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Research on the design of campus sustainable development signage system based on intangible cultural heritage symbols—a case study of guangdong business and technology university

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Abstract. In the context of cultural confidence and the safeguarding of Intangible Cultural Heritage (ICH), Chinese universities are increasingly pursuing campus cultural branding, yet many existing wayfinding systems lack regional identity. This study aims to develop a sustainable signage strategy for Guangdong Business and Technology University by integrating local ICH symbols like Duan inkstone and Cantonese embroidery into an upgraded wayfinding system. Guided by semiotic theory, we propose a design framework that translates heritage elements through extraction, abstraction, and system-wide application, ensuring both functional navigation and place-based meaning. The framework was evaluated through a questionnaire survey of 250 students and visitors, comparing perceptions of the proposed design with the current system. Results indicate that the ICH-integrated design performs better across key outcomes, with cultural association improving by 91.1% and visual recognizability improving by 29.3%. These findings suggest that modernized semiotic translation of ICH symbols, combined with sustainable materials and fabrication considerations, can strengthen spatial guidance and cultural belonging, offering a practical and transferable approach for campus wayfinding upgrades.

Keywords: wayfinding signage, intangible cultural heritage, semiotic translation, campus branding, sustainable design

1. Introduction

Excellent traditional Chinese culture is the root of the nation. In the current context of enhanced cultural confidence, Intangible Cultural Heritage (hereinafter referred to as "ICH"), as a treasure of national culture, its protection, inheritance, and innovation have become one of the core national strategies [1]. Under the impact of modernization, many ICH projects are at risk of being lost, while the rise of the cultural and creative industry has provided new approaches for the activation and dissemination of ICH [2]. As an implicit classroom for talent cultivation, university campuses play a significant role in education through environmental design. However, most existing signage systems in domestic universities are overly functional,

highly homogenized, and identical in form, often adopting general traffic signage standards and lacking exploration of regional culture and the spiritual connotation of the campus [3]. Although such designs meet the basic navigation needs functionally, they are ineffective in cultural communication and emotional connection, making the campus space lack uniqueness and failing to stimulate the cultural identity of teachers and students [4]. As a highland for cultural inheritance and a cradle for talent cultivation, the physical space environment of universities is not only a container for teaching activities but also an important part of implicit courses [5]. Environmental psychology theory points out that visual symbols in the physical environment can subtly shape the identity and values of occupants. However, examining the current construction of university campuses in China, there is a widespread homogenization phenomenon of "thousands of schools with the same appearance". With the expansion of higher education and the rapid construction of new campuses, a large number of campus wayfinding systems directly copy the general standards of municipal traffic signage [6]. Although this approach meets basic navigation needs functionally (such as indicating directions and marking buildings), it is pale and speechless in the cultural dimension. For a university like Guangdong Business and Technology University, located in Zhaoqing, a famous historical and cultural city, cutting off the connection between the campus environment and Lingnan culture as well as Duanzhou's cultural context is not only a waste of regional cultural resources but also leads to the loss of genius loci.

1.1. Existing problems

There is an obvious disconnect between current research and practice. On the one hand, the field of ICH protection focuses more on the inheritance of craftsmanship or static museum-style displays, lacking systematic methods to integrate them into modern public space signage systems; on the other hand, although the field of environmental design emphasizes cultural nature, it often lacks the support of quantitative data, and the evaluation of design effects relies more on the subjective intuition of designers, making it difficult to scientifically demonstrate the specific impact of cultural integration on user experience [7]. Users' loss on campus is not only the loss of geographical location but also the loss of cultural belonging. Especially for external visitors, a campus lacking cultural signs is just a collection of cold buildings, unable to form a unique image map. Therefore, this study aims to solve two core issues:

a. How to translate concrete ICH forms such as Duan inkstone and Cantonese gold embroidery into abstract symbols that meet the functional requirements of modern wayfinding systems?

b. How to quantitatively evaluate the actual effects of the new design in terms of visual recognition, cultural association, and navigation efficiency?

1.2. Research objectives and significance

This study aims to explore a sustainable design path for organically integrating local ICH symbols into campus wayfinding systems. Based on semiotics and environmental psychology, it constructs a theoretical framework for transforming ICH symbols into modern wayfinding designs. Through quantitative data, it accurately evaluates the performance of the current campus wayfinding system in four dimensions: visual recognition, cultural association, navigation efficiency, and user satisfaction. Combining characteristic ICH of Guangdong, specific design improvement strategies are proposed. Through empirical research, the effectiveness of the ICH-integrated design scheme in enhancing user experience and cultural identity is verified. The significance of this study lies in that it not only provides an operable paradigm for the cultural upgrading of university campus environments but also opens up new application scenarios for the living inheritance of ICH, achieving the dual improvement of functionality and cultural nature.

2. Theoretical basis and research framework

2.1. Semiotics and modern translation of ICH

The design transformation of ICH has gone through an evolutionary process from rescue protection to productive protection, and then to creative transformation. Early ICH protection was mostly confined to static museum-style displays, disconnected from modern life [8]. ICH is a living cultural asset, and its sustainable inheritance relies on creative transformation and innovative development. From a design perspective, ICH symbols not only carry profound historical semantics but also need to be integrated with modern aesthetics and technical means [9]. Peirce's semiotic triangle theory provides a core methodology for extracting ICH elements, where a sign consists of a representamen, an object, and an interpretant [10]. In campus wayfinding, the sign itself is the representamen, the location it points to is the object, and the cognition generated by users after receiving information is the interpretant. In traditional campus wayfinding, signs often only stay at the symbolic level, that is, words and arrows refer to locations through artificial agreements, lacking inherent connections [11]. The signage system is essentially a visual symbol system that must consider the cognitive habits and cultural experiences of the audience to achieve effective communication of symbolic meaning. Through the modern reconstruction of ICH symbols, their outdated rustic feel can be removed, their core charm retained, and they can conform to modern aesthetics.

2.2. Image map and micro-landmark design

Kevin Lynch proposed in The Image of the City that people construct environmental cognition through paths, edges, districts, nodes, and landmarks [12]. In large university campuses, the wayfinding system should not only be a path indicator but also a micro-landmark; essentially, the wayfinding system is a visual symbol system [13]. Studies have pointed out that wayfinding systems that conform to universal design principles are people-oriented, consider the needs of users from different cultural backgrounds, and use representative graphic elements combined with place characteristics [14]. The wayfinding system helps people locate, navigate, and identify in space through visual communication, and its basic elements include graphics, text, colors, materials, etc. In terms of design principles, information transmission should be accurate and error-free, the form should be concise and clear, and at the same time, it should have coherence and hierarchy [15]. On the one hand, it is necessary to meet users' needs for quickly obtaining information, such as accurately indicating directions and guiding to target locations in a coherent manner; on the other hand, in design innovation, it is also necessary to maintain the consistency between symbols and the environment to avoid being incompatible with the surrounding environment due to excessive uniqueness. Wayfinding signs empowered by ICH stand out in visually cluttered environments due to their unique shapes and distinct colors, becoming images in the memories of teachers and students rather than just backgrounds. This improvement in imageability directly helps enhance the spatial memory and sense of belonging of teachers and students [16].

2.3. Environmental psychology and genius loci

Norberg-Schulz's genius loci theory holds that a place is not only a physical space but also an existence with unique atmosphere and spiritual characteristics [17]. As an important part of the environmental interface, the campus wayfinding system is a key element in constructing genius loci. A campus should not be an undifferentiated space but a meaningful place. Environmental psychology research shows that cultural cues in the environment can trigger situational memory [18]. When students pass by teaching building signs with Duan inkstone textures every day, this repeated visual stimulation will establish a connection with their

academic activities. Over time, the Duan inkstone spirit of "tempering to achieve success" will be internalized into students' subconscious, realizing the ultimate goal of "educating people through the environment".

Based on the above theories, this study aims to achieve the effective transplantation of ICH into campus wayfinding systems at the design level, construct a conversion mechanism between ICH symbols and wayfinding design, and design questionnaires and observation indicators to evaluate the performance of the wayfinding system.

3. Research methods

3.1. Case selection and site analysis

The university was founded in 1996, upgraded to an undergraduate university in 2018, and officially renamed its current name in 2019. The campus covers an area of approximately 800 mu, with a clustered building layout. The main entrance of the campus faces the urban arterial road, followed by the administrative building, teaching area, and living area in sequence; the central square in the middle of the campus connects various main buildings, with the library and gymnasium on both sides, and the student dormitory area is relatively independent in the southeast of the campus. The roads in the campus are divided into ring roads and branch roads, with an overall clear structure but local nodes that are easy to confuse new visitors. In general, the campus space of the university is moderately sized, but the functional areas of the buildings are scattered, and an effective wayfinding system is urgently needed to connect various areas. Through path analysis, we drew a campus wayfinding plan (see Figure 1), marking the locations of main entrances and exits, road intersections, and key wayfinding nodes. This provides a basic basis for optimizing the layout of signs in the follow-up.

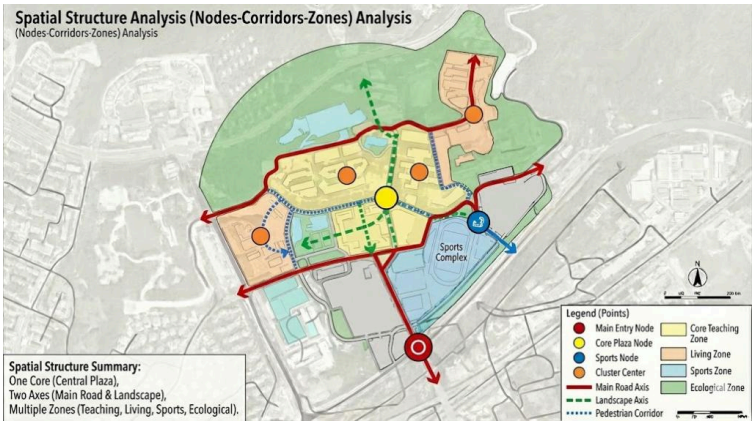

Figure 1. Summary of campus wayfinding plan analysis diagrams

The survey found that the current wayfinding facilities on the campus mainly include name steles at the entrance (as shown in Figure 2), several scattered schematic diagrams (as shown in Figure 3), wall nameplates of teaching buildings and functional buildings (as shown in Figure 4), and a small number of road signs and warning signs (as shown in Figure 5), etc.

Figure 2. Entrance nameplate

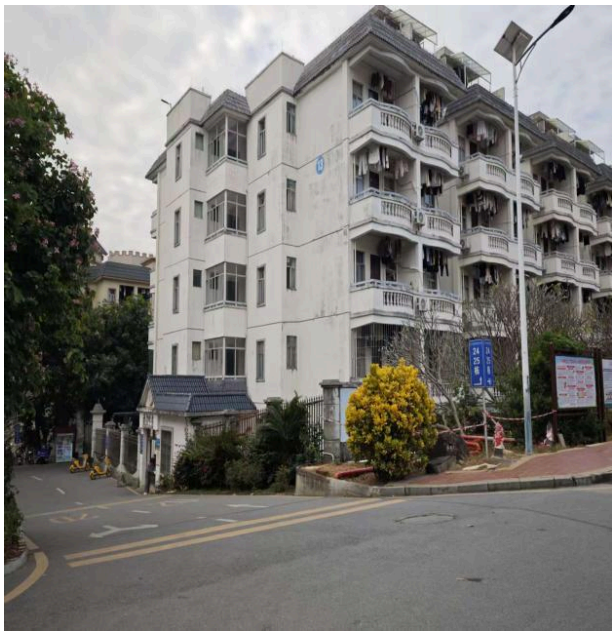

Figure 3. Direction schematic diagram

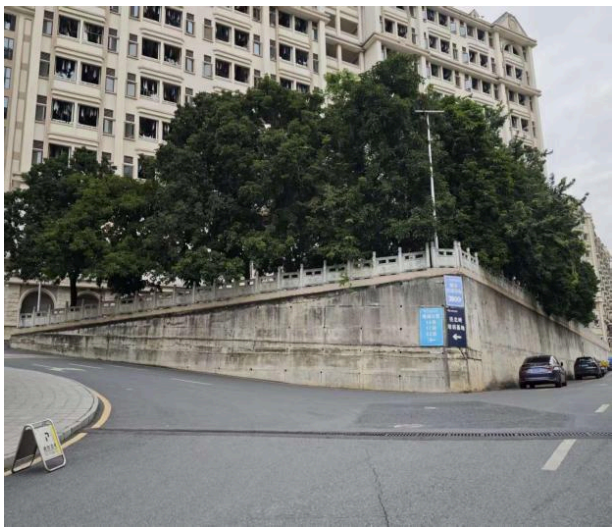

Figure 4. Wall nameplate

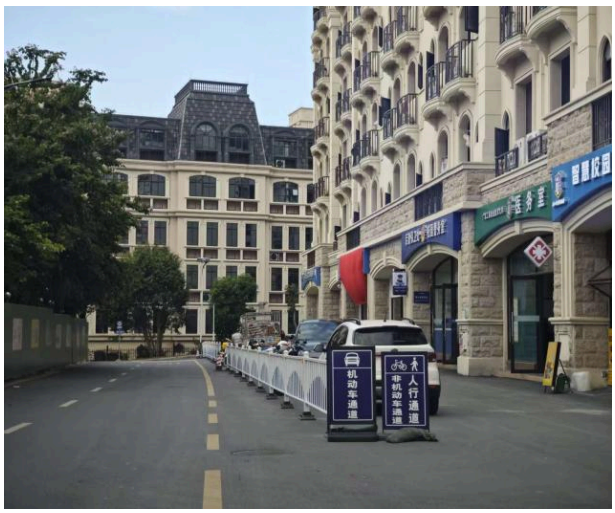

Figure 5. Warning sign

The overall design lacks unified planning, and the style is outdated and monotonous. Through on-site behavioral observation, we also recorded some typical phenomena: during peak class hours, small crowds occur at the intersections of main roads due to unclear guidance; first-time visitors spend time asking for directions; the bulletin board lacks attractiveness in design, so few students stop to read when passing by.

3.2. Extraction of ICH elements

Zhaoqing Duan inkstone, ranked first among China's four famous inkstones, has been a treasure of literati and scholars since the Tang Dynasty. Its stone quality is delicate, and it grinds ink without damaging the brush, endowing it with the Confucian educational metaphor of "bearing virtues and carrying things" and "tempering oneself through study". Duan inkstone is not simply black but dark gray with purple charm. Its shape is mostly

square on the outside and round on the inside, implying being upright in conduct and harmonious in dealing with others. The stone eye is the finishing touch of Duan inkstone (as shown in Figure 6). Duan inkstone is a highly symbolic visual symbol, very suitable for being injected into the university environment as a campus cultural element, implying diligent study, research, and passing on the torch. In the design of the wayfinding system, we extracted Duanxi purple as the main color, used as the background color of signs in the administrative and teaching areas, establishing a solemn and academic tone. The stone eye is extracted as the positioning icon for core nodes, implying adding the finishing touch and focusing attention.

Figure 6. Stone Eye of Duan Inkstone

Cantonese gold embroidery (referred to as "gold embroidery") originated in Zhaoqing. It is an innovative metal wire embroidery craft using metal wire as the main material. Through modeling techniques such as coiling, rolling, jumping, and stacking wires, combined with auxiliary processes such as bonding, welding, curing, and polishing, the works present a stronger three-dimensional sense and gorgeous texture of metal luster (as shown in Figure 7). Cantonese gold embroidery is famous for its full composition, bright colors, and resplendence. In terms of theme expression, it can not only continue the auspicious narratives common in traditional Cantonese aesthetics but also combine with Zhaoqing's regional cultural images, establishing connections between traditional meanings, local symbols, and contemporary expressions. In terms of visual style, Cantonese gold embroidery takes gold as the skeleton, suitable for forming strong contrast and high recognizability through a gold-based tone and an appropriate amount of auxiliary colors; creating a relief-like layering and delicacy through overlapping and linear structures, strengthening the visual semantics of exquisite craftsmanship, three-dimensional gold color, and auspiciousness. As a campus symbol, Cantonese gold embroidery elements can be refined into two types of implementable wayfinding languages. One is golden and exquisite, that is, simplifying the linear textures formed by coiling or rolling wires into borders, dividing lines, title textures, or micro-textures in information areas; the second is auspicious and harmonious, that is, selecting the geometric skeletons of auspicious motifs such as dragons, phoenixes, and flowers for graphic abstraction, which are used as decorative patterns, node landmarks, or cultural wall backgrounds in the signage system, so that the wayfinding system has regional cultural heritage and a friendly campus temperament without overwhelming the main information (as shown in Figure 8).

Figure 7. Gold embroidery thread craft

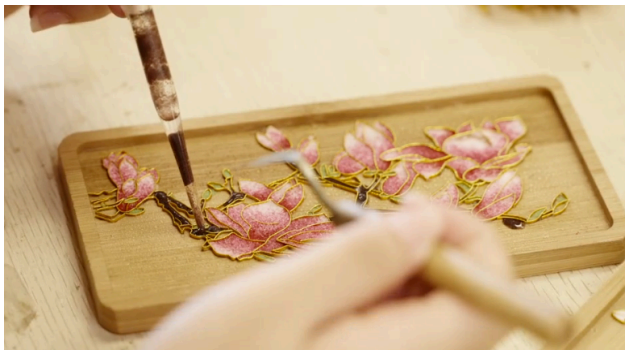

Figure 8. Gold embroidery pattern production process

In the process of symbol selection, we focused on meaning fit and form recognition. Duan inkstone and gold embroidery represent the cultural heritage and artistic essence of Zhaoqing respectively; the former is profound and introverted, while the latter is colorful and magnificent, complementing each other, and can provide main visual elements and auxiliary decorative patterns for the campus signage system respectively. Through discussions with teachers and students, it was learned that Duan inkstone is easy to associate with a rigorous academic atmosphere and profound heritage, while gold embroidery evokes associations with a colorful and passionate campus life. This provides a basis for the accurate use of symbols in the subsequent design.

3.3. Questionnaire design

To quantitatively evaluate the effectiveness of the wayfinding system, the questionnaire content covers four evaluation dimensions: visual recognition, cultural association, navigation efficiency, and user satisfaction. Each dimension examines the respondents' perceptions of the campus signage system from different aspects through several items [19]. The visual recognition dimension focuses on whether the sign shape and information are clear and easy to identify; the cultural association dimension examines whether the presentation of local ICH elements in the signs can trigger cultural resonance; the navigation efficiency evaluates the clarity of the path indicated by the signs and the feeling of time-consuming in finding the way; the user satisfaction comprehensively reflects the respondents' subjective satisfaction with the signage system. The questionnaire is divided into two parts: the first part asks respondents to evaluate the performance of the school's existing signage system in the above dimensions based on their actual experience; the second part shows respondents the renderings and explanations of the new signage system design incorporating ICH symbols, and invites them to make expected evaluations of the new scheme in the same dimensions. Each dimension has 3-5 items, using a 1-5 point Likert scale. The questionnaire was validated for content validity

by three experts in the field of environmental design, and the wording was revised in a small-scale pre-survey [20]. In addition, the questionnaire also includes open-ended questions to collect users' subjective suggestions.

3.4. Sample and data collection

This study selects two groups of people on the campus of Guangdong Business and Technology University: current students and external visitors as research objects. The reason for focusing on these two groups is that, first of all, students are high-frequency users of campus space, who need to frequently use wayfinding signs to move between teaching buildings, libraries, and other places, and have a high degree of dependence on the signage system. At the same time, students have a deeper understanding and emotional bond with the school culture, and are more likely to perceive the campus cultural elements contained in the signs. In contrast, external visitors (including visiting and exchanging personnel, freshmen's parents, and other temporary visitors) are not familiar with the campus environment, so they mainly rely on the signage system when finding routes, and have more urgent needs for recognition and navigation. Their cultural perception mostly comes from the initial impression of the campus, so the signage system is particularly critical for conveying campus cultural information to visitors. There are obvious differences between students and visitors in terms of usage frequency, recognition needs, and cultural background. Conducting research on both groups helps to comprehensively evaluate the applicability and effectiveness of the signage system design for different audiences. Stratified random sampling was used to distribute questionnaires at key nodes such as main entrances and exits, teaching buildings, and canteens of the campus. A total of 280 questionnaires were distributed. During the recovery process, invalid questionnaires with a filling time of less than 60 seconds and all options arranged in a certain regular pattern were excluded [21]. Finally, 250 valid questionnaires were recovered, with an effective rate of 89.28%, including 150 students and 100 external visitors. The sample size meets the requirements of basic statistical analysis. The sample includes 122 males and 128 females, with a roughly balanced ratio, eliminating the potential impact of gender bias on color or graphic perception. This study adopts a repeated measurement design with the same subjects. The same respondent evaluates the existing wayfinding system and the optimized scheme integrating ICH elements in the same questionnaire, thereby obtaining two sets of one-to-one corresponding scoring data.

3.5. Statistical analysis methods

After collection, SPSS 26.0 software was used for data analysis. First, reliability analysis and descriptive statistics were performed on the questionnaire. Then, independent samples t-tests were conducted for each of the four dimensions to compare the evaluation differences between the student group and the visitor group. To test the interaction effect between the wayfinding system design scheme and user type, a two-way analysis of variance was further performed. The results were tested for significance, and the effect difference was judged by the *p*-value. The open-ended questions were classified and coded to extract the design key points and improvement suggestions concerned by users. Finally, combined with quantitative results and qualitative feedback, a comprehensive design strategy was proposed.

4. Data analysis of the current situation of the wayfinding system

4.1. Descriptive statistics of dimensions

Table 1. Measurement dimension verification

Evaluation Dimension	Items	Mean	Standard Deviation	Cronbach's α	Skewness	Kurtosis
Visual Recognition	4	3.21	0.85	0.852	-0.12	-0.45
Cultural Association	3	2.25	0.72	0.821	0.58	-0.21
Navigation Efficiency	4	3.38	0.79	0.843	-0.05	-0.56
User Satisfaction	3	2.80	0.95	0.865	0.15	-0.63
Total Scale	14			0.884		

Note: α is used to evaluate internal consistency; CVI is obtained by expert review

Cronbach's α coefficient was used to test the internal consistency of the questionnaire. The results are shown in Table 1 Measurement Dimension Verification. The Cronbach's α coefficient of the total scale is 0.884, and the α coefficients of each subscale are above 0.82. According to statistical standards, $\alpha > 0.7$ indicates that the scale has good reliability, and $\alpha > 0.8$ indicates excellent reliability. This shows that the questionnaire items designed in this study have extremely high internal consistency, and the data results are reliable.

Through descriptive statistical analysis of 250 valid questionnaires (as shown in Table 1), we found that the existing campus wayfinding system presents an obvious unbalanced characteristic of complete functionality but lack of culture. Cultural Association (M = 2.25, SD = 0.72): This is the lowest score among all dimensions. The skewness (0.58) is positively skewed, meaning that most of the data are concentrated in the low score range (1 point and 2 points). The standard deviation is small (0.72), indicating that the respondents have a high degree of consensus on this issue, that is, everyone agrees that the existing signs have no cultural connotation at all. In the two functional dimensions of Visual Recognition (M = 3.21, SD = 0.85) and Navigation Efficiency (M = 3.38, SD = 0.79), the average scores are slightly higher than the median 3.0, indicating that the existing standardized signs are barely qualified in basic guidance functions, and users can find their destinations through the signs in most cases. It shows that in the university environment, mere functional satisfaction is no longer sufficient to support a high-quality campus experience.

4.1.1. Validity analysis

Table 2. Reliability and validity test of questionnaire data

Index	Value	Criteria
KMO	0.856	0.7
Bartlett's Test of Sphericity	$\chi^2 = 1{,}245.67$	/
	df = 91	/
	$p < 0.001$	< 0.05

As shown in Table 2, KMO = 0.856 (> 0.7) indicates that the sample data has high common factor adaptability; the result of Bartlett's test of sphericity is significant (χ^2 = 1,245.67, df = 91, $p < 0.001$),

indicating that the correlation between variables is significant and the correlation matrix is not an identity matrix. Therefore, the data of this study meets the prerequisite for factor construct extraction, and can provide a reliable data basis for subsequent dimension structure testing and model analysis.

4.2. T-test for differences between students and visitors

Table 3. Differences between students and visitors in the evaluation dimensions of the wayfinding system

Evaluation Dimension	Group	*N*	Mean	SD	*T*	*P*	Cohen's d
Visual Recognition	Students	150	3.24	0.82	0.542	0.589	0.07
	Visitors	100	3.18	0.9			
Cultural Association	Students	150	2.42	0.75	4.861	< 0.001	0.61
	Visitors	100	2	0.61			
Navigation Efficiency	Students	150	3.45	0.76	1.452	0.148	0.19
	Visitors	100	3.3	0.81			
User Satisfaction Evaluation Dimension	Students	150	2.95	0.92	2.603	0.010	0.33
	Visitors	100	2.65	0.88			

Note: $p < 0.05$, ** $p < 0.01$

The results of the independent samples t-test (as shown in Table 3) show that there are significant differences between students and visitors in some evaluation dimensions. The differences in visual recognition and navigation efficiency are not significant ($p > 0.05$), and the effect sizes are very small (d = 0.07) or small (d = 0.19), indicating that the two groups have generally consistent experiences with the basic functions of recognition and guidance of the wayfinding system. In contrast, the difference in cultural association is significant (t = 4.861, $p < 0.001$), and the effect size reaches a medium level (d = 0.61): the student score (M = 2.42) is higher than that of visitors (M = 2.00), suggesting that the cultural information of the existing system is more dependent on the prior cognition of users rather than being actively conveyed through directly decodable visual symbols. At the same time, user satisfaction also shows a significant difference (t = 2.603, $p = 0.010$; d = 0.33), with visitors having lower satisfaction, further reflecting that in unfamiliar usage scenarios, the insufficient overall experience and cultural expression of the wayfinding system will be amplified. Therefore, the subsequent optimization design should strengthen cultural symbols and narrative clues that can be directly understood by non-familiar groups, so as to improve the external expression of the wayfinding system and the comprehensive effectiveness of spatial guidance.

4.3. Analysis of open-ended questionnaires

In addition to quantitative data, qualitative feedback also provides specific improvement directions. Keyword frequency statistical analysis was conducted on the open-ended questions.

"Lack of characteristics" (mention rate 65%): Most respondents believed that the signs are like "highway signs" or "hospital guidance signs". "Sense of loss" (mention rate 40%): Some visitors reported a lack of continuous guidance at complex intersections. "Suggest adding patterns" (mention rate 55%): Users actively proposed hoping to see more graphic elements representing the school or Guangdong characteristics.

5. Design strategies

5.1. Symbol reconstruction

By introducing ICH symbols, we are actually re-concretizing the place. The originally homogeneous and featureless campus space is transformed into a place with a unique style through these highly regionally directional symbols. Wayfinding signs become micro-landmarks on the campus, enhancing the imageability of the space. However, ICH symbols cannot be directly copied and must undergo semiotic abstraction and reconstruction to meet the functional needs of the wayfinding system. We extracted the material texture and color of Duan inkstone to establish an indexical sign. This dark purple thickness points to the geological history of Zhaoqing, the hometown of Duan inkstone, and the research spirit of literati and scholars. When students touch or look at this material, the sign no longer only points to "turn left" but also to the school motto spirit of "bearing virtues and carrying things". The "five-color" system of gold embroidery is transformed into the color coding system of the wayfinding system. For example, the administrative area adopts a calm "dark purple", and the living area adopts a dynamic "vermilion". This color planning not only utilizes the aesthetic value of gold embroidery but also conforms to the regulatory effect of color on emotions in environmental psychology. The vectorization of the kapok pattern in gold embroidery makes it a totemic symbolic sign, strengthening the presence of Lingnan culture (as shown in Figure 9).

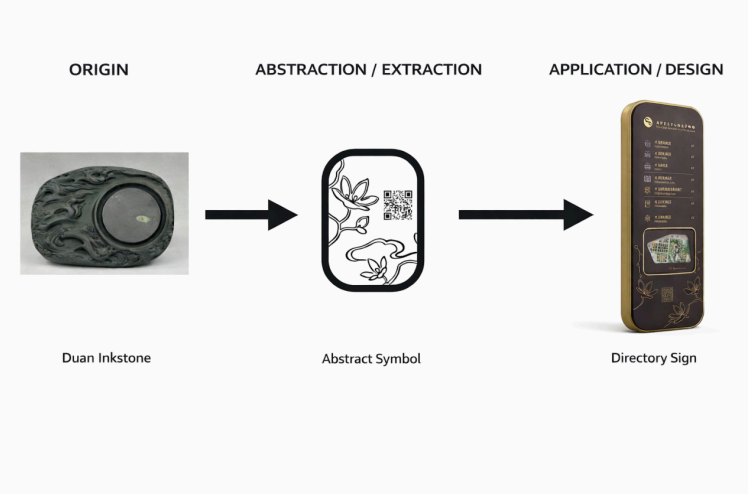

Figure 9. Symbol translation

5.2. Sustainable materials and crafts

In response to the concept of sustainable development, the design scheme abandons traditional acrylic and stainless steel baking paint processes. Recycled bamboo-wood composite materials are selected. Bamboo is a specialty of Guangdong, with a short growth cycle, strong carbon sequestration capacity, and a warm texture similar to Duan inkstone. Laser engraving and color filling technology are adopted to avoid environmental pollution caused by paint volatilization, and the graphic and text information has a concave-convex touch, taking into account the needs of barrier-free design.

5.3. Intelligent interactive experience

To make up for the lack of information in static signs, an invisible QR code is set next to each ICH pattern. When users scan the gold embroidery pattern on the wayfinding sign, the dynamic embroidery process of the

pattern and the cultural story behind it are immediately displayed on the mobile phone screen. It not only realizes navigation but also turns the wayfinding system into a distributed ICH micro-museum, greatly enriching the cultural association.

5.4. Example of the new wayfinding system design scheme

The top of the sign is embedded with the school emblem and name, and the bottom list shows the directions of locations such as the library and service center. The design reflects the characteristics of clear information hierarchy and high visual recognition, integrates with the overall campus environment and architectural style, and enhances practicality and aesthetics. This type of wayfinding sign combines standardized traffic symbols with campus VI elements, facilitating visitors to quickly locate target buildings, and also conveying the standardized image and humanistic care of the campus (as shown in Figure 10).

Figure 10. Example of the new wayfinding system scheme

6. Verification and analysis of the design scheme

To verify the effectiveness of the above design strategies, the research produced high-fidelity prototypes and organized user testing with the same group of people and the same scale ($N = 250$) again.

6.1. Score growth of old and new schemes in each dimension

Table 4 shows that the mean value of cultural association jumps from 2.25 to 4.30, with a growth rate of 91.1%, and the Cohen's d value reaches 2.15 ($d > 0.8$ is a large effect), far exceeding the conventional threshold of $d > 0.8$, which indicates the practical significance of the ICH symbol implantation strategy in improving environmental cultural perception. Compared with standardized traffic signs, the ICH elements translated through semiotics can fundamentally change the user's cognitive framework of the campus space. The large effect size of cultural association indicates that the Duan inkstone and gold embroidery elements implanted in the new design are not weak decorations but core variables that dominate user perception. It completely changes the way users decode signs, from a single functional reading to cultural examination. It confirms that the modern reconstruction of ICH symbols is an effective path to solve the problem of campus cultural homogenization. Secondly, in traditional design concepts, there is often a concern that adding cultural decorations will cause visual interference and reduce the efficiency of information dissemination. However, the data in this study shows that the improvement of visual recognition (+29.3%, $p < 0.001$) indicates that the recognition score of the new scheme has increased instead of decreasing, which benefits from the good contrast between the dark purple of Duan inkstone and the environmental background, and the gold embroidery patterns as auxiliary graphics enhance the visual salience of the signs. This indicates that cultural

nature and functionality are not a zero-sum game but can achieve synergistic improvement. Through reasonable color planning and layout design, cultural elements have instead strengthened the status of signs as figures in the figure-ground relationship, making them easier to be visually captured. Finally, the significant improvement in user satisfaction indicates that teachers, students, and visitors have a high acceptance of this design that combines aesthetic depth and functional efficiency. This satisfaction comes not only from beauty but also from the emotional pleasure and psychological belonging brought by beauty and cultural sense.

Table 4. Comparison of score changes between the old and new schemes in different dimensions

Dimension	Mean of Old Scheme	Mean of New Scheme	Mean Difference	T	P	Growth Rate (%)	Cohen's d
Visual Recognition	3.21	4.15	+0.94	14.52	< 0.001***	+29.3	0.98
Cultural Association	2.25	4.30	+2.05	28.31	< 0.001***	+91.1	2.15
Navigation Efficiency	3.38	4.05	+0.67	10.15	< 0.001***	+19.8	0.72
User Satisfaction	2.80	4.45	+1.65	19.88	< 0.001***	+58.9	1.48

(Note: *** $p < 0.001$)

6.2. Comparison of design scheme effects

Table 5. Analysis of variance results of design scheme effects

Variable	DF	SS	MS	F	P	η^2
Design Scheme	1	310.15	310.15	388.54	< 0.001***	0.44
User Type	1	12.45	12.45	15.22	< 0.001	0.03
Interaction Effect: Design Scheme x User Type	1	1.85	1.85	2.12	0.145	0.004

Table 5 shows that the main effect of the design scheme is significant ($F = 388.54$, $p < 0.001$, $\eta^2 = 0.44$), which means that regardless of who the subjects are, the cultural perception improvement brought by the new design is huge. However, the interaction effect between the design scheme and user type is not significant ($F = 2.12$, $p = 0.146 > 0.05$). This is because there was a significant difference in cultural perception between students and visitors in the old scheme (Table 3), but the disappearance of this interaction effect in the new scheme indicates that the new design has successfully bridged the cognitive gap. This shows that the ICH elements reconstructed through semiotics have universal cognitive value across groups. The shape of Duan inkstone and the color of gold embroidery have become symbols that can be perceived without specific background knowledge. Whether it is students who are familiar with the school history or tourists visiting for the first time, they can equally feel the strong cultural atmosphere from the new signs. It indicates that the design strategy proposed in this study has a high degree of universality and communication effectiveness, realizing the equal transmission of genius loci by ICH culture to every campus user.

7. Conclusion and prospect

7.1. Research conclusions

Although the traditional campus wayfinding system meets the basic spatial navigation needs, it is relatively weak in the cultural communication dimension (cultural association M = 2.25) and shows significant exclusivity to external visitors. The abstraction, vectorization, and color systematization of ICH symbols such as Duan inkstone and gold embroidery can significantly improve various performance indicators of the signage system. In particular, the cultural association has increased by 91.1%, and there is no negative impact on visual recognition; on the contrary, the recognition efficiency has increased by 29.3% by enhancing visual salience, which confirms the feasibility of the dual-excellence model of culture and functionality. The interaction effect analysis shows that the design based on ICH symbols has universal cognitive value, which can effectively eliminate the cultural perception difference between different groups of people on and off campus, making the campus environment an open medium for the living inheritance of ICH.

7.2. Practical implications

For university managers, this study shows that investment in wayfinding systems is not only infrastructure construction but also low-cost and high-efficiency cultural construction. Campus signs should not directly copy municipal traffic standards but should be custom-designed. The design should draw inspiration from the local land and extract local ICH or school history symbols. A post-occupancy evaluation mechanism should be introduced before and after the design, and data should be used to continuously optimize the environmental experience.

7.3. Limitations and prospects

This study only selects one university as a case, with strong sample regionality. Future research can be expanded to universities of different types and regions to verify the universality of the design strategy. At the same time, with the development of the Internet of Things technology, future wayfinding systems should further explore in-depth integration with smart campus systems to achieve personalized and dynamic intelligent guidance. Although this study confirms the significant improvement of visual perception in the short term, there is a lack of longitudinal data support for whether aesthetic fatigue exists after long-term use. Future research can introduce eye-tracking technology to more accurately measure the attention allocation mechanism of users when looking at ICH patterns; at the same time, explore the combination of augmented reality technology and physical signs, transforming static ICH symbols into dynamic digital cultural experiences, and further expanding the narrative boundary of campus wayfinding systems.

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