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Interaction Between Designers and AI: Literature Review of Research to Highlight the Characteristics of Co-Creation and Methods for Analyzing It

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ABSTRACT

The proposal begins with a literature review and aims to investigate how the user experience of designers changes when transitioning from traditional software to artificial intelligence. AI tools automate tasks and take on a more active role compared to traditional computer-aided design tools, often referred to as "co-creators." This work seeks to identify the differences between using traditional software and software integrated with AI. In particular, it aims to outline the characteristics of the interaction between designers and AI, such as user satisfaction, trust, or surprise with the outcomes, role coordination, and more. Subsequently, the methods used by studies to analyze these aspects will be defined. This analysis serves as a foundation for creating protocols to systematically study designer-AI co-creation interactions and shed light on the unexplored aspects in existing research.

Keywords: Co-creation, Think aloud, Design process, HCI, Designer-AI

INTRODUCTION

In the recent period, hardware implementations have provided the opportunity to develop increasingly performative AI and make it accessible to a wider and wider audience not strictly related to the field of computer science. AI-based design tools are proliferating in the design field, acting as agile co-creators and assisting designers in increasingly complex design tasks, where the term indicates object processing activities with countless optimization goals. These tools are a valuable resource, but their effective use requires a new set of skills from human agents compared to traditional CAD software (Gmeiner et al., 2023). For example, designers do not directly manipulate 3D geometry, but formulate design goals from which the AI system must start.

While directions of possible applications are multiplying, we still know relatively little about how designers can cognitively collaborate with AI-based design tools.

The difference between traditional software and AI with which we design becomes relevant and the starting point of this thesis, a study also aimed at helping to fill the gap in the literature on the topic. While the study of the

cognitive interaction between human agents and AI has been examined in computer science and engineering and in some artistic contexts (Kantosalo & Riihiaho 2019; Karimi, Rezwana et al. 2020; Lin et al. 2020); so far the research related to AI and design that has focused mainly on the analysis of interaction with AI, points out that few studies consider the nature of cognitive design problems (Bernal et al., 2015) and that only a few of these have analyzed computational support in the early stages of design where designers play a key role (Liao et al., 2020). Early research on the design and evaluation of AI applications rarely delves into how AI and designers interact cognitively during design; only some new research on mental models has been able to describe some aspects of it (Bansal et al., 2019; Cai et al., 2019; Holstein et al., 2020; Wang et al., 2020; Zhang et al., 2021,).

Based on the recent literature in the area of Human-Computer Interaction (Gmeiner et al., 2023; Holstein et al., 2020; Wang et al., 2020; Zhang et al., 2021) this study aims to identify and explore how to study the cognitive aspects characterizing designer-AI interaction, in particular to understand what are the most effective and least invasive methodologies of experiments to analyze conflict resolution and goal negotiation.

USES OF AI: AUTOMATION AND CO-DESIGN PARTNERSHIPS

From the utilization of AI in design (an increasingly growing number of case studies) and the industry literature, relevant themes are emerging regarding the potential impact of artificial intelligence (AI) on the design process. However, it is noted that the use of these technologies can lead to a limited understanding among designers and end users regarding how these technologies affect both the design process and the final outcome (Stige et al., 2023).

As indicated by Asatiani et al. (2020), artificial intelligence is considered a "black box" that currently lacks the capacity to provide explanations regarding decision-making processes. Therefore, even though AI-enabled digital solutions can be accurate, designers and end users may not immediately (at least in the short term) comprehend the causal relationships that underpin them. This mode of interaction can make it challenging for designers to quickly develop a comprehensive understanding of how the tool works, thus potentially limiting their creativity. This represents an important starting point to understand how the design process currently takes place and what the limitations are regarding the collaboration between designers and end users.

Collaboration between UX designers, computer scientists, and engineers is necessary to achieve effective integration of AI into the design process. Furthermore, considering that AI is unable to directly understand or utilize the implicit knowledge guiding certain phases of the design, there is doubt about its ability to completely replace human designers for the time being. However, this partnership will require designers to expand their skills by gaining knowledge in artificial intelligence and machine learning. In this way, they will be able to discern which challenges can or cannot be addressed by AI, as indicated by Sun et al. (2020) and Yang (2017).

Recent research has developed generative design interfaces that allow for interactive exploration of multiple design options or for more iterative involvement of the designer in the process through real-time generation and evaluation of the design (Gmeiner et al., 2023). However, there are still limited empirical studies that assess how engineers and designers learn to work with AI-based design tools in realistic contexts, with one of the first comprehensive studies conducted by Gmeiner and his colleagues.

It is, therefore, important to distinguish when AI can automate a phase and when it can serve as a co-creator. Let's begin by examining the first theme, which is automation.

AUTOMATION

The automation of key phases in the design processes is an aspect that, despite the growing practical interest in its completion, has not received sufficient attention thus far.

It is essential to explore how AI can be specifically used to automate these phases and provide support for the creative challenges that designers encounter during the design process. This involves identifying the tedious and repetitive tasks that can be automated and understanding how automation can enhance the workflow of designers, thus increasing their creativity.

Since the design process encompasses a series of diverse phases and activities, it is equally relevant to examine how the potential automation of some of these phases can alter the nature of the work carried out by the designer and the entire design process.

As previously mentioned, the introduction of AI requires designers to provide essential input regarding what is required as the outcome of the design. Consequently, designers collaborating with AI can place a greater emphasis on formalizing conceptual, structural, functional, and aesthetic aspects of the design. This process necessitates a combination of creativity, problem-solving, meaning creation, empathy, and collaboration, as emphasized by Oulasvirta et al. (2020).

CO-CREATOR

AI tools, when they take on a more active role compared to traditional computer-aided design tools, and therefore not just in automation, are referred to as "co-creators" (Gmeiner et al., 2023).

Today, the design process, especially in user-centric contexts, involves the participation (sometimes referred to as co-design) of various stakeholders, such as the client who commissioned the product/service and, increasingly, the intended end users.

In addition to developing the skills necessary to support these participatory approaches with human agents, designers will increasingly be called upon to acquire technical competencies for co-designing with AI-based tools, which means becoming familiar with these tools and learning how to use them effectively as co-creators.

Up to now, published literature has offered limited insights into the process through which designers acquire the skills needed to use AI-based design tools.

A significant example of this knowledge gap has been discussed by Yang et al. (2020), who highlighted how UX designers currently have deficiencies in relevant knowledge, particularly when it comes to Deep Neural Networks (DNN). Therefore, it becomes imperative to comprehensively understand the competencies and skills required of designers, both in the short and long term, in order to enable them to keep up with the constantly evolving developments in the field of AI.

Furthermore, it is important to emphasize that effective and practical collaboration with AI presents a complex challenge for designers because it requires a significant learning process. These professionals must learn to work synergistically and think collaboratively with artificial intelligence agents, which operate differently from human collaborators or complex CAD tools (Gmeiner et al., 2023).

ANALYSIS & CATEGORIZATION

Given the premises regarding the role that AI can assume and the analysis of case studies examined in the literature, several key aspects characterizing the interaction between designers and artificial intelligence (AI) during the co-creation process emerge. These aspects, identified and structured in a table, have been associated with effective analysis methods for in-depth understanding.

The analysis of interaction aspects begins with an overall framework of the experience and an exploration of the designers' expectations. These initial aspects are followed by more specific considerations related to the operational roles of both designers and AI, as well as the organization and coordination of these roles. In particular, the concept of the "mental model," often mentioned in the literature, proves to be a fundamental element in understanding how co-creation projects between designers and AI develop.

Further analysis elements concern very detailed aspects and have therefore been grouped into two categories: the first set includes the analysis of conflict resolution, timing, and project flow; the second set encompasses evaluations of satisfaction with design outcomes, elements of surprise, trust, and reassurance.

It is important to note that, for analyzing the co-creation process or products, mainly two methods are employed: observation, with a qualitative focus, and document collection, with a quantitative focus. On the other hand, to obtain direct feedback from users, primarily two other methods are used: interviews, with a qualitative focus, and questionnaires, with a quantitative focus. These analysis tools allow for a detailed examination of the interaction between designers and AI, as well as the dynamics involved in this co-creation process.

Table 1. Key aspects of designer-AI interaction and related research methods.

Aspects Analyzed	Reference Bibliography	Investigation Methods
General experience	Cabrera et al., 2023; Rezwana & Maher, n.d., 2022	COFI (Co-Creative Framework for Interaction Design) think aloud (qualitative) interviews during and post task (qualitative) questionnaires (quantitative)
Expectations	Chong et al., 2022; Figoli et al., 2022; Galdon et al., 2020; Israelsen & Ahmed, 2019; Lotfalian Saremi & Bayrak, 2021; Uusitalo et al., 2022	pre-task interviews (qualitative) questionnaires (quantitative)
Roles and Coordination	Rezwana & Maher, n.d., 2022	supervision during the activity & think aloud (qualitative) interviews during and post task (qualitative) questionnaires (quantitative)
Single mental model and shared	Bansal, et al., 2019; Bernal et al., 2015; Gmeiner et al., 2023; He et al., 2023	think aloud (qualitative) interviews during and post task (qualitative) questionnaires (quantitative)
Conflict resolution, timing and project flow	Amershi, et al., 2019; Cabrera et al., 2023; Wang, et al., 2020	supervision think aloud (qualitative) interviews during and post task (qualitative) questionnaires (quantitative)
Satisfaction with the result of the design, surprise, trust and reassurance	Amershi, et al., 2019; Gmeiner et al., 2023	think aloud (qualitative) interviews during and post task (qualitative) questionnaires (quantitative)

CONCLUSION

From the literature, it is evident that the think-aloud method is the most widely used and effective approach for interaction analysis. However, as observed in other case studies, it allows designers to spend less time in the design process and leverage more neurocognitive resources during the design process (Shealy et al., 2023). In fact, Wright & Monk in 1991 concluded that user testing with think-aloud methods is not only an effective evaluation technique for designers but also that designers can benefit significantly from conducting their evaluations.

It is hypothesized that, through interaction with AI, designers can also benefit from reworking their thoughts and acquiring information. This is because they must continuously make their thoughts and information explicit (e.g., when interaction occurs through writing prompts) to the AI and formulate them in ways that are comprehensible.

This categorization is intended to create protocols for systematically studying designer-AI co-creation interactions. It aims to identify specific areas for analysis and determine which design phases are best suited for using the methods described. This paper highlights that many aspects are still unexplored in existing research and that each of these aspects requires more in-depth investigation.

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