Co-creation Process with Generative Artificial Intelligence. An Experiment in Product Design

López-Forniés, Ignacio; Asión-Suñer, Laura

Design and Manufacturing Engineering Department. Universidad de Zaragoza.
C/ María Luna 3 (Edificio Torres Quevedo), 50018 Saragossa, Spain.
ignlopez@unizar.es; lauraasion@unizar.es

Abstract Artificial Intelligence (AI) is revolutionizing creativity by enhancing creative processes in design and other related disciplines. As a creative assistant, it facilitates co-creation and explores new possibilities for user-centered design. As a factor of originality and innovation, creativity to support collaborative and multi-disciplinary approaches utilizing AI is emphasized. It is noted that AI tools are capable of generating images from text, which highlights the interaction between designers and AI during the conceptualization process. AI has found an important role to play in creative capabilities by enabling improvisation, co-creation, and interactive interpretations between human and machines. For students to become familiar with these AI tools, teachers must be trained in explaining their operation and limitations. An analysis is run with a sample of 80 Industrial Design Engineering students to highlight the advantages and challenges associated with this human-machine co-creation process, and to conclude by presenting options for future developments in this field.

Keywords: Creative process, Co-creation, Artificial Intelligence, Generative models

Introduction

Artificial intelligence (AI) is presently a revolution, especially in the creativity field by enhancing creative processes and maintaining human thinking as an essential element to generate original and innovative ideas. It is effective in creative and artistic activities like design by generating high-quality content (Zylinska, 2020). As creative assistants, these tools facilitate the creation process and explore new possibilities for user-centered design (Anantrasirichai & Bull, 2022; Ayuso

del Puerto & Gutiérrez Esteban, 2022). However, the debate about the usefulness of AI as a tool to enhance human creativity continues (Wu et al., 2021).

People see creativity with AI as a new philosophy that uses the conquests that humanity has achieved as a result of the convergence of technological and cultural developments. Technology through AI allows us to access and process the vast amount of accumulated knowledge and discoveries, and cultural evolution has led us to value creativity and innovation as fundamental milestones for progress (Wu et al., 2021).

In order to avoid anxiety about the possible negative consequences of erroneous, improper or malicious AI uses, and social factors, such as bias in decisions or invasion of privacy, it is important to acquire a better understanding of AI as another technological tool (McCormack et al., 2020). Human intelligence is flexible, creative and experienced in exploiting knowledge and strategy, whereas AI faces repetitive and predictable tasks (Wu et al., 2021).

The ideation stage is crucial for the design process, during which designers generate, develop and communicate new ideas that are then converted into concepts to produce innovative design solutions (Guo, 2023). AI use has become increasingly important in the realm of creative capabilities by allowing for improvisation, co-creation, and interactive real-time interpretations between humans and machines (McCormack et al., 2020). In this evolution context, updating students to make good use of these AI tools is necessary, as is ensuring that teachers are trained in explaining the basis of operation, interaction, interpretation of the results and knowing the limitations so that students fully understand how it works and its limits, and so that it does not appear magical (Wikström, 2018).

Co-creation is the collaboration between people who contribute ideas, knowledge and skills to solve problems or to create products in an innovative way (Sanders & Stappers, 2019). Numerous parties contribute to collaborative creativity in a combined and collaborative manner, which transcends the model of division of labor and distribution of tasks (Candy, 2002). Creative ideas merge and combine by reflecting the team's mix of personalities and motivations, and by producing more creative solutions than the simple sum of individual contributions.

AI tools are used in both research and applications for the privileged, and they will be increasingly applied to a wide range of everyday activities (Moore, 2019). They will continue to gain popularity for their sophistication and improvement in capabilities. As an assistant in creative stages, AI enhances originality, flexibility and productivity (Frith et al., 2021).

An experiment aims to understand what creative traits are the most enhanced when co-creating with AI. Text-to-image tools are used to design an everyday object that has a new characteristic defined by the designer and, thanks to AI, can be improved to contain a more defined formal design, albeit in a conceptual phase.

Collaboration between designers and AI

Whereas AI tools can stimulate creativity, we see that it has a more descriptive character than conferring the desired final object a meaning that it is open to biased interpretations because it is a process based on data and certain learning of machines (Verganti et al., 2020). This aid facilitates co-creation in a broad and rich data context by solving iterative problems, but not speculative and abductive ones.

Having AI as a co-creation assistant in a design process can affect divergent and convergent thinking. During a teaching experiment, divergent cognitive-behavioral preferences have been observed in designers' proactivity due to the images generated by AI that caused difficulties in completing the task (Simeone, 2022). In conceptual design, AI can inspire and assist, but too much reliance on it can be harmful. The teacher must be alert to the designer's divergent process so that (s)he reflects on his task and AI tools do not distract, but support design convergence and decision making. Performance and improvisation are among the most challenging creative activities performed by humans.

Different AI models are applied to the creative process in design. One model type is collaborative parameter-based AI systems that provide users with a high autonomy level for making decisions in real time (McCormack et al., 2020). Other models are oriented toward education, such as the STEM-DAL integrates Sciences technology Engineering Maths with Design Arts and Literature, an inclusive AI education model for co-creation (Wu et al., 2021). Other models depend on interactions with AI, such as the Collaborative Ideation Partner (CIP), where AI is a partner that provides inspirational sketches based on visual and conceptual similarity to the sketches drawn by a designer (Kim et al., 2021). Finally, models simplify user tasks, such as Human-AI Design Process, a low-fidelity design prototyping tool that replaces traditional sketches by providing visual feedback (Guo, 2023).

Stimuli

Ideation is a crucial stage in the design process, when new ideas are generated and developed, and this process includes the transformation of ideas through different modes of expression, such as sketches. AI can enhance human creativity by providing visual stimuli that inspire designers. In short, AI can assist designers in the ideation stage by providing visual feedback (Guo, 2023; Kim & Maher, 2023).

There are sensory stimuli, such as visual, auditory, olfactory, tactile and gustatory, and also informational stimuli, such as words, phrases, images and sounds. These stimuli can enhance creative thinking by providing information at different complexity levels (Kim et al., 2021). AI advances enable it to become an expert

participant in the creative process by providing stimuli, and by generating images, text and sounds (Miller, 2020).

AI offers several advantages in product design by employing verbal and visual stimuli. It applies Natural Language Processing (NLP) techniques to analyze texts and generate ideas (Tholander & Jonsson, 2023). AI tools can analyze visual trends, generate unique and customized designs, and create virtual scenes, models and prototypes. With AI, designers can generate ideas, be inspired, better understand consumer needs, personalize designs, and name products and companies through verbal and visual stimuli.

Proposed experiment

As part of a classic conceptualization exercise, students were given the task of introducing innovative functionality into a simple, everyday object. In this exercise, 80 second-year students of an Engineering degree in Industrial Design and Product Development participated and obtained 80 valid results. The exercise lasted 60 minutes, plus 10 more minutes spent on preparing for delivery. It was structured around a series of clearly defined phases (Figure 1).

First of all, the objective of the exercise, the stimuli to be used, the available tools, the steps to follow and the evaluation method were explained to the students. A time allocation recommendation was made for each phase, which students could choose to follow or not. The applied stimuli were mainly visual and were generated using image and text AI tools. These tools were based on instructions so that students could write and rewrite in two different phases of the exercise.

The Results section presents a detailed analysis of the influence exerted by visual stimuli on the design exercised. This analysis provides information on how these visual stimuli can affect the creative process and the final design result. In summary, this exercise aims to demonstrate the potential of AI as a support tool in the design process by allowing students to explore new ways of conceptualizing and creating everyday objects.

Tools

When working with students who are not experts in AI, it is necessary to start with simple, free and varied tools. The goal is for these tools to enrich their expressive repertoire. Multiple tools have been developed to support human-AI collaboration with sketches, such as *Coco Sketch* (Davis, 2013) or *Drawing Apprentice* (Davis et al., 2015). Others are based on text-image interaction, such as *Stable Diffusion*, *DALL·E*, *DeepDream AI Image Generator*, *Bing Image Creator*, *Starry AI* or

Wepik. There are applications that have already been integrated into applications with more capabilities, such as *Canva*, *Adobe Firefly* for Photoshop, *Picsart AI Image Generator*, among other options.

Fig. 1 Description of the creative process, phases and expected results.

Assessment

It is crucial to evaluate whether the stimuli generated by AI (AI) have had a positive impact and to what extent they have influenced the final design. To make this evaluation, five variables were considered, and an analysis of the relation among them was carried out. Each variable could have five values: null (0), low (2.5), medium (5), high (7.5) and very high (10).

The *Originality* variable refers to the novelty of the proposal; that is, whether the combination of the everyday object and the function currently exists. This verification is done by searching on *Google, Google Images, Bing* and *ChatGPT.* Extreme values correspond to existence on the market, while intermediate values correspond to the existence of similar elements.

The *Flexibility* variable refers to the ability to not only vary thinking, but to also open up new options and alternatives. In this case, we value the number of thematic groupings or alternatives that have been tested in queries, which can be increased by the feedback from stimuli caused by the generated images.

Productivity is a variable that is measured by the number of generated ideas. In this case, it is measured by the number of made queries regardless of whether they vary a lot or a little in relation to those already made.

The *Detail* variable is measured by the precision in the definition of the idea. In this case, it is measured by the definition of the inputs for searches. A greater degree of detail can also lead to more accurate answers than those desired.

Changes are measured by *variation* in relation to the initial idea. What is measured is the number of changes, modifications or improvements that has been introduced into the final design due to exposure to visual stimuli. A maximum change occurs when the original idea completely changes or the function improves.

The *Evaluation* indicator averages the previous variables by representing the degree of resolution of the proposed problem globally.

Results

Table 1 analyzes the results of the 80 exercises. The count and percentage for each variable and obtained level are shown.

Table 1. Evaluation of the obtained results.

	evaluation	*originality*	*flexibility*	*productivity*	*detail*	*changes*
null	0 0%	0 0%	1 1.25%	1 1.25%	1 0%	2 2.5%
low	3 3.75%	10 12.5%	30 37.5%	17 21.25%	26 32.50%	22 27.5%
medium	19 23.75%	15 18.75%	19 23.75%	28 35%	24 30%	20 25%
high	47 58.75%	31 38.75%	26 32.5%	29 36.25%	26 32.50%	30 37.5%
very high	11 13.75%	24 30%	4 5%	5 6.25%	3 3.75%	6 7.5%

Below is a complete example of a specific case depicting the process followed and the results obtained in each phase (Figure 2).

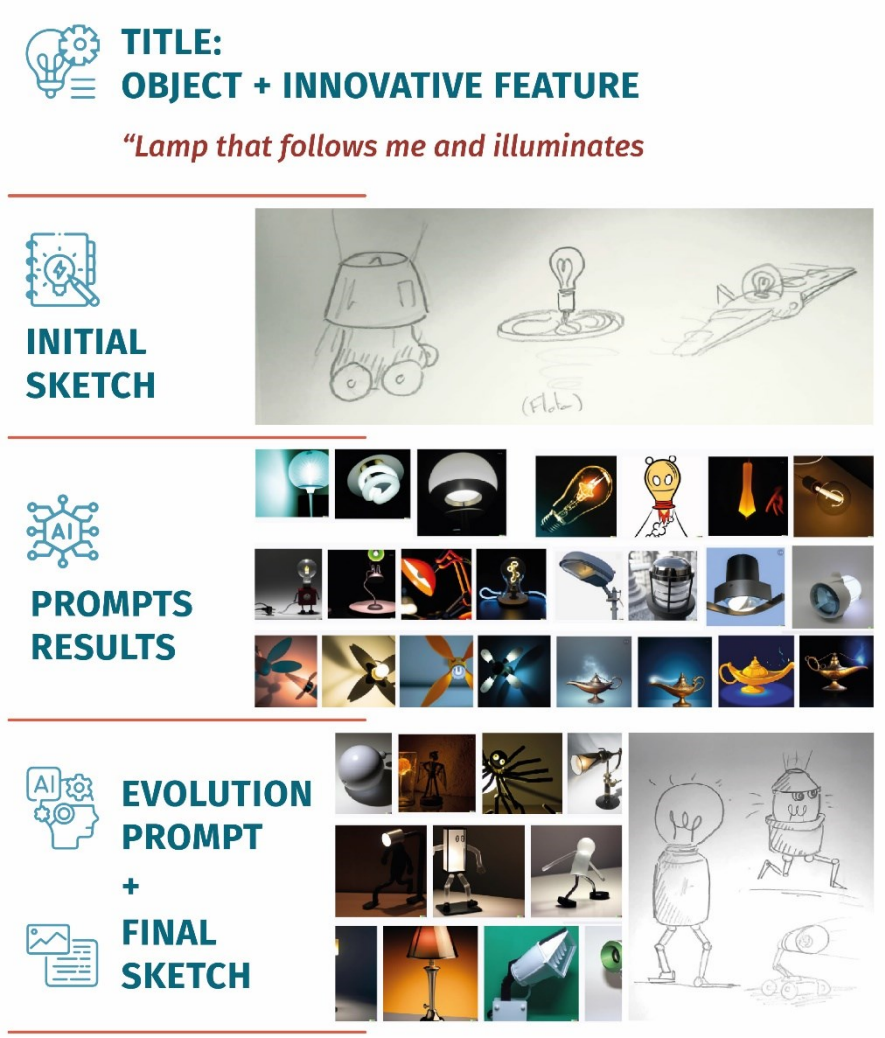

Fig.2 Complete example of a student.

In general terms, the obtained results are satisfactory. A high level stands out in the *originality* variable, with 39% of the results classified as high and 30% as very high. The *productivity* variable distributes 70% of the results between the medium and high levels, while the *detail variable* presents 59% high results and 13% very high results. The *change* variable shows a balanced distribution, with 38% high, 28% low and 25% medium results. The *flexibility* variable presents 38% low, 33% high and 24% medium results. A high level of 59% stands out for the *evaluation indicator*, with similar distribution to that of the *detail* variable.

Originality is high because free thought is proposed at the beginning of the exercise without restrictions. However, *flexibility,* which is an indicator of creativity, is

low. This suggests that stimuli have not led to abductive and alternative thinking, but have contributed to productivity.

The objective of the exercise is for the original idea to be perfected after producing changes and improvements. The results for the *changes* variable indicate that distribution is centered on high, low and medium values, and that 30% (null and low levels) do not achieve the expected changes, while 70% exceed them.

The *changes* variable in isolation. It is observed that detail is related to *flexibility* and *productivity,* while the other variables have moderate relations. This suggests that the *detail, productivity* and *flexibility* variables evolve throughout the year and influence the result. When analyzing the medium, high and very high values for the *change* variable in isolation, all the variables have low relations. This suggests that the results derive from each student's creative profiles and the visual stimulus only influences some of them.

After analyzing the results, initially students must have more knowledge of AI tools and understand the objective of the exercise. Some did not focus on the task, but reveled in experimentation. It is essential to emphasize that the precise definition of the search parameters returns more accurate results. We must ensure that keywords are specific and relevant to the objective of the exercise. It is also necessary to explain to students that tools have limitations, and AI needs to be combined with human intelligence to obtain better results. The combination of the tool with student creativity enhances their creative capacity, but does not replace it. It serves as a complement to explore new options, but by always making critical and creative decisions. Although AI can be a valuable tool in the design process, it is essential for students to understand how to use it effectively to improve their creative process.

Discussion

Several positive aspects were identified that are applicable and could be repeated in future instances. Students, who are accustomed to digital interfaces and technological tools, quickly adapt to this type of environment. The participants perceive the system as being more of an assistant than a collaborator by recognizing its potential to foster creativity.

One part of the experiment seeks to demonstrate the possibility of establishing a co-creation process. This goal was achieved, although the process turned out to be more instrumental than collaborative. The tools selected for the experiment are instrumental in nature and function through text instructions and interactions. Perhaps the results would have varied if more collaborative tools had been used.

In addition, certain problems were identified, such as lack of reflection after receiving the generated images. Some students repeated the same instructions with slight variations, which resulted in poorly differentiated final products and lack of flexibility. This may be due to idea fixation, a concept associated with vision fixation (Kwon et al., 2019). Hence when the collaborative creative process is carried out in groups without the help of AI, results that are directed toward the desired

objective and concept through mutual interactions are obtained. However, the interaction between the individual and the machine presents difficulties for fulfilling objectives (Guo, 2023).

AI as a collaborator is an area of growing interest in the creation and design field. However, many efforts in this area aim to achieve performance at a human expert level or to even replace the human (McCormack et al., 2020). Instead, AI must support and enhance human creative activity in a collaborative way.

Conclusions

The experiment obtained acceptable results, but the use of the tool being more assistive than collaborative was detected. The evaluation of the results was generally satisfactory, but unremarkable compared to experiences without AI.

Numerous studies have shown that the co-creation process between humans and intelligent agents can act as a catalyst for creativity. This process of combining human intuition with the data processing capabilities of AI can lead to innovative solutions and unique insights. The effectiveness of this collaboration is not a guaranteed fact, but depends on designers' attitudes and preferences, and also on flexible minds that explore alternatives.

Novel designers still do not fully understand how AI tools work. They perceive them as surprising given their speed, productivity and quality of presentation compared to the time spent and effort made to produce similar sketches. Superficial use can generate high expectations of obtaining visually impressive results, but ones that are unrealistic and not aligned with the design objectives. This could result in reluctance to use such systems in more complex contexts.

Open-minded designers willing to explore can find AI an ally in their creative process. Those who resist change or do not feel comfortable with its use might miss out on its benefits. AI has the potential to inspire and assist designers in conceptual design by providing new ways to approach problems and to generate ideas. This can lead to new ways of using AI with traditional creative techniques. However, relying too much on AI can have adverse results. If designers are not critical of AI results, they risk limiting their own creative thinking and generating solutions that lack validity.

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