



REVIEW ARTICLE

Artificial Intelligence in Graphic Design: A Critical Synthesis of Tools, Methods, and Creative Implications

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ABSTRACT

The main issue discussed in this review is the following: Although the number of artificial intelligence (AI)-driven design systems is growing exponentially, there is no single conceptual framework that could explain how these systems correspond and/or do not correspond to the principles of creative, communicative, and contextual nature that mark the practice of a professional graphic designer. To fill this void, the article conducts a systematic review of AI use in three areas, including automation in professional design software, non-expert template systems, and experimental AI systems created by science. The review is conducted with the help of a systematic approach that includes database searches (2019–2024), specific search inclusion and exclusion factors, and thematic synthesis of the studies devoted to layout generation, visual analysis, sentiment model, and generative image systems. The results demonstrate that AI can achieve success in automated processes, e.g., segmentation, layout refinement, typographic correction, and quick generation of stylistic variations, but technical systems often turn design into an operational process, and template-driven tools may tend to standardize the visual result and de-professionalize authorship. A synthesis of these three fields of knowledge makes the paper add a single conceptual framework, which explains in what circumstances AI can aid the hybrid intelligence of humans and AI and in what circumstances the existing models do not address the creative nature of the graphic design. This model offers a backbone to the future study of co-creative systems which maintain agency by designers and increase the computational opportunities of visual communication.

Keywords: Artificial intelligence, graphic design, human–computer interaction, creative process, hybrid intelligence

INTRODUCTION

Graphic design is a communication and expression technique that largely uses “visual” means, combining words, pictures, and imagination. To successfully communicate ideas or information through visual art, it also uses design thinking and a variety of strategies to innovate and modify language, images, and symbols. Design language symbols are integral to visual art.^[1] To convey the conceptual complexity of their work, designers employ design methodologies to explore new symbolic expressions and utilize these fundamental symbolic aspects to capture the aesthetic attributes of a piece. This aspect holds significant value for both research and the dissemination of artistic creations. Graphic design, although artistic, falls under the category of practical art. Unlike pure artworks, which are typically a direct expression of the artist’s personal thoughts and emotions, graphic design pieces reflect the designer’s interpretation of the emotions and needs of the intended audience.^[2] The quality of pure art is very subjective, whereas graphic design is influenced by objective limitations. Graphic design has artistic, educational, and commercial significance as a useful art form. The quality of graphic design works is primarily evaluated based on these criteria: aesthetic appeal, the effectiveness in conveying

information, and cultural relevance, with the artistic value measured in terms of aesthetic merit and cultural identity, as shown in the graphic design evaluation model in Figure 1.

Although the present study introduces this model for contextual background, it is not adopted as an operational framework for analysis. Rather, Figure 1 serves to illustrate how graphic design value has traditionally been conceptualized across artistic, informational, and commercial dimensions. This triadic structure provides an important reference point for the current research, which investigates whether contemporary artificial intelligence (AI) systems are capable

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of meaningfully supporting these dimensions or whether they remain constrained to technical and efficiency-driven functions. In this sense, the figure establishes a conceptual baseline against which the paper evaluates the degree to which AI aligns with the creative essence and communicative purpose of professional graphic design.

The most intuitive and the main means to interact with an audience are through visual communication. The unique combination of art and communication that is achieved through the use of graphic design makes visual language a unique method of expression and communication, unlike other modes of art. It is not only superficially attractive but it also sets out to impose deeper artistic feelings by use of rhythmic and structural visuals. In graphics design, the symbols of language are used as a channel to convey emotions and its order and form give it a rich rhythmic nature which adds more weight to the design for the viewers.^[4]

Since time immemorial, graphic design language analysis has been manual. Nevertheless, the digital era is transforming this practice and it is important that the basic principles of the design language in the digital age are known. These new features of digital language of design, as well as examination of its positive and negative aspects, can sharpen our perception. The current graphic design uses sophisticated technology and to a certain extent, this has automated the process of expression. Even though visual language in graphic design is not wholly automated, digital technologies allow designers to obtain higher automation, whereby the process of implementation following preliminary commands made by a human operator is predominantly computerized.^[5] Since these automations rely on programming, programmatic aspects are also observed in graphic design of the digital environment.

AI enables the automated analysis of graphic design language through technologies such as image segmentation and image sentiment analysis. Effective segmentation algorithms must be highly accurate, especially for high-resolution images

and intricate details in design, while also meeting real-time requirements. Current segmentation algorithms face three main challenges: they often cater to low-resolution images, they struggle with accurately segmenting fine details like edges or hair, and they still rely on some level of human interaction, even in advanced deep learning models.^[6]

Figure 2 depicts that the user and AI work together in the design process. The user creates the cycle when he suggests the design requirements, which the AI system interprets, analyzes, and creates a strategic response. The AI then implements and gives a rough design. The result is evaluated by the user and crucial and non-crucial factors are filtered. In case of changes required, this will repeat until the user is comfortable with the process and then result in the finalization and storage of the design. This human-AI feedback loop is the key to involving the user in shaping the AI-generated content and supports the design model of co-creation based on automation and human preference.

To explain the conceptual focus in this review, a number of key terms are defined. The creative nature of the graphic design is perceived in this paper as a complex of purposeful problem solving, interpretation of the context, and aesthetic authorship combined with symbolic meaning-making that defines professional practice. Hybrid intelligence systems are those where human designers and AI models both make decisions on the design: the human designer gives conceptual direction and other contextual judgment; the AI system provides computational generation, optimization, and prediction. Intimately connected is human-computer co-creation, a process of work based on feedback that enables designers to improve AI-generated outputs, refining them bit by bit to fit particular communicative, aesthetic, and contextual goals. These definitions become the conceptual grounds of the further analysis of AI use in graphic design.

In conjunction with layout and content generation, the image sentiment analysis, which is actually a type of image

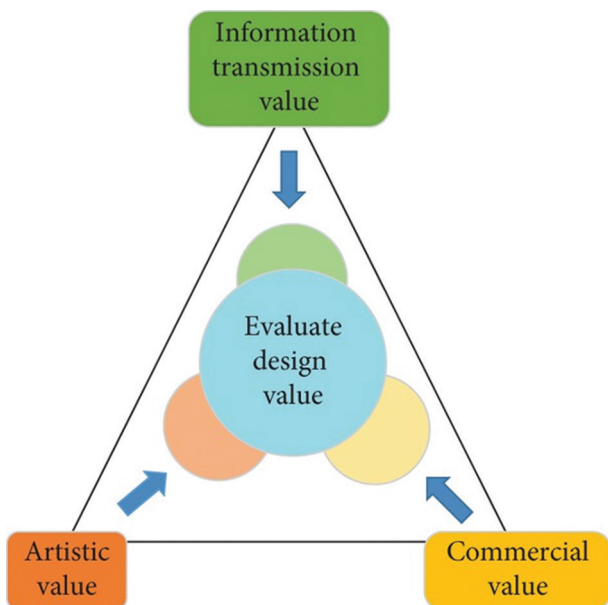


Figure 1: The model of graphic design work evaluation^[3]

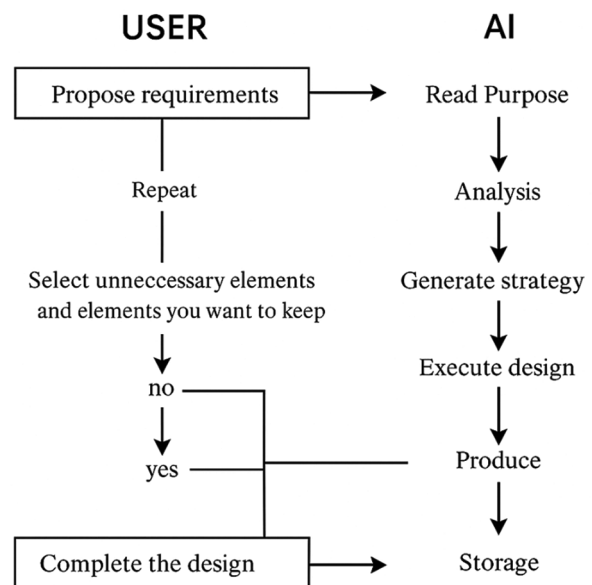


Figure 2: Iterative human-artificial intelligence collaboration model in graphic design workflow^[7]

classification, is an AI technology that recognizes features that carry emotional content. Such analysis often unfolds in terms of low-level sentiment features, mid-level semantic features, and high-level representations on deep neural networks. Sentiment recognition involving images can be more time-consuming than sentiment analysis involving text, since images can consist of complicated visual cues, which indirectly convey feelings. Since images and text are often used together in everyday communication technology, the current development of multimodal sentiment analysis takes textual and visual characteristics, balancing the weaknesses of one with the strengths of the other.^[8]

Even though the development of AI-based design tools accelerates, there is no single framework that shows how the technical practices of AI correspond (or do not correspond) to the basic principles of creative, communicative, and situational aspects of professional graphic design. Current literature is mostly divided into three areas, namely automation within professional software, consumer-oriented template tools, and scholarly models based on computer science. This conceptual dissection creates confusion regarding the real impact and importance of AI on the design practice. The innovative quality of this paper is that these three traditionally separated research and practice areas, which are professional software automation, consumer template tools, and academic AI design models, are so synthesized into a complete conceptual framework that one can see where AI fits in, and where it does not, in the creative nature of graphic design. Based on this, the current paper critically analyses and cross compares these three areas to recognize gaps in concepts, practical issues, and upcoming opportunities to hybrid human-AI design practices.

REVIEW METHODOLOGY

The paper takes the organized review approach to consolidate the recent advancements in using AI in graphic designing. The general objective is to combine the discoveries of professional design practice, consumer-centric tools, and research based on computer science with a view to develop a cohesive conceptual framework of the interaction of AI with the creative, communicative, and contextual aspects of graphic design.

An extensive literature review was provided in large academic databases that all include design research, human-computer interaction, and AI, such as Scopus, Web of Science, IEEE Xplore, ACM Digital Library, and ScienceDirect. The choice of these databases was due to their indexing of a wide variety of peer-reviewed journals and conference publications on visual communication, computational design, and AI technologies. The search strategy used included the combination of search terms, including AI, graphic design, and computational creativity, where example search terms are AI AND graphic design, AI AND visual communication, computational layout design, machine learning AND graphic design, generative adversarial network AND design, hybrid intelligence AND design, and human-AI co-creation. The terms were narrowed down through repeated iterations to capture both technically related research that involved the application of AI models to visual composition and design-oriented research that engages with the aesthetics, symbolism, communication, and experience aspects of the contemporary graphic design

practice, to ensure the inclusion of interdisciplinary sources that capture the multifaceted relationship between AI technologies and current graphic design practice.

The inclusion and exclusion criteria were based on specific criteria which made the selection of studies to be relevant to the present practice of graphic design. The studies were included in case they had been published within the last 3 years (2019–2024); this period was chosen based on the assumption that during this timeframe, advanced AI models, including generative adversarial networks, diffusion architecture, deep sentiment analysis, and attention-based mechanisms, were implemented in visual communication and design processes on a systematic basis. Qualifying papers had to clearly focus on AI or machine-learning systems used in areas such as graphic design, visual communication, computational layout generation, brand identity, image synthesis, aesthetic evaluation, sentiment-aware composition, or designer-friendly creativity support and must be found in peer-reviewed journals or conference proceedings. Moreover, articles in the sample had to show a direct connection to design practice, such as the suggestion of layout algorithms to visual communication,^[9] generative models of logo or interface design,^[10,11] or AI systems to aesthetic or emotional evaluation of graphical artefacts.^[3,12,13] It was narrowed down to include studies that did not pertain to the visual communication or creative practice or that did not focus on specific non-graphic design (e.g., a product or architectural design) and did not involve non-peer-reviewed materials (e.g., an editorial or a magazine essay). These were the criteria that made sure that the corpus of final models and systems under the AI models had a substantial theoretical, methodological, or even practical implication for the development of the art of graphic design as a creative and communicative practice.

The search results were filtered using the title and abstract levels to filter out publications that were obviously out of the scope of this review. The rest of the records were then subjected to full-text scrutiny to assess their relevance to the inclusion criteria, specifically with attention to three factors, namely the explicit use of AI or machine-learning methods, availability of a graphic design or visual communication context, and sufficient methodological or conceptual detail to permit meaningful cross-study comparison. A filtered collection of current scholarship was determined through this multistage review process, which included studies on automated layout and composition systems,^[9,14,15] generative and transformational visual models,^[3,10,16,17,11-18] sentiment- and attention-based evaluation of graphic artefacts,^[3,12,13,19] and hybrid or AI-assisted design work processes.^[20-22] Taken together, these papers form the summative and theoretical base on which the synthesis and critique in the rest of the paper can be based.

The chosen articles were then analyzed with the help of a thematic synthesis. Both studies were examined to establish the AI methods behind them, the particular design task they were developed to address, and their expressed or suggested impact on creativity, authorship, and visual communication. Thematic comparison and clustering allowed identifying three broad areas of AI implementation into graphic design: Automation as professional design programs, template and generative tools targeted at non-expert users,

and experimentation and scholarly AI models that fall at the interface of computer science and design research. In these areas, the degree to which AI systems are engaged in what this paper considers to be the creative nature of graphic design, and how AI systems facilitate - or restrict - the development of hybrid intelligences and human-computer co-creation were given particular consideration. This thematic synthesis gives the conceptualization of the critical analysis to be elaborated in the succeeding sections.

THEMATIC REVIEW OF AI APPLICATIONS IN GRAPHIC DESIGN

The power of technology has been an issue of grave concern among professional graphic designers who are gradually experiencing the erosion of automation and other disruptive technology.^[23] Since the electronic publishing revolution of the late twentieth century, technologic revolution has historically empowered designers by supplying them with more efficient tools and digital processes. However, in the long run, these developments also led to democratization of design in which non-professional gained greater access in terms of tools and skills in graphic design. This change is reflected in the development of in-house design departments in non-design organizations, which have moved rudimentary design work-page layout and photo-editing into in-house work units due to matters of cost and time savings.^[24,25] Consequently, the inclination to in-house graphic services has increased tremendously, with 98 percent of in-house creative agencies providing graphic design services presently.^[26]

Figure 3 shows the chronological evolution of historically used tools and the design paradigms, as well as the production techniques, in parallel with the critical developmental points in the development of society. The stage starts with the Hunting Society (1.0) where simple manual objects and primitive tools that aided in supplying food existed. It is then

succeeded by the Agrarian Society (2.0) where more organized manual production and early types of material craftsmanship became possible with the introduction of metal instruments, irrigation methods, and settlements. The Industrial Society (3.0) is a watershed defining the transition to mechanization because they invented steam-powered machinery and industrial design that enabled large-scale production, standardized, and mass production. The Information Society (4.0) was introduced in the second half of the twentieth century as a result of the popularization of computer technologies, such as computer-aided design (CAD) and production systems based on information technologies that changed the design process and made it more accurate. At the beginning of the twenty-first century, with the emergence of AI, there has emerged Society 5.0, a super-smart phase of design, where computational and generative design approaches prevail, in which intelligent production and AI-mediated creativity are becoming more and more dominant factors in the design innovation of contemporary design.

Integration of technology in in-house design environment has also come with new challenges. Sometimes, in-house designers are seen as lack of creative capabilities that are attributed to external agencies and this is where the issues of legitimacy and professionalism arise.^[27-29] Most companies still tend to hire outside agencies to do conceptual and high-impact work and use the internal teams to rely on quicker and less-costlier results.^[30,31] This segmentation creates a two-level model in the field of graphic designing, one stage being conceptual, strategy-based designing, and the other one being template-based implementation. This is because, in case the introduction of AI-driven tools occurs on the basis of making design practice faster and more efficient, a risk exists of design practice becoming focused on automation and aesthetically acceptable solutions instead of the rich interpretive and communicative work. This is unlike the conventional role of the designer as a communicator who understands the needs

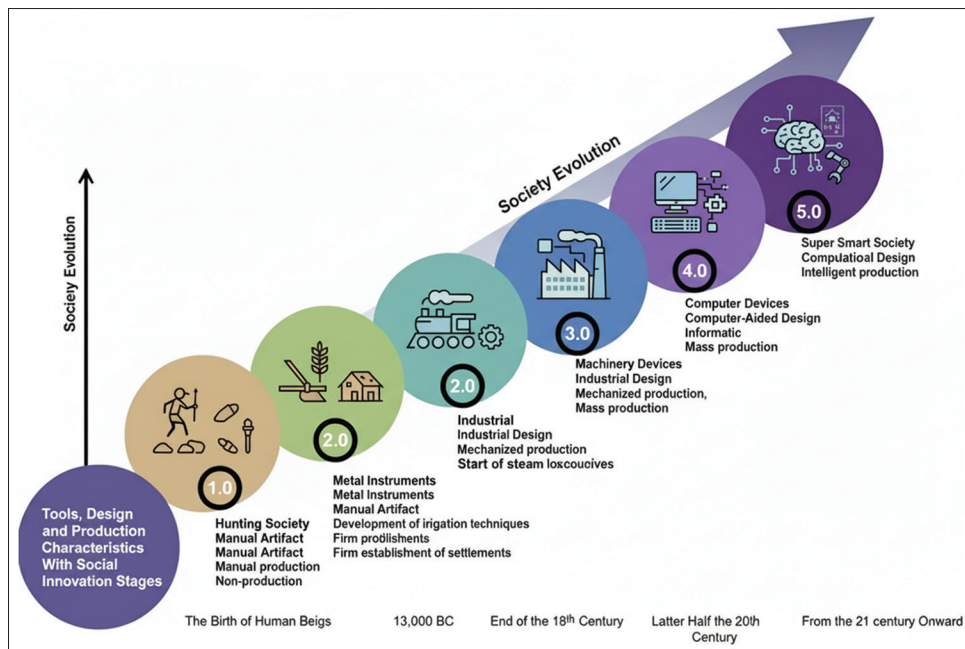


Figure 3: Evolution of societal development and design paradigms from manual production to artificial intelligence-driven creativity

of the clients and the cultural situations and influences to create visual messages.^[32,33] A mix of aesthetic and functional capabilities that are sensitive to the needs of their clientele, as well as the wider socio-cultural environments, like the complications posed by complex socio-cultural situations that are hard to duplicate in automated processes, make graphic design a practice that is challenging to automate, as is commonly suggested by Logan^[34] and Lunenfeld^[35] to argue.

More recently, tools like Canva or Adobe Spark have further democratized design by offering the solutions that are based on templates and designed to meet the specific needs of the non-professionals, which in many cases include the elements of AI to help users with layout or color selection.^[36] Although these tools facilitate the involvement of more people in the visual communication process and allow the untrained users to create the visual components that make coherent results, they also threaten with commercializing graphic design and homogenizing its visual results. Templates promote the re-use of common forms and styles that might not be as subtle or contextual as professional work can be.^[37] Professional designers in this landscape might have their work related to, or substituted by, quick template designs, which helps to shorten the definition of what is good graphic designing.

A substantial body of AI-related work in graphic design originates from computer science and related technical disciplines. In this research, design is often framed as a sequence of well-defined tasks that can be automated, such as layout optimization, style transfer, or image harmonization. For example, O'Donovan *et al.*^[38] developed an AI system to assist in single-page layout creation, while other studies have explored intelligent generation rules for posters^[39] and personality traits in graphic design.^[40] In these approaches, design principles from the graphic design literature are frequently translated into computational constraints or optimization criteria, but the more fluid and context-dependent aspects of design practice are often neglected.^[8,41]

Most of these AI advances are built into professional software, such as Adobe InDesign, Illustrator, and Photoshop, with such features as actions and being able to batch edit a piece of work, or complex compositing tools like the healing brush being an example of some revealing these advances.^[36] The AI-based solution Sensei of Adobe is marketed as an opportunity of enhancing the level of accuracy and efficiency, which is going to be able to automatize the monotonous processes without

sacrificing the ability to create creatively.^[42] Nevertheless, as soon as these technologies are introduced in the design processes without thorough involvement in the study of design theory, these technologies can involuntarily transform graphic design into a series of aesthetic and space optimization tasks. An example is Cook and Sekyeong^[41] who define design as having a functional relationship with existing technologies, which differs with traditional conceptions of a graphic design as a communicative and cultural practice.^[43,44]

Such functional attention, though successful in formally structured work, runs the risk of simplifying the concept of graphic design as a group of processes connected with layout, style, or color without paying attention to the creative brief, audience, purpose, and cultural or ethical aspects involved in professional design work.^[33,45,46] Other researchers have tried to distinguish between high-level conceptual and low-level technical tasks^[47] but much computational work is still done in the latter. The classification in Table 1 is not followed directly in one of the previous sources. Instead, it is a synthesis that was created by the author because of recurrent patterns that were identified through the literature reviewed. Although single research papers talk of automation in professional tools,^[36,42] template-based consumer platforms,^[37] or AI-based experimental systems,^[38,47] these are isolated in individual research papers. The current review is an attempt to gather these scattered insights to a consistent structure of analysis. Therefore, Table 1 is the personal integrative model of the author, created on the basis of the literature but not directly based on it, which gives a conceptual platform on the relationship between various AI uses and both practical and creative aspects of the graphic design.

Table 1 is an original synthesis by the author. The examples listed are drawn from published studies, but the categorization framework professional automation, template-driven consumer tools, and experimental academic research was developed specifically for this review to bridge disconnected discussions in the literature.

Recent years have seen rapid growth in AI models specifically applied to visual communication and graphic design. A hybridized grid and content-based automatic layout (HGC-AL) proposed by Liao and Hu (2023)^[9] allows more fluid grid layouts that adhere to design directions and limitations and provide better aesthetic quality and functionality. The idea of using AI to aid in creating attractive and unique

Table 1: Types of AI graphic design applications

Category	Description	Examples and remarks
Automation in Professional Software	Focuses on automating repetitive and labor-intensive tasks to free up designers for creative work	Adobe Photoshop “actions”: Batch editing. ^[21] “Healing brush”: Simplifying compositing tasks. ^[21] AI applications like Adobe Sensei: improve accuracy and efficiency. ^[36]
Template-Driven Tools for Amateurs	Offers accessible, template-based design tools aimed at non-professional users; primarily used for quick and simple designs.	Canva and Adobe Spark ^[21] ; Relies heavily on templates and lacks customization needed by professionals ^[22]
Experimental Research in AI and Graphic Design	Academic research focused on developing AI that integrates with creative and conceptual aspects of design; primarily originates from computer science with a functional perspective.	Projects focusing on single-page layout generation. ^[39] Hybrid intelligence approaches. ^[27] Challenges in adapting AI to nuanced and context-driven design tasks. ^[23]

AI: Artificial intelligence

brand identities was also shown by Mateja *et al.* (2023),^[10] who suggested an ensemble tree model optimization tool (ENTMOOT) to create SVG logo animation and conduct aesthetic analysis.

The graphic design assistance system created by Liu (2023)^[20] is on the principles of a convolution-automatic encoder (CAE) designed to assist in image recognition, generating geometric elements, and aesthetic analysis, thus automating the complex visual analysis tasks, as well as enhancing the creative capacity of designers. Cheng *et al.* (2023)^[14] utilized the Latent Diffusion Models (LDMs) in layout design, which allow the automatic layout generation with specified conditions and further manipulations through interactive editing the layouts to investigate the levels of similarity.

Other researches are devoted to the user response and attention. Chakraborty *et al.* (2023)^[12] adopted an attention model of graphic designs (AGD) to forecast the distribution of visual attention and the sequence of browsing in users of graphic layouts, which provides insights into people interaction with the graphic layouts and consequently assists the designers to optimize visual hierarchy and interaction. Huo and Wang (2022)^[15] used a LeNet convolutional neural network (CNN) with a spatial transformer network (STN) to identify and optimize elements of poster layout, producing aesthetically compliant layouts and offering layout adjustment plans in a very short period of time.

Other studies examine how the old can be blended with the new aesthetics. The symbolic model of new media art suggested by Lee (2022)^[48] involves a combination of conventional artistic symbols and modern digital technologies and allows for extracting and changing the stylistic features of images in a manner allowing them to combine both heritage and innovation. Li and Tang (2022)^[16] created a smart image-processing framework that used convolution-based operations to process the traditional imagery and extract brightness to enhance the extraction of features in designing heritage-related tasks. Ruiz-Arellano *et al.* (2022)^[49] analyzed AI-generated images in the context of persuasive design, where a multi-stage procedure consists of integrating the machine intelligence and the creative intention to enable the quality of visual discourses.

A sentiment and image segmentation deep-learning model introduced by Lu and Huang (2022)^[3] can be used to assist in intelligent design with the identification of emotional tone of the visual material and the ability to capture the expressiveness of the graphic design. Zheng (2022)^[21] proposed a neural network of visual memory of artistic graphic designs, which records the spatiotemporal features of the design layouts that allow automated rearrangement of the design schemes to achieve a better coherence and visual appeal. Luo and Zeng (2022)^[17] have suggested an improved model of automated historical image colorization (EDL-AHIC) of grayscale historical images using deep learning and local and global features to restore historical images and design heritage features, which can be used in the restoration and heritage design process.

Ni and Zhang (2022)^[50] multidimensional visualization fusion system to analyze complex data, Lin *et al.* (2022)^[11]

to use GANs to realize image synthesis with intelligent design robots, and constraint-based GANs with visual promotion designs by Qu *et al.* (2021) are also important contributions. Yang (2021)^[18] built a pseudo-client framework of detecting originality in graphics design, which serves stylistic originality and detection of plagiarism. Conditional GANs were applied to learn personal style with only a few examples (Lin and Martelaro 2021),^[22] and models based on DCGAN were proposed to create context-aware color schemes of user interfaces (Lee and Cho 2020).^[51] Wang and Fu (2020)^[19] and Kim and Suk (2020)^[13] investigated emotion responses prediction based on machine learning predicting the responses to graphic elements and poster designs.

Figure 4 presents a visual taxonomy summarizing many of these AI models and their applications across graphic and logo design, automated layout generation, and visual content creation and image processing.^[52]

Building on the individual studies reviewed above, Table 2 synthesizes and organizes recent AI applications in visual communication design published between 2019 and 2023. The table does not reproduce any existing typology from a single source; rather, it is an original compilation by the author that collates key information from multiple studies including application domain, model type, characteristic functions, and implications for design practice. By structuring these diverse contributions side by side, Table 2 provides a comparative overview that makes visible common technical tendencies, recurring design goals, and emerging patterns in how AI is being integrated into graphic design workflows.

Table 2 is a synthesis done by the author. With the entries being on published studies referenced in the rightmost column, the categorization, column format, and comparative framing are unique to this review. All these works show that AI in graphic design is no longer just a matter of automation, but a multidisciplinary ecosystem that can be used to supplement creativity, interpretation, and visual communication.

CROSS-DOMAIN CONCEPTUAL SYNTHESIS

Comparing the results between professional software, consumer applications, and academic AI models demonstrates some similarities and conflicts in the way AI interacts with graphic design. In all three areas, the automation of repetitive tasks or computation-intensive tasks is the most consistent match of AI. In software used professionally, this may involve batch processing, image correction, and layout alignment; in template platforms, it may be seen as automatic layout generation or color suggestions; and in academic models, it may be seen in layout optimization algorithms, segmentation systems, and generative image models. In them, AI evidently assists in minimizing the iteration time, complexity reduction in the high-dimensional visual space and facilitates exploratory searching of different design variations.

However, there are significant differences in how these systems relate to and support the creative spirit of graphic design. Most computer science-oriented models view design as an optimization problem, the success of which is measured by high-level or formal measures such as balance, readability, or user attention measures. These criteria, though useful, tend



Figure 4: Taxonomy of AI models in graphic design: Applications in generation, layout, and visual processing^[52]

to ignore the interpretive depths of design, including narrative framing, cultural subtlety, or moral staging. Consumer tools of a template type, in their turn, facilitate design accessibility at the cost of often bringing in implicit norms and stylistic defaults that could homogenize visual culture and shut out contextually specific or experimental practices. Even sophisticated design programs are starting to add intelligent functionality that is likely to guide designers toward specific stylistic clichés or composition templates, especially when time constraints and anxiety to use automated recommendations tempt the user.

The main conceptual gap is the inability to design models that precisely merge design context: Audience, purpose, cultural context, and rhetorical intent into AI-assisted workflow. Existing systems never engage the design brief, client constraints, or strategic communication objectives in a systematic manner and they never assist the designers in the initial ideation phase during which problem framing and idea discovery happen. Consequently, AI is normally used downstream, during the staging or optimization phase, where its impact can be heavy but its role in creative authorship can be minimized.

The cohesive framework put forward in the present paper, therefore, points at one of the critical tensions: on the one hand, AI is actively employed to speed up and perfect the superficial layer of design, but, on the other hand, it is highly unrelated to the conceptual, communicative, and cultural work that defines the concept of graphic design as a professional practice. It is important to acknowledge and respond to this disjunction to come up with stronger versions of hybrid intelligence in design.

DISCUSSION

The concept of hybrid intelligence is potentially a promising way of repositioning the role of AI in graphic design. Alternative to making AI lead in the place of human designers, hybrid intelligence focuses on systems where human and machine abilities are scheduled together. With these systems, designers retain the frame of the problem, conceptual direction, and interpretation of the context, and AI provides assistance through large-scale pattern recognition, prolific generation of alternatives, and optimization within constraints specified by the designer.^[53-55]

Table 2: Synopsis of AI applications in visual communication design (2019–2023)

Author (s)	Application area	Model used	Model characteristics	Impact on design
(Liao & Hu, 2023)	Graphic layout design	Content-based automatic layout with hybridized grid (HGC-AL)	Enables flexible, fluid arrangements that adhere to design limitations and principles by combining grid and content-based layouts	Enhances aesthetics and layout efficiency, allowing for automated and adaptable content arrangement
(Mateja <i>et al.</i> , 2023)	Brand logo animation	Tool for optimizing ensemble tree models (ENT- MOOT)	Creates SVG logo animations and conducts aesthetic evaluations to guarantee eye-catching design	Highlights AI's role in creating engaging animations and opens up new possibilities for brand representation.
(Liu, 2023)	Assistance system for graphic design	An AI-powered system for graphic design assistance; convolutional automatic encoder (CAE)	Facilitates the creation of geometric elements, picture recognition, and aesthetic analysis to expedite design.	Increases design efficiency by automating complex visual analysis, providing more space for creative tasks
(Cheng <i>et al.</i> , 2023)	Layout design	Model of latent diffusion (LDM)	Creates layouts according to user- specified criteria, enabling interactive layout customization.	Brings interactivity to layout creation, offering designers novel control and flexibility in workflows
(Chakraborty <i>et al.</i> , 2023)	User experience and design	Focus on AGD (graphic design)	Predicts user attention and browsing patterns within graphic layouts	Improves user engagement by optimizing layout elements to capture and guide attention
(Huo & Wang, 2022)	Design of Poster Layout	Lenet CNN; spatial transformer network (STN)	Recognizes and optimizes layout elements for effective poster design and template adjustments	Automates poster layout, enhancing both efficiency and adherence to aesthetic standards
(Lee, 2022)	Art in new media	Model of symbolism in new media art	Integrates traditional art forms with digital technology, capturing symbolic and stylistic features of artworks	Fosters creativity by blending classical art with modern technology for innovative expressions
(Li & Tang, 2022)	Perceptive image processing	Convolutional operations in an image feature extraction model	Enhances accuracy in extracting brightness features from traditional artwork for use in intelligent graphic design	Expands AI's applications in heritage-inspired design, ensuring precision in feature extraction
(Ruiz-Arellano <i>et al.</i> , 2022)	Creation of visual content	Model of persuasive design	Combines AI-generated visuals with persuasive design techniques to create impactful imagery	Enriches design discourse by offering new tools for visual storytelling and emotional engagement
(Lu & Huang, 2022)	Help with intelligent design	Sentiment analysis and image segmentation model based on deep learning	High-precision segmentation and sentiment analysis to identify emotional tone in visual content	Enhances the emotional depth of designs, providing designers with better tools for expression
(Zheng, 2022)	Creative graphic design	Neural Network for Visual Memory	Analyzes spatiotemporal features in graphic designs, supporting the automated reorganization of artistic schemes	Increases coherence in design, allowing dynamic visual layouts with enhanced appeal
(Luo & Zeng, 2022)	Design of interfaces	Automated historical image colorization with enhanced deep learning (EDL-AHIC)	Integrates local and global features to colorize grayscale historical images with high-quality output	Contributes to design restoration efforts, enriching visual communication by improving colorization accuracy
(Ni & Zhang, 2022)	Image visualization	Image multidimensional visualization fusion system	Enhances image processing, feature extraction, and handling of complex image data for multidimensional presentation	Improves the representation of complex data, providing designers with more versatile visualization options
(Lin <i>et al.</i> , 2022)	Synthesis of images	Generative adversarial network (GAN) and intelligent design robot	Uses GAN models to generate high-quality composite images with color harmonization for enhanced realism	Advances image synthesis by offering more precise and realistic composite design options
(Qu <i>et al.</i> , 2021)	Visual promotion	Generative adversarial network with constraints (GAN)	Automatically produces graphic solutions while maintaining design guidelines and maximizing visual appeal.	Enhances efficiency in visual advertising by producing consistent, visually appealing designs
(Yang, 2021)	Graphic design similarity detection	PseudoClient	Measures stylistic similarity in design, particularly in detecting plagiarism and generating rational designs	Supports originality by identifying stylistic similarities, helping to prevent design plagiarism
(Lin & Martelaro, 2021)	Graphic design	Conditional generative adversarial network (CGAN)	Learns and predicts personalized styles based on a small set of examples to generate style-consistent designs	Customizes design elements to fit individual preferences, promoting personalized design outcomes

(Contd...)

Table 2: (Continued)

Author (s)	Application area	Model used	Model characteristics	Impact on design
(Lee & Cho, 2020)	User interface design	Deep convolutional GAN (DCGAN)	Generates context-aware color schemes by integrating design Semantics and user interface requirements	Supports aesthetic coherence in UI design, ensuring color schemes align with functional needs
(Wang & Fu, 2020)	Cultural product design	Machine learning- based emotion prediction	Analyzes graphic elements to predict audience emotional responses, optimizing design impact	Informs design choices with emotional data, enhancing the cultural relevance of creative products
(Kim & Suk, 2020)	Graphic design	Maximum entropy model	Utilizes entropy- based learning to analyze and predict design elements' emotional impact	Refines graphic design by tailoring it to elicit desired emotional responses in viewers
(Sheng, 2020)	Real-time video enhancement	Enhanced video harmonization model	Maintains high- quality detail in video enhancement, suitable for real-time applications in design	Improves design integration in video, enhancing clarity and visual impact
(Martins <i>et al.</i> , 2019)	Typeface design	Genetic algorithm-based typeface evolution model	Uses genetic algorithms to evolve font styles based on user-specified fitness functions	Promotes innovation in typography by adapting fonts to user preferences
(Kovacs <i>et al.</i> , 2019)	Design of graphics	Model for context-aware asset search	Evaluates color selection and picture compatibility, allowing for more precise search and selection in design tools	Enhances design efficiency by streamlining asset selection, improving workflow

AI: Artificial intelligence

In this view, a creative spirit of graphic design involves protecting the processes in which human ability cannot be substituted: the development of purposefully framed briefs, the expectation of the audiences, the interpretation of cultural symbols, and the decision-making process that is full of values in the context of representation and beauty. AI can help, such as by coming up with a series of candidate layouts that follow fundamental compositional principles or by estimating what parts of a poster will be the most interesting, though the choice of the layout that conveys the desired message in the most effective way is a human task.

Simultaneously, the implementation of AI into the design processes brings with itself several risks and constraints. First, the increasing free access to tools based on templates might motivate organizations to ignore professional designers altogether when performing routine operations, and this could diminish the value of design skills and reduce the professional activity to oversight or troubleshooting responsibilities. Second, since AI systems are being trained using massive datasets of existing designs, they are likely to recreate current styles, biases, and aesthetic standards, which will further complicate unconventional or subversive work on the part of designers. Third, designers can become overconfident in automated proposals, and over time wear out their trust or competence in activities that were previously deemed central to design education and practice.

The need to work interdisciplinarily is thus paramount. To ensure AI development is directed by the needs of the design practitioners, they can state their requirements in a way that extends beyond efficiency and efficiency, i.e., developing support for exploratory and speculative practices, mechanisms of supporting authorship, and making algorithmic decisions visible and challenged. The importance of including users and the stakeholders such as designers themselves in the development of AI systems is highlighted by human-computer interaction and participatory design research.^[56-58] These

partnerships may aid in making sure that AI supplements do not restrict the expressive and interpretive aspects of graphic design.

CONCLUSION AND FUTURE DIRECTIONS

This paper has discussed the current uses of AI in the field of graphic design in three broad areas: Automation in professional software, consumer tools that have templates, and experimental or academic models of AI in design. Although the fields have been traditionally debated as distinct entities, the examination given herein has united the two domains under a single conceptual model, which revolves around the ways and the manner in which AI is augmenting or degrading the creative, communicative, and contextual aspects of graphic design. The originality of this paper is that it will bring together the three formerly distinct research and practice areas, including but not limited to professional software automation, consumer template tools, and academic AI design models, into a cohesive conceptual framework, showing where AI is fitting and where it does not fit into the creative nature of graphic design. This way, the paper will directly answer the main issue stated in the introduction, i.e., the lack of a consistent approach that will explain how the technical potential of AI can be applied to the very principles that can be used to define professional practice in graphic design.

In this context, the review identifies some inherent gaps within the existing AI models. Most of the output of computer science is still functionally oriented, maximizing layout, style, or image processing but design is seen as a series of technical processes. This task orientation may push aside the creative nature of graphic design its deliberate problem solving, its situational reading, and its symbolic authorship by turning it into parameter adjusting and pattern copying. Consumer tools that are based on templates, though effective in the democratization of access to design, have the risk of normalizing standardized, decontextualized visual

productions that reduce the subtlety of the designer as a cultural intermediary and strategic communicator. Although AI is branded as a productivity enhancer in even professional software, existing implementations are focused more on efficiency and automation than more expressive forms of co-creation and conceptual support.

The implications of this research on the design practitioners and the researchers are significant. To designers, the single framework helps understand where AI can be most effectively applied to the current work processes, i.e., automation of low-level, repetitive tasks, and provides an indication of where uncritical dependence on automated or template-based systems can impact professional value, originality, and critical authorship. To researchers, especially those working in AI and HCI, this framework highlights the necessity of going beyond the functional approach to defining good design to models that explicitly consider the intent of the creative work, the intended audience, the cultural context, and how ethical the work is. It also identifies the relevance of interdisciplinary cooperation, whereby graphic designers will be able to provide field-specific expertise on visual language, narrative, and meaning-making, and not just as end-users of pre-existing technical systems.

Based on this synthesis, there are various research directions that can be pursued in the future. First, we need user-centered hybrid intelligence systems, which are fully architected around the work processes, values, and cognitive strategies of professional graphic designers, and not by retrofitting generic AI tools into the design process. Second, co-creation models are to be oriented on further development and empirical research, putting emphasis on iterative human-AI interaction, interpretability of AI-generated suggestions, and mechanisms that assist designers to retain authorship and control of the concepts. Third, novel assessment systems will be needed to determine the aesthetic or functional value of AI-based designs, as well as their creative, cultural, and communicative value. Finally, longitudinal and practice-based research in design studios, in-house teams, and academic contexts would offer more insight on how AI transforms professional identities, pedagogies, and collaboration in graphic design.

To summarize, AI can contribute greatly to the practice of graphic design, although its advantages are not self-evident. Unless attention is given to creative essence, professional roles as well as contextual meaning, AI will reduce design to a range of optimized but conceptually shallow outputs. This paper presents a single coherent idea that connects the concepts of professional automation, consumer technology, and theoretical AI models to demonstrate why AI should continue to be integrated into the overall functioning of graphic design more symbiotically and responsively, i.e., in a manner that augments, and does not supplant, the cognitive, creative, and problem-solving abilities of a graphic designer. Provided that future research and practice will take this direction, AI and graphic design may be used to help create a future where computational power and human creativity are truly complementary, where the essential identity and veracity of the profession are retained, and new fields of visual communication and innovation are discovered.

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