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ethical leadership
a new frontier for design

L'ÉCOLE DE DESIGN Nantes Atlantique

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Ethical Leadership: A New Frontier for Design

Cumulus Conference Proceedings Nantes 2025

Conference Chair: Frédéric Degouzon (L'École de design Nantes Atlantique)

Conference Project Manager: Jade Gagnepain

Design: Esther Medeiros

Visual Identity : Eliott Gouyette, Julie Durand, Louna Mignonneau, Matthias Rischewski

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COMMUNICATION DESIGN EDUCATION FOR THE AI ERA: OBSERVATIONS FOR A RESPONSIBLE COLLABORATION WITH COMPUTATIONAL PARTNERS.

Marco Quaggiotto*[a]

a Politecnico di Milano, Department of Design
*marco.quaggiotto@polimi.it

ABSTRACT | The exponential evolution of artificial intelligence (AI) over the past 30 years has rapidly transformed it from an academic pursuit into a widely accessible technology with far-reaching effects across industries and creative practices alike. In this paper, while recognizing the inherent uncertainties of forecasting such rapid technological evolution, we aim to present a review of quantitative industry metrics and qualitative expert insights to provide the design community with a grounded basis for debate on the formative and professional shifts driven by AI.
Methodologically, the study employs a meta-review strategy, analyzing key industry reports, scholarly articles, and commentaries published over the past half-decade. From the thematic analysis of the collected sources, we extract recurring macro themes and contextualize general AI developments within the specific challenges and opportunities of Communication Design. The analysis unfolds in a structured progression: starting with an overview of the rapid evolution of AI technologies, it then explores the core characteristics of AI—particularly the shift toward generative models and example-based learning—and finally scrutinizes the practical challenges of control and collaboration between human designers and AI systems.
The first observation establishes AI's rapidly evolving role, bolstered by growing academic output, increased economic investments, and accelerated technological scaling. The second considers AI's rapid trajectory and the historical precedents for such a transformation, drawing parallels to earlier technological revolutions in design. The third observation analyzes AI's focus on pattern recognition and its tendency to reinforce the hegemonic perspective, posing risks of stereotyping and cultural convergence in visual

representation, challenging diversity and inclusivity in design. The fourth observation reflects on control, noting challenges designers face both in guiding AI toward nuanced creative intentions, and in training new models. The fifth observation reflects on the profound restructuring of design workflows as AI assumes roles traditionally held by designers, reflecting on the need for designers to take an active role in guiding these tools to ensure innovation and originality and on the skills and competences needed to steer intrinsically AI's imitative nature.
As a final contribution, the paper presents a hypothesis for education in design developed at the School of Design of Politecnico di Milano in the Communication Design degree program, advocating for an adaptive approach in design curricula, bridging humanistic insight with technological literacy to meet the demands of an AI-integrated creative landscape. The hypothesis presents a dual approach to design education founded on visual cultural literacy alongside technical expertise to equip future designers to critically engage with and direct AI technologies. This reflection aims to contribute to ongoing discourse on AI's implications within design, underscoring the responsibility of institutions like Politecnico di Milano to prepare future designers through updated pedagogical and professional frameworks in response to these technological transformations.

KEYWORDS | ARTIFICIAL INTELLIGENCE, COMMUNICATION DESIGN, DESIGN EDUCATION, DESIGN ETHICS

1. Introduction

In the past five years, advancements in Artificial Intelligence (AI) technologies have transformed what was primarily an academic research endeavor into a widely accessible technology, with tangible impact across various industrial sectors and a significant impact on practice and education in the discipline of communication design.

In the context of design research and related disciplines, the intersection of artificial intelligence and graphic design is an active area, with studies focusing on different aspects of its impact, such as its transformative potential (Stoimenova and Price, 2020; Song et al., 2022; Guzman and Lewis, 2020); its impact on creative methodologies and production practices (Serra and Miralles, 2021); its ethical and cultural issues and role of human oversight (Zhang et al., 2021; Gunkel, 2012); and the evolving role of the designer (Kwon et al., 2023; Afolabi et al., 2024).

In such a rapidly evolving context, while predicting the medium to long-term impact on visual and graphic design disciplines is a complex task subject to risks of oversimplification, this contribution aims to gather some observations on the current state, the emerging directions, the elements that seem to be critical elements for an informed discussion. With this aim, this paper presents a review that combines quantitative industry metrics with qualitative expert insights to examine the traits of current AI trends and their impact on design. The objective is to provide a founded base for debate in the design community with regard to the current and future formative and professional context.
While we acknowledge that even with a clear understanding of current technological developments, the implications of these changes with respect to the adjustments needed in didactics and education remain uncertain, we feel that defining a clearer picture of the current scenario can help reflect on the dimensions of change, if not on its specific modalities.

2. Methodology

This contribution is based on an analysis and meta-review of the main industry reports, commentaries, and literature addressing developments in AI in the last 5 years to provide a quantitative glimpse into the evolution of AI technologies, while also incorporating expert opinions to offer qualitative depth. From the collected literature, observations were extracted through thematic analysis in order to identify recurring macro themes and relate general commentaries to the disciplinary context of Communication Design.

The observations identified follow a structured progression, beginning with a broad technological perspective on AI, with limited reference to the disciplinary context, before gradually examining aspects critical to the context of Communication Design. While Artificial Intelligence is introduced in general terms, the primary focus is on Generative AI, and the mechanisms through which Machine Learning algorithms generate content.
The observations progress from the current state of AI (3.1, 3.2), through its fundamental characteristics (3.3), to its practical challenges (3.4), and finally its implications for design education and practice (3.5).
At the end of the contribution we share a first hypothesis, grounded in the available evidence, that represents an approach being tested at the School of Design of Politecnico di Milano in the Communication Design degree program, to frame and address such shifts in design practices.

3. Observations

3.1 A Context of Rapid Evolution

The starting observation, certainly obvious but not without relevant consequences, is that AI technologies not only represent a central reality in the current technological, cultural, and social landscape but also constitute a field characterized by continuous and rapid evolution. Data from industry reports and academic literature describe a context not only of growth that manifests across multiple interconnected dimensions but also of acceleration.

In the academic sphere, we see a remarkable intensification of scholarly attention and resource allocation. Publication volume on arXiv, an open-access platform for sharing scientific research, demonstrates exponential growth, doubling approximately every 23 months (Krenn et al., 2023), while citation patterns reveal AI-related works have increased from 5% to 20% of all computer science citations within a decade (Maslej et al., 2024). This academic expansion has catalyzed substantial institutional responses, evidenced by initiatives such as Horizon Europe's €95.5 billion allocation for 2021-2027 and a global tripling of AI-focused degree programs since 2017. Higher education institutions across both technological and humanistic disciplines have systematically integrated AI-specific curricula, responding to the growing demand for expertise in this rapidly evolving field (Maslej et al., 2024).

The industrial sphere presents an even more dramatic transformation. Industrial adoption of Artificial Intelligence demonstrates remarkable expansion across multiple indicators. Patent activity, predominantly driven by American and Chinese multinationals, has increased 31-fold since 2010 (Maslej et al., 2024), while organizational integration has reached significant levels, with 42% of large organizations having implemented AI solutions and an additional 40% actively exploring implementation (Alex Singla et al., 2024). This industrial momentum is particularly evident in design-adjacent sectors, where

generative AI investments witnessed an eight-fold increase in 2022, accumulating $25.2 billion in funding distributed among the companies pioneering advanced AI models and tools, such as OpenAI, Anthropic, Hugging Face, and Inflection. The expansion extends beyond corporate boundaries, encompassing both established technology companies—exemplified by Google's biannual doubling of internal AI projects (Young, 2018)—and the open-source community, where GitHub's AI-related projects have grown from 845 in 2011 to approximately 1.8 million in 2023, accompanied by a tripling of community engagement between 2022 and 2023 (Maslej et al., 2024).

The technological infrastructure supporting Artificial Intelligence has experienced unprecedented growth, with computational resources—such as processing power, specialized hardware, and data storage—allocated to AI training expanding at an annual rate of 400-500% over the past decade. This growth trajectory has remained consistent across various model architectures, particularly in generative systems including Large Language Models, image synthesis, and multimodal systems (Sevilla & Roldán, 2024). The convergence of expanding computational capacity, enhanced algorithmic efficiency (Ho et al., 2024), and sustained investment (Cottier et al., 2024) has facilitated the development of increasingly sophisticated models.
This increased sophistication can be observed in two main areas: dataset size and model complexity. Datasets—the collections of examples AI models use to learn—have grown significantly, reaching sizes of 2 trillion tokens (individual pieces of text, such as words or fragments) for language models, and 3 billion images for visual systems (Villalobos et al., 2024). At the same time, the complexity of these models has grown rapidly, with the number of parameters—the internal adjustable settings that determine how a model processes information—doubling every 8 months for language models and every 12 months for image recognition models since 2018 (Villalobos, 2022).

The practical ramifications of this technological acceleration manifest in quantifiable performance metrics. AI systems have progressively surpassed human capabilities across multiple cognitive domains: image classification (2015), simple text comprehension (2017), visual reasoning (2020), and text-based logical inference (2021) (Maslej et al., 2024). The pace of advancement has been so rapid that established evaluation frameworks (e.g. ImageNet, SQuAD, SuperGLUE) have become insufficient as benchmarking tools, compelling the development of more sophisticated evaluation methodologies, which themselves struggle to present meaningful challenges to rapidly evolving AI systems (Chollet et al., 2024).

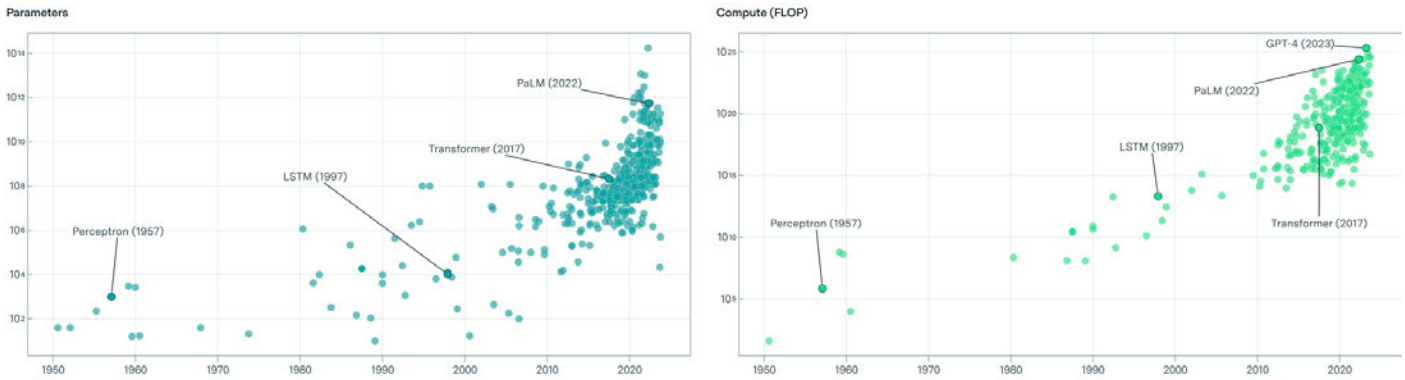

Figure 1: Exponential growth over time of number of parameters and computational resources employed in the training of AI systems (Villalobos, 2022; Sevilla & Roldán, 2024).

3.2 The Unabated Acceleration of AI

A corollary to this first observation, emerging from the analysis of key metrics, is that this acceleration shows no signs of slowing. In other words, if Artificial Intelligence indeed represents a paradigmatic shift, we are currently witnessing its preliminary phases rather than a completed transformation.
Like the advent of the Internet in 1995 or the mobile revolution of 2007, we are likely at the dawn of a transformative change. We begin to view, with skepticism, the first websites, the first applications, the first smartphones, questioning their true purpose and whether the surrounding enthusiasm is justified. As in these previous cases, we cannot predict the outcomes of this evolution or whether it will succeed. However, if AI proves to be an authentic paradigm change, it is plausible that its impact will be at least as profound and pervasive, if not greater, compared to previous technological revolutions (World Economic Forum, 2023).

Empirical evidence of this transformation can be observed in businesses' initial adoption of AI-enabled tools, their integration into production processes, and the use of generative models for increasingly complex tasks (Alex Singla et al., 2024). However, the rapid pace of these changes makes reliable predictions about future developments difficult.
In the specific context of Communication Design, the first quadrimester of 2024 has seen the introduction of over twenty advanced generative AI models by major sector players. Models such as Midjourney 6, Stable Diffusion 3, and Imagen 3 for image generation, Gemini Pro 1.5, Claude 3, ChatGPT-4o, and LLaMA 3 for multimodal tasks, Sora and VideoFX for video generation, along with Suno 3 and Stable Audio 2 for sound and audio generation, are the new models defining the state of the art in generative AI in 2024, and which will likely be obsolete by year's end.

Figure 2: "A hyper-realistic image of Harry Potter" as rendered by various versions of MidJourney.

Activities previously considered exclusively human domain, such as the generation of images, texts, videos, sounds, 3D models, and interfaces, are now beginning to be

executed with increasing sophistication by AI models, opening new opportunities and challenges. While the results in some of these tasks are still crude, the extremely rapid evolution of text-to-image models offers a paradigmatic example of how quickly this technology is progressing, and how soon we might see results that today seem beyond AI's capabilities. While Midjourney's first release in February 2022 produced rudimentary, barely recognizable images at small dimensions, unsuitable for professional use, version 6 (released in December 2023) has not only reached a level of quality capable of generating photorealistic images but has also progressively provided users with a series of tools and parameters useful for guiding image generation in specific directions. This rapid improvement does not constitute an isolated case but rather reflects a broader trend in the AI industry, eloquently represented by one of Silicon Valley's mantras according to which current models, however miraculous, are often presented as "the dumbest model any of you will ever have to use" (Altman, 2024).

With monthly frequency, increasingly sophisticated models redefine the boundaries of possibility in AI, rendering previous versions obsolete in a rapid cycle of advancement. In this context, the possibility of AI systems reaching human-level capabilities across a broad range of tasks has moved from science fiction to very concrete possibility, where several industry leaders, including Dario Amodei (CEO of Anthropic), Shane Legg (co-founder of Google DeepMind), and Jensen Huang (CEO of Nvidia), have suggested that these capabilities could emerge within the next five years (Amodei, 2024; Legg, 2024; Nellis, 2024). While speculations about the impact that reaching such a milestone could have are beyond the scope of this contribution, it is likely that, in such a scenario, concerns regarding the future of Communication Design might become secondary.

3.3 Learning from Examples

The third thematic cluster—crucial for communication design—focuses on how contemporary AI systems learn. Unlike traditional software, which follows rules explicitly coded by programmers, today's AI models acquire their abilities by studying large collections of examples (an "example-based learning" approach). This data-driven method represents a substantial departure from earlier algorithmic practice and is widely regarded as a paradigm shift within computational science.
While conventional algorithmic systems operate within predefined parameters and are particularly suited to tasks characterized by well-delineated and invariable rules, such as processing queries on complex data structures or analyzing formal systems, AI systems are capable of addressing more complex and nuanced tasks, such as image recognition and text translation. This capacity for adaptation and learning makes such systems particularly suitable for tasks requiring a high degree of flexibility and considerable generalization capability.
Within generative AI, this example-based approach most often takes the form of supervised learning, where—at a high level—models ingest vast collections of paired examples (an input such as a caption and the corresponding output, such as an image). Beginning with no innate skill, the system progressively infers the statistical relationships linking each input to its output and progressively develops a predictive model that can extend those learned patterns to new situations: identifying previously unseen objects, translating unfamiliar sentences, or generating fresh visuals from textual prompts.

This observation, apparently trivial, carries two corollaries. The first is that the nature of Artificial Intelligence systems is inherently tied to pattern identification and replication: it is essentially a mimetic process, where the computational apparatus acquires, through examples, the ability to imitate human behavior. The famous "Turing test," originally termed "imitation game" in the 1956 publication by Alan Turing (1956), proposes to replace the question "can machines think?" with a more empirically approachable issue:

"can machines exhibit intelligent behavior indistinguishable from human behavior?" In other words, it configures itself as an imitation test: it quantifies the effectiveness with which an artificial system manages to replicate human behavior and whether such replication proves sufficient to elude human discernment.
While the original Turing test was to be conducted through written conversation, today it's possible to conceive variants of the test applicable to a multiplicity of tasks: from image generation to language translation, to video production. In each of these domains, the fundamental question remains unchanged: is the produced simulation sophisticated enough to deceive a human observer?
The answer to this question is, increasingly often, affirmative. If some version of the Turing test in its original formulation has plausibly been surpassed without fanfare in recent years (Mitchell, 2024; Jones & Bergen, 2025), in the realm of visual communication, the most recent generative systems are capable of producing images that are substantially indistinguishable, and paradoxically even more convincing than real images.
As early as 2021, in a study where participants were asked to distinguish between real faces and AI-generated faces, the average accuracy was only 48.2%, substantially equivalent to random choice (Nightingale & Farid, 2022). In a subsequent study from 2023, the five faces most often judged as human were all AI-generated, while only one of the five faces most often judged as AI was actually AI-generated (Miller et al., 2023).
In light of recent progress in image generation systems (Flux, MidJourney, and Stable Diffusion), video (Sora, Runway), texts (ChatGPT, Claude, Gemini), and other types of content, it is realistic to admit the human observer's defeat regarding the ability to distinguish between AI-generated and real content. If for some type of content such a transition hasn't already occurred, it's reasonable to suppose it will happen in the very near future.
In the words of Microsoft's Chief Scientific Officer, Eric Horvitz, humanity finds itself at the beginning of a transition toward what he terms a "post-epistemic" context, a scenario characterized by a growing, if not insurmountable, difficulty in discerning between reality and fiction, with significant repercussions for the foundations of democracy, mechanisms of social trust, and communication paradigms in their entirety (Horvitz, 2022).
The initial manifestations of such phenomena are already before us. In reference to the journalistic context, in March 2024, shortly before the writing of this article, a network of websites dubbed CopyCop was identified, responsible for the dissemination of over 19,000 articles in English and French. Such content, originally sourced from authoritative journalistic sources, was "rewritten" by Artificial Intelligence systems with the intent of introducing elements of disinformation within substantially truthful news (Atherton, 2024).
In the social media realm, simultaneously, we observe the emergence of phenomena characterized by the exploitation of content designed to elicit specific emotional responses, such as anger, nostalgia, and indignation, to amplify engagement and increase profits through advertising strategies or other forms of monetization. Despite the extremism and low verisimilitude of this content often making it easily identifiable, sometimes becoming objects of derision among younger generations, their impact on older audiences (hence the colloquial designation "boomer traps") is steadily increasing, and the prospect of their evolution toward increasingly sophisticated forms raises significant concerns regarding the risk of growing dissemination of polarizing and manipulative content.
In general, the primary concern does not lie so much in the possibility of creating content indistinguishable from authentic content, but rather in the fact that the process of diffusion and industrialization of these practices may enable anyone to generate unlimited quantities of images and texts, automatically and at negligible costs, opening problematic scenarios regarding our ability to navigate an increasingly unreliable information context.

The second corollary is the observation that, in this mimetic process, the frequency of representation of a particular pattern in the training dataset is directly proportional to its prevalence in generation processes. Without appropriate precautions, in other words, artificial intelligences are subject to a phenomenon known in literature as "dataset bias" that leads AI models to replicate and amplify patterns present in training data. This means that due to the intrinsic nature of the learning modalities on which they are based, artificial intelligences do not configure themselves as inclusive tools, nor even neutral ones, but tend instead to represent the majority, the dominant form, the prevalent model, excluding minorities, marginal forms, alternative models (Mehrabi et al., 2021). In the design context, this tendency manifests through the communicative form of stereotype and prejudice, triggering a feedback cycle that reiterates and amplifies the dominant perspective, promoting a communicative monoculture (Bianchi et al., 2023).
The repercussions of this mechanism manifest in various ways: in facial recognition models that struggle to recognize faces of people with dark skin (Johnson & Johnson, 2023), in automatic translation models that translate in sexist or racist ways, in text generation models that produce discriminatory or offensive content. More insidiously, such effects also manifest in image generation models, visual representations that reflect prevalent aesthetic canons, traditional gender roles, and consolidated behavioral models, thus marginalizing alternative expressive forms, divergent visions, and critical perspectives (Anand et al., 2023; Naik & Nushi, 2023; Wan et al., 2024).
The probable large-scale diffusion of AI-generated content, predicted for the coming years, raises problematic scenarios in relation to the already complex issue of employing stereotypes in visual and textual content, and their role in perpetuating and reinforcing models of discrimination and inequality (Bucchetti, 2021). The risk is that of further exacerbating the gap between dominant visions and alternative visions, between consolidated forms of communication and emerging forms of communication, between hegemonic cultures and subaltern cultures, proposing a worldview where all Indians are old with beards and turbans, all women are models, all poor people are black (Turk, 2023).

Figure 3: 100 images generate using Midjourney with the prompt: “A Nigerian person” (Turk, 2023)

This intrinsically reactionary nature of generative artificial intelligences manifests both on

the representational plane and on the linguistic plane. Generative artificial intelligences, if left alone, through a sort of "cultural convergence" mechanism tend to converge toward rather recognizable styles, characterized by a "glossy" aesthetic that is simultaneously curated and homogeneous, reflecting dominant aesthetic canons inspired by the worlds of fashion, cinema, and advertising. A world made of saturated colors, marked lights and shadows, symmetrical compositions, young and attractive subjects, urban and minimalist settings, design objects and technology, reassuring poses and gestures, neutral and smiling expressions.
Regarding visual languages and styles, as with content, generative artificial intelligences are not machines for invention, but for imitation. Autonomously, they do not contribute to evolving the state of the art, do not give life to aesthetic experimentation or new forms of expression, except in cases where malfunction and glitch become an integral part of the creative process. While the deformed aesthetic of early GANs, the confusions due to mixed training processes, generation errors due to dataset artifacts, or model malfunctions have found recognition in artistic and experimental contexts (Klingemann, 2018; Obvious, 2018), the high-quality and realistic content generation capabilities of recent models have found lukewarm interest in the same contexts, which prefer to work through experimentation in training processes, dataset manipulation, creation of new models, where there is space for error, for the unexpected, for the unanticipated. Left to itself, AI innovates only when it doesn't function properly.

3.4Control and Collaboration

The fourth observation is that to overcome this highly imitative nature, it is necessary for the designer to be able to manage and control the generation process. Although this observation is also evident, the difficulty in controlling the generation process is still one of the main challenges limiting a more widespread and conscious use of generative artificial intelligences. While it is relatively easy to obtain a high-quality graphic/visual product from a generative model, it is extremely complex to obtain a result that reflects the designer's intentions, or even just to intervene in the generation process to modify the result in a controlled way. As assistants, generative artificial intelligences are comparable to talented designers and illustrators who don't speak our language, don't share our cultural references, and refuse to intervene iteratively on a project, preferring to produce results autonomously and independently.

The reasons underlying this difficulty are multiple and concern both the intrinsic nature of Artificial Intelligence models and the modes of interaction between designer and generative systems.
From a technical perspective, Artificial Intelligence models are notoriously difficult to interpret (Gilpin et al., 2018) and, beyond an understanding in terms of general generative principles, the reasons behind a particular generation process are often unpredictable and difficult to interpret. Context sensitivity, the tendency to produce different results from similar inputs, and opacity regarding internal generation processes make generative processes particularly complex to decipher and, consequently, difficult to predict, especially in scenarios that significantly deviate from the original training context.
From a semantic and cultural perspective, the context in which generative artificial intelligences operate does not correspond to that of users, and our knowledge of the world is not necessarily shared by AI (Prabhakaran et al., 2022). This can lead to results, sometimes amusing, sometimes disturbing, where Artificial Intelligence ignores key elements of context, producing results that do not reflect our intentions. If AI doesn't know that Waldo is a character notoriously difficult to find in a children's book, it might generate images where Waldo is clearly visible, or similarly, if AI doesn't know that Mother Teresa

was a religious figure known for her charity, it might misinterpret a request to generate an image of Mother Teresa fighting against poverty, producing images where Mother Teresa is depicted as a superhero fighting against an army of poor people.

Figure 4: generated image from the prompt: “A photo of Mother Theresa fighting poverty”

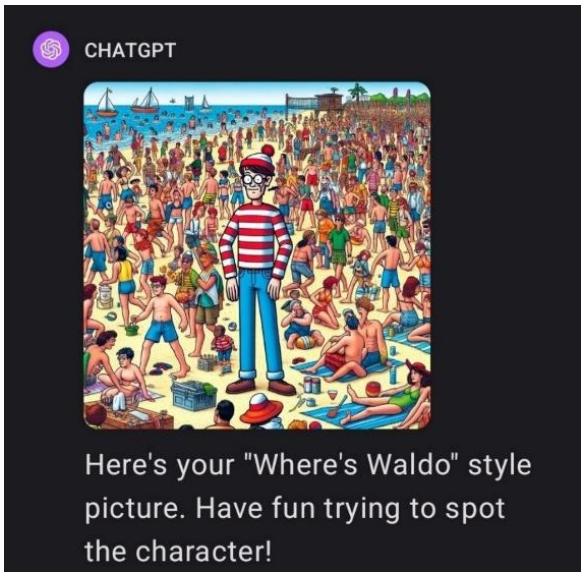

Figure 5: generated image from the prompt: “make a ‘Where's Waldo?’ picture”

Finally, regarding communication and collaboration modes with the user, control systems often prove inflexible. This difficulty in dialoguing with generative systems, well-known in the sector and subject of countless studies aimed at developing tools and methodologies to address it (Zhang et al., 2023), forces (for now) human designers to learn specific languages and interaction modalities to extract from artificial systems results that approach their intentions, in a process that is anything but immediate and intuitive. Training process anomalies, such as the presence of descriptions like "4k," "award winning," "trending on ArtStation" or "featured on Behance" in the captions of images present in the training dataset, are used as "magic words" that can be employed to induce the model to generate high-quality images. Image-specific area generation operations (inpainting) are used to apply corrections or modifications to problems in generation processes. Upscaling models are used to increase the resolution of generated images. Generation operations starting from images recompose collages of generated images to obtain more coherent results (Oppenlaender, 2022).
In contrast to the common perception of an automated and autonomous process where artificial intelligence models generate output independently from a textual description, the operational reality of generative AI proves significantly more complex. In the context of producing high-quality images, sector professionals confront a process that requires specialized competencies and may involve generating hundreds of images with different prompts and parameters, followed by a process of selection, combination, layering, manual editing, regeneration, and refinement that can require numerous iterations, the employment of multiple models and tools, and considerable time investment.
Depending on objectives and context, these control-seeking operations can occur at different levels, requiring more or less advanced competencies, more or less in-depth technical knowledge (Cotroneo & Hutson, 2023). Whether control occurs through accurate definition of the textual input guiding generation (prompt engineering), through integration of control models within the generative model (spatial conditioning), through adaptation of pre-trained models with specific objectives (fine-tuning), through selection and manipulation of training data (dataset curation), through modification of generation models (model hacking), the designer must be able to intervene in the generation process so that the model serves the designer and not vice versa.

Regardless of the level of technical depth, controlling generation processes requires a thorough understanding of the mechanisms underlying Artificial Intelligence systems, the modalities through which these can be influenced, and the consequences that can derive from such interventions. This knowledge, which requires a non-trivial level of technical competence, becomes fundamental, with the development of generative Artificial Intelligence technologies, to enable conscious use of these technologies, and to enable profitable and responsible use of the same.

Alongside these significant difficulties in controlling the generation process, if designers were to then venture into creating new models, they would face additional challenges related to controlling the learning process, which adds further ethical and design considerations to the already significant technical and methodological difficulties. If controlling the generation process requires a thorough understanding of the mechanisms underlying Artificial Intelligence systems, the modalities through which these can be influenced, and the consequences that can derive from such interventions, controlling the learning process requires an analogous understanding of the mechanisms underlying training mechanisms, the modalities through which these can be influenced, and the consequences that can derive from such interventions.
The typology of data to which they are exposed, the quality and quantity of this data, the modality of labeling and filtering, the selection and manipulation of training data, the definition of objectives and evaluation metrics, the choice of models and algorithms, the definition of parameters and hyperparameters, the evaluation and selection of models, the management of biases and distortions, are all elements that require specific competence and ethical awareness that go well beyond the technical competencies required for using pre-trained models (Whang et al., 2021).
The omission or underestimation of one or more of these elements can result in AI systems that uncritically replicate patterns and relationships present in training data, potentially amplifying discriminatory, racist, sexist, or otherwise problematic characteristics. The experience of the Tay chatbot, developed by Microsoft in 2016 and withdrawn after a few hours due to racist and offensive behaviors (Schwartz, 2019), highlights the intrinsic complexity in preventing harmful behaviors by Artificial Intelligence systems, and emphasizes the responsibility of designers not only in the model development phase but also in defining operational contexts and ethical limits within which AI must operate.

These difficulties in controlling generative models, which will certainly find solutions or mitigations in the future, do not imply that these technologies cannot be used to realize high-quality projects with great impact. On the contrary, the conscious and competent use of these technologies has already led to the emergence of new expressive modalities, new forms of communication that have contributed to the renewal of the creative and design landscape. They emphasize, however, the necessity for designers to possess not only technological competencies but also knowledge in terms of visual culture and language that allows them to understand the tool's potential, imagine the result, and be able to guide the process.
From a technical perspective, it becomes fundamental that designers acquire a solid understanding of the mechanisms and fundamental principles of Machine Learning processes, in order to be able to choose and manage the most adequate tools based on their objectives. At the same time, understanding the cultural context, visual culture, and reference terminology proves equally crucial, especially when operating in areas where content generation is closely tied to semantic and cultural interpretations.
Language, elevated to a primary tool for controlling and guiding the creative process, reveals the mastery of artistic, stylistic, and linguistic references, along with the ability to

express oneself in perceptual and semantic, cinematic and photographic, typographic and compositional terms, which allow steering the model in the desired direction. The designer's cultural and visual repertoire becomes the lexicon for dialoguing with AI.

3.5 Impact on Practices and Education

The final thematic cluster emerging from the analysis of AI discourse refers to the impact on technologies on the profession and practice. While in Communication Design the most visible current applications are tools for image generation or background removal, AI technologies have the potential to radically transform the modalities of production and consumption of visual and textual content, as well as communication and design processes. Artificial Intelligence represents not merely a new tool, but a new paradigm that demands critical analysis and redefinition of professional boundaries and competencies.
While on one hand AI relieves designers from operational tasks, such as background removal, photo retouching, and image cataloging, on the other hand we are already observing the first signals of a deeper restructuring of creative processes, with the emergence of tools where the design process itself becomes AI-assisted, requiring designers to assume a role as curator and art director, delegating part of the design solution exploration activities to autonomous models (Adeleye, 2024).

This transformation is not unique to design. In medicine, for instance, AI systems are demonstrating unprecedented diagnostic capabilities, particularly with complex pathologies like neoplasms. Recent studies (Donnelly et al., 2024; McKinney et al., 2020) show these systems achieving precision comparable to, or exceeding, human capabilities, enabling significantly earlier diagnoses than traditional methods.
A famous 2019 article in the British Journal of Radiology posed the question that many fields now face: "Will Machine Learning end the viability of radiology as a thriving medical specialty?" (Chan & Siegel, 2019). Their conclusion suggested that while AI systems would not replace radiologists, the field would need to adapt to a new paradigm where AI becomes an essential tool.
This reflection extends across professional domains, from law to journalism, from engineering to medicine: how will Artificial Intelligence transform our working practices, and what competencies will be necessary to adapt to this evolution?

Despite a tendency toward exceptionalism, Design too is called to a serious and urgent reflection on the competencies and knowledge necessary to face not so much the current technological context, but the future of exponential growth that seems to await us. In the university and advanced education context, the question is even more urgent: how to prepare new generations of designers for potential future scenarios? What competencies to transmit to students enrolled in 2024, who at the end of their educational path will find themselves operating in a professional context radically different from the current one? Once again, the answer goes beyond updating study programs with the introduction of new technologies and requires a collective reflection on how Artificial Intelligence interacts with design disciplines.

4. Discussion: responsible collaboration with AI

4.1 Culture and Code: A Tentative Direction for AI in Design Education

At this point, after five observations, we risk a hypothesis. Politecnico di Milano, one of the top universities in Europe by number of students and by ranking (QS Ranking, 2025), has offered, since 2003, a bachelor's degree and a master's degree in Communication Design. The approach to design that characterizes the course is a Polytechnic approach, which

combines human sciences and technology in the formation of professionals capable of managing visual and multimedia communication processes consciously and critically. The hypothesis we make for a responsible collaboration with AI is articulated in these two areas.

Regarding the human sciences dimension, the progressive delegation of operational tasks to AI systems is shifting the designer's role toward creative direction, curation, and guidance of the design process. In this context of increasing automation and tool autonomy, a deep understanding of visual cultures and imagery becomes crucial. This knowledge enables designers not only to maintain an active role in guiding generative models but also to conceive and communicate design visions effectively to both human and non-human collaborators. This evolution demands careful attention to ethical responsibilities. Designers must ensure that automation neither perpetuates biases nor reinforces stereotypes, while preserving diversity in visual culture. Although AI collaboration can enrich creative processes, designers retain full, non-delegable responsibility for their own choices and those of artificial collaborators, toward clients, users, and society.

Regarding the technological dimension, to avoid being relegated to a passive role as tool users, it is necessary for designers to acquire a deep understanding of emerging technologies (Torrisi, 2017). Such knowledge is fundamental not only to direct and coordinate artificial junior designers but aims to redefine the perception of Artificial Intelligence: not a static software, but a fluid and malleable process, in which it is possible to intervene to experiment, and to construct one's own tools. This ability to intervene at the technical level, by modifying photocomposition processes, printing procedures, photographic reproduction techniques, has always constituted a fundamental element of a critical design culture, aware of the tool's impact in the creative process and capable of imagining solutions that go beyond the consolidated repertoire. In the AI context, where the default mode is copy, imitation, replication, and stereotype, the ability to tamper with the tool, to exploit its limits and weaknesses, becomes crucial to overcome the conception of the tool as mere automation and liberate the creative and critical dimension proper to design.

4.2 First steps at Politecnico di Milano

At the School of Design of Politecnico di Milano, in the Communication Design degree, the first steps have been taken in the direction traced by this hypothesis. Beyond various types of experimentation with generative AI tools in bachelor's and master's degree design laboratories, the educational offering has been enriched by teachings including "Visual Cultures and Iconographic Systems" in the first year of the bachelor's degree and "Digital Image Culture" in the first year of the master's degree course, with the objective of contributing to providing the critical, cultural, and interpretative competencies necessary to face the new design context. Parallel to this, in the context of advanced educational paths (Politecnico di Milano, 2025), the "Computational Visual Design" course has been activated experimentally through which students have been called to confront the technological dimension of design. Specifically, the course proposes to provide the conceptual and technical tools to address communication design in computational terms, providing conceptualization, modeling, and abstraction competencies useful for facing design in a context where Artificial Intelligence is an integral part of the creative process.

In the research context, the relationship between communication and AI develops along

multiple trajectories, encompassing critical analysis of technologies and practices, experimentation in specific applications, and exploration of new expressive modalities, with ethics and responsibility as common threads. This diversity is reflected in recent master's research projects ranging from analyses of gender bias in generative model training datasets (Bazzan, 2022), to studies of AI adoption in independent publishing (Cozza, 2024), to mappings of AI as a design support tool (Bruno, 2023), highlighting the need for critical examination of algorithmic stereotype reproduction and the designer's role in mitigating biases through dataset curation and interpretation, while raising questions about authorship, originality, and editorial responsibility.
More experimental directions of research have explored technical aspects of AI development, moving beyond pre-trained models to systems tailored for specific design needs. Examples include GAN training from curated datasets for automated visual asset generation in brand design (Urietti, 2023) and fine-tuned diffusion models for representing complex territories like Po Valley, integrating photography with AI to create new representational paradigms (Pennacchioni, 2024). These projects explore AI not merely as an efficiency tool but as a medium for investigating novel forms of representation.

5. Conclusions

While these initiatives represent a promising beginning, they are intentionally provisional: they should be seen as an initial reflection intended to spark further experimentation. Curricular structures will need to be validated through evidence-based evaluation and ongoing dialogue with students, faculty, and external partners. At this stage, we do not feel it is yet appropriate to present detailed proposals, beyond the invitation to keep cultural and technical dimensions in view together, in order to avoid both technocratic reductionism and self-referential drifts.
Forecasting the future remains challenging: we might be significantly underestimating the transformative impact of exponential growth on Communication Design, or developments in generative Artificial Intelligence may be approaching a plateau. Regardless of the path AI takes, successfully navigating this transformation requires both deep cultural literacy and technical fluency to help designers maintain their role as conscious mediators of communication, capable of guiding AI tools while remaining mindful of their broader societal impact. The future of design education lies in the introduction of new tools, but in fostering professionals who can critically engage with technologies while maintaining the ethical and cultural awareness essential to responsible design practice.

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About the Authors:

Marco Quaggiotto, Associate Professor at Politecnico di Milano, specializes in communication design, focusing on digital interfaces, and the intersection between design, AI, and computational methods. He coordinates the DataInterfaces lab, integrating design, data science, and AI, and serves as Secretary of the Communication Design degree program.

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