

A Study on the Digital Development of Bailuyuan Nijiaojiao, Based on the Guanzhong Culture of Qin

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ABSTRACT

On the Bai Luyuan east of Xi'an, Shaanxi Province, there exists a ceramic whistle that produces a high-pitched and resonant sound. Known as "Bailuyuan Nijiaojiao", this artifact is recognized as a Shaanxi Provincial Intangible Cultural Heritage. Distinct from traditional clay sculptures, the Bai Lu Plain Clay Whistle utilizes locally sourced clay from Whalefish Gully, fired at low temperatures to create a sound-cavity structure that mimics the calls of deer and birds. Originating from the Qin region, this craft carries distinct cultural elements of Guanzhong heritage. To better preserve and promote this tradition, innovative digital development techniques are being applied. Through cultural empowerment theory, user-centered design principles, and technology-integrated innovation strategies, researchers are developing digital cultural products that authentically represent the Bailuyuan Nijiaojiao.

Keywords: Bai Luyuan Nijiaojiao, Digital development, Guanzhong culture.

1. INTRODUCTION

The "Nijiaojiao" (literally "clay whistle"), also known as "Wawashao" and locally called "Shuahuo", is a clay toy shaped through mold-pressing techniques and fired at low temperatures to produce audible sounds. Through extensive field research at the Bai Luyuan Nijiaojiao site in Xi'an's Dizhai area, Shaanxi Province, and in-depth discussions with Liu Xinxia, inheritor of Shaanxi's Intangible Cultural Heritage, we uncovered its origins. According to Liu Xinxia's oral account, prehistoric pottery whistles unearthed at Xi'an's Banpo site over 6,000 years ago are among China's earliest musical instruments. The Bai Luyuan Nijiaojiao traces its roots to single-note whistles excavated from the Banpo site in Xi'an's eastern suburbs. Liu Xinxia demonstrated her replica Banpo pottery whistle, featuring a simple design that produces a single, resonant tone. Both Banpo and Bai Luyuan sites are located in Xi'an's eastern suburbs. The Banpo whistles, dating back to the Neolithic era, were ceramic instruments with a single blowing hole and exhaust port, capable of emitting only one sound. These whistles served as hunting tools to lure prey. Most Bai Luyuan

Nijiaojiao also feature single-note tones, some bright and clear, others rich and mellow, resembling deer calls or bird songs. Thus, Bai Luyuan Nijiaojiao stands as a living testament to Banpo culture.

As times evolve, the Bai Luyuan Nijiaojiao clay sculpture faces multiple challenges. Conversations with inheritor Liu Xinxia revealed both dedication and frustrations. The difficulties stem from two aspects: First, the traditional craftsmanship requires meticulous patience – even a minor mistake could ruin the entire process. Younger generations show diminishing interest in this heritage art. Following the passing of inheritor Elder Xu Wenyue, Liu Xinxia now stands alone preserving this craft, creating a potential cultural gap. Second, the limited geographical reach of Bai Luyuan Nijiaojiao – concentrated mainly in Dizhai Bai Luyuan and surrounding areas – results in minimal market exposure. Its narrow appeal fails to meet modern consumers' diverse demands, leaving it at a competitive disadvantage in the market.

2. ARTISTIC CHARACTERISTICS AND TECHNIQUES OF BAI LUYUAN NIJIAOJIAO

2.1 Artistic Characteristics

Bai Luyuan Nijiaojiao's clay figurines feature a diverse collection of decorative and hanging pieces. Crafted with artistic precision and handcrafted techniques, these figurines showcase a rounded, dignified silhouette, typically measuring 5-15 cm in size. The collection includes human figures, animal motifs, botanical designs, and cartoon characters. Human figures range from mythical deities like the Three Stars of Happiness, Prosperity, and Longevity and the Eight Immortals, to theatrical characters from Qin Opera such as the 10-person ensemble in "Da Luanjia", characters from "Fang Fan" and "Hei Ding Ben", iconic figures from "Journey to the West", and the Terracotta Warriors. Animal designs feature the Chinese zodiac animals, fish, butterflies, deer, and turtles. Botanical elements are represented by gourds, while cartoon characters include the Pleasant Goat and Big Wolf series and Minions.

The clay figurines of Bai Luyuan Nijiaojiao exhibit two distinct forms: single-piece molded casting and double-piece combined-round sculpture. Their color scheme features bold contrasts, embracing the aesthetic of vibrant reds and greens. As descendants of the Qin people who revered black, artisans often apply extensive black pigment during production. Decorative motifs are sometimes gilded, resulting in a glossy, oil-painted finish. Analogous colors are widely employed, creating harmonious variations within unified color schemes. The focus lies in the head and chest areas, where rich hues are concentrated, while the lower body is painted with large color blocks to achieve a balanced simplicity and complexity. Both animal and human figures strike a delicate balance between realism and abstraction, employing expressive techniques to achieve "form and spirit in harmony." When shaping figures, artisans emphasize key characteristics to balance detail and simplicity. For instance, animal figures prioritize the head with shortened limbs reduced to stubby toes, sometimes omitting tails entirely. Human figures are typically depicted standing upright, with refined facial features and flowing clothing patterns that highlight elegance while eliminating superfluous dynamic gestures.

To align with children's toy characteristics, the design and production process are rooted in child

psychology, featuring lively and dynamic shapes. The pitch of the clay's "jiao jiao" sound depends on the positioning of the blowing hole and air outlet: higher placement produces a clear, bright tone, while lower placement results in a deeper, more resonant sound. In recent years, the "Pleasant Goat and Big Wolf" series and Minions designs have primarily catered to aesthetic preferences.

To fulfill people's aspirations, the Fu-Lu-Shou design has been refined. The Lu motif embodies the essence of Wencai Shen (the God of Wealth), symbolized by a golden ingot in hand, representing children's academic progress and steady advancement. This decorative piece serves as a vessel for wishes.

2.2 Techniques

The creation of Bai Luyuan Nijiaojiao (clay whistle) involves three core processes: sculpting, painting, and firing. Key steps include soil collection, clay preparation, mold-making, formwork, shaping, hole formation, sun-drying, firing, and coloring. Craftsmen utilize locally sourced mid-layer soil from Whalefish Gully, ensuring the whistle's clean and safe sound when blown through its mouthpiece. The most challenging part is creating the whistle holes, requiring artisans to master the sound production principles. All tools used for shaping the whistle are handmade by the artisans themselves.

3. BAI LUYUAN NIJIAOJIAO DIGITAL DEVELOPMENT FOUNDATION

In the digital age, integrating the Bai Luyuan Nijiaojiao with digital technology to develop generative digital cultural products holds significant practical value. From the perspective of cultural preservation, digital technology can preserve the production techniques and cultural essence of Bai Luyuan Nijiaojiao in digital formats, preventing the loss of traditional craftsmanship. Simultaneously, through digital dissemination channels, it amplifies the cultural influence of mud call, enabling broader public recognition and appreciation of this folk art. Economically, digital cultural products can expand market reach for mud call, enhance product value, boost local cultural industries, and create employment opportunities. From user demand, these digital cultural products meet modern consumers' needs for personalized, interactive, and

experiential products, delivering innovative cultural experiences.

3.1 *Bai Luyuan Nijiaojiao Questionnaire Survey Data Statistics*

A questionnaire survey was conducted on the digital development of Bai Luyuan Nijiaojiao. Some of the data are as follows:

First, among the cultural connotations users most want to explore, 70.64% of content focuses on production techniques, with practical aspects like clay screening and perforation skills being the core focus. Folklore applications account for 58.72%, highlighting dual attributes of toys and ritual use that reflect users' curiosity about cultural functions. Historical origins make up 46.79%, emphasizing inheritance ties to Banpo clay whistles as a moderate interest in cultural roots. Heritage bearers' stories hold equal importance (46.79%), matching the attention to historical origins. Whistle sound principles receive the lowest attention (40.37%), with limited demand for purely technical content. Users prefer tangible, perceptible cultural elements, with hands-on craft content being the top priority. The dual nature of folklore applications—combining cultural and practical value—makes it the second most popular focus. Historical inheritance and personal stories are equally important, as users seek to understand both "where it comes from" and "who makes it." Purely theoretical content like acoustic principles lacks appeal and needs to be presented through real-world applications.

Second, users identified cultural identity through traditional craftsmanship as the most essential characteristic of Bai Luyuan Nijiaojiao, with clear whistle tones ranking second. Cultural identity (34.86%) emerged as the top priority, reflecting users' emphasis on the product's symbolic value. The clear whistle tone (30.28%) was considered a core functional feature, closely matching cultural significance in importance. Handcrafted warmth (24.77%) was moderately valued, highlighting users' appreciation for artisanal craftsmanship. Natural materials (10.09%) received the least attention, indicating lower priority for material perception. Collectively, cultural identity and core functionality accounted for over 65% of user preferences. The handmade warmth served as a supplementary value, demonstrating recognition of non-standardized production methods. Natural material attributes showed weaker demand, likely

because users prioritize final product aesthetics over raw material characteristics.

Third, among the Nijiaojiao character designs, traditional opera figures remain the most popular choice (2.81 overall score), followed by cartoon characters and cultural merchandise. Folk deity designs receive the lowest preference (2.39). Traditional opera characters dominate as core best-sellers, leveraging their strong cultural identity to become user favorites, making them ideal for digital adaptation. Cartoon characters and cultural merchandise serve as complementary options, catering to diverse audience needs while balancing tradition and innovation. Animal designs gain popularity through consistent acceptance, serving as foundational products to support the product matrix, while folk deity designs act as niche cultural products to precisely reach specific user groups. The design preferences align closely with digitalization demands.

Fourth, the primary concerns regarding the digitalization of Bai Luyuan Nijiaojiao revolve around cultural distortion, followed by high technical barriers and perceived impracticality, while copyright issues rank relatively lower. Cultural distortion accounts for 66.97% of user concerns, making it the foremost worry that significantly outweighs other issues. This aligns with users' prior emphasis on "traditional cultural identity" and "historical roots," reflecting fears that excessive digital innovation might strip Bai Luyuan Nijiaojiao of its intangible cultural heritage essence. High technical barriers (38.53%) tie for second place, highlighting accessibility challenges in digital formats. User demographics span multiple age groups, particularly middle-aged and elderly audiences interested in intangible heritage, who lack proficiency with AR, VR, and AI technologies and fear exclusion from interactive experiences. Practicality concerns (38.53%) mirror technical barriers, as users reject digitalization limited to "curiosity-driven displays." Their focus on practical attributes like "craftsmanship" and "folk applications" indicates demand for tangible value rather than superficial visual experiences. Copyright issues (24.77%) receive the lowest attention, mainly among users of digital collectibles and AI co-creation platforms. This reflects partial concerns about intellectual property protection, though not a core demand. The 11.93% "no concerns" group demonstrates openness to digital innovation, recognizing technology's positive role in heritage dissemination and representing early core audiences for digital transformation. The high

proportion of cultural distortion reveals that digital transformation must prioritize "preserving traditional essence" as its foundation, ensuring all innovations remain rooted in the core of intangible cultural heritage. Addressing dual concerns about technical barriers and practicality, digital formats should balance "low operational complexity" with "real-world value," avoiding excessive focus on flashy technology at the expense of user experience. Different challenges demand distinct digital approaches: cultural distortion requires enhanced integration of traditional elements, technical barriers necessitate simplified workflows, while practicality demands features like knowledge dissemination and interactive engagement.

3.2 Core Digital Development Theory

3.2.1 Cultural IP Empowerment Theory

Cultural IPs serve as the driving force for developing digital products, enhancing their differentiation and cultural symbolism through cultural value and emotional resonance. By delving into historical, regional, and folk cultural cores, we select IP elements with strong communicative power and digital adaptability from traditional symbols, classic stories, and local cultures. Through cultural translation techniques, we transform abstract cultural connotations into visual, perceptible, interactive, and shareable carriers, allowing product functions to embody the value of cultural IPs.

3.2.2 User Center Design Theory

Starting with user needs and pain points, we accurately identify real user requirements and adapt them to specific scenarios. We design features and interaction logic based on actual usage contexts. Through rapid iteration and optimization, we gather user feedback via prototype testing and gray release, continuously refining the product.

3.2.3 Technology Convergence Innovation Theory

By integrating technologies from multiple domains, we break the limitations of a single technology to achieve functional innovation and experience upgrades. Cross-domain technology collaboration enables different technologies to complement each other, avoiding excessive technology accumulation.

4. BAI LUYUAN NIJIAOJIAO DIGITAL DEVELOPMENT STRATEGY

Based on the statistical analysis results of Bai Luyuan Nijiaojiao questionnaire survey, the digital development strategy is specified from the following three aspects according to the core theory of digital development.

4.1 Cultural IP Mining and Transformation Strategy

Firstly, to prevent product homogenization, we will deeply explore the cultural IP of Bailuyuan's clay figure Guanzhong, highlighting its unique core values. Zhang Yiwu suggests that relevant local departments, before introducing cultural IPs, should fully understand the local history and culture, natural resources, and market demand, and select cultural IPs that are in line with these aspects as well as appropriate promotional mechanisms.[1] By transforming the legend of Bailuyuan into a tangible symbol of the white deer, users can quickly grasp its essence.

Second, the core elements of Guanzhong culture are shown in "Figure 1".

The Bai Lu Plain is steeped in rich historical and cultural heritage. As recorded in the Book of the Later Han: Treatise on Commanderies and States, "To the west of Xinfeng County lies the Bai Lu Plain, where white deer were said to appear during the reign of King Ping of Zhou." Legend has it that while leading his court eastward, King Ping witnessed a snow-white divine deer carrying ganoderma mushrooms (a medicinal fungus) descend from the loess plateau encircled by the Ba and Chan rivers. Wherever the deer passed, vegetation flourished, pests vanished, and epidemics disappeared. The locals thus named the plain "Bai Lu Plain" (White Deer Plain).

During Emperor Wen of Han (Liu Heng) 's reign, Chang' an (present-day Xi 'an) served as the capital. His mausoleum, the Ba Ling, is located on the Bailu Plain in Xi' an—where the Bailu Plain Mud Spring originates—establishing it as a significant Han Dynasty imperial tomb site in the Guanzhong region. In 2021, the archaeological excavation of Baling was listed among China's "Top Ten New Archaeological Discoveries." Its unique burial system of "adapting to natural terrain without artificial structures" embodies the Han Dynasty's governance philosophy of "light taxation

and public rest," now standing as a symbolic representation of Han culture in Guanzhong.

Emperor Wen of Han's "Wenjing Era of Governance" featured three core policies: "personal farming of state-allocated fields", "abolition of corporal punishment", and "tax relief". His principle of "rational governance" (as recorded in historical texts: "All decorations at the Ba Ling Mausoleum were made of earthenware, with no use of gold, silver, copper, or tin") aligned perfectly with the "simple and pragmatic" folk customs of

Guanzhong region, providing a profound cultural foundation for the essence of product culture.

The painted pottery figurines excavated from the Ba Ling tombs (including civil officials, attendants, and horses) exemplify the Han Dynasty's sculptural style characterized by "slender figures and simplified drapery patterns", echoing the Bai Luyuan Nijiaojiao's signature "compact, dynamic, and rustic" aesthetic. Moreover, both the Ba Ling chime bells and Bailuyuan Nijiaojiao are musical instruments, sharing profound cultural resonance in their artistic essence.



Figure 1 Folk culture elements of Guanzhong.

4.2 Interaction Strategy

New media technologies such as digital image processing, virtual reality, and augmented reality have changed the existence and presentation forms of intangible cultural heritage.[2] Centered on user engagement, Bai Luyuan Nijiaojiao creates a highly immersive interactive experience through IP, scenario, and technology integration. Leveraging the emotional connection with Guanzhong cultural

IP, it features interactive elements like Nijiaojiao character design and Nijiaojiao chime bell music performances to enhance brand recognition. The platform also facilitates co-creation of IP content, inviting users to participate in derivative projects such as virtual avatar design and digital collectible co-creation.

4.3 Digital Communication Strategy

The first is the campus promotion. It is to develop digital online courses, and conduct popular education on the intangible cultural heritage project of Bai Luyuan Nijiaojiao through online teaching. By leveraging the school's aesthetic education immersion action plan, it is necessary to organize the "Bai Luyuan Nijiaojiao into campus" activities, featuring digital exhibitions of mud call production videos, interactive digital experiences, digital cultural and creative product exhibitions, as well as workshops and design competitions for mud call. These initiatives aim to spark students' interest in China's excellent traditional culture, foster positive values, and cultivate them as potential advocates for intangible cultural heritage.

The second is to utilize social media platforms such as Kuaishou, TikTok, and Xiaohongshu to publish images, short videos, and other content related to Bai Luyuan mud called Nijiaojiao, comprehensively introducing and promoting the artistic characteristics, aesthetics, practical functions, and traditional cultural connotations of the product.

The third is to cooperate with cultural websites and cultural self-media accounts to effectively promote traditional culture among target users who are interested in traditional culture by leveraging their platform influence and user groups.

5. DIGITAL CULTURAL CREATIVE PRODUCT TECHNOLOGY DEVELOPMENT AND REALIZATION

5.1 Brand Design

5.1.1 The Brand Logo of Bai Luyuan Nijiaojiao Reflects the Cultural Characteristics of Guanzhong

The logo captures the essence of Guanzhong culture through its regional symbolism, craftsmanship, cultural themes, and color aesthetics, serving as a visual emblem of the intangible cultural heritage of Bai Luyuan Nijiaojiao and its local traditions.

The white deer emblem in the logo is directly linked to "Bai Luyuan", a core cultural landmark of Guanzhong. The deer antlers and body contours not only reflect the animal's physical characteristics but also echo the cultural origins of Bai Luyuan.

Beyond being a geographical area, Bailuyuan embodies Guanzhong folk legends (such as the story of the white deer protecting the region), becoming a spiritual totem of Guanzhong's historical culture. This regional symbolism transforms the logo into a visual anchor of Guanzhong culture, echoing the intangible cultural heritage roots of "Bai Luyuan Nijiaojiao" originating from Bailuyuan.

As a representative of traditional Guanzhong clay sculpture craftsmanship (inheriting the lineage of Xi 'an Banpo single-tone clay whistles), the Zhongbai Deer figurine embodies a rustic and minimalist style with the rugged charm of folk clay sculptures. It faithfully captures the aesthetic essence of Guanzhong handicrafts- "simplicity revealing ingenuity". This artistic approach aligns with Guanzhong folk art traditions (such as Fengxiang clay sculptures and Huxian peasant paintings), reflecting the enduring heritage of Guanzhong's folk craftsmanship.

The symbolic theme resonates with Guanzhong Nijiaojiao's creative tradition, which centers on Qin opera and mythological narratives. The white deer, as a mythical motif (symbolizing auspiciousness in 'the white deer carrying ganoderma mushroom'), forms part of Guanzhong's folk cultural ethos, echoing Nijiaojiao's folkloric themes.

The design features a brown background with beige-white and brown-toned white deer motifs, beige-white "Nijiaojiao" text, and a red "Bai Luyuan" seal. This color scheme creates an elegant and rustic aesthetic that aligns with traditional intangible cultural heritage, evoking a sense of stability and depth. The contrast between colors also enhances the layered visual composition. The design echoes the earthy essence of Guanzhong's loess land while incorporating symbolic elements of folk traditions. The beige-white tones faithfully reproduce the texture of Nijiaojiao's raw clay, blending rustic charm with ceremonial ritualism. The red "Bai Luyuan" seal not only identifies regional origins but also adds traditional seal aesthetics, reinforcing the brand's cultural heritage.

The emblem masterfully blends traditional elements with contemporary aesthetics—such as merging the iconic white deer clay sculpture with minimalist typography. This fusion preserves the cultural heritage of Guanzhong's intangible cultural legacy while embracing modern sensibilities, showcasing its innovative spirit in preservation. A prime example is Bai Luyuan's clay figurine 'Nijiaojiao' which creatively incorporates cartoon

motifs and Terracotta warrior elements while honoring traditional craftsmanship. ("Figure 2")



Figure 2 Bai Luyuan Nijiaojiao logo.

5.1.2 Digital Avatar Design

Emotional design is an innovative approach to meet this demand, which essentially involves systematically exploring and accurately translating the 'emotional code' carried by intangible cultural heritage skills. This requires integrating theories from multiple disciplines such as art, psychology, and cognitive science to build a systematic framework.[3] For the persona design of the digital avatar, we selected the Han Dynasty as the historical backdrop, closely aligning with the core cultural IP elements of Guanzhong region. The transformation from the white deer symbol to a female figure with antlers on her head, combined with Han Dynasty attire, caters to young audiences' preference for fashionable aesthetics. In terms of visual design, we adhere to human body proportions to enhance the virtual idol's cute anime-style appeal. The iconic antler element ensures users remember key features within three seconds. Color coordination uses pink for warmth and pale yellow for youthful settings, maintaining overall harmony and unity. ("Figure 3")



Figure 3 Digital human image design.

5.2 Generative Digital Cultural and Creative Product Design

5.2.1 The Design of the Integration of Bai Luyuan Nijiaojiao and Baling Chime Cultural and Creative Products

The logo design embodies the essence of logical construction. In terms of morphological symbolism, it skillfully integrates the majestic posture of a white deer raising its head from the folk song "Nijiaojiao" of Bai Luyuan, along with animal motifs, the tile-shaped structure of the Baling Chime, and decorative patterns like the Kuilong dragon, cloud-thunder, and nipple-nipple pattern. This fusion creates a distinctive design where the tile-shaped bell body harmonizes with the white deer holding the bell. The color scheme features the earthy brown of Nijiaojiao as the dominant hue, complemented by golden accents on the deer antlers, exuding elegance and solemnity. ("Figure 4")



Figure 4 Cultural and creative brand logo.

The White Deer Bell Pendant features 3D modeling with three-dimensional effects. Its design integrates the traditional Heva-shaped Chime (bronze chime bells) and white deer motifs. The bell's knob is meticulously sculpted into a reclining white deer, which holds the hanging hole at the bell's top with its head held high. The deer antlers are simplified, while the bell's side features pressed Qin opera mask patterns. Through material craftsmanship, the clay body and black glaze blend with bronze-inspired elements, while the cultural core fuses into "folk ritual music," transforming imperial instruments into carriers of local culture. In interactive scenarios, the Qin opera melody plays in harmony with the white deer's vocal resonance. ("Figure 5")



Figure 5 White deer with bell pendant.

The digital design of the desk ornament set creatively combines the traditional chime bells with the Chinese zodiac signs, blending folk traditions with ritual music. The twelve bells unearthed from the Baling site feature progressively larger sizes, each corresponding to a zodiac animal. Their surfaces are adorned with distinctive Baling chime motifs including dragon patterns, nipple-shaped studs, and characteristic bell edges, all cast in a bronze hue. By leveraging the folk cultural essence of Bai Luyuan's clay figurine "Nijiaojiao," these bells transform from imperial ritual objects into accessible cultural artifacts for local communities to engage with, play with, and pass down through generations. Meanwhile, the figurine itself elevates the cultural significance of intangible heritage by harnessing the bells' historical weight, breaking free from the perception of being merely niche collectibles. ("Figure 6", "Figure 7")



Figure 6 Zodiac dragon.



Figure 7 Zodiac tiger.

5.2.2 Virtual Instrument Design

The game features a virtual instrument called Nijiaojiao, which plays music with distinct Han Dynasty characteristics. By capturing the metallic resonance of bronze chime bells and combining it with the crisp whistle sound of Nijiaojiao, a unique timbre is generated. Following the traditional arrangement of Han Dynasty chime bells, 5-8 virtual Nijiaojiao instruments at different pitches are designed to recreate the chime bell's tonal logic, covering the commonly used Han Dynasty scales and enabling the performance of simple Han Dynasty melodies. Using audio tools to separate "striking sounds, resonance sounds, and tail tones," the spatial reverberation of chime bells is simulated, creating an immersive auditory experience that closely resembles ancient music scenes.

5.2.3 *Personalized Clay Design Platform Development*

The designers are developing a personalized clay figurine design platform for web and mobile devices, integrating AIGC technology and 3D modeling. Digital cultural tourism experience design is not simply the superposition of digital technology on cultural tourism, but an interdisciplinary practice with the core goal of situation generation and emotional recall.[4] Users can input personalized requirements including themes (e.g., Guanzhong folk characters, historical figures, animals), styles (e.g., traditional, cartoon, minimalist), color preferences, and pattern specifications. The AIGC technology automatically generates multiple design proposals based on user inputs. Users can view, modify, and adjust these designs—such as adjusting proportions, changing colors, adding patterns, or even uploading custom sketches. The platform then converts these sketches into 3D clay figurine models using advanced 3D modeling technology.

The platform integrates rich cultural elements of Guanzhong region, providing users with a cultural resource library. When developing cultural tourism IPs, maintaining coordination between cultural heritage and commercialization while innovating communication methods is crucial. Gamification and entertaining strategies prove particularly effective in stimulating public interest. [5] The platform archives diverse content including Guanzhong folk patterns, historical artifact designs, and regional dialect characters. Examples include Qin opera masks, paper-cut motifs, Shehuo folk performance masks, shadow puppet designs, as well as traditional patterns like the Kuilong dragon and cloud-thunder designs found on artifacts excavated from Baling. When creating unique Nijiaojiao clay figurines, users can directly select Guanzhong cultural elements from the library, seamlessly integrating them into designs to highlight the cultural essence and originality of Bai Luyuan Nijiaojiao. The platform also offers cultural knowledge explanations. During product design, users receive detailed introductions to the historical context and cultural significance of related elements, enhancing their cultural immersion experience.

5.2.4 *AR White Deer Plain Bai Luyuan Nijiaojiao Interactive Product*

The designers developed the AR White Deer Plain Nijiaojiao Interactive App. By scanning

specific patterns or scenes on smartphones or tablets, users can overlay a digital Mud Jiaojiao model into real-world environments. This interactive narrative experience employs dynamic design translation techniques, stimulating target consumers' senses through multi-dimensional storytelling and synesthetic responses. The system activates method-based interactions and situational engagement, enhancing user participation and interactive immersion. [6] Users can interact with the AR Nijiaojiao in various ways: touching it triggers traditional Chinese dialect greetings and Qin Opera vocal segments, dragging it changes its position and posture, and even taking photos with it. These features significantly boost the product's entertainment value and interactive appeal.

6. CONCLUSION

The digital development of Bai Luyuan Nijiaojiao is supported by technology, translating the cultural genes of Guanzhong, which is a practice of empowering Guanzhong culture IP, user-centered design and technological integration and innovation. On the basis of maintaining the authenticity of culture, with manual skills as the root digital technology as the wing, it presents multi-dimensional breakthroughs and reconstruction through young digital images, immersive interactive experience and co-creation participation of the public. The digital development breaks the time and space limitations of Bai Luyuan Nijiaojiao with local customs, unlocks the digital path of dissemination and transformation while protecting traditional skills, and radiates charm in the balance between upholding the classics and innovation.

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