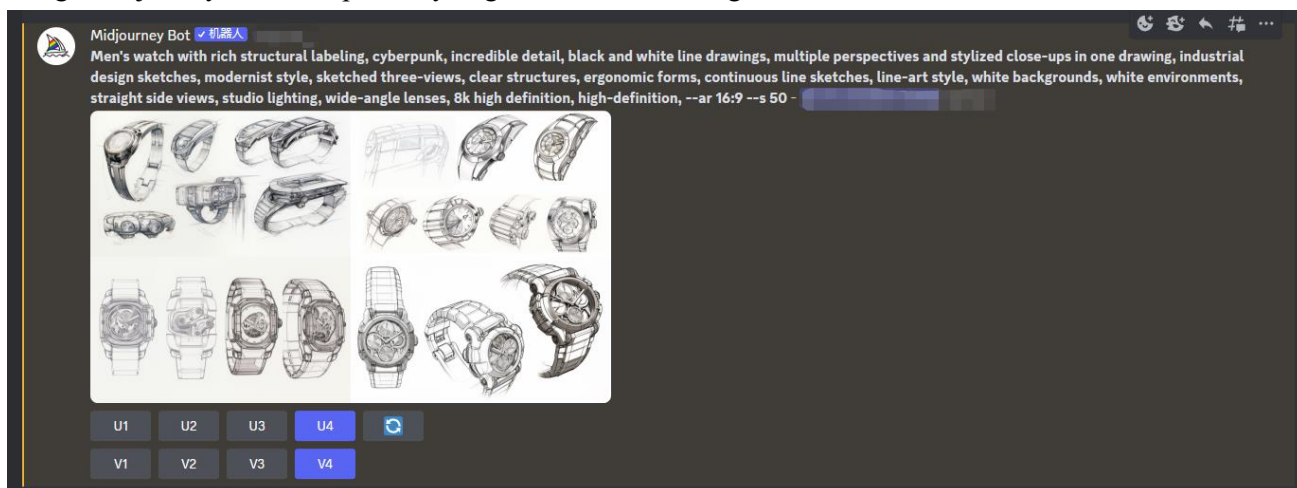


Fig (3): Product design concept sketches generated by Stable Diffusion (Self-Drawing)

Rapid Visual Rendering: The imagery engendered through AI augmentation finds application as a potent tool within students' arsenal for the elucidation of design concepts, the exposition of creative opuses, and the facilitation of cogent intercommunication. Once the contours of the product configuration attain lucidity, AI-driven instruments can be enlisted for the refinement of the rudimentary sketches via the paradigm of image-to-image generation. Within this operational paradigm, students are conferred with the simplicity of inputting keywords evocative of product aesthetics. These lexical inputs encompass a spectrum of terms, including but not limited to, "modernist," "post-modern," "abstract," all of which serve as the embodiment of design styles, whilst also encompassing nuanced factors such as material composition, luminal aspects, and chromatic nuances. Through judicious orchestration of these inputs, in tandem with the elucidation tendered by image-generation algorithms, the skeletal contours of designs undergo an artistic metamorphosis,

engendering a gestalt that resonates harmoniously with the aspired stylistic ethos. In the context of a wristwatch design, adroit keyword articulation encompassing facets such as material composition, chromatic tonality, design ethos, illumination orchestration, and analogous parameters instantaneously conduce to the manifestation of a superlative tridimensional portrayal of the envisioned product, characterized by its fidelity to aesthetics and contextual precision.



Fig (4): 3D rendering of product design generated by Mid journey (Self-Drawing)

In conclusion, the convergence of computer vision and AI-fueled image generation technology, amalgamated with the infusion of specialized lexicon, bequeaths an instrumental creative apparatus within the realm of product design. This synergistic amalgamation not only engenders an elevation in the technical acumen underpinning visual rendition, but also imbues the design endeavor with an augmented realm of innovation and creative horizons for designers.

ii. Teaching Approaches by Instructors

In an era marked by nascent scientific and technological progress and constrained pedagogical landscapes, the prominence of the transmission-reception-based face-to-face instructional methodology has endured as the quintessential pedagogical archetype within higher education. This didactic mode, replete with historical precedence, imparts discernible efficacy in diffusing systematic knowledge and honing skills. Within academic realms such as the "Computer-Aided Design" course, this instructional paradigm facilitates the students' voyage by commencing with rudimentary cognition and rudimentary tool mastery, progressively culminating in a nuanced grasp of applied principles pertinent to computer-aided design instruments. Notwithstanding its merits, the face-to-face approach confronts inherent limitations pertaining to spatial-temporal constraints, pedagogical interaction, and personalized tutelage, culminating in a moderately impactful instructional outcome.

In the milieu of the "Computer-Aided Design" course, the assimilation of a blended teaching model proffers manifold dividends. This modus operandi not only redresses the limitations intrinsic to conventional face-to-face pedagogy but also harnesses the virtues of online pedagogy to augment students' erudition and holistic competence. Connoted as blended learning, this pedagogical amalgamation of conventional classroom instruction and virtual pedagogy engenders a synergetic confluence that befits both orthodox pedagogical traditions and the digital pedagogical zeitgeist, bequeathing students a pedagogical milieu that is imbued with enhanced richness, flexibility, and personalization.

Within the ambit of the "Computer-Aided Design" curriculum, pedagogues can adroitly deploy methodologies such as prerecorded lectures and the dissemination of curated instructional resources to inculcate foundational knowledge. Subsequently, during hands-on training sessions conducted offline,

instructors can deliver personalized guidance. This pedagogical praxis engenders a constellation of benefits:

Flexibility in Pedagogical Blueprinting: Pedagogues enjoy the latitude to adroitly structure course content in congruence with the stipulated pedagogical objectives and the heterogeneous proclivities of the student cohort. Selected components can be delineated within conventional classroom instruction and interactive interludes, while alternative facets are imbibed through virtual mediums for subsequent learning and practice.

Conventional Classroom Tutelage: The hallowed realm of conventional classroom tutelage retains its preeminence within the tapestry of blended learning. Within these confines, instructors can expound upon intricate design paradigms, shepherd cogent discussions, respond to inquiries, orchestrate collaborative endeavors, and animate interactive pedagogical activities.

Temporal and Geographical Pedagogical Flexibility: The flexibility afforded to students in terms of temporal and geographical prerogatives is a hallmark of blended learning. Students are empowered to elect the when and where of their pedagogical endeavor, an adaptive tenor that harmonizes pedagogical engagement with their individual routines and predilections.

To culminate, the felicitous orchestration of pedagogical content and digital didactic resources, alongside the judicious implementation of blended teaching methodologies, conspires to facilitate the seamless amalgamation of blended teaching within the academic precincts of the "Computer-Aided Design" course. This evolution seamlessly attends to the pedagogical exigencies of the contemporary student cohort, nurturing both their procedural dexterity and comprehensive proclivities, thereby heralding an ascendant trajectory for pedagogical potency.

iii. Integration with Relevant Specialized Courses

The strategic integration of artificial intelligence (AI) technology into the pedagogical landscape of "Computer-Aided Design" engenders an opportunity for symbiotic alignment with cognate disciplines, yielding a synergetic educational gestalt. This deliberate fusion is poised to orchestrate augmented instructional dividends by capitalizing on interdisciplinary synergy. Particularly germane to expeditious knowledge acquisition, the interface between "Computer-Aided Design" and courses such as "Materials and Processing Techniques in Design" can be leveraged to effectuate amplified pedagogical efficacy.

The latter course, "Materials and Processing Techniques in Design," serves as an academic conduit for students to gain erudition concerning the intrinsic attributes and intricate processing methodologies pertaining to materials that are ubiquitous in product design, including metals, plastics, and timber. Leveraging the potency of image generative AI tools, these materials can be seamlessly transmuted into vividly realistic renderings with alacrity. This harmonious confluence proffers a salutary duality, bolstering instructional methodologies for educators while concomitantly expediting the cognitive acculturation of learners.

Furthermore, the salience of image generative AI tools finds pertinence within pedagogical domains encompassing foundational design paradigms, product design methodologies, and the realm of furniture design. These AI tools, orchestrated within a pedagogical context, furnish students with novel creative stimuli and innovative design constituents. By fomenting their creative ingenuity, these tools stimulate ideational fecundity. The synergistic interplay of image generative AI tools and instructional objectives begets a dynamic realm where students can traverse diverse design trajectories

within an efficient interactive milieu. This dispensation of expeditious exploration precipitates the truncation of temporal investments customarily expended on conventional manual drafting or prototype crafting. Evidently, this tactical symbiosis empowers students to previsualize design implications during nascent phases, thus facilitating preemptive anomaly detection and iterative refinements. Consequently, the caliber of design propositions is substantially elevated.

In summative resonance, the strategic melding of AI technology with the pedagogical tapestry of "Computer-Aided Design" unveils a conduit for collaborative amalgamation with kindred courses. This scholarly marriage, orchestrating a harmonious synergy of distinct disciplines, bears the potential to yield pedagogical dividends marked by accelerated knowledge diffusion and a catalytic surge in creative sagacity among students.

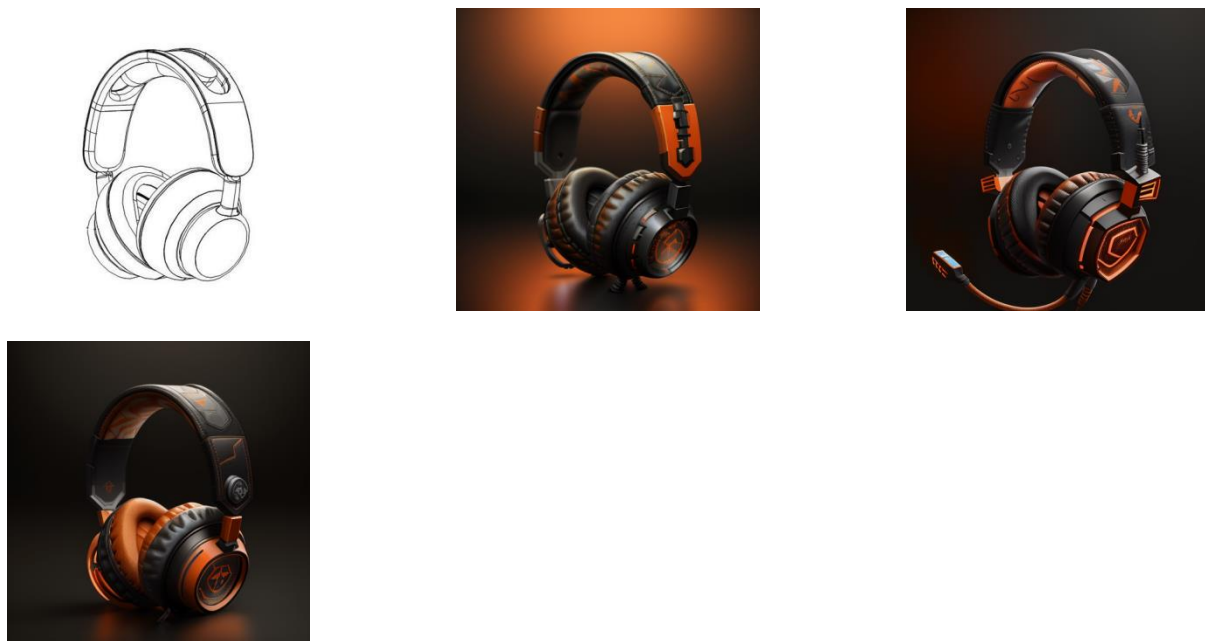


Fig (5): 3D rendering of the effect of different materials in the same product by Stable Diffusion (Self-Drawing)

Limitation

While this paper provides valuable insights into the application of artificial intelligence (AI) technology in the "Computer-Aided Design" (CAD) course for product design, it is essential to acknowledge certain limitations. These limitations primarily include the absence of concrete classroom teaching practice cases, limited coverage of the functionalities of available AI tools for design practice, the uncertainty introduced by the rapid development of technology, and the lack of in-depth research into legal and copyright issues related to product design. Therefore, researchers and decision-makers should be aware of these limitations when utilizing the conclusions of this study and should consider the latest research and practical experiences to make informed decisions:

(1) It is crucial to recognize that the absence of specific classroom teaching practice cases limits readers' understanding of how these theories can be applied in real educational settings. While this paper provides a broad range of technologies and methods, it does not offer detailed case analyses or evaluations of classroom effectiveness. This limitation may pose challenges for readers when applying these concepts in actual classrooms. Future research can address this gap by collecting and analyzing real cases from different educational backgrounds to provide more specific guidance and

recommendations to practitioners.

(2) Currently, there are numerous AI tools available for design practice. Due to limitations in time and resources, this paper briefly introduces only two works, "Mid-journey" and "Stable Diffusion," without providing detailed usage instructions for other available AI tools. A more comprehensive exploration of the functionalities and usage methods of these tools would be beneficial for practitioners.

(3) The rapid development of AI technology introduces a degree of unpredictability. Given the writing timeframe of this paper, some arguments may have become outdated, or significant changes may have occurred in the near future. For instance, new algorithms, tools, and platforms in the AI field may have already influenced or are poised to influence methods and practices in product design. Consequently, when using the conclusions of this paper, readers should closely monitor the latest research and trends to ensure the continued practical relevance of their applications in product design education.

(4) Although this paper primarily focuses on the technical aspects of AI technology and methods, it does not delve deeply into the legal and copyright issues associated with these technologies. With the widespread adoption of AI, ethical and legal concerns have become increasingly important. Privacy, data security, algorithmic bias, and other issues may spark controversies in product design works. Future research should place more emphasis on studying these legal and copyright issues to assist product designers in creating exceptional design works while navigating the legal landscape effectively.

In summary, this paper offers valuable insights into the application of AI technology in the CAD course for product design, but it also comes with certain limitations. We encourage future research to continue exploring these issues to enhance students' innovation capabilities, promote the better utilization and development of AI technology in product design, and address these limitations. This will require filling the gap with concrete classroom cases, providing comprehensive information about available AI tools, staying current with technology trends, and conducting in-depth research into legal and copyright issues, ensuring that we maximize the potential of AI technology.

Conclusion and recommendations

As image-generative AI technology continues to find extensive applications in the field of product design, higher education institutions are encountering a pivotal moment characterized by new challenges and abundant opportunities, particularly within the domain of managing the "Computer-Aided Design" course. In this article, we delve deeply into the strategies for optimizing the teaching management model of the "Computer-Aided Design" course, with a keen focus on curriculum development, instructional methodologies, and the interplay with other specialized courses. Here's an elaboration on these optimization directions:

Curriculum Content Enhancement: The careful curation of course content stands as the linchpin for fostering students' practical design acumen and igniting their innovative spirit. The infusion of image-generative Artificial Intelligence (AI) technology has not just opened up more efficient and flexible avenues for realizing conceptual ideas and swiftly crafting visual representations, but it has also emerged as a catalyst for elevating students' inclination towards innovation. By introducing AI-powered tools, students can explore design possibilities with unprecedented speed and

precision, thereby enhancing both their creative mindset and design efficiency.

Refining Instructional Methodologies: The optimization of how instructors impart knowledge is paramount in this endeavor. The introduction of a blended teaching approach, blending traditional face-to-face instruction with digital and online resources, emerges as a powerful solution. This approach mitigates the limitations associated with conventional classroom teaching and ushers in an era of flexible and personalized learning experiences. By embracing this pedagogical innovation, educators can better cater to the diverse learning styles and preferences of students. Moreover, it encourages students to take more ownership of their learning journey, fostering a sense of empowerment and self-directed learning.

Integration with Complementary Courses: Fostering synergy between the "Computer-Aided Design" course and other specialized courses represents a strategic imperative. Embracing AI technology across multiple disciplines is a transformative step that can broaden students' design horizons and cultivate a holistic understanding of its applications. Whether it's integrating AI into architecture, industrial design, or urban planning, the interdisciplinary nature of this approach exposes students to a more comprehensive skill set and a broader spectrum of design contexts.

Optimizing the teaching management model is an evolutionary process, requiring educators to remain in tune with the ever-evolving landscape of technological advancements and the dynamic needs of students. The integration of AI technology into the "Computer-Aided Design" course extends beyond mere skill acquisition. It catalyzes a paradigm shift in design education, emphasizing not just what students learn but also how they learn and apply their knowledge. This holistic approach not only hones their practical capabilities and innovation sensibilities but also streamlines design processes, lowers the barriers to entry in the field, and broadens the horizons of what can be achieved. Ultimately, it nurtures a new generation of design professionals equipped to excel in an ever-changing design industry. In this context, the relentless pursuit of technological advancements and the continuous refinement of teaching management models remain foundational to the ongoing progress in education.

References

- Chen, L., Chen, P., & Lin, Z. (2020). Artificial Intelligence in Education: A Review. *IEEE Access*, 8, 75264–75278. <https://doi.org/10.1109/ACCESS.2020.2988510>
- Crompton, H., & Burke, D. (2023). Artificial intelligence in higher education: the state of the field. *International Journal of Educational Technology in Higher Education*, 20(1). <https://doi.org/10.1186/s41239-023-00392-8>
- Enjellina, Beyan, E. V. P., & Anastasya Gisela Cinintya Rossy. (2023). Review of AI Image Generator: Influences, Challenges, and Future Prospects for Architectural Field. *Journal of Artificial Intelligence in Architecture*, 2(1), 53–65. <https://doi.org/10.24002/jarina.v2i1.6662>
- Escotet, M. Á. (2023). The optimistic future of Artificial Intelligence in higher education. *PROSPECTS*. <https://doi.org/10.1007/s11125-023-09642-z>
- Holmes, W., & Tuomi, I. (2022). State of the art and practice in <scp>AI</scp> in education. *European*

- Lakshmi, A. J., Kumar, A., Kumar, M. S., Patel, S. I., Naik, S. K. L., & Ramesh, J. V. N. (2023). Artificial intelligence in steering the digital transformation of collaborative technical education. *The Journal of High Technology Management Research*, 34(2), 100467. <https://doi.org/10.1016/J.HITECH.2023.100467>
- Lee, S., Lee, M., & Lee, S. (2022). What If Artificial Intelligence Become Completely Ambient in Our Daily Lives? Exploring Future Human-AI Interaction through High Fidelity Illustrations. <https://doi.org/10.1080/10447318.2022.2080155>, 39(7), 1371–1389. <https://doi.org/10.1080/10447318.2022.2080155>
- Lively, J., Hutson, J., & Melick, E. (2023). Integrating AI-Generative Tools in Web Design Education: Enhancing Student Aesthetic and Creative Copy Capabilities Using Image and Text-Based AI Generators. *Journal of Artificial Intelligence and Robotics*, 1(1). <https://digitalcommons.lindenwood.edu/faculty-research-papers/482>
- Mambang, M., Cipta, S. P., Prastya, S. E., Zulfadhilah, M., Marleny, F. D., Ropikah, R., Syafi'i, M. R., Maulida, N. M., Pembriano, S. N., Risma, R., Bakri, M. Z., Kartika, K., & Putri, P. (2022). Rancang Bangun Alat Musik Tradisional Berbasis Android. *Jurnal Nasional Komputasi Dan Teknologi Informasi (JNKTI)*, 5(2), 149–154. <https://doi.org/10.32672/jnkti.v5i2.4036>
- Newton, A., & Dhole, K. (2023). Is AI Art Another Industrial Revolution in the Making? <https://arxiv.org/abs/2301.05133v1>
- Southworth, J., Migliaccio, K., Glover, J., Glover, J., Reed, D., McCarty, C., Brendemuhl, J., & Thomas, A. (2023). Developing a model for AI Across the curriculum: Transforming the higher education landscape via innovation in AI literacy. *Computers and Education: Artificial Intelligence*, 4, 100127. <https://doi.org/10.1016/j.caeai.2023.100127>
- Wang, X., Li, L., Tan, S. C., Yang, L., & Lei, J. (2023). Preparing for AI-enhanced education: Conceptualizing and empirically examining teachers' AI readiness. *Computers in Human Behavior*, 146, 107798. <https://doi.org/10.1016/j.chb.2023.107798>
- Yu, H., & Guo, Y. (2023). Generative artificial intelligence empowers educational reform: current status, issues, and prospects. *Frontiers in Education*, 8. <https://doi.org/10.3389/feduc.2023.1183162>
- Zhang, K., & Aslan, A. B. (2021). AI technologies for education: Recent research & future directions. *Computers and Education: Artificial Intelligence*, 2, 100025. <https://doi.org/10.1016/J.CAEAI.2021.100025>