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Employing AI in Modeling and Designing Industrial Products

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Article Info.	Abstract
	The current research paper explores how artificial intelligence (AI) can be used to model and design three-dimensional (3D) industrial products, namely comparing the AI-based design approaches with the traditional computer-aided design (CAD) models. A smart electric kettle is chosen as a representative industrial product during the study because it uses a descriptive-analytical and comparative research design to evaluate the differences in the development of the form, efficiency of the workflow, integration of functions, and ease of use. It has been found that the conventional CAD modelling is linear and constraint based, which ensures that it is geometrically accurate and manufacturable, but limits the speed of exploring other forms. on the other hand, AI-based and generative design tools allow better continuity of surfaces, integration of components, and faster development of iterative production due to automatic optimization and reduced human input. The results indicate that AI-supported processes are more flexible and creative exploration, particularly in the initial design phases, and help to make processes more ergonomic and functional. However, the research finds that there are significant limitations that are inherent to AI-based design such as a tendency to over-optimal geometries that can undermine manufacturing viability. The findings indicate that the most successful AI application to industrial design should be a hybrid system that combines the exploratory and optimization features of AI with the structural control and realism of traditional CAD systems. The study is a contribution to the growing body of knowledge of AI-based industrial design, as it provides a practical, product-level comparative study.

1. Introduction

The recent quick progress in the field of artificial intelligence (AI) has significantly changed modern industrial design, particularly in the sphere of three-dimensional (3D) modelling and product development. With more and more industries incorporating digital technologies into their workflows, AI can become a radical new paradigm that can improve creativity, efficiency, and engineering productivity. Empirical studies suggest that AI-based applications, especially generative design software and machine-learning-aided CAD applications, do introduce new possibilities to automate complex modelling processes, optimise geometrical configurations, and decrease the time constraints of iterative design processes. The innovations not only increase the precision and flexibility of the conceptual frameworks but also strengthen the nexus between computational intelligence and industrial manufacturing requirements. This, however, does not mean that AI will be pushed to the periphery as an add-on technology but is an essential element that will probably shape design processes in various engineering fields in the future [1]. Designers, engineers, and researchers are more inclined to use AI in modelling 3D industries in this dynamic environment to determine the practical implications and value increase in the long term. According to AI-oriented literature on the latest trends in industrial design, the shift to data-driven, simulation-based, and generative computational models is evident, thus enhancing aesthetic and practical characteristics of industrial products [2]. This change provides greater opportunities to experiment with concepts, to prototype virtually and to refine models automatically, and allows designers to create a wide variety of high-quality prototypes with much less manual effort. At the same time, industries are faced with pressing questions about usability, workflow integration, and the boundaries of AI-based creativity in the current design pipelines. These considerations highlight the need to focus on academic studies that will help to evaluate the potential of AI in terms of improving 3D product modelling, reducing associated difficulties, and aligning the technology with the existing standards of industrial design [3].

1.1. Literature gaps

Despite the fact that the current academic literature covers the concept of integrating AI into 3D modelling and industrial design in great detail, there still is several gapful areas. Most of the available literature concentrates on the technical performance of AI-based generative modelling systems, e.g., structural optimization, automated geometry generation or parametric refinement, but offers little analysis of the application of such tools in real-world industrial design processes [2]. As an example, in contrast to the study by [3], who explore the dynamics of large language models and CADs, the authors focus on the capabilities of the algorithm and do not address the more general issues that the designers

face when implementing AI into the product development cycle. Similarly, surveys of the latest developments in 3D generation tools tend to describe the level of categorization of AI tools in a broad manner without evaluating their usefulness, constraints on their use, or relative advantages and disadvantages compared to conventional modelling techniques [4]. This leads to the disjointed perception of the real work of AI in enhancing decision-making, creativity, and iterative design in practice in industries.

A second significant gap is associated with the fact that there is a scarcity of empirical or design-based comparative studies that directly compare AI-generated models to traditionally generated CAD models, through the lens of industrial performance [5, 6]. Although mention that the most recent uses of AI in industrial design are still in the concept or exploration phases of the technology, they also indicate that a significant proportion of research is still largely theoretical, lacking systematic comparisons based on consistent design requirements or quantifiable performance metrics. Moreover, the literature focuses on the single aspects of AI-driven modelling, e.g., self-repairing CAD systems [7] or multimodal AI-CAD interfaces, without generalizing these results into a comprehensive framework that will explain the overall impact of various AI tools on product quality, manufacturability, and workflow efficiency. The lack of detailed studies, which compares AI-assisted and traditional modeling approaches, further generates an appropriate gap in methodological literature [8]. It is this absence that highlights the urgency to conduct research that goes beyond technological summaries, and instead, provides standardized comparative research that can provide design practitioners, engineers, and industrial stakeholders with an understanding of the feasible benefits and limitations of the implementation of AI in three-dimensional product representation.

1.2. Problem statement

Although the field of artificial intelligence is rapidly developing and the use of AI in computer-aided design processes is becoming widespread, there remains a major gap in comprehending how AI-based solutions can be successfully and systematically utilized to improve the modelling and design of three-dimensional industrial products. The literature is inclined to highlight the technical potential of generative algorithms, AI-CAD interaction, or automated geometric optimization, but seldom a thorough analysis of how these technologies contribute to-or disrupt-fundamental stages of industrial design practice [9]. Studies investigating AI-enhanced CAD settings show high potential of enhancing design automation, parametric modelling, and information transfer between design and manufacturing, yet show discrepancies in the assessments of such systems in relation to traditional workflows. Besides, the recent reviews indicate a disjointed development, with numerous publications on 3D AI generation still being based on algorithmic novelty, not on the practical design usability, designer-system interaction, or the industrial feasibility of AI-generated models [10]. Even in areas where applications have been reported in the industrial design domain, such as in investigations into larger trends and adoption of tools, the body of literature does not yet include systematic frameworks that assess the actual functional value, constraints, and effects of AI on efficiency, accuracy, and decision-making in 3D product development. In turn, the lack of such integrated, evidence-based evaluations that would help elucidate the possibility of using AI to enhance the 3D modelling results and resolve the issues of practical, methodological, and workflow challenges that are still present in industrial design settings is the core research problem [11].

1.3. Objectives of the study

- To examine how generative design, multimodal CAD interfaces, and automated 3D modelling pipelines, all based on artificial-intelligence-enabled systems, can be used to improve the efficiency, accuracy, and creative power of industrial product modelling.
- To compare the usability, workflow integration, and practical performance of AI-generated 3D models to traditional CAD modelling strategies, and determine the positive changes in structural quality, manufacturability, and design optimization.
- To discover the most important challenges, constraints, and unresolved questions related to the use of AI in the design of three-dimensional industrial products, as well as to suggest knowledge that should fill these gaps in accordance with the current trends in technologies and the needs of the industry.

1.4. Major contributions of the study

The paper is a synthesis and a continuation of existing research on the application of artificial intelligence in designing three-dimensional industrial products. To begin with, it offers a combined analytical viewpoint, linking the recent developments in generative design, AI-enabler CAD modelling, and automated geometric processing, which are commonly studied separately in the literature [11, 12]. Second, the work provides a systematic comparative analysis of AI models with conventional CAD models, which has an important gap in terms of the practical applicability, workflow efficiency, and industrial viability of AI-driven modelling methods. Third, it unites fragmented research results to pinpoint the fundamental challenges, shortcomings, and issues that hinder the wider application of AI to industrial design, which will give a better idea of what progress and improvements to the methodology should be made in the future. Together, these works assist a more detailed and practical interpretation of how AI can be used in a meaningful way to improve the process of 3D modelling in the context of industrial product development [13].

1.5. Significance of the study

The value of this research is that it can explain the practical worth and constraints of applying the concept of artificial intelligence to three-dimensional industrial product modelling an area where the current research is still inconsistent but focused more on the technical demonstrations and less on the design-based analysis. This research provides valuable information, which directly responds to the still-open questions in the area of workflow efficiency, usability, and industry applicability [14]. Moreover, its comparative mindset adds to the better comprehension of what is missing in the recent reviews to understand why AI-generated models are superior to traditional CAD designs in terms of optimization, structural quality, and design flexibility [15]. The study thus offers the industrial designers, engineers and researchers' evidence-based basis on when and how AI-based modelling methods can be successfully adopted to eventually inform better design practices and inform the creation of new AI-enhanced design systems.

Five main sections are used to structure the paper in order to have a clear and coherent presentation of the research. Introduction provides the background, research problem, objectives and significance of the study. The Theoretical and Conceptual Frameworks proceed to introduce the background concepts regarding AI-based modelling, generative design, and industrial CAD systems. Literature Review is based on the application of AI in the three-dimensional product design, summarizes the existing research and identifies the contributions and gaps that motivated the present study. The Methodology section describes the design, sample, instruments, procedures, and methods of analysis of the

study. This is followed by the Results and Discussion that provides comparative assessment of the AI-generated and traditional CAD models and explains the results within the context of prior research. Lastly, the Conclusion provides a conclusion of the major findings, the limitations of the study, and future research directions.

2. Theoretical Framework

The theoretical background of the current work is the changing nature of the relationship between AI technologies and computer-aided design (CAD) systems in the framework of 3D modelling of industrial products. Recent studies show that generative design and machine-learned modelling represent a paradigm shift of the traditional deterministic CAD processes to data-driven, algorithmic processes that can create and optimize geometric shapes autonomously [16]. The models combine design limitations, performance specifications and material considerations to generate a group of optimized design candidates, thus reorganizing the conceptual and structural stages of industrial product development. The theoretical framework is further extended through the development of 3D model generation that integrates deep learning with geometric reasoning, which allows systems to learn shapes, re-construct fragmented models as well as automate parametric decision-making processes, which go beyond the traditional rule-based models paradigms [17]. Together, these advancements offer a solid theoretical foundation to comprehend the way AI increases the quality of modelling, increases the efficiency of its calculations and expands the creative potential of designers.

To supplement this background, AI-driven CAD systems provide a theoretical perspective which analyzes how designers interact with intelligent modelling systems. Research into multimodal interfaces indicates that natural-language inputs, sketch-based interaction, and real-time inference models simplify modelling and facilitate intuitive user interaction with higher-order design concepts [17]. Research on AI-based CAD integration observes that the hypothetical usefulness of these systems lies not only in geometric automation but also in the fact that they could bridge design cognition with computational intelligence by either adaptive model refinement or context-aware assistance [17]. In addition, theoretical studies of usability and model quality of AI-generated three-dimensional forms point to the need to make the AI-generated geometries address the industry requirements in terms of manufacturability, structural integrity, and compatibility with existing CAD ecosystems [18]. Together, these theoretical frameworks offer a comprehensive view of the transformational opportunities of artificial intelligence in the modeling of industrial products and explain the intellectual disputes linked with the adoption of AI to traditional design procedures.

2.1. Conceptual framework

The conceptual framework in Figure 1 of the proposed study is based on the interplay of artificial intelligence technologies and computer-aided industrial design processes with a focus on the application of AI in modeling, optimizing, and refining three-dimensional product shapes. Current literature shows that generative algorithms, AI-based CAD interfaces, and automated three-dimensional modelling systems are all transformative elements that can help designers to simplify their modelling, create optimized design variants, and improve structural and geometric results [18]. The conceptualization of AI as an intermediate mechanism that interprets design constraints and user input by means of multimodal interaction and computational inferences, and then generates three-dimensional models, can outperform traditionally manually created artefacts of CAD, in optimization, accuracy and completeness of models [19].

In this conceptualization, AI has an impact on three main areas of the design workflow: design generation, design evaluation, and design refinement. AI-generated geometry refers to the process of generating geometry using generative modelling and deep inference pipelines; AI-based assessment refers to quality assessment, constraint analysis, and structural interpretation in accordance with industry needs. Refinement is a process of automated correction, parametric adjustment and adaptive refinement based on self-repairing or data-driven optimization. The connection between these areas creates a design process that is cyclic, iterative, and computationally enhanced where both the designer and the AI system work in tandem. This integrative framework offers a theoretical framework on the Figure 1 redesign of efficiency, creativity, and decision-making in the industrial product development using AI-driven modelling [19].
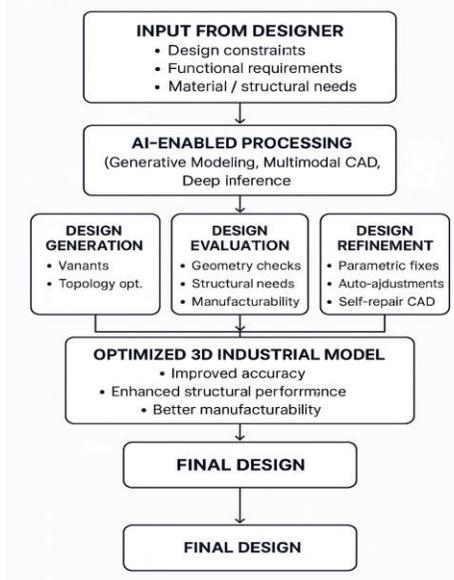

Figure 2. Conceptual framework diagram

3. Literature Review

The literature review of artificial intelligence in three-dimensional industrial modelling shows that there is a diversity of studies which are interconnected. A series of recent publications has been devoted to the massive change of industrial design processes that has already become the reality of introducing AI-driven generative systems. Each of these publications emphasizes the assumption that generative algorithms and machine-learning models can produce large sets of design solutions, lessen the time required to do manual modelling, and scale computational effectiveness to the maximum. According to researchers like [18], AI-assisted optimisation pipelines give designers more liberties to test structural and geometrical shapes that would otherwise require time to generate in conventional CAD programmes. This view has been backed up by complementary research [19], which describes the progress of 3D generative systems that are capable of repairing, refining, and inferring complex shape geometrical forms. These studies all suggest that AI is a paradigm change between deterministic, human-crafted modelling and performance-based design exploration using AI.

At the same time, the practical implementation-related aspects of introducing AI in industrial design have been researched in significant literature. The research on robotic design, interactive modelling interfaces, and parametric product development shows that AI can enhance accuracy, structural consistency, and adaptability of modelling processes. As an example, the design-related applications indicate that AI-related procedures can be utilized to provide support in building more coherent 3D models and make the design itself dynamic. In other works, AI is combined with digital models like BIM and it has been shown how generative algorithms can be used to automatically generate structural layouts and how self-repairing models can be used by employing generative algorithms, as reported by. In addition, the research of AI-driven CAD interfaces, such as the one presented by [19], helps emphasize the significance of multimodal interaction to make the model generation more user-friendly to designers. However, against all these developments, academic scholars like [9] observe that issues relating to model usability, reliability, and industrial standards remain. Together, both of these bodies of previous work demonstrate the potential that the use of AI in 3D industrial modelling has and the problems that remain with it.

4. Methodology

4.1. Study design

This research works with the descriptive-analytical comparative methodology that is suitable to examine the impact of artificial intelligence on the development of the design model in three dimensions and compare the results of AI-based design models with the results of the design models created through the traditional computer-aided design (CAD) practices. The study does not make use of laboratory tests and statistical manipulations but rather focuses on the systematic visual and methodological analysis to identify the differences in forms, functionality, and design processes in the two modalities. This is the way to analyze design qualities exhaustively and make empirically based inferences based on comparative evaluation and relevant academic literature.

4.2. Samples

The research object is a smart electric kettle. It was selected as a good example of a full-fledged industrial design product incorporating functional performance, usability, aesthetic elements, and smart control capabilities. The electric kettle was chosen as a smart one due to the following reasons:

- It is a popular industrial product that is meant to be used in homes.
- It allows studying the interdependence of forms, functions and usability.
- It enables the implementation and comparison of the traditional CAD modeling and AI-based design methods on a product.
- It can be suitable in comparative research in the field of three-dimensional design of industrial products.

Figure 2. represents the chosen sample as a finished industrial product, and it will be used as a reference point in the future design analysis the chosen sample as a finished industrial product, it will be used as a reference point in the future design analysis.

4.3. Study instruments

Traditional Computer-Aided Design (CAD) Tools. The current research used them to create a typical parametric CAD model based on manually defined constraints and parameters set by designers as demonstrated in Figures 2 and 3.

Figure 2. Smart electric kettle

Figure 3. Traditional CAD model of smart electric kettle

Visual Analysis: Comparative, Design methodologies that were based on artificial intelligence were used to generate or optimize other design solutions based on predefined inputs and design requirements. A logical visual comparison was made to assess the design outputs, design processes, and design details of the traditional CAD model against the AI-generated design.

4.4. Procedure

Sample Identification. This paper chooses the smart electric kettle as the case study and outlines its main parts that are the body, handle, spout, and base. Development of the Traditional CAD Model. The creation of a three-dimensional representation with the use of classical computer-aided design (CAD) techniques, with focus on elementary geometrical shapes and constraint-based modeling, with no use of optimization processes based on artificial intelligence. Generation of the AI-based Design Model. The development and optimization of an alternative or optimal design are realized through AI-based or generative design methods, specifically improvements in form, surface and mass distribution.

Comparative Visual and Analytical Assessment. As presented, the analysis is done to compare the traditional CAD model and the AI-generated design. Functional Detail Analysis. In this study, certain design features are analyzed, such as handle ergonomics, spout design and pouring safety, and base structure and control interface. Design Workflow Analysis. The traditional CAD design workflow and the AI-driven design workflow are compared to assessing the differences in the efficiency and the organization of the workflow. Identification of Limitations and Challenges. A review of the drawbacks of AI-based design approaches shows that there are multiple issues of concern, including overoptimization and manufacturability issues.

4.5. Analysis criteria

The study applies qualitative analytical criteria, including

- The overall form and geometric pattern of the design are viewed in the framework of aesthetic integrity and space efficiency.
- The usability and ergonomics are tested to make sure that the interaction between the user is user friendly and comfortable to the physicality.
- Functional performance is measured through empirical testing and analysis of reliability and hence validates that the system is functioning within the operational requirements of the system.
- The integration of design components is studied to determine the effectiveness of component interaction and system cohesion.
- The process-optimization indicators and resource-allocation measures are used to measure the workflow efficiency of design.
- Practical limitations of AI-based design approaches are outlined and put into perspective by the context of technical feasibility and morality.

4.6. Study limitations

The study is limited to descriptive and comparative survey of the design models and is not involved in physical prototyping, user testing and quantitative statistical analysis. Such limitations are not accidental and do not weaken the exploratory and analytical quality of the study.

5. Results

Consistent with the overall goals of the study, the findings herein will assess the effects of AI-based design techniques on modelling three-dimensional models of industrial products, contrast AI-based design techniques with traditional CAD techniques and determine the potential benefits and limitations of AI-based design in the context of an industrial design. The prototype product, a smart electric kettle as shown in Figure 1, acts both as the reference datum against which all the design strategies are evaluated in terms of their capability to meet functional, ergonomic, and formal requirements.

Empirical results relevant to research objective: Comparative research of the design differences between traditional CAD and AI-based Modeling. Concerning the first research question, which aims at comparing the design manifestation in an orthodox CAD modelling and the AI-aided design strategies, the data generated indicate that there are substantial dissimilarities in form development, surface continuity, and component integration.

5.1. Traditional CAD modeling results

The traditional Computer-Aided Design (CAD) image of the intelligent electric kettle, as shown in Figure 2, represents a constraint based, manual-controlled design process. The following attributes are demonstrative of this model:

- Clearly defined geometric boundaries and parametric constraints,
- Predictable surface transitions based on designer input, and
- A structured and sequential modeling process.

While the traditional CAD approach provides a high level of control and geometric precision, the results reveal limited flexibility in exploring alternative forms or rapidly adapting the design once the primary constraints are established.

5.2. AI-Generated design results

The AI-assisted design model in Figure 3, on the other hand, has higher formal flexibility and a more fluid geometry change. The results produced by the AI explain:

- Improved surface continuity
- More integrated relationships between the body, handle, and spout
- Alternative formal solutions beyond conventional CAD logic

These findings directly address the first research objective by demonstrating how AI-assisted tools expand the design space compared to traditional CAD modeling, as shown in Figure 4.

5.3. Direct comparison addressing research objective 1

The comparison of the two design approaches is depicted in figure 4. It has been proved by this comparison that:

- Traditional CAD models prioritize structural clarity and geometric order, and

▪ AI-generated designs prioritize holistic form integration and visual continuity.

Thus, the first research objective is achieved by clearly identifying the design-related distinctions between the two modeling approaches.in Figure 5. to identify key differences in form and functional integration.

Findings relating to research objective: comparative study of the design workflow efficiency and integration.

Figure 4. AI-generated electric kettle design

Figure 5. Traditional CAD vs -generated design

The second research objective aims at comparing the design processes related to traditional CAD and AI-based modeling, in terms of efficiency, flexibility, and integration. The traditional CAD process as illustrated in Figure 6. is linear and sequential in the way it models with the design changes being based on manual adjustments of constraints.
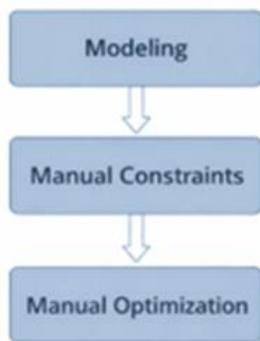

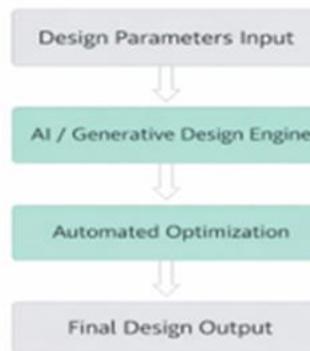
Figure 6. Base design & control interface

Figure 7. AI-Based design workflow for smart electric kettle modeling

Contrarily, the AI-driven workflow shown in Figure 7 represents a more flexible process in which design parameters are exposed to AI-driven optimization processes. This workflow enables rapid iteration, reduces human input and improves the process of integrating design phases.

The results obtained support the conclusion that AI-supported workflows can enhance design efficiency and flexibility and thus respond to the second research objective. Findings With respect to Research Objective 3: Recognizing the Benefits and drawbacks of AI-Based Design.

The third purpose of research is to identify the advantages and limitations of the use of AI-driven design in the framework of the industrial product modeling. The ergonomic and functional analysis proves the benefits of AI-assisted design. The handle is smoother and has a better continuity of grip as shown in Figure 8 that was generated by AI. Equally, Figures 9 and 10 illustrate better spout design and a more efficient combination of the base and the control interface.

Figure 8. Handle-design ergonomics and grip

Figure 9. Spout design – pouring accuracy & safety

Figure 10. Base design & control interface

The current results emphasize the ability of AI-based tools to support the process of usability improvement and functional optimization. Limitations and Challenges. Despite the above advantages, the empirical results also reveal limitations that are presented by AI-based design strategies. As Figure 11 shows, generative AI approaches may produce geometries which are over-optimized as such, thus creating challenges related to manufacturability and real-world application.

Such limitations directly respond to the third research objective by outlining key limitations that should be considered when implementing AI-assisted design in the real-life industrial setting.
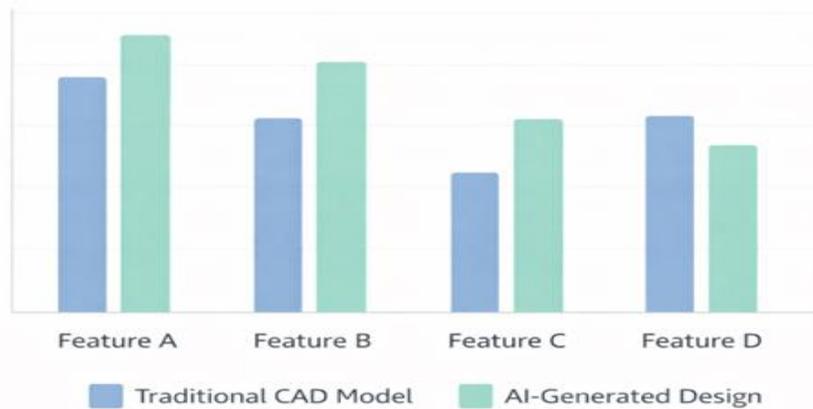
Figure 11. Comparative evaluation of electric kettle design

6. Discussion

6.1. Results interpretation in case of design theory

The empirical evidence of this study supports the hypothesis that AI-assisted design produces a qualitative change in the process of three-dimensional industrial product modeling compared to the traditional CAD-based approaches presented. In theoretical perspective, these results are in line with already established theories of industrial design that preempt the processes of dynamic interaction between form, function, and usability. Traditional CAD modelling, as in Figures 2 and 8, is an example of a deterministic, constraint-driven process following classical paradigms of parametric design where the designer has a exhaustive command of geometric decisions.

Conversely, the AI-generated results of design shown in Figures 3 and 9 are consistent with the modern design theories of exploratory and adaptive design processes. AI-aided tools increase the ability of the designer to navigate within the complex design spaces, which allow the creation of alternative forms that would not be obtained by linear modelling strategies. This observation supports theoretical claims that describe artificial intelligence as a co-creative agent, as opposed to an alternative to human design expertise.

6.2. Perspectives of form development and generative design

The continuity of surfaces and formal integration that are perceived in the AI-generated kettle design (Figure 3) can be viewed in the context of the generative design theory. Generative design models focus on form generation that is based on rules and data and allow systems to suggest solutions that do not follow traditional aesthetic forms. The fact that the transitions between elements are smoother, especially between the body and the handle and the spout. This implies that AI-based modelling will enable consistent form development.

These findings agree with the previous studies in the field of AI-based industrial design, which argue that generative systems are more specific in solving complicated geometric relationships and formal consistency. However, the data also supports the idea that these benefits depend on clear design parameters, thus supporting the theoretical claim that AI systems are within the constraints that are set by human designers.

6.3. Theory of workflow transformation and design process

Comparing the standard CAD workflow (Figure 8) with the AI-based workflow (Figure 9), one can note a complete change of the design process. In process-theoretical terms, traditional CAD processes follow a linear logic that resembles rational design models, in which one decision leads to another, with decisions adding more functionality to the earlier decision.

The AI-based workflow, in its turn, represents a more iterative and adaptive process, which is in line with the modern design-thinking models, which value iteration, feedback, and speedy exploration. The ability of AI-assisted tools to solve several design parameters simultaneously reduces the cognitive and time load on the designer and supports literature that AI can be used to improve efficiency and exploration of creative options at an early stage of design.

6.4. Usability and human-centered design concerns

The developed ergonomic and functional advantages that can be observed in the AI-generated design, specifically in the handle curvature (Figure 5), spout geometry (Figure 6), and base integration (Figure 7) can be explained in the context of human-centered design. The human-centered design theory emphasizes product flexibility to the user requirements, comfort, and patterns of interaction.

Despite the lack of empirical user testing in this study, visual and functional testing indicates that AI-assisted design has a potential to aid the ergonomic refinement in case the usability-related parameters are considered in the design process. This conclusion is consistent with the existing studies that emphasize the effectiveness of computational tools in improving ergonomic regularity and functional assimilation in product development in the industrial sector.

6.5. Shortcomings of ai-based design and implications in practice

Along with the advantages that are listed, the outcomes also shed light on significant constraints that are present in AI-based design methods. The over-optimized or over-complicated geometries shown in Figure 10 are a well-known example of a problem of generative and AI-assisted design, the incompatibility of formal optimization with real-world manufacturability.

Theoretically, this constraint validates the argument that AI-based design should be informed by manufacturability and production expertise. The results support the hybrid design method where the AI-generated solution is critically evaluated and refined by the conventional design knowledge to make the solution viable, economical, and meet the standards of industrial production.

6.6. Addition to the industrial design knowledge

Result discussion shows that the study is useful in the body of knowledge that is continuously being developed around AI adoption in industrial design practice. The study fills a gap in the literature, as most studies have focused on isolated or technical aspects of design but have not been conducted on a whole industrial product (like a smart electric kettle) in comparison to traditional CAD. The findings indicate that AI-based design could be used to explore the form more effectively, increase the efficiency of the working process, and better functional integration; at the same time, they support the long-term significance of traditional CAD tools to control the structural features and their realization. This moderate position corresponds to the modern theoretical paradigm which suggests a dualist synthesis of AI and human-centered design approaches.

7. Conclusion

This paper has explored the use of artificial intelligence in the design of three-dimensional industrial products, comparing the use of AI-aided modeling with traditional CAD-based design in a smart electric kettle. Results indicate that AI-based design technologies trigger significant qualitative changes in the form development, workflow optimization, and functional integration, whereas traditional CAD solutions still provide the necessary control over the geometric precision and design restraints. The comparative analysis shows that the traditional CAD modelling is typified by a structured constraint-based process that ensures predictability and manufacturability. On the contrary, AI-assisted design supports more formal exploration and generates smoother surfaces, inter-component relationships are more integratively defined. These differences emphasize the complementary and not the competitive nature of the two approaches. In regard to workflow, the findings indicate that AI-based design significantly increases flexibility and speed of iteration through the automation of optimization processes and reduction of repetitive work. This observation supports modern design theories which promote iterative, exploratory, and data-driven design, especially in the initial stages of developing an industrial product. At the same time, the paper has found that AI-assisted design has serious disadvantages, especially the tendency towards over-optimized geometries, which may negatively affect the manufacturability and usefulness of the design. These restrictions highlight the importance of maintaining human design judgment and production expertise in order to successfully embody AI tools in the industrial design processes. In general, the paper finds that integrating the concept of artificial intelligence in industrial design will be successful when a hybrid approach is adopted, which is the combination of the exploratory capabilities of AI-based tools and the rigour and real-world applicability of traditional CAD methodologies. This type of integration can be used to improve the quality, efficiency and innovation of the designs without decreasing the feasibility. The results contribute to the growing body of research on the use of AI in industrial design and show that it can be applied to the design of entire consumer products and not just isolated components. Even though the study was limited to a qualitative and visual research without the implementation of physical prototyping and user testing, it presents a solid background to the future research that can be conducted to include experimental validation, usability testing, or quantitative performance indicators. To conclude, artificial intelligence is not something that is set to replace the current design methodologies, methods, or experience, but is instead a supplement to creative and analytical abilities. In conclusion, artificial intelligence cannot be seen as a substitute to the current design methods, approaches, and human skills, but as the continuation of creative and analytical possibilities.

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