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Artificial Intelligence for Design

The Artificial Intelligence of Objects

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Abstract

Artificial Intelligence (AI) is increasingly permeating various domains, revolutionizing traditional processes and opening new avenues for innovation. In the realm of design, AI holds immense promise, offering capabilities to augment human creativity, streamline workflows, and deliver personalized user experiences. This paper explores the intersection of AI and design, highlighting its transformative potential and key implications. Firstly, for instance, AI-powered design tools automate repetitive tasks, freeing up designers' time for more creative endeavors, while generative design algorithms can generate myriad design options based on specified constraints, enabling designers to explore more efficiently brand-new solutions. Additionally, AI-driven predictive analytics provide insights into user preferences and market trends, facilitating informed design decisions and enhancing product relevance; moreover, AI enables the creation of personalized user experiences by analyzing vast datasets to understand individual preferences and behaviors: this personalization extends across various design domains, from user interfaces and digital products to physical spaces and services. Ethical considerations are paramount in the integration of AI into design processes: designers must address issues of transparency, fairness, and bias to ensure that AI-driven solutions uphold ethical standards and respect user privacy; furthermore, human-AI collaboration emerges as a fundamental paradigm, where AI augments human creativity and decision-making rather than replacing it entirely. Challenges such as technical complexity, data privacy concerns, and the need for upskilling within the design workforce accompany the integration of AI in design; thus, addressing these challenges requires interdisciplinary collaboration and a holistic approach encompassing technological, ethical, and socio-economic dimensions. In this framework, this paper sets the stage for further exploration of AI's transformative impact on design and the ethical considerations guiding its integration into practice.

Keywords

Design; objects; products; interaction; generative design

Introduction

The big potential offered to the contemporary design by the so-called Artificial Intelligence cannot be denied or underestimated any more. And this is true not because we must accept the idea of substituting the human thought with a sort of autonomous virtual dimension of things, but for the impact that AI can have on the real world and on the real human relationships with spaces and objects, within a new social and cultural framework (Crawford, 2021). Vogiatzaki and Spyridonidis (2022) underline how the concept of intelligence has recently changed following two directions: on one hand it has been extended to what is not human, that is that also machine now can be considered 'intelligent'; on the other hand, the idea of intelligence is not anymore only individual but collective when not social, and this means that the contemporary interpretation of intelligence goes toward a unavoidable dialogue between humans, machines and environment, and this is particularly true for all the actors involved in the design activity. In a certain sense, while other design disciplines like architecture have a very strong armor which protects their territorial boundaries and thereby, as happened in occasion of every technological revolution in history, the AI has to work harder to pass through them, design, being more fluid and 'open', is immediately called to control the entry of this new actor on the stage.

But, as underlined by Del Campo (2004), the impact of AI in design and in the relationship between human and machine has to be read in terms of language renewal, creative opportunity, theoretical explorations and not in terms of preconceived certainties regarding the final aesthetical configurations of objects. New technological paradigms, new network-based systems, new computational structures, which are just some of the constituting elements of the AI, can be understandably seen as critical for the design approach, but not so much if we consider them as services or tools to manage the now essential digital dimension of creativity, the complexity of the processes of ideation and production, the levels of user's active participation and the interdisciplinary dialogue in the work teams (Cattabriga & Joler, 2023). But these tools seem to be something different compared, for examples, to those that appeared some years ago within the CAD/CAM systems; and the difference is that now we are facing to 'tools for thinking' instead of 'tools for making' that are going beyond our traditional conception of modern science applied to the design ambit (Carpo, 2017). Otherwise, as Neil Leach tells us (2021), a fundamental aspect of AI is who uses it and for which purpose, and this awareness leads us to its human aspect, transforming it from a 'cool tool' into 'culture'. If a definition is needed, using the ChatGPT (an AI system of data) we can say that Artificial Intelligence is a field of computer science that deals with creating systems and programs capable of performing tasks that usually require human intelligence. The goal of artificial intelligence is to develop actions and/or knowledge starting from a data set and through algorithms and models that allow computers to learn, reason, solve problems and make decisions autonomously, without being explicitly programmed for each specific action, in a condition of continuous self-powering.

Within its branches, we can first of all mention the machine learning (a subset of AI) and the deep learning (a subset of machine learning). The machine learning is a system through which is possible to teach the machine to do something without explicitly programming it but letting it adapt its decisions from experience, using an algorithm which provides the machine a set of rules and basic data; with the deep learning is a variant of the traditional programming through which the development of specific algorithms allows the machines to learn from their own errors and perform specific actions autonomously, like how our brain processes informations; or the prompt generators (text, audio, video, etc.) and the generative design systems able to create texts (i.e., ChatGPT), images (i.e., Midjourney, Stable Diffusion) and optimized 3D models starting from requisites and using algorithms and parameters able to overcome the limitations and the low speed of the traditional design methods.

With the emergence of AI, which has broken the conventional technological frontiers, it's true that the limit between transhuman and post-human (intended as more-than-human) dimension can become quite fine, but we don't have to forget that the design discipline has an intrinsic openness for technological systems innovation and, in general, for all the new form of knowledge and information that absorbs like a sponge: the problem is what kind of use we're asked to do of these new scientific additions and in which way the relationship between the individual and collective dimensions are supposed to change. In other words, which are the aesthetical, cultural and social implication of the diffusion of AI systems (Kuutti, 2009).

Design and AI: A Possible Marriage

Based on the information processing psychology since the Seventies and Eighties, AI increased by more than 80% in the last two years. Actually, the relationship with design is in a phase of experimentation, mainly in the preliminary and concept phase of the projects. But which are the real potentials of this relationship in the near future?

In general, as a matter of fact, the generative power of design is something not totally new, as well as its 'open' character and its intrinsic flexibility (Maldonado, 2015): according to the new possibilities offered by the computer science, for several decades now design has gone overcoming the ordinary linear systems starting using the computers not in a passive way anymore but in a dynamic mode that could enable the definition of synchronic infinite alternative solutions to specific design problems (Cross, 2001). Thus, despite of the word 'intelligence', if we accept the fact that AI is a way to 'do', the role of design must continue to be 'to think' about things, actions, values and sustainable attitudes and behaviors; more generally, the actual role of design toward technology is not that much different from other situations in the past: by observing what's going on around us, we can detect the same risks of overshadowing the social values and of not considering the ethical responsibility of the design actions. Moreover, technology goes undoubtedly faster than our capacity to collectively decide what kind of vi-

sion of the future we want to share and build. But, in conclusion, what it's probably true is that design is definitely changing itself from a discipline into a creative process whose ethical reference however remain steadfastly the protection of people, places and eco-systems (Pham, 1991).

Actually, the ambit of AI which has more applications in the field of design is the so-called 'generative design': it's a form of AI capable of exploring the project of objects at different scales, through which parameters like materials, costs and morphological objectives are transformed into design solutions. In truth, for the design ambit the real big opportunity will be offered by the possibility of producing objects with automatic 3D printing using robots able to analyze the information previously produced by the systems of generative design to build prototypes, models and final products. This is already enough to underline how the AI system of things is not exempt from improvements, whose margins are to be found in the quality and quantity of the input information (context), the possibility to verify the solution before their modelling (modifications), the capacity of reducing the resources (times and costs). But beside the freedom and the possibilities given to the designer in the present and future, the main aspect that seems to be fundamental is the concrete possibility of easily integrate technology, creation and management of the products. Downstream of this, more and more companies are going to ask design to control this integration through specific methodologies which can guarantee a more rapid and effective design cycle both for project and production: these methodologies are ascribed to the design thinking approaches. The use of design thinking in the AI ambit means making products and services more comprehensible and accessible for clients; furthermore, the same systems of AI are asked to be not a 'secret' for customers but totally available, at least under a communication, operative an economic point of view: in this point, the design thinking approach can effectively intervene, making clearer the phases of the brief and/or the product design specifications, as well as those of the concept, managing the transition from one to the other. After all, and as a direct consequence, also the user experience does it draw advantage from the AI systems. First of all, in terms of personalization, with the possibility to reach high quality customized user experiences based on real behaviors, preferences and real time interactions; secondly, for its power to translate them into dynamic and adaptive interfaces and returned to customers in terms of support, suggestion and a wide range of possibilities to choose.

The Aesthetic, Productive, Social and Cultural Dimension of AI in Design

Beyond the indisputable fact that AI has gained a very big space around us, influencing our everyday interactions and the way we interpret and live both the physical and digital world of products, a distinction between the different dimension of the dialogue between design and AI is strongly needed to help to address future investigations.

The aesthetic dimension: AI as a new language

An important issue is if the use of AI by design leads necessarily to specific aesthetical outputs, morphologies and forms. In other words, the question is: does the relationship between AI and design contains a unique exit in terms of aesthetical language? In this case, what happens to the historical archetypes? And what about the cultural relationship between objects and environment? As happened in other moment in history, the emergence of technological innovations brings with it new forms and new languages which can represent it: under this point of view, it does not make much sense to stand up for the rights of minimalism, in relation to the possibility of exploring new aesthetical territories. But observing how AI is going to replace the formal geometry with mathematical algorithms, a reasonable doubt about the ability to guarantee high aesthetic quality levels can come. May be an interpretative key could be the fact that design can bring things to the surface making them visible and legible. This role of 'showing' what people cannot read with the traditional tools starts having sense instead of asking ourselves if AI is useful or not, always beside the 'traditional' objective of the problem solving and search for innovation (Verganti, Vendraminelli & Iansiti, 2020). Still under an aesthetical point of view, another aspect can be related to the issue of customization: being possible to easily generate a big number of configuration and transforming them into concrete objects, the purchase of products' experience it connotes to a brand-new individual dimension made of personalization and dynamic adaptability according to specific requirements. This means that the new products' aesthetical outputs tend to be not unique any more but different, and if this aspect under the point of view of the *venustus* can appear as a criticality, from an ethical perspective it's a cultural achievement, at least when distortions and aberrations are correctly controlled.

The productive dimension: AI as a tool

Under a productive point of view, the organizational models of the traditional companies are not always capable to manage the scale production and its customization at the speed that society requires. Neither do designers in the project phase, because the effective capturing of user's feedback on a preliminary idea or concept needs time to be correctly elaborated and this process, when based on traditional tools, cannot but be sequential. Hence, AI as a tool can make possible to overcome these limitations on one hand increasing the speeds of the process' phases, on the other hand facilitating the chances of reaching innovation, through the following concrete elements:

- Availability of real time data (big data and internet of things);
- virtualization, automation and distribution of cloud computing and data mining;
- Automatic management of some process' phases, including virtual simulations, prototyping and additive manufacturing;
- improvement of the forecast models on customers' future behavior;
- scalability and speed of processes of innovation research.

These elements, in their turn, lead to the following objectives:

- increase of efficiency (functionality);
- improvement in accuracy (precision);
- reduction in costs (economy);
- enhancement of experience (participation);
- new points of view and new perspectives (lateral thinking).

If we consider the AI as a tool, we can use it in a generative way to create contents starting from systems of data: but considering the transformative impact of AI on the design industry, its capacity to make the design processes more efficient through automation and its strategic role in searching for innovation and break into new markets, we must consider AI not just as a tool but mainly as a paradigm shift in which, beyond the utility of managing UX research, market analysis, personas interviews, data processing, prototyping, digital fabrication, etc. (most of them open source), becomes fundamental the relationship between the solutions and their ethical impacts.

The social dimension: AI as a dialogical facilitator

Belonging to the Internet of things, the social power of AI in the design ambit can be recognizable along two main ways: on one hand, objects, software and systems from simple machines are gaining more and more ‘humanity’ and are going to build ‘horizontal’ dialogues with people that can very easily attract, being now intelligent sensors able to elaborate (and sometimes invent) all kind of information and data (centripetal sociality). On the other hand, the same objects, software and systems can increase the level of interaction between people (designers, producers and users), building specific intelligent environment or dialogical conditions (centrifugal sociality) which are not necessarily virtual but certainly innovative and sustainable (Arcagni, 2015). Thereby, AI establishes new relationships between clients and products, between companies and customers, between designers and users: this means that the risk of a substitution (machines for men) doesn’t seem to be realistic but a new approach to technology appears all the more necessary. New skills will be fundamental to overcome problems and reduce errors, increase efficiency, have access to new possibilities and free levels of creativity, maintaining AI in playing a supportive role.

The cultural dimension: AI as a renewal

The ultimate goal of the AI in the field of design is its capacity to contribute to the development of the cultural sector of things, according to the always changing social transformations that can have an influence on it. In the cultural dimension the AI becomes an opportunity to extend participation to a wider audience, respecting all the different points of view that a community can be made of (Franzato, 2017). Moreover, it assumes, as paradoxical as it may sound, a strategic importance in protecting the cultural craftsmanship, first of all because it extends the ability of a single craftsperson and, in general, the know-how of a small productive reality transferring in a larger scale

production its creations so to be more competitive reducing the gap with the bigger companies; secondly, because it frees the artisans from all those activity that take time away from creation, experimentation, search for innovation, giving them unprecedented opportunities; thirdly because it recognizes to design a new responsibility in managing and controlling over organizational complexity, thus helping craftsmanship to update its tradition while maintaining its cultural identity (Stevens, 2019).

Case Studies

For nearly a decade, the design ambits interested by the generative systems offered by the AI that, using a mix of algorithms and ‘text-to-image’ technologies, allow the use of shared computer resources aimed at producing infinite preliminary and/or final configurations, range from fashion design to product design, from furniture design to graphic design. In general, the most common solutions using AI in the field of design are related to intelligent data processing, virtual assistance, image and language processing, etc. More specifically, in the ambit of the product design are to be counted intelligent objects (objects with sensors that interact with the environment and able to learn directly from the users), autonomous robot and vehicles, all fitted with sensors able to interact with environment and programmed to learn directly from the users. An example is the creation of a series of eating accessories, designed by oio studio (2022) and

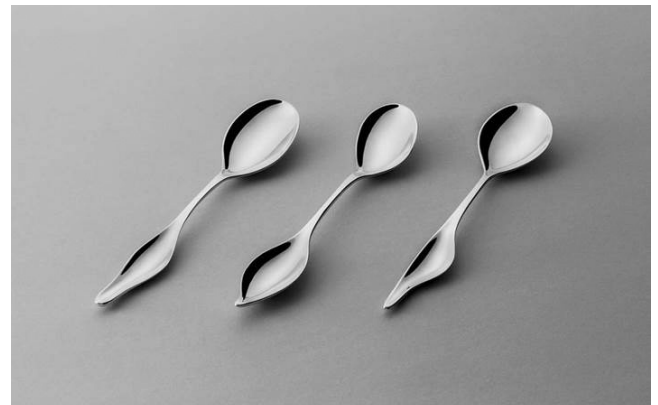


Figure 1: oio studio, Spawns, Greggio Argenterie, 2022 (Image font: oio.store)

manufactured in one of the oldest silverware factories in Italy (*Greggio Argenterie*), generated by a machine in thousands of variations; for the moment only three spoons are in production (Spawn no. 22, 51 and 83) but, through a process that the designers have called ‘artisanal intelligence’, in the near future other infinite combinations can be crafted (Figure 1).

In the automotive sector, the BMW Vision Next 100 has to be mentioned, a visionary vehicle born in 2016 from a generative design system which uses an ‘alive geometry’ made of more than 800 triangles that can dynamically change position and form. Moreover, the Airbus A320 which employs new lightweight and stable partition panels, produced by a generative design process, which are the result of the analysis of thousands of variations and configurations (2016) and whose final solution is a breeze wall which imitates the growth of human bones, the 55% lighter than a normal wall. In the field of furniture design,



Figure 2: Philippe Starck, AI Evolution (Console, Lounge, Chair), Kartell, 2019 (Image font: kartell.com)

the company Kartell, in collaboration with Philippe Starck, has recently produced a collection of objects created with a generative design process (A.I. Console, A.I. Lounge, A.I. Chair) in which the aesthetical research is aimed at reducing to a minimum the size of the components and the formal impact of their connections (2019); furthermore, the reduction of times and resources has been quite significant (Figure 2).

Another analogous interesting experience is the chair project by Schmitt & Weiss, a chair developed with the AI and born from a set of images of XX century's iconic chairs processed by a system of algorithms which generated new configurations. Or the Elbo Chair, developed by A. Harsuvanakit & B. Preston of the Autodesk's generative design lab, which comes from the intention of making reference to the Danish mid-century modern style chairs; in this case, the designers only decide to have the seat 18 inches off the floor and the chair to be capable of supporting 300 pounds: all the other aspects have been found out by the algorithms. Lastly, the Tamu Chair, designed by Patrick Jouin with the think tank 3DExperience for Dassault Systèmes, using generative design, had the objective to be foldable, light and space-saving, other than sustainable in the use of materials and in the production process. In the ambit of fashion design, the use of AI seems to have at least three general issues: first of all, the capacity of designers to be more efficient; secondly, the possibility has more designers increasing their number; thirdly, the hope to have better fashion consumers. The first issue is related to the problem of creativity: does the AI permit designers to improve their creativity? Undoubtedly the speed of the AI processes and the quantity of input they work with are a very big help, but designers must be careful and must ensure that AI amplify their work without replacing it. The second issue has something to do with democratization; under this point of view, we must accept the idea that the easy access to the AI tools can allow non-experts people to create clothes, expressing their creativity without being designers. The democratization is an important aspect contained in the 'philosophy' of AI, so the fact that the distance between expert designers and laypeople is getting smaller and smaller, it represents something that cannot be stopped: but this transformation has a positive aspect, which is the fact that designers and people can build a dialogue made of a more comprehensible language: in other word, and here we come to the third issue, the easy access to the AI tools can improve not only the creativity of non-expert people but also their sensibility, transforming them into more learned and aware consumers. And this



Figure 3: G-Star Design Office, AI Denim Cape, G-Star Raw, 2023 (Image font: g-star.com)

is definitely a guarantee for the achievement of higher level of quality in the final products that are put on market. One example of application of AI in the fashion design ambit is The Fashion Designer AI produced by the E-Commerce Amazon with the machine learning in 2017. It consists of a program which, learning from a data base of images, elaborates various configurations of fashion objects and clothing items, very useful both for professionals and clients. A recent and interesting experience is represented by the experimentation of G-Star Raw, called G-Star AI Denim Cape (2023), which is an endgame developed with the help of Midjourney and made of 12 unique concepts, conceived through the AI platform and then carefully crafted in their details (Figure 3). In graphic design there are many tools designed to create visual contents from libraries of pre-constituted models, images, icons, and fonts. Some of these programs are Canva, Nvidia Canvas, Topaz Photo AI or Let's Enhance (for images and pictures editing), Imagen, Midjourney or DALL.E 2 (for image creation) Writesonic and ChatGPT (for texts, articles, etc.), Design.ai or Topaz Video AI (for logotypes, videos, branding, advertising etc.), Adobe Sensei (for data streams, schemes, etc.), Alpaca (for 3D modelling), Adobe Firefly (for integrated creation of texts and images), Khroma (for color management), Uizard (for web applications, web sites, software desktop, etc.). All programs and platforms which have the ratio of speeding up the work of designers, improving the final product's systems of communications. As an example, we can mention the home fragrances Moooi, designed by EveryHuman and created with AI,

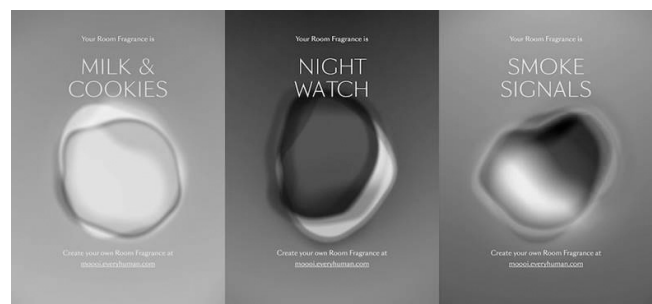


Figure 4: EveryHuman, Moooi Room Fragrances, 2023 (Image font: mooi.everyhuman.com)

which uses a platform called Algorithmic Perfumery through which is possible to create a personal fragrance starting from a survey on the website mooi.everyhuman.com, where users can answer some questions about sensation and feeling so to create the 'perfect' fragrance they are looking for (Figure 4).

Conclusions

The relationship between design and AI holds immense potential to radically change the future of human life. Through the integration of AI technologies into design processes, we witness a paradigm shift in how products, services and user experiences are conceived, developed and delivered. The above-mentioned examples are some of the many experiences that, in general, can be seen as concrete evidence of the interest that designers and productive companies working in the most diverse sectors show of the possibilities offered by AI. In their aesthetical aspects it is possible to detect a certain enthusiastic attitude toward experimentation and, on the other hand, an almost playful dimension in their functional proposals, despite the differences between each creative specificity; but a common element is always the dimension of 'dialogue', the necessity to talk with someone or something which is perhaps the expression of a sort of ethical coming out that takes the place of the old egoistic showing off. As a short and temporary conclusion of this essay, whereby it was necessary, we can summarize the following key points:

- creativity and innovation: AI empower designers to explore new frontiers of creativity and innovation by automating tasks, generating new ideas and optimizing their work in terms of efficiency and effectiveness;
- user centered solutions: the dialogue between design and AI enables the creation of high personalized and user centered solutions, driven by insights derived from data analytics, predictive modelling and user behavior analysis;
- efficiency and optimization: AI-driven design tools streamline workflows, enhance productivity and optimize design processes by automating repetitive tasks, analyzing vast amount of data and generating optimized design solutions;
- ethical aspects: Designers must grapple with ethical considerations surrounding the use of AI in design, including issues of transparency, fairness, privacy and bias. Responsible AI design practices are essential to ensure that AI-driven solutions uphold ethical standards and serve the best interests of users and society as a whole;
- human-AI collaboration: the symbiotic relationship between humans and AI fosters collaborative design processes, where AI augments human creativity, problem-solving capabilities and decision-making, leading to the co-creation of more innovative and impactful solutions;
- new opportunities and future challenges: while the integration of AI in design offers numerous opportunities for advancement and transformation, it also presents challenges such as technical complexity, data privacy concerns, and the need for upskilling and reskilling within the design workforce. Addressing these challenges requires a holistic approach that encompasses technological, ethical and socio-economical dimensions.

In essence, the convergence of design and AI represents a pivotal moment in the evolution of creative processes and problem-solving methodologies. By embracing AI technologies thoughtfully and responsibly, designers can harness their transformative potential to address complex challenges, unlock new possibilities and shape a future where human-entered design flourishes in synergy with intelligent systems.

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