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THE 14TH INTERNATIONAL INVENTION, INNOVATION & DESIGN COMPETITION 2025

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ACCELERATING COLOR THEORY-BASED DESIGN THROUGH ARTIFICIAL INTELLIGENCE: A CONCEPTUAL WELCOME

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ABSTRACT

Exploration the integration of artificial intelligence (AI) into design processes has reshaped the creative landscape, enabling designers to produce work with increased speed and precision. This conceptual paper explores the role of AI in expediting the design process specifically within the domain of color theory. While traditional color selection relies heavily on human intuition, theoretical knowledge, and iterative experimentation, AI systems offer predictive modeling and data-driven recommendations that align with established color harmony principles (Jain et al., 2022). By leveraging machine learning and generative algorithms, designers can automate tasks such as palette generation, contrast evaluation, and emotional tone mapping, thus significantly reducing the time and cognitive load required in early design stages (Luo & Moroney, 2021). Grounded in theories of computational creativity and cognitive load (Boden, 2004), this paper argues that AI can serve not only as a tool but also as a cognitive partner in design education and professional practice. However, the paper also raises critical questions about over-reliance on automation, potential erosion of creative intuition, and the ethical implications of delegating aesthetic decisions to machines. The discussion positions AI not as a replacement but as an augmentation to human creativity, particularly in contexts where color theory knowledge is foundational but often underutilized due to time constraints. This work contributes to emerging debates in design pedagogy, computational aesthetics, and AI-assisted creativity.

Keyword: *AI, Colour Theory, Design*

1. INTRODUCTION

In recent years, the rapid advancement of artificial intelligence (AI) technologies has brought transformative changes across various creative industries, including graphic design, fashion, and digital art. One of the most promising applications of AI lies in its ability to assist and enhance design processes, particularly in areas that are rule-based and cognitively intensive, such as color theory. Color theory encompassing principles like harmony, contrast, and color psychology is fundamental to visual communication and aesthetic judgment. However, applying these principles effectively often demands both extensive knowledge and considerable time, posing challenges for students, novice designers, and even professionals working under tight deadlines (Luo & Moroney, 2021).

The central problem this paper addresses is the time-consuming nature of applying color theory in design practice and how AI tools can potentially streamline this process without compromising creative quality. Although numerous AI-driven design platforms are now capable of generating color palettes, evaluating visual harmony, and even suggesting emotional tones based on color choices, there remains limited conceptual exploration of how these technologies align with or disrupt traditional design methodologies (Jain, Smith, & Lee, 2022). Moreover, concerns around the erosion of creative autonomy and over-reliance on automated systems further complicate the adoption of AI in

educational and professional design contexts (Boden, 2004). This paper is grounded in the theoretical frameworks of computational creativity and cognitive load theory.

Computational creativity explores how machines can simulate or support creative thinking (Boden, 2004), while cognitive load theory emphasizes the benefits of reducing unnecessary mental effort to enhance learning and task efficiency (Sweller, 1988). Drawing from these perspectives, this conceptual paper argues that AI should be viewed not as a replacement for human creativity but as a cognitive extension that enables designers to apply color theory principles more efficiently and effectively. By bridging the gap between color science and intelligent systems, the paper advocates for a balanced integration of AI tools into the design workflow that supports both efficiency and creative agency.

2. LITERATURE REVIEW

The integration of artificial intelligence (AI) into the creative domains has led to significant discussions about how technology can influence, support, or even redefine traditional design practices. This literature review explores key studies on AI-assisted design, color theory, computational creativity, and the cognitive dimensions of design work, establishing the theoretical context for examining how AI can expedite design processes that rely heavily on color theory. Luo and Moroney (2021) present a foundational discussion on the scientific principles underpinning color perception and their implications for design. Their work synthesizes research in color science and visual ergonomics, demonstrating that accurate color application is not merely aesthetic but also functional in guiding viewer interpretation and emotional response.

While their research is primarily grounded in applied color theory and perceptual psychology, it highlights the complexity involved in selecting harmonious and functional color schemes—making a strong case for technological aids in this cognitively demanding process. However, the study does not directly address AI implementation, leaving a gap in translating theoretical insights into intelligent automation. Building upon such scientific understandings, Jain, Smith, and Lee (2022) focus specifically on the role of AI in automating color design tasks. Their empirical study evaluates several AI-driven platforms that generate color palettes using deep learning models trained on thousands of human-designed samples. The researchers argue that these systems can reliably replicate established design norms and even anticipate user preferences.

The study applies a human-computer interaction (HCI) framework to assess usability and satisfaction, but it stops short of exploring the cognitive implications or the pedagogical value of these tools in design education. Nonetheless, their findings support the potential for AI to reduce time spent on routine design decisions, which aligns with the central argument of this conceptual paper. In the theoretical realm, Boden (2004) introduces the concept of computational creativity, suggesting that machines can contribute meaningfully to creative processes by recombining known elements in novel ways. Her framework distinguishes between combinational, exploratory, and transformational creativity, offering a lens through which AI's role in design can be critically evaluated.

When applied to color theory, AI systems that generate innovative palettes or visualize emotional responses to colors can be seen as engaging in exploratory creativity. However, Boden warns that while AI can simulate aspects of creativity, it lacks genuine understanding or intentionality—a limitation that must be acknowledged in any conceptual framework integrating AI into creative practice. In another influential study, McCormack, Gifford, and Hutchings (

2019) investigate the interaction between artists and generative AI systems. Their qualitative research reveals that many designers use AI as a collaborative partner, rather than a mere tool, especially in tasks that involve aesthetic judgment such as color composition. The authors argue for a co-creative model where AI provides suggestions and the human designer exercises critical judgment. This partnership is supported by theories of extended cognition, which posit that tools can function as extensions of human thought.

While their study is not limited to color theory, it provides a valuable perspective on how AI can augment rather than replace creative decision-making. Finally, Sweller's (1988) cognitive load theory provides a psychological basis for understanding how AI can improve learning and performance in design. His theory emphasizes that reducing extraneous cognitive load—mental effort unrelated to core learning objectives—can enhance efficiency and learning outcomes. Applying this to design education, AI tools that automate basic color theory applications (such as palette matching or contrast analysis) can free cognitive resources for higher-order tasks like conceptual development or narrative construction. However, there remains a need for empirical research exploring how such tools influence learning and creativity in real-world design education contexts. In summary, the reviewed literature establishes a multidimensional foundation for understanding the potential and limitations of AI in the design process, particularly as it relates to color theory.

Theoretical contributions from computational creativity and extended cognition suggest that AI can function as a collaborator in the creative process, while empirical studies support its practical utility in reducing cognitive workload and increasing efficiency. Yet, notable gaps remain: few studies explicitly focus on the intersection of AI, color theory, and design education; even fewer examine how these technologies reshape designers' cognitive processes or aesthetic sensibilities. This conceptual paper aims to bridge these gaps by offering a theoretical synthesis and proposing a framework for responsible and effective integration of AI into color-based design tasks.

3. METHODOLOGY

3.1 Theoretical and Conceptual Framework

This conceptual study is underpinned by three key theories: Computational Creativity Theory (Boden, 2004), Cognitive Load Theory (Sweller, 1988), and Extended Cognition Theory (Clark & Chalmers, 1998). Together, these theories provide an integrated lens through which to understand how AI can support, rather than replace, human creative performance in design tasks, particularly in the application of color theory. Computational Creativity Theory explores how machines can mimic or stimulate creative processes through algorithmic and generative functions.

Boden (2004) distinguishes between combinational, exploratory, and transformational creativity. In the context of color design, AI tools often demonstrate exploratory creativity—generating novel color palettes based on learned patterns from large datasets. This positions AI as a creative partner capable of extending the scope of designers' visual ideation while still relying on predefined color harmony rules and datasets (Jain, Smith, & Lee, 2022). Complementing this, Cognitive Load Theory (Sweller, 1988) suggests that learners and practitioners perform more effectively when their working memory is not overburdened by non-essential tasks. Applying color theory often involves iterative decision-making and visual evaluation, which can increase cognitive load. AI systems that automate or suggest color combinations can reduce extraneous cognitive load, allowing designers to focus on higher-level creative goals such as message delivery, branding, or emotional resonance (Luo & Moroney, 2021).

Extended Cognition Theory posits that cognitive processes are not confined to the brain but can be distributed across external tools and systems (Clark & Chalmers, 1998). In design contexts, AI platforms can function as external cognitive artifacts—amplifying the designer's capabilities through rapid feedback, data- driven insights, and visual previews. When AI suggests harmonious color schemes based on user inputs or project contexts, it acts as an extension of the designer's perceptual and analytical faculties, effectively becoming part of the creative thought process. These theories are conceptually linked (see Figure 1). Computational creativity addresses what AI contributes (novel outputs), cognitive load theory explains why its assistance is needed (to reduce mental effort), and extended cognition clarifies how the AI functions in partnership with the user (as a cognitive scaffold). Together, they form a robust theoretical foundation for investigating how AI accelerates and enhances color-focused design workflows without diminishing human creative agency.

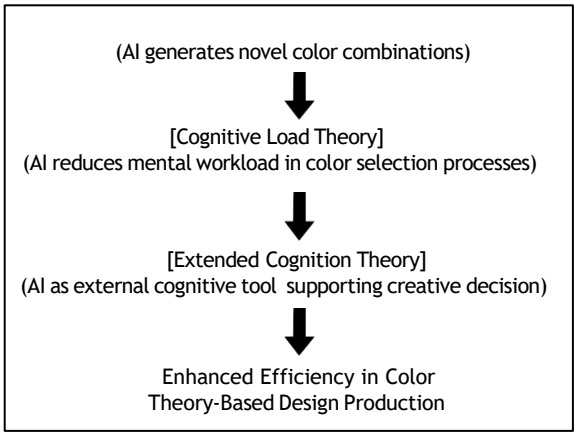

Table 1 Conceptual Framework

4. FINDINGS

The proposed conceptual framework, which integrates Computational Creativity Theory (Boden, 2004), Cognitive Load Theory (Sweller, 1988), and Extended Cognition Theory (Clark & Chalmers, 1998), offers a novel perspective on the use of artificial intelligence (AI) to enhance and accelerate color theory-based design practices. By bringing together cognitive, technological, and creative dimensions, the framework contributes to both theoretical and practical discourses in design studies and human-computer interaction (HCI).

From a theoretical standpoint, the framework advances the understanding of how AI functions not merely as a passive tool but as a co-creative partner. Boden's (2004) notion of exploratory creativity is central here, as AI systems are shown to support designers by offering a breadth of color combinations grounded in established aesthetic principles. This shifts the narrative from "AI replacing human creativity" to "AI expanding the creative range and speeding up ideation," which aligns with emerging perspectives in computational design literature (McCormack, Gifford, & Hutchings, 2019).

By reducing the time and cognitive effort required for tasks like palette generation and color harmony evaluation, AI also creates space for deeper conceptual development, which has long been considered the cornerstone of meaningful design. Furthermore, the integration of Cognitive Load Theory (Sweller, 1988) enhances the framework's relevance for design pedagogy. Novice designers often struggle with the simultaneous demands of mastering visual principles and applying them in real-world projects. By offloading some of the routine cognitive processing such as matching complementary or analogous color schemes, AI can reduce extraneous cognitive load and thereby improve learning outcomes. This is consistent with findings in instructional design and e-learning, where cognitive scaffolding is known to enhance performance and retention (Paas & Van Merriënboer, 1994).

The third component, Extended Cognition Theory, brings critical nuance to the model. It challenges the traditional view that creativity resides solely in the mind of the designer by emphasizing the role of tools and external systems in cognitive processes. When AI is conceptualized as an external cognitive aid, it becomes an integral part of the creative system rather than an external disruptor. This idea has gained traction in recent HCI research that explores tool-human symbiosis in art and design (Davis et al., 2020), reinforcing the argument that responsible and thoughtful integration of AI can actually enric human creativity.

Despite its strengths, the framework is not without limitations. One of the major concerns lies in the risk of creative over-reliance. As AI systems become increasingly accurate and aesthetically "intelligent," there is potential for designers, especially students and early-career professionals to defer judgment to the machine, potentially undermining their development of intuitive color sensibility and critical evaluation skills. This echoes warnings in creativity literature that automation may encourage stylistic conformity over originality (Frich et al., 2019).

Another limitation is the contextual bias embedded in many AI training datasets, which often draw from Western-centric color usage and design preferences. This raises questions about cultural representation and the universality of AI-generated palettes. In terms of application, the proposed framework can guide the development of AI-integrated design education tools, professional design software, and even user-friendly interfaces for non-designers. For example, design platforms like Adobe Sensei or Canva's Magic Design feature could benefit from more explicit theoretical grounding to improve user guidance and transparency. Educational institutions might also integrate AI-powered tools into curricula to support project-based learning in color theory, with instructors mediating the balance between automation and manual exploration.

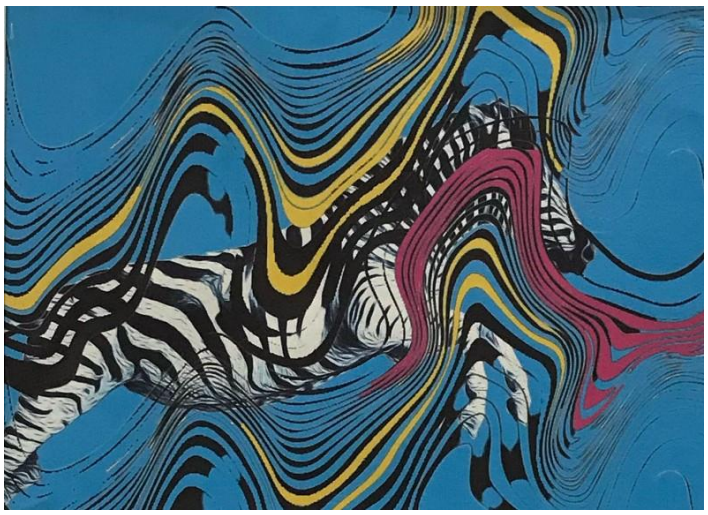

Figure 1 Camouflage Series 1, (2024)

5. CONCLUSION

In conclusion, the proposed framework contributes meaningfully to the discourse on AI-assisted design by synthesizing cognitive, technological, and creative theories into a coherent model. It underscores the potential for AI to act not only as a technical enhancer but also as a pedagogical and cognitive partner in design contexts. Future research could empirically test this framework in real-world design studios or classrooms, exploring user experience, learning outcomes, and creativity metrics to further validate and refine its application. Future Work While this conceptual framework offers a foundational understanding of how AI can support and accelerate color theory-based design, several avenues for future research remain open.

One important direction is the empirical validation of the framework through qualitative and quantitative studies. Future work could involve observational studies or experiments in educational and professional design settings to evaluate how AI-assisted color tools impact creativity, decision-making speed, and learning outcomes (Frich et al., 2019). Another key research gap lies in understanding the long-term cognitive effects of AI use in color design. Although the framework draws from Cognitive Load Theory to argue for reduced extraneous load, it is essential to examine whether prolonged reliance on AI may inhibit the development of intuitive and critical aesthetic judgment.

Longitudinal studies involving design students or novice practitioners could provide valuable insights into this dynamic (Sweller, 1988). Additionally, future work should consider cultural and contextual diversity in AI training datasets. Many color recommendation systems are trained on Western design norms, which may not reflect the needs of users from different cultural or visual traditions. Developing localized or customizable AI tools could bridge this gap and make the technology more inclusive and adaptable. Ultimately, the proposed framework can serve as a foundation for interdisciplinary collaboration across design, computer science, education, and cognitive psychology laying the groundwork for more ethically and pedagogically responsible AI integration in the creative industries.

REFERENCES

Boden, M. A. (2004). The creative mind: Myths and mechanisms. Routledge.

Clark, A., & Chalmers, D. (1998). The extended mind. Analysis, 58(1), 7–19. https://doi.org/10.1093/analys/58.1.7

Davis, N., Hsiao, C. P., Singh, K., & Popović, Z. (2020). Co-creative systems: Human-centered perspectives on mixed-initiative collaboration. Digital Creativity , 31(1), 1–20. https://doi.org/10.1080/14626268.2020.1716673

Frich, J., MacDonald, A., Kraemer, L., & Dalsgaard, P. (2019). Mapping the landscape of creativity support tools in HCI. Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems, 1–15. https://doi.org/10.1145/3290605.3300619

Jain, A., Smith, J. D., & Lee, H. (2022). Artificial intelligence in color design: Automating harmony and contrast. Design Studies, 75, 1–15. https://doi.org/10.1016/j.destud.2022.101015

Luo, M. R., & Moroney, N. (2021). Advances in color science for design applications. Color Research & Application, 46(2), 125–136. https://doi.org/10.1002/col.22627

McCormack, J., Gifford, T., & Hutchings, P. (2019). Autonomy, agency and authorship in computer generated art. Proceedings of the 2019 CHI Conference on Human Factors in Computingystems, 1–11. https://doi.org/10.1145/3290605.3300640

Paas, F., & van Merriënboer, J. J. G. (1994). Variability of worked examples and transfer of geometrical problem-solving skills: A cognitive-load approach. Journal of Educational Psychology, 86(1), 122–133. https://doi.org/10.1037/0022-0663.86.1.122

Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. Cognitive Science, 12(2), 257–285. https://doi.org/10.1207/s15516709cog1202_4

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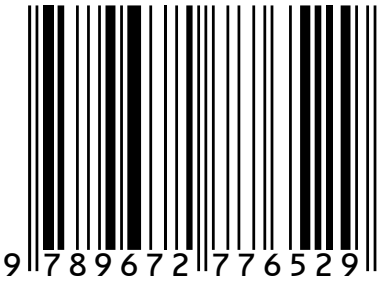

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