



Video Projection-Mapping on Box Structures: Techniques and Applications for Immersive Storytelling

Tombak Matahari^{1*}

¹ Visual Communication Design Study Program, Faculty of Engineering and Technology, Sampoerna University,
Jakarta, Indonesia

*Corresponding email: tombak.matahari@sampoernauniversity.ac.id

ABSTRACT

This study examines the effective application of video projection mapping to box-shaped structures, creating immersive storytelling experiences within exhibition environments. The research aims to address both technical and design-related challenges—such as positioning projectors, minimizing shadows, and accurately aligning visuals—while also exploring how narrative development, motion graphics, and typographic choices impact viewer engagement. The project is grounded in a practice-based approach, using the new Indonesia Nusantara Presidential Palace as a case example. A two-minute audiovisual sequence was developed to tell the architectural story through a combination of motion graphics, voice-over, and spatial projection. Findings suggest that box structures offer unique potential as portable storytelling media when paired with carefully executed visual and audio elements. Despite testing the current implementation on a small scale in controlled settings, the approach holds promising implications for mobile exhibitions and modular display formats. This work contributes to exhibition design by offering a flexible and replicable method for integrating spatial media and storytelling on volumetric forms.

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1. INTRODUCTION

This research aims to examine how video projection mapping can be applied to box-shaped structures as a storytelling tool within exhibition environments. It focuses on identifying practical solutions for projector placement, reducing shadow interference, and achieving precise surface alignment. At the same time, it explores how visual storytelling elements such as motion graphics, narrative flow, and typography can be optimized to create engaging and accessible content. By applying a practice-based approach through a real-world case study, this research also demonstrates how such structures can function as flexible, mobile exhibition media that support immersive experiences (Moon, 2023).

Reflecting on its early applications helps us understand the evolution of projection mapping. One of the most iconic examples emerged in 1969 when Disney introduced projection techniques in their Haunted Mansion attraction at Disneyland. As shown in **Figure 1**, the ride featured numerous optical illusions, notably five singing busts known as the 'Grim Grinning Ghosts.' Through projection mapping, videos of actors singing were projected onto these busts, creating the compelling illusion of animated, lifelike characters. Since then, projection mapping has gained popularity because it enables versatile and impactful visual experiences across various fields, including entertainment, advertising, art installations, and, in particular, exhibition design.

In the entertainment industry, projection mapping has significantly enhanced live performances and interactive installations, resulting in more engaging and memorable audience experiences (Derkach et al., 2023). Similarly, advertisers employ projection mapping to project dynamic brand

narratives onto architectural structures, capturing public attention through innovative visual storytelling methods (Wai, 2023).

In artistic contexts, video projection mapping has emerged as a powerful medium that merges traditional artistic expressions with cutting-edge technology, creating immersive and emotionally engaging art forms (Pahrulroji & Soeteja, 2024). Video projection mapping is a transformative tool, particularly within exhibition design, converting static exhibition spaces into vibrant narrative environments that foster meaningful audience interactions (Ioakeim et al., 2021; Yuan & Alizadeh, 2024). In our experience, this method has shown highly effective in narrating complex cultural and historical narratives, bridging traditional storytelling methods with modern interactive approaches (De Paolis et al., 2022).

In addition, the power that transforms projection mapping in exhibitions offers them amazing ways to present complex narratives and interactivity differently from traditional media.



Figure 1. 1969 Disneyland Haunted Mansion (Source: Disney Information Station), (Taken from: <https://www.wdwinf.com/disney-world/magic-kingdom/haunted-mansion.htm>)

The concept of world-building serves as a foundational framework in immersive storytelling, facilitating the creation of engaging narrative spaces (Breuleux, de Coninck, & Therrien, 2019). As projection mapping evolves in every creative field, we

can expect its most profound impact on immersive storytelling, which is becoming a critical aspect of contemporary visual communication. Exhibitions underscore their importance as crucial tools in contemporary visual communication and immersive design practices (Breuleux et al., 2019).

Due to its ability to capture audiences, create emotional connections, and facilitate a deeper understanding of complex narratives, immersive storytelling has become one of the cornerstones of visual communication today, as illustrated in **Figure 2**. Unlike traditional storytelling methods that rely mainly on passive observation, immersive storytelling actively engages audiences, allowing them to feel present within the narrative environment (Breuleux et al., 2019). This active participation enhances audience retention and emotional resonance, creating memorable and impactful communication experiences (Yuan & Alizadeh, 2024).



Figure 2. Immersive Graphics space (Source: teamLab Forest Fukuoka, (Taken from:<https://www.teamlab.art/jp/e/forest/>)

One example is innovation in digital media and interactive technologies, which have dramatically expanded the potential of immersive storytelling, enabling storytellers to craft rich and nuanced narratives through multisensory experiences. As a result, immersive storytelling is increasingly recognized as a powerful tool in fields ranging from education and cultural heritage

preservation to entertainment, marketing, and, notably, exhibition design (Ioakeim et al., 2021; De Paolis et al., 2022).

Integrating immersive storytelling and video projection mapping has transformed contemporary exhibition design, creating visually engaging and narratively compelling environments. Through the effective use of projection mapping, exhibitions can convey intricate stories and detailed information more clearly and interactively than traditional displays, significantly increasing visitor engagement and understanding (Derkach et al., 2023).

Engaging visual communication not only captures consumer attention but also facilitates a more straightforward and quicker understanding of the message, thereby enhancing overall impact (Manic, 2015). In this context, box structures offer mobility and cost efficiency, allowing exhibitors to easily move installations and reduce setup costs. Compared to standard projection mapping, which typically projects onto a single flat surface, box structures can display visuals on two or more angled surfaces. Even with just one projector, this setup creates a different and more engaging visual experience. The angles between surfaces add depth and make the projection feel more dynamic and unique. While large-scale projections may look impressive, they are often fixed in place and expensive to set up. Box structures, on the other hand, provide more flexibility and can be reused in different spaces. By transforming these simple forms into storytelling tools, designers can create immersive environments that emotionally connect with the audience and generate lasting memories (Pahrulroji & Soeteja, 2024).

These boxy forms provide a novel approach to constructing immersive narrative environments by repurposing existing storytelling spaces. However,

these structures come with their technical challenges. Since only one projector can be installed, we must contend with issues such as shadow casting, uneven illumination, and difficulties in precisely aligning projected visuals to edges and corners. While acknowledging these challenging geometries, this research also targets the implementation of projection mapping onto box-based installations, specifically to communicate architectural narratives.

Because of their practical advantages, they primarily enhance mobility, modularity, simplicity, and flexibility in layout design. Their geometric simplicity allows easy transportation and quick setup for exhibitions or installations, making them highly adaptable across various settings. As shown in the proposed design (see **Figure 3**), the modular box-based booth supports easy setup and transport, offering defined surfaces ideal for projection in mobile exhibition environments.

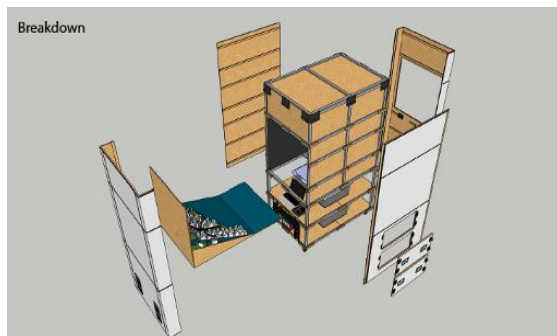


Figure 3. Proposed booth design, highlighting the modular and practical advantages of box structures in exhibition contexts

2. RESEARCH METHODOLOGY

Employing a practice-based research methodology, this paper explores the potential applications of video projection mapping on box structures as a new medium operating within exhibition spaces, creating immersive narrative experiences and a new portable medium

for exhibitors. The steps in the methodology are as follows:

2.1. Contextual Framing and Problem Identification

The first step of the study was to identify a flaw in projection mapping as it is currently practiced: its reliance on box structures. Projection mapping is often used on flat surfaces or large buildings. However, it poses specific technical and spatial challenges for box-like structures, such as edge warping, corner alignment, and shadow interference. The box form was chosen for its potential as a small-sized storytelling tool and for its utility in modular display design.

2.2. Projection Setup Experimentation

The team conducted multiple projections using study measurements to address the optical and spatial challenges. At this stage, the following optimizations were made:

- The projector was positioned and angled for optimal viewing.
- Overall brightness and surface coverage.
- Shadow minimization.
- Calibration of edge blending and alignment.

These tests informed the selection of the optimal projector configuration (Option B), as illustrated in **Figure 4**, which offered the most effective coverage with minimal shadow artifacts.

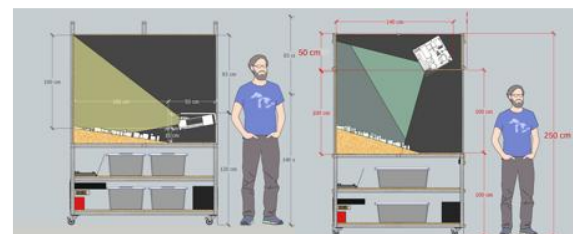


Figure 4. Projection study to optimize the covered area and minimize the shadow

As shown in **Figure 4**, one of the issues that needs to be addressed is the shadow cast by the projection.

2.3. Narrative Development and Visual Design

A narrative skeleton accompanied the technological prototyping so that the content projected onto the box construction was framed. The narrative was set at the Nusantara Presidential Palace (IKN). This included:

- Visual storyboarding for projections onto surfaces
- Voice Over (VO) coupled with an animated narrative
- To address visual obstructions during projection, a setup was developed to analyze and minimize shadow formation on the target surface, as illustrated in **Figure 5**. In **Figure 6**, content planning for multiple distributions across the planes of the box was crafted.



Figure 5: projection study for shadow minimalization

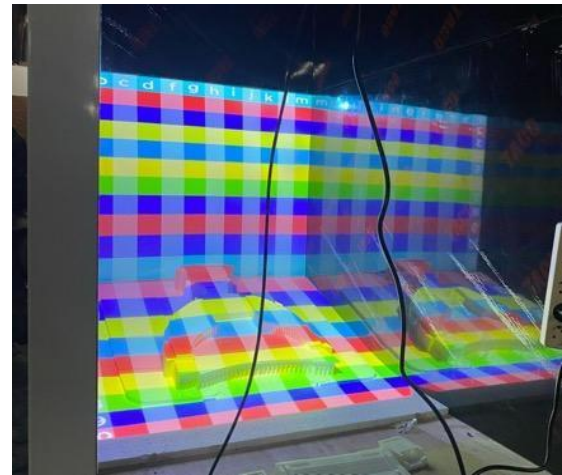


Figure 6. Projection mapping design area coverage

2.4. Prototyping and Installation

The box structure based on the IKN exhibition booth was designed in physical prototype form (refer to **Figure 6**) to create a portable exhibition medium. The story flow was rehearsed in an exhibition environment after setting up the projection system, and modifications were made to the viewer's positioning and projection alignment in real-time using software called Resolume.

3. CASE STUDY: PROJECTION MAPPING FOR THE NUSANTARA PRESIDENTIAL PALACE EXHIBITION

The case study demonstrates the application of video projection mapping on a modular box configuration designed for architectural storytelling in the context of an exhibition. The installation aimed to illustrate the staged evolution of the new Presidential Palace being built in Nusantara (IKN)—and the challenges of expedited construction schedules and topographically complex environments.

3.1. Technical Design and Projection Setup

The project commenced with investigating the spatial and optical constraints posed by the 1x1 meter cubic maquette used as the projection surface.

Initial projection configurations revealed common technical limitations, including shadow interference and incomplete surface coverage—challenges frequently encountered in applications on irregular or volumetric forms (Wai, 2023; Derkach et al., 2023). To address these issues, iterative testing led to repositioning the projector for the purpose of downward projection that effectively minimized shadow casting and maximized illumination uniformity across all visible planes of the box (**Figure 7**).

To ensure visual clarity, the maquette was built using 3D printing technology and painted in a white matte (**Figure 8**). This approach is endorsed by best practice within the realm of projection-based media installations, whereby the neutrality of surface reflectivity is conducive to achieving high contrast and projection sharpness (De Paolis et al., 2022). The maquette was a display object and will become a replica object for the exhibition that will receive projection mapping graphics from the projector.



Figure 7. The adjusted projector position setup minimized shadow interference and ensured full surface coverage on the box structure.

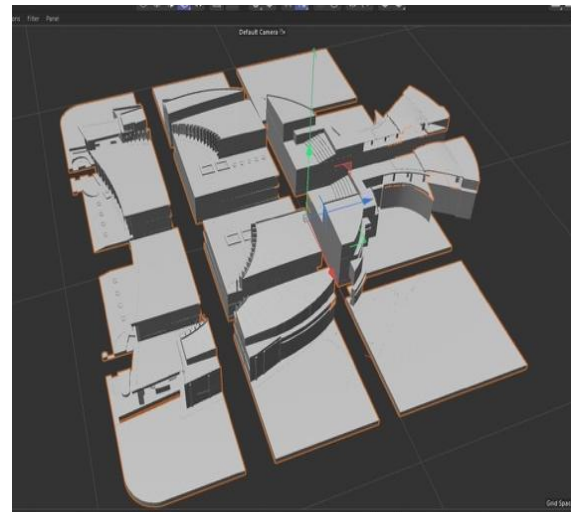


Figure 8. 3D-printed white box maquette used for projection testing.

3.2. Content Development and Narrative Integration

Once the technical setup was finalized, the next focus was on developing content that would work in harmony with the projection surfaces of the box structure. The team created a vertically oriented visual sequence that included animated infographics, architectural blueprints, environmental overlays, and synchronized voice-over narration. The structure of this content followed immersive storytelling principles, where spatial layout and information flow were carefully considered to guide the viewer's attention in a clear, cinematic progression (Yuan & Alizadeh, 2024; Breuleux et al., 2019).

To make the story more engaging, visual metaphors and symbolic transitions were used to add emotional weight and atmosphere. Much like other immersive design approaches, the narrative wasn't just shown—it was embedded into the physical form of the box itself. This transformed the box from a simple object into a storytelling environment, where each surface played a specific role in unfolding the narrative (**Figure 9**).



Figure 9. Infographic visual layout designed for vertical storytelling

The animations were designed to move naturally across the planes of the box. Their pacing was carefully adjusted to ensure that viewers had enough time to absorb the information without feeling overwhelmed. Well-timed sequences help audiences stay focused and make it easier to follow complex visuals—especially in layered, multimedia formats (Mayer, 2020).

Voice-over was equally important. It provided structure, helped transition between scenes, and gave meaning to what was being shown. A professional narrator was selected to ensure clarity and consistency, enhancing the overall tone of the installation. Research shows that when used effectively, voice-over can increase understanding and make the experience more memorable—especially in exhibition settings where visual storytelling alone may not be enough (Stqry, 2021).

3.3. Challenges and Critical Reflections

Although the box structure was a relatively compact format, achieving immersive effects posed some nontrivial

design tradeoffs. Keeping visual consistency across edge junctions, making vertical infographics readable, and preventing projection overflow demanded meticulous alignment and spatial mapping. These constraints reaffirm the findings of earlier studies on projection mapping in confined or complex geometries (Ioakeim et al., 2021; Pahrulroji & Soeteja, 2024).

Additionally, controlling animation speed and graphical depth was necessary to strike a balance between narrative clarity and visual dynamism. In contrast to large-scale or planar projection contexts, the exhibition medium required content to stay comprehensible at various viewing angles and lighting circumstances (**Figure 10**).



Figure 10. Final mock exhibition installation of the projection-mapped box structure.

4. RESULTS AND DISCUSSION

The design of video projection mapping on a series of box structures for the Nusantara Presidential Palace exhibition brought valuable lessons learned regarding technical implementation and the significance of the visual language that supported immersive storytelling in an exhibition design.

4.1. Projection Setup and Technical Performance

To narrow them down, the experimental phase proved that the major technical difficulties were shadow interference and incomplete surface coverage. This is commonly observed in projection-mapping applications on volumetric objects. The research confirmed through iterative experimentation that the projector was mounted in a 90-degree vertical orientation and positioned at the upper left corner of the box structure, angled at 33 degrees, to optimize surface coverage and minimize shadow interference, offering the most optimal result, enabling comprehensive coverage of the box's surfaces while minimizing shadow distortion (**Figure 11**). The decision to fabricate the box model using a 3D-printed white matte surface enhanced contrast and color accuracy, facilitating more precise visualization of projected graphics and narrative elements (De Paolis et al., 2022). See **Figure 12**.

4.2. Look and Feel Design

This project also stressed the significance of the visual communication design process itself. Given the story theme, two approaches were explored: a high-tech, futuristic artwork or a calmer, nature-based visual identity. Visual analysis and design development led to the selection of this second option, which aims to retain the contextual identity of Kalimantan's green environment and complement the architectural concept of the Nusantara Presidential Palace, intended to blend in with its natural surroundings.

We also noticed that typography was a crucial element. Typography fundamentally shapes how information is perceived and understood, with readability and legibility being necessary for effective visual communication (Arya, 2023). After conducting research, we

selected a legible sans-serif typeface with strong stroke contrast, which was tested for readability from various angles and distances. The designer positioned the text in the top center so viewers from outside the box structure would clearly see the information. See **Figure 13**.



Figure 11. The final result is that if we put a 90-degree vertical project on top of the box structure, it will cover both surfaces and minimize shadow.

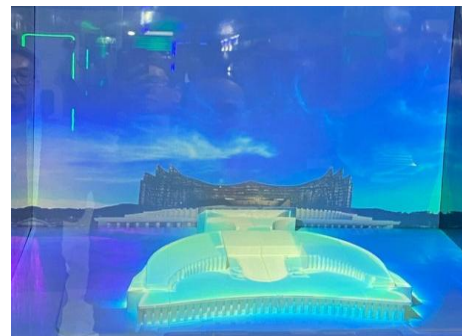


Figure 12. The 3D-printed white matte surface enhanced contrast and color accuracy.



Figure 13. Typographic Composition made it blend with visuals, but also stand out, and is easy to read for viewers

4.3. Storytelling, Animation, and Sound Design Integration

The storytelling was structured into four coherent segments:

1. Opening—introducing Kalimantan's landscape and the macro vision of the IKN project.
2. Segment 1—highlighting the Istana Garuda area.
3. Segment 2—explaining the Presidential Palace layout.
4. Closing—emphasizing the palace's role and the developer's commitment.

A distinctive feature of the installation was the integration of narrated audio to accompany the animation. Sound plays a key role in creating immersive experiences by both accompanying the action and emphasizing the narrative flow, as well as acting independently to direct attention. (Saroka, 2023)

A professional narrator guided the audience through the storyline. This assisted in understanding the spatial and architectural details with ease. The merging of sound and sight transformed the installation from a mere infographic into something like a movie. Studies have shown that narration and visual storytelling significantly enhance comprehension and viewer engagement in spatial media (Stqry, 2021).

The length of the animation was also a decision that needed consideration. The team found, through trial and error, that 2 minutes was the optimal length of animation for retaining viewers' attention and conveying all the story segments. Research suggests that audience engagement tends to decrease in animations exceeding two minutes, especially in public or exhibition contexts where viewers may face numerous distractions (DreamFarm Studios, 2022).

Effective multimedia design leverages narrative guidance to enhance learning experiences, emphasizing the importance of narrative construction in user engagement (Plowman & Luckin, 1999).

4.4. Challenges and Reflection

Although the project met technical and narrative requirements, it encountered challenges with projection blending along the box's edges and readability in varying lighting conditions. A final consideration was the delicate balance between supporting a rich sense of place without reaching a point of information overload. We improved clarity by simplifying animations, adjusting the pacing of narration, and refining the visual hierarchy.

The role of exhibition space as a box structure was demonstrated with the project's success, and it easily proved to be a replicable model for exhibition-based storytelling, where mobility, audience attention, and design flexibility are vital factors. A synergy and interlinkage of narrative structuring, sound, typography, and projection design made this installation a fine balance between information delivery and immersive storytelling, delivering on all fronts where immersive theater converged with documentary and underclass storytelling in space.

5. CONCLUSION

This research shows the effectiveness of using video projection mapping on box structures towards achieving powerful storytelling, especially in architectural exhibitions, and also as a portable medium for exhibitors; the project encountered numerous technical difficulties related to the projection of images on three-dimensional surfaces, such as dealing with shadow interference, edge distortion, and

ensuring the content was properly aligned. We believe this highlights the exciting possibilities this technology offers for engaging audiences. The installation achieved consistent visual coverage and enhanced audience immersion through a 90-degree vertical orientation mounted at the upper left corner of the box structure, angled at 33 degrees by a 3D-printed matte white maquette, and carefully calibrated spatial mapping.

This research was more than just technical; it was also a systematic exploration of visual communication design, striving for an equilibrium of narrative clarity, visual appeal, and typography to produce a story-driven, emotionally impactful exhibition. This decision to combine nature-inspired visual palettes with modern architectural narratives wonderfully expressed this project's dual identity: future development that is attuned to Kalimantan's natural landscape.

Additionally, implementing a voiced commentary and an overall runtime of two

minutes for the animation, based on research regarding viewer attention span, was vital to securing audience retention.

The importance of this research lies in the combination of technical testing and immersive narratives on such a small, modular box structure. This projection surface is rarely discussed in existing literature. This project successfully demonstrates how to transform small-scale, volumetric surfaces into interactive, story-rich platforms, in contrast to large-scale facade mappings. The research contributes a replicable framework and methodology for designers, exhibition practitioners, and communication strategists who seek to create portable, scalable, and impactful exhibition designs.

In summary, this study contributes to the use of projection mapping on box structures, which can be an engaging medium as well as an effective tool for content dissemination and storytelling in exhibition design, spatial narrative media, and visual communication design.

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