Design Ideation with AI - Sketching, Thinking and Talking with Generative Machine Learning Models

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ABSTRACT

Generative machine learning models provide opportunities to support design work in various parts of the design process. This study investigates how generative machine learning and large language models may play a part in creative design processes of ideation, early prototyping and sketching. A workshop was conducted in which design practitioners and design researchers developed design concepts for a provided design case, with the help of GPT-3. The findings point to three main themes, including i) the practical usefulness and limitations of the system in design ideation processes, ii) how the form of user interaction shapes users' expectations of the system's capabilities and potentials, and iii), how the broader discourse around AI both limits and enables how co-creative processes involving human and AI unfolds. The discussion outlines design implications and alternative framings of this kind of co-creative design practices based on post-human perspectives on design and technology use.

CCS CONCEPTS

• **Human-centered computing** → *Interaction design process and methods*; **Natural language interfaces**.

KEYWORDS

GPT-3, ChatGPT, Large Language Models, LLM, generative machine learning, co-creation, post-human design, ideation, computer supported ideation

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1 INTRODUCTION

In digitally mediated creative practices, such as interaction design and various forms of digital fabrication, smart or intelligent tools are becoming increasingly common to support or in various ways augment the design process. We are seeing technologies that display capabilities that were previously ascribed solely to human actors, such as design ideation, sketching, and creativity. As a consequence, we need to open up for conversations around what role we should ascribe to these technologies in design-oriented practices and how to integrate them with human values and skills in a co-participative fashion. In this paper, we investigate opportunities and concerns in co-creative design activities with the use of generative AI systems, based on large language models (LLMs), and in particular how these may be entangled in co-creative design ideation and rapid sketching activities. The rapid development of AI and generative machine learning technologies [7], such as GPT-3 [5] and most recently ChatGPT, has made it critical to investigate what new forms of co-creativity such tools may enable and how it can be shaped to align with human values, especially as several of these technologies are explicitly designed to act as or resemble intelligent human actors, being able to produce various forms of original text, images, or programming code of a quality in a style that may be indistinguishable from content created by human actors. This brings to the table questions regarding how to practically integrate such non-domain specific large-scale language models in interaction design practices, and how the interactions and analyses that they are capable of, differ from existing, more specialized AI-based tools aimed at supporting creative design practices. Notably, these technologies have received substantial public and media attention for their impressive capabilities in engaging in human-like conversation on a diversity of topics, as well as responding to human queries in seemingly intelligent and reflective ways. However, we argue that there is a need to study and reflect on how to integrate these kinds of systems in interaction design practices without getting stuck in conversations on the degree to which they are able to mimic or replace human skills and activities. Conceptually, this development coincides with theoretical explorations in interaction design research around notions such as post-anthropocentric [8] and post-human design [34], co-performance [16], more-than-human design [11], and machine agency [22], which all suggest a reconsideration of the view that humans should be viewed as the only source of creative agency, to instead see various forms of interactive and digital technologies as co-participants and co-creators in the processes of generating ideas or in the forming of creative expressions. Most fundamentally, by shifting the focus of viewing the human actor as the sole locus of creative agency, a number of challenges are raised in respect to what it means to do design with these tools, and how these emerging practices can be understood in terms of co-creation. In this study, we investigated these issues through a workshop in which professional and academic interaction designers used GPT-3 as a resource to develop and sketch out design ideas for a given use scenario targeting the emergency waiting room experience for families. The practical design exercises were intertwined with

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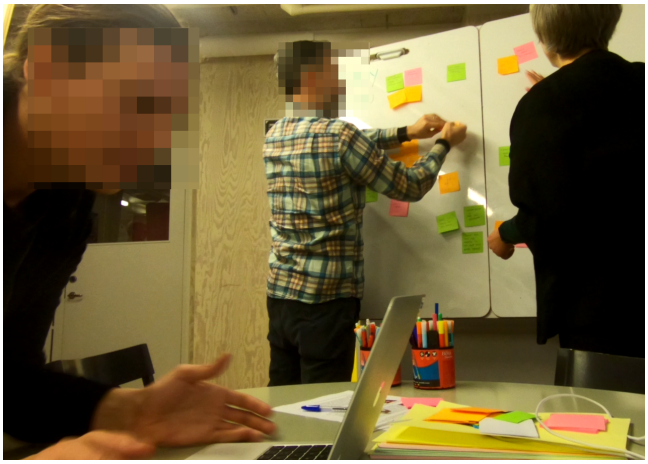

Figure 1: Participants engaged in ideation using generative AI

reflections on the experience of the activities at hand, and on more general issues relating to co-designing with AI. The analysis of the collected materials resulted in three broader contributions presented in this paper: a) An outline of opportunities and challenges for the use of generative AI systems in interaction design ideation activities, b) A discussion of implications for the development of novel interfaces and metaphors for the use of AI-based ideation system, and c) reflections on conceptual aspects of co-creativity in the context of interaction design practice and AI

2 BACKGROUND

2.1 Computer-supported creativity

There is substantial interaction design research into ways of supporting the early stages of design processes, such as ideation and sketching [10, 12, 14, 36]. Design ideation is commonly conducted through group work in more or less structured approaches often using well-organised methods. Examples of ways to support such processes include various brainstorming approaches, role-play and embodied [36] sketching techniques, as well as card-based methods [26]. The card-based approaches exist in many variants and aim to support designers in actions such as generating design alternatives, team building and collaboration, opening up design spaces, reconsidering design problems from new viewpoints, and providing checklists or reflective tools for consideration of values, norms, risks, and challenges. Card-based approaches are typically designed to be open-endedly used in design exercises and a key aspect of most card decks is that designers can easily vary the way they use them depending on the user and the context of the particular task at hand. The static character of card decks is also what makes them flexible and easily shifted between context and settings [26]. There is also a range of digital tools and systems developed to support the creative processes of designers [10], providing for example generation of design alternatives in visual and graphic design, tools for narration and storytelling, game-design tools, and support for programming. Bernal et al. [4] account for different ways computational aids may support design, particularly pointing to specific designer activities such as the *generation*, *evaluation*, and *selection* of design solutions. They further categorize the resulting designer-computer actions as either; a) *computer aided actions*, providing feedback or facilitating tasks, b) *computer based actions*, automating processes, and d) *computer augmented actions* - extending the designer's capabilities to potentially improve the design quality. What becomes apparent in this overview, is that a majority of existing support tools for designers are highly specialized, potentially providing specific responses to the users in ways that may effectively tie on to what the user is trying to achieve. This significantly differs from the general purpose, large language models, that are in focus in this paper.

Computer-supported creativity could also be discussed in terms of *co-creation*, highlighting tools that also produce actual design content through the automation of certain design tasks. The concept of computer-aided design (CAD) and the implementation of CAD software tools emerged in the 1960s as a means to streamline the design process and reduce the amount of time and expertise required. According to Albaugh et al. [1], CAD systems can be classified as "time-saving systems" that delegate repetitive or time-consuming work to the computer, freeing up the designer to focus on the creative aspects of design. An advancement of CAD is the field of generative design [21], which involves the use of algorithms to generate design variations and optimize existing solutions, particularly in 3D models for industrial design and architecture. A subcategory of generative design is grammar-based techniques, which enable the automatic creation of complex forms and patterns from simple textual specifications [6]. In general, these computer-aided design tools support design and creativity by reducing participation barriers through the automation of complex tasks. Additionally, they also facilitate the exploration of design spaces by presenting variations of potential solutions, which can serve as inspiration for design [20].

2.2 Prompt engineering and natural language interaction

A key characteristic of the kind of AI systems used in this study is that they rely on natural language interaction, allowing the user to interact with them in an open-ended chat-based dialogue, to some extent resembling that of human-to-human interaction. Furthermore, there are no clear limitations on the kind of topics that the system may interact around. It provides potentially relevant responses to user input no matter if it concerns cooking, space technology, or 15th-century history. This type of open-ended black-box system introduces a number of challenges for the user in the interaction. Studies on voice-based conversational agents such as Alexa and Siri, highlight how natural language interfaces do not communicate their capabilities in the same way as traditional graphical user interfaces. Instead, users bring expectations of using natural language from other settings, most commonly from interaction with other natural language speakers, and adapt their interpretation of the system's response accordingly. [18, 23]

A different perspective on the natural language interaction with the large language models such as GPT-3, is in terms of *prompt programming* or *prompt engineering*, where the focus is not so much on mimicking human-to-human conversation, but rather on learning how to instruct the system to get appropriate and useful responses.

As noted in previous studies, such as [15], interaction with large language models often becomes an issue of struggling with syntax, and "cracking the code" for how to talk to the system. Reynolds and McDonell [25] note that interaction with a language model that draws on natural language interaction can be understood as a form of programming in natural language: "Prompt programming is programming in natural language, which avails us of an inexhaustible number of functions we know intimately but don't have names for. We need to learn a new methodology, but conveniently, we've already learned the most difficult foundations. The art of prompt programming consists in adapting our existing knowledge to the peculiarities of interacting with an autoregressive language model" (p.3). This highlights how natural language is indeterministic and thereby much more complex than traditional programming languages, potentially making design for natural language interaction more challenging.

2.3 Co-creativity and post-human interaction design

The anthropomorphic and human-like character of the interaction with generative AI and large language models challenges existing paradigms on the interplay between human and machine in the context of creative design and ideation. Contemporary theories on post-humanism and post-human design [8, 35], may contribute with useful conceptualizations for characterizing activities of co-creation between humans and artificial intelligence. This connects to the broader conceptual conversation in HCI on material and machine agency [2, 3, 11, 22, 29, 32] as being shared, or distributed, among humans, machines, and artefacts, and the reconsiderations of processes of design and interactivity that these imply. At its core, post-human perspectives on design reject the traditional dichotomies between humans and machines in favour of a perspective on design in which humans and machines are considered to be co-participants in processes of ideation, design and making. These theories put to the fore how human agency must be understood as entangled with agencies that stem from non-human entities, e.g. as extensively elaborated in notions such as agential realism [3] and machine agency [22]. Of particular relevance for the present work are studies that question traditional categorizations of design and creativity as relying on step-by-step models as going from design ideas - to digital representations - to machine execution, and instead view humans, materials, and machines as entangled in co-creative and co-performative ways [15].

We argue that novel artificial intelligence systems are particularly interesting to explore as a form of non-human co-performer as they display properties that resemble those that would be ascribed to - or expected by - human actors, such as problem-solving and natural language interpretation. An important strand in post-human and post-anthropocentric interaction design has challenged common expectations of AI systems to work as rational predictable actors, for instance through notions such as uncertainty [19], imperfection [13, 31, 33], and under-determination [1], and the consequences these have on the way we conceptualize and design tools and methods for these practices.

3 STUDY SETUP

The study was organised as a half-day workshop with eight participants. The participants consisted of five professional designers (two industrial designers, two organizational designers, and one user experience designer), and three researchers in interaction design and HCI. Before the workshop, the participants were informed about the overall goal and the activities that would be conducted. The workshop was divided into three phases; a rapid design exercise with the support of AI tools for ideation, visualisation and sketching, a design reflection exercise, and finally, speculative design activity to envision novel usages of AI tools for interaction design. The participants were divided into three groups so that each group had one participant with prior experience in using the AI system. For the initial design exercise, the participants were provided with the following design challenge: *"You have been asked to radically improve the experience of families with children visiting the emergency room, with a particular focus on the waiting room experience."* The design challenge was created based on the research and outcomes from a prior design project. The provided material consisted of a brief general description and three more detailed user personas, with Figure 2 showing one of the personas as it appeared in the material. The design exercise was set up using commonly used

Figure 2: One of the three personas that were provided to the participants as part of the design challenge, and that were also incorporated in some template prompts to the AI

design methods in interaction design and consisted of ten separate design activities, as outlined in Table 1. For each of the activities, the participants were asked to integrate the use of the AI tool into their activities. The setup of the design exercises should not be understood as an attempt to create a realistic design situation, since the activity was moderated and time-boxed, restricting the designers' control of the design process. Each activity however resembles commonly appearing activities in design, creating opportunities for the participants to relate their experiences to experiences from their professional practices.

The AI tools that were used were the GPT-3 model (davinci-003) from OpenAI [5], used in the "playground"-mode, through OpenAI:s webpage (see Figure 3), and the DALL-E 2 model, also from OpenAI, for image generation. For each design activity, a number of preset templates were generated, with suggestions for prompts to use as input to the AI system. Some of the presets were more extensive, such as the prompts used for ideation, in which the three predefined personas were incorporated into input to the

Table 1: Design Activities performed during the workshop

Design activities	
1. Group ideation (without AI)	6. Choose one concept (without AI)
2. Ideation with GPT-3, using three different presets	7. Create concept visualisations using Dall-E
3. Select three concepts (without AI)	8. Create a mood-board using Dall-E
4. Design critique on concepts with GPT-3	9. Create an implementation and testing plan using GPT-3
5. Create design alternatives with GPT-3	10. Create a scenario using GPT-3

system (see Figure 3), and the scenario activity, in which an example scenario was provided. The ideation presets were also configured to result in a chat-like interaction, whereas other presets were shorter, providing examples of how to ask for variations of a concept or to identify problems in a suggested concept. In each activity, the participants had to modify the presets, to include their own ideas, or to articulate specific instructions to the AI system. The following quotes depict a few example presets that were used:

> *Perform a design critique and identify ten problems with the proposed design concept: (Add your concept here)*
> *Provide ten alternative design variations and elaborations of the following design concept: (Add your concept here)*
> *Provide details on how the following concept could be realized using both technological and organizational means. Also detail an implementation and testing process. (Add your concept here)*

The entire session was filmed, and design ideas and sketches from the participants were collected. The participants also wrote two rounds of individual written reflections concerning their experiences and ideas around the use of the AI tools in the design activities. The workshop also involved discussions in groups on more general questions regarding the use of generative AI in design, such as discussing its overall usefulness in design practice, possible novel forms of interaction, and how to perceive of unpredictable or unexpected behaviour of the system. This part generated both written reflections from the groups and video recordings of their discussions. The video recordings and written reflections were transcribed and added to a spreadsheet used for analysis. The findings were then analysed using thematic analysis and open coding.

4 FINDINGS

The design phase of the workshop was carried out at a high pace, where the three groups worked in parallel with the given challenge, through the ten design activities. A majority of the activities required that the participants interacted with the AI system, but there were also activities where the groups worked without a computer, such as an initial brainstorming session, and activities in which the groups had to narrow down first to three, and then select one design concept to move forward with. As depicted in Figure 1, the activities were not fully centred around the computer., often one person in a group took responsibility for interacting with the computer, whereas the others took notes on post-its, and organized them on a whiteboard. The activities shifted from moments when all three group members were engaged with the interactions on

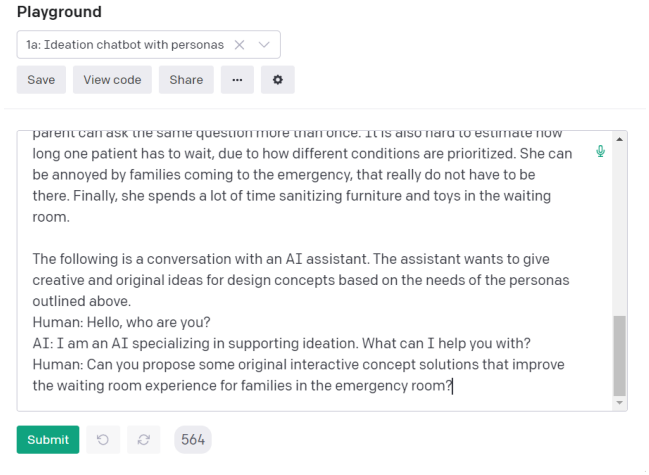

Figure 3: The playground user interface including parts of one of the presets that were used for ideation

the screen, to activities where they shifted focus from the screen to instead interact with each other around the table or standing by the whiteboard. Throughout the workshop, a large number of data was generated by the AI tools, including concept ideas, concept variations, lists of potential problems, scenarios, concept art, and mood boards. Much of the generated data was quickly discarded by the groups, but they were asked to save particularly interesting ones in a separate document. The participants were also encouraged to use the AI-generated output as inspiration, but they could also come up with their own ideas or rewrite AI-generated suggestions in any way they liked. Some examples of AI-generated ideas that the participants saved include:

> *An autonomous AI-sanitizing system with an attached camera that can detect dirt and other contaminants on the toys in the emergency waiting room*
> *Waiting room furniture is designed as a labyrinth. With see-through glass so separated families can communicate with each other*
> *An interactive personal augmented reality playmate for kids that guide, support and provide comfort for the kid during a visit to the hospital*

The examples also included problems identified by the AI-tool in relation to the suggested concepts, e.g.:

> *Interacting with the AI toy may not be engaging enough to keep children occupied for long periods of time*

There is no mention of how the platform will handle emergency cases where a patient may require immediate attention

Some of the generated concept art generated using the AI-based image generator (DALL-E 2) are illustrated in Figure 4.

The core of the analysis of the study is based on the participants' reflections and conversations around the design activities and can be structured into two main categories. The first concerns the opportunities and challenges that the participants experienced from using the AI tool in the design exercises. These bring to the fore how they experienced that the AI worked to support certain design actions while getting in the way of others. The second category concerns the interactional challenges that users faced when using the tools and the consequences of these for engaging in meaningful and productive design actions.

4.1 Rapid generation of design alternatives

The participants identified a range of different practical usages of the system such as rapidly generating design alternatives, identifying design problems or creating short scenarios of use around various design challenges. Other useful usages the participants identified included things such as creating various forms of checklists for things to keep track of in a design project, getting a first set of ideas to start out from, or getting hard-started or inexperienced groups going at an ideation session. Each of these activities is time-consuming, but not experienced as particularly complex or advanced, reflecting what [15] denoted as a way that tools may *lower friction* in design work by simplifying or speeding up the process. The possibilities for rapid generation of design ideas that the system allowed for, and the large number of potential ideas that this could result in was one of the most reflected themes among the participants. The way we had set up the presets in the system supposedly reinforced this, but due to how easily new queries could be posed to the system, it allows for getting immediate responses without any practical limitations. The participants identified a range of different strengths and weaknesses in the fact that the 20-30 new design ideas could be generated in only a few minutes. Several participants did not find the ideas that were generated to be particularly novel or creative. They were described as being "*simplistic*" or "*too straightforward*", thereby not providing any value beyond what the participants could quickly create on their own. A contrasting point of view of several participants regarded a criticism of the system for being "*too good*" at what it does. By generating a large number of quite similar ideas, it was claimed that the system would run the risk of narrowing the designers' perspective on a particular problem rather than opening up a design space and helping to see novel opportunities.

Despite such scepticism, in the written reflections, many participants discussed the variety of more constructive usages that they could envision from the possibilities to rapidly generate a large number of design alternatives. Several participants suggested that the system could be valuable in order to get rid of "*the obvious*" or "*less creative*" design ideas, allowing the designers themselves to spend less time on design ideas that would not lead in any creative directions. This type of interaction is similar to that of specialized tools for algorithmic or generative design, which effectively produce variants of design concepts by rule-based or random manipulation of different parameters of a design. As noted by [4], generative design can lead to apparently creative outcomes since every new combination brings opportunities to look for new emergent properties or affordances. In reflecting on how the rapid and immediate generation of new design ideas may influence a design process, some participants discussed how the more slow-paced, reflective elements of a design process might get lost with the introduction and use of tools that instantly can be used to regenerate new ideas and propose alternatives design. One participant framed this as a need to address the risk that AI tools may counteract how human designers often need the time to "*slowly and achingly*" arrive at the key aspects of a design idea and how ideas often grow and change overnight, and furthermore, how such slow, reflective, refinement and articulation of a design idea happen when you move to unusual settings, juxtapose ideas with other alternatives, or experiment with how an idea would be manifested and experienced in alternative design materials [28].

4.2 Lack of context and memory

In contrast to the usefulness of the rapid generation of ideas, another theme that emerged in the reflections of the participants around the use of the system in the design activities concerned 1) the system's lack of understanding about the context of the design problem being worked on, and 2) the system's lack of memory of the unfolding interaction and emerging design concept. As discussed above, several of the participants found the ideas and issues generated by the system to be useful and relevant for the ongoing design exercise. However, a number of more critical reflections pointed to how experiences of the "*system's lack of context*" was problematic and that ideas and issues identified about the design ideas that were generated *"lacked depth"*. This was formulated in a number of ways such as that the system had "*no reality check!*" or that the system was only useful for "*going wider, not deeper*". Hence, the system was experienced as working well to produce quick ideas on a topic but not to elaborate or unpack it to any further extent. In a related fashion, one participant described this as a "*lack of holism*" in the responses from the system. As the participants used the system to explore and dig deeper into one specific design scenario, several participants reflected on how the system did not develop an understanding of the design idea in a manner that aligned with how their own thinking about the idea developed. One participant phrased this as experiencing that it was "*unclear what it [the system] remembers*" regarding the ongoing interaction and the design idea being developed. While the system often generated design ideas in a fashion that one would expect required an understanding of the design problem, the participants reflected on that there was no actual way of knowing if the system repeatedly created new ideas from scratch or if these were generated in relation to what had been proposed earlier.

Despite this, several participants talked about how they noted a "*high understanding from the AI*" in its interpretation of the queries and the design ideas and problems that it generated. However, in order to explore a design space it is critical for designers to know the direction of their design process, where they are currently at,

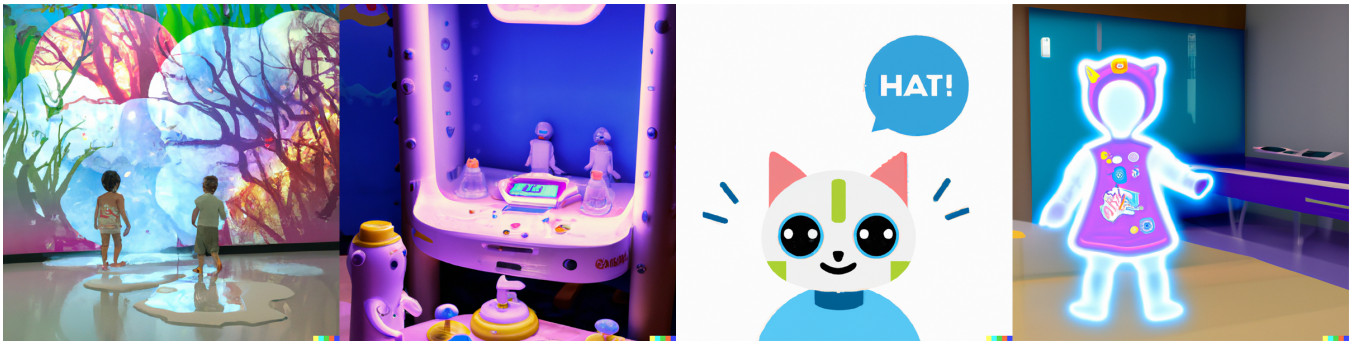

Figure 4: AI-generated concept illustrations, illustrating, a) A game for children where projected bubbles on the floor help children to keep distance to avoid spreading germs, b) Toys for the waiting room that uses UV-light to disinfect the toys after usage, c) and d), a personal digital assistant targeting children and parents, that can answer questions about the hospital record

where they have been, and where they are headed. This was experienced as problematic by several of the participants that expressed that they found the system to be most useful in "*searching for ideas*" or to "*generate and probe a variety of different perspectives*". Clearly, at the core of any design effort is to have an understanding of the circumstances in which the design work is conducted and to remember how the different considerations and design choices relate to one another. As noted by [4], it becomes hard for computational design support to integrate seamlessly with an ongoing design process as "designers are able to rapidly identify relevant aspects of a problem and constantly shift the direction of design development through reformulation, analogy, or co-evolution but receive little or no computational support for such behaviour". This also ties into the well-established discussion in HCI on the situated nature of human interaction [30], and the challenges for intelligent systems to cope with the contextual nuances and complexities that are always at stake in social human activities [23].

The participants experienced the lack of contextual understanding and memory as a weakness of the system. However, this property was also discussed as a potential resource in the design process, in that it would resemble "*unrealistic humans*" that would propose ideas without being limited by what was possible. In a similar vein, it was proposed that ."*humans should do realism*" and that an AI system could instead be used to go beyond the expected.

4.3 Talking to the machine

Several of the participants highlighted the work of articulating instructions to the system as a core part of the design activities. Similarly, [15] pointed out how users in natural language interaction with generative machine learning systems experienced that they had to develop an understanding of an undefined *syntax* that the system would understand in interacting with it. Our findings suggest how users needed to pay significant attention in articulating queries to the system in order to work out ways to get the system to respond as they wished or expected. While some experienced that the system required them to spend too much attention on the details of formulating such queries, others felt claimed that the process helped them "*figure out and fine-tune*" their design idea within the group. Thus, the interaction had the dual purpose of getting the most out of the capabilities of the machine, and at the same time to develop and refine define ideas between the designers working together, independently of the responses that the system actually provided.

Furthermore, the participants reflected on how the seemingly endless number of ideas and alternatives that the system could generate after some time of using the system was experienced as becoming "*similar to googling*". One participant mentioned that even though the style of interaction was quite different to most search engines. the activity resembled that of browsing through an almost endless number of alternatives in an archive or resembling that of traversing similar style video clips on social media platforms. As discussed above, the participants got engaged in an ongoing refinement process of articulating queries that would result in useful and interesting responses. This involved experimenting with various phrasings, and making choices of certain terms or words in order to get the system to "*understand*" what they were aiming for. One participant compared this to articulating search terms to a database and using filters to delimit between a large number of options. The key difference is that the AI system used in this study has no predefined syntax or a given set of parameters, but the articulation has to be made using natural language. This reflects Reynolds and McDonell's [25] discussion of how successful prompt programming for large language models instead "entails high-level, mentalistic concepts like tone, implication, association, meme, style, plausibility, and ambiguity". Furthermore, the participants reflected on how the reframing of design ideas through a metaphor of search would influence how a designer would understand, interpret and make use of the system's responses to various interactions. Viewing the interaction as a form of browsing and searching for ideas in a space of available resources, it was suggested, would provide a different experience of the system than interacting through the articulation of open-ended natural language queries, or being in a conversation with the system would. Thus, the experience of how the system could be used in an interaction design process is shaped not only by how well it performs particular tasks such as ideation or generating design alternatives, but also by the particular metaphor of interaction that the system builds upon.

4.4 Sketching with text and visuals

Most of the activities in the design exercise relied on text-based interaction with the GTP-3 model. One part of the design task, required the use of DALL-E 2 image-generation model to generate concept illustrations and mood boards for the project. A recurring conversation among the participants concerned the difference between text-based and visual interactions. In reflecting on the character of the visualisations and illustrations created by the system, several participants pointed to how the seemingly "well-polished" character of the visualisation would make it challenging to generate alternative designs, as there were no glitches, defects or *sketchiness* that a designer could pick up on to question or challenge various aspects of an idea. *"I think a problem with the AI generating a visualization so easily is that you straight away get a narrow view of what the solution will look"*. Some participants however expressed a contrasting view in discussions about the difference between a visually generated concept idea, vs. a text-based one, where the participants argued that the generated images were still more ambiguous and open for interpretation compared with the, sometimes detailed, textual concept suggestions.

The role played by the particular modality in which the interaction is carried out ties into conversations on the practices of *sketching* in ideation and design activities. Sketching has often been put to the fore as a foundational activity in all design practices, as a form of dialogue where externalizing ideas in written or visual forms becomes an integral part of thinking and doing design [9, 14, 17, 27]. In a study on the tools that designers use for ideation, Jonson [14] shows that most designers use a mix of language-based and visual tools, suggesting that design ideation emerges in interaction or in conversations between visualisation (non-verbal) and language (verbal). That textual interaction is central in the use of large language models such as GPT-3 is not surprising, since language and text-based modalities are the foundational elements that they are built and trained on. In addition, AI models for image generation, like DALL-E, are very much dependent on language, and textual forms of interaction. During the workshop, some participants expressed that they would have liked a system that combine text and image generation capabilities in one interface. This dependence on text and natural language highlights some of the limitations that the participants experienced seamlessly shifting between verbal and non-verbal forms of sketching. In addition, the participants' accounts on the impact of the "finishedness" of both visual and textual outputs from the AI models, point to a tension with sketching as a process of engaging with the open-endedness and unfinished character of design ideas in the early stages of a design process. This reflects early studies on the impact of CAD tools on creativity, where Lawson and Loke [17] note that *"inability of conventional CAD drawing tools to sustain ambiguity, uncertainty and parallel lines of thought makes them very different from manual sketching"*. How large language models and generative image models may support various aspects of sketching will thus have to be explored further.

5 DISCUSSION

Our findings highlighted both opportunities and challenges for integrating large language models in creative design and ideation. Here we will focus on three particular issues that we argue are of central importance for future developments of AI-based tools to support creativity in interaction design processes: Firstly, we discuss the characteristics of this kind of computer-supported ideation, in comparison with other tools. Secondly, we highlight different ways of understanding interactions with the system in terms of four kinds of interaction metaphors, and why that framing matter. Finally, we propose a conceptualization of the interactions with the AI-tools based perspectives from co-creativity and more-than-human design.

5.1 Design ideation with AI

Our study shows that the participants saw a range of potentially useful ways for integrating and making use of this kind of system in design work. This included both speeding up the design process to avoid unnecessary time-consuming humps along the way, as well as engaging designers in reflections and articulations of their ideas, helping them see new perspectives and opportunities. Importantly, the participants did not find the responses from the system to be "good" design in itself, but became meaningful in relation to the participants' interpretation of the design task. Not surprisingly, no matter how the participants interpreted the intelligibility and usefulness of the system, the necessity and importance of human reflection in these processes were deemed critical. One aspect that recurred throughout the workshop was an emphasis on situating the actions of the system within a certain context or practice within which the participants' interpretation and sense-making would take place. Whatever response the system provided, "human reflection" and meaning-making were always deemed critical in order for the system's responses to be interpreted as meaningful design actions. On several occasions, however, the design ideas that the system proposed were described as being "*hollow*", by lacking reference to the intentions and rationales behind the queries articulated by the participants.

This raises a number of concerns regarding how to position these kinds of tools in interaction design processes, and how they relate to other existing tools and methods designed to support creativity and ideation. One issue regards how important the seemingly intelligent interaction and human-like communication is for the usefulness of such a system. Does the design ideas or design problems that the system generates contribute to any substantial degree beyond what, for instance, various types of design cards that support designers in rapidly envisioning different alternatives, perspectives or values? While this is a question that needs further empirical work to be answered, it highlights the need to further unpack how the various actions of an AI tool may play a role in emerging design processes. As has been previously noted, existing tools to support creativity and ideation are in most cases highly specialized, targeting either particular design practices, such as generative CAD tools for industrial designers, or support for particular design domains. Large language models differ through their generic capabilities, while at the same time being able to contribute with domain-specific knowledge. This can be contrasted to card-based approaches, which are often generic across settings and contexts, and lack domain-specific knowledge [26]. What became apparent in our findings was that the participants appreciated the more generic reasoning capabilities

more than the domain-based knowledge support. The system's ability to generate design variations or identify problems or challenges to a concept solution was considered more useful than the generation of unique design ideas. Actions and activities involving the AI tool that provided a space for interpretation and meaning-making were appreciated by the designers, while more "precise" programming style actions, as studied by [15], were more challenging to see a use for.

Another issue that recurred throughout our findings concerned how working with the AI tool on a particular task compared to working with another person on the same task. One participant in the study argued that the AI system would be most useful when working alone, providing a means to engage in an interaction, getting feedback on ideas, and developing them further. The AI system would essentially fill the role of another human co-worker. Other accounts from the participants, instead lifted that the strengths of the AI system lie in its capabilities to go beyond what is possible for a human designer, such as generating a large number of ideas or variations in a very short time, mirroring what Bernal et al. [4] categorize as computer-based actions, aimed at automating and speeding up processes. One participant argued that humans should "do realism", whereas the AI should contribute with ideas and input that are out of reach of the human designers. This type of support, Bernal et al. [4] would categorize as computer-augmented actions that aim to improve the design quality. Along these lines, the ability to provide odd, random or unexpected contributions might cause confusion, as well as encourage reflection and spur new directions of creativity. Albaugh et al [1] argue that this is a particular type of support that differs from the time-saving approaches that were discussed previously, and instead provides a "time deepening" function, disrupting the process, and opening up for new avenues of thought.

5.2 Interaction metaphors

The interaction with the GPT-3 system in this study made use of the "Playground" interface, provided by OpenAI. This interface is a graphical user interface, where the main interaction element is a large text field, where the user can input text, and where also the text generated by the AI appears line by line, and a "Submit" button that will initiate the response from the model (see Figure 3). This fairly plain interface opens up for several possible interaction metaphors, depending on the system's behaviour. In comparison, the more recent ChatGPT interface has a similar design but is explicitly presented as a form of chat, based on an interaction metaphor most commonly used in human-human communication systems, such as text messaging and chatting. In the participants' accounts in our study, they explicitly and implicitly described the interactions with the system in relation to other interactive systems and forms of interaction, which reflect not only different ways of understanding how the system works, but it also suggests how different framings of the overall structure of the activity shape how the interaction unfolds. In the following, we will discuss four different interaction metaphors, that could be identified in our data; a) *conversation-based metaphor*, b) *command-based*, c) *search-based*, and d) *chance-based* interaction metaphors. Next, we further reflect on how they influence the relations and interactions between human and technology in interaction design ideation.

A conversation-based interaction metaphor suggests a conversation between human and technology, mirroring human-to-human dialogues. A significant part of the accounts in our findings reflect this perspective, attributing subjective characteristics to the AI model, for example talking about what it *"understands"* in the conversation, and that *"getting to know the AI"* was common ways that the participants described their ways of interpreting the actions of the AI. This reflects studies of conversational interfaces [18] that point to how users commonly bring expectations on how such interaction would be similar to human conversational structures [23, 24], and that people (as well as designers) often expect that interactions with a machine would unfold in a similar manner as human social interaction would, mirroring the assumption that a speaker produces meaningful and intelligible utterances in response to someone's actions. Importantly, this has been identified as one of the reasons for the interactional troubles that reoccur in interactive systems that attempt to imitate human conversations, since the machine inevitably lacks some of the contextual cues that human interlocutors typically rely upon in human-to-human interaction [30] . This kind of asymmetrical relation to the context of the conversation and memory of how it has unfolded was explicitly reflected in our participants' conversations around how well the system perceived their actions. As pointed out by [23], one reason why these troubles arise is that conversational interfaces are seldom designed to allow users to engage in the kind of repair work that is at the core of how human conversations unfold. Further, our findings showed how the conversational style of interaction shaped the way users interpreted and made sense of the responses that the system generated concerning the design exercises, and often created a frame of expectations that went beyond what the system was actually capable of, illustrated, for instance, by remarks from the participants regarding how well the system *understood* the design problem or its *interpretation* of their queries.

A more prominent interaction metaphor that can be identified in our data, is an understanding of the AI system as *command-based*, suggesting that you provide a particular instruction to the system in order to get a particular response. As has been discussed earlier, the users' work of figuring out a working syntax is a non-trivial task in the context of the open natural language interaction with large language models, and has been described in terms of prompt engineering or prompt programming [25]. Co-creating ideas with the AI system in the design exercise was often based on instructions such as "Propose five concept ideas on...". Notably, this type of interaction is distinctly different from the type of direct manipulation interfaces used in most tools designed for sketching and lo-fi prototyping. The shift from command-based systems with complex syntax (e.g. the Emacs text editor), to systems based on physical manipulations of graphical elements, was largely driven by the development of tools to support creative work such as programming and design.

A related analogy of use that was explicitly brought up by the participants, was that the interaction of generating new concept ideas resembled that of *searching or browsing* the internet using search engines. The participants highlighted similarities such as the natural language interface, through which users may become

increasingly skilled in formulating search queries, and gets a well-defined output in response. Furthermore, the participants highlighted that the ideation process using the AI system extensively involved browsing and sifting among large numbers of more or less relevant idea suggestions, which in a sense became a way of defining the boundaries of the design space. Framing the activity through this kind of use of the large language model mirrors that of using systems for generative design of 3D models [21], which uses rule-based algorithms to generate design variations, serving as inspiration for design [20]. A final example of how the system was interpreted by the participants, is based on accounts saying that they felt that the system responses would sometimes not at all correspond to their intentions, providing more or less random output, reflecting a *chance-based* interaction. As has been shown in earlier studies [15], giving the users something else than what they asked for, may actually support creativity, by introducing a form of *creative friction* that encourages reflection in action, and opening up for unexpected turns in the design process. Chance-based interaction is also foundational in most card-based approaches for ideation and creative design in that there is always an element of randomness and surprise in the cards someone receives.

The four interaction metaphors presented above do not form an extensive list of all possible ways in which interaction with AI could be understood, but the discussion highlights that the common conversational interaction metaphor need to be challenged, in order to frame and reconfigure what users' expect from the system in relation to what it is actually capable of, as well as how they would interpret and understand the actions and responses of the system. Conversational or command-based approaches might not be ideal interaction forms to support sketching activities, while being better suited for design activities that aim at opening up design spaces or rethinking problems.

5.3 Designing with - perspectives on co-creation

A preceding study [15] on co-creation with AI in creative programming, highlighted how the presentation or "framing" of the tool in relation to the activity influenced the users' expectations of the system's action and how they valued and interpreted the meaning of its responses. In particular, the distinction between understanding the AI system as either a tool or as a co-creator was emphasised as two alternative ways of framing the interaction in relation to the users, and which would foster different ways of interpreting its actions. This aligns with how perspectives such as more-than-human design and co-creativity in the last decade have been concerned with re-conceptualising the ways novel interactive technologies can hold various forms of *agency* in interactive settings. Notions such as material- and machine agency have been introduced in order to rethink the actions and relations that emerge when these technologies become entangled with human users. Importantly, in HCI, the notion of machine agency is not about ways of understanding how human agency and intelligence is manifested in technology, but about how novel forms of agency may expand and co-exist with human agency. Such questions of the agential capacities of the system were also an overarching issue that appeared throughout the present study, most prominently through the participants' engagement with the system's potential to *understand* various aspects of the user's actions, such as queries to create certain kinds of design alternatives, or how *imaginative, or creative* the system was in the responses that were generated. A typical comment from the participants was that there was "*generally high understanding from the AI*" or sometimes the opposite "*it was not very creative*", but also in more diffuse ways *"Sometimes it does whatever it wants, but often it feels like it understood things in approximate ways, and that it after its best abilities did what it should"*.

The users expectations regarding the AI's capacity for understanding and creativity are certainly relevant ways to reflect on the qualities of a system such as this, but to consider the AI system as a co-creative design partner does not require that it displays human thinking skills, or that we draw on conceptions such as *understanding* or *intelligence* in interpreting the value of the system's actions. We find that this runs the risk of overshadowing more pragmatically oriented considerations of how the qualities of the system may be used in design processes, no matter how well they reflect what we would perceive as human cognitive traits. We believe that our findings challenge several existing conceptualizations relating to the agential capabilities of interactive systems; both the tool perspective, referring to an entirely passive system that only carries out the user's instructions, as well as a perspective of intelligent agents, as discussed above. This ties into the conversations around any alternative conceptualisations that could capture the nuances and complexities involved in the "dance of agency" [22] of co-creative settings involving both humans and AI tools.. Wakkary's [35] notion of more-than-human design, and specifically the notion of "designing with" suggests one perspective that serves to reconfigure the dichotomous ways of perceiving the relations between users and systems, to instead consider design as a joint achievement among different actors and artefacts. We argue that such a perspective on design with general-purpose AI tools, provides an opportunity to reframe our perception of the system behaviour, in a way that purposefully helps designers to draw on and integrate its capabilities in design practices, no matter how similar they are to human design skills. This challenge as we see it, lies in reframing the space *in-between* the user and the technology in a fashion that helps designers to perceive the tool as able to do the things that they cannot do. In other words, this entails framing the use and interaction with this kind of system, not as different ways of seeing how the human and technology can engage in co-creativity by doing almost the same things, to instead seeing them as doing different things differently.

6 FINAL REMARKS

In this paper, we have accounted for a small scale study of how large language models and generative AI can support creative design and ideation. The analysis of the participants' reflections, highlights both opportunities and challenges in the interaction and use of the system for purposes of design . The opportunities that were most clearly identified, concerned saving time, by quickly mapping out a design space, and identifying the most obvious ideas, as well as finding potential flaws in various design challenges. The participants also saw a potential for generating complementary working materials such as scenarios and personas. The participants

however did not trust the AI to be able to generate high-quality and innovative solutions on its own, pointing to that the system is lacking an in-depth contextual understanding of the design case and also, the fact that the AI system was perceived as being very fast resulted in a view that the system was more useful for *going wide* when exploring a design space, *rather than going deep*.

The analysis highlights how the experience of using the system was influenced by the interaction metaphor that the system are based upon, and a kind of conversational style of interaction that mimic human-to-human communication may work as a resource, as well as a hindrance in the design process. The participants experienced similarities in the interaction with the AI system to that of using a search engine. In addition, our findings suggest that the users' expectations of the systems as being humanly intelligent and creative, brings in human-like traits that potentially gets in the way of alternative conceptions for design of interfaces and interaction for co-creation with AI. To open up for novel alternatives, we have argued that post-humanist and more-than-human perspectives on design allow for a consideration of machine generated design actions as creating opportunities to design co-creative settings that make better use of the different capabilities and characteristics of human and machine.

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