

AI IN THE DESIGN PROCESS: TRAINING THE HUMAN-AI COLLABORATION

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ABSTRACT

Artificial intelligence (AI) systems are attracting more and more attention as possible tools to enhance creativity in the design process. However, alongside potentialities, introducing non-human agents in a design team can bring specific criticalities, which need a high level of awareness on the part of designers to be tackled. An exploratory study on the perception of design students regarding the inclusion of AI tools in the early stages of the design process was conducted. The results are discussed in the paper, with a specific focus on the possible role of training in supporting the development of critical awareness regarding the challenges posed by human-AI collaborations.

Keywords: Artificial intelligence, human-AI collaboration, human-AI criticalities, human-AI perception, human-AI training

1 INTRODUCTION

With society increasingly becoming more and more complex, new challenges arise in the design discipline. Nowadays, designers must address ever-changing wicked problems in their design process [1], taking into consideration the technical, the human, the digital, and the social perspectives [2]. Due to the wide range of specific knowledge designers need to keep up with today's dynamic society and rapid technological advancement, design tools and competencies run the risk of being inadequate to design products that are well aligned with the user's needs [3].

Artificial Intelligence (AI) appears an intriguing solution to address this challenge, able to provide many potentialities during the design process, particularly in the early stages. Indeed, AI's impact on the process outputs exponentially increases if applied in the early phases, considering that the most polarizing design decisions are made here [4]. However, some criticalities regarding human-AI collaboration might emerge when introducing non-human agents in the design process and design teams. Regarding human-AI collaboration, many studies have already highlighted "technical" and "sensitive" criticalities. *Technical criticalities* are related to AI and humans' practical competencies and management [5], [6]. Instead, *sensitive criticalities* are related to the team members, with their own experiences, sensibilities, and inclinations. Being more nuanced, we can identify three kinds of sensitive criticalities: predisposition [7], perception [6], and communication [8] criticalities.

Essential knowledge regarding the impact of AI systems in the design processes is still missing [9]; hence designers approaching these technologies need to develop a high level of critical awareness to use them efficiently and safely. In this regard, since designers can learn and improve their ability to collaborate with AI agents over time [10], proper training on the implementation and usage of AI systems would expand their knowledge and encourage them to optimize the use of these technologies, bringing competitive advantages on team effectiveness [11].

On the contrary, if educational programmes poorly acknowledge the importance of disruptive technologies such as AI, they will form uncertain professionals [12] unable to comprehend the current socio-technical paradigm fully. Therefore, higher education should prepare students by equipping them with the right tools and competencies to approach these new technologies properly with a proactive and welcoming attitude [13] while being aware of the associated limits and risks.

Based on this state-of-the-art, an explorative study was undertaken to understand design students' perceptions regarding the inclusion of AI tools in the early stages of the design process. Also, the study aimed at understanding the possible role of training in supporting the development of awareness regarding the criticalities of human-AI collaborations. The present paper discusses a specific part of a

more extensive research activity, which is described in: (*Artificial intelligence in the design process: The Impact on Creativity and Team Collaboration* [14]).

2 METHOD

A qualitative study has been conducted in the Design & Engineering Master's at Politecnico di Milano by designing and delivering a workshop that involved 16 students as participants [14]. The workshop aimed to create the condition for students to engage with a short hands-on design experience cooperating with specific AI tools. It formed the opportunity for the researchers to collect data about students' perception of AI tools before and after the design activity.

In a simplified manner, the workshop simulated a design process up to the definition of one or more concepts through three phases: the research, the sketching, and the colour selection phase.

The participants were divided into eight groups composed of two students. During each distinct phase, the team members collaborated with different non-human agents (i.e., Google search for the research phase, sketch-run for the sketching phase, and Coolors for the colour selection phase). The eight groups were split into two types, simultaneous and delayed. Simultaneous groups worked throughout the whole duration of the workshop alongside the AI systems. Instead, per each phase, delayed groups had an initial period without the help of the AI system, followed by a subsequent period with it.

All students were asked to answer three questions with a rating scale of 1 to 10 by filling out a survey at the beginning of the workshop to observe pre-existing perceptions towards the human-AI design collaborations.

After the activity, throughout a final survey, the same three questions were posed to students to observe possible changes in their vision. In the third question, participants had to state their position (i.e., in favour or against) the inclusion of AI tools in the early design process; the question was followed by an open question to explain the reasons concerning the workshop experience. The dataset was qualitatively analysed to make students' perceptions emerge.

3 RESULTS

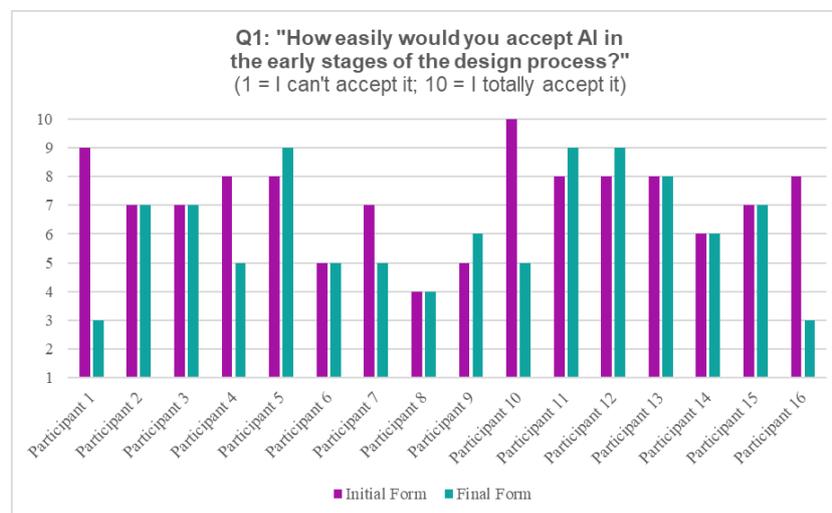


Figure 1. Participants' answers to the first question

The first question was intended to understand the students' level of acceptance towards the use of AI systems in the early stages of the design process (Figure 1). The answers to the initial survey highlighted an overall welcoming attitude, with most of the participants positioning themselves on the higher half of the scale. This result is consistent with the answers to the students' final survey at the end of the design activity. However, a correlation between the direction of the changes and their intensity emerges from comparing initial and final answers. Indeed, considering only the participants who changed their position before and after the workshop, we can identify the ones who took a more favourable position (participants 5, 9, 11, 12) and those who took a less favourable position (participants 1, 4, 7, 10, 16). Positive shifts are moderated, while unfavourable changes are far more substantial, with the extreme cases of participants 1, 10, and 16 showing an initial perception of openness towards AI, which became negative after the workshop. Therefore, using AI tools within the workshop experience caused these

participants' sudden and intensive re-evaluations, which can become a challenge in human-AI relationships.

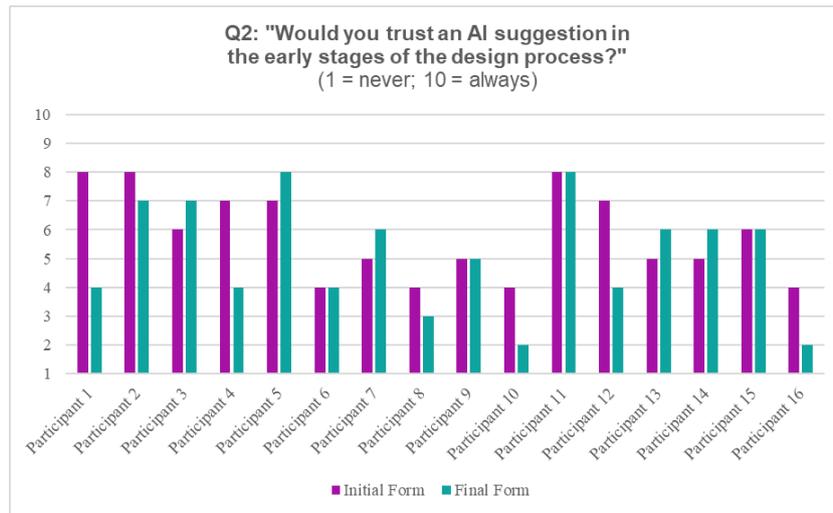


Figure 2. Participants' answers to the second question

The second question focused on the level of trust participants would grant to AI systems. Compared to Figure 1, the answers in Figure 2 lay lower on the scale, showing that participants struggle to trust AI suggestions in the early stages of the design process. In this case, almost all participants have shifted from their initial perception, demonstrating how trust can easily change in a human-AI relationship. The intensity of such changes is less marked and more varied than in the previous case. However, 6 participants' shifts were directed toward a less favourable position, highlighting that students were more susceptible to experiences that worsen their perception than those that improve it. Participants 1, 4, 12 can be seen as extreme cases.

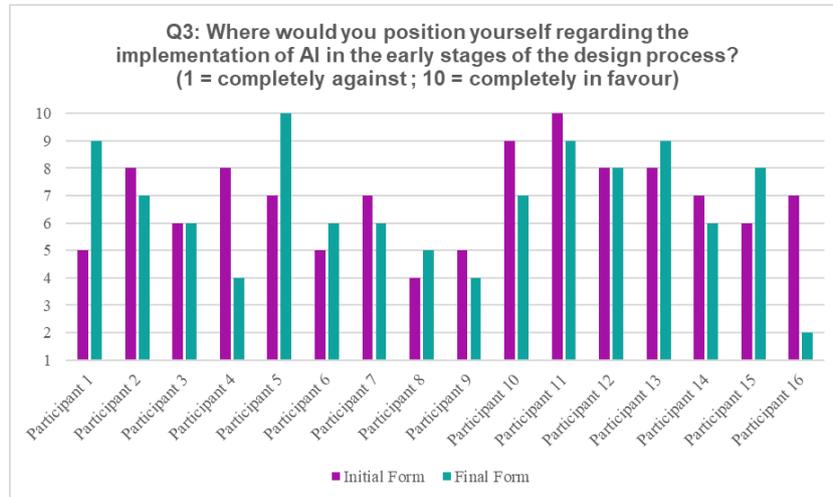


Figure 3. Participants' answers to the third question

The third question was meant to make the participants' position towards AI emerge. The answers are more varied than the first and second questions (see Figure 3), not showing any average or tendency. Even if all students experienced the same design activities during the workshop, we could observe that, between the initial and the final survey, there are both shifts from an unfavourable position towards a more favourable one (participants 1, 5, 6, 8, 13, 15) and shifts in the opposite direction (2, 4, 7, 9, 10, 11, 14, 16). Moreover, some of these changes are substantial (participants 1, 4, 5, 16), while others are only minor. Even if students received the same inputs, they reacted personally, leading to distinct opinions and perceptions regarding using AI tools in the early stages of the design process. Moreover, participants' answers to this question provides evidence to assume that the workshop influenced the students' perception and sensitivity toward the issue. This means that working with AI systems even for

a short duration impacted participants' perception and awareness. The open answers where participants motivated the evaluation to the third question provide insights on this phenomenon. Some participants highlighted the role of the designer in a relationship with AI systems (Table 1), others targeted possible improvements aimed at optimizing the human-AI collaboration (Table 2), and others made a position statement (Table 3).

Table 1. Open answers with a focus on the designer role within the human-AI relationship

	Regarding the third question, in a short sentence, can you tell me why?
Participant 1	I think that having a couple of eyes more (even if not human ones) is always a good idea, and a can be very helpful. even because at the end you are the one who is having the final word on the choices.
Participant 2	I am still interested in being inspired by the AI's results, but in the end, I recognise that I need to make the judgment myself and understand if an AI-generated idea is good or not.
Participant 10	AI Tools can't replace a proper concept-driven design process - but I think it can really enrich it. If the designer knows how and when to use it, it can show us possibilities that we have not thought of before. But we should treat the results carefully and use them more as an inspiration.

Table 2. Open answers with a focus on human-AI relationship improvements

Participant 7	In general, AI is pretty useful. but it has to know your design process. For instance, if you are in a divergent phase of reasoning, it should provide "out-of-the-box" suggestions. Meanwhile, if you are in a convergent moment, it should help narrow down your choices.
Participant 13	Because the design is a creative process, and the AI should be used more as a tool that helps the designer to understand what he struggles to find and express rather than the main part of the creative process.

Table 3. Open answers related to the third question with a position statement

Participant 4	It is useful, but I like to start from scratch and not let my imagination and creativity be affected by any hint that AI can give.
Participant 6	AI can be really helpful in finding new random and complex shapes but is really hard to use when you have a clear idea about what you want.
Participant 11	While some AI can be helpful in the process, it really comes down to the quality of the tool, and the extension of its use. If we try to make a design following the directions of AI tools, the possibilities of innovating are short.

4 DISCUSSION

From these results, some considerations can be made. In the answers to the first question, participants displayed an overall welcoming attitude towards introducing AI systems into the early stages of the design process. However, this positive curiosity was also tempered by uncertainty, especially from the second question answers, where students expressed their doubts regarding AI trustability. Moreover, most participants changed their views after completing the workshop, highlighting a high level of influenceability. The direction of such judgmental shifts was varied, with participants adopting a more favourable stance and participants adopting a less favourable one. Even if the same design experience was proposed to all the students, they perceived it personally, leading to different conclusions. That being said, a correlation exists between the direction and the intensity of the shifts. Indeed, participants who changed their view towards a more favourable one displayed moderated shifts. In contrast, participants who changed their opinion towards a less favourable one expressed intensive shifts with higher frequency. This shows that participants were cautious about adopting a more accepting and open perception towards AI while being more susceptible if they adopted a sceptical view.

The unpredictability of shifts in students' perception and the tendency to be susceptible to worsened experiences can become critical in training designers to use AI. The lack of deep-rooted and aware opinions about the issue put the participants in a delicate phase of evolving thinking and experimentation, far from holding a clear argument and, thus, extremely malleable. Therefore, the first collaboration experiences with AI systems are vital in defining students' views towards AI in design.

Indeed, the possibility of adopting sceptical views at early stages may hinder an efficient collaboration, where the human agents grant an inappropriate or insufficient level of trust towards the non-human agent.

Trust is a crucial element within any team, particularly in groups involving non-human agents that are less familiar and more difficult to assess for humans, increasing the risk of trusting non-humans too much or too little. Over-trust can condition human agents into complacency and misuse of AI tools, leading to costly mistakes. On the other hand, under-trust can cause unbalanced workloads, leading to the disuse of a machine or the avoidance of a person [15]. A fair design process should limit the phenomenon of over-trust and under-trust as much as possible.

During the workshop, participants were stimulated to build their vision and improve their awareness of AI, as shown in Table 1. Here, some students have already developed a certain level of consciousness about the human-AI relationship, figuring out a possible role for the designer to judge AI-generated outputs, thus maintaining the full responsibility of the design process. This aspect is vital because it shows the capability to increase the students' awareness through design experiences, highlighting training as an effective solution to addressing human-AI challenges. Indeed, we want to stress the importance of providing a proper and gradual introduction for design students to disruptive technologies, including AI, allowing them to gradually understand the technology in a safe environment and through a period of familiarization.

Preparing novice designers for AI technologies means providing tools and knowledge to safely use them, still responsibly maintaining the design process under control. Assuming that AI systems and related human-AI collaboration are not infallible, it is up to the designer to evaluate the machine's work and choose whether to consider its output or discard it if it does not meet expectations. In this scenario, a new role for designers emerges. Indeed, if operational tasks are increasingly assigned to AI, designers could shift towards judging and supervising positions. Design arbiter is our way to define a figure who combines the skills and sensitivity of the designer with excellent critical analysis expertise, helpful in evaluating the outputs provided by AI systems and appropriately implementing them in the design process. Therefore, the designer arbiter will be less concerned about the operational responsibility and individual manual activities took on by AI, assuming a position more focused on managing and supervising design tasks. The designer arbiter more intensively applies her expertise at a higher level, such as the project's general direction, the understanding, and framing of the problem, infusing her sensitivity, intuition, and know-how into the design process. The ability to manage collaboration with AI systems or, more precisely, to design for AI [16] will be a crucial competence of the designer arbiter.

5 CONCLUSION

AI systems are capable of helping designers tackle increasingly complex design problems. However, introducing non-human agents into the design team can become a difficult task due to emerging specific criticalities, which we distinguish into "technical" and "sensitive". The workshop results made it possible to gain insights into students' perceptions of the introduction of AI systems in the early stages of the design process. The students' overall welcoming attitude towards the issue was tempered by their difficulty in trusting AI suggestions. Even if all students went through the same experience, they perceived the workshop personally. Indeed, after the design activity, most of them changed their view on AI towards more and less favourable positions. Moreover, a correlation between the direction and the intensity of the shift emerged, highlighting a greater susceptibility of participants to worsening their perception than improving it. Finally, during the workshop, participants improved their awareness of the issue, exposing practice as a valuable method to train students into professionals capable of optimizing human-AI collaboration through applied judgmental skills.

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