Research on Nianzishan Cultural and Creative Magnet Design Based on the Integration of Practical Teaching and Rural Revitalization

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Abstract. Rural revitalization requires cultural products that translate local heritage into usable and market-oriented experiences. Taking Nianzishan District as a case, this study proposes an integrated practical-teaching framework for cultural and creative magnet design, combining field investigation, cultural IP extraction, prototype fabrication, and user evaluation into a closed design loop. The design transforms military industry culture, Jin Great Wall heritage, and seasonal landscapes into a series of magnet products, supported by a prototype-stage magnetic attraction estimation model for structural design. Experimental results show a small deviation between estimated and measured magnetic force under specified conditions, while questionnaire results indicate preliminary positive subjective acceptance in multiple dimensions. The findings suggest that the framework has the potential to support design education and provide a reference for county-level cultural tourism product development..

Keywords: Rural revitalization; Practical teaching; Cultural and creative magnet; Nianzishan cultural IP; Magnetic attraction model; School-local collaboration.

1 Introduction

Rural revitalization increasingly emphasizes cultural identity and public participation, making cultural and creative products an important medium for transforming local heritage into consumer experience [1]. However, many tourism souvenirs remain limited to decorative imitation, lacking systematic cultural interpretation and functional validation, which constrains their long-term value in cultural communication and regional branding [2].

Taking Nianzishan District as a case, this study proposes an integrated practical-teaching framework for cultural magnet design. Refrigerator magnets are selected as carriers due to their portability and everyday visibility, while requiring both cultural expression and structural reliability.

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The proposed approach establishes a closed loop from cultural IP extraction to prototype fabrication, technical verification, and user evaluation, linking cultural interpretation with measurable design parameters to enhance the reproducibility of teaching practice and the credibility of cultural product development.

2 Literature Review

2.1 Cultural Creative Products and Rural Revitalization

Cultural and creative products have become an important medium for rural tourism, regional branding, and heritage dissemination [3]. Existing studies emphasize that successful cultural products should not only reproduce visual symbols, but also communicate place identity through material, function, narrative, and user interaction. In rural revitalization contexts, cultural products can connect local resources with tourism consumption and public memory, creating a bridge between cultural preservation and industrial activation [4].

Nevertheless, current practice still faces two limitations. First, many products select symbols in a fragmented way, resulting in weak cultural hierarchy and low recognizability. Second, the evaluation of product feasibility often depends on subjective judgment, while technical parameters such as material behavior, magnetic force, coating adhesion, and packaging sustainability are rarely integrated into the design process. These gaps make it necessary to construct a more systematic method that links cultural IP extraction with verifiable product engineering.

2.2 Practical Teaching and Product Design Education

Practical teaching in design education emphasizes real tasks, interdisciplinary collaboration, and iterative making [5]. Compared with classroom-based exercises, school-local projects enable students to conduct field research, engage with stakeholders, and test design outcomes in real contexts, extending design beyond visual expression to include cultural analysis, material selection, production, and user evaluation [6].

However, such projects are often limited to short-term display activities, with weak integration of research, production, and evaluation, resulting in outcomes that lack technical validation and market relevance. To address this gap, this study proposes a structured workflow that integrates field investigation, cultural IP translation, magnetic structure calculation, prototype testing, and user evaluation within a teaching-oriented design framework.

3 Methodology

3.1 Field Investigation and School-Local Collaboration

As shown in Fig. 1, the research was conducted in Nianzishan District through field visits, government consultation, tourist observation, and questionnaire collection. The teaching team organized a course workshop and design training process, in which students recorded landscape features, cultural narratives, existing souvenir forms, and visitor preferences. Local government representatives provided information about regional tourism positioning, cultural promotion needs, and possible production channels. These materials formed the basis for cultural IP extraction and product definition.

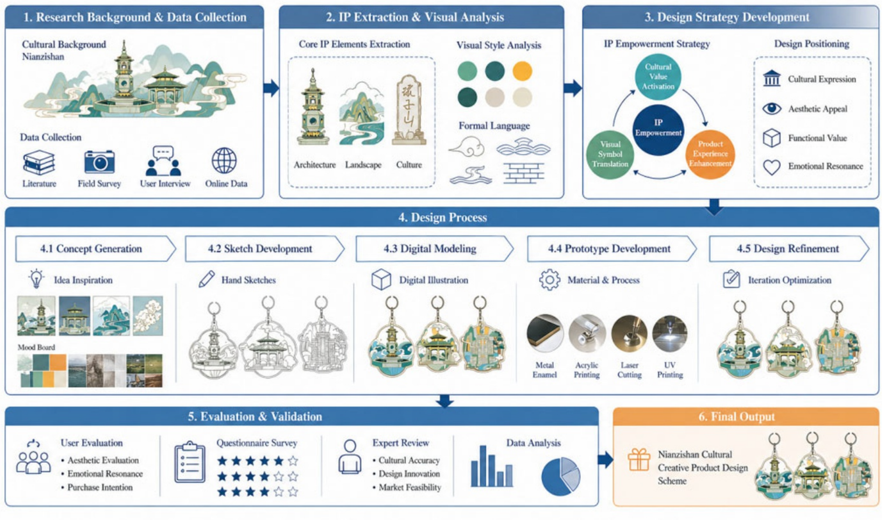

Fig. 1. Workflow of the practical-teaching-based cultural magnet design framework.

3.2 Cultural IP Extraction and Visual Translation

Three cultural IP groups were selected: military industry culture, Jin Great Wall heritage, and four-season natural scenery. The military series emphasizes machinery, industrial memory, and local production spirit. The Great Wall series extracts contours, wall textures, and historical symbols from regional heritage. The seasonal series uses mountain, forest, snow, and color changes to express the ecological image of Nianzishan. To improve visual consistency, the design follows three principles: flattened semantic expression, contour-line mapping, and color quantization. These principles reduce excessive details while retaining cultural recognizability.

3.3 Product Structure, Material, and Magnetic Design

The magnet body adopts polymer resin micro-injection and Maifan stone craft effects to balance lightweight production, tactile quality, and regional material association. Irregular outlines and rounded corners are used to strengthen visual identity and reduce edge damage. Surface graphics are produced through printing and coating processes, while the back structure embeds N35 neodymium magnets. The basic magnet is a flat cylinder with radius r = 5 mm and height h = 4 mm. A slight 0.1 mm protrusion is reserved to reduce the air gap between the magnet and the metal surface.

At the prototype screening stage, magnetic attraction is estimated by the following simplified empirical model:

$$F \approx V \times \rho \times K, V = \pi r^2 \mathrm{h} \tag{1}$$

where V is magnet volume in mm^3, $\rho = 0.0075$ g/mm^3 is the approximate material density, and K = 600 is a calibrated composite coefficient used only for this prototype configuration. In this study, K reflects the N35 neodymium magnet, resin body, coating process, contact geometry, and refrigerator-panel test condition adopted for the sample. It should not be treated as a universal constant, because the coefficient may change with magnet grade, surface coating thickness, steel composition of the refrigerator door, effective contact area, and air gap. With r = 5 mm and h = 4 mm, V = 314.16 mm^3, and the estimated attraction is approximately 1413.72 g, or 1.41 kg. Compared with a product mass of 23 g, the value provides a sufficient design margin for this prototype under the stated conditions.

To prevent sliding on a vertical metal surface, the static condition is expressed as:

$$\mu F \geq mg \tag{2}$$

where μ is the friction coefficient between the contact surface and the refrigerator panel, F is magnetic normal force, m is product mass, and g is gravitational acceleration. Since magnetic force decreases rapidly with air gap, the protruding embedded design is used to control contact distance. Single-magnet and multi-magnet layouts were compared during prototyping, and the single central magnet was selected for small products because it provided sufficient attraction with lower cost and simpler assembly.

3.4 Eco-Friendly Packaging Design

The packaging adopts a molded sugarcane-bagasse shell and soy-ink printing. This choice reduces plastic use and supports the environmental narrative of rural tourism products. The package also includes desiccant treatment to protect the magnet surface during transportation and storage. A simple carbon-footprint estimate is introduced in the teaching process to guide students to consider environmental impact rather than treating packaging only as visual decoration.

4 Experiments and Comparative Analysis

4.1 Experimental Setup

Prototype validation was conducted from four aspects: magnetic attraction, coating adhesion, user acceptance, and teaching/social effect. The mold precision was controlled within ±0.10 mm, and coaxiality was checked with a target value not exceeding 0.15 mm. Magnetic force was measured by a push-pull force gauge under repeated attachment and detachment tests. Surface coating was evaluated using the cross-cut adhesion method. User acceptance was collected through 178 valid questionnaires covering appearance, cultural recognizability, tactile quality, price value, and environmental recognition. The questionnaires were distributed by convenience sampling among university teachers and students involved in practical teaching, visitors contacted during fieldwork, and potential cultural-creative product consumers. Therefore, the survey reflects subjective acceptance rather than actual purchase conversion or observed product-handling behavior. Teaching and social effects were recorded through the number of interns trained, product series developed, and local adoption feedback.

4.2 Main Experimental Results

Table 1. Main experimental and evaluation results.

Item	Indicator	Result	Interpretation
Magnetic force	Measured attraction	1.36 kg	3.5% below 1.41 kg estimate
Product weight	Average sample mass	23 g	Falling safety margin
Coating adhesion	Cross-cut test	4B	Expected durability met
User acceptance	Valid questionnaires	178	Subjective positive feedback
Teaching effect	Practice output	Multiple series	Course and local cooperation

Table 1 summarizes the main validation results. The measured magnetic attraction was close to the theoretical estimate under the tested prototype conditions, indicating that the empirical model can provide useful guidance during early structural design after calibration. The 4B coating result shows that the surface process can meet normal handling requirements. The questionnaire results preliminarily suggest that users responded positively to the combination of regional symbols, compact form, tactile quality, and environmental packaging.

Compared with common market alternatives, the proposed design differs in three aspects. Ordinary tourism magnets often rely on landmark images or low-cost decorative imitation, while the Nianzishan series organizes military industry memory, Jin Great Wall heritage, and seasonal landscape symbols into a coherent local narrative. Purely pictorial cultural magnets emphasize visual recognition but seldom explain production logic or functional reliability; this study adds magnetic-force estimation, anti-sliding verification, coating testing, and eco-friendly packaging into the design workflow. Functional magnetic stickers on the market may provide holding force but usually lack regional cultural storytelling. The proposed product therefore seeks to integrate cultural communication, practical teaching transformation, and daily display function, rather than claiming absolute superiority over all market products.

4.3 Discussion

This study demonstrates that practical teaching can effectively support rural cultural product development when integrated with fieldwork and technical validation. By combining cultural analysis, material selection, structural design, and prototype testing, students engage in a more comprehensive design process beyond visual expression.

The proposed magnetic attraction model serves as a preliminary tool for early-stage design rather than a substitute for precise simulation. Its applicability is limited to calibrated prototype conditions, and the coefficient K may vary with material and structural factors, requiring recalibration in different contexts. In addition, the durability of Maifan stone craft effects under varying environmental conditions needs further verification.

User evaluation is also limited. Questionnaire results reflect subjective perceptions from a convenience sample and lack behavioral evidence. Therefore, findings should be regarded as preliminary. Future studies should include larger samples, controlled comparisons, and long-term usage observations to improve validity..

5 Conclusion

This study proposes a cultural and creative magnet design framework integrating practical teaching with rural revitalization. A closed-loop process was established, including cultural IP extraction, design translation, prototyping, technical validation, and user evaluation.

The main contribution lies in linking cultural narratives with measurable design parameters. The magnetic model and anti-sliding condition provide practical guidance for early-stage design, while prototype testing and user feedback offer preliminary evidence of feasibility. The results also highlight the value of school-local collaboration in design education and cultural tourism development.

Future work will explore AR/NFC-based interaction and further examine life-cycle sustainability and broader applicability of the framework..

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