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IMAGE-BASED AI TOOLS FOR DESIGN ENGINEERING: A WORKSHOP STUDY ON STUDENT PERCEPTIONS OF ETHICS AND USEFULNESS

Andreas Dagman, Karl Fine De Licht

Chalmers University of Technology, 1. Department of industrial and Material Science, 2. Technology Management and Economics

ABSTRACT

AI tools have become increasingly popular and accessible in various domains, including industrial design engineering. However, there is a lack of empirical studies on how these tools affect the design process and outcomes, as well as the ethical implications of their use. In this paper, we present a research study that aims to explore how students at bachelor level in Industrial Design Engineering, particularly those without prior knowledge, perceive the usefulness of text-to-image generative tools. We also examine their main ethical considerations regarding the use of these types of tools, as well as AI tools in general.

Our findings indicate a cautious but curious attitude towards AI technologies, underscoring the need for a nuanced approach in their integration into educational curricula. The apprehension towards adopting these tools reflects a broader concern about ethical implications, technological dependence, and the potential overshadowing of human creativity. However, the study also reveals an eagerness to understand and utilize these technologies, suggesting a latent potential for enhancing creative processes in design engineering. As our study shows, students are keenly aware of the challenges and opportunities presented by AI, highlighting the importance of clear guidelines and ethical frameworks.

In conclusion, the integration of AI tools like text-to-image generative models in design engineering education presents both challenges and opportunities. The key to successfully navigating this integration lies in a balanced approach that emphasizes ethical usage, critical understanding, and creative collaboration. Through such an approach, we can prepare the next generation of designers to effectively and responsibly harness the potential of AI in their work, ensuring that human creativity remains at the forefront of design innovation.

Keywords: Text-to-image generative methods, Industrial design engineering, AI-tools in education, Ethic in AI, Standard: 6, 8.

INTRODUCTION

With the launch of Chat-GPT by OpenAI in November 2022, there has been a notable increase in the use and public awareness of AI tools. Chat-GPT is a Large Langue Model (LLM) and a generalist tool that initially focused on understanding and producing text and code but has since expanded its capabilities to include image generation, among other functions. AI has long been a supportive tool in various sectors, but these new applications have significantly increased public awareness of its potential. In academia there have been several studies investigating the perception of use of AI in higher education, (Chan, et.al.2023) and (Kumar & Raman, 2022). Concurrently, the rise of generalist AI tools has been accompanied by the

emergence of specialist tools. These include Midjourney and DALL-E, which focus solely on image generation (text-to-image tools); GitHub Copilot, dedicated to coding assistance; and Elicit, which specializes in research overviews, to name just a few.

The introduction of AI tools has not been unequivocally positive, however. There are notable risks associated with these tools, both in terms of the quality of their output and the ethical implications of their use. These issues need thorough examination, and it is imperative to develop a deeper understanding and establish robust routines to address them at both a societal level and in everyday life. Given the staying power of these tools, it is crucial for the academic world to formulate a strategic approach, preparing students for the utilization of such tools before they embark on their professional careers. Accordingly, there should be clear guidelines governing the use of AI tools (see e.g., de Fine Licht 2023).

To initiate this research and policymaking, it is important to explore how today's youth engage with these tools and their perceptions of the tools' usefulness.

Aim:
In this paper, we present results from a study aimed at investigating how students at bachelor level in Industrial Design Engineering, particularly those without prior knowledge, perceive the usefulness of text-to-image generative tools. We also examine their main ethical considerations regarding the use of these types of tools, as well as AI tools in general.

The research questions are:

1. What are the perceptions of text-to-image generative tools among students who are unfamiliar with these technologies?
2. What ethical considerations do students have regarding the use of text-to-image generative tools, specifically in professional and academic contexts?

BACKGORUND AND THEORY

AI encompasses a broad spectrum of technologies and tools designed to simulate human capabilities through machine learning and complex algorithms. These tools can analyze vast amounts of data, identifying patterns, and make decisions or predictions based on the information they process. Among the diverse range of AI tools, some notable categories include large language models (LLM’s) like OpenAI's GPT series, which are trained on extensive text corpora to understand and generate language in a manner reminiscent of human writing or conversation. Another significant category is text-to-image generative models, such as OpenAI's DALL-E and Midjourney, which can create detailed and coherent images from textual descriptions using advanced AI techniques. Building upon these advancements in AI, particularly in the realm of text-to-image generation, is the practice of prompt engineering. This method involves crafting detailed and precise prompts or instructions to effectively guide generative models, enhancing the quality of the output by providing the model with clear and specific guidance. For example, a study by Liu and Chilton (2022) explores the impact of prompt keywords and model hyperparameters on producing coherent results and offers design guidelines for optimizing the performance of text-to-image generative models. These insights are crucial for harnessing the full potential of AI tools in creating high-quality, realistic images.

As these AI technologies continue to evolve and integrate into various sectors, their impact on educational environments has become a topic of significant interest and investigation. Through a year of workshops and discussions about AI tools in higher education with fellow examiners and teachers at the university level, as well as insights from the literature (see, for example,

Neumann et al., 2023; Rudolph et al., 2023; Sullivan et al., 2023), we have made several preliminary observations.

Firstly, many teachers and examiners express concern that students might use these tools to cheat on exams. This fear has sparked a significant discussion about countermeasures, including the development of new tools designed to identify AI-generated text. Secondly, it is observed that students tend to adopt new technologies and hence these tools more quickly than teachers and examiners. This ties into the first point, highlighting a gap between what students can do with these tools and what educators believe they can do. Thirdly, and related to the first point, is the belief among many educators that these tools are easy to use, which implies that students don't need extensive knowledge to potentially use them for cheating. This appears somewhat contradictory to the second point, but not entirely, as many teachers and examiners do not use these tools themselves. Therefore, 'knowing how to use the tools' might simply mean understanding what the tools are and how to navigate them effectively. Fourthly and finally, many teachers and examiners believe that students are mostly positive towards these tools and are eager to use them and that the anxiety they may feel primarily stems from not having clear guidelines on what is permissible in their usage. Thus, one perception among teachers and examiners is that we don’t need to incentivize students to utilize these tools, rather the opposite, we need to make sure against overreliance.

The use of Text-to-image generative tools is part of the CDIO Standard 8: Active Learning and 6: Engineering learning workspaces. Based upon the latest version of the CDIO standard (Malmqvist et.al., 2020). Both as part of the digital learning workspaces as well as part of the active learning. The students explore the possibilities with the tools what it can do and what are the borders. The workshop and reflections are also connected to how words and taxonomy regarding design and expressions are intercorrelated to form.

METHOD

To achieve user data different kinds of methods can be used such as interviews, questionnaires, surveys, focus groups etc. As a researcher you need to choose the right method depending on which type of research question you aim to answer, (Kvale, 1996). The retrieved user data also needs to be analyzed in either a quantitative or qualitative way. The quantitative data is numerical and can build up for example statistics and the quantitative data is focused in interpreting the answers and form knowledge on that material.

To give a preliminary answer to our research questions we utilized a workshop methodology. Workshop methodology is a participatory approach often employed in academic and professional settings to engage participants in hands-on, interactive learning experiences. This method involves organizing focused sessions where a small group of participants, typically with varying levels of expertise and experience, collaborate on specific topics or projects. Workshops are designed to be immersive and experiential, encouraging active participation, discussion, and knowledge sharing. The goal was to facilitate a deeper understanding of the subject matter, foster creativity, and stimulate innovative thinking. In educational contexts, such as in university programs, workshops can be particularly effective for introducing new technologies or concepts, allowing students to directly engage with the material and apply theoretical knowledge in practical scenarios. By combining instruction, collaborative exercises, and reflective activities, workshops offer a dynamic and interactive environment conducive to learning and exploration.

The workshop involved two groups of 35-40 students each, in the first and second year of the industrial design engineering program at Chalmers University of Technology. The idea with the workshop was to introduce AI tools with emphasis on Text-to-image generative AI tools, such as DALL-E and Midjourney to the students early in their education, to let them see the possibilities, limitations, and challenges of the tools, as well as to get an idea of what entry-level approaches the students have to these tools. We found that the knowledge and use of language models such as Chat-GPT was about 50% among the students, but the usage rate of Text-to-image generative tools such as DALL-E and Midjourney was significantly lower, around 20%. We introduced the basics of prompt engineering during the workshop, with a focus on text-to-image generative programs that differ from prompt engineering within language models.

In the workshop the students were allowed to try out the text-to-image generative tools and reflect on their usefulness, creativity, and ethics in terms of professional and academic contexts. We collected data from the workshop through observations and an open-ended reflective questionnaire that the participants should answer at the end of the workshop individually or in small groups. The questions posted was:

- How did you experience using this type of tool? Problems/Opportunities
- How did the use of AI tools affect your creative process during the workshop?
- How do you view collaboration between humans and AI technology in creation processes? What benefits or challenges do you see with this collaboration?
- Which ethical aspects related to the use of AI do you consider to be most relevant or important? Why?

The answers were then compiled and analyzed in a qualitative way to try to find preliminary answers to the posted research questions.

RESULT AND ANALYSIS

The analysis was conducted qualitatively, and the results from this analysis are presented below in relation to each question posed. Additionally, results from observations made during the actual workshop are also included. The structure of the results and analysis chapter is as follows: each of the questions posed to the students at the end of the workshop is presented, and the answers are compiled into one to three main areas that were common in the responses. These areas are then further elaborated upon.

How did you experience using this type of tool? Problems/Opportunities

For most of the students, it was their first time using these kinds of tools, a factor that should be taken into consideration when interpreting the analysis results. In this section, three primary areas were identified, which are presented and analyzed below.

Quick Inspiration and Visualization

One of the things the students perceived was that the Text-to-image generative models were inspiring and fun to use but they also were frustrated since they did not achieve what they intentionally were aiming to create. Beginning with inspiration and visualization, a consistent theme was the appreciation of AI tools for providing quick inspiration and aiding in visualizing complex concepts. Students acknowledged that these tools facilitate idea generation and can make the creative process more efficient. However, there was a shared sentiment of frustration due to the tools' inability to perfectly capture their intended creations, highlighting a gap between expectation and output.

"I found it a bit difficult to really achieve the intended images through text, you really have to practice how to phrase yourself to get a good result." Student in second year

Specification and Detail Challenges
The students also faced challenges in effectively communicating their creative visions to the AI, often requiring multiple iterations to achieve desired results. This points to a need for more intuitive interfaces and improved AI understanding of human directives.

"One advantage is that you quickly get a very detailed illustration. One challenge will be to communicate one´s ideas in the right way."

Risk of Limited Creativity
Interestingly, while AI tools were seen as enhancing creativity in some respects, there was a concern about the potential limitation of human creativity, suggesting a delicate balance in the integration of AI in creative endeavors.

How did the use of AI tools affect your creative process during the workshop?

In addition to the observations already mentioned, the questionnaire responses also revealed discussions about the practical use and technical challenges associated with AI tools. In this section three different main areas were identified, presented, and analyzed, below.

Limitations and opportunities for creativity:
AI tools can sometimes limit creativity because they are based on existing data and have difficulty generating entirely new concepts. However, they can also enhance creativity by quickly generating detailed illustrations and providing new attributes and variations on existing things.

Challenges of Communication
Students highlighted the iterative nature of working with AI, emphasizing both the potential for rapid prototyping and the challenges in achieving precise outcomes. This aspect underscores the evolving relationship between human intention and AI interpretation, where students often found themselves adapting their creative strategies to align with the capabilities and limitations of the AI. The need for multiple iterations to refine results highlighted a learning curve in effectively communicating with AI systems, pointing towards a potential area for future development in AI tools' user interfaces and interaction design.

Use as a Complementary Tool
The students thought that the use of AI tools can help them develop their thinking and see how different words and sentences generate different results. This can make experimenting with different ideas fun and engaging in the creative process. AI was seen as a useful complementary tool, if they understand and know what is created in AI. It was perceived to shorten and expand the creation process and results. However, they express concern about becoming too reliant on AI. This would lead to a degeneration of knowledge and competence in the area.

"As long as you understand and know what is created in AI, it can be a very useful complementary tool. On the other hand, it is not very good if you become dependent on AI and cannot create yourself if needed." Student in second year

How do you view collaboration between humans and AI technology in creation processes? What benefits or challenges do you see with this collaboration?

There will most probably be an interplay and collaboration between humans and AI in the future. Therefore, this was investigated. In this section three different main areas were identified, is presented, and analyzed, below.

AI as a Partner rather than a tool

Moreover, the students' experiences brought to light the idea of AI as a partner in the creative process, rather than just a tool. This partnership, while offering novel avenues for exploration, also raised questions about the balance of creative control and the extent to which AI can or should influence the final output. These insights align with broader discussions in AI and creativity, where the intersection of human and artificial creativity is constantly being renegotiated.

"I believe that collaboration between humans and AI is something that cannot be avoided but something that we need to learn to use to our advantage. In the creative process, I believe that we need to be vigilant not to give the entire idea generation to AI and not to start valuing the human creativity and creation process as something inferior to the AI's creativity and creation. So, it's about how we include AI in the creation process." Student in second grade

The Role of Humans

Both groups emphasize the importance of humans maintaining control over the creative process. They see the human being as the one who comes up with well-thought-out ideas and who can decide what is better and worse. They also see humans as the ones who need to put their own stamp on things and not let AI mimic other people's work too much.

"Humans need to have ideas and some kind of vision to feed the AI with information.
which it can then work along. The human is the one who steers while the AI is the car that goes where we want to go. So far..." Student in first year.

Ethical Considerations

Regarding ethical implications, students were aware of AI's significant impact on employment, well-being, and the broader societal context. This encompasses concerns about AI replacing human roles, potentially leading to unemployment and a devaluation of human creativity.

Which ethical aspects related to the use of AI do you consider to be most relevant or important? Why?

The ethical aspect is of special interest and therefore scrutinized below. From the analysis of the gathered data, the students discussed the ethical implications of using AI tools to create images, by answering the question: What ethical aspects related to the use of AI do you consider to be the most relevant or important? Why? In the subsequent analyses, we identified different areas that the students found to be of main interest. Three examples of these were:

1. AI has a great impact on people's work, employment, and well-being,
2. AI has a great responsibility and power over people and other beings,
3. AI poses a great opportunity and a great challenge for people and other beings.

Ownership and Intellectual Property

Another major concern revolved around the ownership of AI-generated content. Students questioned the extent to which creations made with AI assistance can be considered original and who holds the rights to such works. This ambiguity in intellectual property rights of AI-assisted creations poses a significant ethical and legal challenge. Lastly, the discussion also veered into AI's expanding role and its profound implications on human life and decision-making. Concerns were raised about AI making choices that could be deemed unethical in scenarios where it replaces human decision-making.

AI and Ethics

Despite recognizing the challenges, students also saw AI as a valuable resource in reducing repetitive tasks and contributing to creative processes. This underscores the importance of a balanced approach where AI is used responsibly and ethically, complementing rather than supplanting human creativity and decision-making.

AI as a Resource

Despite the concerns, there is also an understanding that AI can be a valuable resource that can contribute to creativity and reduce unnecessary and repetitive tasks. This underlines the importance of using AI responsibly and ethically.

At the workshop's end, students showcased their created images and reflected on the results and their creative process. There the students discovered that the AI interpreted their words differently than they had anticipated. For instance, using the term 'innovative' did not lead to the tool generating novel ideas, but rather produced futuristic representations of existing technical solutions. Similarly, the words 'environment' or 'environmental' prompted the AI to create images predominantly featuring green hues and elements like leaves or trees. They also encountered difficulties in incorporating text and creating human figures with accurate anthropometry in their images.

DISUSSION

The workshop highlighted a somewhat surprising duality in the students' experiences with text-to-image generative models. On one hand, these AI tools were perceived as inspiring and enjoyable, playing a significant role in sparking creativity and aiding in the visualization of complex concepts. Students appreciated the efficiency and immediacy with which these tools facilitated idea generation, marking a notable advancement in the creative process. AI tools present an opportunity for students and practitioners to visualize concepts without extensive training in traditional sketching techniques.

However, this positive reception was tempered by frustration. Despite the initial excitement, students frequently encountered a disconnect between their creative intentions and the AI's interpretations. The tools, while adept at providing a starting point for creativity, often fell short in accurately materializing the students' envisioned outcomes. This discrepancy showcases the limits of AI in understanding and executing complex human creative visions and points to the necessity for further advancements in AI technology to bridge this gap. Thus, it might not be as easy to use the tools for the more advanced assignments you get at the university level and even if teachers and examiners are even worse at using the tools, this might suggest that the knowledge in how to use the tools in some aspects are still too low for the students to have that much of an upper hand with regards to the teachers.

Additionally, these albeit limited results suggest that students need to learn more about how to use these tools effectively, for example, by becoming better at prompting. This is easier said than done, as the teachers today often do not know how to do this properly and have limited time to learn. Furthermore, the models are continually tweaked and adjusted, and many more new tools are likely to emerge in the coming years. This presents a real challenge for teachers in enabling students to become proficient with these tools, particularly on the technical side. University professors also have many other responsibilities to manage. In many countries, they are facing an increasing number of students with the same resources. Consequently, if the AI tools do not become much more user-friendly, students might be left to navigate them largely on their own.

On a positive note, there are aspects teachers and examiners can impart to students that aren't as susceptible to change as those discussed in the previous paragraph. Firstly, we can teach them to express themselves and become knowledgeable about how to describe materials, moods, etc. This skill will likely always be essential in crafting effective prompts. So, even though many aspects of prompting may evolve, the ability to describe one's vision accurately and precisely might remain constant. This is already a focus in design programs, but there's potential for further improvement. Secondly, the norms governing the use of these tools and how their usage should be documented in academic writing have developed significantly over the past year. These norms are likely to become quite universal and, at least on a higher level, stable. For instance, in a thesis, it will probably become standard practice to detail which AI tools were used, how they were employed, and their impact on the study. This is something we as teachers and examiners can help students understand and internalize. Thirdly, the integration of these tools into the workflow may also be less subject to change than previously thought. For example, treating AI not merely as tools but more as collaborators could be one approach. Determining how and when to utilize these tools to maximize creativity and avoid overreliance could be another.

Another more general finding from this study was that these groups of students expressed significant skepticism and anxiety towards these tools, which cannot be simply attributed to a lack of understanding about permissible uses within the university context. For instance, only about 50% of the students had tried out general-purpose tools like ChatGPT, and a mere 20% had engaged with text-to-image tools. This was somewhat unexpected, given that they are enrolled in a design program at a technical university where one would presume a greater inclination to experiment with tools aimed at assisting their core interest: designing. The students also voiced concerns about ethical issues related to these tools and the possibility of being replaced by them in the future. As one student aptly observed, we may need to view AI not just as tools, but as partners. However, it's also crucial to recognize the importance of human creativity and expression. Thus, in our study groups, there was a hesitancy to use these tools that seemed contrary to what one might expect. Instead of over-relying on them and neglecting key aspects of their program, they avoided using them altogether. This avoidance might be detrimental to their future prospects since these tools are not always straightforward to use, and they will likely need this knowledge post-graduation.

Thus, the need to adapt our curriculum to integrate these AI tools effectively becomes apparent. This adaptation should not only focus on the technical aspects of using AI but also on fostering a deeper understanding of its role and implications in the broader context of design and creativity. However, addressing these challenges extends beyond the realm of academia and requires action at a societal level. Legislative frameworks need to be developed to regulate the use of AI tools, ensuring ethical standards and responsible usage. These laws should aim to strike a balance between encouraging innovation and protecting the interests of those in creative industries. By doing so, we can provide students with compelling reasons to engage with AI tools, not just to enhance their immediate academic projects, but as a vital component of their long-term professional and ethical development. Ensuring that students are well-versed in these aspects will equip them to navigate the evolving landscape of technology and design, thus preparing them for a future where AI is an integral part of the creative process.

CONCLUSION

In this study, we have explored the perceptions and ethical considerations of industrial design engineering students regarding text-to-image generative tools. Our findings indicate a cautious but curious attitude towards these AI technologies, underscoring the need for a nuanced approach in their integration into educational curricula. The apprehension towards adopting

these tools reflects a broader concern about ethical implications, technological dependence, and the potential overshadowing of human creativity. However, the study also reveals an eagerness to understand and utilize these technologies, suggesting a latent potential for enhancing creative processes in design engineering.

We recommend that educators and policymakers take a proactive role in guiding students through the landscape of AI tools. This involves not only teaching the technical aspects of AI applications but also fostering a critical understanding of their ethical implications and practical uses in design. The incorporation of AI tools into educational settings should be balanced, ensuring that students are equipped to use these tools effectively and ethically. As our study shows, students are keenly aware of the challenges and opportunities presented by AI, highlighting the importance of clear guidelines and ethical frameworks. Moreover, the results emphasize the need for ongoing dialogue between students, educators, and the industry about the evolving role of AI in design engineering. This dialogue should address concerns about the potential replacement of human skills and creativity, while also exploring the benefits of AI as a complementary tool in the creative process. By embracing a collaborative approach, we can ensure that future designers are not only technologically proficient but also ethically informed and creatively empowered.

In conclusion, the integration of AI tools like text-to-image generative models in design engineering education presents both challenges and opportunities. The key to successfully navigating this integration lies in a balanced approach that emphasizes ethical usage, critical understanding, and creative collaboration. Through such an approach, we can prepare the next generation of designers to harness the potential of AI effectively and responsibly in their work, ensuring that human creativity remains at the forefront of design innovation.

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Andreas Dagman is a university lecturer at Chalmers University of Technology in Gothenburg. He has published articles on topics such as geometric variation, product development, and sustainability. One of his recent articles examines how to teach computer-aided design at a higher education level during the COVID-19 pandemic. He holds a Msc in industrial design engineering.

Karl Fine de Licht holds a Doctoral Degree in Practical Philosophy from the University of Gothenburg and has been an Associate Professor of Ethics and Technology at Chalmers University of Technology since 2019. His career includes roles as a Postdoctoral Researcher at KTH, a permanent position as a researcher and research manager at RISE, Senior Lecturer at Uppsala University, and a visiting research scholar at UC Berkeley. de Fine Licht has organized significant conferences and has been a supervisor for PhD students. He has served as a reviewer for several prestigious institutions and journals and has been involved in numerous research projects, focusing on ethics in technology and urban development. His extensive publications showcase his expertise in ethics, sustainability, and AI.

Corresponding author

Andreas Dagman
Chalmers University of Science and Technology
Chalmersplatsen
41296 Gothenburg, Sweden
andreas.dagman@chalmers.se