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International Journal Fine Arts and Creative Innovation are created to promote and support the dissemination of work to faculty members, academics, researchers, students, and the general public. Artists and art enthusiasts around the world have the opportunity to publish academic works and research covering all types of creative arts, invention, innovation, product innovation, innovative artistic processes, educational innovations, and more.

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International Journal Fine Arts and Creative Innovation has a policy of supporting researchers, academics, faculty, and students both internally and externally. It serves as a platform for exchanging academic knowledge, research, and creative work. It provides a space for expressing opinions, debates, and criticisms regarding art and culture. Innovations in various sciences bring benefits to the public in various areas, including:

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The editorial team follows a process for creating the journal, starting from receiving articles and proceeding through a thorough screening. The team selects experts with knowledge and expertise in each field to review the articles. This is the main standard criterion for requesting certification. The articles in this journal are diverse and comprehensive, which is one of the important goals of preparing academic journals.

The editorial department is willing to receive research articles and academic articles in the fields of visual arts and innovation to disseminate to educational institutions and others in the future. The editorial team thanks all those who submitted articles. Copyright of the articles belongs to the authors and Shinawatra University and is reserved by law. We also thank all the experts who sacrificed their time to review and provide suggestions that will be useful in developing and improving the journal for even greater quality in the future.

With kind regards,

Dr.Chanyanan Somthawinpongsai
Editor-in-chief

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MIXED MEDIA ART AND DESIGN FROM WASTE MATERIALS FOR COMMUNICATING SUSTAINABILITY.

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Abstract

Environmental problems arising from production, consumption, and the growing volume of discarded materials affect both ecosystems and contemporary ways of life. This is especially evident in materials with short service lives but long environmental persistence, such as plastics and single-use packaging. This article examines the potential of mixed media art to transform waste materials from “objects that have outlived their usefulness” into “media of meaning” through the concepts of Sustainable Art, Eco-Design, and Circular Design. It discusses the roles of physical properties, histories of use, and material traces as components of visual communication.

In addition, the article proposes a five-stage creative framework: Collect, Decode, Experiment, Transform, and Communicate to enable artists and designers to connect material experimentation with sustainability issues systematically. This approach suggests that the artistic use of waste materials should extend beyond simple reuse or recycling toward the development of a Material Narrative, through which materials can communicate relationships among humans, consumption, culture, and the environment.

Keywords: Mixed Media Art, Waste Materials, Sustainable Art, Design for Sustainability, Circular Economy

Introduction

Linear systems of production and consumption commonly follow a “produce–use–discard” sequence, causing large quantities of materials to be reclassified from resources as waste once their original function has ended. However, the report Turning off the Tap by the United Nations Environment Program indicates that addressing plastic pollution requires systemic change, including eliminating unnecessary plastics, redesigning products and packaging, promoting reuse, and improving recycling, to make plastics systems more circular (United Nations Environment Program [UNEP], 2023).

Within art and design, waste materials can therefore be reconsidered as “creative resources” that embody both physical properties and social meanings. Transforming plastic bottles, textile scraps, metal, paper, packaging, or electronic components into artworks is not only a means of reducing waste; it also shifts viewers’ perceptions of materials previously regarded as valueless.

The study by Zainal Abidin et al. (2024), which analyzed the use of waste and recycled materials in the works of Malaysian artists, found that waste materials can function as creative media in both two-dimensional and three-dimensional art and can help stimulate awareness of environmental problems. Working with discarded materials, therefore, becomes a space where aesthetic experimentation intersects with social and environmental responsibility.



Figure 1. Framework for transforming waste materials into artistic media for communicating sustainability.

Objective

1. To examine the potential of mixed media art to transform discarded materials into meaningful visual media.
2. To discuss how material properties, histories of use, material traces, and circular design principles contribute to the communication of sustainability.
3. To propose a five-stage creative framework for integrating material experimentation with sustainable art and design practice.

Literature Review

Mixed Media Art and the Concept of Assemblage

Mixed media art enables creators to combine multiple materials, techniques, and processes within a single work, including painting, printmaking, collage, sculpture, photography, sound, light, video, found objects, and natural materials. This flexibility makes mixed media art particularly suitable for experimenting with discarded materials, because each material possesses distinct color, surface, weight, rigidity, transparency, and a different history of use.

This approach is closely related to assemblage, which Tate describes as art created by bringing together diverse elements, often including everyday objects or objects the artist finds (Tate, n.d.). In works made from waste, the selection of objects therefore depends not only on shape or color but also on meanings already attached to them, such as product labels, signs of use, cracks, fading, or rust.

Materials as Media of Meaning

What distinguishes art made from waste materials from craft-oriented recycling is that the material does not function merely as “something used in place of a new material”; rather, it becomes part of the work’s meaning. Artists should therefore ask both what properties a material possesses and what circumstances it has passed through before entering the artwork.

- Plastic may signify convenience, single-use consumption, transparency, and a durability that becomes problematic after use.
- Metal can signify industry, strength, coldness, and traces of time produced by oxidation or rust.
- Paper and packaging can introduce text, advertising, trademarks, and the language of consumption into the artwork.

- Textile scraps can connect with the body, memory, clothing, and the environmental impacts of the fashion industry.
- Electronic components can reflect cycles of device replacement, technological advancement, and the problem of electronic waste.

When artists preserve these “traces” rather than conceal them, the materials function as visual evidence that connects viewers to systems of production, consumption, and disposal. Objects can therefore communicate environmental issues through their own material presence.

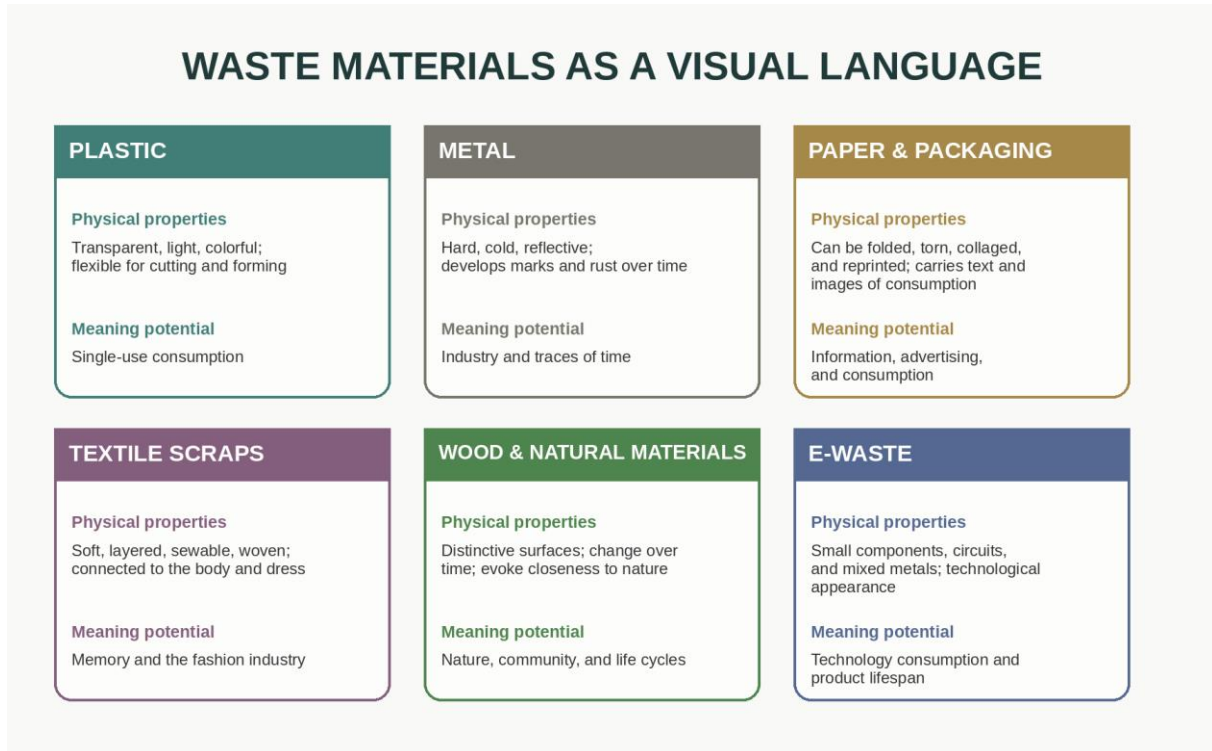


Figure 2. Examples of analyzing waste materials as a visual language and as carriers of meaning.

Circular Design: Sustainability Beginning at the Design Stage

The Ellen MacArthur Foundation’s concept of the Circular Economy is based on three design-driven principles: eliminating waste and pollution, circulating products and materials at their highest value, and regenerating nature (Ellen MacArthur Foundation, n.d.-a). These principles encourage artists and designers to understand sustainability more broadly than simply “reusing old things,” because attention must be paid to the entire life cycle of materials, from before the work is made to after it is exhibited.

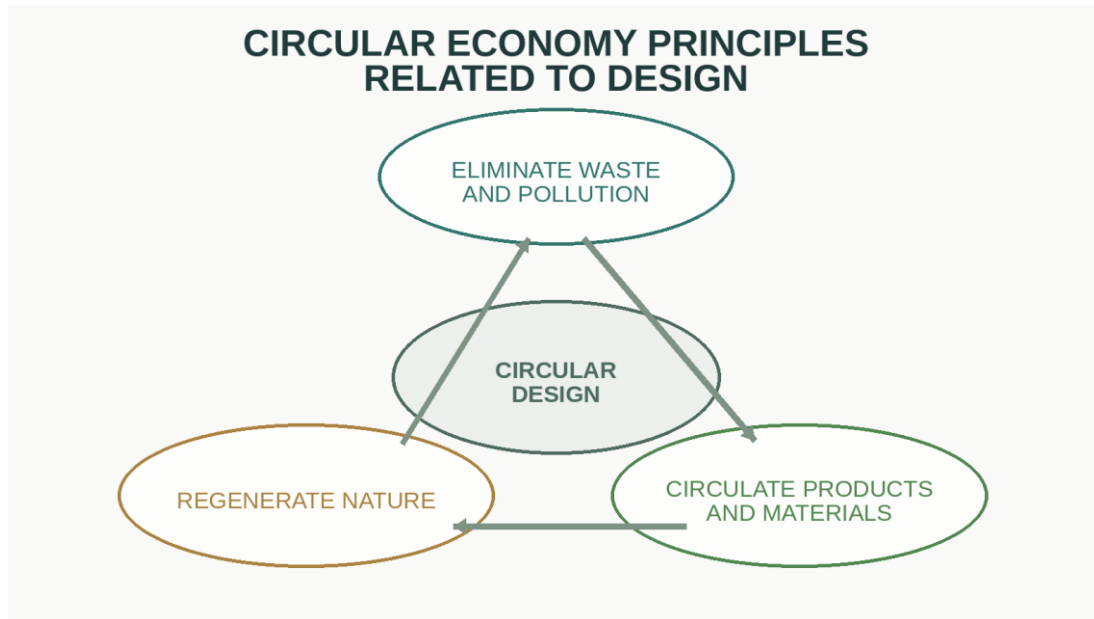


Figure 3. Three circular economy principles applicable to the creative process (adapted from the Ellen MacArthur Foundation).

Circular Design emphasizes decisions made early in the design process, when material selection, assembly methods, durability, disassembly, reuse, and end-of-life outcomes can still be determined (Ellen MacArthur Foundation, n.d.-b). In mixed media art, this perspective may lead to works designed for disassembly, the use of non-destructive fastening methods, reduced reliance on adhesives and chemicals, and the retention of materials after exhibitions for subsequent use.

Case Study: El Anatsui and the Transformation of Discarded Materials into Cultural Surfaces

One important case study in transforming discarded materials into an artistic language is the work of El Anatsui, a contemporary artist known for large-scale hanging sculptures constructed from discarded materials, particularly aluminum bottle caps and seals. *Dusasa II* (2007), in the collection of The Metropolitan Museum of Art, is made from found aluminum, copper wire, and plastic disks. The materials are flattened, bent, pierced, and connected to form a large, flexible surface that can be folded and hung in multiple configurations (The Metropolitan Museum of Art, n.d.).

The significance of the work lies not simply in its use of recycled materials but in the way those materials connect multiple contexts at once: Ghanaian kente cloth, mosaic patterns and textiles within art history, and traces of beverage consumption and waste in contemporary society. The Metropolitan Museum of Art explains that Anatsui's work connects traditional culture, Western art, and contemporary life. Discarded material, therefore, does not lose its former history; instead, it becomes a medium for dialogue between cultural values and the problems of consumption.

From Waste Material to Material Narrative

A productive direction for contemporary creative practice is to shift the conceptual frame from seeing Waste Material merely as Recycled Material toward developing it as Meaningful Material and, ultimately, Material Narrative. In other words, creators should not stop at reuse; they should investigate what stories the material can tell and determine which pre-existing traces to preserve and how extensively to transform the material.

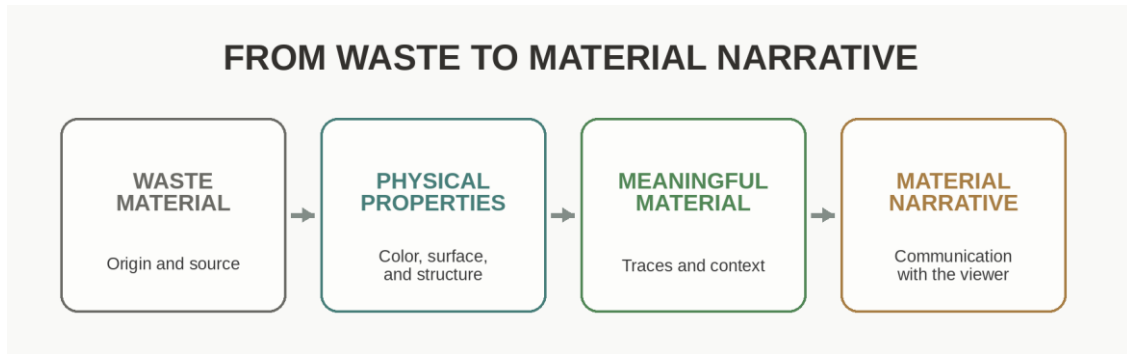


Figure 4. Development of waste materials from physical resources toward a Material Narrative.

Beach waste, for example, may carry fading, corrosion, scratches, and grains of sand. If these traces are preserved, viewers can directly perceive time, the object's movement, and the impact of human activity on coastal environments. Similarly, textile scraps from factories may retain seams, labels, or cut marks, revealing systems of mass production. At the same time, electronic circuit boards can use circuit pathways as visual elements to reflect relationships among humans, technology, and rapid device replacement.

Research Methodology

To prevent creative practice from separating “material experimentation” from “sustainability concepts,” the following five-stage process can be used as a practice-oriented framework.

Stage	Practical Guidelines
1. Collect	Explore material sources; record the type, quantity, origin, and condition of each material, as well as the reasons it became waste.
2. Decode	Analyze color, surface, rigidity, flexibility, weight, changes over time, and social and cultural meanings.
3. Experiment	Test cutting, folding, tearing, threading, weaving, sewing, pressing, melting, or assembling. Record results concerning form, structural strength, safety, and waste generated during experimentation.
4. Transform	Select promising experiments and develop them into compositions, forms, structures, and prototypes while maintaining the relationship between material and concept.
5. Communicate	Define the intended viewer experience, such as raising awareness, prompting questions, making the volume of waste perceptible, or changing perceptions of material value.

Research Results

The value of art made from waste materials does not depend solely on the number of kilograms of waste removed from the system. The amount of material used in a single artwork may be very small compared with the volume of waste generated at the urban or global scale. Art's distinctive role is to make visible what people have learned to overlook and to transform abstract information about consumption into a tangible experience.

When large quantities of single-use objects are brought together within an exhibition space, viewers can perceive “quantity” through scale, repetition, and density without reading numerical data. At the same time, materials bearing genuine traces of use can make environmental problems feel more immediate than images or statistics in reports. Art can therefore serve as a shared space for perception, discussion, and questioning everyday patterns of consumption.

Discussion

Accordingly, the message of an artwork need not stop at “we should recycle.” It can lead to deeper questions: Why do we design objects for a single use only? Why are long-lasting materials assigned to very short-lived functions? How can designers reduce waste generation at the source? These questions reposition sustainability from an end-of-pipe recycling issue toward a design responsibility that begins with decisions about materials, systems, and product life cycles.

Suggestions

If this topic is developed into creative research, researchers can define specific materials or study sites, such as marine plastic waste, textile scraps from the fashion industry, construction offcuts, or waste materials from local communities, and then conduct systematic material experiments to establish a Material Experiment Sheet database.

- Study the sources and types of materials, including the environmental problems associated with them.
- Systematically test material properties and techniques, documenting the process through images and experiment records.
- Develop multiple prototype directions and evaluate them with experts or audience groups.
- Analyze how audiences perceive sustainability issues through material, form, and exhibition strategies.
- Consider the life cycle of the artwork after exhibition so that sustainability is embedded in the actual process rather than appearing only as a stated theme.

This framework can connect mixed media art with research in Material-Driven Design, Design for Sustainability, Environmental Art, and Creative Practice Research, helping research outputs generate both process-based knowledge and verifiable creative works.

Conclusion

Designing mixed-media art from waste materials is a process that integrates beauty, experimentation, and environmental responsibility. Discarded materials possess not only physical properties but also histories of production, consumption, use, and deterioration. Returning these materials to the artistic field therefore transforms both the status and the meaning of objects.

When Sustainable Art, Eco-Design, and Circular Design are applied, creators can move beyond formal recycling to question the systems that generate waste and design creative processes that consider the full material life cycle. From this perspective, waste material is not the “end point” of an object. Still, it can become the starting point of a new artistic language in which beauty, meaning, and sustainability coexist.

References

- Bocken, N. M. P., de Pauw, I., Bakker, C., & van der Grinten, B. (2016). Product design and business model strategies for a circular economy. *Journal of Industrial and Production Engineering*, 33(5), 308–320. <https://doi.org/10.1080/21681015.2016.1172124>
- Boetzkes, A. (2019). *Plastic capitalism: Contemporary art and the drive to waste*. The MIT Press.
- Candy, L., & Edmonds, E. (2018). Practice-based research in the creative arts: Foundations and futures from the front line. *Leonardo*, 51(1), 63–69. https://doi.org/10.1162/LEON_a_01471
- Ceschin, F., & Gaziulusoy, I. (2016). Evolution of design for sustainability: From product design to design for system innovations and transitions. *Design Studies*, 47, 118–163. <https://doi.org/10.1016/j.destud.2016.09.002>
- Donkor, E. K., Boakye-Yiadom, F., Ankrah, O.-A., & Micah, V. K. B. (2024). Sculpture, circular economy and ecological reflections: Redefining waste through sustainable art in Ghana. *World Art*, 14(3), 279–303. <https://doi.org/10.1080/21500894.2024.2367962>
- Dumée, L. F. (2022). Circular materials and circular design—Review on challenges towards sustainable manufacturing and recycling. *Circular Economy and Sustainability*, 2(1), 9–23. <https://doi.org/10.1007/s43615-021-00085-2>
- Geyer, R., Jambeck, J. R., & Law, K. L. (2017). Production, use, and fate of all plastics ever made. *Science Advances*, 3(7), e1700782. <https://doi.org/10.1126/sciadv.1700782>
- Italia, M., Papile, F., Santi, R., & Del Curto, B. (2023). Sustainable material selection framework: Taxonomy and systematisation of design approaches to sustainable material selection. *Sustainability*, 15(24), 16689. <https://doi.org/10.3390/su152416689>
- Kagan, S. (2014). *Art and sustainability: Connecting patterns for a culture of complexity* (2nd ed.). transcript Verlag. <https://doi.org/10.14361/transcript.9783839418031>
- Kanrattanasutra, P. (2021). The creation of art from metal waste with participation of young volunteer in order to raise environmental awareness. *Journal of Fine Arts, Chiang Mai University*, 12(2), 12–51.
- Karana, E., Barati, B., Rognoli, V., & Zeeuw van der Laan, A. (2015). Material driven design (MDD): A method to design for material experiences. *International Journal of Design*, 9(2), 35–54.
- Organisation for Economic Co-operation and Development. (2022). *Global plastics outlook: Economic drivers, environmental impacts and policy options*. OECD Publishing. <https://doi.org/10.1787/de747aef-en>
- Weintraub, L. (2012). *To life!: Eco art in pursuit of a sustainable planet*. University of California Press.

GENERATIVE AI, ART, AND AESTHETIC PHILOSOPHY: HUMAN-AI CO-CREATION IN THE AGE OF INTELLIGENT TECHNOLOGY

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Abstract

The rapid development of Generative Artificial Intelligence (Generative AI) is transforming both the technological and conceptual foundations of contemporary artistic practice. Technologies based on deep learning and generative modeling can interpret human inputs and produce complex visual variations through computational processes, challenging established concepts of craftsmanship, originality, authorship, and creative agency. This conceptual paper examines Generative AI at the intersection of art, technology, and aesthetic philosophy. Through literature review and philosophical analysis, it critiques approaches that position AI either as a passive digital tool or as an autonomous replacement for the human artist. Instead, the paper develops the concept of Co-creative Agency, in which human intention, computational generation, critical artistic judgment, and contextual interpretation interact through an iterative creative process. The analysis further proposes that latent-space exploration, prompt-based interaction, multimodal input, and material translation expand the contemporary creative environment without eliminating the importance of human artistic knowledge. Aesthetic value in AI-assisted art therefore does not reside solely in technical novelty or the generated image. Rather, it emerges through the relationship among human intention, technological possibility, critical curation, cultural context, and material transformation. The paper concludes that Generative AI should be understood as a technologically mediated creative environment that expands artistic practice while simultaneously increasing the artist's responsibility for meaning, ethics, cultural sensitivity, and final aesthetic judgment.

Keywords: Generative AI, Aesthetic Philosophy, Co-creative Agency, Human–AI Interaction, Creative Technology

Introduction - Revised Closing Paragraphs

From a technological perspective, this transformation is significant because Generative AI differs fundamentally from conventional digital tools. Traditional software generally responds to predefined human commands, whereas generative systems can interpret input, model statistical relationships learned from large datasets, and produce multiple visual possibilities through computational generation. Recent latent diffusion approaches, for example, generate images by operating within compressed representational spaces and can condition generation on inputs such as text (Rombach et al., 2022). Technology therefore participates not only in execution but also in variation, transformation, and the expansion of creative possibilities.

This condition suggests that contemporary artistic production should be examined through three interconnected dimensions: human intention, technological generation, and artistic interpretation. Human intention establishes conceptual direction, cultural meaning, and aesthetic goals; technological systems expand and transform visual possibilities; and artistic interpretation determines which outputs acquire significance within a particular social, philosophical, and artistic context. The central question is therefore no longer simply whether

a computer can create art, but how computational systems participate in the processes through which artistic meaning is constructed (Hertzmann, 2018).

Accordingly, this paper aims to examine how Generative AI transforms the relationship between technology and artistic creation, how creative agency is redistributed within human-AI interaction, and how aesthetic value may be reconsidered when technological systems actively participate in visual production. The proposed framework does not assume that AI possesses human consciousness or artistic intention. Rather, it focuses on the relational process through which human judgment and computational generation interact to produce, refine, and contextualize artistic possibilities.

1. Deconstruction of Traditional Aesthetic Frameworks - Additional Synthesis

These transformations indicate that Generative AI does not merely introduce a new tool into an existing artistic system. Rather, it restructures the relationship among artist, technology, process, and artwork. The traditional model, in which technological media primarily extend human intention, becomes increasingly inadequate when a generative system can produce alternatives that were not specified in every visual detail by the artist. This distinction is consistent with broader discussions of generative computer art, where questions of autonomy, authorship, intention, and system behavior have long complicated the conventional tool model (McCormack et al., 2014).

Therefore, the aesthetic significance of Generative AI should not be evaluated solely by comparing machine-produced images with human craftsmanship. It is also necessary to examine the technological process through which possibilities are generated, choices are made, meanings are assigned, and authorship is negotiated. This shift provides the conceptual foundation for understanding Generative AI through the framework of Co-creative Agency.

2. From Digital Tool to Technological Co-creative Agency - Revised Section

Viewing Generative AI merely as an advanced paintbrush obscures its distinctive role within the creative loop. Conventional artistic tools, including many forms of digital software, primarily extend the artist's capacity to execute a predefined decision. Generative systems operate differently because they can produce multiple visual alternatives from the same conceptual input, introduce variation, and return results that the artist may not have anticipated. Algorithmic serendipity therefore becomes part of the creative process rather than a technical side effect (Boden, 2004).

The technological distinction between conventional digital tools and Generative AI can be represented through two simplified models:

Conventional digital model: Human Intention -> Digital Tool -> Artistic Output

Generative model: Human Intention -> AI Interpretation -> Generated Possibilities -> Human Evaluation -> Refinement -> Regeneration

The second model is iterative rather than linear. The artist establishes a concept or intention, the generative system produces computational interpretations, and the resulting images become visual feedback for subsequent human decisions. Unexpected outputs can redirect the artist's thinking, reveal new formal possibilities, or expose inconsistencies between the intended concept and its visual representation. The artist then refines the prompt or input, changes constraints, rejects outputs, combines elements, or redefines the conceptual direction.

This interaction establishes a form of technological mediation. AI does not require attribution of human consciousness in order to influence the creative process. Its significance lies in the way computational operations structure the possibilities that become available for human consideration. Co-creative Agency should therefore not be interpreted as an equal division of authorship between human and machine. Instead, it describes a dynamic relationship in which different forms of agency operate at different stages of the creative process.

Human agency remains central in establishing purpose, cultural meaning, ethical boundaries, and final aesthetic judgment. Technological agency operates through generation, transformation, variation, and computational interpretation. Artistic value emerges from the relationship between these functions rather than from the isolated action of either participant. This distributed process also helps explain why observers may attribute creative credit differently depending on how much human intention, selection, and transformation are visible in the final work (Epstein et al., 2020).

3. Technological Dimensions of Human-AI Artistic Creation - New Section

3.1 Generative Technology and Creative Possibility

Generative AI introduces a technological environment in which artistic possibilities are produced through computational processes rather than exclusively through direct human manipulation of material or digital form. Contemporary generative models learn statistical relationships from large collections of data and use these relationships to produce new configurations in response to human input. In image generation, latent diffusion models demonstrate how complex visual synthesis can occur through learned representations and conditioned generation (Rombach et al., 2022).

For artistic practice, the significance of this technology lies not simply in the speed of image production but in its capacity to produce variation. A single artistic idea can be translated into numerous visual alternatives, allowing the artist to compare composition, texture, spatial relationships, visual atmosphere, and stylistic direction within a compressed period of experimentation. The output therefore need not be treated as a finished artwork. It can function as a sketch, conceptual study, compositional experiment, visual hypothesis, or intermediate prototype.

This distinction is important because it shifts discussion away from the narrow question of whether an AI-generated image is itself art. Generative technology can also be understood as an exploratory stage within a larger artistic process. The creative value of the system may therefore lie as much in the possibilities it makes available for human judgment as in the image it produces.

3.2 Latent Space as a Technological Creative Environment

The concept of latent space is particularly important for understanding the technological transformation of artistic practice. In conventional artistic production, exploration generally occurs through direct engagement with physical materials or visible digital elements. In generative systems, however, visual characteristics are computationally represented through multidimensional relationships that are not directly visible to the artist. Latent diffusion models make this representational layer operational by conducting image synthesis within a compressed latent space before reconstructing the visual output (Rombach et al., 2022).

From an aesthetic perspective, latent space can be interpreted as a new type of creative environment. Artists do not manipulate every pixel directly; instead, they navigate

computational possibilities through prompts, reference images, parameters, selection, iteration, and comparison. The creative act therefore includes an indirect form of exploration in which the artist repeatedly tests how conceptual language and visual references are translated by the system.

Physical Creative Space -> Digital Creative Space -> Generative / Latent Creative Space

This progression should not be understood as a replacement sequence in which each new medium makes the previous one obsolete. Physical craftsmanship, digital technique, and generative exploration can coexist within the same artwork. Latent space is therefore best understood as an additional technological layer through which ideas can be explored before being translated into a final artistic form.

3.3 Prompting as a Human-Technology Creative Interface

Within Generative AI practice, prompting functions as an interface between human conceptual intention and computational generation. A prompt can communicate subject matter, composition, visual atmosphere, material qualities, cultural references, spatial relationships, emotional tone, or conceptual direction. However, the system does not receive artistic intention directly; it receives a representational instruction that must be interpreted computationally. The gap between intention and generated result is therefore a productive site of both experimentation and misunderstanding.

Prompting should not be understood as a purely technical skill. Its effectiveness depends substantially on the artist's knowledge of visual language, aesthetics, art history, composition, symbolism, culture, and the conceptual purpose of the work. Without such knowledge, increasingly detailed prompts may produce technically sophisticated images that remain conceptually weak or culturally superficial.

Artistic Knowledge -> Conceptual Intention -> Prompt/Input -> AI Interpretation -> Visual Possibilities -> Critical Evaluation

When the artist revises the prompt after evaluating generated results, prompting becomes part of an iterative design and inquiry process. The generated image operates as visual feedback that informs the next human decision. Prompt development can therefore be understood as a component of artistic direction and critical inquiry rather than merely a method for obtaining visually attractive outputs.

3.4 Multimodal AI and Expanded Artistic Media

Human-AI artistic interaction increasingly extends beyond text-to-image generation. Generative systems can be conditioned by different forms of input, including text, images, sketches, spatial constraints, and other visual references. This development expands the relationship between AI and artistic media by allowing existing human-made materials to enter the generative process and by allowing generated outputs to be transferred back into other media.

An artist may begin with a drawing, photograph, pattern, material texture, cultural motif, or existing physical artwork and use generative technology to explore alternative interpretations. Conversely, generated outputs may subsequently be transformed through painting, sculpture, textile, craft, installation, animation, or mixed-media processes. The relationship therefore operates in more than one direction:

Physical / Human-Made Input -> AI Transformation -> Digital Possibilities

AI-Generated Output -> Human Interpretation -> Material Transformation

This reciprocal movement creates a hybrid creative ecology in which computational technology becomes one stage within a broader artistic workflow. Generative AI is therefore not restricted to functioning as a final image-production medium; it can participate in research, ideation, experimentation, prototyping, transformation, and presentation.

3.5 Human-AI-Material Co-Creation

Although much discussion of Generative AI focuses on digital images, artistic creation frequently continues beyond the computational output. AI-generated forms can be translated into physical materials through painting, printing, sculpture, craft, textile, installation, or mixed-media processes. Material behavior introduces resistance, texture, scale, weight, imperfection, and embodied knowledge that are not reducible to the generated image.

Human Knowledge -> AI Exploration -> Human Selection -> Material Experimentation -> Artistic Transformation -> Final Artwork

Within this model, the final work does not originate from AI alone. It emerges through multiple transformations involving human cultural knowledge, computational generation, critical selection, physical craftsmanship, and material behavior. This paper therefore proposes the concept of Human-AI-Material Co-Creation as an extension of Co-creative Agency. The framework recognizes that artistic agency can move among conceptual, computational, and material domains.

Technology generates possibilities, but the artist determines how those possibilities are interpreted, embodied, transformed, and situated within artistic practice. This perspective is particularly relevant to contemporary art and design because it positions Generative AI as a new technological layer that can interact with existing forms of craftsmanship rather than as a simple replacement for them.

4. Redefining the Artistic Spirit and Aesthetic Value - Revised and Expanded

The technological dimensions discussed above require a reconsideration of where artistic spirit and aesthetic value are located. If complex visual forms can be generated computationally, then technical execution or visual sophistication alone is insufficient to determine artistic significance. The artistic value of AI-assisted creation may instead emerge through the relationship among intention, technological possibility, critical judgment, transformation, and context.

The artist remains responsible for determining why a work should exist, what issue it addresses, which visual possibilities are meaningful, what should be retained or rejected, how cultural references should be treated, and how the final work should be presented to an audience. AI can produce formal possibilities, but the construction of artistic meaning remains dependent on human and social interpretation. The artistic spirit of AI-assisted art should therefore not be located within the algorithm itself; rather, it emerges through the relationship between human consciousness and technological possibility.

4.1 Aesthetics of Curation and Context

As visual generation becomes increasingly automated, the artist's role shifts in part from direct physical execution toward critical selection, refinement, contextualization, and transformation. An AI-generated artifact does not acquire artistic value merely because it is technically complex or visually attractive. Its significance depends on how it is situated

within a broader conceptual, social, cultural, philosophical, or historical framework (Manovich, 2018). Curation therefore becomes a creative act because selection determines which computational possibility is allowed to enter the artistic context and why.

4.2 Relational Aesthetics of Human-AI Interaction

The spirit of AI-assisted art may also be understood relationally rather than as a static property embedded in the object. The work can embody a record of negotiation between human intention and computational interpretation. In this view, aesthetic experience includes not only the final image but also awareness of the process through which the artist responded to, resisted, redirected, or transformed machine-generated possibilities. Meaning emerges through the relationship among creator, system, artwork, and audience.

4.3 Algorithmic and Data-Mediated Aesthetics

Another dimension of AI-assisted art concerns the technological conditions underlying generated images. Generative systems do not operate outside human visual culture; their outputs are shaped by patterns learned from existing data, model architectures, and computational procedures. The aesthetic possibilities available through a system are therefore mediated by both human cultural histories and technological design.

This raises a critical aesthetic question: Does Generative AI produce a new aesthetic, or does it computationally reorganize existing human aesthetic conventions? The answer is unlikely to be absolute. Generative systems can produce configurations that appear novel, yet the conditions of generation remain connected to accumulated cultural data and computational structures. Aesthetic evaluation should therefore consider not only the visible output but also the technological mediation behind it.

This perspective suggests that AI aesthetics are neither entirely technological nor entirely human. They are data-mediated and culturally situated, emerging from the interaction between existing visual culture, computational systems, and contemporary artistic interpretation. The artist's critical awareness of these conditions becomes especially important when working with cultural heritage, identity, or historically specific visual symbols.

4.4 Authenticity, Process, and Technological Transparency

The use of Generative AI also requires a reconsideration of artistic authenticity. In traditional practice, authenticity has often been associated with the physical artwork, the trace of the artist's hand, or a documented origin. Generative systems complicate this relationship because multiple variations can be produced rapidly and similar visual forms may be regenerated through related inputs.

In this context, authenticity may increasingly depend on the transparency of the creative process. Information concerning human intention, prompt development, selection, modification, material intervention, and technological production can help clarify how a work was made and where significant artistic decisions occurred. Process and provenance therefore become relevant contextual evidence rather than merely technical documentation.

This does not mean that metadata or process records automatically create a new technological aura. Rather, it suggests that the conditions through which authenticity is constructed are changing. In AI-assisted art, originality may be evaluated not only through the uniqueness of a final image but also through the specificity of the conceptual process, the artist's interventions, the transformation of generated material, and the context in which the work is presented.

5. Discussion: Toward a Human-AI Aesthetic Ecology - New Section

The analysis presented in this paper suggests that the impact of Generative AI on art cannot be adequately understood through a binary opposition between human creativity and machine creativity. Such a distinction overlooks the interactive processes through which contemporary AI-assisted artworks are produced. Earlier debates on generative computer art similarly demonstrate that questions of authorship, intention, autonomy, and interpretation become more complex when computational systems participate in creative processes (McCormack et al., 2014).

The proposed model of Co-creative Agency instead positions artistic creation within an interconnected system composed of human intention, computational possibility, critical selection, cultural knowledge, material transformation, and contextual interpretation. Each component performs a different function. Human creators establish purposes and interpret meaning; technological systems expand and transform possibilities; materials introduce physical constraints and sensory qualities; cultural contexts influence interpretation; and audiences participate in the construction of aesthetic value.

This relationship may be described as a Human-AI Aesthetic Ecology, in which creative value emerges across processes rather than being located exclusively in a single actor or object. Such an ecology also clarifies why the language of co-creation must be used carefully. Distributed agency does not imply equal consciousness, equal intention, or equal responsibility. Current Generative AI systems do not possess human social accountability or cultural responsibility, and the conceptual paper does not claim otherwise.

The human artist therefore remains responsible for conceptual decisions, ethical judgment, cultural sensitivity, selection, disclosure, transformation, and final presentation. The emergence of Co-creative Agency should not diminish the importance of the artist. Instead, it expands the artist's responsibility: the artist must understand not only how to produce visual forms, but also how technological systems shape those forms, what cultural assumptions may be embedded within them, and how machine-generated possibilities should be positioned within meaningful artistic contexts.

6. Implications for Art Practice, Technology, and Education - Revised and Expanded

Redefining the Artist's Role: The integration of Generative AI expands the role of the artist from physical maker to conceptual director, technological collaborator, critical curator, and contextual interpreter. However, technological competence should complement rather than replace artistic knowledge. Artists require visual literacy, cultural awareness, and aesthetic judgment in order to direct generative processes meaningfully (Elgammal, 2019; Miller, 2019).

Critical AI Literacy: Art and design education should develop critical AI literacy alongside technical competence. Students should understand not only how to operate generative systems but also how such technologies are shaped by datasets, computational structures, limitations, and biases. Critical understanding allows technology to become an object of artistic inquiry rather than simply a production shortcut.

Integration of Digital and Material Practice: Generative AI should be integrated with existing artistic and material practices. Students can use generated outputs as conceptual sketches, experimental references, structural studies, or visual prototypes before translating them into painting, sculpture, craft, textile, installation, animation, or mixed media. Such

integration reinforces the idea that AI is one component of an expanded creative process rather than a replacement for material knowledge.

Ethics and Cultural Responsibility: AI-based art education should include authorship, copyright, transparency, dataset ethics, cultural representation, and algorithmic bias. The capacity to reproduce recognizable cultural forms does not necessarily imply an understanding of their historical or symbolic significance. Human cultural knowledge and ethical judgment therefore remain essential when Generative AI is used to engage with heritage, identity, or culturally sensitive imagery.

Curricular Adaptation: Art institutions should balance traditional skill training with philosophy of technology, critical AI literacy, experimental generative practice, and reflective discussion of ethics. The educational goal should not be to teach students simply to produce faster images, but to enable them to evaluate when, why, and how intelligent technology contributes meaningfully to an artistic problem.

Conclusion - Revised Summary of Findings

Generative AI represents both a technological transformation and an aesthetic challenge for contemporary art. Its significance does not lie simply in the ability of machines to generate visually complex images, but in the emergence of a new creative relationship between human intention, computational systems, material processes, and artistic interpretation.

The concept of Co-creative Agency developed in this paper demonstrates that Generative AI should neither be reduced to a passive digital tool nor treated as an autonomous replacement for the human artist. Artistic creation emerges through a dynamic process in which humans establish conceptual direction and cultural meaning, generative systems expand computational possibilities, and artists critically select, modify, contextualize, and transform those possibilities.

From a technological perspective, latent-space exploration, iterative prompting, conditioned or multimodal input, and the translation of generated forms into material practice expand the range of creative possibilities available to artists. However, technological capacity alone does not determine artistic significance. The central distinction is between generating form and constructing meaning. AI technologies can participate powerfully in the generation and transformation of visual forms, while human artists remain essential in establishing intention, interpretation, ethical judgment, contextualization, and cultural significance.

The future of AI-assisted art may consequently be understood not as a transition from human art to machine art, but as the development of a human-technology creative ecology. Within this ecology, aesthetic value emerges through the dynamic relationship among human knowledge, computational possibility, critical curation, material transformation, and audience interpretation. Generative AI expands the possibilities of artistic form, but human interpretation transforms those possibilities into artistic meaning.

Limitations - Suggested Expansion

As a conceptual paper, this study does not provide empirical evidence concerning how audiences evaluate AI-assisted artworks across different levels of human intervention. The proposed concepts of Co-creative Agency, Human-AI-Material Co-Creation, and Human-AI Aesthetic Ecology therefore require further testing through artistic case studies, audience research, and comparative analysis. In addition, Generative AI technologies evolve rapidly;

changes in model capabilities, interfaces, transparency mechanisms, and legal frameworks may alter the forms of interaction described in this paper. The present framework should consequently be understood as an analytical model for a developing technological context rather than as a fixed description of all future AI-assisted art.

Future Research - Suggested Expansion

Future studies should examine how viewers attribute originality, emotional resonance, authorship, and artistic value to works created through different levels of human-AI collaboration. Experimental studies could compare artworks presented with hidden authorship, disclosed AI involvement, documented prompt histories, or visible material intervention. Such comparisons would help determine whether knowledge of process changes aesthetic evaluation.

Practice-based research should also investigate how AI-generated outputs are transformed through physical media such as painting, sculpture, textile, craft, installation, and mixed media. This would allow the proposed Human-AI-Material Co-Creation framework to be evaluated through actual studio processes rather than conceptual analysis alone. Further research is also needed on cultural representation, dataset bias, copyright, provenance, and ethical disclosure, particularly when generative systems are used with culturally specific or heritage-based imagery.

References

- Anscomb, C. (2022). Creating art with AI. *Odradek: Studies in Philosophy of Literature, Aesthetics, and Theory of Cognition*, 8(1), 13–51.
- Anscomb, C. (2025). AI: Artistic collaborator? *AI & Society*, 40, 3419–3429.
<https://doi.org/10.1007/s00146-024-02083-y>
- Boden, M. A. (2004). *The creative mind: Myths and mechanisms* (2nd ed.). Routledge.
- Chiodo, S. (2024). What AI “art” can teach us about art. *Journal of Aesthetics & Culture*, 16(1), Article 2395511. <https://doi.org/10.1080/20004214.2024.2395511>
- Elgammal, A. (2019). AI is blurring the definition of artist. *American Scientist*, 107(1), 18–21.
<https://doi.org/10.1511/2019.107.1.18>
- Epstein, Z., Levine, S., Rand, D. G., & Rahwan, I. (2020). Who gets credit for AI-generated art? *iScience*, 23(9), Article 101515. <https://doi.org/10.1016/j.isci.2020.101515>
- Goodfellow, P. (2024). The distributed authorship of art in the age of AI. *Arts*, 13(5), Article 149.
<https://doi.org/10.3390/arts13050149>
- Hertzmann, A. (2018). Can computers create art? *Arts*, 7(2), Article 18.
<https://doi.org/10.3390/arts7020018>
- Ivanova, M. (2025). AI, art and morality. *AI and Ethics*, 5, 4269–4278.
<https://doi.org/10.1007/s43681-025-00735-3>
- Loivaranta, T., Hautala, J., & Lundman, R. (2025). Spectrum of creative agencies in AI-based art: Analysis of art reviews. *Digital Creativity*, 36(3), 223–237.
<https://doi.org/10.1080/14626268.2025.2491471>
- Manovich, L. (2018). *AI aesthetics*. Strelka Press.
- McCormack, J., Bown, O., Dorin, A., McCabe, J., Monro, G., & Whitelaw, M. (2014). Ten questions concerning generative computer art. *Leonardo*, 47(2), 135–141.
https://doi.org/10.1162/LEON_a_00533
- Miao, F., & Holmes, W. (2023). *Guidance for generative AI in education and research*. UNESCO.
- Miller, A. I. (2019). *The artist in the machine: The world of AI-powered creativity*. The MIT Press.
<https://doi.org/10.7551/mitpress/11585.001.0001>
- Moruzzi, C., & Margarido, S. (2024). A user-centered framework for human-AI co-creativity. In F. F. Mueller, P. Kyburz, J. R. Williamson, & C. Sas (Eds.), *CHI EA '24: Extended abstracts of the 2024 CHI Conference on Human Factors in Computing Systems* (pp. 1–9). ACM.
<https://doi.org/10.1145/3613905.3650929>
- Oppenlaender, J., Linder, R., & Silvennoinen, J. (2025). Prompting AI art: An investigation into the creative skill of prompt engineering. *International Journal of Human–Computer Interaction*, 41(16), 10207–10229. <https://doi.org/10.1080/10447318.2024.2431761>
- Rombach, R., Blattmann, A., Lorenz, D., Esser, P., & Ommer, B. (2022). High-resolution image synthesis with latent diffusion models. In *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR)* (pp. 10684–10695). IEEE.
<https://doi.org/10.1109/CVPR52688.2022.01042>
- van Hees, J., Grootswagers, T., Quek, G. L., & Varlet, M. (2025). Human perception of art in the age of artificial intelligence. *Frontiers in Psychology*, 15, Article 1497469.
<https://doi.org/10.3389/fpsyg.2024.1497469>

THE ART CREATION OF CAT THEMED BASED ON THE MIXED TECHNIQUES OF COLORED LEAD AND COLORED POWDER

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Introduction

This research aims to develop a relatively innovative cat-themed painting technique by mixing Colored Lead and Colored Powder. The study explores how these media complement each other in conveying delicate textures and soft atmospheric effects, and evaluates the practical value of this cross-media approach in contemporary art creation. Colored Lead provide hair details, shadows and the required clarity, saturation, and structural accuracy; Colored Powder offer strong coverage and smooth tonal transitions but lack saturation and edge definition. Creative experiments further revealed that cat whiskers require rigid linear clarity, leading to the introduction of a small amount of acrylic pigment to strengthen structural emphasis. A practice-based method, supported by theoretical analysis, was used to produce cat-themed artworks. Qualitative data were obtained through process records and reflective journals, while quantitative data came from audience and buyer questionnaires evaluating visual appeal, emotional resonance, thematic clarity, and medium effectiveness.

The results indicate that this combined technique integrates the strengths of each material: Colored Lead enhance hard-texture expression, Colored Powder enrich atmospheric and emotional tone, and acrylic lines highlight structural details. Audience feedback further confirms that the mixed method creates artworks with stronger emotional impact, clearer thematic expression, and higher visual distinctiveness. The study concludes that this multi-media technique forms a relatively innovative expressive approach and offers practical value for contemporary cat-themed art creation.

Abstract

Cat-themed art has become an influential visual language in contemporary culture, carrying rich symbolic, emotional, and market significance. However, within traditional easel painting, the realistic and emotionally expressive depiction of cat fur remains technically challenging, particularly when attempting to balance fine detail with atmospheric softness. This study investigates a mixed-media painting approach that integrates colored pencils and colored powder to construct a “new cat imagery” that combines cultural symbolism, material innovation, and contemporary visual aesthetics.

The research aims to (1) explore methods for reinterpreting cat imagery through the fusion of traditional cultural elements and modern visual symbols, (2) validate the complementary visual capabilities of colored pencils and colored powder in rendering fur texture and emotional atmosphere, and (3) evaluate the practical and communicative value of this mixed technique within contemporary art practice and the art market.

A practice-based research methodology was adopted, combining theoretical analysis, creative experimentation, and audience feedback. The creative process employed a hybrid workflow that integrates artificial intelligence – generated imagery, digital image editing, museum-grade giclée printing, and hand-rendered techniques using colored powder, colored

pencils, and acrylic accents. Quantitative data were collected through audience questionnaires and market observation, while qualitative insights were derived from process documentation and visual analysis.

The results demonstrate that colored pencils and colored powder exhibit strong visual complementarity: colored pencils provide structural clarity and detailed fur rendering, while colored powder enhances softness, depth, and emotional atmosphere. Audience feedback indicates high visual appeal, emotional resonance, and thematic clarity in the resulting artworks. The study concludes that this mixed-media approach offers a relatively innovative expressive method for cat-themed easel painting, contributing a viable technical model and conceptual framework for cross-media artistic creation in contemporary visual culture.

Keywords

Art Creation, Cat-Themed Painting, Colored lead, Colored Pencil

Objective

1. Cultural Analysis Objective: To propose a method for constructing a "new cat imagery" that fuses traditional elements with modern visual symbols.
2. Technical Exploration Objective: To validate the complementary visual capabilities of Colored Lead and Colored Powder in detailed depiction and atmospheric rendering.
3. Effectiveness Evaluation Objective: To evaluate the practical value of the cross-media art creation of cat-themed based on the mixed techniques of colored lead and colored powder.

Literature Review

Existing studies on cat-themed art primarily focus on cultural symbolism, emotional representation, and visual aesthetics across historical and contemporary contexts. Scholars have examined the symbolic meanings of cats in Eastern and Western art traditions, highlighting their associations with spirituality, independence, domesticity, and emotional companionship. In modern visual culture, research has increasingly addressed the role of cats within popular media, digital platforms, and consumer-oriented art markets, emphasizing their strong emotional appeal and communicative potential.

From a technical perspective, prior literature discusses the material characteristics of colored pencils and colored powder separately. Colored pencils are widely recognized for their precision, line control, and suitability for detailed rendering, particularly in depicting fur texture and structural forms. Colored powder, by contrast, is valued for its soft tonal transitions, atmospheric depth, and expressive color blending, though it is often regarded as less effective for fine-detail articulation. While mixed-media practices have been explored in broader contemporary art research, systematic studies focusing specifically on the integration of colored pencils and colored powder in animal-themed easel painting remain limited.

Research on cross-media and intermedial artistic practices highlights the growing importance of combining multiple materials and visual languages to expand expressive possibilities. However, existing studies often prioritize digital or installation-based media, leaving a noticeable gap in practice-based research addressing traditional drawing materials within contemporary mixed-media frameworks. This study positions itself within this gap by synthesizing cultural analysis, material experimentation, and audience feedback to investigate

a hybrid approach to cat-themed painting, contributing both technical insight and practical value to current artistic discourse.

Research Methodology

This study adopts a mixed-methods research design that integrates qualitative artistic analysis, practice-based experimentation, market observation, and quantitative audience research. The methodology is structured to examine how a hybrid technique combining colored pencils and colored powder can enhance emotional expression and market relevance in cat-themed artworks.

1. Research Design

The research is conducted through three interconnected methodological approaches:

- (1) qualitative case study analysis, focusing on representative artists across traditional, digital, and AI-generated media;
- (2) practice-based artistic experimentation, in which the researcher develops original cat-themed artworks using colored pencil and colored powder techniques; and
- (3) quantitative and market-oriented data analysis, including questionnaire surveys, social media feedback, and auction price observation.

This integrated design allows for triangulation between visual form, audience response, and market performance, ensuring both artistic depth and empirical reliability.

2. Case Study Method

A qualitative case study method is employed to analyze selected artists known for cat-themed creation across different media, including ceramic sculpture, oil painting, digital illustration, and AI-generated imagery. Each case is examined through dimensions of form, color usage, emotional expression, and medium characteristics. The purpose of this analysis is to extract transferable visual strategies and emotional mechanisms applicable to the researcher's own mixed-media practice.

3. Practice-Based Artistic Experimentation

Practice-based research forms the core of this study. The researcher conducts systematic creative experiments combining colored pencils and colored powder in a cat-themed painting. Colored pencils are primarily used to establish structural accuracy, line definition, and fine details such as fur texture and facial features, while colored powder is applied to construct atmospheric depth, tonal transitions, and emotional ambiance. Iterative experimentation and reflective documentation are used to evaluate the expressive and technical outcomes of this hybrid approach.

4. Market Observation Method

Market observation focuses on both digital and traditional art platforms. International NFT platforms (such as OpenSea) and Chinese art market platforms (such as Artron Auction Catalogues) are examined to collect data on transaction prices, presentation formats, subject trends, and audience interaction. Artworks are organized in descending price order to facilitate comparative analysis. These observations provide empirical insight into pricing structures, stylistic preferences, and market positioning for cat-themed artworks.

5. Quantitative Data Collection

Quantitative data are collected through structured questionnaires distributed to viewers and potential collectors. The survey addresses preferences in style, emotional tone, size, usage

context, and creative elements. A total of 120 questionnaires were distributed, with 105 valid responses analyzed. Descriptive statistical methods are applied to identify dominant audience preferences and emerging trends.

In addition, social media data such as likes, comments, and keyword frequency—are analyzed to assess audience engagement with different media approaches.

6. Data Analysis and Triangulation

Data analysis combines qualitative interpretation with descriptive quantitative analysis. Questionnaire results, market data, and creative experimentation outcomes are cross-referenced to identify consistent patterns. This triangulation strengthens the validity of the findings by confirming that visual strategies, emotional responses, and market performance align coherently.

7. Ethical Considerations

All data collected in this study are used for academic research purposes only. Questionnaire participation was voluntary and anonymous, and all market data were obtained from publicly accessible sources. Proper attribution is provided for all referenced artworks and platforms.

Research Results

This section presents the main findings derived from the questionnaire survey, market observation, social media analysis, and practice-based experimentation. The results demonstrate how the mixed technique of colored pencil and colored powder performs in terms of audience preference, emotional effectiveness, and market positioning within cat-themed art.

1. Audience Preference Results

The questionnaire results indicate a clear audience preference for emotionally accessible and visually gentle cat imagery. Among the 105 valid responses, realistic and cute (moe) styles were favored most strongly. Realistic styles were selected by 59.0% of respondents, while cute or friendly styles accounted for 44.8%. In contrast, abstract and highly symbolic approaches received comparatively lower attention.

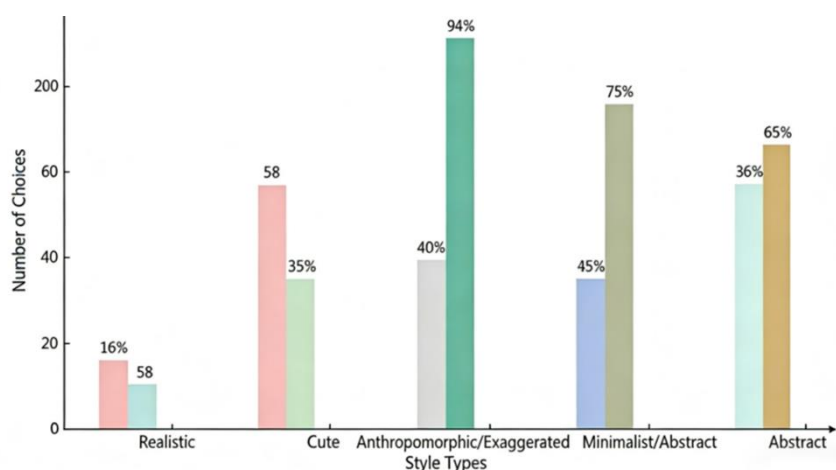


Figure 1 Bar Chart of Column chart of cat-themed painting style preference distribution

Regarding emotional preference, respondents were allowed to select multiple options. The results show that “warm and friendly” emotional qualities received the highest support (64.8%), followed by “lively and spirited” (49.5%). Emotional categories such as “mysterious and dreamy” (25.7%) and “spiritual or symbolic” (17.1%) attracted smaller yet meaningful niche interest. These findings suggest that emotional warmth and approachability are dominant drivers of audience acceptance in cat-themed artworks.

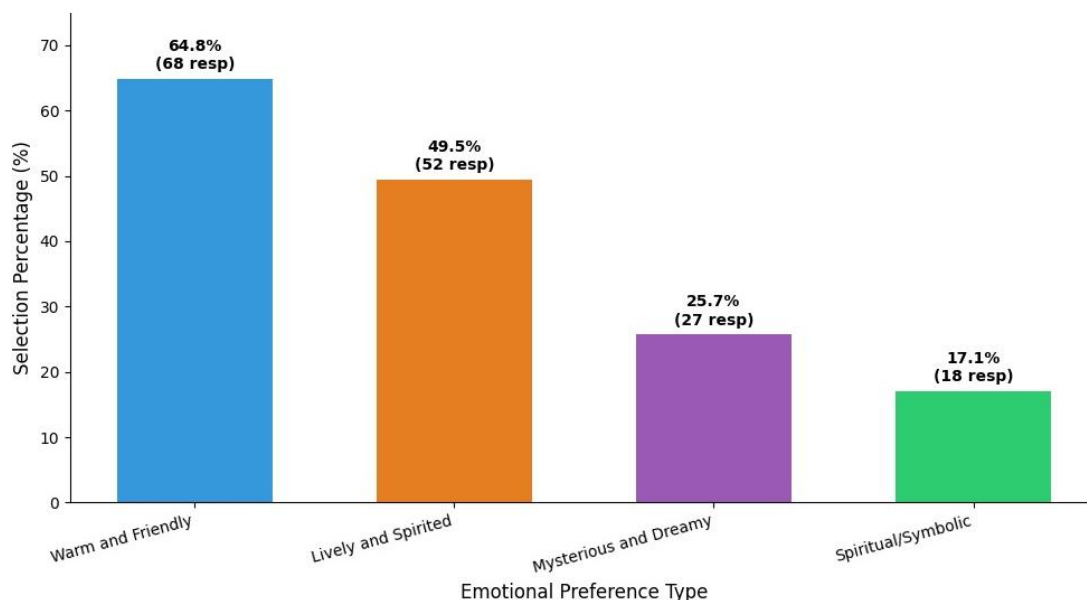


Figure 2 Pie Chart of Distribution of cat-themed painting themes and emotional preferences

2. Size and Usage Preferences

In terms of artwork size, medium-scale works (approximately 600 × 800 mm) were preferred by more than half of the respondents (53.3%), indicating suitability for domestic interior display. Small-scale works also showed stable demand, while large-scale formats were less favored.

Usage context data further confirm that cat-themed artworks are primarily perceived as daily decorative objects. Living rooms and office spaces were the most common intended display environments (68.6%), followed by bedrooms and study areas (39.0%). Gallery or collection-oriented use accounted for a smaller proportion, reflecting the practical and emotional orientation of audience demand.

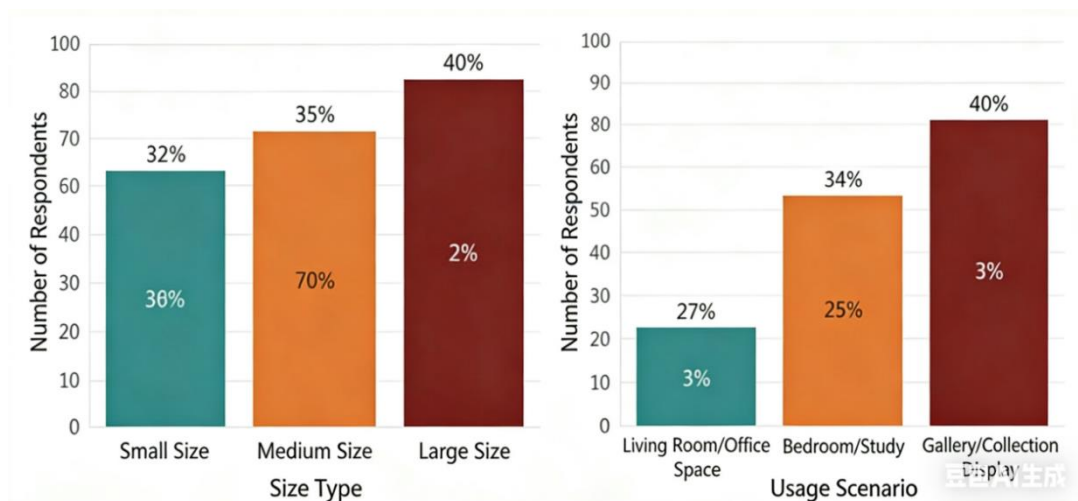


Figure 3 Bar Chart of Size preference distribution and use placement preference distribution of cat-themed painting

3. Key Creative Factors Influencing Purchase Decisions

When evaluating creative elements, respondents placed the greatest importance on color coordination (70.5%) and emotional expression (66.7%). Storytelling and composition also played significant roles, while investment value and academic background were considered secondary factors. This indicates that emotional resonance and visual harmony are more influential than speculative or institutional considerations for most viewers.

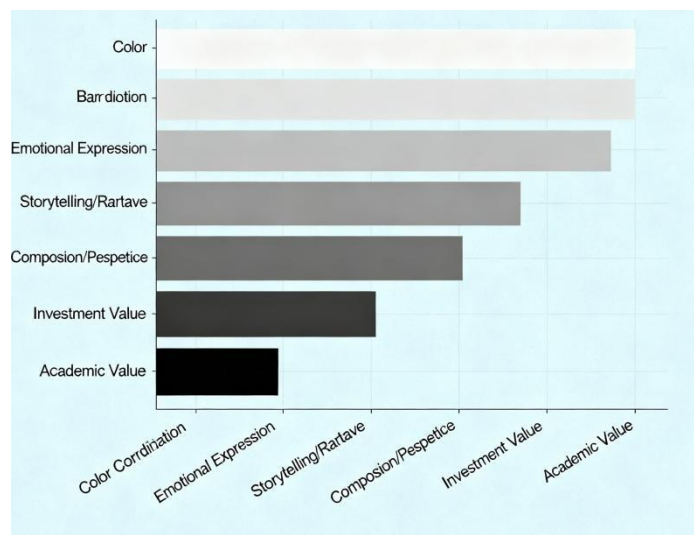


Figure 4 Bar Chart of Column chart of the distribution of attention of cat-themed painting creation elements

4. Social Media Feedback Analysis

Analysis of social media engagement reveals that mixed-media works combining colored pencil and colored powder achieved significantly higher interaction levels than single-medium works. On average, mixed-media cat artworks received approximately 850 likes, compared to 520 likes for colored pencil-only works and 610 likes for colored powder only.

works. Frequently appearing keywords in user comments included “healing,” “delicate,” and “atmospheric,” highlighting the emotional effectiveness of the hybrid technique.

5. Market Observation Results

Market data from auction platforms and digital art marketplaces demonstrate a clear segmentation of price ranges. Traditional cat-themed works by established artists occupy the high-value segment, while contemporary colored pencil and colored powder works by emerging artists are primarily concentrated in the mid-range market (RMB 5,000 – 30,000). This segment shows strong demand yet relatively limited innovation, indicating potential for differentiation through mixed-media techniques.

Digital cat-themed artworks (NFTs) show high transaction frequency and strong community interaction, although prices are subject to market volatility. These observations suggest that mixed-media cat artworks may effectively bridge traditional craftsmanship and contemporary visual culture.

6. Integration and Triangulation of Results

By synthesizing questionnaire findings, social media data, market observation, and creative experimentation, the results reveal a high degree of consistency across data sources. The mixed colored pencil and colored powder technique demonstrates clear advantages in balancing structural precision and atmospheric softness, directly aligning with audience emotional preferences and mid-market demand. This confirms the feasibility and applicability of the mixed-media approach as both an artistic and market-oriented strategy.

Discussion

This study investigates the feasibility and effectiveness of combining colored pencil and colored powder in cat-themed art through quantitative data, market observation, and practice-based research. The discussion interprets the results in relation to audience perception, emotional communication, material language, and market positioning, highlighting both artistic and practical implications.

1. Emotional Accessibility as a Core Driver of Audience Engagement

The findings demonstrate that emotional accessibility plays a decisive role in audience preference for cat-themed artworks. The dominance of “warm and friendly” and “lively and spirited” emotional responses indicates that viewers tend to associate cat imagery with comfort, companionship, and emotional healing. This aligns with contemporary visual culture, in which cats function as affective symbols rather than purely symbolic or conceptual figures. The relatively lower preference for “mysterious” or “spiritual” expressions does not suggest a lack of artistic value but reflects a narrower audience niche. This suggests that artists working with mixed media should prioritize emotional clarity while allowing space for symbolic depth through subtle visual cues rather than overt abstraction.

2. Material Complementarity in Mixed-Media Practice

The success of the colored pencil and colored powder combination can be attributed to the complementary qualities of the two media. Colored pencil provides structural precision, contour control, and detail articulation, which aligns with the audience’s preference for recognizable and realistic forms. In contrast, colored powder contributes softness, atmospheric depth, and emotional diffusion, enhancing the sense of warmth and visual comfort identified in questionnaire and social media data. The results confirm that the mixed-media approach is

not merely a technical fusion but a strategic visual language that bridges clarity and ambiguity. This balance directly supports emotional resonance and increases visual accessibility without sacrificing artistic complexity.

3. Market Positioning and Mid-Range Demand

Market observation data indicate that cat-themed artworks primarily circulate within the mid-price range, where demand is stable but stylistic differentiation is limited. The mixed-media approach demonstrates clear potential to fill this gap by offering works that combine craftsmanship, emotional appeal, and visual sophistication. The higher engagement levels observed on social media platforms further suggest that mixed-media cat artworks possess strong communicative advantages in contemporary visual ecosystems, where immediacy and emotional readability are critical. This positions the mixed technique as a viable strategy for emerging artists seeking both artistic identity and market sustainability.



Figure 5 The Corresponding Auction Prices

(Yachang Art Market Monitor, 2025)

4. Data Informed Creation as a Methodological Advantage

One of the key contributions of this research lies in translating quantitative data into creative decision-making. Rather than using data as post-hoc validation, this study integrates audience feedback, keyword analysis, and market observation directly into compositional planning, emotional tone selection, and material layering strategies.

This approach addresses a common disconnect between research and practice in art creation. By embedding data awareness into the creative process, artists can maintain expressive autonomy while enhancing communicative effectiveness and audience alignment.

5. Limitations and Future Directions

Despite its contributions, this study has limitations. The sample size and platform scope, while sufficient for exploratory analysis, may not fully capture regional or cultural variations. Future research could expand comparative analysis across different cultural contexts or incorporate longitudinal market data to assess long-term value trends.

Additionally, further experimentation with digital extensions such as hybrid physical – digital presentations or NFT adaptations could deepen the understanding of how mixed-media cat imagery functions across media boundaries.

Suggestions

Based on the findings and discussion of this study, several recommendations are proposed to support future artistic practice, research development, and art education related to mixed-media cat-themed artworks.

1. Suggestions for Artistic Practice

Artists working with cat-themed subjects are encouraged to adopt a mixed-media strategy that balances structural clarity and emotional atmosphere. The combination of colored pencil and colored powder should be planned from the early conceptual stage rather than applied as a decorative addition. Clear delineation of form using colored pencil, followed by emotional modulation through colored powder, can enhance both visual readability and affective depth.

Furthermore, artists should consciously align emotional tone with audience perception. Emphasizing warm, friendly, and lively qualities while integrating symbolic elements in a restrained manner can broaden audience engagement without compromising artistic individuality.

2. Suggestions for Market Oriented Creation

Given the stable demand observed in the mid-range art market, artists should develop a clear pricing and positioning strategy. Mixed-media works that demonstrate technical sophistication and emotional accessibility are well suited to this segment. Regular analysis of auction results, online platform feedback, and collector preferences can help artists refine their creative direction and market communication.

In addition, social media platforms should be used not only for promotion but also as observational tools to assess audience response, emotional keywords, and visual trends. This data can inform both content creation and presentation strategies.

3. Suggestions for Research Methodology

Future research should further integrate quantitative and qualitative methods to strengthen the analytical foundation of practice based studies. Expanding sample sizes, diversifying platforms, and incorporating cross cultural comparisons would enhance the generalizability of findings.

Researchers are also encouraged to document creative processes more systematically, transforming artistic intuition into analyzable data. This approach can contribute to more robust interdisciplinary research connecting art practice, visual culture, and market studies.

References

- Addiss, S. (2006). *The art of Zen: Paintings and culture in Japan*. Shambhala.
- Arnheim, R. (1974). *Art and visual perception: A psychology of the creative eye*. University of California Press.
- Artprice by Artmarket.com. (2021). *The art market in 2021: Global art market report* (24th annual report). Artmarket.com. <https://imgpublic.artprice.com/pdf/the-art-market-in-2021>
- ArtStation. (n.d.). *Digital art community*. <https://www.artstation.com/>
- Baetjer, K. (1995). Pastel portraits in the age of elegance: Rosalba Carriera and her contemporaries. *Metropolitan Museum Studies*, 27(2), 101–120.
- Baidu News. (n.d.). *Cat and bamboo* [Ink and color on paper, hanging scroll]. National Palace Museum, Taipei.
https://mbd.baidu.com/newspage/data/dtlandingsuper?nid=dt_4820083669403977866
- Barthes, R. (1977). *Image–music–text*. Hill and Wang.
- Bateson, P. (Ed.). (2000). *The domestic cat: The biology of its behaviour* (2nd ed.). Cambridge University Press.
- Baxandall, M. (1985). *Patterns of intention: On the historical explanation of pictures*. Yale University Press.
- Boardman, J. (2016). The expressive potential of colored powders in contemporary pastel art. *Art Journal*, 75(2), 45–58.
- Chen, X. (2011). *The cultural history of Maneki-neko in Japan*. Tokyo University Press.
- Chen, Y. (2021). *Cats in art history: From ancient iconography to digital-age aesthetics*. Shanghai Fine Arts Publishing.
- Chess, S. (2025). *Neko Atsume: Affective play and mobile casual gaming*. University of Georgia Press.
- Demos, T. (2008). *Pastel techniques for realistic animal fur*. Fine Art Publishing.
- Elkins, J. (2008). *Six stories from the end of representation*. Stanford University Press.
- Gal, N. (2019). *Cats and the Internet*. In *Wikipedia*.
https://en.wikipedia.org/wiki/Cats_and_the_Internet
- Gottfried, M. (2004). Chardin and the pastel tradition in eighteenth-century France. *European Art Review*, 12(1), 55–73.
- Gupta, A. (2018). Symbolism of cats in Western art. *Journal of Art History*, 12(3), 45–57.
- Gǔyǔn Liúguāng. (2024). This Ming dynasty emperor who loved cats actually painted them so exquisitely [Note]. *Xiaohongshu*.
<https://www.xiaohongshu.com/discovery/item/671f5a2d000000002603586d>
- Haining, P. (2008). *The illustrated history of cats*. Thames & Hudson.
- Hansen-Löve, A. A. (1983). Intermediality and intertextuality: Problems of correlation between verbal and pictorial art. *Wiener Slawistischer Almanach*, 11, 291–360.
- Higuchi, M. (2020). Cute economy and emotional resonance: The cultural evolution of pet-centered lifestyles. *Journal of Cultural Studies*, 15(2), 45–62.
- Jeffares, N. (2006). *Dictionary of pastellists before 1800*. Unicorn Press.
- Lambourne, L. (2002). *Louis Wain: The man who drew cats*. Tate Publishing.
- Li, Y. (2025). The rise of contemporary colored lead art in China. *Chinese Journal of Fine Arts Education*, 42(2), 88–104.
- Marks, A. (2010). *Japanese woodblock prints: Artists, publishers and masterworks, 1680–1900*. Tuttle Publishing.
- Mason, R. (2012). Techniques for rendering animal fur. *International Journal of Illustration Studies*, 5(3), 201–215.
- Mia. (n.d.). *Sketch painting process using colored lead and powder* [WeChat post]. WeChat.

- Morgan, J. (2025). *Fur texture rendering using colored powder and oil*.
<https://www.jasonmorgan.co.uk/>
- Mu Mu. (2025, March 12). Some ancient Egyptian, Greek, and Roman murals featuring cats [Xiaohongshu note]. *Xiaohongshu*. <https://xhslink.com/o/6d5EiRY6KCS>
- Myrick, J. G. (2015). Emotion regulation, procrastination, and watching cat videos online. *Computers in Human Behavior*, 52, 168–176. <https://doi.org/10.1016/j.chb.2015.06.009>
- Okada, H. (2019). *Feline symbolism in contemporary Asian visual culture*. Tokyo University Press.
- OpenSea. (n.d.). *NFT marketplace*. <https://opensea.io/>
- Pastel Society of America. (2020). *Pastel painting: Technical guidelines and best practices*.
<https://www.pastelsocietyofamerica.org>
- Paul, C. (2016). *Digital art* (3rd ed.). Thames & Hudson.
- Rogers, L. W. (1929). *Elementary theosophy*. Theosophical Press.
- Serpell, J. A. (2000). Domestication and history of the cat. In D. C. Turner & P. Bateson (Eds.), *The domestic cat* (pp. 180–192). Cambridge University Press.
- Shhan Art. (2023). *Black Cat Series #15* [Digital artwork]. OpenSea.
- Shhan Art. (2023). *Black Cat Series #18* [Digital artwork]. OpenSea.
- Smith, A. (2020). Cross-media practices in contemporary illustration. *Journal of Visual Arts Practice*, 19(4), 278–292.
- Sunnypals. (2025). *Custom pet portraits – Hand-painted whimsical dog & cat paintings*.
<https://sunnypals.com/>
- Susak, D. (2023). *The secret of drawing life: Artistic techniques from graphite to colored pencil*. Independent Artist Publications.
- Winkler, H. (1998). The development of colored lead in European art. *European Journal of Art History*, 7(1), 33–49.
- Wu, L. (2022). Digital intimacy and cultural nostalgia. *New Media & Society*, 24(7), 1350–1368.
- Xiao. (2025). *Woman with a cat (Bonnard)*. In *Wikipedia*.
[https://en.wikipedia.org/wiki/Woman_with_a_Cat_\(Bonnard\)](https://en.wikipedia.org/wiki/Woman_with_a_Cat_(Bonnard))
- Zhao, S. (2017, December 12). *Colored powder works* [WeChat post]. WeChat.
- Zhao, S. (2025, December 12). *Colored powder works (2017 & 2022)* [WeChat post]. WeChat.
- Zhao, Y. (2022). Techniques of cross-media drawing. *Art & Design Review*, 10(3), 112–125.
- Zhao, Z. (2022). The symbolic and commodified cat in contemporary culture. *Journal of Animal and Visual Culture*, 7(1), 55–77.

RESEARCH ON ADAPTIVE DESIGN OF SLEEP-AID SPACE ENVIRONMENT BASED ON MULTI-MODAL AI PERCEPTION TECHNOLOGY

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Abstract

In an era of rapid urbanization and widespread digital connectivity, sleep disorders have evolved into a serious global public health crisis. The deterioration of sleep quality is closely related to the stress of modern life and the static and unresponsive nature of the built environment. Traditional interior design gives priority to static aesthetics and layout, often ignoring the dynamic physiological needs of human circadian rhythms. To address this fundamental disconnect, this study explores the integration of multimodal artificial intelligence (AI) sensing technology into sleep-assisted environments, aiming to construct a theoretical design framework for active participation of physical environments in sleep regulation.

Using qualitative research and a literature review, this paper analyzes the complex relationship between visual, auditory and tactile environmental sensory inputs and sleep physiology. The study criticized the limitations of existing smart homes relying on user intervention and proposed a "perception-decision-action" autonomous cycle with multimodal AI as the "central nervous system". The system captures physiological and environmental data in real time using a non-invasive network of millimeter-wave radar, thermal imaging and environmental sensors. AI can dynamically adjust lighting color temperature to stimulate melatonin secretion or adjust HVAC systems to match body temperature during sleep without conscious user intervention. The conclusion shows that the transformation from passive spatial accommodation to active intelligent environmental adaptation can significantly improve the efficiency of sleep initiation and maintenance, which provides a theoretical basis for future indoor design of healthy adaptation.

Keywords: Multi-modal AI, Adaptive Design, Sleep-Aid Environment, Interior Design, Circadian Rhythm

Introduction

Sleep is a fundamental biological imperative that accounts for about a third of human life. It is a key mechanism for physiological recovery, memory consolidation, metabolic regulation, and immune system maintenance. However, the conflict between the development trend of modern civilization and the biological needs of human beings is increasingly prominent. An all-weather (24/7) society characterized by high-pressure work environments, irregular shift schedules and the widespread presence of artificial electronic devices emitting blue light has triggered a global sleep crisis. According to the World Health Organization and several sleep medicine organizations, a significant proportion of urban populations suffer from chronic insomnia, sleep fragmentation or circadian rhythm disorders. Chronic sleep deprivation has been linked to serious health problems such as cardiovascular disease, obesity, depression, and significant cognitive decline.

Although medical and pharmaceutical interventions remain the primary means of treating sleep disorders, the role of the physical environment, especially the bedroom, is often overlooked in clinical discussions. At the same time, in the design world, bedrooms are often

seen only as spaces for furniture rather than as therapeutic tools. Traditional interior design methods focus on static elements such as bed layout, wall color, and fabric texture. Once these elements are determined, it becomes difficult to adapt to users' changing physiological needs throughout the night. A room that looks good at 10:00 a.m. may not promote deep sleep at 2:00 a.m. The rigidity of this design reflects its failure to match the temporal characteristics and biological dynamics of the human organism.

The core problem of current residential design in promoting sleep health lies in the lack of adaptability and intelligence. Existing so-called "smart home" technologies tend to be fragmented and reactive. They rely on manual user actions, such as voice commands, App adjustments, or physical interactions, which places a "cognitive burden" on users. For individuals who have insomnia, the very act of picking up a cell phone to adjust the thermostat or dim the lights is alarming and thus counterproductive to the goal of promoting sleep. At present, there is a clear lack of a systematic design theory that integrates multimodal AI perception with environmental psychology to create a space that automatically "cares" for occupants without explicit instructions.

This study aims to bridge the disciplinary gap between AI technology and fine arts/design with the following objectives:

1. From the point of view of environmental psychology and chronobiology, the theoretical relationship between environmental factors (light, sound, temperature) and sleep physiology is analyzed.

2. Clarify the role and mechanism of multimodal AI perception in capturing and interpreting human sleep states in spatial contexts without invading privacy.

3. A comprehensive adaptive design framework for sleep-aiding environments is proposed, which operates autonomously to support circadian rhythms.

This study adopts qualitative research methods centered on text analysis and literature review, and does not involve human subject experiments or collection of raw biometric data. Instead, it integrates existing knowledge from three different fields: sleep medicine (chronobiology), computer science (AI and IoT sensing), and environmental design. By cross-referencing the data patterns and theoretical models of these disciplines, a new conceptual framework for adaptive interior design was constructed.

Content

1. Symbiotic relationship between environment and physiology

To design an effective sleep environment, we need to understand the biological mechanisms of sleep and its interaction with external stimuli. The theoretical basis of this study is grounded in biological "Zeitgeber" theory and environmental psychology.

1.1 Neurobiological mechanisms of circadian rhythms: the role of the suprachiasmatic nucleus (SCN)

The circadian rhythm, which runs on a 24-hour cycle, is regulated by the suprachiasmatic nucleus (SCN) of the hypothalamus. The SCN acts as a "master clock" that synchronizes internal biological processes with the external solar day. Light is the SCN's most potent "timing factor" (time giver).

Melatonin pathway and autonomous photosensitive retinal ganglion cells (ipRGCs): The retina has autonomous photosensitive retinal ganglion cells (ipRGCs), which are distinct from rod and cone cells. These cells express melanopsin, which is extremely sensitive to short-wavelength light (blue light), with a peak sensitivity of about 460-480nm. When stimulated by blue light, ipRGCs project directly to the SCN via the retinal-hypothalamic tract (RHT), and the signal is relayed to the pineal gland, thereby inhibiting melatonin secretion. Melatonin is a hormone that signals the body to fall asleep. Conversely, lack of blue light or exposure to long-wavelength light (amber/red, >600nm) promotes melatonin synthesis.

Thermoregulation and sleep structure: sleep is closely related to thermoregulation. To initiate sleep, core body temperature (CBT) must drop by about 1°C. This cooling process is accomplished by vasodilation of distal limbs (hands and feet) to radiate heat away from the core. If the ambient temperature is too high, it will hinder heat dissipation and increase sleep latency (the time required to fall asleep). In addition, different stages of sleep (NREM vs. REM) have distinct thermal sensitivities; REM sleep, in particular, is characterized by a loss of thermoregulation (a warm state) that makes sleepers vulnerable to fluctuations in ambient temperature.

Acoustic sensitivity and cortical arousal: The brain continues to process auditory information even during sleep. Sudden changes in decibel levels (transients) trigger the reticular activation system (RAS), triggering cortical arousal. This fight-or-flight mechanism fragments sleep and prevents the body from entering deep sleep (NREM stage 3), which is critical for recovery.

1.2 Environmental psychology and supportive design

Roger Ulrich's supportive design theory suggests that health is promoted when environments foster a sense of control, provide positive social support, and give positive distractions. In the bedroom context, the concept of "control" is contradictory. Despite user expectations of ownership, controlling environmental variables requires effort and vigilance. Thus, the study suggests that the ultimate form of supportive design in sleep is anticipatory control, i.e., environmental self-management to support the user's passive state, thereby reducing the cognitive load required to achieve comfort. This is consistent with the concept of "Calm Technology," where technology hides behind the scenes and supports users without distracting them.

2. Multimodal AI Perceptual System Architecture

The term "multimodal" refers to AI's ability to process and fuse multiple types of input data simultaneously. In the design context, the system mimics the human sensory system, creating a "conscious" room. The proposed architecture consists of three layers: perception layer (input), processing layer (AI core) and action layer (output).

2.1 Advanced non-invasive sensing

To make the sleeping environment restorative, it should be unobtrusive. Traditional medical sleep monitoring requires electrodes (EEG) or wearable devices that disrupt the natural sleep experience. This study advocates "Device-Free Sensing" embedded in buildings:

Millimeter Wave Radar (mmWave): This is the key to the perception layer. Unlike RGB cameras, which raise serious privacy concerns, millimeter wave radar (which typically operates at 60GHz or 77GHz) uses frequency-modulated continuous wave (FMCW) technology.

Vital signs monitoring: It detects chest displacement with sub-millimeter accuracy to calculate respiratory rate and heart rate variability (HRV). High frequency (60GHz) allows high-resolution detection of microDoppler features associated with respiration.

Sleep Staging: By analyzing breathing patterns (e.g., deep sleep monitoring in NREM), by monitoring breathing (including irregular breathing in non-REM and REM periods) and large body movements (body movement recordings), advanced algorithms can estimate sleep stages (awake, light sleep, deep sleep, REM periods) with accuracy comparable to medical grade contact devices.

○**Privacy protection:** Since no optical images are generated, user privacy is naturally guaranteed.

Thermal imaging sensor: A low-resolution infrared sensor (e.g., 32×32 or 64×64 pixel array) is used to map the temperature distribution of the user's body surface. This allows the system to identify whether the user is overheated (such as kicking a quilt) or too cold before

they consciously wake up. It also acts as a reliable bed occupancy detector capable of operating in total darkness.

Environmental sensors:

1. Acoustic sensors: measure decibel levels (dB) and spectra to distinguish between persistent background noise (white noise) and disruptive impulsive events (alarms, barking dogs, door closings).

2. Photometric sensors: measure not only brightness (lux Lux) but also spectral composition (correlated color temperature- CCT, Kelvin) to ensure that lighting is in tune with the circadian phase.

3. Air quality sensors: monitor CO₂ levels, humidity and volatile organic compounds (VOCs). Studies have shown that carbon dioxide levels above 1000ppm can lead to fragmented sleep and morning drowsiness due to mild hypercapnia.

2.2 Edge Computing and Data Fusion

To ensure privacy and real-time response, the system uses an Edge Computing architecture, where data is processed locally within the home rather than transmitted to the cloud.

Multimodal data fusion: The AI core uses fusion algorithms to correlate data from different sensors. For example, a single sensor detecting a drop in room temperature may be ambiguous. But when thermal cameras detect user tremors and radars detect restless motion, the fusion engine can confirm "thermal discomfort" with high confidence.

Reinforcement Learning (RL): The system optimizes environmental parameters with reinforcement learning agents. AI's "reward function" is defined by the quality of the user's sleep (e.g., longer duration of deep sleep, fewer awakenings). Over time, AI can learn user-specific preferences, breaking through common factory settings and building personalized sleep models.

3. adaptive environmental control strategy

Based on the theoretical framework and technical capability, this study classifies according to sensory modalities and proposes a set of comprehensive adaptive design strategies covering three aspects: vision, hearing and atmosphere.

3.1 Dynamic circadian lighting protocol

Lighting design needs to shift from static on/off functions to dynamic spectral ecosystems that mimic natural solar processes.

Bedtime phase (circadian entrainment): Two hours before the user's historical bedtime, the AI initiates a "sunset protocol."

Spectrum: Illumination converted to warm spectrum (2000K - 2700K). Crucially, the spectral power distribution (SPD) is adjusted to minimize energy in the 460 - 480nm range to ensure melatonin secretion.

Intensity: Ceiling lights are completely turned off, only perimeter, low lighting (wall lamps, lamp troughs) remains. The illumination at eye level is controlled below 50 Lux.

Night phase (safety and maintenance): During sleep phase, the room remains in "all black mode." However, adaptability is critical to safety.

Navigation mode: If the millimeter wave radar detects that the user sits up (with the intention of leaving the bed), the system will activate the LED strip under the bed. These strips emit a soft amber light (10 Lux). This long-wavelength light provides visual guidance for easy access to the bathroom without stimulating intrinsically photosensitive retinal ganglion cells (ipRGCs), allowing users to easily fall asleep again.

Wake phase (cortisol arousal response): To reduce sleep inertia, the room initiates a "sunrise simulation" 30 minutes before alarm time.

Spectrum: Light changes from warm red to cool white (6500K).

Intensity: Gradually increases from 0 to 300 Lux. This stimulates the cortisol arousal response (CAR), which naturally awakens the brain and resets the body clock for a new day.

3.2 Intelligent Soundscape Construction

Silence is not always optimal for sleep because complete silence amplifies the perceived loudness of sudden external noise (signal-to-noise ratio is too high).

Active Noise Masking: Designed with an intelligent sound masking system. If the acoustic sensors detect intermittent low-frequency noise (such as distant traffic or HVAC hum), the system generates complementary "pink noise" or "brown noise."

Mechanism: Pink noise has equal energy in each octave, mimicking the frequency distribution of many natural sounds, such as rain or rustling leaves. This effectively "fills in" the background environment towards silence, moderately raising the acoustic floor, and thus reducing the harshness of sudden peak noise.

Pro-life soundscapes: At moments when high physiological stress is detected (e.g., elevated heart rate before bedtime or insomnia symptoms), the system can deploy pro-life sounds (e.g., rain, wind, waves). Studies have shown that these natural-based sounds suppress sympathetic nervous system activity more effectively than artificial music or silent environments.

3.3 Thermal comfort and air quality regulation

Thermal environments are often the primary cause of sleep disruption, especially "micro-arousals" caused by thermal discomfort.

Predictive thermoregulation: Adaptive systems learn a user's thermal comfort preference profile over time.

Sleep period: When the user goes to bed, the system may lower the ambient temperature moderately (e.g., to 19 - 21°C) to drive down the core temperature required to initiate sleep.

REM sleep protection: In the early morning hours, when REM sleep is dominant and the body loses its ability to regulate body temperature, the system may moderately raise the temperature or adjust the smart mattress to prevent the user from waking up from the cold.

Air quality feedback loop: Ventilation systems are often noisy and have draft problems. AI systems optimize air quality by monitoring carbon dioxide levels. When a CO₂ threshold (e.g. 800ppm) is breached, it quietly and gradually activates ventilation or purification systems to ensure oxygen saturation is maintained at levels conducive to cognitive recovery while avoiding acoustic interference.

4. Enlightenment to Interior Design Practice

4.1 From static design to dynamic design

The integration of multimodal AI requires interior designers to fundamentally transform their approach to bedroom design. Design is no longer limited to material selection and furniture layout, but also involves the overall planning of intangible systems. Designers must consider the fourth dimension of space: time. The environment is no longer a static background, but a dynamic participant in the user's life.

4.2 Ethics and Privacy in Design

Such a high level of surveillance in the most intimate spaces of the home raises significant ethical questions. Designers must prioritize "Privacy by Design." Relying on unidentifiable data sources (radar and thermal imaging) rather than optical cameras is a key design decision to build trust. In addition, local processing of the data (edge AI) ensures that the user's bedroom does not become a monitoring node. The design shall communicate this safety to the user through physical indicators indicating when the sensor is active or local data processing is taking place.

4.3 Intelligent Aesthetics

Finally, the "intelligence" of space must be integrated at the aesthetic level. Sensors should be hidden in architectural elements or furniture (e.g. radar behind headboards, CO₂ sensors in nightstands). Technology should remain invisible ("calm technology") and the emphasis should remain on comfort and aesthetics of the space. The target lives not in a machine, but in a space that feels natural and organic, intelligently empowered by hidden machines.

Conclusion

5.1 key findings

This paper discusses the fusion of multi-modal artificial intelligence (AI) perception technology and modern interior design, and constructs an adaptive design framework for sleep-aid space environment. Through a comprehensive analysis of relevant literature and design theories, it is obvious that the traditional static bedroom design model is no longer sufficient to meet the complex sleep challenges of modern society.

The main findings indicate that:

1.Holistic Integration:Effective sleep-aid design must move beyond isolated smart items (such as smart light bulbs or air purifiers) to build a holistic ecosystem where AI coordinates lighting, sound, and temperature. This integration ensures that all environmental stimuli are synchronized in time and serve the physiological goal of inducing sleep.

2.Non-invasive Interaction:The success of this type of environment is highly dependent on the presence of "invisible" technologies. The application of millimeter wave radar and thermal imaging technology proves that users do not need to wear equipment or frequently operate screens, and the space itself should have the ability to sense user needs (such as temperature changes, respiratory rate) and automatically respond. This non-sensory interaction reduces cognitive load and helps maintain relaxation.

3.Deep Personalization: Adaptive design enables mass-produced dwelling units to break "one size fits all" comfort standards through machine learning algorithms. The system is able to learn and adapt to an individual's unique sleep patterns and sensitivity thresholds over time, delivering a highly customized sleep experience that is truly human-centric.

5.2 research significance

This research has made important contributions to the field of design at both theoretical and practical levels:

Theoretical model innovation:The model of "Intelligence-based Human-Centric Design" is proposed, which directly transforms neurobiological principles into spatial design parameters and provides new theoretical support for interior design.

Interdisciplinary Paradigm:Shows how art and design disciplines can be effectively integrated with computer science and medicine. Emphasizes the transformation of the designer's role-from creator of visual aesthetics to orchestrator of healthy environments.

Social value:providing a non-pharmacological, environmental intervention solution to the growing sleep crisis. If widely applied, this design strategy could significantly improve public health and reduce the socioeconomic costs of sleep deprivation.

5.3 study limitations

Although this study constructs a relatively perfect theoretical framework, there are still the following limitations:

Lack of empirical data:This study mainly adopts text analysis and literature review to construct theory, lacking clinical experimental data based on physical prototype. Theoretically effective adjustment of environmental parameters (such as the specific influence of color temperature change on melatonin) may be disturbed by many variables in the actual complex residential environment, which needs further quantitative verification.

Technology implementation costs: The proposed multi-modal sensing systems (especially high-precision millimeter wave radar and thermal imaging) are currently costly and may limit their popularity in ordinary homes.

Complexity of individual differences: Although personalized learning mechanisms have been proposed, this study has not yet provided a perfect coordination algorithm solution for possible physiological needs conflicts between bed partners (e.g., one person is afraid of heat and the other person is afraid of cold).

5.4 future expectations

Based on these findings and limitations, future research should focus on:

Experimental prototype construction and empirical research: Future work should focus on building a full-featured "Sleep Lab" prototype. EEG and PSG data were collected to quantify the effects of adaptive environments on sleep latency and sleep efficiency.

Deepening privacy and ethical frameworks: As technology penetrates the private space, data privacy and ethical considerations must be better addressed in future design implementations. More transparent data processing protocols and user interfaces need to be developed to enhance user trust in intelligent systems.

Multi-user collaborative algorithm: For the case of two or more people sharing sleeping space, develop more complex game algorithms to balance the environmental needs of different users and achieve precise control of local micro-environment (such as zoning temperature control of smart mattresses).

References

- Arendt, J. (2010). Shift work: Coping with the biological clock. *Occupational Medicine*, 60(1), 10–20. <https://doi.org/10.1093/occmed/kqp162>
- Blume, C., Garbazza, C., & Spitschan, M. (2019). Effects of light on human circadian rhythms, sleep and mood. *Somnologie*, 23(3), 147–156. <https://doi.org/10.1007/s11818-019-00215-x>
- Cajochen, C. (2007). Alerting effects of light. *Sleep Medicine Reviews*, 11(6), 453–464. <https://doi.org/10.1016/j.smrv.2007.07.009>
- Chinoy, E. D., Duffy, J. F., & Czeisler, C. A. (2018). Unrestricted evening use of light-emitting tablet computers delays self-selected bedtime and disrupts circadian timing and alertness. *Physiological Reports*, 6(10), e13692. <https://doi.org/10.14814/phy2.13692>
- Foley, L. (2025, July 10). *Bedroom environment: What elements are important?* Sleep Foundation. <https://www.sleepfoundation.org/bedroom-environment>
- Hatori, M., & Panda, S. (2010). The emerging roles of melanopsin in behavioral adaptation to light. *Trends in Molecular Medicine*, 16(10), 435–446. <https://doi.org/10.1016/j.molmed.2010.07.005>
- Kaplan, S. (1995). The restorative benefits of nature: Toward an integrative framework. *Journal of Environmental Psychology*, 15(3), 169–182. [https://doi.org/10.1016/0272-4944\(95\)90001-2](https://doi.org/10.1016/0272-4944(95)90001-2)
- Lack, L. C., & Wright, H. R. (2007). Chronobiology of sleep in humans. *Cellular and Molecular Life Sciences*, 64(10), 1205–1215. <https://doi.org/10.1007/s00018-007-6531-2>
- Strøm-Tejsen, P., Zukowska, D., Wargocki, P., & Wyon, D. P. (2016). The effects of bedroom air quality on sleep and next-day performance. *Indoor Air*, 26(5), 679–686. <https://doi.org/10.1111/ina.12254>
- Topol, E. J. (2019). High-performance medicine: The convergence of human and artificial intelligence. *Nature Medicine*, 25(1), 44–56. <https://doi.org/10.1038/s41591-018-0300-7>
- Ulrich, R. S. (1984). View through a window may influence recovery from surgery. *Science*, 224(4647), 420–421. <https://doi.org/10.1126/science.6143402>
- Ulrich, R. S. (2008). Biophilic theory and research for healthcare design. In S. R. Kellert, J. H. Heerwagen, & M. L. Mador (Eds.), *Biophilic design: The theory, science, and practice of bringing buildings to life* (pp. 87–106). John Wiley & Sons.
- Walker, M. (2017). *Why we sleep: Unlocking the power of sleep and dreams*. Scribner.
- World Health Organization Regional Office for Europe. (2018). *Environmental noise guidelines for the European Region*. <https://www.who.int/publications/i/item/9789289053563>
- Zielinski, M. R., McKenna, J. T., & McCarley, R. W. (2016). Functions and mechanisms of sleep. *AIMS Neuroscience*, 3(1), 67–104. <https://doi.org/10.3934/Neuroscience.2016.1.67>

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