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Integrating AR Technology with I-Space Theory for Safeguarding Henan's Clay Sculpture Intangible Cultural Heritage

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Abstract

This paper presents a theoretical exploration of how augmented reality (AR) technology can be utilised to safeguard the intangible cultural heritage (ICH) of Henan clay sculptures. Drawing on the I-Space framework from information theory, the study conceptualises ICH as a structured flow of information that can be encoded, abstracted, and diffused through digital means. In response to the erosion of original cultural environments, the paper proposes a model that utilizes AR to support the reconstruction and transmission of ICH in alignment with modern digital ecosystems. Three core challenges — technical encoding, semantic abstraction, and communicative effectiveness — are examined through Shannon and Weaver's communication theory and mapped across the I-Space model. The paper further discusses strategic pathways for enhancing the preservation and dissemination of clay sculpture heritage using AR. While theoretical in nature, this study lays the groundwork for future empirical research that aims to integrate digital technology with cultural preservation, providing new insights for creative multimedia applications in heritage contexts.

Keywords Information Space Theory; Intangible cultural heritage; Clay sculpture; AR technology
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Introduction

Intangible cultural heritage (ICH) has long been a central topic in cultural research, with most scholarly outcomes concentrated within the fields of the humanities and social sciences. However, the effective safeguarding of ICH necessitates interdisciplinary collaboration, particularly between cultural disciplines and science and technology. In recent years, the utilisation of digital technologies has become a critical strategy for supporting the continuity and visibility of ICH (Luo et al., 2025; Zhu,2025; Gao, 2024).

Among technological interventions, digital technologies hold exceptional promise in conserving and transmitting ICH knowledge. UNESCO's "Memory of the World" initiative exemplifies international efforts to protect cultural heritage using appropriate digital platforms, aiming to make such heritage accessible to a wider global audience (Xinhua News Agency, 2021).

Despite ongoing efforts, several key challenges remain. These include understanding the unique characteristics of ICH; developing sound technological and theoretical foundations for its preservation; addressing gaps in the digital processing of ICH content; clarifying the ultimate objectives of safeguarding; and establishing a sustainable international network for ICH conservation (Bai & Tang,2025; Zhang & Xu, 2024). Determining the ultimate aim of ICH safeguarding and identifying optimal strategies for its promotion and re, creation require interdisciplinary collaboration and iterative practice.

In this context, augmented reality (AR) offers significant potential to visualise and simulate ICH elements, and also to embed them in digitally enriched environments for educational and experiential purposes（Hashim, 2022；Hua,2024; Gao,2024）. This paper contributes to the growing discourse on ICH digitisation by adopting a theoretical perspective informed by digital communication models and the I-Space framework from information theory. Through this approach, it explores how AR technology can support the sustainable safeguarding of ICH, specifically, the clay sculpture traditions of Henan province.

This study aims to conceptually examine how AR technologies can support the safeguarding and transmission of intangible cultural heritage (ICH), specifically Henan's clay sculpture traditions, by applying the I-Space framework. By mapping the technical, semantic, and communicative challenges across ICH preservation stages, it offers a structured foundation for future empirical integration of AR within cultural heritage contexts.

Three Issues in the Safeguarding of Intangible Cultural Heritage

The term 'intangible' implies its nature as a form of structured information, i.e. the intangible cultural heritage is a form of information, a body of information organised in a particular form (UNESCO,n.d.). The intangible cultural heritage exists independently of its material carriers, or its value is much greater than the material carriers on which it is stored (Zhao & Gao, 2025). The reason why the safeguarding of intangible cultural heritage is proposed is that with the gradual disappearance or change of the original environment on which it depends for its existence and continuity under the impetus of modern science and technology, intangible cultural heritage, which already lacks a material basis, will easily be extinguished along with the environment, and it will be difficult for people to know about it anymore. The need for safeguarding has therefore become increasingly urgent (Lang et al., 2023; González-Rodríguez et al., 2020).

As a form of information, the safeguarding and dissemination of intangible cultural heritage are inextricably linked, since the basic objective of safeguarding intangible cultural heritage is its continuation and dissemination, as well as its further development on that basis (Chen,2025). The functional techniques related to its dissemination are closely aligned with modern information technologies. The realisation of the transformation of ICH into a form of survival in the new information environment requires the support of information communication theories and technologies. Shannon and Weaver (2003) have identified three types of problems in any communication system.

- Level A problem: How exactly a particular message is communicated.
- Level B problem: How exactly does the message convey the intended meaning?
- Level C problem: How effectively the received meaning influences action in the desired way.

Level A issues are technical in nature. For information to be disseminated on a given technological platform, it must be ensured that the sender and the receiver of the information follow a common protocol. This is the central formalisation issue for ICH, also known as encoding. Because modern information science is based on computer science, the first problem to be solved in the dissemination of ICH information on computer technology platforms is how to transform ICH information into forms that can be recognised by computers, such as how to allow computers to recognise a certain folk dance or a certain folklore. Only after the computer recognises and converts the information into a form that it can handle can it store or disseminate it thousands of miles away. A Level A issue may be conceptualised as a translation problem, transforming ICH into machine, readable formats. The A-level problem focuses on how to solve the time and space resource constraints (Boboc et al., 2022).

Level B issues are semantic issues. It is a secondary problem under the premise of the solution of level A problem. In the case of intangible cultural heritage, the level B problem can be understood as the choice of coding form and the quality of coding. There are various forms of information that can be recognised by computers, so how to choose the most appropriate form of coding for ICH information is the core of the semantic problem. Again, using the analogy of translation, the B-level problem is the choice of language to translate and the rhetorical style to be used.

The C-level question is the "decoding" of the content of the message back into the world of human life, based on a good solution of the A-level and B-level question（M.Callieri et al.,2022). This reverse "translatability" requires that after the Level A and B questions have been addressed, the ICH information should be supplemented by the development of a set of supporting technical tools to achieve the accuracy of the translation and the operability of further innovations.

Intangible Cultural Heritage in a Spatial Framework

For the sake of consistency with the concepts in information science, hereinafter the raw recorded ICH information that has not been processed is referred to as "ICH data", which refers to all the relevant characteristic elements of ICH that can be perceived by human senses in its original state, such as sounds, colours, movements, and the audio signals, video signals, photographs, etc., that have been directly recorded. Intangible cultural heritage information" refers to information that has been processed. As far as ICH is concerned, the difference between data and information lies in the fact that data is a faithful record and a precise expression of a certain physical quantity. Data is only a matter of recording method and recording accuracy, but not understanding and intention, while information is a more understandable form obtained after saving and simplifying the data. For example, recording a certain folk song in both pentatonic and stave is a great simplification and economisation of the data format of audio recording. The way the data is processed incorporates the subjective intention of the processor (Wu,2024), such as professional instrumentalists who consider the pentatonic score to be the most intuitive form of expression, while general folk song lovers may prefer to look at the simplified score.

The conversion process from data to information is an important task for AR technology in ICH safeguarding (Sun, 2023; Fan,2013; Wang, 2024).

Max H Boisot, a British economist, established an "information space" or "I-space" or "I-one-space" model in his study of knowledge assets (Max, 2000). which is a good platform to promote the exchange between scholars of intangible cultural heritage culture research and information technology experts. This paper applies the I-Space model to conceptually analyse various challenges in the digital

preservation of ICH, with a view to enhancing communication and understanding. I-space is a three-dimensional space, as shown in Figure 1.

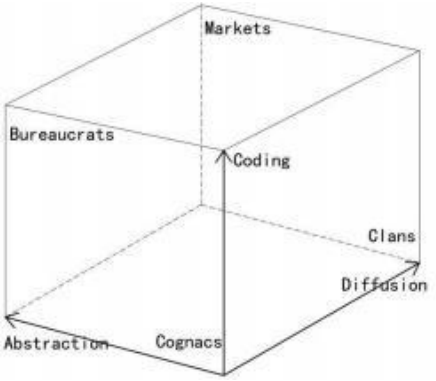

Figure 1. I- Space structure
(Image Credit: Max H. Boisotz's Monograph Information Space)

The three axes of I-space are encoding, abstraction and diffusion. In the context of ICH safeguarding, the degree of encoding is used to measure the extent to which ICH expressions can be recognised by computers, abstraction assesses whether ICH has been appropriately categorised and represented in abstract forms, and diffusion is used to measure the breadth of dissemination, i.e., the extent to which the ICH data has been accessed, understood and accepted.

The I-space is a framework for characterising information, and information located in different regions of the I-space has different characteristics and meanings, the four most important of which are the cognoscenti, the clans, the bureaucrats and the markets.

The Cognac area is located near the origin of I-space, where information is very personal, and its information environment is also personal and difficult to share. The information in Cognac is a product of the individual's spiritual world. Most of the personalised artworks are located in the Cognac area, and modern art has a tendency to be crowded towards the spatial point of origin, which is contrary to the preservation of the Intangible Cultural Heritage. However, the Cognac area is also the most creative area, and most of the creative ideas are born in the Cognac area, and then gradually move to the other areas of the I-Space. The clan area is located in the lower right part of I-space, where information is diffused on a small scale, but only if there is a shared information environment. The Bureaucratic Zone is located in the upper left of I-space, where information has all the conditions for diffusion, or "participation in a transaction," but is artificially controlled, and information products that can be used as objects of transactions, such as software or trade secrets, are located in the Bureaucratic Zone. The market area is located in the upper right part of the I-space, and this is the area where information can diffuse freely. Information not only has the conditions for proliferation, but can also proliferate uncontrollably or even be encouraged to proliferate, as in the case of Internet advertising.

The concept of "market" here refers to the idea that information is traded freely and without restriction, and the information that is traded will flow down from the market area to participate in a new cycle of learning and creation.

The information process of the original intangible cultural heritage is a process from the cognac to the clan, i.e., from originality to the formation of a shared information environment with many participants (both producers and receivers). When the original information environment of intangible cultural heritage changes, it either remains within the clan area or even develops into a market area, or it gradually returns to the cognate area and disappears. Most of the current ICH is located between the Euphrates and the Clans. The closer the intangible cultural heritage is to the Euphrates, the more urgent the need to safeguard it, because the living environment of the information in the Euphrates is very narrow, and it is very easy to disappear or change its essence. For example, some traditional handicrafts are only mastered by a few old craftsmen, which is typical of "cognac ICH". On the other hand, the pressure to preserve ICH in the clan areas is much less, and the shared information environment gives it vitality.

Technical routes for the Safeguarding of Intangible Cultural Heritage of Clay Sculpture in Henan Province

Framing the Case and Bridging from Theory

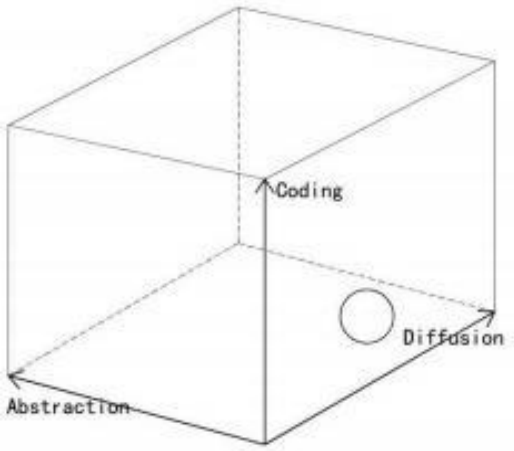

Figure 2. Current Position of Clay Sculpture in the I-Space
(Photo Credit: Author's Own Drawing)

This positioning reveals both strengths and vulnerabilities. While the clan area preserves authenticity and fosters intimate knowledge transfer, it also limits scalability, digital translation, and long-term sustainability. As older generations pass on, and without systemic support, the tradition risks falling into obscurity. Therefore, the challenge is not merely to record this heritage but to

meaningfully reposition it within the I-Space, towards a state of higher abstraction, greater codify-ability, and broader diffusion.

Two possible strategic directions for this repositioning are proposed in the subsections that follow. Each represents a distinct safeguarding path. One prioritises cultural preservation, aiming to protect and revitalise traditions while maintaining their integrity. The other envisions industrial development, seeking to adapt the heritage for commercial viability, design innovation, and broader market exposure. Both routes require deliberate movement across the I-Space, but with different emphases and outcomes.

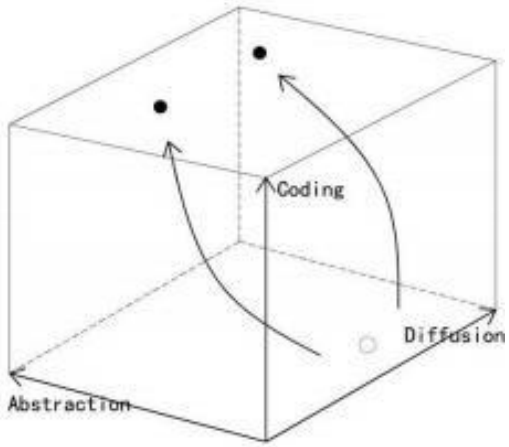

Figure 3. Target Positions for Safeguarding Clay Figurines in the I-Space
(Photo Credit: Author's Own Drawing)

Together, these pathways offer a structured way to think about the future of Henan's clay sculpture heritage. The I-Space model provides the analytical scope, while AR technology offers the practical means for implementation. These paths are discussed in detail in the following sections.

Mapping the Heritage Attributes and Movement Trajectories

To effectively reposition Henan clay sculpture heritage for long-term safeguarding, we must first unpack its current characteristics, both tangible and intangible, through the I-Space model. This means assessing how well the knowledge surrounding the sculptures is abstracted, codified, and diffused. These dimensions serve as the guiding coordinates for plotting a possible trajectory that leads to more sustainable cultural visibility and transferability.

Henan clay sculptures are deeply rooted in local traditions. Each piece carries elements of regional symbolism, crafted with intuitive gestures and subtle storytelling techniques. However, much of this richness remains undocumented or only partially translated into other communicable forms. This

places the sculptures at a low level of codification. Their tactile nuances, symbolic choices, and embedded knowledge, while accessible to practitioners, are often difficult to capture in structured formats that would make them easy to preserve or digitally transmit.

In terms of abstraction, the situation is similarly constrained. There is no widely agreed-upon system to categorise the sculptures beyond surface-level distinctions like form or subject matter (e.g. animals, deities, village life). Their cultural contexts are known locally but are rarely translated into broader interpretive frameworks. Without a shared schema or taxonomic structure, the ability to reframe the heritage for cross-cultural understanding or interdisciplinary reuse remains limited.

As for diffusion, the sculptures do enjoy moderate public visibility. They are featured in local museums, cultural exhibitions, and academic discussions, and are also passed down in some family workshops. However, this reach is often fragmented and tied to specific regions or events. They are not yet part of global digital platforms, educational resources, or mainstream media culture, which means that their diffusion, while not marginal, is relatively confined.

When plotted against the I-Space framework, these attributes place Henan clay sculpture firmly within the Clan Quadrant. In this space:

- Codification is low, as knowledge is passed orally or through demonstration.
- Abstraction is low, due to the absence of formal classification systems.
- Diffusion is moderate, mostly among specific groups, scholars, or cultural event participants.
- From this position, there are two conceptual pathways for safeguarding Henan clay sculpture, each requiring movement along different axes of the I-Space.

The first trajectory involves moving upwards and outward, towards higher abstraction and broader diffusion, by developing a culturally sensitive classification system and leveraging AR technology to share the heritage in new formats. This route favours community preservation, interpretive clarity, and public awareness.

The second trajectory starts with codification, aimed at adapting the sculptures for use in design industries, branding, or educational experiences. Here, the heritage is made “production-ready”, turned into scalable digital assets without necessarily abstracting their deeper meanings at first. Abstraction follows, shaped by use-case demands.

Both routes move the heritage toward the Market Quadrant of the I-Space, where content is systematised, widely accessible, and embedded in global circulation networks. Each comes with distinct opportunities and trade-offs.

Figure 3 illustrates both trajectories, Route A (cultural preservation) and Route B (industrial development), as conceptual movements within the I-Space. Understanding these directional shifts is critical. They offer not just a way to visualise how heritage can evolve within the digital environment, but also help stakeholders anticipate what must change structurally in order for that evolution to succeed. In the following sections, each route will be unpacked in detail.

Route A: Cultural Preservation, Oriented Strategy

The first strategic path envisions a future for Henan clay sculpture that prioritises cultural integrity and knowledge continuity. This route aims to reposition the heritage within the I-Space framework while preserving its identity, narrative richness, and communal roots. Rather than adapting the heritage for industry or commercial design, the goal here is to deepen its abstraction, formalise its knowledge structures, and broaden its cultural reach, all while maintaining fidelity to the original context.

This process begins by addressing the low abstraction that currently limits

interpretive and comparative engagement with clay sculpture. As highlighted earlier, there is no widely accepted system for categorising the forms, styles, or symbolic meanings of these works. Many classifications are informal or based on workshop traditions rather than shared academic frameworks. A concerted effort is needed to develop an inclusive abstraction model, perhaps through community workshops, expert panels, and academic collaborations, that recognises stylistic schools, narrative themes, regional variations, and sculptural archetypes.

This model need not be rigid or prescriptive. Instead, it should allow space for flexibility, community input, and evolving interpretations, especially as new works are created or rediscovered. By establishing higher-level abstraction, clay sculpture can be more easily integrated into cultural databases, school curricula, museum metadata systems, and even digital knowledge graphs used by search engines or artificial intelligence tools.

Once abstraction is strengthened, the next step involves enhancing codification, making the knowledge behind the artefacts easier to transmit and interact with. This is where AR technology plays a meaningful role. Rather than simply displaying a digital replica of a sculpture, AR can animate the cultural process: showing how the figure was sculpted, what tools were used, how colours were

applied, and what each gesture symbolises. These experiences could be layered with oral histories, interviews with artisans, and interactive prompts that allow users to virtually "co-create" a sculpture step-by-step. In this way, codification becomes a narrative and educational experience, not just a technical representation.

The final stage in this route is diffusion. Once abstraction and codification are in place, sharing the heritage becomes more impactful. Rather than presenting clay sculpture as a static artefact in isolated exhibits, it can now be positioned in networked cultural ecosystems, across museums, mobile AR applications, digital storytelling platforms, and immersive learning environments. Users might walk through a virtual village and encounter animated clay figures at significant locations, each telling a part of a larger regional story.

Importantly, this diffusion does not dilute meaning, it extends it. When thoughtfully implemented, digital sharing tools can help preserve nuance while amplifying reach. This is especially vital for engaging younger generations and diaspora communities who may not have direct access to workshops or physical artefacts but still wish to reconnect with cultural identity.

This path, from low to high abstraction, increasing codify-ability, and broadening diffusion, moves the heritage toward the upper-right zone of the I-Space, often termed the Market Quadrant. But in this case, the market is not commercial; it's cultural, an open space for shared access, interpretive growth, and international appreciation. Figure 3 illustrated this target trajectory within the I-Space framework and provides a reference for spatial positioning. By framing the clay sculpture tradition in this way, the cultural preservation route does not freeze it in time. Instead, it treats heritage as living knowledge, something that can evolve, adapt, and be reinterpreted, so long as its core values and narratives are upheld. This model supports both academic inquiry and grassroots participation, offering a sustainable path that balances tradition with transformation.

Route B – Industrial Development-Oriented Strategy

While the cultural preservation route focuses on safeguarding tradition, the second pathway considers how Henan clay sculpture can be reimagined for creative industries and commercial innovation. This industrial development-oriented strategy seeks to reposition the heritage within the I-Space not only for wider access but also for functional integration into design, production, and digital content ecosystems.

This route begins with codification—not as a follow-up to abstraction, but as the entry point. The rationale is practical: in design and industrial contexts, content must first be structured into interoperable formats. Clay sculptures would need to be digitised in high fidelity, their surfaces mapped,

their volumetric data cleaned, and their features segmented for reuse. This could involve techniques like 3D scanning, texture mapping, photogrammetry, or procedural modelling.

AR serves as a vital visualisation and prototyping tool in this process. Designers and developers can use AR to see how a digitised clay figure might look in an interior space, on product packaging, in fashion accessories, or within a game environment. Interactive overlays can highlight design motifs, test colour palettes, or simulate material transformations—allowing rapid iteration before full production. In this context, AR bridges artisanal forms and industrial workflows, without compromising fidelity.

Once codified, the next step is selective abstraction. Unlike the cultural route—where abstraction supports symbolic interpretation—industrial abstraction is about modularity and adaptability. Clay figures might be classified not by regional heritage but by design function: decorative, emblematic, collectible, or symbolic. Categories could be formed based on visual weight, symmetry, motif type, or even

emotional tone (e.g., playful, nostalgic, spiritual). This does not erase cultural meaning but layers new design logic over the existing forms.

This approach allows heritage to move fluidly across platforms and products—appearing in AR-enhanced retail environments, customisable souvenir designs, user-generated filters, or even animation rigs. It positions clay sculpture as a creative asset—something with embedded heritage value but formatted for contemporary reuse. The potential commercial markets include:

- Cultural tourism: AR experiences for heritage towns or themed hotels;
- Retail branding: Limited-edition packaging with interactive sculpture mascots;
- Creative education: 3D model kits for art and design schools;
- Entertainment media: Animated characters or background elements in AR-enhanced storytelling.

With successful codification and abstraction in place, diffusion is the final leap. Unlike the cultural route, where diffusion targets learning and appreciation, here the focus is on distribution and interaction. Digital marketplaces, online design libraries, social AR platforms (like Snapchat Lens Studio or Meta Spark), and even metaverse environments become potential stages for heritage-enhanced content. This is where tradition and trend converge, each influencing the other.

Still, this path comes with real tensions. There's a risk of superficiality or cultural reduction, where motifs are copied without meaning, or figures are stylised for mass appeal. To address this, frameworks for cultural licensing, ethical attribution, and community co-design must be implemented. Just as there are fair-trade certifications for physical crafts, there could be "heritage-authenticated" labels for digital reuse.

Importantly, the industrial development route does not imply cultural abandonment. It treats heritage as a design language, not frozen in a museum but alive in marketplaces, adaptable yet rooted. The outcome may be hybrid, but with the right governance, it can remain respectful. This route also moves Henan clay sculpture into the Market Quadrant of the I-Space, but via a more commercially motivated trajectory:

- Starting with codification,
- Advancing through abstraction,
- And accelerating toward rapid diffusion.

When placed alongside the cultural strategy, this industrial route offers a complementary vision, not a replacement. It caters to different stakeholders, taps into different values, and opens up new roles for AR, not only as a display technology but as a design companion, cultural translator, and economic enabler.

The Role of AR as a Cross-Route Enabler

In both safeguarding trajectories, cultural preservation and industrial development, AR plays more than a supportive role. It acts as a cross-route enabler, uniquely positioned to enhance codification, visualise abstraction, and accelerate diffusion. The adaptability of AR allows it to operate across the entire safeguarding spectrum: from cultural immersion to commercial deployment.

In the cultural preservation route, AR serves primarily as a contextual interpreter. It helps translate layered traditions into accessible, experiential formats. AR can reveal the process behind each sculpture, how clay is prepared, shaped, and painted, through overlay animations or spatial storytelling. It can map oral histories onto physical figures or simulate the environment where these artefacts were traditionally made and used. A similar use of AR has been applied in New Zealand's "Whakaaro" project, where Māori carving traditions are digitally overlaid in museums to convey spiritual context and carving techniques through mobile devices (UNESCO, 2020).

For example, an AR application could allow users to view a sculpture through their smartphone and hear the artisan's voice explaining why a certain motif was chosen. Or it could recreate a festive

village scene, populating it with historically accurate clay figurines in real-world spaces like museums or classrooms. In this way, AR doesn't just digitise heritage, it remediates it, enriching its narrative and keeping it alive in new cultural contexts.

In the industrial development route, AR becomes a design and production interface. It allows creatives to visualise sculpture-derived motifs in real-time environments, testing them in packaging design, interior layouts, or wearable product concepts. For instance, a user might point their phone at a blank T-shirt and see an animated clay guardian figure projected onto it, responding to movement or voice input. These interactions provide instant feedback on form, scale, emotional resonance, and audience response.

AR also supports modularity and co-creation. Design studios could use AR as a collaborative tool for customising sculpture-based elements across multiple iterations. Clients and users might engage with heritage designs through real-time filters, sliders, or gamified inputs, selecting colours, adjusting facial expressions, or adding inscriptions.

Across both routes, AR enhances diffusion not only in reach but in quality. It creates new touchpoints for interaction that were previously impossible, combining visual appeal, interactivity, and contextual storytelling in ways that printed catalogues, static exhibits, or 2D apps simply cannot match.

Moreover, AR applications can be deployed in layered modes:

- Informational (e.g., textual descriptions layered over digital objects),
- Immersive (e.g., spatial reconstructions of heritage scenes),
- Narrative-driven (e.g., animated figures guiding users through a cultural journey),
- Interactive (e.g., user participation in digital sculpting or decision-making).

Each of these supports not just wider access but deeper engagement, a key component of sustainable safeguarding.

Importantly, AR enables feedback loops between user interaction and heritage presentation. Analytics from AR platforms can inform which elements resonate with users, how long they engage, which narratives spark curiosity, and where confusion arises. These insights can help cultural institutions or designers refine their representations and educational strategies, bridging traditional knowledge with data-informed storytelling.

Yet, while AR offers immense promise, its deployment must be guided by ethical, technical, and cultural considerations:

- Ethically, creators must respect the heritage's integrity, credit its origins, and avoid trivialisation.
- Technically, the fidelity of digitisation must be high enough to honour the original's detail and craftsmanship.
- Culturally, communities should be consulted—not only as sources of knowledge but as active partners in design, decision-making, and distribution.

When used with care, AR becomes more than a medium, it becomes a shared space where tradition and technology intersect, inviting new generations to experience, question, and carry forward what came before.

Limitations of the Conceptual Framework and AR Integration

While the dual-route framework and its alignment with the I-Space model offer a structured way to reimagine the safeguarding of Henan clay sculpture heritage, several limitations must be acknowledged.

First, this section presents a theoretical application rather than an empirical study. The proposed safeguarding trajectories, cultural preservation and industrial development, are conceptual in nature. They are not based on field-tested interventions or real-world case implementations involving artisans, communities, or AR developers. As such, while they are grounded in plausible logic and design thinking, the effectiveness of each step remains untested in practice.

Second, the use of the I-Space model, while helpful in structuring information flow and strategic positioning, also comes with constraints. The model assumes that movement along codification, abstraction, and diffusion axes is linear or controllable, which is rarely the case in dynamic cultural ecosystems. Real-life heritage movements are often non-linear, socially negotiated, and influenced by factors that exceed what I-Space can map, such as political agendas, local resistance, or economic instability.

Third, while AR is positioned as an enabler across both routes, it is important to temper expectations. The technical limitations of AR, including hardware accessibility, platform fragmentation, and rendering capacity, can significantly affect implementation. Moreover, digital literacy levels vary widely among target user groups, including both heritage custodians and younger audiences. An AR intervention that seems compelling in design labs may not translate well into rural settings or under-resourced communities.

There is also a risk of oversimplification or cultural distortion. Especially in the industrial route, adapting heritage for commercial use can lead to the unintentional stripping away of context, symbolism, or historical nuance. Codified forms might privilege what is easy to digitise or popularise rather than what is meaningful to the source community. Without robust ethical guidelines and participatory design, this could contribute to cultural commodification.

Finally, these proposals assume a level of institutional support, infrastructure, and policy alignment that may not yet exist. For these pathways to work, collaboration between heritage institutions, technologists, community groups, and design industries is essential. Such collaboration takes time, resources, and negotiation.

These limitations do not invalidate the proposed framework. Rather, they highlight the need for further empirical research, stakeholder involvement, and iterative prototyping. Conceptual clarity is a strong starting point, but the next phase of work must address implementation complexity, community responsiveness, and long-term sustainability.

Level A, B, C - Intangible Cultural Heritage Safeguarding

Building on the I-Space model, this section introduces an additional analytical framework to deepen our understanding of the challenges in safeguarding intangible cultural heritage (ICH) - the three levels of communication identified by Shannon and Weaver. These are:

- Level A – Technical: Focused on how accurately the information is transmitted from sender to receiver.
- Level B – Semantic: Concerned with whether the meaning of the message is properly understood.
- Level C – Effectiveness: Evaluates whether the intended effect or behavioural change has been achieved.

Safeguarding ICH, particularly in a digitally supported context, requires careful attention to all three levels. It is not enough to digitise or visualise heritage, we must also preserve its meaning and ensure it resonates with and influences future users. Below, we explore each level through the lens of Henan's clay sculpture tradition and show how AR technology may support (or fall short of) addressing each one.

Level A – Technical Encoding and Preservation

At this level, the main concern is the accurate transmission of information, how ICH is captured, digitised, and stored in ways that retain its essential content. For clay sculpture, the aspects requiring encoding include its three-dimensional form, colour schemes, and production techniques. These elements can be recorded using digital tools such as high-resolution photography, 3D scanning, or motion capture of the sculpting process. The aim is to preserve the physical attributes and procedural knowledge in stable digital formats.

However, digitisation at this level often captures only surface-level characteristics. It rarely conveys symbolic depth or context unless those are deliberately embedded. As a result, many safeguarding efforts remain stuck at Level A, assuming that technical preservation alone is sufficient. Figure 4 maps out technical solutions including digital scanning, media capture, and procedural encoding.

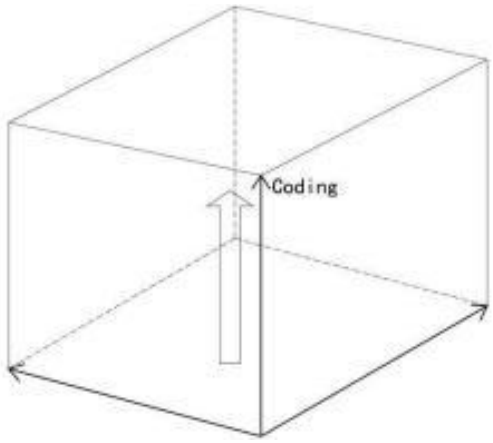

Figure 4. Resolution Route for A-Level Issues in Clay Sculpture Safeguarding
(Photo Credit: Author's Own Drawing)

Level B – Semantic Understanding and Interpretation

The semantic level focuses on the transmission of meaning. It asks whether the recipient understands what the encoded heritage represents, beyond its physical features. The ‘message’ refers to the digitally encoded representation of the sculpture, while the ‘meaning’ corresponds to its cultural and artistic semantics. For example, a sculpture of a tiger may symbolise bravery in a local folktale, or its posture may reference a ritual or historical event. These meanings are often tacit or context-bound, making them hard to extract through digitisation alone.

This is where AR becomes essential. It can add explanatory overlays, simulate contextual scenes, or present user-driven narratives (Hashim et al.,2018. For instance, viewing a sculpture in AR might trigger a story from the artisan’s perspective, or visualise the setting where it was originally displayed.

Nonetheless, interpreting meaning still requires sensitive curation. Misrepresentation is a risk, especially if AR narratives are designed by those unfamiliar with the heritage. Effective safeguarding at Level B demands cross-disciplinary collaboration between technologists, curators, and cultural stakeholders. Figure 5 shows how semantic layers may be added to raw digital artefacts through interpretive abstraction.

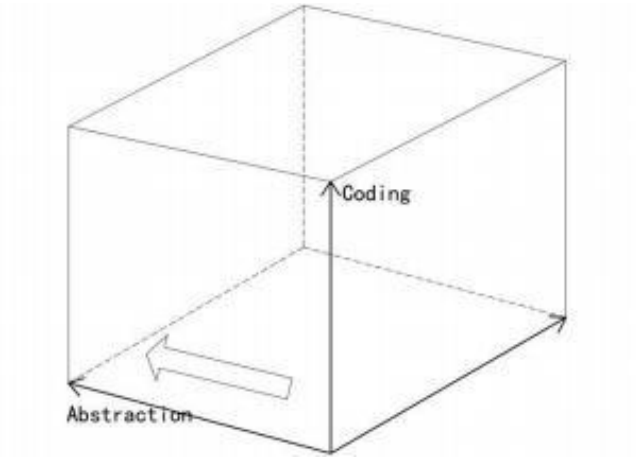

Figure 5. Abstraction Process and the Embedding of Meaning
(Photo Credit: Author's Own Drawing)

Level C – Effective Transmission and Cultural Impact

The third level considers whether the information, once received and understood, achieves its intended effect. In the context of ICH, this means:

- Does the heritage evoke emotion?
- Inspire learning or imitation?
- Reinforce identity or social values?

Decoding may be viewed as a creative reinterpretation informed by encoded abstractions and design frameworks. This could include users building on the heritage—incorporating it into new designs, performing rituals inspired by it, or using it to spark intergenerational dialogue. These are signs of cultural vitality, not just passive observation.

However, Level C is the hardest to measure and support. It involves unpredictable variables: audience background, situational relevance, and emotional readiness. AR can assist by inviting participation (e.g. allowing users to virtually "try sculpting" or remix traditional forms), but true cultural impact often takes time and depends on community involvement. Figure 6 presents examples of audience participation, narrative immersion, and sensory engagement techniques.

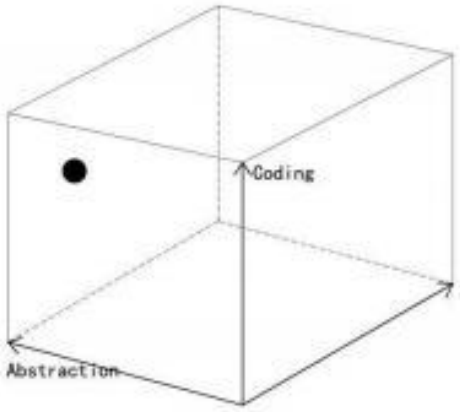

Figure 6. Strategies for Achieving Semantic and Behavioural Engagement
(Photo Credit: Author's Own Drawing)

Movement Across Levels and Loopbacks

Safeguarding ICH rarely moves cleanly from Level A to C. There are feedback loops and recursive processes. For example, a technical encoding at Level A might inspire reinterpretation at Level C, which in turn generates new meaning that must be re-codified. Figures 7 and 8 depict bidirectional pathways for cultural renewal and continuity across communication levels.

The I-Space and the Shannon-Weaver levels overlap here:

- Movement from Clan to Market in I-Space aligns with deeper engagement at Level B and C.
- Movement from low codification to high abstraction supports clearer interpretation and interaction.

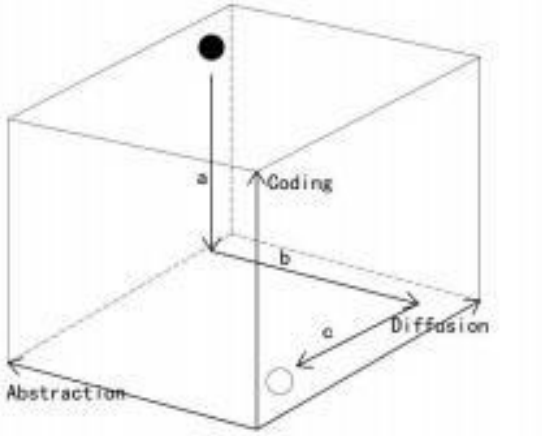

Figure 7. Route for Resolving Level B Issues through Abstraction and Reinterpretation
(Photo Credit: Author's Own Drawing)

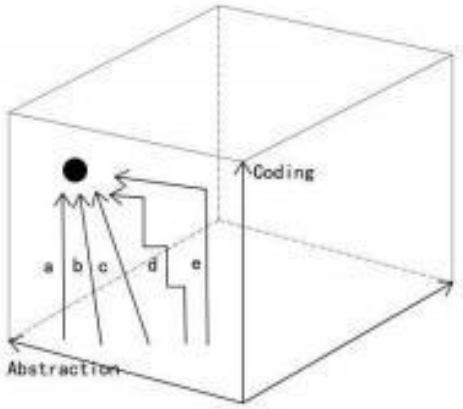

Figure 8. Return from Market to Clan via Feedback and Re-embedding
(Photo Credit: Author's Own Drawing)

Conclusion

The establishment of a reasonable and effective information perspective that is compatible with research in the field of culture and digital technology is the key to the intervention of digital technology in the safeguarding of intangible cultural heritage, and also a channel to promote the communication between cultural workers and technologists. This paper adapts the I-Space model from knowledge management theory to systematically describe the various problems faced by the safeguarding of intangible cultural heritage, and gives a clear technical route. This discussion illustrates the theoretical potential of the I-Space framework to guide future AR-based ICH interventions, contingent upon empirical development.

The safeguarding of intangible cultural heritage is different from the safeguarding of tangible cultural heritage, and the flow of information determines that the safeguarding of intangible cultural heritage needs to establish a dynamic, cyclical and self-constructive system.

To date, much of the research on digital preservation remains concentrated on Level A technical issues, with less emphasis on semantic (Level B) and action, driven (Level C) outcomes. There is a pressing need to extend digital safeguarding efforts beyond data capture—to approaches that also preserve meaning, stimulate interaction, and encourage creative reinterpretation.

The conceptual framework proposed in this paper remains a viable yet abstract approach that requires future empirical validation. Pilot projects, participatory design studies, and long-term ethnographic follow-up will be essential for testing its feasibility and effectiveness in practice. Moreover, partnerships between heritage institutions, local communities, and immersive technology designers will be crucial to avoid one-sided interpretations or unintentional cultural flattening. Figure 9 encapsulates the iterative, feedback-driven nature of ICH safeguarding, suggesting that movements across the I-Space are not one-way but cyclical, adaptable, and context-dependent.

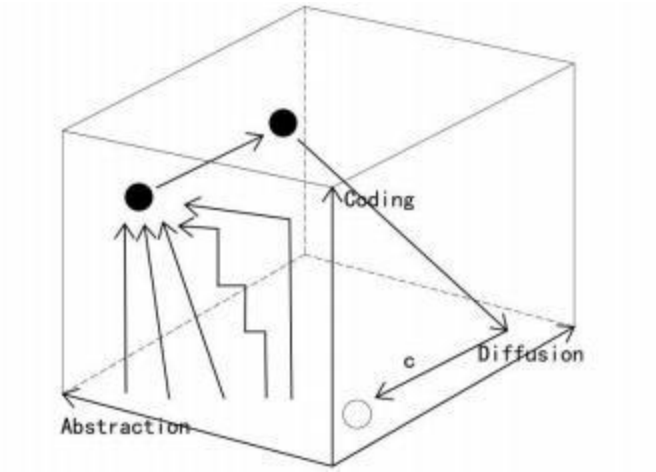

Figure 9. Circular Safeguarding Process in the I-Space
(Photo Credit: Author's Own Drawing)

Ultimately, safeguarding ICH in the digital age is not only a technical task; but also a cultural negotiation. AR and information theory provide powerful tools, but they must be guided by human judgement, ethical sensitivity, and respect for the evolving traditions they seek to preserve.

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