FROM CULTURAL GENES TO SMART LIGHTING DESIGN: MODERN TRANSLATION OF COMMERCIAL LANTERNS FROM THE SONG DYNASTY

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Abstract

Integrating historical cultural elements into contemporary smart lighting design presents a challenge, as it requires balancing innovation with heritage preservation. This study focused on Song Dynasty commercial luminaires and aims to: (1) investigate the formal characteristics of these luminaires through design archaeology, revealing their balance of standardization and personalization; (2) develop a model for translating traditional cultural elements into modern lighting design; and (3) propose a methodology for integrating smart lighting and neo-consumption trends, recontextualizing cultural elements in contemporary design.

Through analysis of 42 Song paintings, 17 textual records, and 23 archaeological artifacts, this study revealed the integration of form and function in the commercial lighting systems of the Song Dynasty through archaeological design analysis, highlighting the intersection of historical and modern design. The findings showed that Song Dynasty lighting fixtures were not only practical tools but also cultural symbols, encompassing transformations in materials, structures, functions, and meanings. Using the tri-axial translation model (form-function-culture), the study translated design elements from traditional Song Dynasty lighting into contemporary lighting design, exploring how traditional culture can be applied in modern design. Additionally, the research introduced a four-stage evolutionary methodology that integrates cultural gene extraction, design encoding, contemporary mapping, and user decoding, achieving an organic fusion of traditional heritage with smart lighting technologies, promoting the inheritance and innovation of Song Dynasty cultural heritage in modern design.

The findings highlighted that successful cultural translation involves both modernizing forms and reawakening cultural memory. This work provided a scalable methodology for designers to balance heritage preservation with innovation, offering tools for creating lighting systems that connect emotionally while meeting contemporary needs. By recontextualizing Song design principles, the study promoted

sustainable, human-centric smart lighting, demonstrating that ancient wisdom can guide future design practices.

Keywords: Cultural Translation, Smart Lighting Design, Song Dynasty Commercial Luminaires, Parametric Reinterpretation, Modular Heritage Design

Introduction

The integration of cultural heritage into contemporary lighting design has gained significant scholarly attention in recent years, driven by advances in smart technologies and growing consumer demand for culturally meaningful products (Nie, 2023; Wang, 2022;). However, translating historical lighting aesthetics into modern applications remains a challenge, often limited by fragmented methodologies that prioritize isolated techniques over holistic frameworks (Gupta & Gupta, 2017; Song et al., 2024). This study addresses this gap by examining China's Song Dynasty (960–1279 CE), a period renowned for its sophisticated urban commerce and lighting systems, to develop a systematic approach for reinterpreting historical lighting design principles in contemporary contexts, particularly with the rise of smart lighting design.

Song Dynasty commercial lanterns were not merely functional objects but embodied cultural narratives through their forms, materials, and placements. For example, wine shops used jar-shaped lanterns, while herbal stores adopted gourd-like designs—a practice akin to modern branding (Chen, 2022). Despite historical richness, prior research has focused disproportionately on elite interiors (Wei, 2020) or furniture (Wang, 2025), neglecting the role of everyday lighting in mediating spatial behavior and cultural identity. Recent efforts to bridge this gap, such as parametric reinterpretations of traditional crafts (Wang, 2022) and AI-driven pattern regeneration (Peng, 2023), highlight technological potential but lack systemic strategies to harmonize heritage with interactivity and sustainability.

This study aims to address the research question: How can the design principles of Song-era lighting systems be systematically decoded and adapted to inform intelligent, culturally resonant solutions for contemporary lighting applications? To answer this, we combine design archaeology with computational methods. Drawing from 42 Song paintings, 17 textual records, and 23 archaeological artifacts, we identify three core principles—modularity, material hybridity, and symbolic encoding—and reinterpret them through parametric modeling (e.g., 3D-printed bamboo-inspired frames) and smart-LED systems with motion sensors (Kim et al., 2017). For instance, hexagonal lantern skeletons, once standardized for mass production in the Song era, are reimagined as customizable IoT-enabled modules (Jiang & Miao, 2023).

By simplifying complex design archaeology into a three-step framework—extracting cultural DNA, reinterpreting functional needs, and revitalizing symbolic narratives—this study offers a roadmap for designers seeking to balance heritage preservation with innovation. Our findings not only enrich scholarly discourse on cultural translation but also provide practical tools for creating lighting design that resonate emotionally while meeting modern demands. In an era where consumers increasingly value culturally meaningful design, this work demonstrates how the past can illuminate the future—literally and metaphorically.

Research Objectives

1. To investigate the formal DNA of Song dynasty commercial luminaire typologies through design archaeology, revealing their techno-aesthetic synthesis of standardization and personalization.

2. To develop a translational model for converting traditional cultural elements into contemporary lighting design, examining historical form adaptations across material, functional, and spatial dimensions.

3. To propose an evolutionary methodology for luminaire design that integrates smart lighting and neo-consumption trends, enabling the recontextualization of cultural genes within modern design paradigms.

Literature Review

As research on cultural heritage preservation and design translation continues to deepen (Nie, 2023; Wang, 2022), a pressing concern within the design discipline is how to meaningfully integrate traditional craftsmanship with contemporary design ideologies, while remaining sensitive to historical contexts. Against this backdrop, the Song Dynasty (960–1279) stands as a pivotal period in Chinese history that witnessed the sophisticated integration of artisanal aesthetics and commercial culture (Wen, 2022). Within the realm of commercial architecture during this era, the design intelligence embedded in lighting systems—particularly lanterns—merits renewed scholarly attention. Far from serving merely functional purposes, lighting devices in Song commercial spaces embodied complex layers of cultural meaning, including aesthetic symbolism, ritual connotation, and social identity (He, 2017).

However, existing scholarship has primarily focused on literati spaces, court furnishings, or artistic artifacts (Jiang & Miao, 2020; Wang, 2025; Wei, 2020). The dynamic interplay between objects, spatial organization, and human behavior in Song commercial settings remains underexplored, especially in terms of how lighting installations such as lanterns were conceptualized, constructed, and culturally encoded. While a substantial body of literature exists on Song Dynasty furniture, decorative arts, and palace interiors,

there is still a noticeable gap in understanding how commercial lighting systems functioned both pragmatically and symbolically within public and transactional spaces.

Research on Song design practices has often centered on household furniture and material culture. For instance, Shao (2011) reconstructs the genealogy of Song furniture through the analysis of *Yingzao Fashi* and contemporary paintings, emphasizing the fusion of form and function. He argues that furniture design in the Song Dynasty was not only visually elegant but also imbued with social and cultural functions. However, while such studies have elucidated the cultural logic behind domestic design, they fall short of addressing the role of lighting objects—especially lanterns—within the broader commercial and spatial framework of the time.

From a sociological perspective, Yang (2015) examines the interaction between literati aesthetics and furniture objects in texts such as Record of Hunshi Pavilion, revealing how spatial arrangements reflected broader social structures. Similarly, Wei (2020) discusses how objects within a space mediate human behavior and cultural expression, advocating a "heritage-driven" logic of spatial design. Though these studies offer valuable insights into the socio-cultural conditions of Song interiors, they are largely confined to elite settings, neglecting the spatial configurations and symbolic functions of commercial lighting devices, such as lanterns, in everyday marketplaces.

In the realm of design philosophy, Chen (2022) explores dialectical notions such as *Gewu Zhizhi* (investigating things to attain knowledge) and *Zhizhi Xiangshang* (seeking the ideal through forms) to analyze the epistemology of Song material aesthetics. Peng (2023) addresses the transformation from ritual to folklore, highlighting how traditional crafts can be reinterpreted through modern design perspectives. While these studies provide a philosophical grounding for understanding material symbolism, they do not extend their theoretical frameworks to the tangible design elements, materials, or cultural applications of lighting in contemporary design contexts.

More recently, the emerging field of design archaeology has been positioned as a methodological bridge between traditional crafts and modern design innovation. This interdisciplinary approach not only emphasizes the excavation and conservation of design heritage but also its recontextualization to meet current design challenges (Wang, 2025). For instance, Jiang and Miao (2020) propose an ecological framework for translating historical motifs into modern design vocabulary. However, such efforts often remain at the conceptual level and lack concrete case studies that illustrate how ancient lighting devices like Song lanterns can be functionally and aesthetically reimagined for contemporary settings.

Lanterns during the Song Dynasty were far more than utilitarian lighting tools; they were rich repositories of social and cultural meaning. Their formal attributes (e.g., hexagonal frames), material choices (e.g., bamboo, paper), and ornamental details (e.g., carvings, motifs)

conveyed messages about festivals, class status, and urban identity (Nie, 2023). While some scholars have noted the balance between standardization and personalization in Song lantern design, few have conducted systematic analyses of how these designs addressed both functional and symbolic needs within commercial contexts.

Despite the growing body of literature in Chinese art, design, and cultural history, several critical gaps remain:

First, while existing research has richly documented furniture and elite interior objects, the lighting systems of commercial architecture—particularly their role in mediating spatial behavior and cultural representation—remain underexamined. Second, although some studies touch upon the transformation of traditional crafts, they often focus on isolated techniques or styles, without addressing how holistic lighting systems can be translated and redesigned for modern commercial environments. Third, while theoretical frameworks have emerged, practical design applications based on archaeological insights—especially those dealing with lantern morphology, semantics, and interactive potential—are still scarce.

This study aims to address these gaps through design archaeology, deconstructing Song lanterns' morphological DNA to reveal modular-spatial relevance and employing a tri-axial translation model (Gene⟶Element⟶Scenario) to deconstruct the typological, functional, and symbolic dimensions of Song Dynasty lanterns. Through this analytical and translational process, the study reimagines historical lighting wisdom as an adaptable smart lighting solution for contemporary commercial spaces.

Conceptual Framework

The conceptual model of this study (see Figure 1) explains the relationship between the independent variables (Morpho-Semiotic Layer, Functional-Semiotic Layer, Cultural-Semiotic Layer) and the dependent variable (Innovative Lighting Fixture Design). Grounded in Peirce (1958) triadic semiotic theory, it explores how these independent variables influence the symbolic composition of modern lighting design, ultimately leading to the creation of innovative lighting fixtures.

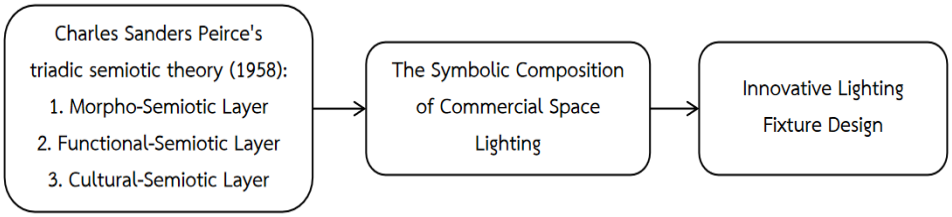

Figure 1 Conceptual framework

Research Methodology

This study adopts a mixed-methods approach, integrating historical visual-textual research, field-based spatial anthropology, and computational design analysis to investigate the symbolic composition of lighting display in Song Dynasty commercial spaces and its contemporary translation. The methodology unfolds in three stages, each aligned with distinct methods and analytical techniques as follows:

Stage 1: Historical Visual-Textual Analysis and Data Structuring

This stage employs a design-translational literature research method to systematically analyze both textual and pictorial sources. Key documents include commercial treatises such as *Dongjing Menghua Lu* and *Mengliang Lu*, and 42 Song Dynasty paintings including Along the River During the Qingming Festival and *Zhakou Panche Tu*.

Sample: 42 Song-era visual works and 17 textual records.

Data Collection: Vector-based tracing using Adobe Illustrator to create a morphological atlas of lanterns.

Data Analysis: quantitative analysis of lantern typologies via frequency mapping across Kaifeng and Lin'an using historiometric methods, and spatial visualization using GIS tools to reconstruct the "lantern-market-canal" topology.

Stage 2: Field Investigation and Spatial-Anthropological Grounding

This stage addresses potential cognitive gaps between textual records and material remains through on-site ethnographic and archaeological validation, using a methodology that integrates Participatory Design Anthropology, Reverse Engineering, and Material Culture Studies.

Sample: 7 archaeological commercial sites (e.g., *Kaifeng Zhouqiao Ruins*, *Southern Song Imperial Street* in Hangzhou) and 23 Song-related lantern artifacts (including items from *Kyoto's Chion-in Temple* and *Ningde's Baofu Temple*).

Data Collection: (1) 3D laser scanning to capture lantern-hanging spatial parameters (e.g., height range: 2.1–3.6m; spacing: 0.8–1.5m); (2) Reverse-engineering of structural modules using photogrammetry and CAD; (3) Participatory observation of contemporary lantern artisans in Fuzhou's *Sanfang Qixiang* historical district, documenting the workflow from bamboo skeleton binding to paper mounting.

Data Analysis: Synthesis of archaeological, technical, and experiential data to build a living research archive that integrates spatial evidence, craft heritage, and embodied interaction.

Stage 3: Typological Induction and Systematic Design Translation

This stage formulates a structured design translation framework that proposes an evolutionary methodology for luminaire design—integrating smart lighting and neo-consumption trends—by recontextualizing cultural genes within modern design paradigms, through the induction of historical archetypes and their evaluation via Typological Analysis, Shape Grammar, and Multicriteria Evaluation (AHP).

Sample: 127 lantern shape datasets obtained from Stages 1 and 2.

Data Analysis: (1) Cluster analysis via SPSS to categorize lanterns into three functional archetypes: identification-oriented (e.g., gardenia lanterns), festival-oriented (e.g., lotus lanterns), and functional lighting (e.g., globe lanterns); (2) Morphological rule extraction using shape grammar to identify combinatory logic (e.g., units, linking modules, hanging density of 1.2 lanterns/m²); (3) Design translation evaluated using Analytic Hierarchy Process (AHP), measuring four dimensions: cultural perception (weight = 0.382), technical feasibility (0.218), spatial adaptability (0.264), and economic viability (0.136).

Results

Objective 1: Rooted in holistic commercial analysis, Song Dynasty epitomizes lighting design studies via advanced urban economy and vernacular culture. Its lantern systems—synthesizing technical-artistic-commercial imperatives—establish historical-modernization paradigms, exemplified by the Qingming Scroll.

Table 1 Luminaire in commercial spaces

Commercial Space	Image Source	Luminaire Elements	Luminaire Forms
Shiqian Jiaodian, Qingming Shanghe Scroll (Detail)		Light boxes	Two types: freestanding (similar to Sunyang Zhengdian) and suspended (thin-framed, hung on both sides of the entrance).
Sunyang Zhengdian, Qingming Shanghe Scroll (Detail)		Lanterns, light boxes	3 curved-top white/black signage lightboxes; 4 gardenia floral lanterns; 4 eaves-hung spherical/rhomboidal lanterns; square/circular lanterns on arched decor.

Table 1 Luminaire in commercial spaces (Con.)

Commercial Space	Image Source	Luminaire Elements	Luminaire Forms
Flower Market, Flower Market Children at Play (Detail)		Woven lanterns	Bamboo, rattan, or metal frame lanterns with internal candle illumination.
Tavern, Jinling Scroll (Detail)		Light boxes	Square, framed structure suspended above the entrance, embedded with painted patterns.
Blacksmith Workshop, Jinling Scroll (Detail)		Wall-mounted lamps	Bowl-shaped iron oil lamps fixed to walls with nails, fueled by wicks.

Table 1 summarizes key features of Song Dynasty lantern design and commercial lighting aesthetics. Lantern materials fused bamboo, rattan, paper, and silk with metal frameworks to ensure lightweight durability. Lightboxes typically featured wooden frames with translucent parchment, exemplified by Shiqian Jiao Dian's freestanding units with stabilizing curved tops. Innovations included bamboo-woven permeable skeletons, iron sconces with bowl-shaped oil reservoirs, and modular detachable systems.

Song commercial lighting prioritized chromatic and textual clarity. Lightboxes often adopted minimalist white-and-black schemes (e.g., Sun Yang Zheng Dian signage), while festive lanterns used vermilion-and-gold palettes to enhance conviviality (e.g. the tasseled bamboo units in Songren Huashi Xiying Tu). Some designs incorporated landscape motifs, as seen in Jinling Tu's tavern lightboxes, transforming functional lighting into cultural expression.

Objective 2: The research findings reveal that human needs progress from material to spiritual realms, as outlined in Maslow's hierarchy. In the evolution of artifacts, functional objects such as lamps transcend mere utility, becoming significant cultural symbols. These symbols consist of both form and meaning. Traditional lantern

symbolism can be deconstructed into three key elements: material form, contextual entities, and sociocultural interpretations.

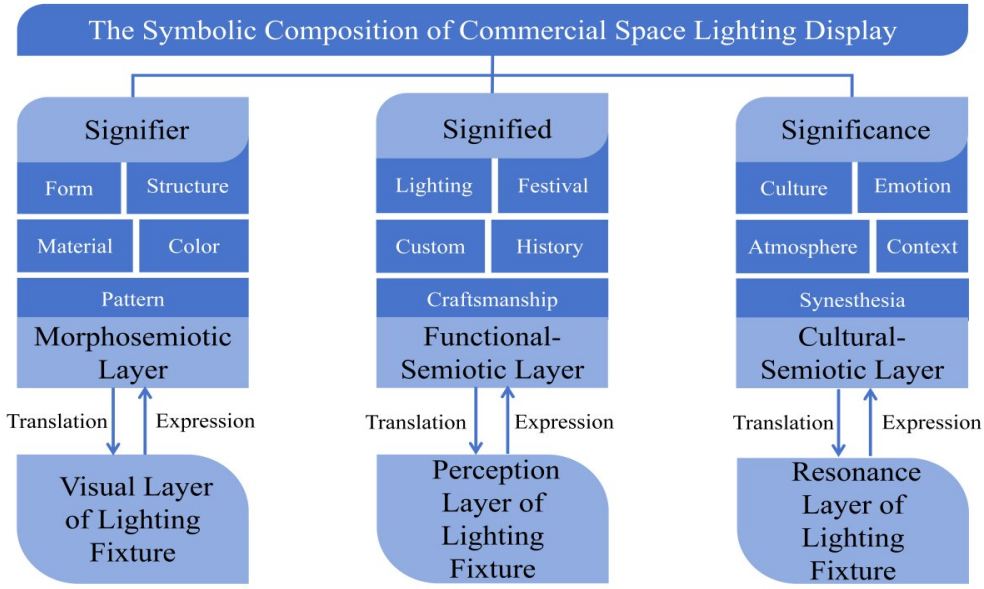

Figure 2 Model for Translating Traditional Culture into Lighting Design

Figure 2 presents the translational model for converting traditional cultural elements into contemporary lighting design, which includes three dimensions as following.

(1) Morpho-Semiotic Layer transcoding of Song lanterns involves a multifaceted refinement of their form, structure, materials, patterns, and colors. 3D cage shades, inspired by polygonal archetypes, are restyled through frameworks, texture-light interplay, minimalist motifs, and purified hues. This synthesis of tradition and modernity produces cage shades that embody cultural uniqueness, modern harmony, and industrial compliance.

(2) Functional-Semiotic Layer transcoding of Song commercial lanterns spans lighting, usage, history, folklore, and craftsmanship. Modernized through smart-LED systems and touch-blow sensors, these lanterns integrate historical narratives through reimagined forms and interactivity. This synergy between craft and industry enhances both practicality and marketability, yielding eco-lighting solutions that balance heritage continuity with user-centric innovation.

(3) Cultural-Semiotic Layer transcoding. Song commercial lanterns transcend mere utility to become cultural embodiments of national ethos. This study translates Tang-Song lantern culture through modern aesthetics, exploring regional and poetic motifs. Recontextualized into modern interiors for both daily and festive use, they employ light-shadow interplay to merge contemporary and traditional elements. As symbols of memory and aspiration, they synthesize modernity and heritage through neo-vernacular design, revitalizing historical narratives.

These findings illustrate how a translational model was developed by identifying and transforming key elements of traditional Song lanterns. The model converts material, functional, and symbolic aspects of lantern design into a contemporary lighting framework, bridging the past with the present while retaining cultural relevance and modern adaptability.

Objective 3: The research results propose an evolutionary methodology for luminaire design that responds to smart lighting technologies and neo-consumption trends, aiming to recontextualize traditional cultural genes within contemporary design paradigms.

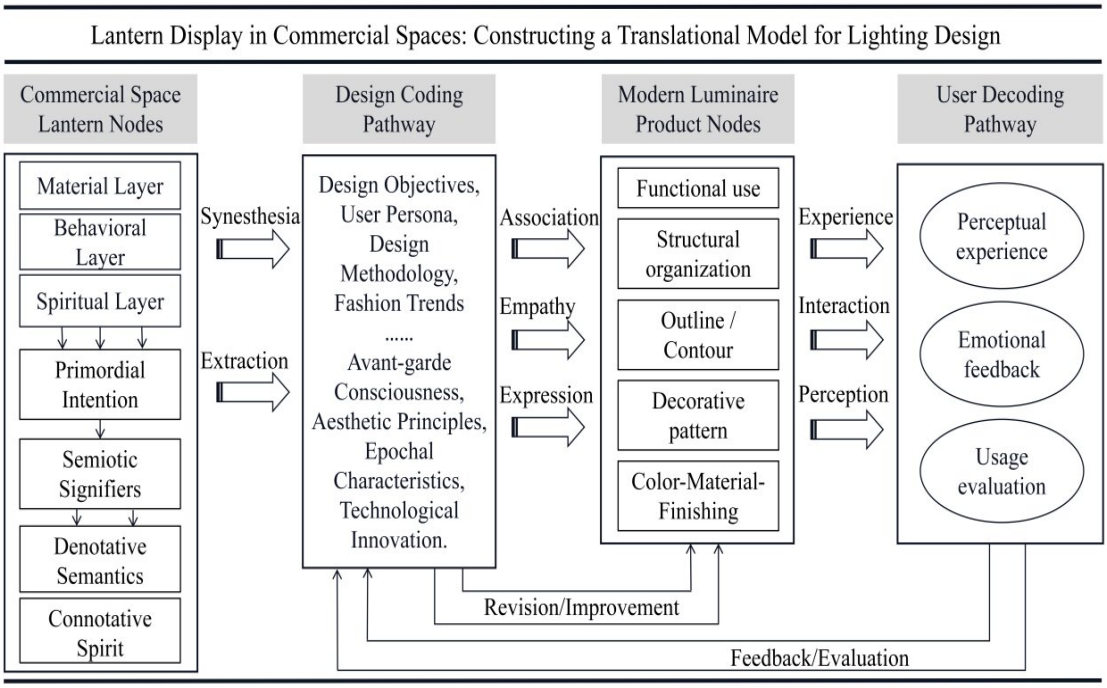

Figure 3 Translational Model for Lighting Design

As illustrated in Figure 3, the proposed translational model for lighting design follows a four-phase framework:

1. Cultural Gene Extraction (Song Commercial Space Lantern Nodes): This phase distills core cultural and design elements from historical Song lanterns—such as formal aesthetics, structural logic, material tactility, and light-shadow interaction—within their socio-cultural and ideological contexts.

2. Design Coding Pathway: Traditional and contemporary design elements are algorithmically transformed into three-dimensional forms through feature abstraction and creative computational modeling, enabling systematic reinterpretation.

3. Contemporary Lighting Mapping (Modern Luminaire Product Nodes): This stage establishes functional and aesthetic criteria—form, utility, and ambience—rooted in modern user lifestyles, technological integration, and spatial dynamics.

4. User-Centered Decoding: The final phase bridges encoded design outputs with user expectations through functional-semantic analysis and interaction-based adaptation, ensuring the cultural-symbolic meanings are accessible, intuitive, and experience-driven.

This methodological framework not only bridges traditional heritage and modern technology, but also reflects a shift toward interactive, narrative-driven lighting experiences tailored to evolving consumer behaviors and cultural reinterpretation.

Based on the findings from previous three stages, this research establishes a Song-modern framework through a triaxial parametric-philosophical system, revitalizing the luminous-humanistic synergy. Exemplified by Shuying Mingfang's cross-media literati contexts and Qianxi Hongming's digital light-shadow regeneration, the study advances the synthesis of heritage and modernity within commercial design paradigms.

The design of Shuying Mingfang (see Figure 4) reinterprets Song literati aesthetics using a formal-behavioral-symbolic framework applied to gardenia lanterns. Parametric brass-glass structures convey the material harmony of the Song dynasty, integrating adaptive floral displays, layered projections, and context-responsive lighting. Engraved bamboo-pine motifs and chromatic-poetic perforations spatialize cultural narratives, while a tactile-visual-olfactory-contemplative multisensory system grounds Song aesthetics within modern interior spaces. The specific final design can be seen in Figure 5.

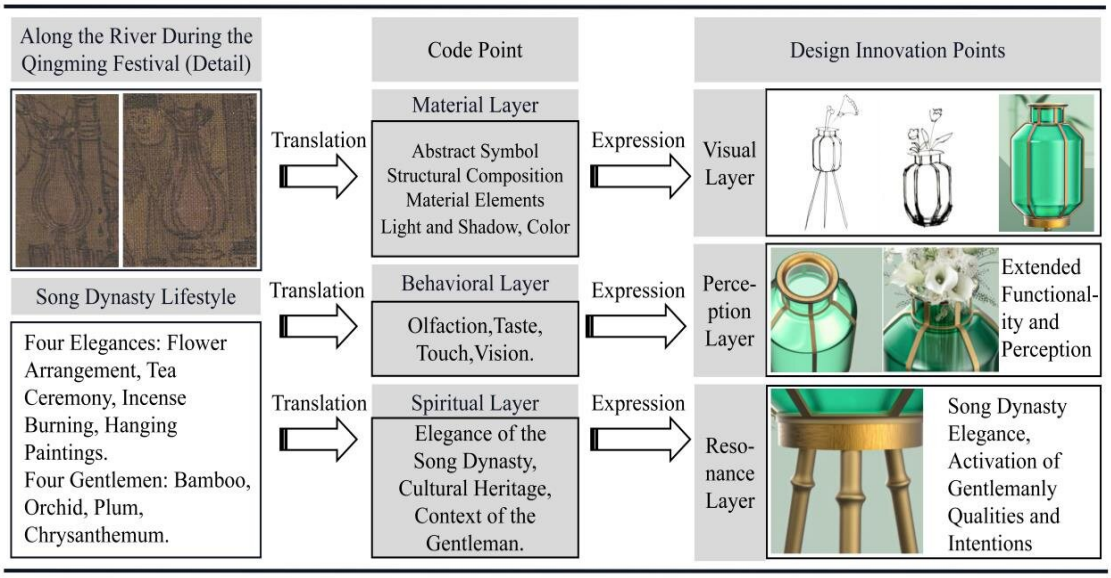

Figure 4 The Translation Design Path of Shuying Mingfang

Figure 5 Shuying Mingfang

The design of Qianxi Hongming (see Figure 5) reimagines Song lantern motifs through a triaxial formal-interactive-poetic framework, bridging historical craft with technological innovation. Rooted in the concept of object-as-symbol, parametric reconfiguration generates dual-layer glass-steel composites that embody the metal-jade harmony. A smart-magnetic modular system employs algorithmic apertures and flicker effects to evoke classical poetics, while tactile-kinetic-contemplative engagement breathes new life into cultural heritage through a craft-tech synthesis. The specific final design can be seen in Figure 7.

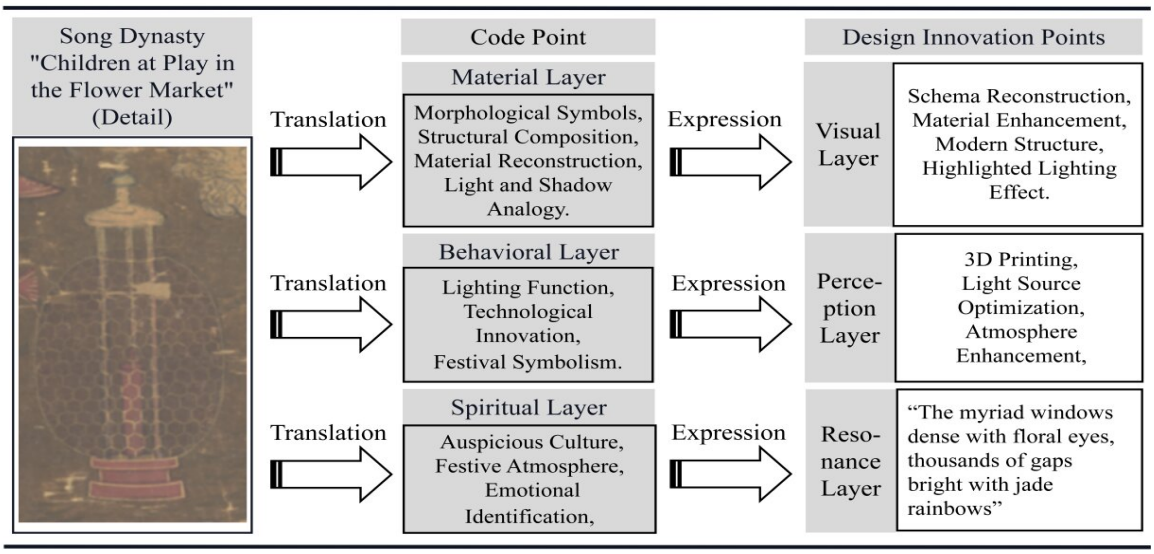

Figure 6 The Translation Design Path of Qianxi Hongming

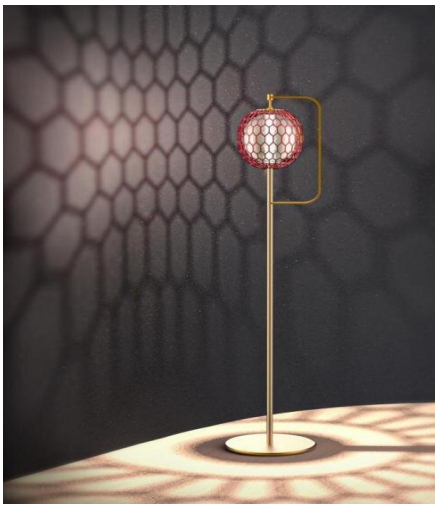

Figure 7 Qianxi Hongming

Discussion

This study aims to decode the formal DNA of Song dynasty commercial luminaire typologies through a design archaeological lens, revealing their techno-aesthetic synthesis of standardization and personalization; to develop a triaxial translational model that reinterprets traditional cultural elements into contemporary lighting design across material, functional, and spatial dimensions; and to propose an evolutionary methodology that integrates smart lighting technologies and neo-consumption trends, enabling the recontextualization of cultural genes within modern design paradigms.

The findings related to Objective 1 demonstrate that applying design archaeology to Song commercial lanterns enables a functional-symbolic synthesis by translating industry-specific traits into distinctive stylistic languages—for instance, wine-jar lanterns representing taverns and gourd-shaped lanterns denoting herbal medicine shops—thereby enhancing brand semiotics. This effect may stem from the immediate visual and contextual legibility of traditional symbols and the spatiotemporal adaptability of modular systems. Such outcomes align with Eco (1976) semiotic theory on cultural-symbolic transmission, as well as Alexander (1964) modular theory, which emphasizes the reconfigurability of form to achieve aesthetic-functional harmony. The analysis of Song commercial lighting systems reveals a sophisticated integration of modularity, material hybridity, and functional adaptability. For instance, the hexagonal lantern frames and bamboo-woven permeable skeletons (Table 1) exemplify a proto-industrial logic that prioritized lightweight durability—principles mirrored in modern parametric design frameworks. Recent studies, such as Su and Du (2023), highlight how Song-era modular joinery (e.g., *Yingzao Fashi* techniques) inspired contemporary prefabricated architectures, validating our findings on standardized adaptability. Beyond

lanterns, this modular DNA extends to other Song artifacts: Li (2024) employs historical analysis and morphological induction to examine the structural characteristics of Yan Ji furniture in the Yan Ji Tu, exploring its historical context and artistic value to inform innovative transformation in contemporary furniture design. Such cases align with Chen (2022) argument that Song design philosophies prefigured sustainable urban solutions by balancing standardization with cultural specificity.

The results from research objective 2 revealed that the triaxial model (Morpho-Function-Cultural) bridges historical symbolism and modern functionality. For example: (1) Morpho-Semiotic Layer transcoding: Bamboo-woven techniques (Table 1) were reimagined as parametric 3D-printed cage shades (Figure 2), resonating with Nie (2023) work on dialectical materiality, where craft traditions are digitized without losing tactile authenticity; (2) Functional-Semiotic Layer transcoding: Modernized through smart-LED systems and touch-blow sensors, the design concept resonates with Kim et al. (2017), whose MudGet system demonstrates how ambient lighting environments can be intuitively generated and controlled via LED-based mood extraction; (3) Cultural-Semiotic Layer transcoding: The *Bi* motif, a Song symbol of cosmic harmony, was digitized into pendant lights casting fractal shadows (Wen, 2022), illustrating how cultural narratives can be encoded into light-shadow interplay. This model's applicability extends beyond lanterns. Xu and Jing (2021) applied similar principles to Song calligraphy, transforming minimalist black-white signage into AI-driven digital billboards that adapt glyphs to pedestrian flows—a direct parallel to our behavioral-layer innovations.

The results from the research for Objective 3 revealed that Song-contemporary material-design dialogue establishes a triaxial framework translating lantern culture, integrating parametric reconstruction and philosophical embedding to revitalize luminous-humanistic synergy. The four-phase framework (Gene Extraction ⟶ Design Coding ⟶ Contemporary Mapping ⟶ User-Centered Decoding) addresses the tension between heritage preservation and technological innovation. For instance, the evolutionary methodology unfolds through three interrelated phases: Cultural Gene Extraction draws from the structural logic of Song iron sconces (Table 1) to inform Qianxi Hongming's magnetic modularity (Figure 3), facilitating user-customized configurations and echoing Jiang and Miao (2020) IoT-enabled "living heritage" systems; Design Coding reinterprets Song landscape motifs—such as those in the Jinling Scroll tavern lightboxes—into parametric perforations, resonating with the Hangzhou Silk Museum's use of AI to regenerate brocade patterns based on environmental data (Hangzhou Municipal People's Government General Office, 2024); and User-Centered Decoding is reflected in the tactile-kinetic interactions of

Shuying Mingfang (Figure 4), illustrating how multisensory engagement fosters a deeper cultural resonance, as highlighted by Wang (2022) in exploration of embodied design.

Body of Knowledge

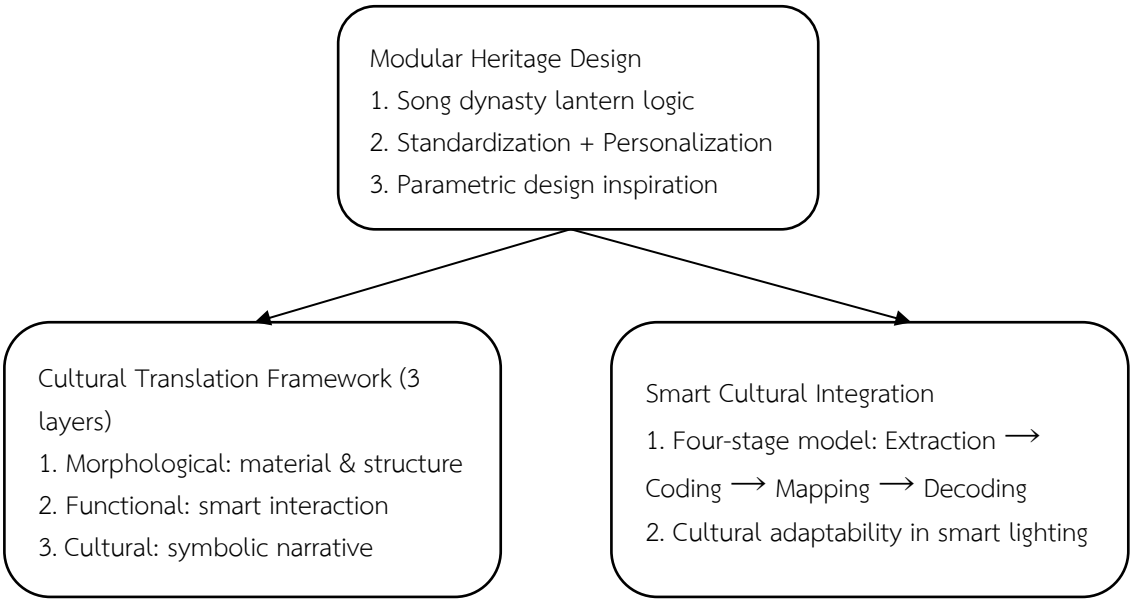

Figure 8 Body of Knowledge

The mind map (see Figure 8) articulates a tripartite framework for recontextualizing Song dynasty lighting design within contemporary smart design paradigms. The first thematic axis, Modular Heritage Design, identifies the historical design philosophy behind Song lanterns—characterized by a fusion of standardization and personalization through modular forms such as hexagonal skeletons and bamboo weaving. These principles offer valuable prototypes for contemporary parametric design. The second axis, Cultural Translation Framework, proposes a three-layered approach to reinterpreting traditional elements: the morphological layer addresses material and structural transformation, the functional layer explores smart interactive features, and the cultural layer emphasizes symbolic narrative continuity. The third axis, Smart Cultural Integration, introduces a four-phase methodology—cultural gene extraction, design coding, modern mapping, and user decoding—to enable seamless cultural adaptability within IoT-based lighting systems. By integrating neuroaesthetic insights, this model underscores the multisensory and emotional resonance of cultural forms in intelligent environments.

Conclusions

This study translates and reconstructs Song commercial lighting systems in contemporary design through historical-artifact analysis, deconstructing their functionality, craftsmanship, and cultural symbolism to reveal dual aesthetics of vernacular practicality and ritual solemnity. A tripartite framework—morpho-semiotics, craft reinterpretation, cultural revitalization—guides historical-modern transformation. Design experiments, including "crimson-shadowed candlelight" recreations, demonstrate adaptive strategies, while case studies validate that typology reconstruction necessitates formal modernization and cultural memory revival, offering a methodology for culturally-grounded lighting innovation.

Suggestion

Based on the research findings, the researcher provides the following recommendations:

1. Recommendations for the application of research findings

First, the modular typology developed in this research can be extended beyond lantern forms to encompass other architectural and decorative elements from the Song dynasty, such as geban partitions or calligraphic panels. Parametric design and digital fabrication techniques like 3D printing offer new possibilities for translating historical structures into contemporary modular systems. Second, incorporating biodegradable and sustainable materials—such as mycelium-based composites—can enhance production efficiency while aligning with environmentally responsible design practices. Third, integrating neuroaesthetic principles into the user experience evaluation—such as through emotional mapping or multisensory interaction—can deepen user engagement and enhance cultural resonance.

2. Recommendations for Future Research

Future research may explore AI-assisted cultural translation, using generative design algorithms to reinterpret traditional patterns and forms with greater agility and adaptability. Comparative cross-cultural studies, such as exploring structural parallels between Song modularity and other regional traditions, could contribute to a broader framework of transcultural design principles. Additionally, integrating immersive technologies into spatial storytelling—such as XR-based environments—can enable hybrid cultural narratives that blend historical aesthetics with interactive, multisensory experiences, opening new avenues for the evolution of luminous cultural design.

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