

Curating Chinese Classical Furniture and Interior Furnishings in a Unity3D Virtual Museum: Prototype Design and Pilot Evaluation

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Abstract

Traditional museum displays often restrict Chinese classical furniture to fixed viewing angles, making it difficult for visitors to understand its spatial placement, material detail and interactional qualities. This paper presents a practice-based study of a Unity3D virtual museum for Chinese classical furniture and interior furnishings. The study treats digitisation as curatorial translation rather than simple model transfer: furniture form, screen-based narrative imagery, spatial atmosphere, interpretive media and visitor action are reorganised into a digital museum encounter. The prototype integrates furniture category browsing, 360-degree rotation, zoomed inspection, audio/text interpretation, guided roaming, free roaming, VR viewing and video demonstration. Four forms of evidence are presented: a curatorial and system-composition diagram, production workflow, implementation screenshots and pilot visitor-evaluation results. A formative evaluation with 25 university participants examined six visitor tasks and six experience dimensions. Across 150 task attempts, 135 were completed, giving an overall task-completion rate of 90.0%. Visual clarity scored highest ($M = 4.62$, $SD = 0.28$), while immersion scored lowest ($M = 3.71$, $SD = 0.59$), and roaming was the least completed task (76%). The findings suggest that the prototype supports visual presentation and basic object inspection, but that spatial orientation, interpretive continuity and immersive comfort require further refinement.

Keywords: Chinese Classical Furniture; Interior Furnishings; Virtual Museum; Unity3D; Visitor Experience

1 Introduction

Chinese classical furniture and related interior furnishings are often presented in museums as visually refined but physically distant heritage. Chairs, cabinets, beds, screens and room settings can express craftsmanship, domestic order, ritual practice, elite taste and narrative imagery, yet visitors are usually limited to frontal viewing and short labels. This is not only a problem of display capacity. Furniture heritage is spatial, tactile and relational: its meaning depends on scale, proportion, material surface, bodily use and its position within interior life [1-4].

Digital museums provide one route for addressing this interpretive limitation. Three-dimensional engines can support alternative viewing angles, repeated inspection, guided routes and audio-visual explanation. However, a virtual museum does not become a museum experience simply because models and cameras are assembled in a scene. The central issue is how digital functions translate cultural meaning into visitor attention, learning and participation [5-9].

For Chinese classical furniture, this interpretive problem is especially concrete. Scholarship on Ming and Qing furniture stresses proportion, hardwood materials, joinery, restrained ornament and the relationship between furnishings and interior order [10, 11]. Broader studies of Chinese material culture also show that domestic objects communicated taste, status and bodily practice rather than operating as isolated utilities [12, 13]. A digital museum that presents this material should therefore do more than display attractive models. It needs to make visible how an object is positioned, approached, inspected and understood within a cultural setting.

This study develops and evaluates a Unity3D-based virtual museum prototype for Chinese classical furniture and interior furnishings. The project includes categories such as chairs, flower stands, rose chairs, side cabinets, classical beds, living-room furniture, decorative furnishings and folding screens. It supports category browsing, exhibit information, audio interpretation, rotation, zoomed inspection, guided roaming, free roaming, VR viewing and video-based demonstration. The contribution is not a new graphics algorithm, but a compact design-production-evaluation model for organising furniture heritage as an explorable digital museum encounter.

The article asks three practical questions: how can curatorial principles guide a small-scale Unity3D heritage prototype; what production workflow makes the prototype reviewable; and what does a pilot visitor evaluation reveal about usability, visual legibility, interpretation and immersive comfort? By connecting design rationale, implementation evidence and formative visitor feedback, the study offers a transferable model for small and medium-sized cultural heritage teams developing digital museum prototypes.

The article is deliberately practice-based. It does not claim that Unity3D itself is novel, nor that the prototype replaces conservation documentation or a public museum exhibition. Its value lies in showing how a modest virtual museum can be organised as a curatorial workflow: design principles define the interpretive intention, production steps make the system auditable, screenshots document the visitor-facing result, and pilot feedback identifies revision priorities. This positioning is important for cultural institutions and university teams whose digital heritage work often has to balance limited resources with the need for visible, usable and culturally responsible outputs.

2 Curatorial Design Rationale

Museum experience research emphasises that value is produced through the relationship among objects, interpretation, space, visitors and institutional framing, rather than through information transfer alone [1-4]. This perspective is especially relevant for furniture because a chair, cabinet or bed is both an object and a trace of bodily practice. It carries cultural meaning through material, structure, ornament, proportion and use. Scholarship on Chinese furniture also stresses hardwood surfaces, joinery, restraint, room placement and the relation between furniture and lived interiors [10, 11].

The virtual museum is therefore framed here as curatorial translation. Translation does not mean copying an object into digital form as if the digital version were equivalent to the historical object. It refers to the practical act of reorganising the conditions of encounter: deciding which aspects of furniture heritage should be made visible, repeatable, navigable or narratable. Material texture may be translated through rendering and close-up viewing; form through 360-degree rotation; spatial atmosphere through the virtual hall; and interpretation through labels, audio and visit sequences.

Curatorial translation also helps distinguish between different object types within the same exhibition. Chairs, stands and cabinets benefit from rotation because their value is often expressed through silhouette, side profile, symmetry and construction. Beds and room settings require spatial viewing because the visitor must understand furniture as part of domestic arrangement. Folding screens require a further strategy: the screen is a furniture object, but its cultural meaning may also be carried by painted or narrative surfaces. For this reason, the prototype treats screen-based imagery as an interior-furnishing problem rather than as an unrelated painting display. The digital action changes from simply turning an object to enlarging, reading and contextualising a surface.

This rationale also sets a limit on the claims of the prototype. It is not a conservation-grade digital twin and does not replace physical museums, material presence or human mediation. It is better understood as a complementary digital environment for inspection, orientation, education and dissemination. Its value lies in whether Unity3D functions are accountable to curatorial purposes rather than presented as isolated technical features [6-9, 14].

The six design principles in Fig. 1 should therefore be read as operational criteria. Authenticity concerns the coherence of object form, texture, lighting and spatial placement; education concerns labels, audio and category logic; experience concerns movement, inspection and agency; usability and stability concern whether first-time visitors can complete a route without confusion; sustainability concerns whether assets and media can be replaced; and innovation concerns the careful matching of digital functions to heritage interpretation rather than the pursuit of novelty for its own sake.

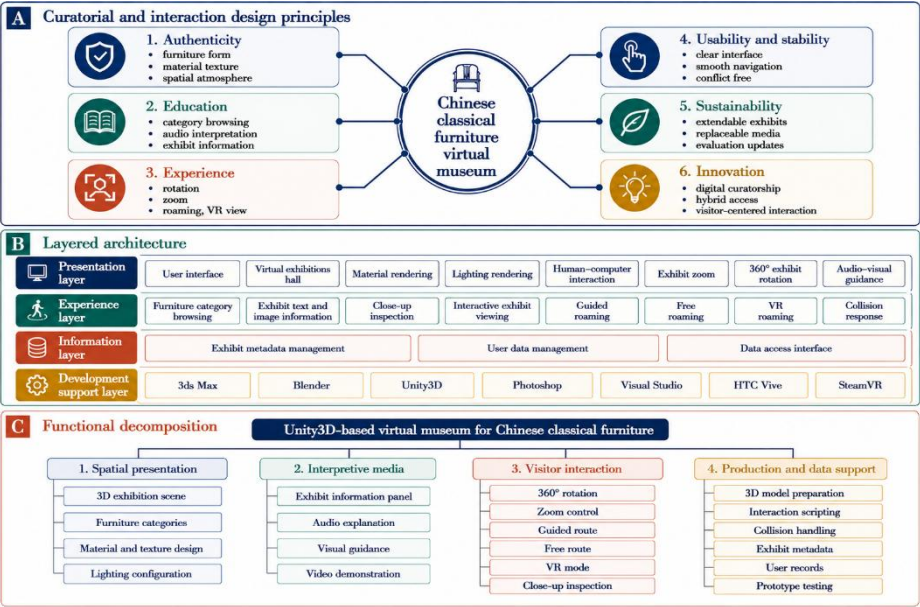


Fig. 1 Design Principles and System Composition

3 Prototype Design and Implementation

A. System Composition

Figure 1 summarises the design logic of the prototype. Six principles were used to connect the cultural characteristics of Chinese classical furniture and screen-based interior furnishings with practical requirements of a Unity3D virtual museum. Authenticity was addressed through attention to furniture form, material rendering, lighting and spatial arrangement. Education was supported through category browsing, exhibit information and audio interpretation. Experience was developed through rotation, zoomed inspection, guided roaming, free roaming and VR viewing. Usability and stability were treated as curatorial concerns because a virtual museum fails as an interpretive environment when visitors become disoriented or unable to inspect the object.

The system was arranged in four layers: presentation, experience, information and development support. These layers connect the user interface, virtual exhibition hall, material rendering, lighting, human-computer interaction, exhibit information, audio-visual guidance, metadata management and Unity3D development tools. This structure positions the engine as curatorial infrastructure rather than a neutral container. Models, labels, audio, cameras, collision boundaries, lighting and visitor routes jointly define how furniture becomes visible.

B. Production Workflow and Visitor Pathway

The production process, shown in Fig. 2, moved from furniture and furnishing asset preparation to Unity-based scene configuration and exhibition-space integration. Representative furniture and furnishing assets were prepared for exhibition use, interaction regions and collision boundaries were configured in Unity, and a wireframe exhibition layout organised circulation,

display zones and object placement. This sequence makes the transition from curatorial principles to working environment visible and reviewable.

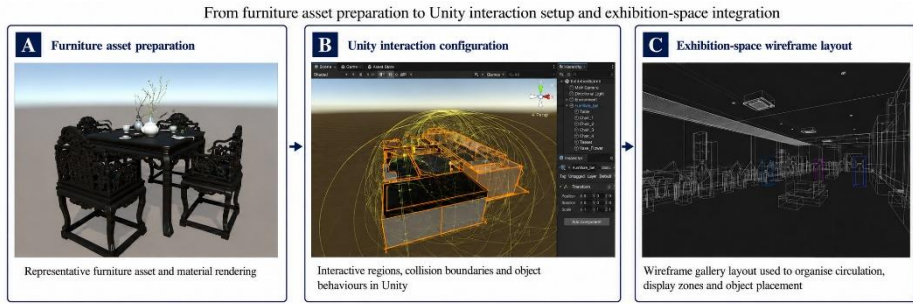


Fig. 2 Production Workflow

In practical terms, the workflow involved four repeated decisions. First, each object or furnishing had to be prepared at a level of detail suitable for exhibition rather than for conservation measurement. Second, the scene required lighting, scale and placement that allowed visitors to perceive an interior atmosphere without making the environment visually crowded. Third, interaction scripts had to connect object selection, rotation, zooming and information display in a way that felt predictable to first-time users. Fourth, the prototype needed a video output because not every reviewer, teacher or public audience member can open the Unity project. The recorded walkthrough therefore became part of the dissemination design, not merely a technical by-product.

The implemented prototype is documented in Fig. 3. Visitors first enter a main interface, browse the exhibition space and select furniture displays. For chairs, cabinets and beds, interaction emphasises rotation, zoomed inspection and spatial placement. For folding screens, which are treated here as screen furniture within the broader interior-furnishing system, the cultural carrier also includes surface painting and narrative imagery; the interface therefore supports enlarged viewing and text-based explanation of the two-dimensional pictorial surface. Visitors can read or listen to interpretive information, move through a guided or free route, and reflect on a remembered feature or cultural impression. The visitor pathway is intentionally simple: enter, browse, inspect, learn, navigate and reflect.

The screen-related panels in Fig. 3 illustrate why the title of the study includes interior furnishings. In a screen display, the structure of the object and the surface narrative cannot be separated. The visitor does not only inspect a wooden frame; the visitor also reads an image-bearing surface that contributes to the object's cultural function inside a room. The prototype therefore uses zoomed viewing and explanatory text to translate the screen as both furnishing and narrative medium. This object-specific strategy strengthens the overall curatorial logic because it avoids applying one uniform interaction model to all categories.

The visitor pathway is organised as a sequence of encounters. Visitors first enter the interface, then browse categories, approach an object or furnishing, change the viewing angle, consult audio or text explanation and finally move through the exhibition space. Guided roaming supports a curatorially ordered first visit, while free roaming allows repeated and self-directed exploration.

This distinction is important because too much freedom may produce disorientation, whereas too much guidance may reproduce the fixed route of a physical gallery. The prototype therefore uses both modes to balance orientation and agency.

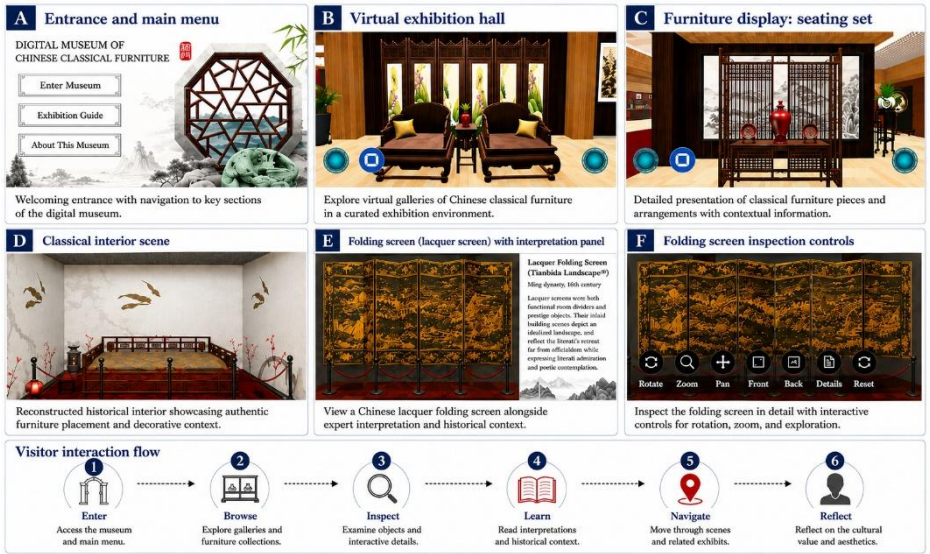


Fig. 3 Prototype Interface and Visitor Interaction

The prototype was designed as a feasible model for university laboratories, educational teams and small or medium-sized cultural institutions. It does not attempt to reconstruct an entire historical house or provide conservation-grade models. Instead, it demonstrates how existing modelling tools and Unity3D can be organised into a coherent digital exhibition when guided by explicit curatorial principles. Video output was also treated as part of the museum communication strategy: even when users do not open the Unity project, a recorded walkthrough can communicate the exhibition sequence, interface, objects and interaction modes.

4 Pilot Visitor Evaluation

A. Evaluation Design

A small-scale pilot evaluation was conducted with 25 voluntary university participants. The sample included eight humanities-related participants, nine STEM-related participants and eight art/design-related participants. The evaluation was formative rather than generalisable. Its purpose was to check whether first-time users could recognise and use the main visitor-facing functions and to identify which aspects of the prototype should be revised before wider deployment.

Each session lasted approximately ten to fifteen minutes. Participants were informed of the purpose and procedure, provided consent, completed a short visit sequence and filled in an anonymous questionnaire. No sensitive personal information was collected. The dataset used for analysis contained disciplinary background, binary task-completion records and dimension-level mean scores.

The evaluation was designed as formative prototype feedback rather than as a confirmatory psychological experiment. Participants were not asked to judge historical accuracy in a specialist sense; instead, they were asked to complete a short visit sequence and report how clearly they could understand, view and navigate the prototype. This choice matches the stage of the project: before a large museum-based study is meaningful, the basic visitor-facing functions must first be tested for visibility, usability and interpretive coherence.

Six tasks were observed: T1 entering the virtual museum; T2 identifying at least two furniture categories; T3 selecting one exhibit and rotating or zooming it; T4 noticing or activating audio/text interpretation; T5 following a guided route or completing a short free-roaming segment; and T6 describing one furniture feature or cultural impression after the visit. The questionnaire used five-point Likert-type items grouped into usability, visual clarity, cultural interpretation, interaction engagement, immersion and perceived cultural value [15, 16].

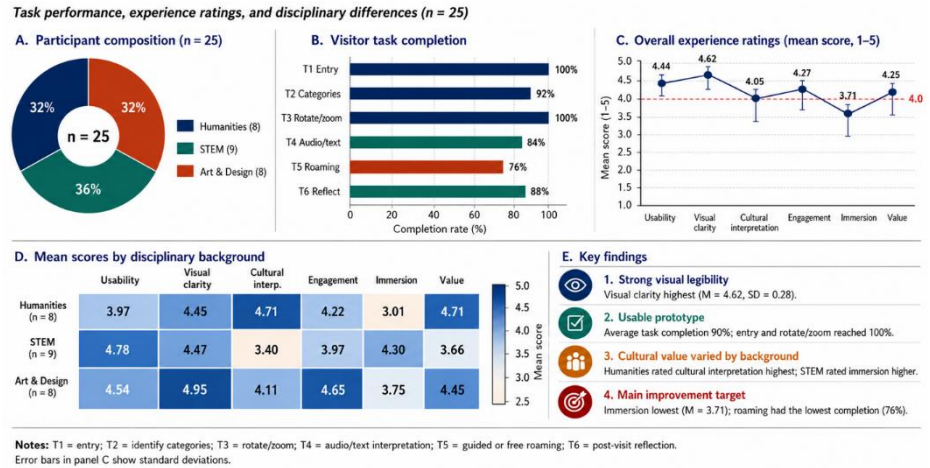


Fig. 4 Pilot Evaluation Results (n = 25). Panel D is descriptive only

B. Results and Interpretation

The results are summarised in Fig. 4. Across 150 task attempts, 135 were completed successfully, giving an overall completion rate of 90.0%. Entry and rotate/zoom reached 100%; furniture-category identification reached 92%; post-visit reflection reached 88%; audio/text interpretation reached 84%; and guided/free roaming was lowest at 76%. This pattern shows that basic access and object inspection were robust, while movement through the virtual environment remained the weakest component.

The rating results are consistent with this interpretation. Visual clarity received the highest mean score (M = 4.62, SD = 0.28), followed by usability (M = 4.44, SD = 0.41), interaction engagement (M = 4.27, SD = 0.37), perceived cultural value (M = 4.25, SD = 0.51), cultural interpretation (M = 4.05, SD = 0.59) and immersion (M = 3.71, SD = 0.59). These standard deviations are reported as descriptive pilot indicators and should be read together with the small sample size and formative purpose of the evaluation. Exploratory disciplinary observations suggest possible differences in what participants noticed, but the subsamples are too small for statistical claims; they are used only as revision

clues for interpretation, interface guidance and visual presentation.

The dimension scores should also be interpreted in relation to the task data. The high visual-clarity score indicates that participants could identify forms and scenes, while the weaker immersion score suggests that presence and movement continuity require further work. The lowest task completion rate occurred in roaming, which points to concrete design problems: route prompts, camera speed, spatial cues and the relationship between guided and free movement. These are not merely interface problems. In a furniture and interior-furnishings museum, movement is part of interpretation because it determines how objects are related to rooms, screens, cabinets and viewing positions.

5 Discussion

A. Museum Complementarity

The study shows that a Unity3D prototype can be reframed as curatorial infrastructure. This matters because digital heritage projects are often described through technological vocabulary: rendering, interaction, interface, database or device support. These elements are necessary, but they do not by themselves explain museum value. In this project, technology becomes meaningful only when it supports furniture browsing, close inspection, spatial orientation, interpretive explanation and reflective viewing.

The first implication concerns complementarity. The prototype should not be understood as a substitute for physical museums. It cannot reproduce material presence, wood smell, real scale perception or the social atmosphere of a gallery. It can, however, provide repeated viewing, 360-degree inspection, controlled camera movement and shareable video demonstration. These functions extend specific forms of attention that physical furniture display may restrict.

B. Object-Specific Interaction

The second implication concerns the digital presentation of furniture and screen-based furnishings. Furniture is quieter than monumental heritage or spectacular narrative reconstruction. Its value often lies in proportion, surface, joinery, ornament, domestic relation and restraint. Folding screens add a related but distinct interpretive problem: they are furniture objects whose surfaces may carry pictorial narratives. The solution is therefore not necessarily more visual spectacle, but object-specific inspection. Rotation and zoom are modest technical operations, yet they become interpretively important when they direct attention to contour, symmetry, construction, room placement and, in the case of screens, narrative surface imagery.

C. Revision Priorities and Future Work

The pilot results also convert a general judgement of digital experience into concrete development priorities. The prototype should retain its visual legibility and basic interaction strengths, but future work should improve route prompts, camera speed, spatial cues, audio/text integration and comfort in VR or roaming modes. Roaming should be treated as a curatorial issue, not only an interface issue, because movement is the mechanism through which visitors

relate furniture objects to interior space.

This documentation logic is also useful for museum management. A prototype can look visually complete while still failing in orientation or interpretation. By combining workflow evidence with visitor tasks, the study provides a basis for deciding where limited development effort should go. The results suggest that refinement should focus less on decorative effects and more on clearer wayfinding, better integration of audio with visual attention, smoother camera control and stronger prompts that help visitors know what to inspect. These revisions would make the system more robust for teaching, exhibition preview, online dissemination and future public testing.

A further implication concerns sustainability. Many digital museum prototypes remain difficult to maintain because assets, labels, audio files and scene decisions are stored as undocumented project fragments. The present study separates design principles, workflow, implementation evidence and evaluation results so that future updates can be made without losing the curatorial rationale. For example, a new furniture category could be added by following the same chain: clarify the interpretive feature, prepare the object or scene, define the appropriate interaction, document the visitor-facing result and collect feedback on whether the function supports understanding.

Several limitations remain. The prototype uses selected furniture categories and available digital materials; it does not provide conservation-grade documentation. The evaluation used a convenience sample of 25 university participants rather than a museum-based public sample. The study also reports task completion and dimension-level scores rather than full item-level psychometric validation or thematic analysis of open comments. Future work should expand object metadata, compare desktop, video and VR modes, include broader visitor groups and integrate stronger prompts for cultural interpretation.

Future work should therefore proceed in three directions. The first is content expansion: object metadata should include names, periods, materials, construction features, room placement and interpretive notes. The second is interaction refinement: different object types should receive different inspection modes, especially ordinary furniture, interior scenes and screen-based narrative surfaces. The third is evaluation expansion: a broader public sample should compare desktop, video and VR access, while qualitative comments should be thematically analysed to understand what visitors actually remember after the experience.

6 Conclusion

This paper has presented a Unity3D virtual museum prototype and pilot visitor evaluation for Chinese classical furniture and interior furnishings. The study began from a curatorial problem: fixed-angle physical display often makes furniture difficult to understand as material, spatial and bodily heritage. It then translated this problem into a design-production-evaluation chain composed of curatorial principles, system structure, workflow documentation, implementation evidence and visitor feedback.

The pilot evaluation indicates that the prototype is strongest in visual clarity and basic usability, but weaker in immersion and roaming. These findings are preliminary, yet they provide a clear revision agenda: retain visual and object-inspection strengths, enrich interpretation, improve route guidance and strengthen spatial continuity. The study contributes a practical model for

small-scale digital museum projects that seek to present traditional material culture through manageable tools, explicit curatorial logic and formative visitor evidence.

Overall, the study contributes a transferable model for small-to-medium digital heritage projects. It shows that a virtual museum can be evaluated not only by technical completion, but by whether its functions are accountable to curatorial purpose. For Chinese classical furniture and interior furnishings, the most important digital question is not simply how to render objects, but how to help visitors inspect form, follow spatial relations, understand screen-based narratives and connect individual artefacts to the cultural logic of interior life.

DECLARATIONS

Ethics Approval and Consent to Participate

The pilot visitor evaluation was conducted as a low-risk prototype feedback study with voluntary adult participants. Participants were informed of the purpose and procedure before participation, and informed consent was obtained. The anonymised dataset contains no sensitive personal information, biometric data or personally identifying responses.

Conflict of Interest

No potential conflict of interest was reported by the authors.

Dataset to Be Available

The prototype video, screenshots, anonymised pilot evaluation dataset and analysis materials are available from the corresponding author upon reasonable request.

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