

# THE SEMANTIC POTENTIAL OF JEWELRY MATERIALS: VISUAL INTERPLAY OF BLACK GOLD AND TRADITIONAL YELLOW GOLD IN THE LY DYNASTY LOTUS MOTIF

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| Article Info                                                                                                                                                                                                                                                                                                                                                                                                                        | Abstract                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
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| <p><b>Article type:</b><br/><i>Research Article</i></p> <p><b>Article history:</b><br/>Received: [...]<br/>Received in revised form: [...]<br/>Accepted: [...]<br/>Available online: [...]<br/>(<a href="#">editorial office completes this</a>)</p> <p><b>Keywords:</b><br/><i>Material semantics, Black Gold alloy, Ly Dynasty lotus motif, Cultural Product Design model, Emotional durability, Heritage jewelry design.</i></p> | <p>Current heritage-inspired jewelry design predominantly focuses on superficial morphological simulation, thereby neglecting the expressive potential of material semantics. Addressing this gap, this study applies the Cultural Product Design (CPD) framework in conjunction with visual semiotics to propose a novel material scenario for the 11<sup>th</sup> century Ly Dynasty lotus motif. Methodologically, the research integrates three-dimensional computer-aided design and manufacturing (3D CAD/CAM) technology with a modular assembly approach to functionally combine two distinct precious metals: a light-absorbing homogenous Black Gold alloy and a highly reflective Traditional Yellow Gold. Structural components were engineered with a mechanical locking tolerance of <math>\pm 0.02</math> mm to facilitate lost-wax micro-casting. The principal findings indicate that the stark optical contrast (chiaroscuro) between the Black Gold base and the Traditional Yellow Gold relief petals successfully materializes the Zen Buddhist dualistic philosophy regarding the symbiotic relationship between ignorance and enlightenment. Furthermore, ergonomic optimizations, specifically allocating Black Gold to recessed areas and applying a safety fillet radius (<math>R \geq 0.4</math> mm) are theoretically projected to mitigate friction-based mechanical wear while reducing metal weight by 40%–50%. Ultimately, the deliberate manipulation of metallurgical properties elevates jewelry from a decorative accessory to a narrative agent, aiming to foster emotional durability and proposing a conceptual design strategy that could position the product as a contemporary heirloom.</p> |

**Cite this article:** Last Name, Initial., Last Name, Initial., & Last Name, Initial. ([Year]). Title of the paper in sentence case. Journal of Design Thinking, [Volume]([Issue]), [pages]. [https://doi.org/\[DOI\]](https://doi.org/[DOI])

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**Publisher:** University of Tehran Press. **DOI:** [https://doi.org/\[to be assigned\]](https://doi.org/[to be assigned])

# Introduction

In the era of global cultural integration, the translation of traditional artistic heritage into contemporary design paradigms has emerged as an inevitable trajectory, particularly within the realms of applied arts and jewelry design. In Vietnam, endeavors to forge “contemporary heirlooms” imbued with profound national identity have predominantly been approached through a morphological lens. Consequently, designers tend to focus exclusively on the extraction and superficial simulation of ancient motifs on physical surfaces exemplified by the application of the Ly Dynasty lotus motif in goldsmithing. However, this disproportionate emphasis on form has inadvertently eclipsed the profound expressive potential inherent in the materials themselves (material semantics).

Objectively examined, research concerning materiality in indigenous-inspired jewelry design in Vietnam is not entirely an academic void. Recent years have witnessed commendable efforts to exploit traditional materials, notably studies elevating Bat Trang ceramics beyond utilitarian boundaries to serve as aesthetic focal points in jewelry (Nguyen et al., 2025), or the renaissance of Hue painted enamels (Phap Lam) in contemporary goldsmithing (Do, 2025). Nevertheless, these studies predominantly utilize exogenous materials (e.g., ceramics, enamels) as decorative embossed details on metal frameworks. Meanwhile, the metal alloy itself the structural nucleus of jewelry art is relegated to a passive, subordinate foundation, stripped of its autonomous narrative function.

From the perspective of visual psychology, Arnheim (1969) asserts that material and color do not exist as static phenomena; rather, they are dynamic visual forces capable of directly transmitting psychological concepts. Extrapolating this to the macro-Buddhist philosophy that governed Ly Dynasty art, “Enlightenment” (light) does not exist in isolation but invariably germinates from “Ignorance” (darkness). The singular use of resplendent Traditional Yellow Gold to recreate the Ly Dynasty lotus merely grazes its superficial splendor, thereby forfeiting the opportunity to materialize the profound depths of Zen Buddhist philosophy (Lin, 2007).

Driven by the aforementioned research gap, this paper proposes a pioneering design solution: the integration of homogenous Black Gold alloy with Traditional Yellow Gold. Employing the Cultural Product Design (CPD) framework methodology, the objective is to establish a philosophically dialogic “material scenario”. By exploiting the intense optical contrast (*chiaroscuro*) between light and shadow, this approach transforms the material into an active expressive medium, effectively translating the spiritual “heritage code” of the Ly Dynasty lotus into contemporary jewelry design.

## Theoretical Framework & Material Semantics

To systematically investigate the translation of historical artifacts into contemporary conceptual design, this study constructs a unified theoretical framework that bridges cultural morphology, corporeal interaction, and sustainable consumer psychology. The framework operates as an interconnected tripartite system: it utilizes the CPD model (Lin, 2007) as its exclusive overarching methodology and structural backbone, employs the concept of embodied cultural perception (Rose, 2016; Skinner, 2013) to interpret the user-product interaction, and targets emotional durability (Cervellon & Shammass, 2013; Chapman, 2005) as the ultimate psycho-ecological outcome. Rather than treating these concepts as isolated phenomena, this research positions them in a causal, sequential lineage: the systematic decoding of heritage motifs across the three levels of CPD acts as the primary stimulus; this stimulus is processed through the user’s corporeal and sensory engagement to evoke an embodied cultural perception; finally, the resulting cultural resonance is hypothesized to stabilize into long-term psychological empathy, achieving emotional durability.

## 1. Morphological Characteristics and Dualistic Buddhist Philosophy of the Ly Dynasty Lotus

Tracing the historical trajectory of Vietnamese fine arts, the Ly Dynasty (11<sup>th</sup>–13<sup>th</sup> centuries) is positioned as a golden age, wherein visual arts reached an academic and normative apex. During this era, with Buddhism revered as the State Religion, fine arts were deeply permeated with Zen Buddhist philosophy, epitomizing a seamless synthesis of Dynastic Power and Divine Authority (Nguyen & Phan, 1989). At the core of the Ly Dynasty decorative motif system stands the lotus iconography a symbol transcending mere botanical representation to become a sacred motif endowed with profound philosophical resonance (Nguyen, 2003).



**Figure 1:** The pedestal of the 11<sup>th</sup> century Amitabha Buddha statue. Photograph taken at Phat Tich Pagoda, Bac Ninh – Vietnam. (Source: Photograph provided by Assoc. Prof. Dr. Trang Thanh Hien, reproduced with formal permission)

Examined through the lens of the Cultural Product Design (CPD) framework, the Ly Dynasty lotus motif must be simultaneously decoded at two distinct levels: the physical surface (visual morphology) and the spiritual depth (philosophical ideology) (Lin, 2007).

**Regarding the Physical Level (Morphological Characteristics):** The Ly Dynasty lotus possesses a unique graphic language, standing in stark contrast to the unrestrained, expressive style of the Tran Dynasty or the strict realism of the Nguyen Dynasty. This formative system is characterized by geometric abstraction and rigorous macro-scale normativity. The lotus petals are structured in multi-layered overlapping spatial arrangements, featuring elongated petal proportions and gracefully pointed tips (Chu, 2001). This arrangement generates a dynamic upward thrust rather than a static posture. Remarkably, although most Ly Dynasty lotus motifs were executed on macro-architectural sandstone blocks, their carved contours exhibit extraordinary delicacy and meticulousness, reflecting a micro-craftsmanship mindset inherited indirectly from the gold-leaf repoussé technique of the Oc Eo culture (Pham, 2016).

**Regarding the Spiritual Level (Dualistic Zen Philosophy):** These morphological traits are not arbitrary stylistic choices, but rather the physical materialization of Dai Viet Buddhist ideology. The multi-layered structure of the lotus pedestal reflects the cosmic worldview regarding spiritual realms and stages of cultivation. The tapered, soaring contours of the petals visually express the Zen ethos of upward aspiration and self-transcendence. Crucially, the innermost philosophical core of this motif resides in its 'dualistic Zen Buddhist philosophy' (defined in this study as the symbiotic relationship between worldly existence and spiritual awakening). Historically, as documented by Nguyen (2003), the Ly Dynasty lotus rarely exists in isolation; it functions as an ascending pedestal emerging from undulating waves or swirling

mud. Zen philosophy emphasizes that Enlightenment (purity) cannot be decoupled from worldly existence; it must germinate and break through the mud (Ignorance) to radiate. It is precisely this dynamic tension and dialogue between the “Mud” (darkness/negative space) and the “Lotus” (light/ascending form) that endows the motif with its spiritual gravitas. Zen philosophy emphasizes that Enlightenment (purity) cannot be decoupled from worldly existence; it must germinate and break through the mud (Ignorance) to radiate. It is precisely this dynamic tension and dialogue between the “Mud” (darkness/negative space) and the “Lotus” (light/ascending form) that endows the motif with its spiritual gravitas (Nguyen, 2003).

Consequently, the Ly Dynasty lotus constitutes a complete “heritage code” wherein complex geometric structures and micro-scale proportions serve as an exquisite medium to express the Zen philosophical dialogue between Ignorance and Enlightenment. Decoding this organic unity between physical morphology and spiritual philosophy establishes a prerequisite theoretical foundation, clearing the path for applying contrasting material scenarios specifically the interplay between Black Gold and Traditional Yellow Gold alloys in contemporary jewelry design.

## 2. Metallurgical Nature of Black Gold Alloy and the Optical Semantics of Chiaroscuro

In contemporary product design theory, material is no longer confined to the passive role of form-constituting substance; rather, it possesses an autonomous semantic system capable of transmitting cultural narratives and eliciting emotional responses from the observer (Arnheim, 1969). When approaching heritage through the lens of the Cultural Product Design (CPD) model, beyond the *Outer (tangible)* and *Middle (behavioral)* levels, the *Inner (spiritual/intangible)* level necessitates that designers identify compatible physical mediums to materialize invisible values (Lin, 2007).

Within Traditional Yellow Gold smithing, the pristine yellow hue of pure gold has perennially symbolized nobility, sanctity, and the resplendence of divine authority. However, relying exclusively on this singular hue risks rendering the metallurgical language monotonic, severely limiting its capacity to articulate oppositional concepts or multi-layered spatial architectures (Tenuta et al., 2024). The introduction of the Black Gold alloy unlocks a fundamentally novel paradigm of expression. From a metallurgical standpoint, Black Gold is distinctly different from ephemeral surface-coating treatments, such as black rhodium or ruthenium electroplating. Rather, it is achieved through a specialized ‘alloying for oxidation’ process. The core metal is an 18 karat or 14 karat alloy combining pure gold with specific transition metals, most notably cobalt (Co) or iron (Fe), typically in the range of 5% – 25%. After the casting process, the alloy is subjected to a controlled thermal oxidation treatment in air at temperatures between 700°C and 950°C. This heat treatment triggers the transition metals to segregate to the surface and react with oxygen, forming a dense, stable, and adherent black oxide layer (e.g., Cobalt Oxide, CoO) that grows directly from the internal alloy matrix. Unlike simple plated coatings that easily scratch to reveal the base metal, this structurally rooted oxide layer offers superior wear resistance, thereby guaranteeing the *haute joaillerie* (high jewelry) value and longevity required for a contemporary heirloom. Viewed through the lens of applied arts, the somber black tonality of this alloy produces an effect of absolute light absorption, standing in diametrical opposition to the highly reflective and luminous properties of Traditional Yellow Gold.

From the perspective of visual semiotics, the juxtaposition of Black Gold and Traditional Yellow Gold constructs a “Material Scenario” grounded in the chiaroscuro principle of light-dark contrast. Prior studies have demonstrated that combining materials with disparate surface characteristics (such as Bat Trang ceramics or Hue painted enamels integrated into metal frameworks) significantly enhances visual depth and exclusivity in jewelry (Do, 2025; Nguyen et al., 2025). Similarly, when integrating Black Gold into the Ly Dynasty lotus motif, this material does not function as a representation of inferiority or malice. Instead, it is consciously projected as “negative space” a physical manifestation of the Zen Buddhist concepts of Ignorance (*avidyā*), the foundational mud, and the boundless depth of the cosmos (Nguyen, 2003).

When Black Gold is strategically allocated to the recessed base layers, the inner core of the lotus petals, or the supporting pedestal structures, it generates a realm of tranquil darkness. This visually propels and honors the graceful, upward-thrusting contours of the lotus petals, which are cast in highly reflective

Traditional Yellow Gold on the relief layer (Morphological dimension). This material interplay proposes a conceptual resolution to the challenge of “materializing dualistic philosophy,” illustrating how Enlightenment (the yellow hue) ascends and radiates most profoundly when grounded upon the tranquil, melancholic foundation of Ignorance (the black hue) (Arnheim, 1969; Nguyen, 2003). Consequently, the integration of Black Gold and Traditional Yellow Gold is not merely an adherence to a luxury aesthetic trend; rather, it is a deliberate design solution that transforms the material itself into an autonomous language capable of narrating its own heritage story.

## Research Methodology

### 1. Integrated CPD Transformation Matrix: A Methodological Framework for Heritage Jewelry Design

Building upon the decoding of visual characteristics and dualistic Buddhist philosophy in Section “1. Morphological Characteristics and Dualistic Buddhist Philosophy of the Ly Dynasty Lotus”, together with the semantic and technical nature of the Black Gold alloy in Section “2. Metallurgical Nature of Black Gold Alloy and the Optical Semantics of Chiaroscuro”, this study operationalizes these theoretical insights into an Integrated CPD Transformation Matrix derived from the model established by Lin (2007). This matrix serves as a methodological bridge, translating intangible cultural concepts into concrete parametric design parameters and precise material decisions.

Table 1: Integrated cpd transformation matrix for heritage jewelry design

| CPD Level                                         | Cultural & Design Dimension                                                                                                                                                                       | Material & Technical Operationalization                                                                                                                                                                                                                                                                                                                                                                         | Design & Philosophical Output                                                                                                                                                                                                                    |
|---------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Inner level</b><br>(Spiritual & Philosophical) | <ul style="list-style-type: none"><li>Ly Dynasty lotus motif iconography.</li><li>Dualistic Zen Buddhist philosophy (Ignorance &amp; Enlightenment).</li></ul>                                    | <ul style="list-style-type: none"><li>Juxtaposition of light-absorbing Black Gold alloy (base/negative space) and highly reflective Traditional Yellow Gold (relief petals).</li><li>Optical Chiaroscuro (light-dark) contrast.</li></ul>                                                                                                                                                                       | <ul style="list-style-type: none"><li>Materialization of spiritual “heritage code”.</li><li>Transformation of metal alloys into autonomous narrative agents.</li><li>Philosophical dialogue between darkness (mud) and light (purity).</li></ul> |
| <b>Middle level</b><br>(Behavioral & Ergonomic)   | <ul style="list-style-type: none"><li>Human-product interaction &amp; safety.</li><li>Material durability in high-friction zones.</li><li>Emotional connection &amp; product longevity.</li></ul> | <ul style="list-style-type: none"><li><b>Friction-based Allocation:</b> Assigning Black Gold to recessed areas to mitigate mechanical wear.</li><li><b>Ergonomic Edge Treatment:</b> Applying a safety fillet radius (<math>R \geq 0.4</math> mm) to tapered petal tips.</li><li>Lightweighting for daily wearing comfort.</li></ul>                                                                            | <ul style="list-style-type: none"><li>Optimization of physical functionality &amp; user safety.</li><li>Fostering Emotional Durability (Chapman, 2005).</li><li>Positioning as a “Contemporary Heirloom” in high-end luxury jewelry.</li></ul>   |
| <b>Outer level</b><br>(Physical & Material)       | <ul style="list-style-type: none"><li>Macro-to-micro scale conversion.</li><li>3D digital modeling (CAD/CAM).</li><li>Metallurgy &amp; precision goldsmithing.</li></ul>                          | <ul style="list-style-type: none"><li><b>3D CAD Modeling:</b> Geometric abstraction of multi-layered Ly lotus petals using NURBS surfaces.</li><li><b>Modular Assembly:</b> Component separation (Module A: Black Gold base; Module B: Yellow Gold petals) with mechanical locking joints (<math>\pm 0.02</math> mm tolerance).</li><li>Digital Shelling: Hollowing with 0.6 – 0.8 mm wall thickness.</li></ul> | <ul style="list-style-type: none"><li>Bimetallic lost-wax casting feasibility.</li><li>Structural integrity &amp; 40% – 50% weight reduction.</li><li>Precision assembly via mechanical interlocking / high-frequency Laser welding.</li></ul>   |

(Source: Compiled by the author, adapted from Lin, 2007)

Through this Integrated CPD Transformation Matrix, the heritage jewelry design process transcends empirical subjectivity, evolving into a highly controlled scientific methodology. This rigorous framework ensures methodological alignment from the foundational philosophy down to every empirical fabrication parameter.

### 2. 3D CAD Digitization Workflow and Modular Assembly Solution

The translation of a heritage motif from the macro-scale of stone sculpture to the micro-scale of jewelry demands a rigorous digital modeling methodology to overcome scaling barriers and physical fabrication limits (Sutherland, 2003; Tenuta et al., 2024). To actualize the material interaction scenario between Black Gold and Traditional Yellow Gold alloys, this study established a 3D CAD/CAM prototyping workflow encompassing three core technical phases:

**Phase 1: 2D Vector Standardization from Fieldwork Data:** Photographic data of the Ly Dynasty lotus, collected from architectural heritage sites, was imported into modeling software to decode its morphology. Utilizing mathematical graphic algorithms, the natural carved contours were digitized into a precise vector curve system. This process distinctly isolated the tapered proportions of the lotus petal edges and the rhythm of its multi-layered spatial structure (Chu, 2001; Nguyen, 2003).

**Phase 2: 3D NURBS Spatial Modeling and Modular Design:** Within a specialized CAD environment, the 2D vector lines were transformed into free-form yet radius-controlled NURBS surfaces. To resolve the technical challenge of separately casting two distinct precious metal alloys, the 3D model had to be deliberately segregated into a system of independent components (Modular Assembly). The recessed pedestal and negative space areas were separated into Module A (designated for casting the Black Gold alloy), while the soaring, relief lotus petals were separated into Module B (designated for casting the Traditional Yellow Gold alloy). The interfaces between the two modules were engineered with mechanical locking joints (mortise and tenon structures) utilizing a digital tolerance setting of  $\pm 0.02$  mm. This parameter was configured within the CAD environment to align with the standard resolution and minimum clearance limits of high-precision additive manufacturing (SLM/SLA) equipment (Zhang et al., 2024). Within the digital simulation, this is calculated to ensure a robust mechanical connection and theoretically facilitate subsequent high-frequency laser welding without distorting the material structure.

**Phase 3: Digital Hollowing and Ergonomic Optimization:** To fulfill sustainable design criteria and optimize product weight, the software applied a mathematical hollowing algorithm (Shelling) to excavate the entire non-load-bearing internal metal volume. The wall thickness of the digital prototype was set between 0.6 mm and 0.8 mm, a standard threshold strictly enforced to ensure smooth molten metal flow and prevent casting porosity in precision investment casting (Fan & Wang, 2026; Zhang et al., 2024). Digital volume calculations generated by the CAD software compare the hollowed model against a solid baseline, projecting that this solution can reduce the precious metal mass by 40%–50%. Digital volume calculations within the CAD software project that this solution can reduce the precious metal mass by 40% – 50% compared to traditional solid casting methods, yielding an optimal lightness in accordance with jewelry ergonomics (Norman, 2013). Concurrently, adhering to the behavioral filter of the CPD model, all sharp apices of the lotus petals were filleted with a safety radius of  $R \geq 0.4$  mm. This specific geometric intervention satisfies jewelry ergonomic safety standards to prevent skin irritation during bodily interaction (Skinner, 2013). This intervention is theoretically projected to mitigate the risk of dermal abrasion for the wearer while perfectly preserving the soaring, upward-thrusting visual signature characteristic of Ly Dynasty art.

## Design Proposition and Discussion

### 1. Semiotic Transformation: From Physical Material to Spiritual Concept

At this juncture, it is necessary to explicitly distinguish between historically documented meanings and the contemporary design interpretation proposed in this study. While the dualistic mud-lotus dichotomy is a historically documented fact in Ly Dynasty Buddhist culture, the specific assignment of the Black Gold alloy to symbolize “Ignorance/Darkness” and Traditional Yellow Gold to represent “Enlightenment/Light” is entirely the author’s contemporary conceptual interpretation. By applying visual psychology (Arnheim, 1969), the historical metaphor is translated into a modern metallurgical scenario.

The proposed multi-component modular assembly in Phase 2 extends beyond theoretically overcoming alloy casting constraints; it establishes the structural foundation for semiotic transformation. According to the CPD framework, reaching the Inner (spiritual) level requires designers to move beyond superficial morphological replication and establish a system of “Material Semantics” capable of triggering the observer’s psychological cognition (Lin, 2007; Tenuta et al., 2024)..



**Figure 2:** Digital 3D CAD visualization proposing the chiaroscuro visual interaction scenario on the Ly Dynasty lotus motif utilizing a modular assembly structure. No physical prototype was fabricated. (Source: Created by the author, 2026).

The design scenario of the Ly Dynasty lotus, which integrates Black Gold and Traditional Yellow Gold, functions as a visual semiotic matrix. Within this framework, the Physical Material (the Signifier) directly incarnates into the Spiritual Concept (the Signified) via the chiaroscuro principle of light-dark contrast:

**Negative Space and Melancholy (The Black Gold Base):** From an optical physics perspective, the Black Gold alloy (synthesized from transition metals) inherently absorbs the majority of the visible light spectrum (Corti, 2004). When strategically positioned within the supporting pedestals and recessed areas, it generates an optical illusion of fathomless depth. Semiotically, this optical negative space serves as the physical manifestation of the realm of “Ignorance” (avidyā the foundational mud), tranquility, and the concept of “Emptiness” (Śūnyatā) within Zen Buddhist cosmology. Rather than acting as a passive background, it exerts a compelling visual gravitational pull.

**The Relief Layer and Awakening (The Traditional Yellow Gold Petals):** In stark contrast, the tapered, modular components simulating the lotus petals are cast in Traditional Yellow Gold, possessing highly reflective and luminously radiant properties. Upon being mechanically interlocked onto the Black Gold base, this severe physical dichotomy instantly generates an “upward thrust” within the context of visual psychology (Arnheim, 1969). Consequently, within this conceptual framework, the Ly Dynasty lotus motif is hypothesized to transcend its status as a static, decorative pattern to execute a dynamic action: piercing through the darkness of Ignorance to radiate resplendently in a state of Enlightenment.

Ultimately, through the deliberate manipulation of the physical and metallurgical properties of jewelry alloys, the design successfully executes a quantum leap from the Physical/Outer Level (alloys absorbing or reflecting light) to the Spiritual/Inner Level (the philosophical dialogue between Ignorance and Enlightenment). At this juncture, heritage jewelry transcends its conventional aesthetic function to operate as a “narrative agent”, wherein the metallic surface directly articulates the philosophical profundity of 11<sup>th</sup> – 13<sup>th</sup> century royal court art.

## 2. Functional Optimization and Commercial Positioning

### 2.1. Ergonomic Optimization and Friction-Zone Material Protection Solutions

One of the paramount challenges in the haute joaillerie (high jewelry) sector is the physical abrasion incurred during the jewelry’s interaction and kinematic movement on the human body. Although the Black Gold alloy possesses a structurally homogeneous matrix through the metallurgical process (Corti, 2004),

continuous friction against garments or abrasive surfaces can inevitably degrade the material's optical luster over time (Tenuta et al., 2024).

To theoretically mitigate this risk, the author proposes a conceptual design scenario utilizing a "Friction-based Material Allocation" strategy as follows:

- **Negative Space Allocation for Black Gold:** The Black Gold alloy is exclusively allocated to the recessed pedestals, the sunken core of the lotus petals, or the internal cavities. These recessed areas actively prevent direct contact and mechanical abrasion with external environments during everyday wear. This technical intervention ensures the perpetual preservation of the somber, absolute light-absorbing black hue of the alloy (Norman, 2013; Tenuta et al., 2024).
- **Ergonomic Edge Treatment:** Although the Ly Dynasty lotus is characterized by sharply tapered contours to generate an upward visual thrust (Chu, 2001; Nguyen, 2003), at somatic interface points with the wearer's skin, the 3D CAD algorithm applies a fillet command to establish a safety radius of  $R \geq 0.4$  mm. This standard is engineered to theoretically minimize the potential for dermal abrasion or physical discomfort, strictly adhering to anthropometric and product-use psychological principles (Lin, 2007; Norman, 2013).
- **Digital Lightweighting via Hollowing:** The implementation of a thin-wall hollowing algorithm (Shelling) with a standard thickness threshold of 0.6 mm – 0.8 mm (Fan & Wang, 2026; Zhang et al., 2024) not only conserves precious metal mass satisfying the zero-waste design criteria of the circular economy (Chang et al., 2022; Tenuta et al., 2024) but also achieves an optimal lightness. This delivers absolute physiological comfort for the wearer in a contemporary lifestyle context.

## 2.2. High-End Market Positioning and the Activation of "Emotional Durability"

Amidst a global jewelry industry increasingly dictated by fast-fashion consumption cycles and aesthetic homogenization (Skinner, 2013; Tenuta et al., 2024), the integration of Black Gold and Traditional Yellow Gold within the Ly Dynasty lotus motif engenders a radically distinct commercial positioning strategy:

**Exclusive Aesthetics within the High-End Jewelry Segment:** The mastery of homogenous Black Gold metallurgy (Corti, 2004) coupled with the visual language of chiaroscuro liberates the product from the stigmas of superficial replication and derivative heritage design (Do, 2025; Nguyen et al., 2025). The creation asserts its haute joaillerie (high jewelry) status not through the ostentatious display of gold mass, but rather through the absolute exclusivity of its material scenario and the intellectual rigor of its digital craftsmanship (Skinner, 2013).

**Activation of "Emotional Durability":** According to Chapman's (2005) theory of sustainable design, product obsolescence stems not merely from physical degradation, but primarily from the fracture of the emotional connection between the user and the object. By embedding the profound depths of dualistic Zen Buddhist philosophy (Ignorance vs. Enlightenment) into the material dialogue between Black and Traditional Yellow Gold, the jewelry transcends the ephemeral nature of a fashion accessory to become a potent "narrative agent" (Nguyen et al., 2025). The wearer does not merely adorn themselves with an accessory; they embody an 11<sup>th</sup> – 13<sup>th</sup> century royal "heritage code". This profound cultural empathy and pride forge a resilient psychological bond, potentially encouraging the user to cherish, preserve, and pass down the piece across generations, conceptually elevating it to a "contemporary heirloom".

## Conclusion

This study significantly bridges the theoretical and practical gap concerning "Material Semantics" within the Vietnamese heritage jewelry design sector a domain historically dominated by the paradigm of superficial 2D/3D morphological replication. By designating the Ly Dynasty lotus motif (11<sup>th</sup> – 13<sup>th</sup> centuries) as the primary frame of reference, this paper establishes a pioneering design solution: the

integration of homogenous Black Gold alloy with pristine Traditional Yellow Gold to forge a profoundly expressive chiaroscuro visual interaction scenario.

The core contributions of this research are crystallized across three dimensions:

**(1) Theoretical and Philosophical Profundity:** The study substantiates that precious metal does not merely function as a passive structural substrate; rather, its inherent optical properties possess an autonomous narrative capacity (Arnheim, 1969; Lin, 2007). The dialectical interplay between the light-absorbing nature of Black Gold and the radiant reflectivity of Traditional Yellow Gold suggests a visual materialization of the dualistic Zen Buddhist philosophy of the Ly Dynasty: Enlightenment (the lotus) can only ascend and awaken when germinated within the profound melancholy and tranquility of Ignorance (the foundational mud) (Nguyen, 2003).

**(2) Methodological Framework and Digital Fabrication:** The paper successfully operationalizes the Integrated CPD Transformation Matrix (Lin, 2007), establishing a rigorous filtering mechanism that traverses from *the Inner Level* (Buddhist philosophy) through *the Middle Level* (ergonomics) to the *Outer Level* (3D CAD/CAM execution). By proposing a Modular Assembly structure with a stringent  $\pm 0.02$  mm technical tolerance, the research provides a definitive solution to the metallurgical barriers of integrating two independent precious metal alloys (Corti, 2004). Concurrently, the strategic allocation of Black Gold into recessed negative spaces, paired with a  $\geq 0.4$  mm safety fillet radius is theoretically designed to mitigate mechanical abrasion, thereby ensuring the long-term functional viability of the jewelry (Norman, 2013; Tenuta et al., 2024).

**(3) Sustainable Design Orientation:** By infusing materials with heritage narratives and spiritual philosophy, the design is hypothesized to foster “Emotional Durability” (Chapman, 2005). Consequently, the product transcends the relentless obsolescence cycle of fast fashion to potentially emerge as a “contemporary heirloom”. This approach not only dynamically preserves cultural heritage but also strategically positions the identity of Vietnamese goldsmithing within the global luxury market.

Despite the comprehensive formulation of the theoretical framework and the experimental 3D CAD/CAM prototyping scenario, this study acknowledges certain limitations. Specifically, it has yet to conduct a large-scale quantitative survey evaluating consumer acceptance and actual psychological responses to the Black Gold aesthetic within the haute joaillerie segment. This presents a compelling avenue for subsequent empirical research to quantitatively measure customer satisfaction indices and to expand experimental applications across other contemporary colored alloy systems, further advancing the acculturation of national cultural heritage.

## Acknowledgements

*The author wishes to express sincere gratitude to Assoc. Prof. Dr. Trang Thanh Hien for her academic advisorship on traditional Vietnamese fine arts and for providing detailed fieldwork photographic documentation.*

*Special thanks are also extended to jewelry design expert and National Artisan Doan Thach Nhu for his professional consultation and technical guidance throughout this study.*

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