IS HIGH SKETCHING PROFICIENCY STILL AN ADVANTAGE? EXPLORING THE ROLE OF FREEHAND DRAWING IN VEHICLE DESIGN WITHIN THE 2D GENERATIVE AI LANDSCAPE

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ABSTRACT
Industry 5.0 is disrupting industrial design, forcing it to rethink its methodologies and workflows from ideation to conceptualisation, design development, and production. In this industrial revolution, designers are faced with the need to transition from using technology as a tool to collaborating with it. Generative Artificial Intelligence (GenAI) and its applications (e.g., Midjourney, Stable Diffusion, Vizcom) put the role of industrial designers under debate depending on GenAI's influence from designer-creator to designer-curators. Today, GenAI can produce images which used to take many hours to produce, instantaneously. Industrial design fields that rely on freehand representation, such as product and transportation design, stand to be most disrupted. In this paper, the authors explored if high proficiency in two-dimensional (2D) sketching and rendering still constitutes an advantage in transportation design. A vehicle design challenge was proposed. Participants were divided into two groups: ones trained in transportation design sketching and rendering skills, and ones without that training. Participants used auto-ethnography to record their journey and reflect on their experience and process. The researchers observed the changes in roles of designer-creators to designer-curators who also oversee and collaborate with artificial intelligence and reflected, together with participants, on the implications of GenAI for industrial design education. Research outcomes produced recommendations to industrial design programs that value sketching proficiency differently to tailor the integration of GenAI into their curricula to create design-creator, design-curator, or designer-GenAI hybrid profiles.

Keywords: Generative artificial intelligence, design education, design futures, virtual reality, transportation design

1 INTRODUCTION
Sketching and drawing have historically been essential tools used by artists, architects, designers and engineers to conceptualise and later detail their ideas and innovations. In the Renaissance, *good drawing* skills were promoted as the means to structure visual communication, observations, research and representation [1]. Design leaders still propose sketching as key for designerly ways of thinking, enabling exploration, iteration and communication of ideas while also advocating for complementarity between hand-drawn and digitally assisted imagination [2]. Under this tenet, high proficiency in sketching is advantageous for a highly proficient exercise of the design discipline. However, today we live in a dilemma that is, on the one hand, the result of administrative decisions taken in the second half of the last century, while on the other the upcoming impact of a new wave of developments in digital technologies.

Normally, the traditional view is that architecture and industrial design related programs teach freehand sketching as a standard. While a few of these schools still value and emphasise freehand drawing (e.g. schools in which transportation design is taught), research shows that, in general, the learning of sketching and drawing has changed and diminished progressively over the years across the disciplines. The popularisation of 3D CAD from the late 1980s onwards coincided with cost-cutting measures in higher education. Many institutions favoured teaching 3D CAD over sketching with the view that the former was most suited to the industry demand for mass production and was less costly than the investment required to teach hand drawing skills [3, 4]. By the turn to this century, researchers found that the increased focus on CAD often suffered lack of proper instruction, and that there was poor basic freehand drawing knowledge and visualisation ability. Later, they noted that the ICT revolution did not deliver on a promise of more time for teaching drawing. Instead, increasing 3D CAD, training happened at the cost of reduced learning of critical skills for design and innovation such as observation and ideation drawing, which 3D CAD does not substitute [5, 6, 7].

Today, upcoming technologies are again threatening to increase the skills deficit in design education, with its subsequent impact on professional practice. CAD represented an incremental innovation that facilitated drafting and documentation via digitalisation. Now, the advent of artificial intelligence (AI) presents a disruptive and radical innovation that is affecting design education and practice, while the profession has not yet successfully dealt with the less drastic changes brought by the ICT revolution.

Technology change driven by AI is the first and one of the four main factors recent World Economic Forum research identified as affecting the future of work. More than 1,000 leading global employers who collectively represent more than 14 million workers across 22 industry clusters and 55 economies from around the world intend to invest in AI and upskill or change their workforce with the view of drastically transforming their business by 2030 as part of their strategy for survival and competitiveness. Architecture, design, education, manufacturing, construction and their management are within those clusters. "These trends are expected to have a divergent effect on jobs, driving both the fastest-growing and fastest-declining roles, and fuelling demand for technology-related skills" [8]. This forecast follows other leading research reports that show many organisations already suffer from up to 30% of unfulfilled critical roles because of AI and only 5% feel confident about having the capabilities they need to future proof their businesses and organisations in the USA and Europe [9, 10]. Unavoidably, design education and its different areas of application in professional practice need to figure out how to unpack the disruptive power of AI and redefine itself to avoid repeating the hindering effects of previous technological changes.

One starting point is the differentiation between traditional AI and generative artificial intelligence (GenAI). The former excels in pattern recognition for complex, unstructured data, while the latter, a subset of AI, likely outperforms humans in pattern creation by analysing large datasets and generating new patterns in text, images, video, or code through natural language prompts or graphic inputs. This type of AI is especially prone to creativity and novel data creation to synthesise new visual viewpoints, arguments, narratives and discourses for design and architecture. Having struggled for decades with defining an inclusive framework for hand-drawing skills and technology for translating analogue to digital work (e.g. drafting to 3D CAD), design education and practice now face a much larger challenge. They must now consider how and to what extent to integrate with a technology that can produce creative work by itself (if generating new visual narratives probabilistically from learned patterns can be considered "creative"). This shift presents both an opportunity and a challenge. On one hand, it offers a chance to move beyond the limitations of 3D CAD in early-stage ideation and conceptual experimentation. On the other hand, it demands a re-evaluation of the role of designers in a landscape where creation is increasingly shared or controlled by GenAI, with particular emphasis on experimentation and essential practices like freehand sketching, which foster a dialogue of ideation of novel concepts. However, this questions the definition of design expertise when creation is shared between humans and AI, and if designers will continue being creators or become curators of probabilistic options generated by GenAI [11, 12]. To begin addressing the role of sketching proficiency around these points, an experiment was designed for participants with varying freehand drawing skill levels in Australia, the United States, and Canada. This paper presents the pilot application of the experiment and its findings from the Australian group.

2 METHODOLOGIES

Traditionally, proficiency in freehand drawing has provided a significant advantage when exploring and refining concepts. Today, GenAI is said to have the potential to level the playing field for designers with limited drawing skills since it can transform rough sketches into photorealistic renderings with minimal effort. While this capability can enhance efficiency, working with detailed representations too soon in the ideation process risks bypassing the iterative work needed to mature ideas and may lead to fixation on immature ideas [13, 14, 15]. This paper addresses the following key questions: Does high sketching proficiency still offer an advantage while designing, to justify educational investment? And how does

sketching proficiency—high or low—influence whether the designer's intent dominates (designer-creator) or GenAI steers the process (designer curator)?
In this pilot auto-ethnographic study, we selected transportation design as the subject due to its status as the most drawing-intensive discipline within industrial design. Six participants were divided into two groups: Group A, comprising five industrial design students (3 first years, 3 fourth years, and 1 high degree researcher) with no training in transportation design sketching, and Group B, consisting of one designer (one of the researchers) with such training. One participant from Group A and the one from Group B had prior experience with Vizcom, the AI tool chosen for its focus on transportation design.

Figure 1. Hand sketch (I), refined sketch using GenAI (II), three-view layout from 3D model (III), freehand sketch on top of three-view layout (IV), finished three-view proposal (V)

Participants underwent a one-hour training session on Vizcom which covered its tools and proposed workflows for a three-hour design challenge via teleconference (executed a week later). The task was to design a four-passenger ultra-light autonomous vehicle for smart cities in 2040. The challenge was structured into five phases: 1) 15 minutes for reflection and objective-setting using the Golden Circle methodology [16], where participants outlined a user type, the vehicle's purpose, and how it met design goals; 2) 20 minutes for freehand-sketching of side views (paper or digital) (Figure 1, Step 1), then for the creation of GenAI iterations and selection of one to pursue; 3) 25 minutes for refinement of the selected idea (Figure 1, Step 2), the creation of a rough GenAI 3D model and a concept page layout with side, front, and rear views (Figure 1, Step 3); 4) 40 minutes for hand-sketching over the concept page to refine the rough 3D; 5) 40 minutes for refinement and creation of the final three-view proposal. Reflection periods (10 minutes each) followed phases 3 and 5, enabling participants to document their approach to creating GenAI images and compare differences, benefits, and downsides of GenAI tools versus traditional methods. A week later, a one-hour post-challenge session between the participants and the researchers was held to reflect on the challenge experience, the role of sketching, the impact of GenAI, and implications for design education. Finally, researchers evaluated and analysed the data.

3 RESULTS AND DISCUSSIONS

The main types of data collected during the challenge were: 1) Visual data from the Vizcom, containing participants' prompts and visual output, 2) Self-reflection documents from each participant, and 3) Group reflection video call transcript.

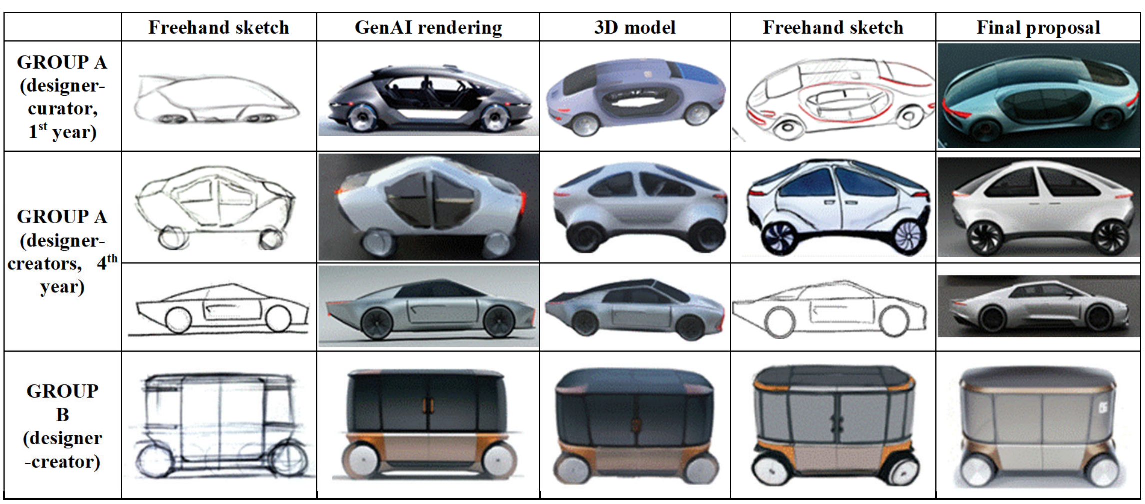

Figure 2. Examples of the design process from initial hand sketch to final GenAI side view

Regarding the visual data from Vizcom, 1 of the 6 participants (from Group A) did not complete the tasks on time. This participant struggled with Vizcom's learning curve. Of the five Group A participants, three favoured a design-curator profile, as design intent showed in freehand sketching was largely lost, and most final features emerged from Vizcom (one participant even skipped sketching on the 3D model). The other two carried a designer-creator process, preserving their design intent with fewer GenAI modifications. Figure 2 shows that while both achieved results faithful to their intent, the participant with lower sketching proficiency had proportional deficiencies in her first sketch that carried over to the final proposal. The Group B participant's work was designer-driven, supporting the idea that high sketching proficiency enables more effective designer-creator profiles with GenAI. Further research is needed to determine if sketching proficiency influences outcomes in designer-curator approaches as this was not addressed in the experiment.

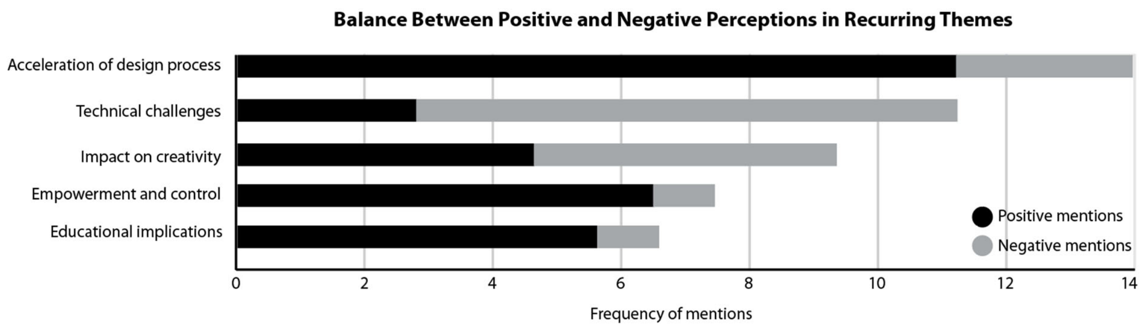

Figure 3. Results from the transcription of the self-reflections and the group-reflection

The participants' self-reflections and the transcription from the group reflection were coded and the aggregated themes were analysed (*Figure 3*). Additionally, the positive and negative perceptions of each of the 5 dominant themes were evaluated using semantic orientation [17]. The key conclusions that emerged are **1) Acceleration of the Design Process**: Generative AI tools significantly sped up the design process, enabling participants to iterate and refine sketches and explore multiple variations in less time. **2) Creativity Enhancement and Limitations**: AI tools provided inspiration and helped overcome creative blocks, but some participants felt constrained, noting that AI sometimes led to conventional designs or deviations from their intent, requiring adaptation to the tool's capabilities and potentially limiting creativity. **3) Technical Challenges and Learning Curve**: Many participants, particularly those new to AI tools, struggled with navigating Vizcom, crafting effective prompts, and generating multiple iterations from a single sketch, hindering their ability to fully leverage the technology. **4) Impact on Design Education**: Integrating AI tools into design education could enhance students' understanding of the design process and boost confidence, but over-reliance on AI risks undermining the development of fundamental sketching skills. **5) Empowerment and Control Over the Design Process**: Despite challenges, participants felt empowered by AI tools, which facilitated easier visualisation, iteration, and documentation of their designs, enhancing their sense of control. However, concerns arose when evaluating final outcomes against the original design statement.

Table 1. Taxonomy of industrial design programs from traditional to AI-competent

Emphasis on Freehand Sketching Proficiency	Traditional Programs of Today	GenAI-competent Programs of Tomorrow
High	*Traditional Visualisation-centric Programs* Freehand sketching and rendering are protagonists, which is reflected in the curricula.	*Design creator programs* Gen AI is leveraged to augment the capabilities of strong sketching skills and facilitate the realisation of superior designer-led visions.
Moderate	*Traditional Holistic Programs* Sketching is valued as one of many tools. A balanced methodological approach is prioritised over extensive drawing courses.	*GenAI-designer co-creation programs* Collaboration with Gen AI to enhance work throughout the design process, with sketching as one of the tools to propose, adapt, or adopt within design proposals.
Low	*Traditional Engineering-Cenric Programs* Technical tools (e.g., CAD) and precision have priority over creative ideation through sketching.	*Design-curator programs* Focus on AI-driven ideation, optimisation, and computational design. With minimal emphasis on sketching, other inputs are used to obtain AI output.

Further discussion on the impact of AI on design education revealed a spectrum of design programs, as experienced by the researchers. Table 1 categorises industrial design programs by their current emphasis on freehand sketching and speculates on how these profiles might evolve to integrate GenAI, balancing the roles of designer-creator and designer-curator to cultivate designers with diverse strengths.

The study addresses whether high sketching proficiency remains advantageous when designing and how it influences the balance between designer intent and GenAI-driven outcomes. Findings suggest that high sketching proficiency enables designers to maintain a designer-creator profile, preserving their intent when collaborating with AI, while lower proficiency often leads to a designer-curator role, where AI dominates the process. GenAI tools accelerate iteration and exploration but risk premature fixation on AI-generated ideas, potentially limiting creativity. The research supports that sketching proficiency remains valuable, and design education should maintain its investment in drawing skills with AI integration to prepare designers for both "creator" and "curator" roles in a rapidly evolving landscape.

4 CONCLUSION AND RECOMMENDATIONS

This pilot study suggests that the value of high proficiency in freehand sketching still applies, even in the age of Generative AI (GenAI). Higher sketching skills helped designers preserve their intent more effectively when collaborating with AI tools, whereas participants less proficient in drawing often saw their ideas diluted by AI-generated outputs. This underscores the importance of sketching skills in leading the creative process rather than merely curating AI-generated options. On the other hand, participants with lowers sketching skill levels appreciated the versatility of the tool which allowed them to visualise ideas for which their sketching skills were not sufficient.

GenAI tools, such as Vizcom, accelerated the design process, enabling rapid iteration and exploration of multiple design variations for all participants. However, the risk of premature fixation on AI-generated ideas poses a challenge, as it may bypass the deeper iterative work needed to mature a concept. This poses a higher risk for lower skilled participants using a design-curator approach. GenAI facilitates visualisation and documentation of design processes but can also deviate from the original design intent, particularly for those with lower sketching proficiency. Thus, design education must evolve to integrate GenAI while maintaining a strong foundation in traditional sketching skills. This poses the question of which foundational skills remain as part of industrial design programs, and at which moment in the curricula emerging tools such as GenAI should be introduced to enhance the formation of new designers rather than hinder it. Additionally, programs must consider how to position themselves in the spectrum of freehand sketching proficiency, and thus, develop adequate GenAI training to prepare students for designer-creator, designer-curator, or hybrid roles.

It is important to mention the feedback loop between industrial design education programs and the industry they train students for. GenAI approaches should be adapted accordingly. Current research results suggest that design education programs that prepare students for integration into practice environments sensitive to designer-led outputs, should maintain their strong curricular emphasis on freehand drawing and use Gen AI to augment capabilities in idea generation and communication. Future research will need to answer how GenAI should assist in this endeavour. For design programs which place students in practice settings where designer-creator output is less important, we recommend caution before removing drawing curricula. Our research suggests that freehand drawing proficiency gives students flexibility to exercise both design-creator and design-curator roles. More research is needed to define to what extent each role should be favoured and thus, the emphasis on freehand drawing.

Future work will see the application of this study in additional contexts with industrial design programs, with participants from Canada and the United States, with diverse freehand sketching proficiencies. All this data will be compiled and processed for a more conclusive analysis. Additionally, the final visual GenAI output from all participants will be presented to a panel of transportation design experts, who will try to differentiate which images belong to which group and reflect on the implications for industry and design education. The research efforts will also seek to distinguish when the control of the design shifts from the designer-creator to a designer-AI partnership, or to designer-curator. It will also be important to explore the extent to which design-curator activities may hinder innovation potential, as GenAI relies on existing datasets of images. Additionally, the work should investigate to what extent more designer influence fosters more innovative outputs. Lastly, GenAI shows promise as a tool which can assist designers in the main stages of the design process: early ideation, design direction, and design refinement. A key priority of the efforts should be to evaluate the impact and value of GenAI in these three stages.

REFERENCES

[1] Novoa M. 2019. Do We need a new theory of drawing? Exploration on technological change between physical and digital visualisation. In *DS 95: Proceedings of the 21st International Conference on Engineering and Product Design Education (E&PDE 2019),* University of Strathclyde, Glasgow. 12th-13th September 2019.
[2] Cross N. Designerly ways of knowing. *Design Studies*, 1982. 3(4): p. 221-227.
[3] Corremans J. A. and Coppieters W. Does the imitation of the sketch style of good industrial designers influence students' drawing skills?. *In DS 88: Proceedings of the 19th International Conference on Engineering and Product Design Education (E&PDE17)*, Building Community: Design Education for a Sustainable Future, Oslo, Norway, 7 & 8 September 2017. 2017.
[4] Corremans J. A., Vaes K. R. and Coppieters W. 2018. Do Better Sketchers Become Better Product Designers?. In *DS 92: Proceedings of the DESIGN 2018 15th International Design Conference.* pp. 2411-2420. (The Design Society, Glasgow).
[5] Evatt M. A. C. 2002. Sketching a dying art. *Proceedings of E&PDE*, pp.229-236. (Professional Engineering Publishing, Bury St Edmunds).
[6] Evatt M. A. C. 2006. Drawing conclusions. In *DS 38: Proceedings of E&DPE 2006, the 8th International Conference on Engineering and Product Design Education, Salzburg, Austria, 07.-08.09. 2006*.
[7] Fava M. A decline in drawing ability?. *International Journal of Art & Design Education.* 2020 May;39(2):319-32.
[8] Zahidi S. *The Future of jobs report 2025.* Available: https://reports.weforum.org/docs/WEF_Future_of_Jobs_Report_2025.pdf [Accessed on 2025, 1 March], (2025) 7 January.
[9] Ellingrud K., Sanghvi S., Madgavkar A., Chiu M., White O. and Hasebe P. 2023. *Generative AI and the Future of Work in America (McKinsey Global Institute)* [online].
[10] Hazan E., Madgavkar A., Chui M., Smit S., Maor D., Dandona G. S. and Huyghues-Despointes R. 2024. A new future of work: The race to deploy AI and raise skills in Europe and beyond. *McKinsey Global Institute*.
[11] Novoa M. Basis for a new theory of drawing framework from traditional handmade to modern virtual simulation. *In DS 104: Proceedings of the 22nd International Conference on Engineering and Product Design Education (E&PDE 2020)*, VIA Design, VIA University in Herning, Denmark. 10th-11th September 2020.
[12] Yu W. F. AI as a co-creator and a design material: Transforming the design process. *Design Studies*. 2025 Mar 1;97:101303.
[13] Lebahar J. C. 1983. *Le dessin d'architecte: simulation graphique et réduction d'incertitude*. Editions Parenthèses.
[14] Jansson D. G. and Smith S. M. 1991. Design fixation. *Design studies*, *12*(1), pp.3-11.
[15] Kannengiesser U. and Gero J. S. 2019. Design thinking, fast and slow: A framework for Kahneman's dual-system theory in design. *Design Science*, *5*, p.e10.
[16] Sinek S. 2009. *Start with why: How great leaders inspire everyone to take action*. Penguin.
[17] Turney P. D. and Littman M. L. 2003. Measuring praise and criticism: Inference of semantic orientation from association. *acm Transactions on Information Systems (tois)*, *21*(4), pp.315-346.