

PROMPT, COMPARE, REFLECT, REPEAT: LEARNING RESPONSIBLE AI USE FOR PRODUCT DESIGN

Ross BRISCO, Kieran GUNN and Alexander “Freddie” HOLLIMAN

University of Strathclyde, United Kingdom

ABSTRACT

Artificial intelligence is rapidly reshaping product design practice and education, creating opportunities and risks for how future designers are trained. While AI tools can support ideation, documentation and decision-making, there is growing concern that uncritical use may weaken foundational design skills and reflective practice. This paper presents the development and initial evaluation of a participatory, workshop-based educational intervention centred on an AI-powered product design assistant tool. The approach aims to teach responsible and effective AI use by making students active participants in prompt construction, output evaluation and iterative refinement. The tool generates structured early-stage design documentation from user prompts, encouraging consideration of components, methodology, constraints and regulations. An exploratory workshop was conducted with Engineering Design students, combining instruction on prompt crafting with guided experimentation and reflection activities. Feedback indicates that participants found the tool useful for early-stage concept development and for understanding how input structure affects AI output. Features that enabled parameter and prompt manipulation were particularly valued, supporting critical comparison and reflective learning. Students highlighted limitations in technical depth, accuracy and verifiability, reinforcing the need for validation and careful task alignment. The findings suggest that participatory AI-building and prompt-design workshops can support AI literacy, critical judgement and responsible adoption in design education, positioning AI as a scaffold for learning rather than a substitute for design thinking.

Keywords: Studio pedagogy, artificial intelligence, formative assessment, engineering design

1 INTRODUCTION

The introduction of artificial intelligence into product design education represents a significant shift in how designers are trained for modern industry demands with collaborative AI design tools now offering notable potential to enhance designers' performances, efficiency and creativity [1]. AI tools may soon become essential components of the design process, from initial concept generation to final product optimisation, making it crucial for educational institutions to understand these technologies and appropriately incorporate them into the curricula. Design educators today face the challenge of not only teaching traditional design principles but also ensuring students understand how to effectively leverage AI capabilities while maintaining creative control and critical thinking skills. The goal of this project was to create a learning environment where students can explore AI's potential to enhance their design capabilities while also understanding its limitations and appropriate applications throughout different phases of the design process. This educational transformation requires careful consideration of which AI tools to introduce, when to introduce them in the design workflow, and how to balance AI assistance with fundamental design skills that remain essential for successful product development.

A dominant theme across educational literature is the capability of AI to support creative ideation and divergent thinking in product design. The paper ‘*How can AI support the creation of novel ideas in product design*’ [2] investigates the use of AI within structured ideation methods and reports that AI systems can increase the breadth and novelty of early-stage concepts when used as a stimulus or co-creator. Rather than replacing student creativity, AI is described as functioning as a generative partner that can propose unexpected combinations, analogies, and directions, thereby enriching ideation sessions. This aligns with studio-based pedagogical models where external prompts and provocations are already valued as creativity triggers.

As well as text-based AI systems, Dhimi et al. [3] explores the educational use of text-to-image systems and related generative tools for rapid visualisation. Comparative studies of AI image generation tools in

design learning contexts indicate that such systems enable students to externalise concepts quickly, explore stylistic variation, and iterate visual directions at a speed not previously possible. This capability is particularly relevant in early concept phases, where students often struggle to translate abstract ideas into visual form. This research has revealed that AI visualisation tools can lower the threshold for sketching and rendering, though concerns are raised that overreliance may weaken the development of foundational visual communication skills if not carefully scaffolded.

Beyond ideation, AI has been demonstrated to have meaningful contribution to later stages of the product design process, including detailed design and technical development. Marquez and Juan [4] reports that AI tools can assist with decisions concerning materials, finishes, configuration options, and parametric variations. Students using AI-supported workflows were able to explore a larger solution space within limited project timelines. Similarly, Lambert et al. [5] discusses an AI-supported pipeline that links concept generation to more production-oriented outputs, suggesting that AI systems can help bridge gaps between conceptual and technical stages of student projects. These studies position AI as a continuity tool across stages, supporting not only creativity but also synthesis and refinement.

Reynolds and Batley's [6] work on generative AI in final-year product design projects highlights that students can use AI tools to generate, refine and iterate design concepts. However, the "depth and completeness" did not align with the student's needs, and the ability to manipulate the output was limited.

Another strand of research examines AI prompt systems and conversational models as learning supports in engineering and product design tasks. The paper '*exploring the usability of AI prompts for mechanical engineering design development*' [7] evaluates how structured prompting strategies affect the usefulness of AI outputs in technical design contexts. Findings suggest that prompt literacy becomes an important meta-skill: students who learn to frame constraints, functions, and evaluation criteria clearly are more likely to obtain relevant and technically meaningful AI assistance. This introduces a new pedagogical dimension in which educators must teach design methods and effective AI interaction strategies.

The paper '*Impacts of generative ai on engineering and product design students' performance*' [8] reports mixed outcomes. Students perceive gains in efficiency, research support, and concept expansion, but both students and educators express concern about superficial learning and the risk of bypassing critical cognitive steps in the design process. AI can compress time spent on exploration and drafting, yet this same compression may reduce opportunities for reflective practice if assignments are not redesigned accordingly. The literature therefore stresses that performance gains are highly dependent on task framing and assessment design. Zhang et al. [9] highlights cautious optimism among lecturers, who recognise AI's potential to enhance workflow and expand creative exploration, but also worry about academic integrity, authorship ambiguity, and erosion of core skills such as sketching, model-making, and independent problem framing. The capability of AI to produce plausible design outputs raises questions about how originality and competence should be evaluated in studio assessment. This makes the argument for redesigned assessment formats that prioritise process evidence, iteration logs, and critical reflection over final artefacts alone.

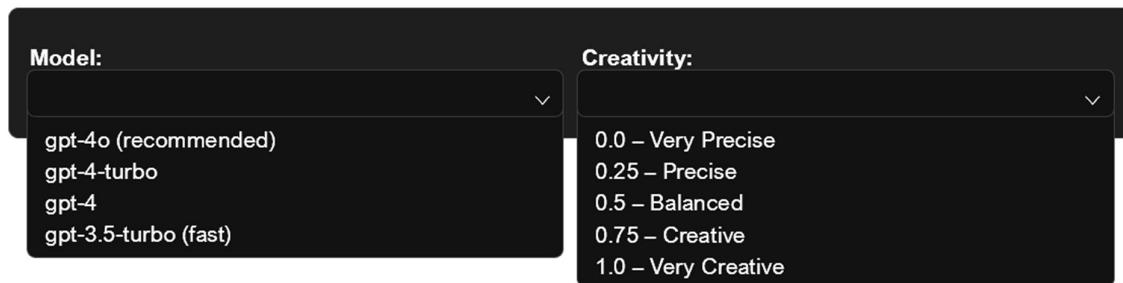
Across the literature, common challenges include the need for educator professional development to harness AI effectively, addressing ethical and accountability issues, and balancing AI support with design reasoning and critical thinking. Meta-analyses emphasise the need for more robust research methodologies and conceptual frameworks that capture AI's educational impacts, rather than reporting practice examples or isolated case studies [1]. Additionally, the broader education literature indicates that AI tools must be designed with user-centred considerations to ensure they support learner autonomy, engagement, and equitable access, particularly in resource-limited environments [10].

This paper details the creation of, and initial evaluation of a product design assistant tool and educational experience. The purpose of the tool is to allow students to understand the importance of the input they provide to AI tools and how this input changes the output. The educational experience teaches students about how to structure the input and how to analyse the output, but also, responsible use of AI for appropriate tasks.

2 METHODOLOGIES

As part of an EPSRC TERC funded project Digital Design Network Plus (D2N+), in response to Research Challenge One, 'Re-imagining the drone design process', an AI tool to support the early stages of the design process was developed. This tool enabled for the exploration of how AI could impact early

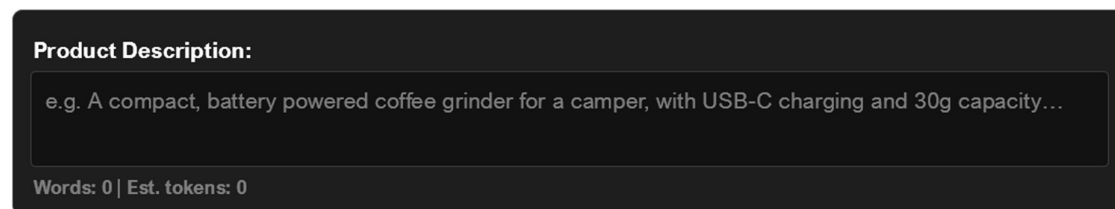
stages design and the broader digital design methodology. The tool was intended as an industry demonstrator; however, benefits were found in educating students on appropriate use of AI. The product design assistant tool functions as a lightweight AI-powered drafting tool that helps users generate structured product design documentation from prompts. After entering an OpenAI API key, the user can select an AI model and adjust a creativity setting to control how conservative (0.0) or inventive (1.0) the generated text will be (*Figure 1*). The user inputs data as a product description (*Figure 2*) and an instructional prompt (*Figure 3*). The instructional prompt works with the product description to return the desired output. For example, the regulations instruction prompt is “You are an expert in product regulations, standards, and compliance. Given a product description, highlight 5–7 key regulations, specifications, and standards that may apply (e.g., safety standards, environmental regulations, industry specifications). Be specific to relevant jurisdictions (e.g., UK, EU, US) and include any testing or certification requirements.” The interface is organised into practical design-document sections, product description, components, methodology, considerations, and regulations. When a user provides basic input about a product idea, the system generates written material for each of these sections, effectively turning a rough concept into more formal, structured design notes.



The image shows a dark-themed user interface with two dropdown menus. The first menu, labeled 'Model:', is open and shows four options: 'gpt-4o (recommended)', 'gpt-4-turbo', 'gpt-4', and 'gpt-3.5-turbo (fast)'. The second menu, labeled 'Creativity:', is also open and shows five options: '0.0 – Very Precise', '0.25 – Precise', '0.5 – Balanced', '0.75 – Creative', and '1.0 – Very Creative'. Both menus have a downward arrow icon at the top right of the selection area.

Figure 1. Model and level of creativity selection

The core functionality is therefore not detailed modelling or drawing, but guided text generation for design thinking and documentation. It helps translate early-stage ideas into clearer written form, encourages users to think across multiple dimensions of a product, and introduces categories that beginners might otherwise overlook. By prompting for components, methods, constraints, and regulatory factors, it nudges users toward a more complete and professional style of product planning which will have an influence on later stage design. This is particularly beneficial for novice designers and students because one of their biggest challenges is knowing what to consider and how to structure their thinking. Beginners often focus narrowly on what a product does, while missing materials, processes, safety, compliance, or lifecycle issues. This tool acts as a scaffold, demonstrating typical headings and considerations found in real design documentation. It can also reduce the intimidation of starting from a blank page by producing first drafts that students can refine, critique, and improve.



The image shows a dark-themed user interface with a text input field. The label 'Product Description:' is at the top left. The input field contains the text 'e.g. A compact, battery powered coffee grinder for a camper, with USB-C charging and 30g capacity...'. Below the input field, the text 'Words: 0 | Est. tokens: 0' is displayed.

Figure 2. Product description input

In an educational setting, the tool can support learning by example. Students can compare their own ideas with the generated output and expand their reasoning. They can also compare the differences in output depending on their input, enabling better prompt crafting in the future. It also helps them learn the language of product design, how to describe function, justify choices, outline methods, and acknowledge constraints which is often as important as designing itself. Used thoughtfully, AI becomes less a shortcut and more a guided framework that accelerates understanding and builds confidence.

The product design assistant tool is also timely in the context of how the design and engineering industries are evolving. AI-assisted tools are becoming increasingly common in professional workflows, from concept development and documentation through to simulation and optimisation.

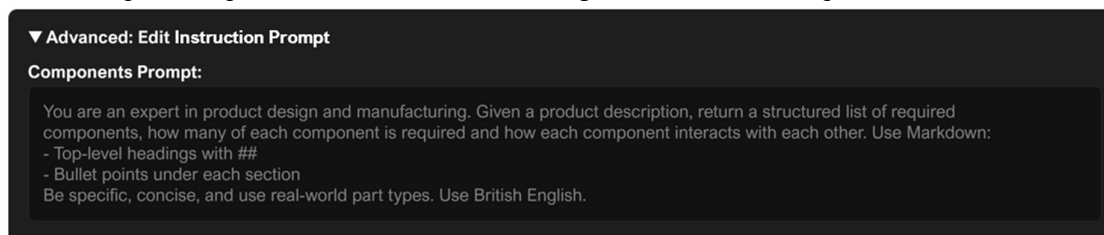


Figure 3. Instruction prompt default input for components

Many companies now expect graduates and junior designers to be comfortable working alongside AI systems, using them to accelerate research, generate drafts, explore alternatives, and structure technical information. A tool like this introduces students to that style of working in a focused, low-barrier way. By practising with AI-supported design documentation early on, learners develop prompt-writing, critical review, and refinement skills that are rapidly becoming part of standard professional competence.

2.1 Developing the educational experience

An initial exploratory workshop was created with the aim of developing an educational intervention on prompt crafting and the usefulness of AI to support product design. The tool was introduced to students for the first time during the workshop. The workshop was attended by students of the department of Design, Manufacturing and Engineering Management at the University of Strathclyde. The workshop included a presentation explaining the development of the tool and tips for crafting prompts for desired outputs. A practical activity included a worksheet that guided participants to design a prompt and reflect and develop their prompts and record differences in output.

Five students participated in the post workshop questionnaire to share their reflections on the usefulness of the tool. The survey comprised a combination of closed Likert-style questions and open-ended free-text questions. One student described themselves as a beginner on the use of AI and four with intermediate expertise. No students reported advanced or expert knowledge. Three male and two females participated. The mean age was 25 ranging from 20 to 32. Survey responses are reported as percentages due to the small sample size, and qualitative thematic interpretation for open-ended responses.

3 RESULTS

Participants reported that the ability to change models (80% useful to 20% neutral), ability to change creativity level (60% useful to 40% neutral) and edit default instruction prompts (80% useful to 20% neutral) were particularly valuable in enabling experimentation with system inputs and comparison of outputs. Students also found that the output categories of Components (100% useful) and Methodology (80% useful to 20% neutral) to be very useful, with Considerations (100% useful) and Regulations (60% useful, 20% neutral and 20% not useful) to be less useful.

The survey revealed a 50/50 split on if students would recommend the tools to others, and a 100% perspective that the output of the tool must be validated.

Participant 1 found that changing the creativity level from balanced (0.5) to creative (1.0) supported the types of creative exploration that would typically support demonstration of diverse ideation within a folio but perhaps was not realistic for real world production.

Participant 2 changed small details to influence considerations of design for manufacture and design for sustainability. This resulted in the tool returning rather complex language that was difficult to understand. However, this was changed by updating the instruction prompt to ask for a simpler response. Participant 3 used an existing project example and added more data to see how the output changed. As the input become more detailed, the output became more appropriate to the challenge.

Participant 4 increased the specificity of materials requirements for a product. However, found that the tool was not useful for this task. Their perception of the usefulness of the output did not change.

Participant 5 increased the level of detail on desired ergonomics for a product which changed the structure of the output to be more descriptive.

Each of the participants shared envisioned uses of the tool being developing an understanding for manufacturing or safety constraints, generating concepts for consideration and ensuring that ideas created align with technical requirements. Suggestions to improve the usefulness of the tool were to support presentation, layout and showcase of outputs, suggesting cost of the product, output in a report format and to evaluating designs against a known criterion.

Students were aware of challenges in the use of the tool being that outputs may not be accurate, lack of referencing to source material, difficulty verifying results, struggling to craft effective prompts and visualising the product using text-to-image or text-to-3DCAD.

4 DISCUSSIONS

From a pedagogical perspective, the structured output categories functioned as cognitive scaffolds, guiding novice designers to consider components, methods, constraints, and regulations that they might otherwise overlook. This aligns with studio pedagogy traditions in which learning is supported through structured prompts, critique, and iteration. Furthermore, the workshop design encouraged reflective practice, as students compared outputs, questioned validity, and refined prompts, positioning AI as a reflective interface rather than an authoritative source.

Participants valued the ability to adjust models, creativity levels, and instructional prompts. These features encouraged experimentation and comparison, shifting students from passive consumption to active evaluation. While generative AI is often criticised for promoting superficial engagement or automation bias [8, 9], the workshop structure appeared to counter this risk. Students iteratively refined prompts, compared responses, and unanimously emphasised the need to validate outputs. AI was therefore positioned as a fallible collaborator requiring judgement, rather than an authoritative source.

Prompt editing emerged as a significant learning mechanism. Small changes in specificity and constraint framing meaningfully altered outputs, reinforcing the importance of prompt literacy as an emerging design meta-skill, aligning with Vuletic and Ashcroft [7]. The act of crafting prompts required students to externalise assumptions about materials, ergonomics, sustainability, and regulation, mirroring early-stage problem framing in professional practice. The structured output categories further supported novice designers in broadening their consideration beyond function alone.

However, important boundary conditions were identified. One participant found limited usefulness when seeking detailed material specificity, highlighting the limitations of generative models for technically precise or database-dependent tasks. The tool appears most effective in early-stage conceptualisation and documentation drafting, with decreasing suitability for highly technical specification. This reinforces the need for task-tool alignment in AI-supported education.

Although individual features were rated positively, only half of participants would recommend the tool, suggesting ambivalence regarding reliability or depth. Categories such as Considerations and Regulations were perceived as less useful than Components and Methodology, possibly reflecting student preference for tangible outputs over compliance-focused content. This tension may indicate the need to more explicitly integrate systemic and regulatory thinking within assessment structures.

5 CONCLUSIONS

This paper introduced and piloted a participatory, workshop-based intervention centred on an AI-powered product design assistant to teach responsible and effective AI use in product design education. By making students active in prompt construction, parameter manipulation, and output critique, the intervention reframed AI as a scaffold for design thinking rather than a substitute for it. The tool's structured sections helped novices move from vague concepts to more complete early-stage design documentation, while the workshop activities foregrounded reflective practice and prompt literacy.

Initial results from the exploratory workshop suggest educational value alongside important caveats. Participants particularly valued the ability to edit system prompts and compare outputs, reporting usefulness in ideation and in understanding how input structure shapes AI responses. At the same time, they flagged limitations in technical depth, accuracy, and verifiability; perceived lower usefulness of Considerations and Regulations for immediate project needs; and a unanimous need to validate AI outputs. One participant's focus on detailed materials requirements highlighted the tool's current boundary conditions, pointing to the need for integrated domain knowledge.

These findings underscore the significance of participatory AI-building for cultivating AI literacy, critical judgement, and ethical awareness in design curricula. When students iteratively iterate prompts, challenge outputs, and document decisions, they practice the same forms of reasoning that underpin

professional competence linking creativity to constraints, justification, and compliance. For educators, the work motivates assessment designs that value process evidence alongside artefacts, aligning with responsible adoption of AI in studio practice.

Overall, the findings suggest that when AI tools are embedded within participatory and reflective studio activities, they can support AI literacy, critical judgement, and structured thinking. Future research should include larger cohorts, comparative conditions, and objective measures of learning outcomes. Taken together, the contribution is twofold: a practical teaching tool and a replicable pedagogical model in an AI-enabled future.

ACKNOWLEDGEMENTS

This research was funded by UKRI EPSRC project *The Digital Design Network plus: designing faster and better with less (D2N+)* Project Code: UKRI394.

REFERENCES

- [1] Ge P. and Fan F. A Systematic Review of the Role of AI Artificial Intelligence in Design Education. *DS 131: Proceedings of the International Conference on Engineering and Product Design Education (E&PDE 2024)*, 103–108. <https://doi.org/10.35199/epde.2024.18>.
- [2] Hamilton V., Brisco R. and Grierson H. How Can AI Support the Creation of Novel Ideas in Product Design. *DS 131: Proceedings of the International Conference on Engineering and Product Design Education (E&PDE 2024)*, 133–138. <https://doi.org/10.35199/epde.2024.23>.
- [3] Dhami S. and Brisco R. A Comparison of Artificial Intelligence Image Generation Tools in Product Design. *DS 131: Proceedings of the International Conference on Engineering and Product Design Education (E&PDE 2024)*, 13–18. <https://doi.org/10.35199/epde.2024.3>.
- [4] Marquez Cañizares J. C. Use of Artificial Intelligence in the Product Design Process. Impact on the Details Design Stage. *DS 131: Proceedings of the International Conference on Engineering and Product Design Education (E&PDE 2024)*, 115–120. <https://doi.org/10.35199/epde.2024.20>.
- [5] Lambert S., Mathews C. and Jaddoa A. Concept to Production with a Gen AI Design Assistant: AIDA. *DS 131: Proceedings of the International Conference on Engineering and Product Design Education (E&PDE 2024)*, 235–240. <https://doi.org/10.35199/epde.2024.40>.
- [6] Reynolds T. & Batley A. Exploring the Impact of Generative AI on Concept Generation, Ideation and Design Methodology: In Product Design Education. *DS 131: Proceedings of the International Conference on Engineering and Product Design Education (E&PDE 2024)*, 37–42. <https://doi.org/10.35199/epde.2024.7>.
- [7] Vuletic T. and Ashcroft A. Exploring the Usability of AI Prompts for Mechanical Engineering Design Development. *DS 131: Proceedings of the International Conference on Engineering and Product Design Education (E&PDE 2024)*, 461–466. <https://doi.org/10.35199/epde.2024.78>.
- [8] Javareshk M. B., Watkins M. A., Jobling P. and Siena F. L. Impacts of Generative AI on Engineering and Product Design Students' Performance. *DS 131: Proceedings of the International Conference on Engineering and Product Design Education (E&PDE 2024)*, 19–24. <https://doi.org/10.35199/epde.2024.4>.
- [9] Zhang Y., Fan Y. and Bohemia E. Perceptions of Lecturers of Artificial Intelligence on Industrial Design Students. *DS 131: Proceedings of the International Conference on Engineering and Product Design Education (E&PDE 2024)*, 157–162. <https://doi.org/10.35199/epde.2024.27>.
- [10] Luo J., Zheng C., Yin J. and Teo H. H. Design and assessment of AI-based learning tools in higher education: A systematic review. *International Journal of Educational Technology in Higher Education* 2025 22:1 2025, 22(1), 42-. <https://doi.org/10.1186/s41239-025-00540-2>.