SPECULATIVE DESIGN THROUGH THE LENS OF AI

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ABSTRACT
This review paper explores the evolving relationship between artificial intelligence (AI) and speculative design. Through a literature review analysing ten case studies, this paper highlights the nuances of using AI-driven tools in envisioning speculative futures. The paper investigates how AI influences speculative design approaches to identify the benefits, limitations, and potential challenges when combining the two. The results are presented according to the three most prominent themes identified across the ten articles: using AI for image generation, perceived accessibility of AI, and using AI to envision future scenarios. While using AI to automate parts of the design process is perceived as a significant benefit, some also regard the results produced by AI as uninspiring and needing more contextual factors. This is addressed in the discussion section, focusing on the challenges of AI-generated images. Lastly, this paper discusses the ambiguous terminology used about speculative design and what implications this could have for future research.

Keywords: AI tools, generative AI speculative design, design fiction, critical design

1 INTRODUCTION
Technology is becoming increasingly advanced and more accessible than ever. This is reinforced by the emergence of artificial intelligence (AI), which has developed even further over the past few years, bringing countless new opportunities. As AI continues to become more mainstream, riding off the success of the language model *ChatGPT* and the vast possibilities of text-to-image programs such as *Dall-E* and *Midjourney*, there are many unanswered questions about adopting these tools. Exploring these new possibilities with a sense of urgency and criticality will be necessary, as many disciplines, including design, are entering uncharted territory. We have moved beyond debating whether AI will have a role in design to discussing exactly what role it will play. Recognizing the impact and utility of different AI tools and differentiating helpful tools from potential distractions seems increasingly vital to understanding how AI can be useful within various areas of design. Focusing specifically on speculative design approaches, this literature review maps out ten different use cases to identify the benefits and challenges of using AI in design. The structure of this paper is organized as follows: the first part is a general introduction to AI, speculative design, and the terminology this article entails. The second part involves the methodology conducted throughout this review and presents the case studies that serve as the base point for this paper. The third part introduces the findings, highlighting how AI is used in speculative design and pinpointing advantages and disadvantages. Based on these findings, the article then culminates a discussion about using AI-generated images in speculative design and the challenge of unclear terminology when researching this topic.

2 THEORETICAL BACKGROUNDS
2.1 The emergence of generative AI
AI covers many opportunities, from general abilities like learning and understanding to more specific tasks like playing chess, creating poetry, and diagnosing diseases [1]. One of the emerging parts of AI is generative AI, an artificial intelligence model that analyses existing data and creates new content like images, text, and music from that data [2]. Ray [2] states that models like *ChatGPT* are versatile applications that can be utilized across various domains. This is further emphasized by Latif et al. [3], who highlight the capacity of generative AI models like *ChatGPT* to summarize text, do problem-solving and creative writing, and answer complex questions. As these models keep evolving, it is predicted to affect the jobs of coders, writers, marketers, and designers [4]. Latif et al. [3] do, however,

state that it is difficult to assess the model's capabilities and is, therefore, more uncertain about the immediate impact on the creative industry.

2.2 What is Speculative Design?

For the past two decades, speculative design has played an important role in challenging the status quo of design practice and raising discussion about technological development [5]. Many have embraced this critical design domain, and there are currently numerous definitions and interpretations of what speculative design entails.

Mitrović et al. [5] explain speculative design as a discipline that asks critical questions about the future while highlighting and presenting how the future might look and offering some essential alternatives for today and tomorrow. Auger focuses more on the utility of speculative design, describing speculative design proposals as "tools for questioning" [16, p.29]. He argues that speculative design aims to showcase how technology affects or may affect our lives to create a discussion about the subject. Lukens and DiSalvo [8] emphasize speculation as a design practice encompassing practices from across various disciplines. They highlight the importance of technological fluency in speculative design moving forward, as the discipline keeps blending multiple design approaches. The need to understand technology and how to use it is becoming even more prevalent as speculative design is getting more recognition as a design practice. Dunne and Raby [6] discuss other design disciplines closely related to speculative design. They point out that several disciplines, such as design fiction, overlap interchangeably. When Lukens and DiSalvo [8] explain the term design fiction, they use speculative design to differentiate design fiction as a more recent manifestation of speculative design.

3 METHODOLOGIES

3.1 Identifying articles

Google Scholar was used to find and identify articles about the use of AI and speculative design. The publication search range was set to post-2018 to focus on research from the past five years and obtain the most up-to-date research. When locating articles predominantly about speculative design as a design practice, the search range was set to post-2000 to get a broader perspective. The search words used to identify articles about the use of AI in speculative design were a combination of: "speculative design" AND "artificial intelligence," OR "AI" OR "generative AI" OR "AI tools." This resulted in 2620 results on Google Scholar. However, most of these articles were found not to be articles about the use of AI in speculative design but rather a combination of words like "AI" and "speculative" without a clear connection to the design discipline. As mentioned in the introduction, several design approaches and terminologies are closely related to speculative design and without clear differentiations. Thus, articles mentioning "design fiction" and "discursive design" were deemed closely enough related to speculative design to be included in this review and increased the dataset to 11,000 results. A process of locating and selecting articles that addressed the use of AI in speculative design projects was done by identifying abstracts, conclusions, keywords, and introductions that described use cases of AI in speculative design. This preliminary screening resulted in ten articles offering a comprehensive overview and highlighting AI's most important use cases in speculative design. The ten articles are shown in Table 1, with title, author, publish year, and a brief description of the use cases.

3.2 Analysis

The ten articles were analysed based on the following parameters: use case of AI in speculative design, advantages, and disadvantages. Afterward, the data findings were contextualized and compared to books and articles discussing the general benefits and problems with speculative design. This was done to identify if similar issues occur with or without the use of AI, if new problems arise, and if some specific areas are better suited for using AI.

Table 1. Articles with publishing year and use-case

Name	Author(s)	Year	Use case
AICA: Artificial Intelligence Conversation Assistant [18]	Bhatia et al.	2020	Future scenario, Prototype Testing concept
Poetics of Future Work: Blending Speculative Design with Artistic Methodology [13]	Yams and Muñoz	2019	Co-creation Future scenario

			Ideation
Generative AI Futures: A Speculative Design Exploration [9]	Lin and Long	2023	Visualize artifacts Ideation Image generation
Exploring the Reflective Space of AI Narratives Through Speculative Design in Japan and Germany [16]	Hohendanner et al.	2023	Future scenarios Create artifacts
Contestable Camera Cars: A Speculative Design Exploration of Public AI That Is Open and Responsive to Dispute [12]	Alfrink et al.	2023	Future scenarios Concept video
Pushing divergence and promoting convergence in a speculative design process: Considerations on the role of AI as a co-creation partner [14]	Simeone et al.	2022	Co-creation Ideation
Work of Fiction: Using Speculative Design to Deliberate on the Future of Hiring [19]	Kaur et al.	2022	Future scenarios
Introducing Speculative Design, Gender, and AI in Lean UX for HCI Education [10]	Gonzalez	2023	Future scenarios Ideation Image generation
Artificial Design Fiction: Using AI as a Material for Pastiche Scenarios [11]	Blythe	2023	Image generation Future scenarios
Co-Design Futures for AI and Space: A Workbook Sprint [15]	Mucha et al.	2020	Future scenarios Co-creation

4 RESULTS

This section breaks down the three most prevalent themes identified across the ten articles: Using AI for image generation, the experienced accessibility of AI, and the use of AI in creating future scenarios.

4.1 Image generation

The emergence of generative AI tools that create images, such as *Dall-E, Midjourney*, and *Stable Diffusion*, has opened new opportunities within speculative design. Three of the ten analysed articles write about using AI to generate images or artifacts. Lin and Long [9] used generative AI tools to create speculative designs and visualize artifacts that have yet to exist, bringing new, realistic manifestations of ideas to life. González [10] also utilized image generation in her workshop, where students created personas, wireframes, and images of the future. She states that AI can produce realistic images, which can be used in a design process. Blythe [11] expands on this concept, highlighting the use of image generation in provocative design fiction to stimulate debate and raise awareness about the climate. He emphasizes the ease of producing these fictional images and sees them as a good tool for discussing different topics. On the contrary, he also mentions that AI-generated images make it seem like a more simplistic narrative and fail to consider the complex social, political, and environmental problems surrounding it.

While González [10] focused on creating realistic images, those were still directed toward a speculative design context. The focus was creating user personas and prototypes to allow designers to explore different designs quickly. In Blythe's [11] case, the images created were not realistic, as he classified the images as nothing more than helpful to be used in a mood board or as a think piece in developing a concept further. One of the problems with speculative design today is the over-eagerness to make speculations seem real [6], exemplified in González [10] workshop. Dunne and Raby [6] argue that doing so results in a lack of inspiration and becomes a target of practical thinking. Thus, Blythe's case seems closer to the use of AI that Dunne and Raby envision for speculative design, as the images are created to strike a balance of not being too realistic while still being relatable enough to be a piece for discussion.

4.2 Accessibility

Despite their boost in popularity, speculative design and AI are two disciplines shrouded with unfamiliarity and a general lack of understanding among many. Speculative design might overlap with other design approaches, and AI is complex and constantly changing. It is challenging to grasp either well, let alone both in combination. Alfrink et al. [12] highlight the need for sufficient experience and understanding to constructively debate the implications of implementing AI. Yams and Muñoz [13] experience that using speculative design in future scenarios made it easier for non-programmers to explore different futures. These futures were produced using AI, and through their case study, they also

observed that the more the participants used and learned about AI, the more positive they became towards the technology. They started exploring and ideating more positive futures as they gained more knowledge of what they previously experienced as a complex and challenging technology. Yams and Muñoz, therefore, stress the importance of giving the participants sufficient time to learn and enable them to adapt the use of these tools to fit the needs of their organization. Giving them time to adapt it to their organization also strengthens their understanding as they relate more to their work. Through the same study, it also became clear that the results generated from AI depend on the participants' creative mindset and skills. The students in Simeone et al. [14] highlight the lack of proficiency as a challenge when working with AI as a co-creative partner. The students needed time to understand how to use AI and even expressed their desire to understand some of its fundamental aspects. Later in the process, when they were more familiar and experienced with using AI, they felt that the AI functioned as a co-creative partner. Mucha et al. [15] also mention that AI is perceived as abstract and not well understood by outsiders. They stress the importance of making AI understandable and accessible to more people and propose that design could mediate this gap between people and technology. Throughout their study, they also observed that people became more positive towards AI as they became more familiar with using its tools, which resembles the opinion of the students in Simone et al.'s study [14].

4.3 Future scenarios

Eight of the ten reviewed articles mention the use of AI in speculative design concerning speculations about the future. The use case for these scenarios ranges from creating future scenarios to increase creativity and engagement [13] to envisioning futures where technology-driven digital public spheres are a reality [12]. Throughout the eight articles that use some future speculations, the terminology used when mentioning the future differentiates and ranges between using *future scenarios* [16,15,13], *plausible futures* [9], *possible futures* [13,17], *desirable futures* [15], and *pastiche futures* [11]. Some articles, like Blythe [11], use multiple words, like pastiche, future, and speculative scenarios. The common determinator between the articles is that they all use scenarios to speculate about the future, even though the terminology differs.

In Yams and Muñoz's [13] study, using AI allowed the participants to create products and services for future scenarios. The scenarios made it easier for the participants to understand the negative and positive implications of the products they were creating. Combining AI and scenarios made the participants more creative as they explored more possibilities. Lin and Long [9] saw similar results in their case study, where they experienced that creating scenarios through AI made it easier to develop different concepts. It also helped them to envision what a particular future might look like. Simeone et al. [14] had a different way of utilizing future scenarios, as they asked their participants to create possible future worlds with AI. The scenarios created enabled the participants to engage in the task and think creatively with a specific goal in mind. Yet another way of utilizing scenarios in speculative design is illustrated by Blythe [11], as he introduces AI to make pastiche scenarios. Pastiche scenarios differ slightly from future scenarios, as they borrow characters and styles from literature and popular culture to create and explore different scenarios. The introduction of AI, especially language models, makes producing text in various styles and creating pastiche scenarios easier. However, Blythe critically points out that despite its flexibility and potential, currently, AI does not create sufficiently compelling pastiches.

5 DISCUSSIONS

The analysis of the ten articles has located the advantages and disadvantages of using AI in speculative design. For the next part, the paper will focus on image generation, its challenges, and its potential use in speculative design in the future. The discussion will then delve into speculative design's imprecise terminology and implications for future research.

5.1 Challenges with image generation

Imagery and storytelling are essential parts of speculative design, as this is one of the primary methods, besides prototypes, to convey a design and create meaningful discussions. Utilizing AI, designers can make quick iterations with an immediate visual response. Quick iterations open the possibility to further experiment with diverse and creative visuals, and creating AI-generated images might also inspire designers to discover and experiment with different directions [14].

Understanding the current challenges of speculative design can help contextualize and point out other benefits and limitations of using AI. Dunne and Raby [6] draw attention to the challenge of realism and

how too realistic images can limit the imagination of the people observing them. They highlight the usefulness of cartoon-like images, inspiring people to daydream and think more freely. AI can be prompted to create cartoon-like or unrealistic images, producing many variations in a short time, giving it a significant advantage over traditional approaches. Programs like *Dall-E* and *Adobe Firefly* allow the user to easily alter the image style and compare different images. Thus, the challenge of using AI-generated images is not in creating these images but rather in the designer's knowledge and capability to prompt these programs to achieve the desired results.

Similarly, Blythe [11] expresses disappointment in AI's ability to produce novel and exciting ideas. Even though he highlights automation as beneficial when creating scenarios with AI, he also experienced that most of the images he created were unusable or merely good enough to inspire a final concept. This may be why there is still not an abundance of research illustrating the use of AI-generated images in speculative design. As for now, it is still demanding to use AI to achieve desirable results. It requires the knowledge and time to prompt the programs properly. How long this will be is uncertain, as technology keeps improving. *Dall-E* just released its third iteration, improving the program's understanding of contextual factors and making it more accessible to achieve better results [17].

5.2 Ambiguous terminology

A significant part of this review has been dedicated to identifying articles discussing the use of AI in speculative design. The terminologies used within speculative design overlap, and terms like design fiction, critical design, speculative design, and design future are used interchangeably. A lack of a standardized vocabulary about speculative design can risk confusion or misconceptions. Taking a closer look at how Blythe [11] utilizes terminology, one can exemplify the difficulty in differentiating various design approaches. The beginning of this article gathers critical and speculative design in the same explanation, stating that they often aim to stimulate debate or raise awareness. Auger [7] reflects upon this ambiguous terminology and states that the difference between design fiction and speculative design is subtle, making it difficult for people outside the design community to differentiate speculative design from other related disciplines. Similar tendencies can also be spotted with Dunne and Raby [6] when they point out that design fiction is a narrower genre than speculative design and focus more on using fiction as a workshop tool to explore the implications of technology. By this definition, the study conducted by Lin and Long [9] might seem closely related to design fiction, as it revolves around the future of technology and has a workshop format. The article still refers to speculative design, not design fiction, indicating a discontinuity in how these terms are differentiated among scholars and practitioners. This interchangeable use of terms is further exemplified by how the ten articles use different words to describe future scenarios (see Section 4.3). Additionally, Lukens and DiSalvo [8] explain speculative design as an umbrella term, encompassing practices from different design disciplines. This emphasizes how difficult it can be to distinguish the scope of speculative design from other disciplines, making it harder to use the correct terms. Consequently, locating research connected to AI and speculative design becomes challenging, as only nuances separate speculative design from domains such as critical design. This ambiguous terminology may affect research efforts as highly relevant articles can become challenging to identify due to unclear or inconspicuous search terms. The further AI is being improved, the more research conducted, the more prominent the need for precise terminology might become.

6 CONCLUSIONS

This review has highlighted how AI is utilized in speculative design by analysing ten papers. The case studies illustrate the current use of AI tools in speculative design and pinpoint their advantages and disadvantages. Utilizing AI to generate future scenarios appears to be the most common use case in these papers, as the current AI tools are accessible to designers and can produce adequate results. A benefit of using AI is that it gives people easy access to envision and reflect upon the implications of specific scenarios, functioning as a tool to encourage discussion. For designers, such use of AI can also help to improve creativity, allowing them to challenge themselves to delve into future problems with a more critical mindset. Combining future scenarios with images to either present a potential future or visualize future concepts is identified as one of the primary uses of AI in speculative design. AI enables the rapid creation of images and the possibility to iterate at a moment's notice, testing various image styles ranging from realistic to cartoon-like. Although such image generation can potentially be an important asset in speculative design moving forward, the analysis of the articles also illustrates that AI-generated images currently are perceived as a bit lacklustre, without a solid conceptual framing, or at

best suited as preliminary inspiration. At the rate AI is developing, it might not be far into the future before speculative design can utilize the full potential of AI in more parts of its practice. However, more experience and research need to be added, and a better distinction between different terms used in speculative design could increase awareness about AI's potential and further research on the topic.

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