DIGITAL DO-IT-YOURSELF (DIY) CHARACTER CREATION SYSTEM OF HENGSHAN SHADOW PLAY

By
Miss He PEIHAO

A Thesis Submitted in Partial Fulfillment of the Requirements
for Master of Fine Arts Program in Design
Silpakorn University
Academic Year 2024

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โดย
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วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรศิลปมหาบัณฑิต
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Title	Digital Do-It-Yourself (DIY) Character Creation System of Hengshan Shadow Play
By	Miss He PEIHAO
Field of Study	Program in Design
Advisor	Assistant Professor Dr. Gomesh Karnchanapayap

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This study investigates the digital preservation of intangible cultural heritage through the creation of a Digital DIY Hengshan Shadow Puppet Character Creation platform. The system, which aims to bridge traditional art and modern interaction, strikes a balance between cultural authenticity and user operability, avoiding both overly simplified entertainment and excessive professional complexity. The DIY module is at the heart of the system, encouraging user participation and promoting experiential learning. The study used an interaction design framework and gathered qualitative and quantitative data via expert interviews and 300 valid questionnaires. Heritage, educational technology, and digital media experts shared their insights on user goals, learning behaviors, interface interactions, and cultural translation. The user data was used to identify preferences in interface structure, functional layout, and material organization, with younger users placing a high value on AR and DIY features. Notably, 72% of users had previous experience with DIY cultural products, and more than half were interested in AR-based interaction. Key design recommendations included keeping traditional proportions and structure using a "layer + logic restriction" model, simplifying and simulating the physical puppet-making process, and providing phased, voice-guided learning modules. Visual suggestions included neutral tones, traditional textures, and easy navigation. The results confirmed that aesthetic and experiential learning modes are more appealing than traditional text-based ones. The addition of a brief cultural introduction during onboarding significantly increased engagement, particularly among users unfamiliar with shadow puppetry. Overall, the study emphasizes the potential of augmented reality and interactive media to improve cultural learning and transmission, especially among a younger, digitally native audience.

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He PEIHAO

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CHAPTER 1
INTRODUCTION

Hengshan shadow puppetry, an important part of China's intangible cultural heritage, carries a wealth of historical and cultural connotations (Li et al., 2023). However, as modern society has changed, the audience for traditional shadow puppetry has dwindled, as has younger generations' awareness and interest in this traditional art form (Wang & Yu, 2022). To preserve and transmit this valuable cultural heritage while engaging more young people, modern technology must be combined with traditional art, as well as innovative approaches to cultural dissemination (Li et al., 2025).

Figure 1
Hengshan Shadow Puppetry

Note. Photographed by the author.

1.1 Research Problems

Although numerous studies concentrated on design innovation by applying traditional elements or preserving the cultural essence of shadow puppetry through digital

technology, a significant gap existed in the exploration of how technological methods could enhance content innovation within shadow puppetry. This research integrated a multidisciplinary framework and methodology to propose a specific digital DIY character creation solution for shadow puppetry and explored its practical applications.

1.2 Research Objectives

This study sought to bridge the gap between traditional art forms and contemporary digital innovation, with a focus on the preservation and revitalization of Hengshan shadow puppetry. This research delved into the production processes, explored modern DIY methods and digital tools, and ultimately developed and evaluated a digital DIY innovation, thereby ensuring that Hengshan shadow puppetry remained relevant and accessible to contemporary audiences, particularly younger generations. There were three particular objectives.

1. To study the production process of Hengshan shadow puppetry.
2. To explore how DIY methods and digital technology can support the preservation of Hengshan shadow puppetry.
3. To develop and evaluate a DIY innovation for Hengshan shadow puppetry.

1.3 Research Hypotheses

1. The digital DIY application of shadow puppetry can serve an effective learning tool.
2. The digital DIY application of shadow puppetry can provide a good experience for users.

1.4 Research Scope

This research encompassed a multifaceted investigation into shadow puppetry, the applications of digital technology, user experience, and relevant theoretical frameworks. The study commenced with an exploration of shadow puppetry, analyzing its characteristics, historical significance, and production methods. The evolution of shadow puppetry was examined, along with contemporary application

cases and advancements in technology. The focus subsequently shifted to the exploration of the application of interactive technology in the innovation of shadow puppetry, with an assessment of the effectiveness of such technology in enhancing audience engagement.

The research integrated theories from design, constructivism, and autonomous creation to elucidate the learning and experiential impacts of the findings.

This study established specific boundaries to clarify areas that were not covered. Initially, the research concentrated solely on Hengshan shadow puppetry, thereby excluding other regional styles, in light of the diverse forms of Chinese shadow puppetry. Secondly, the primary focus was on stimulating audience interest through interactive technology, while content related to non-interactive technology was addressed only minimally. The definition of these exclusions allowed the research to maintain focus on its core objectives, thereby ensuring consistency and coherence in both methodology and results.

1.5 Research Significance

This study is significant because it has the potential to reshape the cultural landscape of Hengshan shadow puppetry by combining traditional artistic heritage with digital innovation. First, it addresses the fundamental need to educate and engage audiences in shadow puppetry, laying the groundwork for renewed public interest and appreciation for this intricate art form. This knowledge transfer not only helps to preserve culture, but it also introduces modern audiences to a richer, more immersive cultural experience that goes beyond passive viewership. The study encourages active engagement, allowing audiences to become participants in the story, technique, and artistry of shadow puppetry.

An in-depth examination of the distinctive cultural elements of Hengshan shadow puppetry broadens our understanding of this traditional art form, shedding light on the values, symbolism, and historical narratives embedded in its intricate design. This understanding not only preserves the cultural essence of Hengshan shadow puppetry, but it also offers valuable insights for design and media studies, potentially inspiring cross-disciplinary applications that combine traditional aesthetics with contemporary visual storytelling. Such knowledge encourages design innovation, as traditional

elements can inspire new forms, techniques, and materials, ensuring that shadow puppetry's heritage continues to influence creative industries.

Beyond academic and cultural contributions, the study has practical implications for increasing the visibility and influence of regional cultural heritage in contemporary society. This study introduces young audiences to shadow puppetry in new, accessible ways by utilizing digital tools to facilitate interactive DIY character creation. This method makes the art form more relatable and adaptable, fostering a sense of ownership and personal connection that traditional passive methods may lack. Interactive engagement is especially effective for younger generations, who are more accustomed to digital platforms and may struggle to relate to traditional shadow puppetry without this modern bridge.

Figure 2
Children's Shadow Play DIY Toys

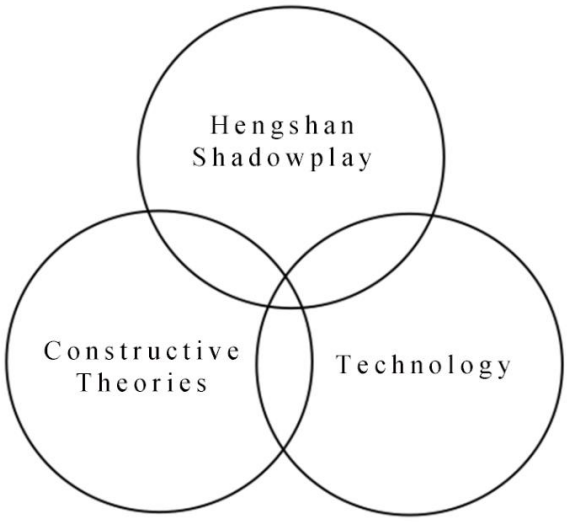
Note. A Product of Yiji Childhood.

The creation of a DIY digital platform for shadow puppetry has broad implications for art education, digital humanities, and the preservation of intangible cultural heritage (Yang et al., 2024).

1.6 Research Framework

The conceptual framework (Figure 3) diagram depicts the intersection of three key elements—Hengshan Shadow play, Constructive Theories, and Technology—that form the basis of a research approach that investigates how digital do-it-yourself (DIY) methods can be applied to traditional art education. The study's core content is Hengshan Puppetry, a culturally rich Chinese folk performance. Constructive theories, particularly constructivism, guide educational strategy, emphasizing active, hands-on learning that builds knowledge through experience and creative engagement. Technology refers to the tools and platforms that enable digital interaction, allowing learners to create, manipulate, and explore shadow puppetry in new ways. This integrated model aims to preserve intangible cultural heritage while also providing meaningful, learner-centered educational experiences.

Figure 3
Research Conceptual Framework



Note. Developed by the researcher.

1.7 Definitions of Terms

Hengshan Shadow Puppetry: A traditional regional theatrical art form from Hengshan County in Hengyang City, Hunan Province, classified as Chinese shadow puppetry. Hengshan shadow puppetry is a distinct form of ethnic folk art in which

shadow puppets made of paper or leather are projected onto a screen, accompanied by vocal performance, music, and lighting effects, to tell stories. Historical tales, folk legends, and opera segments are frequently used to reflect distinct local cultural characteristics. This art form has not only been a popular form of entertainment for local audiences, but it also plays an important role in modern cultural preservation and heritage. Because of its distinct artistic expression and cultural value, Hengshan shadow puppetry has become a significant intangible cultural heritage of the area. In this study the terms “Shadow Puppetry” and “Shadow Play” are interchangeable.

Interaction Design (IxD): A multidisciplinary field that investigates how people interact with interfaces, devices, and environments. It includes interface design, user experience design, information architecture, and user behavior analysis (Huang, 2009). The primary goal of interaction design is to understand user needs and behavioral patterns in order to create intuitive operation processes, clear interface feedback, and effective information presentation that allow users to complete tasks efficiently (Jaspers et al., 2004). For example, interaction design can help users create new shadow puppet characters using existing materials. Interaction design is used in a wide range of digital products and services, including websites, mobile apps, video games, and smart devices, with the goal of improving overall user experience and satisfaction.

DIY (Do It Yourself) Design: DIY design emphasizes self-creation and personalized expression, encouraging people to use their skills and resources to design, create, or modify items themselves rather than relying on commercial products or services (Ferretti, 2019).

In this study, "DIY Solution" refers to the user's ability to independently select parts of a shadow puppet and create a character using both the digital DIY platform and the physical DIY extension. This approach aims to achieve a participatory learning and cultural inheritance method that integrates both "virtual creation" and "physical activity" elements.

Physical DIY extension: Elements from the digital platform that can be printed and act as shadow puppet templates so users can then use them to create physical shadow puppets by physically cutting and assembling parts.

1.8 Structure of the Thesis

Chapter 1. Introduction: This chapter provides an overview of shadow puppetry's history and development, emphasizing the significance of combining shadow puppetry with digital technology. It outlines the research problem, objectives, and hypotheses guiding this study.

Chapter 2. Literature Review: This chapter examines existing literature and related research, with a focus on the preservation and innovation of shadow puppetry. It delves into the artistic characteristics of shadow puppetry and the significance of combining it with digital technology, emphasizing its cultural importance. The chapter also examines literature on shadow puppetry, interactive technology, design principles, and methods, emphasizing the importance of interactive innovation technology in heritage preservation and audience engagement with shadow puppetry.

Chapter 3. Research Methodology: This chapter explains the study's methods, with a focus on the mixed-method approach. The research process is detailed, including the methodology, tools, and analytical techniques used in this study.

Chapter 4. Research Results: Chapter 4 provides a comprehensive overview of the integrated design process used in the study, from initial prototype development to iterative improvements and final product formation. It describes the design process used to achieve the three main research objectives, as well as an in-depth discussion of the refinements made during that process.

Chapter 5. Conclusions and Discussions: This final chapter draws conclusions based on the study's findings and outcomes, discussing the limitations encountered and proposing future research and innovation in the field. Furthermore, it emphasizes specific applications of shadow puppetry in conjunction with digital technology and suggests potential avenues for future research.

CHAPTER 2
LITERATURE REVIEW

Chinese shadow puppetry, an ancient and brilliant folk-art form, is like a living history book, preserving China's profound cultural heritage. In today's society, studying and exploring shadow puppetry is not only an inheritance and tribute to traditional culture, but also a pursuit of its innovative development path of integration with modern elements (Zhang et al., 2012). In this chapter, we will examine all aspects of shadow puppetry, including its origin, development, domestic and foreign status, inheritance and protection, production technology, and so on. Analyze the charm of shadow puppetry in terms of artistic characteristics, and then, using case analysis, interactive technology, and theoretical knowledge, we will create a more comprehensive and in-depth understanding system for shadow puppetry.

2.1 Chinese Shadow Play

2.1.1 The Origin and Development

1. The History

The origins of shadow play, a unique folk-art form, are rich in historical and cultural connotations, and there are numerous theories and relevant historical backgrounds.

One theory holds that shadow play evolved from ancient witchcraft and sacrificial rituals. Early humans, who revered natural phenomena, used witchcraft and sacrifice to communicate with deities. During these ceremonies, simple objects were used to cast shadows on surfaces, eventually evolving into a form resembling shadowplay. For example, in some tribal cultures, shamans used firelight to move rudimentary human-shaped figures, projecting shadows onto animal skins or walls while chanting and dancing. This practice may be the earliest form of shadow play (Stoichita, 1997).

According to historical documents and archaeological discoveries, shadow play is closely related to Han Wudi period stories. According to the "Book of Han: Biography of Foreign Relatives" (Liu, 2016), Emperor Wudi of Han's favorite concubine, Lady Li, died young, and Emperor Wudi of Han missed her greatly. To alleviate Emperor

Wu's longing for his wife, the alchemist Li Shaoweng cut an image of Madam Li out of cotton and silk, painted it with colors, and attached wooden poles to her hands and feet. After nightfall, he lit candles in the tent and, using clever manipulation, made Emperor Wu of Han appear to see Madam Li's figure. Although this incident cannot be definitively proven to be the origin of shadow puppetry, it does provide an influential legendary background for the development of shadow puppetry, revealing early ideas and practices of using light and shadow to present the image of characters.

Another viewpoint attributes the origins of shadow puppetry to folk storytelling and paper cutting. Folk storytelling is an ancient oral tradition that uses vivid descriptions to depict scenes and characters. Over time, performers began to represent these characters with paper cutouts and other forms, using light and shadow effects to enhance the performance. This practice eventually developed into shadow puppetry. Furthermore, the art of paper cutting influenced the design and craftsmanship of shadow puppets, with artisans adapting its techniques to carve intricate patterns and figures on leather.

2. Its Development Through Time

Initial Development: From the Han and Wei Dynasties to the Tang and Song Dynasties

From the Han Dynasty to the Tang Dynasty, the ongoing development of social economy and culture created favorable conditions for the growth of shadow puppetry. During this time, shadow puppetry evolved from simple court entertainment to sacrificial ceremonies for the people (Fei, 2017). The materials and craftsmanship of shadow puppetry have improved alongside the advancements in papermaking and painting. Shadow puppets are no longer made solely of cotton and silk; paper and leather, which are tougher, easier to carve, and preserve, are now used.

The Tang Dynasty was a prosperous period for Chinese culture and arts, during which shadow puppetry advanced significantly. Shadow puppetry became widely popular among the general public, expanding its repertoire beyond myths, legends, and historical tales to include vivid depictions of everyday folk life. Tang poetry, painting, and other art forms provided inspiration for more detailed, colorful, and lifelike puppet designs. Performance styles have also evolved, from simple musical accompaniment to more complex manipulation techniques.

During the Song Dynasty, shadow puppetry matured. The thriving urban economy, the rise of the merchant class, and the proliferation of entertainment venues like theaters and brothels provided fertile ground for its expansion. Technological advancements in puppet production resulted in more refined craftsmanship and lifelike carvings. Professional troupes formed, with specialized roles for puppeteers, singers, and musicians. Music became increasingly important, with regional variations in singing and instrumentation. The repertoire grew beyond traditional historical and mythological themes to include depictions of social realities and folk customs (Jiang, 2024).

Heyday and Prosperity: Ming and Qing Dynasties:

The Ming and Qing Dynasties were the height of Chinese shadow puppetry development, and numerous shadow puppetry schools with distinct characteristics emerged across the country (Dolby, 2009).

During the Ming Dynasty, shadow puppetry became popular among royal and noble circles, with frequent palace performances. This time period saw significant advancements in production techniques, particularly in leather selection and processing, which resulted in puppets that were more durable, flexible, and transparent. Carving techniques became more refined, with artists using various knife techniques to create smooth, intricate details in costumes and facial expressions. Color palettes became bolder and richer, with high-quality mineral pigments used to boost vibrancy and durability. Performance narratives became more complex, and puppeteers demonstrated advanced skills, allowing for lifelike movements such as fighting and dancing (Shen, 1994).

The Qing Dynasty was the golden age of shadow puppetry development, with many well-known shadow puppetry schools established across the country, including Shaanxi shadow puppetry, Tangshan shadow puppetry, Beijing shadow puppetry, Shandong shadow puppetry, Hubei shadow puppetry, and so on. These schools have distinct modeling, production, singing, and performance styles for shadow puppets (Rollins, 2019).

Shaanxi shadow puppets are distinguished by their simplicity and elegance, with graceful lines and vibrant colors. Their facial features are typically high foreheads,

straight noses, and small red mouths, which result in vivid expressions. Shaanxi puppets are primarily made of cowhide and feature fine carvings, sharp knife work, and a variety of decorative motifs, including flowers and animals. The local singing styles, Wanwanqiang and Laoqiang, are melodic and passionate, reflecting a strong regional identity.

Tangshan shadow puppets are known for their exquisite hollow-carving techniques, which result in plump, rounded figures with smooth lines and vibrant colors that create a strong three-dimensional effect. Their singing style, dubbed "Luanzhou Shadow Tune," incorporates Tangshan dialect and produces rich, mellow melodies that vividly express character emotions.

Beijing shadow puppetry, influenced by court culture, has a more ornate aesthetic. Its puppets have beautifully crafted, colorful costumes and props. The performances emphasize standardized, elegant movements, while the singing incorporates various operatic elements, resulting in a high artistic level.

Shadow puppetry was an important medium of cultural exchange. Troupes toured extensively, allowing for the integration and mutual influence of regional styles. Furthermore, shadow puppetry began to merge with other art forms, such as opera and rap, enriching both its content and performance methods.

Table 1 shows the analysis of shadow puppetry of different dynasties and/or regions.

Table 1

Analysis of Shadow Puppetry in Different Dynasties/Regions

Dynasty/Region	**Photo**	**Stylistic Features**
Han Dynasty (250 BC - 8 AD)	 (Photographed by the author)	Minimalist design with archaic simplicity. Early forms focused on undecorated leather silhouettes, characterized by bold outlines and geometric abstraction.

Dynasty/Region	Photo	Stylistic Features
Tang Dynasty (618AD-907AD)	 (Photographed by the author)	Fluid, dynamic lines influenced by Buddhist mural aesthetics. Figures emphasized ethereal postures, with flowing drapery mimicking celestial beings depicted in Dunhuang cave art.
Song Dynasty (960AD-1279AD)	 (Photographed by the author)	Distinct role differentiation (e.g., scholars, warriors, clowns) reflecting specialized theatrical troupes. Human figures adopted exaggerated gestures for narrative clarity.
Ming Dynasty (1368AD-1644AD)	 (Photographed by the author)	Gray Leather Puppets: Pale, translucent leather with 0.1mm precision carvings. Beijing School: Incorporated Peking Opera facial typology (e.g., Lian Po armor motifs).
Qing Dynasty (1636AD-1912AD)	 (Photographed by the author)	Shaanxi Eastern School: Monumental scale (~30cm height), intricate architectural motifs. Beijing School: Codified role systems (Sheng, Dan, Jing, Chou) with lavish polychrome layering.

Dynasty/Region	Photo	Stylistic Features
Shaanxi (960AD-Present)	 (Photographed by the author)	Eastern Route: Grandiose compositions with floral-cloud motifs. Western Route: Symmetrical patterns emphasizing folk symbolism.
Beijing (1421AD-Present)	 (Photographed by the author)	Courtly aesthetics featuring auspicious symbols (Guluqian coin patterns, fish-scale borders). Modern innovations included cartoonish adaptations (e.g., Three Attacks on the White-Bone Demon).

Note. Data collected and compiled by the author.

3. Transformative Age: Modern and Contemporary Period

Shadow puppetry has faced significant challenges since the advent of modern times, with the introduction of Western culture and the rise of new entertainment forms. Emerging media like film, television, and radio quickly gained popularity, diverting attention away from traditional shadow play. As a result, the audience for the art form has steadily decreased, putting shadow puppetry in critical decline.

Despite challenges, shadow puppetry has survived and evolved. On the one hand, traditional artists continue to preserve and promote traditional techniques, performing in folk venues and training new successors. Shadow puppetry, on the other hand, has adapted to modern society by using new materials (Valverde & Perez-Martin, 2020), such as plastic, to reduce costs and improve preservation. Performance styles have also evolved, combining contemporary stage arts with modern lighting and sound effects to increase visual and auditory impact. For example, large-scale productions

now combine traditional shadow puppetry with modern dance and drama, successfully reigniting audience interest.

Shadow puppetry has also played an important role in cultural education, being integrated into school art curricula as a means of preserving traditional heritage. Educational initiatives, such as shadow puppetry programs on campuses, allow younger generations to appreciate and participate in this art form. Internationally, shadow puppetry is regarded as a cultural treasure of China, attracting global attention and admiration. Frequent performances on the global stage highlight its distinct folk charm, promoting cultural exchange and mutual understanding between China and other countries (Chen & Champadaeng, 2025).

Shadow puppetry has evolved and changed over time since its ancient origins. It carries the rich cultural connotations of the Chinese nation and retains irreplaceable value and significance in contemporary society. It is a shining pearl among the treasures of Chinese folk art.

2.1.2 Research Related to Chinese Shadow Play

Domestic and foreign scholars have conducted explorations of shadow puppetry from multiple perspectives, spanning fields such as culture, art, history, and folklore, yielding rich research results (Osnes, 2014).

Shadow puppetry is regarded as an important vehicle for cultural inheritance and dissemination. Domestic scholars emphasize its place within the traditional Chinese cultural system, which includes folk wisdom, traditional values, and national spirit (Li, 2022a). For example, through shadow puppetry stories, we can see the transmission of values such as loyalty, filial piety, and righteousness. Foreign scholars place shadow puppetry in the context of cross-cultural research and investigate its significance in international cultural exchanges. It has evolved into a one-of-a-kind symbol that demonstrates the allure of Chinese culture and assists the West in comprehending the meaning and characteristics of Eastern culture.

Research has shown that its distinct blend of two-dimensional and three-dimensional expression has significant artistic value in character design, costume patterns, and color schemes (Huang et al., 2015). Comparative studies show that Shaanxi puppets have majestic simplicity, charming faces, intricate patterns, and

vibrant contrasts, whereas Tangshan puppets have smooth lines, rounded forms, and soft, rich colors. Foreign scholars frequently compare Chinese shadow puppetry to Western traditions, including European shadow puppetry, pointing out its distinct Oriental charm, particularly in the delicacy of modeling and color use.

In Chinese performing arts, extensive research has been conducted on shadow puppet manipulation techniques, singing, and musical accompaniment. Different regional schools have distinct manipulation styles, with artists expertly controlling joysticks to produce lifelike puppet movements. Vocal styles such as the high-pitched, passionate Qinqiang and the melodious, lingering Wanwanqiang are closely related to local dialects and musical traditions. Foreign scholars have expressed a strong interest in shadow puppetry, examining how puppeteers' behind-the-scenes skills bring vivid stage presentations to life and how music enhances atmosphere and emotional expression, recognizing it as a distinct form of Oriental performing art (Chen & Tang, 2021).

Domestic scholars analyze ancient texts, archaeological findings, and folk legends to trace the origins and development of shadow puppetry from the past. Their research traces its evolution across dynasties, focusing on its early rise during the Tang and Song periods, widespread popularity in folk entertainment, peak in the Ming and Qing eras, and the emergence of distinct regional styles. Foreign scholars, on the other hand, frequently study shadow puppetry through the lens of cultural exchange and dissemination, investigating its potential transmission via trade routes such as the ancient Silk Road (Xia et al., 2023).

In terms of folklore, domestic research connects shadow puppetry to folk customs and habits. Shadow puppetry is an important part of traditional festivals, temple fairs, sacrifices, and other events. It serves not only to entertain the public, but also to perform folk rituals such as blessings and exorcisms. Foreign scholars see shadow puppetry in folk activities as a window into understanding the structure and cultural traditions of Chinese folk society, and they study its organizational form and audience participation methods to better understand Chinese society and culture (Munasinghe, 2020).

2.1.3 Chinese Shadow Puppetry Inheritance

1. In China

In China, Family inheritance is still a strong and time-honored tradition, with many families passing down skills through generations. Elders begin training children at a young age, teaching them the basics of leather selection, carving techniques, and color application. As their skills improve, younger generations learn more complex performance techniques, gaining a better understanding of the essence of the art.

Master-apprentice transmission is also common, with masters carefully selecting apprentices based on both talent and moral character. Apprentices develop comprehensive expertise in both production and performance over the course of years of rigorous training (Wang & Yu, 2022).

School-based education has emerged as a new driving force behind the growth of shadow puppetry. Primary and secondary schools actively promote shadow puppetry on campus by inviting folk artists to lead workshops and clubs (Yan, 2020). Students participate in hands-on activities such as puppet making and learning basic performance techniques, which fosters a greater appreciation for traditional culture. At the collegiate level, art institutions have incorporated shadow puppetry into their curricula to develop culturally grounded and professionally skilled talent. Some universities encourage creative practice by combining modern themes with traditional forms, revitalizing shadow puppetry and creating new avenues for its transmission to future generations.

The researcher has compiled prominent Chinense Shadow Puppetry masters in Table 2.

Table 2
Chinese Shadow Puppetry Masters

Name	**Number of Apprentices**	**Type**	**Picture**
Ouyang Xinnian	1-3	Family	

Name	Number of Apprentices	Type	Picture
Wang Donglin	5-10	School	
Yuan Chunming	5-10	Community	

Figure 4

Shadow Puppetry Stage Layout Utilizes Light and Shadow to Perform

Note. Photograph taken from the https://news.cgtn.com.

The stage layout (Figure 4) is also evolving in a diverse direction, with modern stage design concepts being introduced in large quantities. Multi-layered stages and special props (Figure 5) add to the visual appeal of shadow puppet performances. Furthermore, incorporating modern dance, drama, and other elements enhances the plot of shadow puppetry and makes the performance more vivid and interesting (Lei et al., 2023).

Figure 5

A Shadow Play Stage Setting

Note. Photograph taken from https://m.thecover.cn.

2. In Other Countries

Chinese shadow puppetry has emerged as a dynamic symbol of Chinese culture on the international stage. At major global events such as international art festivals and exhibitions, its captivating performances are met with widespread acclaim and enthusiasm. For example, at France's prestigious Avignon Art Festival, Chinese shadow puppetry captivated audiences, increasing appreciation for Chinese folk art. Its distinct aesthetics have also influenced foreign artists, inspiring contemporary dance choreographers to use puppet-like gestures and visual artists to incorporate shadow puppet motifs into painting, sculpture, and installation, thereby enriching Western artistic expression (Lin et al., 2013).

Some foreign schools and educational institutions have incorporated shadow puppetry as a cross-cultural educational resource into their curriculum. In the United States, for example, some primary and secondary schools have begun offering Chinese shadow puppetry classes (Liu, 2019). Students create shadow puppets and perform simple repertoires on their own, guided by teachers. This educational method not only enriches students' extracurricular activities, but it also fosters their understanding and respect for different cultures, thereby effectively promoting the exchange and integration of Chinese and American cultures. However, foreign shadow puppetry faces some developmental challenges (Ramli & Lugiman, 2012).

Because of the vast cultural differences, some foreign audiences struggle to understand the connotation of shadow puppets. To better communicate the cultural connotation of shadow puppetry to foreign audiences, the performance content must be translated and interpreted with greater precision and meticulousness. Furthermore, there is a scarcity of professional shadow puppetry inheritors and performance groups worldwide (Li, 2022b).

Its inheritance and development rely primarily on individuals and temporary organizations with a strong interest in Chinese culture. This has significantly hampered the long-term and stable development of shadow puppetry abroad, posing certain uncertainties.

2.1.4 Protection Measures

Cultural heritage preservation is critical to maintaining humanity's rich historical legacy, and shadow puppetry has been identified as a valuable form of intangible

cultural heritage (Das & Patel, 2021). Recognizing its artistic and historical significance, the government has implemented comprehensive policies to preserve and promote this ancient art. These initiatives protect traditional skills while encouraging the art to adapt to modern contexts through legal measures, financial support, and technological innovation. This introduction frames an examination of the various strategies that ensure shadow puppetry's continued relevance as a critical component of cultural identity.

The government has implemented a number of policies to protect shadow puppetry, which is a valuable intangible cultural heritage. At the national level, shadow puppetry is designated as a key protected art form, with laws establishing criteria and safeguards for its heirs. To encourage skill transmission, qualified practitioners receive financial support and honorary titles. Furthermore, intellectual property rights safeguard traditional repertoires and performance styles from unauthorized modification or misuse. Local governments tailor protection measures to regional conditions, providing performance troupes with venues, equipment, and promotional efforts to increase the art's visibility and sustainability (Xu, Tao, & Smith, 2021).

Financial investment is critical to the preservation of shadow puppetry. The government has established dedicated funds for related projects, focusing on several key areas: training and livelihood support for inheritors to ensure stable succession; funding performances and exhibitions, such as shadow puppetry festivals, to enhance public visibility; supporting scholarly research and the creation of comprehensive databases to document its history and artistic value; and promoting innovation by encouraging the integration of modern technology. Furthermore, private sector contributions, such as sponsorships and equipment donations, have actively supported the protection of shadow puppetry (Padmaja, 2018).

The protection of shadow puppetry goes beyond skills and artifacts to include the entire cultural ecosystem. This includes preserving the associated folk and regional cultures. Local governments encourage traditional shadow puppetry activities, such as performances at festivals and temple fairs, in order to keep the art form connected to community life. They also preserve regional languages, music, and folklore, which serve as inspiration for shadow puppetry. By cultivating this cultural environment,

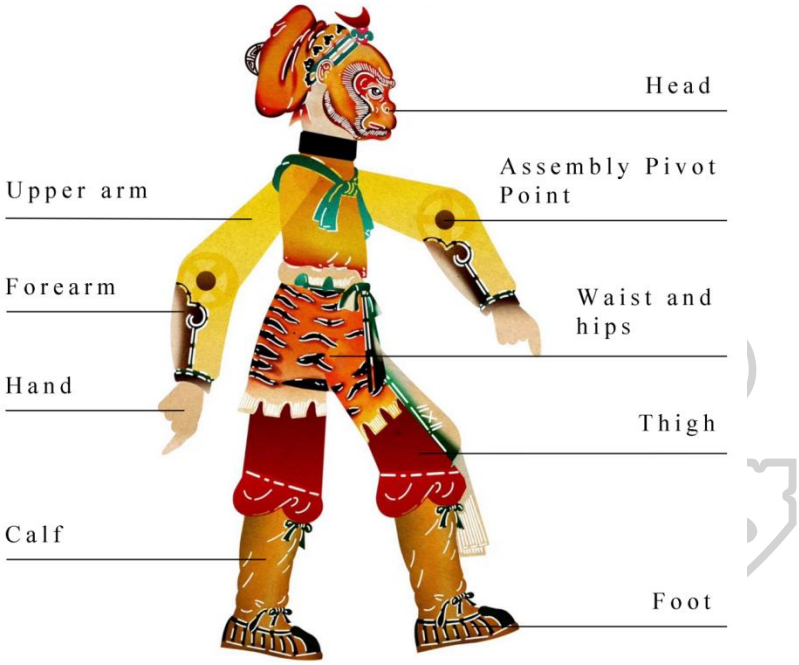
shadow puppetry can thrive authentically, encouraging both inheritance and innovation within its original context.

2.1.5 Materials and Production Process of Chinese Shadow Puppetry

Chinese shadow puppetry's materials and production process make it an exquisite folk art with rich cultural and artistic value. Figure 6 depicts a Chinese Shadow Puppet, Sun Wukong, and its parts.

Figure 6

The Anatomy of a Shadow Puppet Character Sun Wukong



Note. Analyzed and Illustrated by the researcher.

Shadow puppetry materials consist primarily of puppet skins, control rods, and auxiliary components. Cowhide (Figure 7) and donkey skin (Figure 8) have traditionally been used because of their toughness, flexibility, and translucency, which allow for carving and excellent projection effects. Cowhide, which is thicker and more durable, is better suited to large, complex puppets, whereas donkey skin's thinner, delicate texture is ideal for intricate designs. (Li & Cao, 2021).

Figure 7
A Puppet Made from Cowhide

Note. Photograph taken from https://wap.lnd.com.cn.

Figure 8
A Puppet Made from Donkey Skin

Note. Photograph taken from https://www.lymsmuseum.cn.

Paper and plastic (Figure 9) puppets are also used in modern practice: paper puppets are inexpensive and simple to make, making them ideal for beginners or temporary shows; plastic puppets are more durable and water resistant, but have a different texture and artistic quality than traditional leather puppets (Li & Cao, 2021).

Figure 9
A Puppet Made from Plastic Sheet

Note. Photographed by the author.

Controlling sticks are typically made of bamboo or wooden strips, which are lightweight and strong, allowing for flexible puppet manipulation during performances. Bamboo strips are carefully selected and processed to ensure straightness and smoothness, whereas wooden strips are chosen for a consistent texture. The appropriate joystick type is determined by the puppet's size and weight, and it is attached to key joints such as the hands, shoulders, and waist to allow for precise control of puppet movements.

Figure 10
Controlling Sticks Made from Bamboo

Note. Photographed by the author.

Knives, needles (Figure 11), pigments (Figure12) and threads are also used. To vividly color the puppets, pigments, which are typically natural minerals or high-quality modern paints, must be bright, long-lasting, and non- toxic. Knives are useful tools that come in a variety of shapes and sizes, including bevel knives for straight and curved carvings, flat knives for smoothing surfaces or cutting large areas, and round knives for circular or arc patterns. Carved components are assembled using needles and threads to create complete shadow puppets (Yadav et al., 2023).

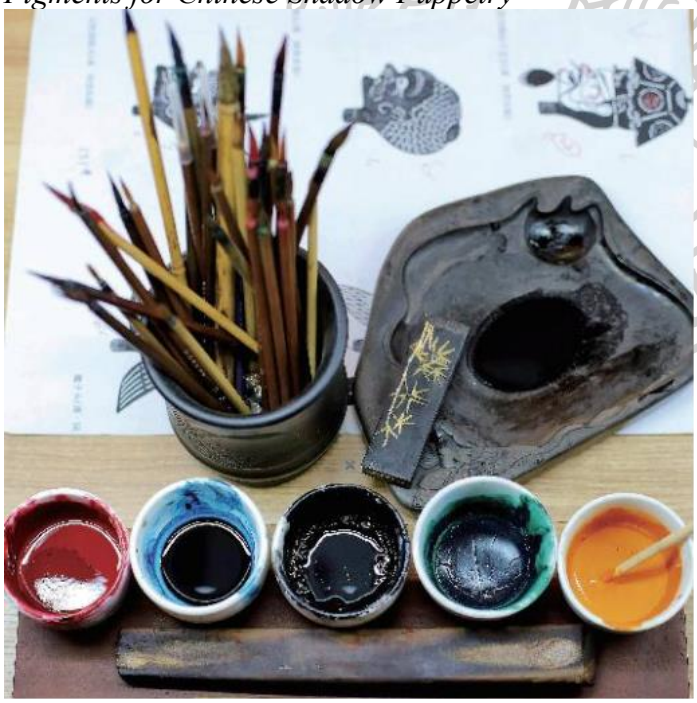
Figure 11

Tools for Creating Chinese Shadow Puppetry

Note. Photograph taken from https://artsandculture.google.com.

Figure 12

Pigments for Chinese Shadow Puppetry



Note. Photograph taken from the https://www.thepaper.cn.

2.2 Shadow Play Analysis

Shadow puppets often used to portray stories from the four great Chinese classics: Romance of the Three Kingdoms, Water Margin, Journey to the West, and Dream of the Red Chamber.

I chose "Journey to the West" and "Romance of the Three Kingdoms" as case studies for shadow puppetry. "Journey to the West" was chosen as it has a clear storyline and an adaptable unit structure, making it ideal for shadow puppetry performance and learning. "Romance of the Three Kingdoms" was selected as a case study because it has a large cast of characters with clear character styles, making it appropriate for visual presentation.

In contrast, "Water Margin" features more violent plots, and "Dream of Red Mansions" focuses on the aristocracy's love, fate, and life philosophy. The language and content of these two books are both complex. This makes them less suitable for the study's target audience.

2.2.1 Puppets from the Story “Journey to the West”

1. Bull Demon King

He has a strong presence, frequently depicting as a human body and a bull's head, wielding a mixed iron stick; his wife is Princess Iron Fan, and his son is Red Boy. He has a rebellious and dominant personality, but he values friendship. He has clashed with the pilgrims several times due to family interests, and was eventually defeated by Nezha, the Pagoda-Bearing Heavenly King, and other heavenly soldiers and commanders.

Figure 13
Bull Demon King

Note. Photograph taken from Suo Le Soulhappy Studio.

2. Bodhisattva Guanyin

The compassionate Bodhisattva Guanyin frequently assumed human form to alleviate suffering. Throughout the Tang Priest's journey, she secretly assisted them on several occasions, offering guidance and subduing demons such as Red Boy, ensuring the Westward Journey's success.

Figure 14
Guanyin

Note. Photograph taken from China National Museum of Arts and Crafts.

3. Jade Emperor

The Jade Emperor wielded great power as the ruler of Heaven, overseeing the Three Realms. When Sun Wukong caused chaos in Heaven, he directed the celestial troops to apprehend him. To maintain cosmic order, he then allowed Sun Wukong to accompany Tang Seng on the Westward Journey via mediation.

Figure 15
Jade Emperor

Note. Photograph credit: Zihao Yang.

4. Golden Horn King

He is the Silver Horn King's twin brother and the elixir-making son of Taishang Laojun. He has a golden horn on his head, a red face and fangs, and is dressed in an eight-diagram robe. He carries treasures such as purple gold and red gourd. He deceives Tang Monk by pretending to be an injured old Taoist, but is eventually defeated when Wukong steals his magic weapon, and Taishang Laojun transports him back to Tushita Palace.

Figure 16
Golden Horn King

Note. Photograph taken from SuoLe Soulhappy Studio.

5. Princess Iron Fan

Princess Iron Fan, the Bull Demon King's wife, possessed the precious Plantain Fan. When the Tang Priest and his disciples were obstructed by the Fiery Mountains, Sun Wukong arrived to borrow a fan. She held grudges against Sun Wukong for the incident involving her son Red Boy and repeatedly refused. After a series of disagreements, she eventually lent the fan, allowing the disciples to continue their westward journey.

Figure 17
Princess Iron Fan

Note. Photograph taken from https://so.redocn.com.

5. Nezha

Nezha is a rebellious child-hero from Chinese mythology who emerged from a lotus after a miraculous three-year pregnancy. With supernatural abilities, he battles sea creatures and defies authority. When Nezha accidentally kills the Dragon King's son, chaos ensues, and he makes the ultimate sacrifice to save his family. Later, his mentor, Taiyi Zhenren, resurrects him with lotus roots, giving him a new body and powerful weapons such as the Wind Fire Wheels and the Fire-tipped Spear. Nezha has been reborn and is now fighting evil and defending the heavens. His story represents youthful defiance, redemption, and the pursuit of justice against oppressive forces in both the celestial and terrestrial realms.

Figure 18
Nezha

Note. Photographed from Collection of National Art Museum of China.

5. The Spider Demon

The Spider Demon, who had become spirits in the Spider Cave, used spider silk to entrap Tang Seng and his disciples. In the battle against Sun Wukong, they were skilled at constructing arrays out of silk and could summon a large number of spiders to assist. Sun Wukong eventually discovered their weaknesses and defeated them.

Figure 19

Spider Demon

Note. Photographed from https://so.redocn.com.

6. Sha Wujing

Sha Wujing, formerly known as the Curtain-Raising General, was exiled to the Liusha River after breaking a valuable glass cup. After becoming Tang Seng's disciple, he faithfully carried the luggage on the journey. Known for his honesty and diligence, he was rewarded with the position of Golden - Body Arhat at the end of the pilgrimage.

Figure 20
Sha Wujing

Note. Photograph taken from Guangzhou Provincial Museum.

7. Sun Wukong

Sun Wukong, the Stone Monkey, descended from a stone egg and became the Monkey King by claiming the Water Curtain Cave. He gained supernatural abilities at LingTai Fangcun Mountain. He then rebelled against Heaven, resulting in his confinement under the Five - Phases Mountain. Eventually, he joined Tang Seng on the Westward Journey, defeating numerous demons and achieving enlightenment after a series of trials.

Figure 21
Sun Wukong

Note. Photograph taken from Guangzhou Provincial Museum.

8. Tang Seng

Tang Seng, who had been devoted to Buddhism since a young age, was commissioned by the Tang Emperor to embark on the arduous Westward Journey in search of Buddhist scriptures. With his unwavering compassion, he avoided killing even demons, frequently falling victim to their deceptions. However, protected by his disciples, he overcame eighty-one tribulations and eventually attained Buddhahood.

Figure 22
Tang Seng

Note. Photograph taken from Guangzhou Provincial Museum.

9. White Dragon Horse

The third prince of the Western Sea, Ao Lie, broke heavenly laws by setting fire to a pearl bestowed by the Jade Emperor. He transformed into a white horse and carried Tang Seng on the Westward Journey while making silent contributions. Following the journey, he returned to his dragon form and was enshrined as the Dragon Horse of the Eight Directions and Wide-Power Bodhisattva.

Figure 23
White Dragon Horse

Note. Photograph taken from Collection of National Art Museum of China.

10. Zhu Bajie

Zhu Bajie, formerly Marshal Tianpeng, was banished to the mortal world for molesting the Moon Fairy and reincarnated as a pig. During the Westward Journey, he was indolent and lustful, but he showed courage in critical moments, contributing to the group's success. He was finally given the title of Altar-Cleansing Buddha.

Figure 24

Zhu Bajie

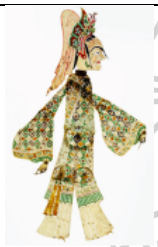
Note. Photographed from Guangzhou Provincial Museum.

11. Analysis of Puppets from "Journey to the West"

The researcher conducted a comparative analysis of all the puppets, including 3material usage, techniques, and color, as shown in Table 3.

Table 3

Analysis of Shadow Puppet Characters From "Journey to the West"

Character	Figure	Material	Techniques	Elements	Color
Bull Demon King		Metal, cloth, leather	Carving, dyeing, painting	Strong, wearing golden helmet and silver armor, tiger whiskers	
Guanyin		Cloth, wood, paper pulp	Carving, painting	Gentle, wearing flowing robe, fine eyebrows and clear eyes	
Jade Emperor		Metal, bamboo	Carving, sewing	Majestic, wearing royal court attire	
King of the Golden Horn		Metal, bamboo, cloth, wood	Carving, weaving, painting, dyeing	golden horns on its head, fangs on its red face, and is wearing a robe	
Princess Iron Fan		Cloth, metal, wood	Weaving, sewing, painting	Mysterious, delicate, slender body, long hair	
Nezha		Cloth, wood	Carving, painting, sewing	Small, agile, red fur, mischievous face, sharp eyes	

Character	Figure	Material	Techniques	Elements	Color
Spider Demon		Bamboo, cloth, wood	Carving, dyeing, painting	Slim, ghostly, wearing black robe	
Sha Wujing		Bamboo, leather, wood	Carving, sewing	Tall, serious, long hair, long beard, neat	
Sun Wukong		Leather, bamboo, wood, cloth, metal	Carving, weaving, painting, dyeing	Yang carved empty face, slender body, red dot on mouth, fine eyebrows, long hair and beard	
Tang Seng		Cloth, paper pulp, wood	Carving, sewing, painting	Round face, simple, long hair, holding a staff	
White Dragon Horse		Bamboo, cloth	Weaving, painting	Slender body, white horse	
Zhu Bajie		Leather, bamboo, wood, cloth	Sewing, painting, carving	Fat, short, thick eyebrows, big mouth, long ears	

Note. Data collected, compiled, and analyzed by the author.

The analysis of Chinese shadow puppet characters in Journey to the West reveals a wide range of materials, techniques, and symbolic design elements used to convey each figure's personality and mythological role. Each puppet is made with a unique combination of materials—ranging from leather, cloth, bamboo, wood, and metal—

and uses traditional techniques such as carving, painting, dyeing, sewing, and weaving to bring the characters to life.

Heroic puppets, such as Sun Wukong, are depicted with intricate features such as a slender body, red dot mouth, and expressive facial details, created from a variety of materials to emphasize his dynamism and supernatural nature. His carved, hollow face, and long hair symbolize agility and wisdom. Similarly, Tang Seng's design is simple—round face, long hair, and staff—reflecting his calm and pious demeanor.

Divine beings such as Guanyin and the Jade Emperor have gentle or majestic features, with softer materials (such as paper pulp or bamboo) and flowing garments emphasizing spiritual elegance and authority. Guanyin's fine features and clear eyes accentuate her compassionate role, whereas the Jade Emperor's royal attire emphasizes his celestial dominance.

Demonic or antagonistic characters, such as the Bull Demon King and Spider Demon, have more aggressive and striking designs. The Bull Demon King is armored, muscular, and tiger-whiskered, demonstrating brute strength. The Spider Demon appears ghostly and slim, dressed in black to represent seduction and danger.

Exaggerated forms—fat body, thick brows, and long ears—are used to depict comedic or earthly characters such as Zhu Bajie, capturing his humorous and gluttonous characteristics. Sha Wujing, on the other hand, appears tall and serious, personifying stoicism and loyalty.

Overall, the puppet design process in this traditional art form strikes a delicate balance between physical aesthetics, material symbolism, and character archetypes. Each puppet's construction and visual style are designed to enhance storytelling, moral themes, and emotional resonance during the shadow play performance.

2.2.2 Puppets from Story “The Romance of the Three Kingdoms”

1. Cao Cao

Cao Cao, a powerful official in the late Eastern Han Dynasty, was both astute and resourceful. He kidnapped the emperor to command the feudal lords and defeated Yuan Shao at the Battle of Guandu, uniting the north. However, his suspicious nature made him a divisive figure during the chaotic Three Kingdoms era.

Figure 25

Cao Cao

Note. Photograph taken from https://njmuseumadmin.com.

2. Diao Chan

Diao Chan, the adopted daughter of Minister Wang Yun in the late Eastern Han Dynasty, was well-known for her beauty. Wang Yun devised a chain of events to eliminate Dong Zhuo. Diao Chan pitted Dong Zhuo and Lu Bu against each other, inciting conflict, and eventually Lu Bu killed Dong Zhuo.

Figure 26
Diao Chan

Note. Photograph taken from China National Museum of Arts and Crafts.

3. Guan Yu

Guan Yu, Liu Bei's second sworn brother, was well-known for his loyalty and righteousness. He killed Yan Liang and Wen Chou at Baima Slope, then crossed five passes and killed six generals on his way to find his brother. While guarding Jingzhou, he flooded the seven armies, stunning the world and establishing great military achievements for the Shu Han.

Figure 27
Guan Yu

Note. Photograph taken from https://www.thepaper.cn.

4. Liu Bei

Liu Bei, the Shu Han's founding emperor, was benevolent and kind-hearted. After taking the Oath of the Peach Garden, he was determined to restore the Han Dynasty. He went to Zhuge Liang's thatched cottage three times to invite him to serve. After arduous efforts, he established the Shu Han regime, earning the people's love and respect.

Figure 28
Liu Bei

Note. Photograph taken from China National Museum of Arts and Crafts.

5. Zhu Geliang

Zhuge Liang, a resourceful strategist who assisted Liu Bei. Even before leaving his thatched cottage, he predicted the world's division into three parts. During the Battle of Red Cliffs, he cleverly used the east wind to help the Sun-Liu allied forces defeat Cao Cao. Throughout his life, he worked tirelessly to restore the Han Dynasty**.**

Figure 29
Zhu Geliang

Note. Photographed by the author.

6. Zhang Fei

Zhang Fei, a valiant general under Liu Bei, had a hot temper. He single-handedly rescued the young master from Changbanpo, frightening away the Cao army. He once saved Yan Yan's life and helped Liu Bei enter Sichuan. Although he was extremely brave, his violent temper resulted in him frequently flogging soldiers while drunk.

Figure 30

Zhang Fei

Note. Photograph taken from https://www.thepaper.cn.

7. Analysis of Puppets from "The Romance of the Three Kingdoms"

The researcher conducted a comparative analysis of all the puppets, including material usage, techniques, and color, as shown in Table 4.

Table 4

Analysis of shadow puppet characters in The Romance of the Three Kingdoms

Character	Figure	Material	Techniques	Elements	Color
Cao Cao		Cloth, leather, silk, metal	Sewing, painting, dyeing, engraving	Cunning, ruthless, wearing official attire, often depicted holding a	

Character	Figure	Material	Techniques	Elements	Color
				sword or riding a horse	
Diao Chan		Silk, cloth, beads, metal	Sewing, painting, weaving	Beautiful, graceful, wearing an elegant gown, adorned with jewelry, often depicted with a fan	
Guan Yu		Metal, cloth, leather, silk	Forging, sewing, engraving	Heroic, calm, long beard, holding a green dragon crescent blade, wearing armor	
Liu Bei		Cloth, leather, metal, silk	Sewing, carving, dyeing, painting	Honest, benevolent, wearing simple robes, holding a sword, and often depicted with a gentle face	

Character	Figure	Material	Techniques	Elements	Color
Zhu Geliang		Silk, cloth, metal	Painting, sewing, engraving, writing	Intelligent, calm, holding a fan, often depicted wearing scholarly robes	
Zhang Fei		Leather, cloth, metal	Carving, sewing, engraving	Fierce, muscular, short black beard, often depicted with a spear, rough expression	

Note. Data collected and compiled by the author.

The analysis of Chinese shadow puppetry characters from The Romance of the Three Kingdoms reveals a highly stylized approach that employs materials, techniques, and visual symbolism to embody the distinct personalities and roles of historical and literary figures. The puppets are made of traditional materials such as cloth, leather, silk, and metal, with fine detail and expressive forms achieved through techniques such as sewing, carving, dyeing, engraving, and painting.

Cao Cao is portrayed as cunning and ruthless, frequently appearing in official attire wielding a sword or riding a horse. The use of luxurious materials such as silk and metal, combined with engraving and dyeing techniques, reflects his ambitious and authoritative personality. His visual portrayal reinforces his status as a complex antagonist.

Chan Diao, a graceful and attractive female figure, is dressed in silk, cloth, beads, and fine metal accessories. Her appearance—elegant gown, jewelry, and fan—emphasizes femininity and charm, with sewing and weaving accentuating delicacy and refinement.

Guan Yu is depicted as a heroic and stoic figure, wearing armor and wielding his signature green dragon crescent blade. His long beard and calm demeanor are carved and engraved into leather and metal, symbolizing strength, loyalty, and honor.

Liu Bei stands out from martial figures because he embodies honesty and benevolence. His simple robes, gentle facial features, and sword identify him as a virtuous leader. The techniques he used, such as dyeing and painting on softer cloth and silk, emphasized his moral integrity and humility.

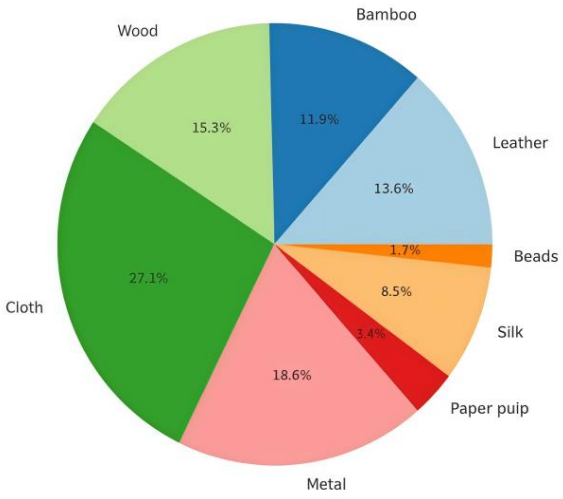
Zhuge Liang is depicted as a wise and scholarly strategist, holding a fan and wearing scholar's robes. Painting and engraving are used to convey a calm, intelligent demeanor that emphasizes intellectual power over physical force.

In contrast, Fei Zhang (Zhang Fei) is fierce and muscular, with a short black beard and a rough demeanor. His representation in leather and metal, along with carving and engraving, emphasizes his warrior nature and emotional intensity.

Overall, this shadow puppetry character design system intricately aligns visual features with narrative identity, enhancing storytelling by physically manifesting abstract virtues and vices through materiality and artistry.

2.2.3 Puppetry Material and Color Usage Analysis

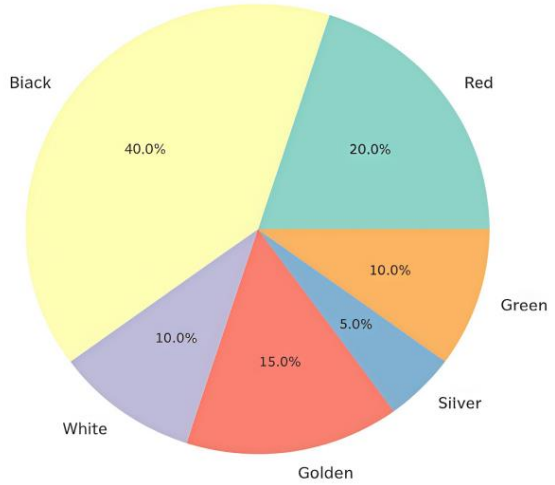
Figure 31
Material Analysis



Note. Analyzed by the researcher.

Figure 31 shows that when making shadow puppets, most people choose cloth (27.1%), metal (18.6%), wood (15.3%), leather (13.6%), and bamboo (11.9%) as materials, and a small number of people choose silk (8.5%), paper pulp (3.4%), and beads (1.7%) to make shadow puppet characters.

Figure 32
Color Analysis



Note. Analyzed by the researcher.

Figure 32 shows that black (40%), red (20%), and gold (15%) are the most commonly used colors when making shadow puppet characters. White (10%) and green (10%) are used in similar proportions, and silver (5%) is also used.

2.3 Theories to Apply to Develop a DIY Shadow Play

2.3.1 Constructivist theory

Constructivist theory emphasizes learners' active participation in knowledge construction, viewing learning as a dynamic process in which individuals acquire and build new understanding through interaction with their environment, based on prior knowledge and experience. It emphasizes the learner's agency by presenting learning as an active exploration, discovery, and meaning-making process rather than a passive reception of information (Hein, 1991).

In this regard, Constructivist theory can be used as a guideline to create an effective shadow play learning system.

2.3.3 Do It Yourself Approaches

DIY, or "Do It Yourself," refers to an individual who relies on his or her own abilities and resources to complete a specific task or create a product without the assistance of a professional (Mellis, 2015). Under various historical and technological conditions, the form and connotation of DIY are constantly evolving, extending from the traditional handmade field to emerging fields dominated by modern technology, such as virtual reality (VR) and augmented reality (AR).

1. Traditional DIY

Traditional DIY (Figure 33) focuses primarily on manual skills in crafts such as woodworking, pottery, weaving, and embroidery. It employs everyday materials such as wood, clay, fabric, and yarn, transforming raw materials into functional or artistic finished products using hands-on methods. For example, woodworking DIY may entail making simple furniture or wooden ornaments, whereas pottery DIY entails shaping clay into vessels or sculptures.

Figure 33
Traditional DIY (Print Making)

Note. Photograph taken from the https://ccjd.jnu.edu.cn

2. Technology Based DIY

Technology based DIY uses advanced computer technology, graphics processing technology, and sensor technology to enable users to create their own virtual reality or augmented reality experience content (Nee et al., 2012). Its scope includes creating simple VR game scenes, AR interactive applications, virtual display spaces, and more. Users can, for example, use relevant software and tools to experience immersive educational scene or to use AR recognition functionality as a part of DIY experience.

3. Comparison Between Traditional and Technology Based DIY Solutions

Both traditional and technological DIY emphasize individual autonomy, allowing creators to control the entire production process and turn ideas into tangible results. While both approaches follow a structured learning process that includes knowledge acquisition, hands-on practice, and iterative refinement, they differ significantly in terms of tools, skills, and outcomes. Traditional DIY is based on manual skills and simple tools, making it easily accessible and rooted in natural materials and physical craftsmanship. In contrast, technological DIY, particularly in VR and AR, necessitates advanced computer literacy, theoretical understanding, and specialized software, yielding digital products such as virtual simulations or augmented experiences. Despite their differences, both forms provide effective platforms for creativity, skill development, and self-expression. As society becomes more digitized, the scope and definition of DIY evolve, bridging craft traditions with new digital practices.

2.4 Technologies for Heritage Preservation

2.4.1 Virtual and Augmented Reality Technologies

1. Virtual Reality (VR)

VR technology provides an immersive experience, allowing users to transcend time and space and fully engage with shadow puppetry performances and their distinct appeal. It offers extensive interaction freedom, allowing users to create diverse immersive environments tailored to their creativity and needs, broadening their experiential options. The strong sense of presence effectively communicates the cultural essence of shadow puppetry, encouraging a greater appreciation for traditional culture. Nonetheless, VR technology has some limitations.

One major limitation of VR technology is the high cost of hardware, such as VR head-mounted displays, which significantly raises the cost of the user experience. Furthermore, users who are unfamiliar with new technologies may face a steep learning curve, limiting shadow puppetry's widespread adoption. Despite these challenges, VR is ideal for reproducing traditional arts that require high display fidelity and immersive engagement, such as shadow puppetry. It excels at cultural immersion and interactive storytelling by creating a fully immersive visual environment that is independent of the real world, giving users the impression that they have entered a new realm of shadow puppetry while wearing the device.

2. Augmented Reality (AR)

AR technology has lower technical requirements than VR, lowering the user entry barrier and allowing non-technical audiences to quickly engage and enjoy the experience, broadening its reach. However, AR lacks the full immersion of VR because it does not create a fully virtual environment, resulting in a weaker integration of virtual and real elements. Furthermore, AR's performance is extremely sensitive to environmental factors; complex lighting or interference can cause operational problems, reducing its overall effectiveness.

3. Comparison Between the Two Technologies

Table 5 below shows the researcher's analysis of the two technologies.

Table 5
Analysis of VR and AR Technologies

Technology	**Immersive**	**Interaction**	**Concurrent Audience**
VR	Yes	Yes	One at a time
AR	No	Yes	Multiple Users

Note. Data collected and compiled by the author.

Virtual Reality (VR) and Augmented Reality (AR) both provide distinct technological advantages for different use cases. VR offers a completely immersive experience, transporting users into a virtual environment and effectively isolating

them from the real world. This makes VR ideal for specialized applications like training simulations or virtual tours. In contrast, augmented reality (AR) superimposes digital content onto the real world, allowing users to remain grounded while interacting with enhanced information. Although AR does not provide full immersion, it can support multiple users at once, making it ideal for collaborative experiences in education, exhibitions, and design. Both technologies allow for interactive engagement, but their respective capacities for immersion and audience scalability define their practical strengths and limitations.

2.4.3 Case Analysis

1. Chinese Bronze Wares: A Gamified Virtual Reality Museum

The project used two primary approaches. The first was contactless 3D scanning, which the team used to create a digital model of the bronze artefacts, avoiding direct contact and potential damage to the cultural relics and ensuring their safety.

Figure 34
Using VR to simulate bronze ware restoration

Note. Photograph taken from 2020 International Conference on Computers, Information Processing and Advanced Education (CIPAE).

The researchers explored integrating gamification with VR to enhance the curation of Chinese bronze wares. Using 3D laser scanning, they non-invasively captured detailed geometric and decorative features with sub-millimeter accuracy. Virtual museum construction combined photogrammetry (Figure 34) and 3D modeling to replicate exhibition spaces with synchronized interactive interfaces. VR curatorial games, developed with Unity and Unreal engines, allowed users to manipulate artifacts—rotating, zooming, and inspecting inscriptions—while triggering contextual narratives on history and casting techniques. This approach transformed static displays into dynamic, participatory experiences, attracting younger audiences and promoting global engagement with bronze culture. It illustrates how gamified VR can effectively bridge preservation and education, providing a scalable model for digitizing and revitalizing heritage artifacts (Zhang & Wang, 2023).

2. Augmented Reality Chinese Cultural Clay

The project supports the cultural protection goal by creating immersive experiences with Chinese clay, allowing users to interact with the subject and increasing interest. Furthermore, it can be played from anywhere which eliminates geographical and temporal barriers, making heritage accessible worldwide, facilitating inheritance and spread.

Figure 35

Do-It-Yourself Painting System Using Augmented Reality

Note. Photograph taken from http: // www.china-simulation.com.

Hou et al. (Hou, Ge, & Liu, 2021) built a MAR-based platform for clay sculpture preservation. They combined structured-light 3D scanning and mesh simplification algorithms to create lightweight digital models of artifacts. ORB-FV feature extraction and KLT optical flow tracking ensured robust markerless registration, overlaying 3D reconstructions onto real-world environments via mobile devices. The Unity3D-engineered system supported interactive coloring, multi-angle inspection, and animated storytelling to contextualize heritage. Culturally, MAR bridged historical artifacts with modern audiences, enabling tactile engagement and global dissemination.

3. "Digital Sponsor" NFTs of Dunhuang

In this project, users can create their own silk scarf using designs from the Dunhuang archeological site. Users can create a unique silk scarf by combining eight primary themes and more than 200 mural details. This is yet another successful example of a do-it-yourself approach to cultural heritage. Additionally, NFT Arts (Figure 36) are available from this very same project.

Figure 36

"Digital Sponsor" NFTs of Dunhuang

Note. Photograph taken from https://jingdailyculture.com.

Ji (Ji, 2024) pioneered the "Digital Sponsor Program" to reimagine Dunhuang's murals through hybrid technologies. They applied photogrammetry-based 3D reconstruction to digitize cave art, while H5 video technology embedded dynamic illustrations and soundscapes into interactive storytelling campaigns. Game design techniques transformed cultural symbols (e.g., celestial beings, lotus motifs) into customizable game skins, and blockchain-powered NFTs assigned unique ownership to digital artifacts. A DIY synthesis algorithm allowed users to fuse traditional patterns with modern aesthetics, generating scarves and digital collectibles. Culturally, this fused heritage with pop culture, engaging Gen Z audiences.

4. Dai Paper-Cut Digital Protection Using VR

This project uses virtual reality (Figure 37) to showcase Dai paper cuts, which are a cultural heritage of the Dai minority. Users can view Dai's papercut artwork by wearing a VR headset.

Figure 37
Dai Paper Cut VR Experience

Note. Photograph taken from 2017 2nd IEEE International Conference on Computational Intelligence and Applications.

Researcher Wu established a digitization pipeline for Dai paper-cut symbology. They used structured-light 3D scanners and multispectral imaging to archive intricate paper-cut patterns, while a CorelDRAW VBA-based CAD system automated design generation and symmetry analysis. Culturally, this preserved vanishing motifs and empowered artisan communities (Wu et al., 2017).

The aforementioned research and projects demonstrate the various applications of technology in cultural heritage preservation. They represent a shift toward interactive, user-centered digital models that combine immersive experiences, social media, and technological innovation. These initiatives are transforming the preservation and dissemination of traditional cultures, ensuring their relevance in the digital age while also encouraging broader, global engagement.

Table 6

Comparison of Digital Heritage Projects: Technologies, Applications, and Impacts

Note.

Project	**Technologies**	**Application**	**Impact**
Chinese Bronze Wares: A Gamified VR Museum	VR technology, contactless 3D scanning, gamification techniques	Simulated pottery-making process; interactive learning	Enhances cultural learning through gamification; protects artifacts by avoiding direct contact; improves safety and efficiency
Augmented Reality Chinese Cultural Clay	Mixed Augmented Reality (MAR), 3D scanning, mesh simplification	DIY coloring; mobile and cloud-based digital heritage display	Breaks geographic and temporal barriers; fosters cultural heritage appreciation; empowers users through creative engagement with DIY exploration
"Digital Sponsor" NFTs of Dunhuang	NFTs	DIY design	Boosts cultural values through NFTs; garners widespread engagement with 44M+ views; contextualizes ancient art for modern audiences; encourages creativity through personalized cultural heritage products
Dai Paper-Cut Digital Protection Using VR	VR technology, digital databases, social media	Digital cataloging; immersive viewing via VR; social sharing of designs	Preserves traditional art in digital form; increases global awareness and accessibility; fosters innovation in cultural practices

Note. Data collected and analyzed by the author.

2.4.4 DIY Applications Analysis

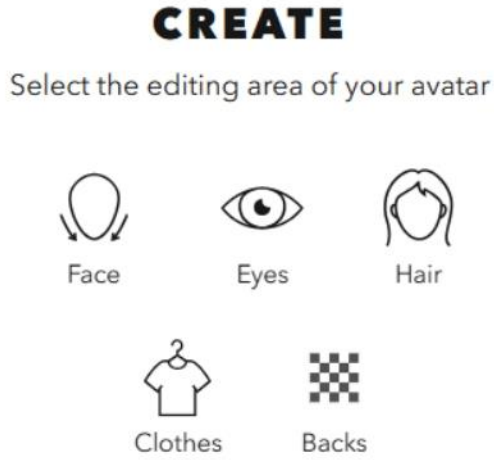
1. Avatar Maker

Avatar Maker (Figure 38) is an image-driven tool for generating virtual avatars, designed to minimize user effort by simplifying complex technical processes through modular interfaces and step-by-step guidance. In the model generation phase, users upload facial feature data via photo or real-time camera capture. The system then applies image feature analysis and preset algorithms to automatically generate a virtual head model, adjusting parameters such as facial shape and contours to produce an initial avatar.

Figure 38
Avatar Maker: Start Screen

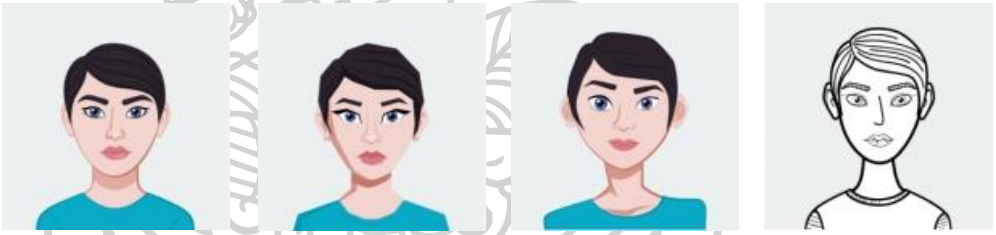
Note. Screen captured by the author from https://avatarmaker.com.

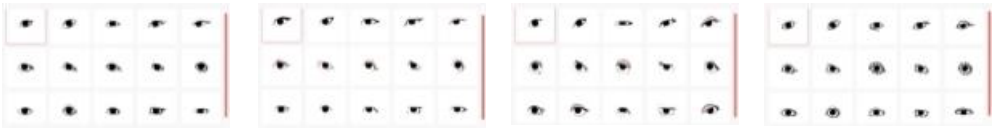
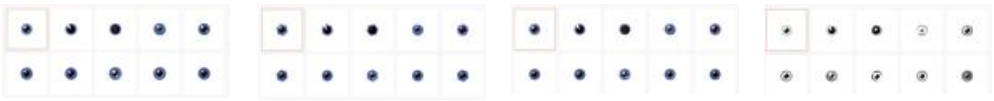
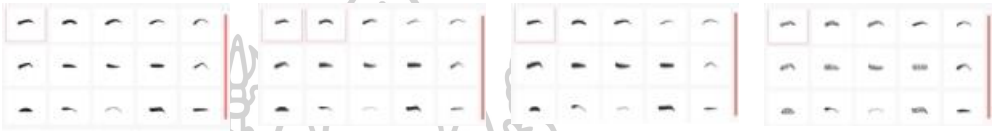
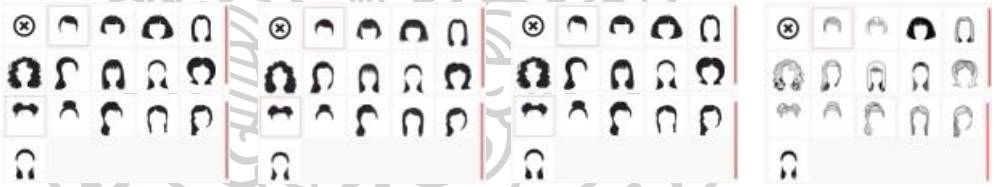
Figure 39
Avatar Maker: Select the Editing Area



Note. Screen captured by the author from https://avatarmaker.com.

Table 7
Avatar Maker: Female Avatar DIY Analysis

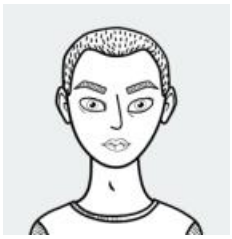
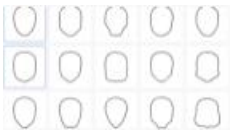
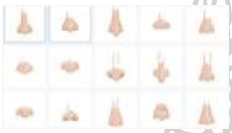
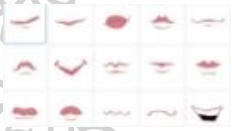
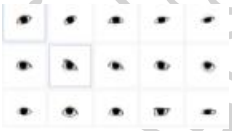
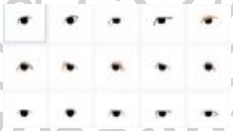
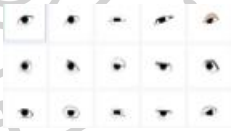
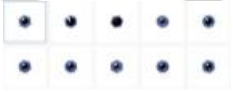
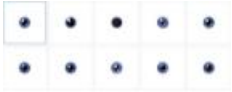
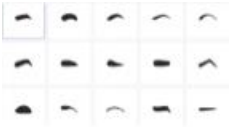
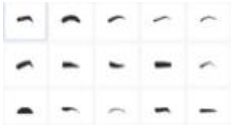
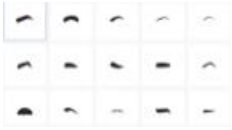
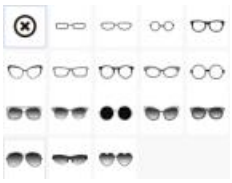
Head	
Face	
Nose	
Mouth	

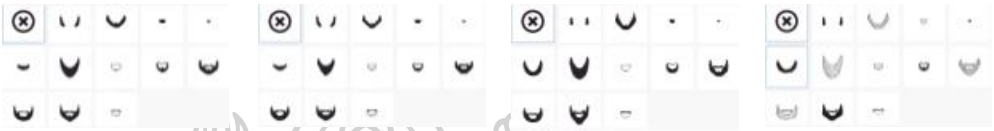
Ear	
Eyes	
Iris	
Brows	
Glasses	
Hair	
Clothes	
Backs	

Note. Data collected and compiled by the author from https://avatarmaker.com

Table 8

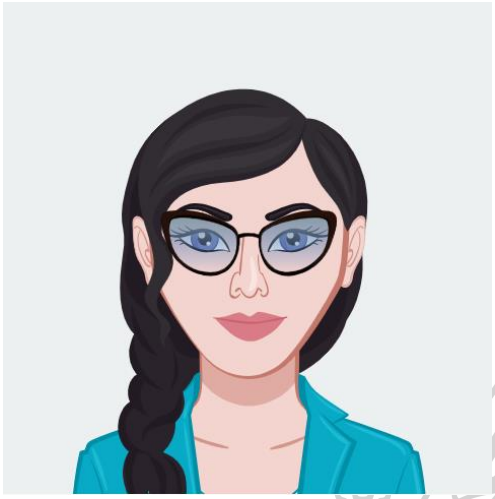
Avatar Maker: Male' Avatar DIY Analysis

Head				
Face				
Nose				
Mouth				
Ear				
Eyes				
Iris				
Brows				
Glasses				

Hair	
Mustache	
Beard	
Clothes	
Backs	

Note. Data collected and compiled by the author.

Figure 40
Female Avatar Result



Note. Screen captured by the author from https://avatarmaker.com.

Figure 41
Male Avatar Result

Note. Screen captured by the author from https://avatarmaker.com.

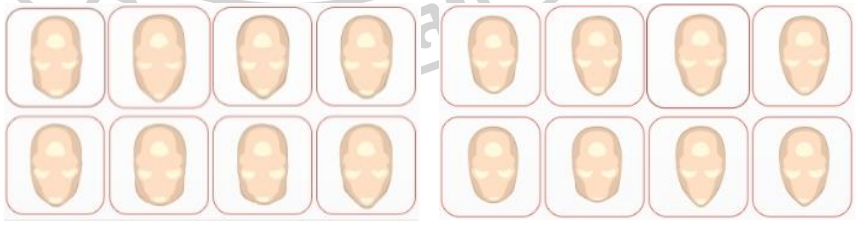
Tables 7 and 8 show Avatar Maker's modular customization system, including the editable components available for creating female and male avatars. Female avatars have 13 customizable elements: head, face, nose, mouth, ears, eyes, iris, brows, glasses, hair, clothes, and backgrounds. Male avatars include all of these features, plus mustache and beard options, for a total of 15 editable categories. This structure exemplifies a balanced design that includes both extensive customization and gender-specific features. The system emphasizes user control and personalization, allowing

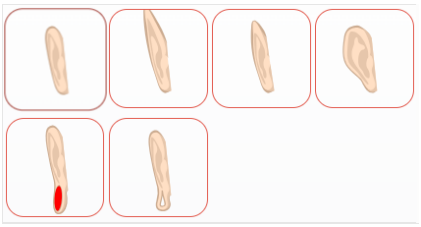
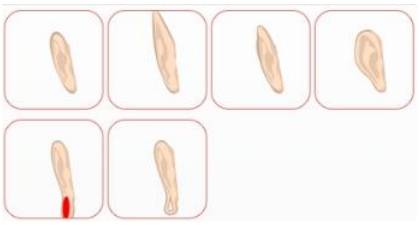
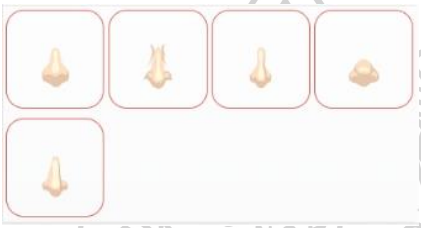
for the creation of detailed and expressive virtual representations via an intuitive and adaptable interface.

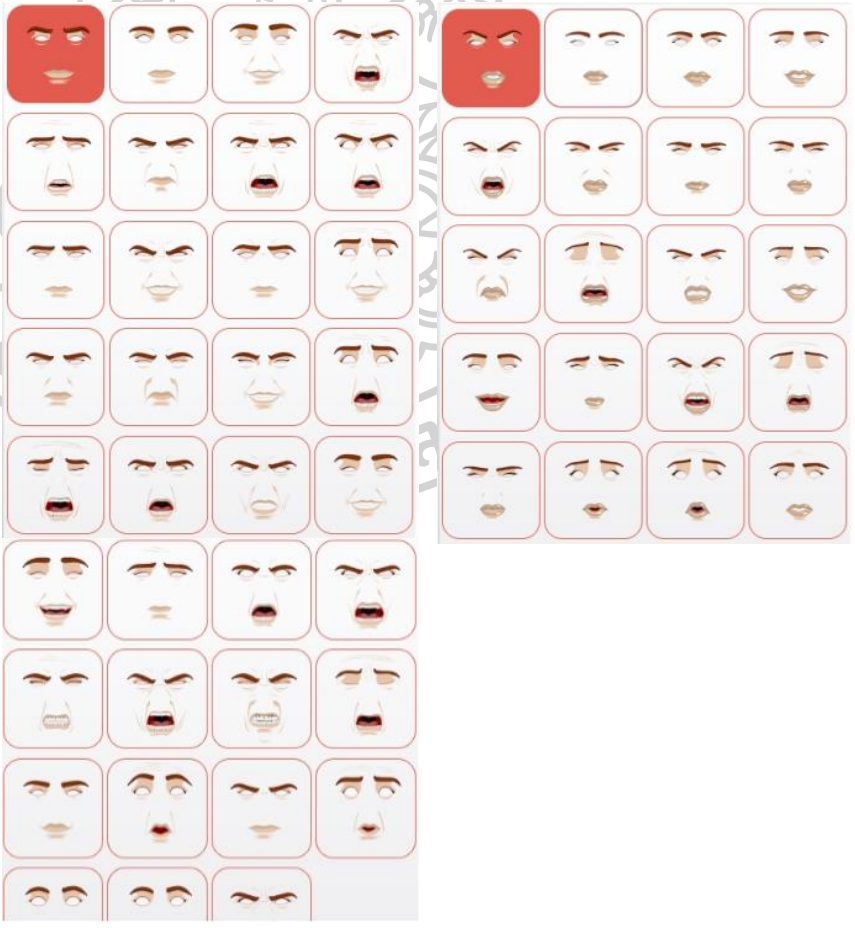
2. Character Creator

Character Creator is yet another avatar creator. You can begin customizing your character by selecting a gender (male or female). Next, use the built-in slider system to personalize the character's body proportions, facial features, and skin color. Then choose and apply appropriate hairstyles, clothing, and accessories to complete the character's appearance. Men have beards, war paint, scars, jackets, watches, and socks, whereas women have makeup, veils, nails, collars, bras, tops, blouses, skirts, bracelets, shorts, and skirts. Table 9 displays a variety of avatar parts that users can customize.

Table 9
Avatar Parts in the Character Creator

	 
Body Head	
Body	

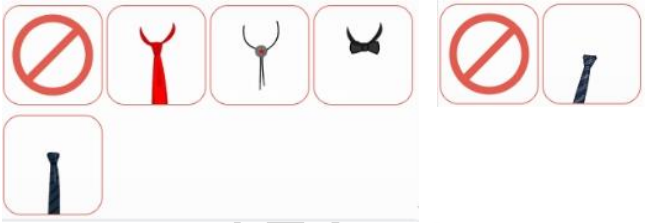
Ears		
Iris		
Nose		
Facial hair		

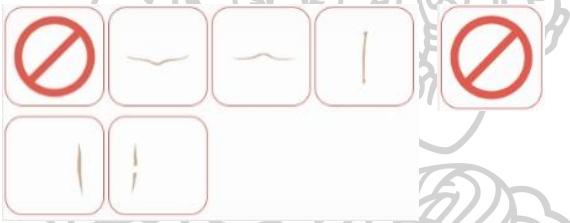
Hair	
Emotion	

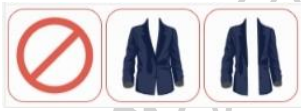
Smoke	
Make up	
Earrings	
Hat	

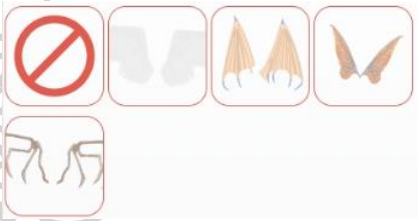
Horns	
Mask	
Glasses	
Eyepatch	
Headband	
Necklace	

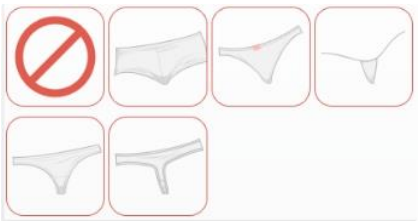
Warpaint	
Earpiece	
Veil	
Tattoo	
Nails	
Collar	
Bra	
Top	

Shirt	
Tie	
Vest	
Button	
Holster	

Shoulder pads	
Scarf	
Scar	
Suit	
Blouse	

Dress		
Jacket		
Blouse		
Coat		
Cloak		
Robe		

Bracelet		
Armband		
Wings		
Watch		
Gloves		
Holding		

Underwear		
Shorts		
Skirt		
Pants		
Belt		
Leggings		

Kneepads		
Socks		
Shoes		
Pet		

Note. *Note.* Data collected and compiled by the author.

Figure 42
A Customized Male Avatar from the Character Creator

Note. Screen captured by the author from https://charactercreator.org.

Figure 43
A Customized Female Avatar from the Character Creator

Note. Screen captured by the author from https://charactercreator.org.

The system allows users to design digital characters with customizable features such as headgear, masks, and props. These elements can be freely chosen and combined by the user, providing a versatile framework for personalized design. This suggests that the system values user agency and creative freedom, allowing for a wide range of character variations via modular customization. The emphasis on accessories such as headgear and props demonstrates a focus on visual distinctiveness and expressive detail during the character creation process.

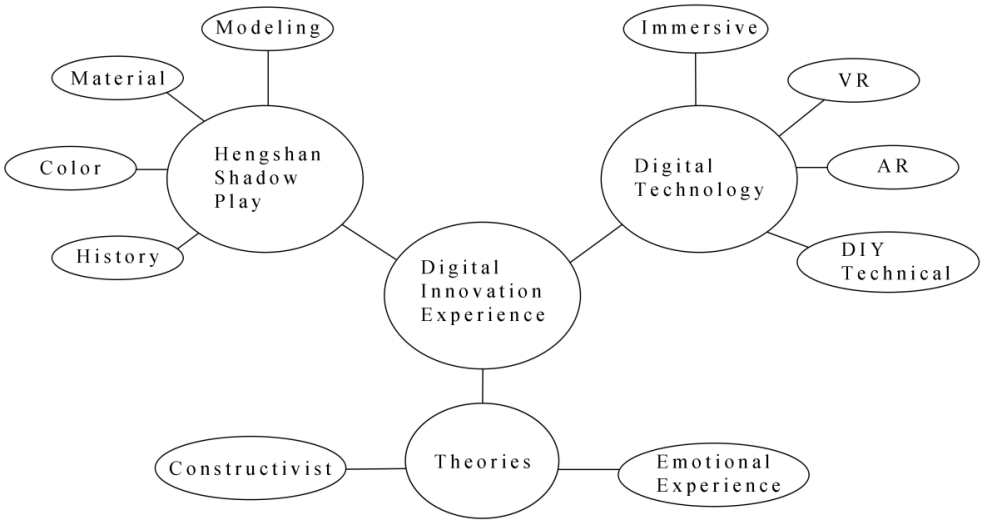
By studying these two cases for research, we learned how a DIY approach can be used to create characters, especially key processes and element design. However, both systems are rather complicated for a young audience, with too many parts to choose

from. As one of the main objectives of our research was to create a system to learn shadow puppet parts and compositions, overly complex systems might hinder learning. Thus, the researchers decided to simplify the parts and make the process less complicated. By doing so, it is possible to make a DIY system that's easy for young users to operate.

2.5 Conceptual Framework

Figure 44

Conceptual Framework



Note. Illustrated by the author.

Figure 44 depicts a conceptual framework that connects "Digital Innovation Experience" to three major categories: "Hengshan Shadow Play," "Digital Technology," and "Theories."

Central Concept: Digital Innovation Experience.

This central node indicates that the ultimate goal is to provide an innovative experience by combining digital tools and traditional art. In the context of a DIY learning system, this "experience" would be the user's journey through learning and creating Hengshan shadow puppetry.

1. Hengshan Shadow Play (Content and Subject Matter)

This part represents the traditional art form that is the focus of the educational system. The sub-elements represent the aspects of Hengshan shadow play that will be incorporated into the learning experience:

Structure (Model): This refers to the design, shape, and structure of the shadow puppets themselves. In a DIY system, this could entail teaching users how to design and construct their own puppet models.

Material: This refers to the traditional materials used for puppets (such as leather and paper). A digital learning system could investigate virtual representations of these materials or recommend practical alternatives for DIY creation.

Color: The colors used in shadow puppetry, which may have symbolic significance or contribute to the aesthetic. The system could teach about traditional color palettes or allow users to experiment with color digitally.

History: The background, origins, and evolution of Hengshan shadow play. This would provide valuable background information for students.

2. Digital Technology (Tools & Methods)

This branch describes the digital tools and approaches that would allow the "Digital Innovation Experience" to learn Hengshan shadow puppetry:

Immersive: This refers to the use of technologies to create a highly engaging and absorbing learning environment.

VR (Virtual Reality): Refers to the potential for virtual environments in which users can explore virtual puppet stages, manipulate virtual puppets, or participate in simulated performances. This could be extremely useful for remote learning.

AR (Augmented Reality): This suggests superimposing digital information on the real world. For a DIY system, augmented reality could guide users through physical puppet construction, display real-time animations on physical puppets, or provide interactive instructions.

DIY: This is essential for any "DIY learning system." It implies that digital tools will allow users to create and experiment for themselves. This could include user-friendly software for creating puppets, animating scenes, and even controlling virtual stages. It implies a preference for practical, hands-on digital creation.

3. Theories

This section provides the following theoretical perspectives that would inform the design of the learning system:

Constructivism: This educational theory emphasizes active learning, in which students build their own understanding and knowledge through experience and reflection. In a DIY system, learners would actively design, build, and experiment with shadow puppets rather than passively receiving information.

Emotional Experience: This emphasizes the importance of emotionally engaging learners. The learning system should strive to evoke a sense of wonder, joy, or satisfaction through the creative process and interaction with the art form. This could be accomplished with engaging narratives, visually appealing interfaces, and opportunities for self-expression.

2.6 Chapter Summary

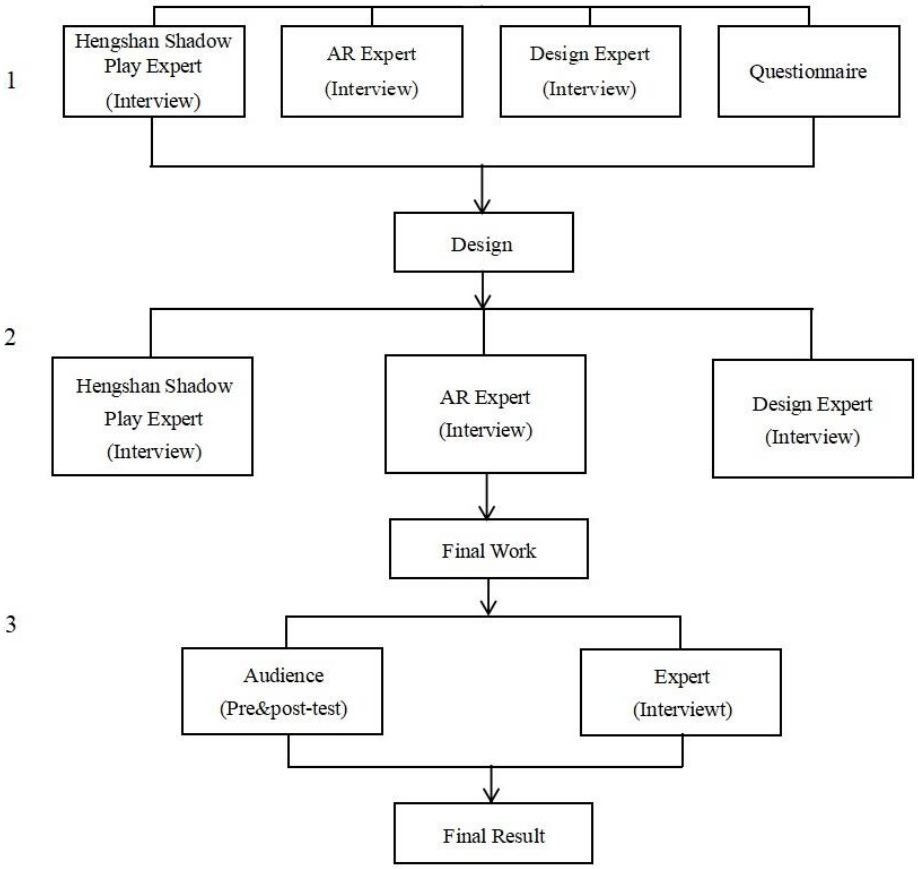
The Digital Innovation Experience for Learning Hengshan Shadow Puppetry should use Digital Technology (specifically immersive VR/AR and DIY technical tools) to engage students in various aspects of Hengshan Shadow Play (modeling, material, color, history). Constructivist principles should underpin the entire learning process, allowing students to actively build their knowledge and skills while also encouraging a positive emotional experience. The "DIY Technical" component of Digital Technology is especially important because it directly supports the user's ability to create and learn hands-on.

CHAPTER 3
RESEARCH METHODOLOGY

To achieve its objectives, this study used a mixed-methods approach. To begin, methods such as literature review and field research are used to create a conceptual framework. The prototype is then created using a combination of qualitative methods (such as expert interviews and field investigations) and quantitative methods (questionnaire surveys). Finally, the final innovation is achieved through the quantitative method of the general public filling out questionnaires, as well as the qualitative analysis of direct suggestions from experienced experts to ensure model integrity.

3.1 Research Phases

Figure 45
Research Phases



Note. Developed by the researcher.

The research was divided into four major phases: establishing the research framework (Phase 1), designing and developing the prototype (Phase 2), modifying the model (Phase 3), and final innovation (Phase 4).

3.1.1 Develop Research framework

In the first stage, the research framework is determined through literature review and case analysis to facilitate subsequent research work.

1. Literature Review Criteria

The main contents of the literature review are divided into two categories: traditional shadow play content and digital reality technology. The knowledge related to shadow play mainly comes from Wang Donglin, the provincial inheritor of Hengshan shadow play, domestic knowledge network and international journals, and the literature related to digital technology is mainly selected from global academic journals. The relevant literature covers the period from 2006 to the present

2. Case Study Criteria

This study adopts the case study method in the use of digital reality technology in shadow puppetry, selects some cases of digital reality technology for analysis and sampling, and analyzes the digital reality technology that is most suitable for research and promotion in combination with shadow puppetry. The relevant cases are selected after 2015 and are not limited to any country.

3.1.2 Prototype Development

In the second stage, the research focuses on developing the prototype using the data obtained from interviews, questionnaires, and observations, and advancing the research process through prototype improvement.

1. Expert Selection Criteria

We chose three experts for interviews based on their expertise in their respective fields: a designer who specializes in user needs and interaction technologies, a Hengshan shadow puppetry professional, and a program development technician.

2. Participant Selection Criteria

The questionnaire was distributed at to adults aged 15 and up using the Questionnaire Star online platform, which has online survey, examination, assessment, and voting capabilities.

3. Study Site Criteria

This study focused on Hengshan County in Hunan Province, with a particular emphasis on the inheritance of Hengshan shadow puppetry and its derivative products. Furthermore, the investigation focused on the history, market, and collection hall of Hengshan shadow puppetry. On-site investigations revealed the regional characteristics of Hengshan shadow puppetry. During this stage, the prototype was greatly improved by incorporating feedback from expert interviews, structured questionnaires, and personal observations in Hengshan County, Hunan Province.

3.1.3 Update and Optimization

In the third phase, the focus is on obtaining feedback on the model through questionnaire surveys and expert evaluations.

1. Audience Evaluation Criteria

Audience Suggestion Form: Audiences were invited to participate in the prototype and provide feedback. The feedback was mainly aimed at collecting user experience and suggestions for innovative improvements, thereby providing design improvement suggestions for the final innovation.

Audience Observation Form: The purpose of the observation was to record the interaction between the audience and the prototype. These observational data played a crucial role in determining the areas for innovative improvement.

2. Expert Evaluation Criteria

We invited experts to evaluate the prototype using their professional knowledge and experience: Two experts were chosen to provide feedback based on their respective professional knowledge. One expert in user experience and interaction design provided insights into the application program's design. The other expert had extensive experience with Hengshan shadow puppetry and shared valuable insights

into its production. This stage encouraged iterative improvement of the prototype, using audience feedback and expert insights to improve the design and function of the innovation, preparing for the final innovation development phase.

3.1.4 Testing and Validation

In the fourth stage, necessary data were collected through two tests, which played a crucial role in improving and innovating the program.

1. First Exhibition

The exhibition was viewed by 40 participants divided into two groups of 20 each. One group went to see the traditional handmade shadow puppets, while another went to the shadow puppetry application program. Following the visit, the two groups completed the necessary tests to assess user satisfaction with the application program.

Audience Evaluation Criteria: The evaluations and suggestions for improvement from the two groups of audiences were collected. These findings confirmed that the audience was more accepting of the application program and provided suggestions for improvement and innovation.

Expert Evaluation Criteria: Three experts in interaction design, shadow puppetry inheritance, and program development technology were asked to make improvement suggestions for the innovation, improving it from various professional perspectives.

2. Second Exhibition

A total of 40 participants visited the shadow puppetry application program in the second exhibition. Similar to the first exhibition, the visitors participated in the pre-test and post-test to prove their knowledge acquisition of Hengshan shadow puppetry.

Audience Evaluation

Audience Suggestion Form: The audience's feedback mainly focused on the functions of the application program, providing unique insights.

Audience Observation Form: By observing the behavior and interaction of the audience during the exhibition, data were provided for the final innovation.

Expert Evaluation: Experts in interaction design, shadow puppetry inheritance, and program development technology were consulted to solicit their feedback on further improving the innovation. Their collective opinions ensured that all key aspects of the innovation improvement were comprehensively considered. These exhibitions and evaluations in the fourth stage helped to validate the effectiveness of the innovation and improve its design based on the audience feedback and expert suggestions, thus preparing for the final determination.

3.2 Research Samples

In this study, the sample group was divided into different categories, and each category played a specific role in the research process.

3.2.1 Questionnaire Survey

Volunteers were recruited to fill out the questionnaire to evaluate the scope and necessity of the research design.

Sample Range: Adult volunteers aged 15 and above who were interested in shadow puppetry.

Sample Size: 300

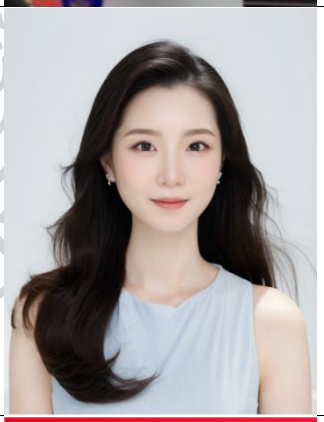
3.2.2 Expert Interview

Experts were invited to evaluate the feasibility of the design in multiple stages. Table 10 shows the list of experts and their fields of expertise.

Table 10

List of Experts

#	Expert	Name / Job Description	Photo
1	AR	**Huang Chen** Head of the Digital Media Program at the VR Industry College of Jiangxi University of Finance and Economics, Doctor of Arts	

#	Expert	Name / Job Description	Photo
2	AR	**Tang Rui** Director of the Digital Media Art Department of the School of Art at Jiangxi University of Finance and Economics.	
3	Design	**Qiu Zhitao** Professor and Master Supervisor at the School of Packaging Design and Art, Hunan University of Technology	
4	Design	**Zhao Nianci** Chinese University of Hong Kong	
5	Hengshan Shadow Puppet	**Ouyang Xinnian** Provincial-level inheritor of Hengshan shadow play	

#	Expert	Name / Job Description	Photo
6	Hengshan Shadow Puppet	**Wang Donglin** Provincial-level inheritor of Hengshan shadow play	
7	Hengshan Shadow Puppet	**Yuan Chunming** Municipal-level Hengshan Shadow Play Inheritor	

Note. Data collected and compiled by the author.

3.3 Research Variables

3.3.1 Independent Variable

DIY Hengshan shadow puppetry character creation system.

3.3.2 Dependent Variables

Audience's knowledge of Hengshan shadow puppetry (Efficacy)

Audience's satisfaction of the application

3.4 Research Tools

3.4.1 Preparation of Research Tools

This study was divided into stages, each with its own set of research tools. Prior to implementing these research tools, preparation was required. The creation of research tools is an important first step in the digital technology development of the shadow puppetry application program. These tools aided in understanding how

shadow puppetry knowledge was conveyed using digital technology. The researchers used questionnaires and interviews as the main research tools, and the steps for creating them were as follows:

Understanding Theoretical Concepts and Related Visual Digital Technologies: First, investigate theoretical concepts and interactive digital technologies relevant to the research.

Define the scope and structure of the research tools: Determine the scope and structure of the research tools based on the study's hypothesis and objectives.

Drafting the research tools and soliciting feedback from advisors: Create the initial draft of the research tools and seek feedback from advisors or mentors.

Discussing and revising the Draft: Send the first draft of the research tools to the mentor for feedback, review, and any necessary changes.

3.4.2 Expert Review of Research Tools (IOC)

Expert Review of the Research Tools: We invited three experts to evaluate the research tools. The evaluation experts were 1. Asst. Prof. Paniti Keowsawat, 2. Assis Prof. Thammasak Aueragsakul, and 3. Assoc. Prof. Dr. Wannaporn Chujitarom.

This index of item-objective congruence was used to examine whether each question is consistent with research objectives. With the following evaluation criteria below.

+1 means congruent

0 means questionable

-1 means incongruent

Figure 46
IOC Expert Review

Note. Photographed by the author.

The IOC evaluation scores of the three experts for the six IOC documents are listed in Table 11. Based on these scores, we found that the research tools are suitable.

Table 11
Experts Review IOC Assessment Results

Expert Name	**Questionnaire IOC Score**	**Expert Interview IOC Score**	**Pre.Test Questions IOC Score**	**Post-Test Questions IOC Score**	**Evaluation IOC Score**
Asst. Prof. Paniti Keowsawat	12÷12=1	42÷42=1	12÷12=1	12÷12=1	4÷4=1
Assis Prof. Thammasak Aueragsakul	12÷12=1	42÷42=1	12÷12=1	12÷12=1	4÷4=1
Assoc. Prof. Wannaporn Chujitarom	12÷12=1	42÷42=1	12÷12=1	12÷12=1	4÷4=1
Final Average Score	1	1	1	1	1

Note. Data collected and compiled by the author.

3.4.3 Research Tools for Assessing Research Gaps

The researchers used structured questionnaires and in-depth interviews to gather consumer feedback on shadow puppetry, which included topics such as Hengshan shadow puppetry, shadow puppetry application program design, and digital technology cognition. These methods, combined with expert interviews and a thorough literature review, allowed the researchers to effectively outline and define current research gaps. The questionnaire for this study was divided into five parts.

Part I: General Information Questions: Survey questions about the respondents' demographic information.

Part II: "Shadow Puppetry" Questions: Survey questions about the respondents' interest and attention to shadow puppetry.

Part III: "Hengshan Shadow Puppetry" The survey questions focused on respondents' understanding of Hengshan shadow puppetry.

Part IV: "Interaction Design" Questions: Survey questions probed respondents' preferences and considerations for application program design.

Part V, "Digital Technology" Questions: The survey questions elicited respondents' opinions and attitudes toward digital technology related to the shadow puppetry application program. The interviews consisted of open-ended questions that delved deeply into the issues of Hengshan shadow puppetry and contemporary digital design.

3.4.4 Research Tools for Improving the Prototype

The interview, questionnaire survey, and observation methods were used to collect data for the prototype's improvement.

Interview Method: This interview gathered feedback and suggestions for improving knowledge and digital display effects after using innovative technology.

Questionnaire Survey: The questionnaire survey method was used to collect participant satisfaction and feedback, which was critical in improving the prototype.

Observation Method: The researchers used an observation form to systematically record the participants' behavior and interactions with the innovation. These observations served as a foundation for the prototype's subsequent updates.

3.4.5 Research Tools for Assessing Innovation

When evaluating the innovative prototype, we used a variety of data collection methods, including interviews, questionnaires, and observations. Interview Method: The researchers conducted interviews with participants to gather their opinions and suggestions for improving knowledge acquisition and impact after using digital creation.

Questionnaire: There were two types of questionnaires: evaluation and test. The evaluation questionnaire focused on the participants' satisfaction and overall evaluation, while the test questionnaire included a pre-test knowledge questionnaire and a post-test knowledge questionnaire to assess the effectiveness of knowledge acquisition following the implementation of the innovation.

Observation Method: The researchers used an observation form to systematically record the interaction between participants and the innovation, with a focus on user creativity.

3.5 Chapter Summary

This study adopted a mixed method approach. First, a conceptual framework was established through qualitative methods such as literature review and case analysis. The framework was derived through a combination of qualitative and quantitative research methods, including expert interviews and questionnaires, to develop a prototype. Then, improvements were made based on the data results of the test feedback, and finally a comprehensive evaluation was implemented. The study provided a diverse data sample based on different test results, with a particular focus on the interest in DIY shadow puppetry. Different research tools, including expert interviews and questionnaires, were used at each stage to collect and analyze data. This qualitative and quantitative approach ensured the rigor of the entire study.

The next chapter presents the research findings based on the methodology described in this chapter.

CHAPTER 4
RESEARCH RESULTS

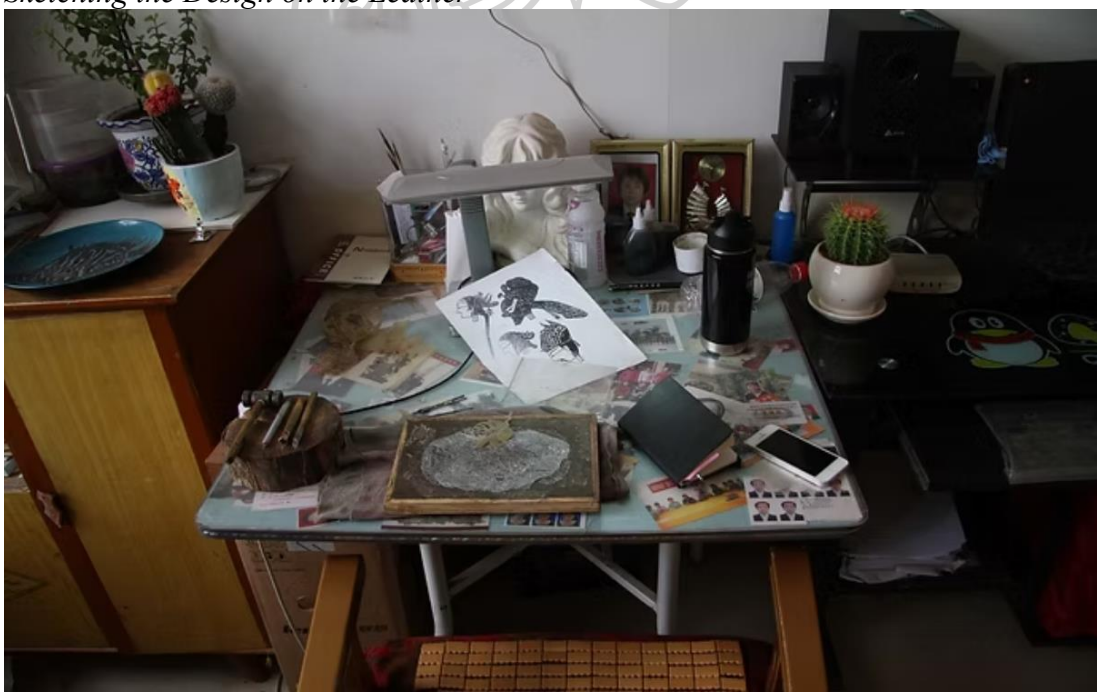
4.1 The Production Process of Hengshan Shadow Play

The researcher developed the standard process for creating a Hengshan shadow puppet after reviewing the literature and consulting with experts.

To make a Hengshan shadow puppet, start by choosing a suitable piece of leather in this case is cowhide—soft, translucent, and moderately thick leather is ideal.

Next, use a knife to scrape any dirt or grease from the hide. After that, dampen the cowhide with a cloth and press it firmly against a wooden board to flatten and soften it even more. After preparing the leather, use a water-soluble pen to sketch the puppet design directly on it (Figure 47).

Figure 47
Sketching the Design on the Leather



Note. Photograph taken from https://www.chineseshadowpuppetry.com/master-cutter-gaofeng-from-gansu-provinc

Carve out the design with a carving knife (Figure 48) or chisel.

Figure 48
Carve the Design

Note. Photograph taken from https://www.chineseshadowpuppetry.com/master-cutter-gaofeng-from-gansu-provinc

Next. use a brush to paint the figure (Figure 49) in traditional colors like orange, green, red, and black.

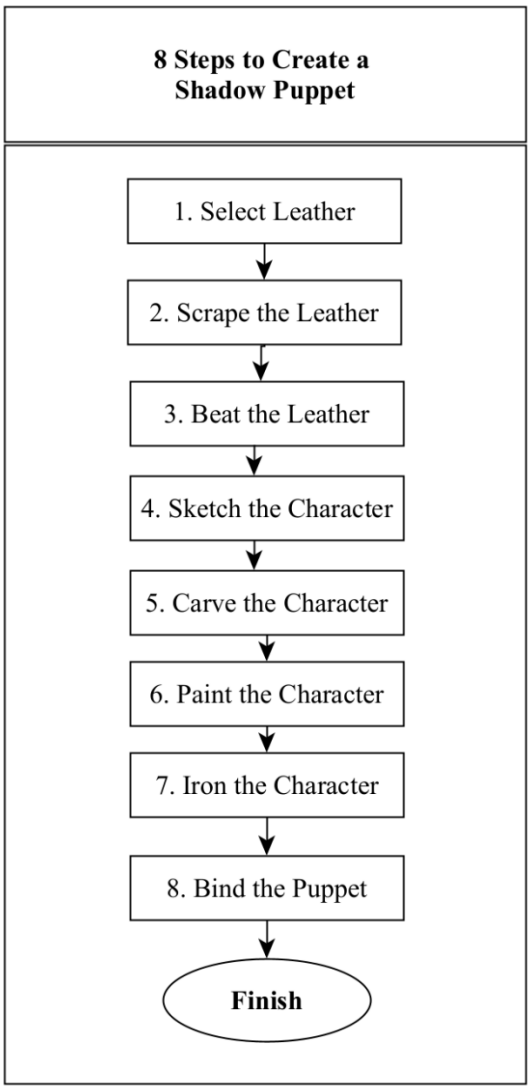
Figure 49
Painting the Puppet

Note. Photograph taken from https://ich.unesco.org/en/RL/chinese-shadow-puppetry-00421

After painting, use a cloth and iron to flatten the puppet. Finally, bind the joints by tying string through small holes at the appropriate bone points, then attach a bamboo rod and iron ring to finish the puppet and prepare it for performance.

Figure 50 depicts the process of Hengshan shadow puppet creation

Figure 50
The 8-Step Process to Create a Hengshan Shadow Puppet



Note. The process was observed then illustrated by the researcher.

The researcher then investigated how to incorporate Digital DIY into the eight-step process of making a Hengshan shadow puppet.

4.2 Gaining Digital DIY Hengshan Shadow Puppet Character Creation Development Direction

The researcher used interaction design theory, which focuses on the information transmission and feedback mechanism between users and systems, emphasizing clear interface logic, ease of operation, and controllability. In addition to the theory, the researcher consulted experts and administered an audience questionnaire.

4.2.1 Expert Interview Results

During the early stages of designing the Hengshan Shadow Play Digital DIY System, systematic user research and expert consultation were conducted to collect basic data from three dimensions: cultural understanding, functional expectations, and interaction preferences, which served as a theoretical foundation and practical reference for the subsequent system architecture design and functional layout.

Three experts were asked to participate in semi-structured interviews. They came from the fields of intangible cultural heritage, educational information technology, and digital media interactive design. Based on their extensive research and practical experience in their respective fields, they make targeted recommendations on system functions, learning path design, interface expression, and so on.

The expert interviews were conducted one-on-one via remote communication, lasting an average of 45 minutes. The interview outline was organized around the main axis of "user object-learning task-interaction method-cultural translation," and interactive discussions were held alongside the system's first draft interface. Table 12 details the experts' suggestions.

Table 12
Experts' Interview Results

Expert #	Field of Expertise	Suggestions
1	Intangible Cultural Heritage Research	To emphasize the local characteristics of Hengshan shadow play, we should pay attention to the expression of regional elements. To avoid distortion when

Expert #	Field of Expertise	Suggestions
		splicing elements, it is recommended that DIY parts be designed using traditional proportion and structural logic. Simultaneously, it is proposed that the production process of real shadow play be appropriately integrated so that the system can perform both "simulation + simplification".
2	Educational Technology Design	To improve the sense of ritual and motivation for task completion, the learning path should be designed in a phased progressive structure that combines step-by-step pictures and texts, supplemented by voice feedback. It is recommended that a "replay mechanism" be added to improve the self-directed learning experience.
3	Digital Media Interaction Design	Modern neutral tones with a small amount of traditional graphic textures are recommended for the interface style, and overly vivid cartoon images should be avoided. The navigation structure should maintain the unity of single-page task logic, emphasise the consistency of the "enter-operate-export" process, and improve overall operation efficiency.

Note. Data collected and compiled by the author.

During the interview, all three experts affirmed the system's overall design direction and agreed that this project has significant practical exploration value in the

current context of intangible cultural heritage digitization. Experts believe that the DIY module is at the heart of this system's innovation, and that a balance should be struck between cultural rationality and user operability. Users should not be trapped in pure entertainment assembly, nor should excessively complex professional operation processes be built. Expert 1 mentioned that the "layer + logical restriction" method can be used to ensure that the character structure is fundamentally correct while still allowing the user free creative space. This method aids in achieving "freedom in boundaries".

Expert 3's points of view on interface expression are particularly useful. He proposed that the system interface control color saturation and decoration density, maintain visual simplicity and function orientation, and use traditional elements (such as cloud patterns and paper-cut borders) to enhance cultural recognition. His recommendations for the navigation process also included a clear transition between "DIY creation" and "AR display" to avoid users' cognitive dissonance, which is encouraging for system process integration.

This round of expert interviews guides the system from concept design to prototype development. Experts approached the problem from three perspectives: cultural expression, functional structure, and interactive guidance, and their recommendations have been adopted and implemented.

4.2.2 Questionnaire Data Collection Results

This survey served the initial prototype development stage of the system, covering interface structure sketches, functional module concepts, material layout suggestions, etc.

A total of 300 questionnaires were distributed, and 300 valid questionnaires were collected, representing target user groups of various ages, genders, and cultural backgrounds. Data statistics and cross-analysis were used to extract and summarize the main tendency characteristics of users in the tables below.

In terms of gender composition, male participants outnumbered female participants by a slight margin. There were 168 males and 132 females, accounting for 56% and 44%, respectively (Table 13).

Table 13
Gender Distribution of the Samples

Gender	Frequency	Percentage (%)
Male	168	56
Female	132	44

Note. Data collected and compiled by the author.

For age structure, the "under 18 years old" group had the highest proportion, accounting for 34.3% of the respondents, followed by the "over 36 years old" group at 23.0% and the "18-25 years old" group at 21.7%. This suggests that the system primarily appeals to a younger demographic, particularly teenagers and young adults who are more open to digital interactions and cultural participation (Table 14).

Table 14
Age Distribution of the Samples

Age Group	Frequency	Percentage (%)
Over 36 years old	69	23
18-25 years old	65	21.7
26-35 years old	63	21
Under 18 years old	103	34.3

Note. Data collected and compiled by the author.

The majority of respondents understand shadow puppetry, with 135 answering "yes," accounting for 45% of the total, and another 165 saying "no," accounting for 55% (Table 15).

Table 15
Awareness of Hengshan Shadow Puppetry

Awareness	Frequency	Percentage (%)
No	165	55
Yes	135	45

Note. Data collected and compiled by the author.

Although the understanding rate is less than half, it demonstrates the fundamental communication ability of traditional intangible cultural heritage among young users. In terms of whether they had tried DIY cultural products, 216 people said yes, accounting for 72%, indicating that the DIY creation system has a strong practical foundation in the target group (Table 16).

Table 16
Experience with DIY Cultural Products

Experience	Frequency	Percentage (%)
No	84	28
Yes	216	72

Note. Data collected and compiled by the author.

The most popular answer to the question "What aspects of shadow puppetry do you want to learn through the system?" was "Art Style" (28.0%), followed by "Role Culture" (25.0%) and "Production Process" (24.3%). "Historical Stories" received relatively little attention (22.7%). These findings suggest that users prefer visually engaging and creatively expressive content over traditional narrative elements. It demonstrates a preference for experiential and aesthetic learning, emphasizing the value of hands-on and stylistic elements in shadow puppetry education (Table 17).

Table 17
Content preferences about shadow puppetry

Content Type	Frequency	Percentage (%)
Art Style	84	28
Role Culture	75	25
Production process	73	24.3
Historical Stories	68	22.7

Note. Data collected and compiled by the author.

According to user preferences for system functional modules, the "AR display module" was the most popular, with 87 respondents (29.0%) choosing it. This was followed by the "DIY assembly module" at 25.7% and "All interested" at 24.7%, with the "learning module" attracting 20.7% of respondents. These findings indicate that users place a high value on interactive and immersive features, especially those that combine physical and virtual engagement. The relatively balanced interest across modules also demonstrates a high level of recognition for the overall system architecture, laying the groundwork for future resource planning and functional weighting (Table 18).

Table 18
Functional Modules Samples are Interested In

Functional Module	Count	Percentage (%)
AR display module	87	29
DIY assembly module	77	25.7
All interested	74	24.7
Learning module	62	20.7

Note. Data collected and compiled by the author.

Regarding the familiarity level of AR features, 159 respondents (53.0%) stated that they are "Likely to Accept" of the technology, while 73 (24.3%) reported a “Neutral” level of acceptance. Notably, 68 people (22.7%) said they "Don't understand" AR features. These findings indicate that, while the majority of users have a positive attitude toward immersive augmented reality technology, there is still

a significant portion of users who are unfamiliar with it. This demonstrates the need for additional guidance, education, and intuitive design in the AR display module to ensure greater accessibility and user engagement (Table 19).

Table 19
Familiarity Level of AR Features

Acceptance Level	Count	Percentage (%)
Don't understand	68	22.7
Highly likely to accept	159	53
Neutral	73	24.3

Note. Data collected and compiled by the author.

142 respondents (47.3%) answered "yes" to the question "Are you willing to recommend this system to others?" indicating a relatively high level of user recognition. 109 people (36.3%) expressed uncertainty, while only 49 (16.3%) refused to recommend. These findings indicate that, while nearly half of the system's users have expressed positive support, there is still a significant group that is neutral or hesitant, indicating potential areas for improvement in system usability, content richness, and overall engagement. Nonetheless, the current level of willingness to recommend lays a solid foundation for word-of-mouth communication and future promotion (Table 20).

Table 20
Willingness to Recommend the System

Recommendation	Count	Percentage (%)
Not sure	109	36.3
No	49	16.3
Yes	142	47.3

Note. Data collected and compiled by the author.

To investigate the relationship between user background and functional preferences, a cross-analysis was performed between "awareness of shadow puppetry" and "most interested functional module". Table 21 shows that users who are familiar

with shadow puppetry are more likely to select "AR display module" (57 vs. 30) and "DIY assembly module" (54 vs. 28) than unfamiliar users.

Table 21
Cross-analysis: Awareness vs. Module Interest

Awareness	AR Module	DIY Module	All Interested	Learning Module
No	30	28	38	34
Yes	57	54	34	25

Note. Data collected and compiled by the author.

This suggests that prior cultural knowledge increases users' interest and expectations for interactive features like augmented reality and character assembly. As a result, including a brief introduction to shadow puppetry during the system's onboarding phase may help new users better engage with immersive functions and deepen their cultural experience.

Figure 51
Keywords mentioned in the questionnaire

Note. Illustrated by the author.

This word cloud diagram (Figure 51) featuring key terms such as "VIDEO GAMES," "TRADITIONAL CULTURE," and "DIY" highlights an interdisciplinary strategy for cultural dissemination. The analysis emphasizes the potential of interactive digital media—particularly video games and Augmented Reality (AR)—to create immersive learning experiences that convey historical narratives and intangible cultural heritage to younger audiences. Central to this approach is a DIY methodology that encourages hands-on engagement and user-centered design, aiming to enhance the user experience through visually compelling styles and integrated graphic elements. By utilizing a multimodal system, this method effectively bridges traditional cultural practices with modern digital tools, fostering the spread and appreciation of heritage in contemporary contexts.

4.3 Design, Development, and Assessment of the Digital DIY Hengshan Shadow Puppetry

Based on the completion of the system's preliminary theoretical construction and user research, this section introduces the overall design and technical development process of the Hengshan Shadow Play Digital DIY System. The system's core concept is "cultural visualization + interactive operability," and it integrates functional modules such as the shadow play production process, user self-assembly, and reality experience before creating a cultural communication platform that combines learning, fun, and display.

The system architecture is primarily made up of four functional modules: the homepage guidance module, learning module, DIY module, and AR display module. Throughout the development process, the system design was carried out in terms of user usage path, functional layout, interface style, interaction fluency, technical integration stability, and iterative optimization. The design prioritizes module functional completion while also emphasizing logical flow consistency and cultural expression across modules.

4.3.1 The Design and Development Process

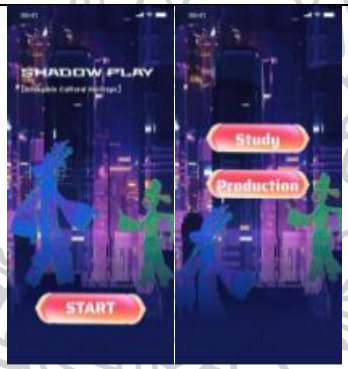
This section will go over the UI and style design, the Functional module design, the Learning content design, the DIY interaction design, and the AR feature design.

1. UI and Style Design

During the initial interface design stage of the Hengshan Shadow Play Digital DIY System, we experimented with different styles based on the three dimensions of user aesthetic preference, cultural adaptability, and operational convenience, before determining the overall interface style suitable for mainstream users through expert review. As the first visual layer of system interaction, the interface style has a direct impact on the user's willingness to use while also serving as an auxiliary function of cultural communication. Table 22 displays interfaces in various styles.

Table 22

The Styles of the Digital DIY Hengshan Shadow Puppetry

Style	**Design**
Cyberpunk	
Cartoon	
Traditional	

In the preliminary design stage, three style schemes were proposed: cyberpunk, cartoon, and traditional. The three styles emphasize a sense of technology, fun, and visual balance, respectively. Although the cyberpunk style has an impact on dynamic vision and light and shadow processing, it appears to deviate from the main theme when displaying traditional culture due to its strong color stimulation; the cartoon style is simple for young users to understand, but the overall style is slightly childish, making it difficult to reflect the profound cultural connotation of Hengshan Shadow Play.

In terms of interface style preferences, "Traditional style" was chosen by 92 respondents (30.7%). This was followed by "no particular preference" (25.7%), "cartoon style" (22.7%), and "cyberpunk style" (21.0%). The data indicate that users have a strong preference for culturally rooted and familiar visual elements, emphasizing the importance of traditional aesthetics in the design of cultural systems. To ensure broad user engagement, it is best to emphasize traditional stylistic elements as a core component of the interface while maintaining usability and modern design sensibilities (Table 23).

Table 23
Preferences for Interface Style

Style Preference	**Frequency**	**Percentage (%)**
No particular preference	77	25.7
Cartoon style	68	22.7
Cyberpunk style	63	21
Traditional style	92	30.7

Note. Data collected and compiled by the author.

To analyze user preferences for visual styles, the questionnaire results show that young people in the new era are particularly interested in technologically "Cyberpunk styles, which are heavily influenced by the rapid development of digital technology. Younger participants, particularly children and adolescents, prefer "cute" design styles that appeal to their age-related aesthetic preferences and effectively capture their attention. Meanwhile, a portion of respondents believe that shadow

puppetry, as a form of traditional cultural heritage, should not be arbitrarily modified or modernized and must maintain its original aesthetic and cultural values.

The traditional style that was eventually chosen primarily uses low-saturation neutral tones (such as white, gray, beige, and so on) in color, supplemented by cultural decorative elements such as paper-cut patterns and red embellishments, which not only keeps the interface fresh and professional, but also incorporates local traditional aesthetic symbols. Many interface design experts and cultural communication consultants believe that this style can better convey the cultural value of shadow puppet art while still retaining a modern digital system.

AR experts emphasize that it is about combining the real and virtual. A traditional-style interface is closely related to the cultural context of shadow play, resulting in a more immersive and authentic experience in augmented reality. Shadow play, a type of national intangible cultural heritage, has distinct traditions in aesthetics, character design, color schemes, and performance style. Using a traditional visual approach demonstrates respect for authenticity and promotes cultural preservation. In contrast, switching to cyberpunk or cute styles risks diluting its historical depth and weakening the audience's connection to its roots.

From a design standpoint, traditional aesthetics help digital cultural products stand out. They strengthen cultural impressions, convey refinement, and help to shape brand identity. Meanwhile, popular styles such as cyberpunk or cute visuals are frequently overused and can easily blend into the mainstream, making it more difficult to achieve distinctiveness and long-term recognition.

The homepage interface serves as the system's primary navigation page, performing functions such as module diversion, visual guidance, and preliminary cultural introduction. Its main components are the top carousel and the bottom double button area. The carousel shows a variety of shadow puppet character shapes and system function prompts; the two operation buttons "Enter Learning" and "Enter DIY" correspond to two core functional modules, and high-contrast color blocks help with click recognition.

In UI design, we first choose the color of cowhide after drying as the background color, and then use traditional Chinese patterns and patterns (such as auspicious clouds, window lattice patterns, scroll feeling, etc.) to elicit users' associations with

Chinese traditional culture and enhance the cultural atmosphere and immersion of shadow play.

To improve the look and feel as well as professionalism, interface design must maintain visual element consistency. Incorporating shadow play elements (such as silhouettes, carved borders, handmade texture backgrounds, and so on) into interface design is not only visually appealing, but it also strengthens the intrinsic connection with the theme.

At the UI detail level, the system uses a consistent linear icon style to reduce unnecessary shadows and decorations while increasing operational focus. The button interaction design includes click color change and dynamic zoom to provide more real-time feedback on user actions. The icons and text positions have been fine-tuned several times to ensure that the information does not overlap or truncate at different screen sizes. The overall layer hierarchy is obvious, and the visual data is clearly prioritized. The interface design process is more than just an aesthetic decision; it also represents cultural meaning.

Through style screening, structural combing, and interaction detail optimization, the system incorporates traditional culture's visual identity on the basis of digital interaction, increasing users' initiative and stickiness in recognizing cultural content and providing a good cognitive starting point for the functional experience of subsequent modules.

As a result, traditional style UI is more likely to evoke nostalgia or cultural identity in users, particularly those who appreciate traditional art and national culture, which has a strong appeal and emotional resonance.

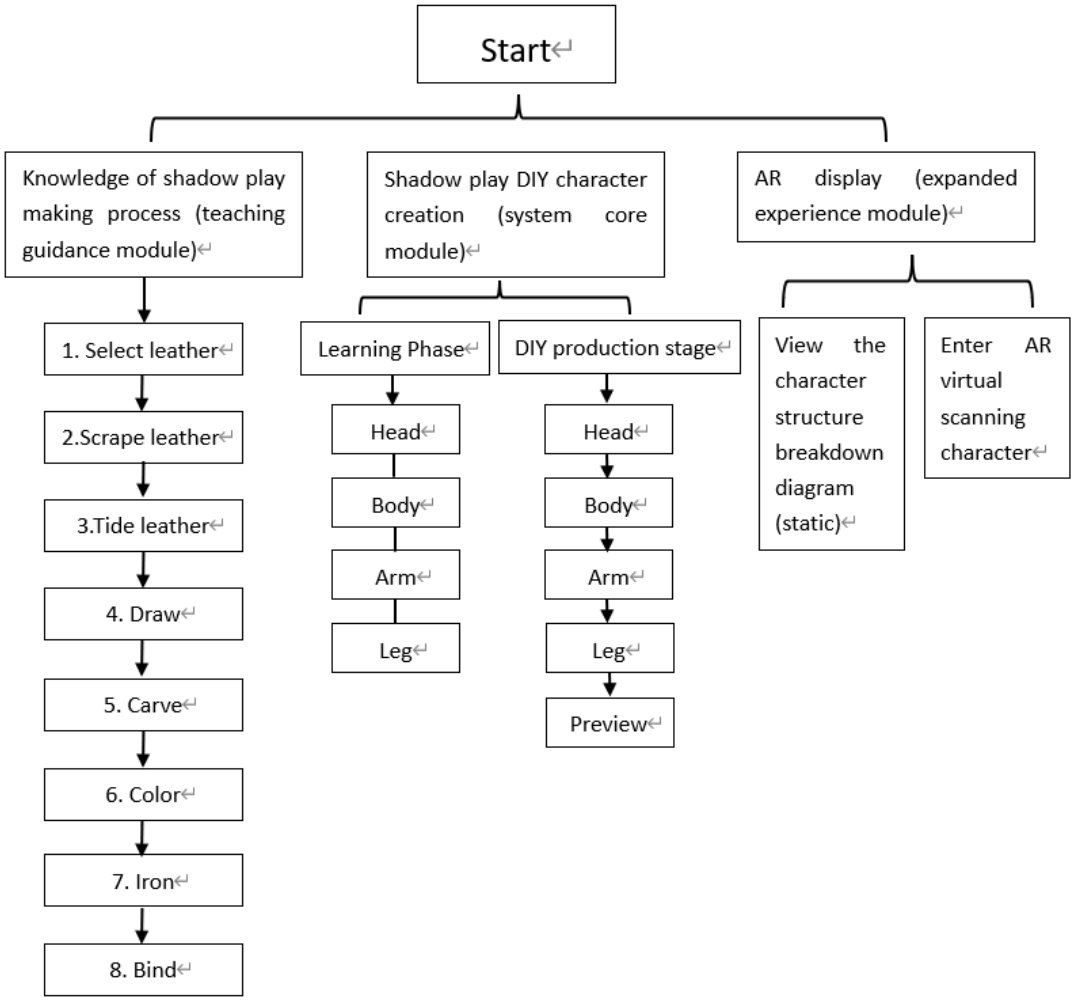
2. Functional module design

Hengshan shadow play's digital DIY system is designed with a modular structure layout throughout. It is broken down into four core functional modules based on the user's usage path and the distribution logic of functional content: home navigation, learning, DIY assembly, and AR display modules.

Each module has its own functional goals and is interconnected in terms of operation process, forming a digital experience chain that gradually deepens from "cognition-operation-immersion" as shown in Figure 52 below.

Figure 52

The System Functional Flow Chart

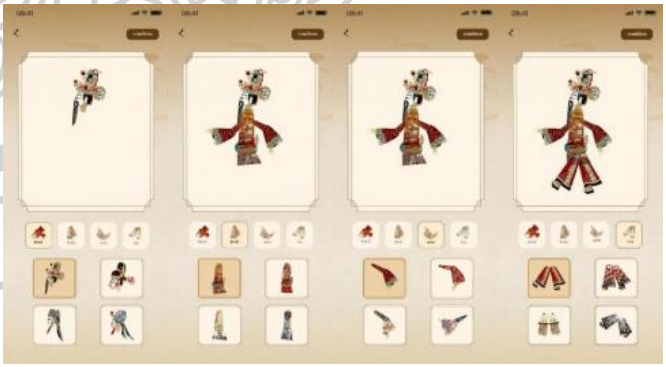
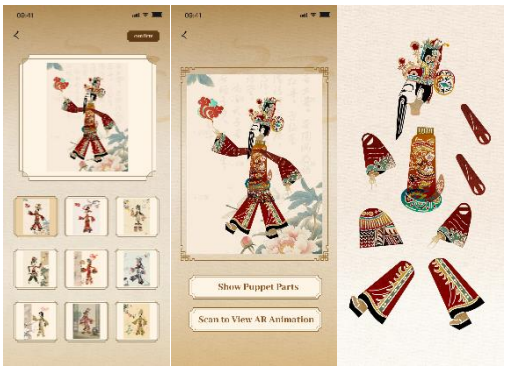


Note. Developed by the researcher.

The functional modules are listed in Table 24.

Table 24

Functional Module Design

Module	**Desi**
Navigation module	
Learning Modules	
DIY assembly module	
AR display module	

Note. Developed by the author.

The home module serves as the system's starting interface. Its primary function is to provide users with a clear operation interface and system function preview. The top of the interface features a carousel display area with shadow play style characters. Through the rotation of two style character pictures, combined with the interface text to strengthen the cultural visual guidance; there are three main operation buttons "Enter Learning", "Enter DIY", and "Enter AR" at the bottom, pointing to the three main interactive function modules respectively.

This structure is not only concise and clear, but it also meets users' cognitive and psychological expectations when they first use the system. The navigator control allows you to jump between modules.

3. Learning Module Design

The learning module is an important component of the Hengshan shadow puppet digital DIY system, as it teaches users basic knowledge and guides the production process. The system's module design is based on the traditional production process of shadow puppet characters, combining constructivist learning concepts with digital interaction methods to create a step-by-step, controllable, and visual learning path. This module is divided into eight distinct steps: "initial understanding of shadow puppets," "material preparation," "leather material drawing," "cutting outlines," "coloring and drawing," "assembling joints," "pole installation operations," and "finished product display," forming a complete process from cultural cognition to process cognition. Each step is accompanied by high-definition diagrams, which aim to help users understand the production logic and process characteristics of shadow puppets using a combination of images and text.

The system's front end employs the v-for traversal structure to render the step data to the page one by one, and each step's information is stored locally in JSON to allow for dynamic content loading and later content adjustment. The graphic and text content are displayed side by side, with the left and right layout maintained in vertical screen devices, allowing users to visually understand the relationship between images and texts. To ensure the autonomy of the learning rhythm, "Previous" and "Next" buttons are located at the bottom of the page, allowing users to freely jump and browse between steps. Button interaction regulates step index changes by binding

events and uses logical judgment to avoid abnormal situations like out-of-bounds and empty page jumps.

Figure 53-61 show the step-by-step learning of this module.

Figure 53

Step 1 Select Leather

Note. Illustrated by the author.

Figure 54

Step 2 Scrape Leather

Note. Illustrated by the author.

Figure 55

Step 3 Tide Leather

Note. Illustrated by the author.

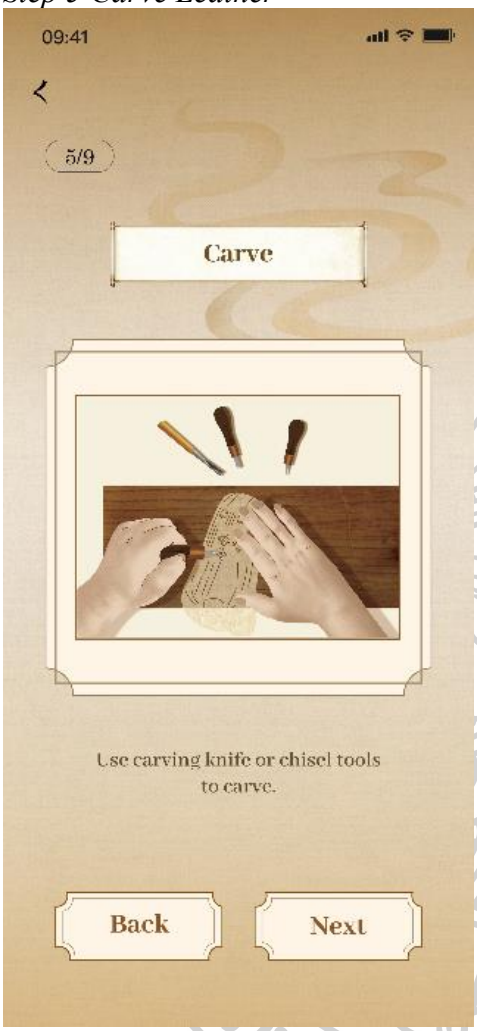
Figure 56

Step 4 Draw Character

Note. Illustrated by the author.

Figure 57

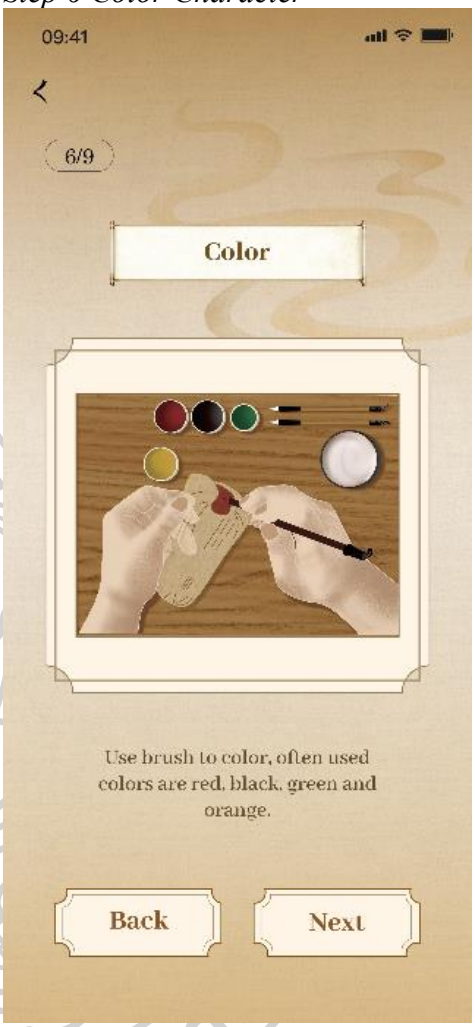
Step 5 Carve Leather



Note. Illustrated by the author.

Figure 58

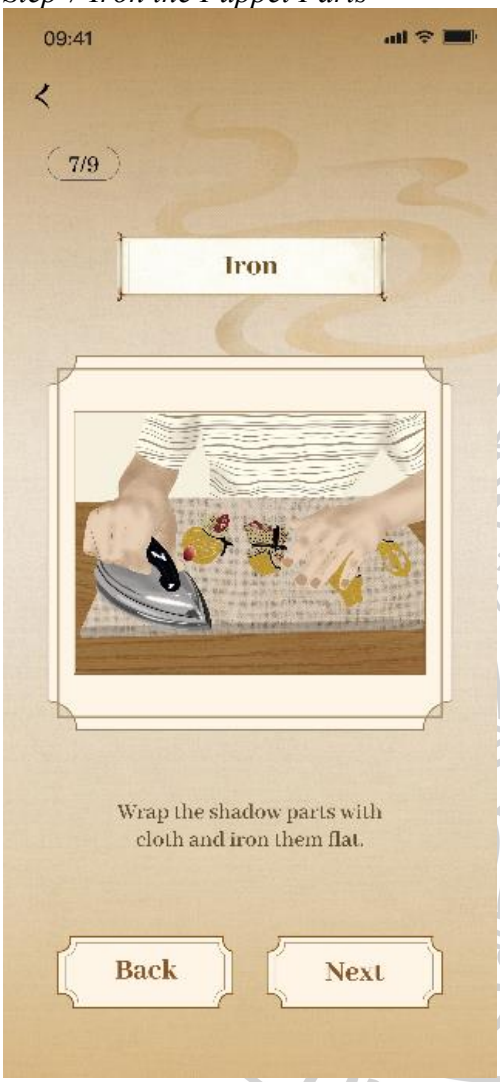
Step 6 Color Character



Note. Illustrated by the author.

Figure 59

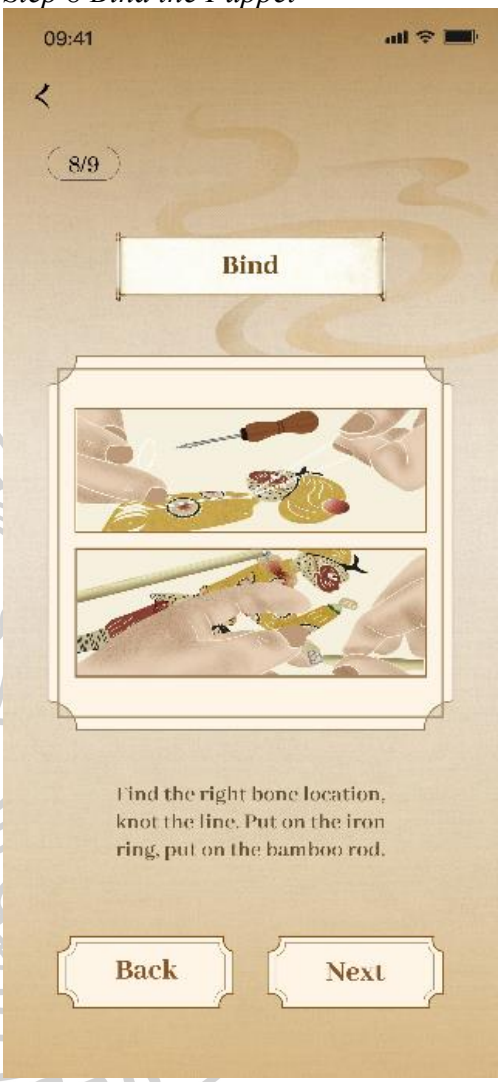
Step 7 Iron the Puppet Parts



Note. Illustrated by the author.

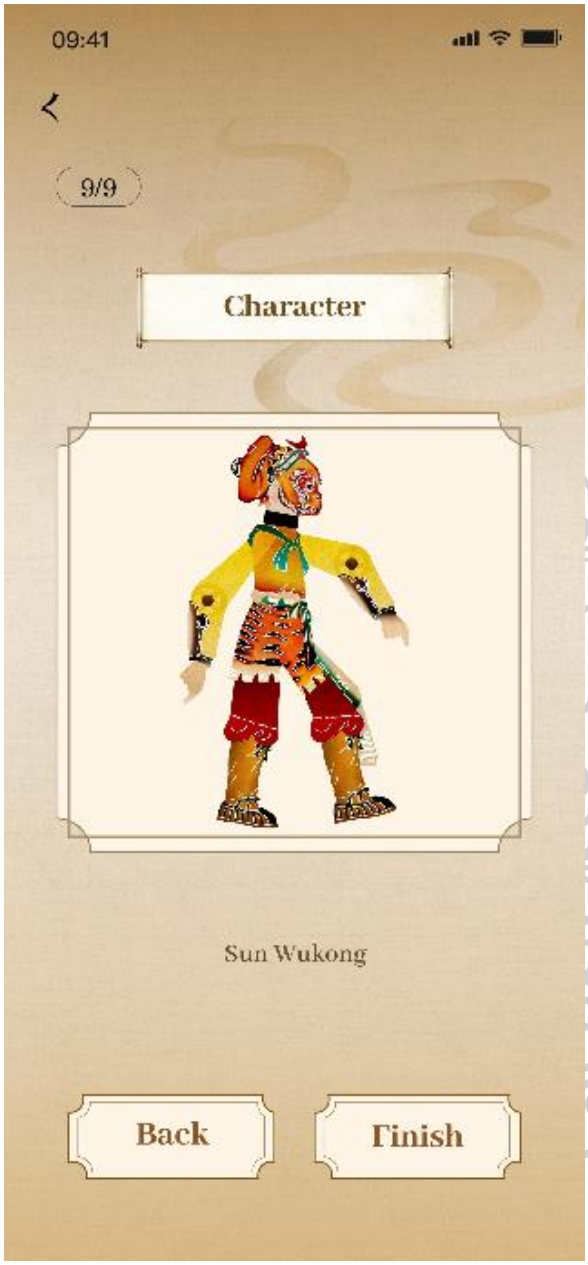
Figure 60

Step 8 Bind the Puppet



Note. Illustrated by the author.

Figure 61
Finished Character



Note. Illustrated by the author.

According to these steps, you can make a complete shadow puppet character, such as Sun Wukong (Figure 60).

The system introduces a sound to improve sensory feedback while the user is operating it. In addition, the "Start Learning" and "Complete Learning" status pages are set at the beginning and end of the module, respectively, to guide users through the system's functional scope. Simultaneously, a path to the DIY module is provided

after the eighth step is completed, demonstrating the natural link between learning and creation.

4. DIY Character Creation Module Design

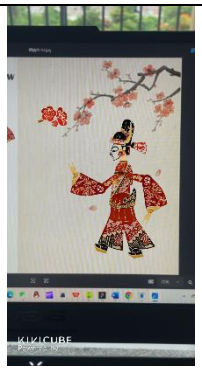
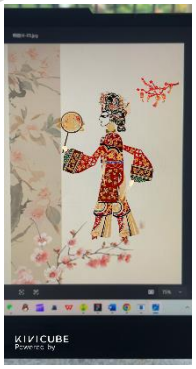
The system includes nine preset characters to help with user immersion and cultural recognition. Users can assemble or modify these common shapes to create their own versions. These characters represent a wide range of cultural themes, including traditional festivals, heroic legends, literati and ladies, religious beliefs, and childlike expressions, and are rendered in a variety of modeling languages and artistic styles. For example, the image of the general emphasizes heroism through design languages such as armor stacking and hard lines in facial makeup; the ladies and literati express classical and gentle temperament through clothing lines and color blocks; and the old man retains strong religious folk elements and symbolic meanings.

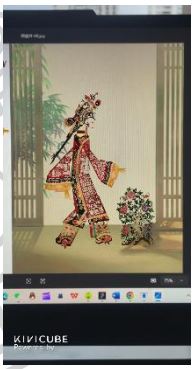
During the character setting stage, the system design team referred to Hengshan's local shadow puppet modeling style and simplified and integrated it with modern user aesthetic habits, making the characters more suitable for dragging, combining, and displaying on the mobile terminal while retaining cultural charm. Tables 25 shows how the puppet parts and AR feature can be accessed.

Table 25

The Application Screens of Puppet Parts and AR Feature

	Screen shot	Puppet Parts	AR
1			

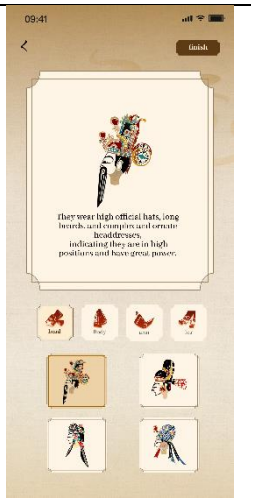
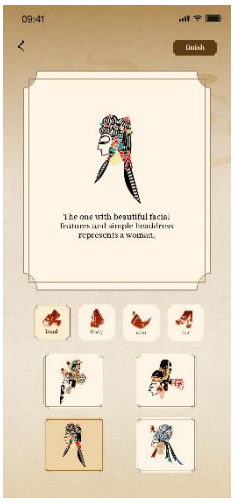
	Screen shot	Puppet Parts	AR
2			
3			
4			
5			

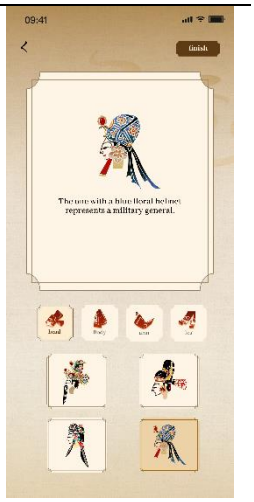
	Screen shot	Puppet Parts	AR
6			
7			
8			
9			

Note. Illustrated by the author.

Tables 26 shows how users can learn about different puppet characters and their parts.

Table 26
Hengshan Shadow Puppet Knowledge

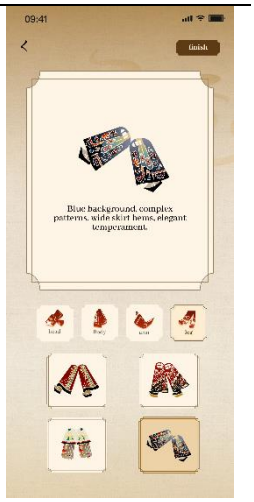
Style	Description	Content
Royal Court Official Character Head	Features elaborate headgear with traditional ornaments, symbolizing loyalty, wisdom, and courage in court characters.	
Scholarly Character Head	The one with a black hat represents a young man with the image of a talented scholar.	
Graceful Female Character Head	The one with beautiful facial features and simple headdress represents a woman.	

Style	Description	Content
Warrior Character Head	The one with a blue floral helmet represents a military general.	
Regal Armor Dress	The main colors are red and yellow, with detailed dragons, trims, and belt decorations, implying nobility and authority.	
Elegant Civilian Dress	The main color is rose, with single patterns like flowers and birds, showing a soft and demure aesthetic.	

Style	Description	Content
Soft Classic Dress	The main color is light gray, with elegant floral skirt patterns and gentle silhouette.	
Noble Formal Dress	The background is dark blue, with symmetrical red-orange patterns forming a refined look.	
Festive Sleeve	Mainly dark red, with emerald vine decorations and black shoulder lines, expressing festivity and grace.	

Style	Description	Content
Golden Festive Sleeve	Bright red tone with gold patterns and vivid floral cuffs, showing a strong celebratory style.	
Subtle Sleeve	Light gray background with olive-green cuffs, decorated with small floral motifs, for a subtle, balanced tone.	
Brocade Sleeve	Colorful background with patterns of flowers, birds, and vines, reflecting rich brocade aesthetics.	

Style	Description	Content
Majestic Red Pants	Dark red decorative legs with gold patterns, classic boots, and symmetrical embroidery.	
Floral Folk Pants	Black and red as the main colors with flower patterns, evoking a traditional rural style.	
Light-colored Playful Pants	Beige and light blue as the main colors, with small animals and plants, suitable for lively roles.	

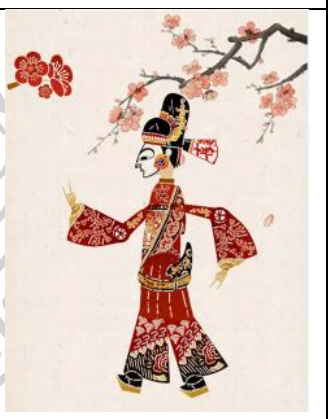
Style	Description	Content
Elegant Dark Pants	Blue-black tone, exquisite patterns, and narrow cut, suitable for elegant male characters.	

Note. Illustrated by the author.

Table 27 show the process of characters' development.

Table 27

Digital Shadow Puppet Character Development Process

Character	Features	Line Art	Digital Shadow Puppet
Royal Court Official Character	Wears a high official hat, a decorative facial pattern, and adopts a ceremonial posture. In ancient Chinese opera, this symbol represents authority and elegance.		
Male Scholarly Character	Wears a high official hat, decorative facial pattern, ceremonial posture. Represents authority and elegance in ancient Chinese opera.		
Graceful Female Character	Ornate hairpiece with flowers and butterflies, holding hand gesture softly. Symbolizes grace, femininity, and classical beauty.		

Character	Features	Line Art	Digital Shadow Puppet
Male Warrior Character	Wears a decorated helmet, strikes a commanding pose, and is dressed in green and red. Promotes bravery, action, and martial spirit.		
Female Character	carries a round fan, has a vivid facial expression, and moves expressively. Suggests a vibrant personality, theatrical flair, and emotional depth.		
Noble Character	Wears a hairpin with a red ornament, maintains a poised stance, and moves her sleeves gracefully. It emphasizes elegance, nobility, and		

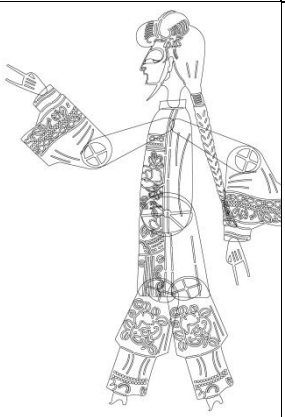
Character	Features	Line Art	Digital Shadow Puppet
	refined femininity.		
Maiden Character	Wears a red hairpin, has a poised stance, and moves gracefully with her sleeves. Highlights elegance, nobility, and refined femininity.		
Female Phoenix Headpiece Character	Wears an ornate headpiece with a phoenix and tassels, and maintains a dynamic posture. represents noble femininity, marital status, and emotional expression.		
Young Male Character	Carries a baton/sword strap, square hat, formal gesture. Denotes discipline, justice, and social order.		

Figure 62

Royal Court Official Character

Note. Illustrated by the author.

Figure 63
Male Scholarly Character

Note. Illustrated by the author.

Figure 64
Graceful Female Character

Note. Illustrated by the author.

Figure 65
Male Warrior Character

Note. Illustrated by the author.

Figure 66
Female Character

Note. Illustrated by the author.

Figure 67
Noble Character

Note. Illustrated by the author.

Figure 68
Maiden Character

Note. Illustrated by the author.

Figure 69

Female Phoenix Headpiece Character

Note. Illustrated by the author.

Figure 70

Young Male Character

Note. Illustrated by the author.

4.3.2 Assessment

1. Expert Assessment

The researcher asked three experts to evaluate the Digital DIY Hengshan Shadow Puppet Application.

Asst. Prof. Donlaporn Srifar Phd. from Rajamangala University of Technology Phra Nakhon, who specializes in Mass Communication Technology, suggests adding a zoom function for image details and a descriptive voiceover to improve completeness. This feedback emphasizes accessibility and a more immersive media experience.

Dr. Khongthat Thongphun, Associate Dean of the Department of Animation and Visual Effects at Chiang Mai University's College of Art, Media, and Technology, suggests incorporating the style and meaning of character style design to improve user understanding. This emphasizes the significance of artistic and narrative depth in connecting users with cultural content.

Yu Bao of Jilin Animation Academy suggests simulating traditional control methods, such as rods for arm movement or sliding gestures, to increase immersion. This comment highlights an innovative approach to interaction design that combines traditional methods with digital interfaces to provide a more authentic and immersive user experience.

Table 28 displays the experts' comments.

Table 28

Experts Comments of the Innovation

#	Name	Title	Photo	Suggestions
1	Assist. Prof. Donlaporn Srifar Phd.	Mass Communication Technology. Rajamangala University of Technology Phra Nakhon		Suggests adding zoom function to view image details and descriptive voiceover to enhance completeness.
2	Dr. Khongthat thongphun	Associate Dean Department: Animation and Visual Effects. College of Art, Media and Technology. Chiang Mai university		Add the style and meaning of character style design to deepen user understanding.
3	Yu Bao	Jilin Animation Academy		Suggests simulating traditional control methods (e.g., rods for arm movement, sliding gestures) to improve immersion.

Note. Collected and compiled by the researcher.

The first expert believes that combining traditional elements of shadow play creates a unified aesthetic tone, and the interface design is simple and clear, allowing users to use it with ease. In the future, it is recommended that users be able to adjust the size of pictures within the system at will, allowing them to see more details, and that descriptive voice be added during the experience to complete the system.

The second expert thought that this was a good attempt to preserve traditional culture, and that the DIY module was very interesting and provided users with a completely new experience that piqued their interest in shadow puppetry. He also

stated that while using the shadow puppet characters, users were unable to understand their meaning. In the future, the system could explain the style and meaning of each character during the user experience, allowing users to gain a better understanding.

The third expert believes that allowing users to freely combine shadow puppet parts (such as the head, body, arms, clothing, and so on) will encourage them to develop their own understanding and creativity in visual composition and story expression.

Furthermore, shadow puppetry has its own aesthetic language and cultural connotation, which appeals to young users who are interested in "Oriental aesthetics" and "national style". Simulating the traditional operation of "up and down two rods to control the arms, left and right sliding to control the character's actions" will provide users with a more immersive experience.

Additionally, the researcher conducted an in-depth interview with the experts. The interview answers are shown in the table below.

Table 29

Data from the Expert Interview Sessions

Expert	Question	Answer
1	Do you think this program helps in learning and promoting Hengshan shadow puppetry?	The DIY program plays a positive role in promoting Hengshan shadow puppetry. Its simple guides and interactive features help users understand the process and cultural meaning, especially for younger users.
2	What suggestions do you have for improving the DIY shadow puppetry program?	While pursuing a youthful style, the traditional texture should be retained. Adding historical background, character stories, or real performance clips can deepen cultural value.
3	What is your view on the use of AR in this context?	AR enhances immersive learning and engagement. However, the usage is too limited. It is recommended to allow AR to project onto flat surfaces at home, forming a "mini puppet stage" to restore interactive performance scenes.

Note. Collected and compiled by the author.

All experts emphasized that the combination of simplified textual guides and interactive DIY operations greatly aids users' understanding of the procedural and aesthetic aspects of shadow puppetry. Furthermore, they noted that the digitized

format is particularly appealing to younger generations, encouraging greater participation and contributing to the preservation and revitalization of this intangible cultural heritage.

Design experts made forward-thinking recommendations focused on striking a balance between modernization and authenticity. While acknowledging the system's appeal to a younger demographic, they advised against oversimplification or excessive cartoonization. Instead, they suggested including more contextual content, such as the history of Hengshan shadow play, character backstories, and even actual performance excerpts, to increase cultural resonance.

Experts in the field of technology recognize the immersive potential of AR technology in increasing user engagement. They believe the usefulness of AR in visualizing digital creations in physical space, but expressed concerns about its limited activation conditions. To address this, they proposed allowing AR projection onto common household surfaces (such as walls and desks), effectively simulating a "miniature stage" environment. This method would not only visualize puppet characters, but it would also restore the core performance and interaction nature of traditional shadow play, thereby reinforcing the system's cultural authenticity.

2. User Evaluation

During the test participants were asked to operate the program independently on their mobile phones, including navigating the interface, assembling shadow puppet characters, previewing results, and attempting to access the AR display function. The testing process was documented through photographs to record user engagement and behavior. Figure 70 shows participants actively interacting with the system during the testing process, including moments of character assembly, preview confirmation, and peer discussion.

Figure 71

User Testing

Note. Photographed by the researcher.

A satisfaction survey was administered using a 5-point Likert scale, with 1 representing "Highly Dissatisfied" and 5 representing " Highly Satisfied." The goal was to determine whether the system met users' expectations in terms of usability, engagement, and visual experience.

Participants were asked to answer three quantitative questions about the key aspects of system performance. The first question focused on the user's experience learning about the shadow puppet production process through the program. The second question asked whether the program had successfully piqued users' interest in traditional shadow puppet culture. The third question measured overall satisfaction with the user interface (UI) design.

The survey results (Table 30) showed a general high level of satisfaction with all items. The highest-rated item was related to cultural interest (Q2), implying that the system's interactive nature increased participants' curiosity and appreciation for shadow puppetry. The question about production learning experience (Q1) also received high marks, demonstrating the effectiveness of the DIY process in conveying cultural knowledge in an engaging manner. Satisfaction with the UI design (Q3) was slightly lower than expected, indicating room for improvement in terms of layout, visual clarity, and stylistic coherence.

Table 30

User Satisfaction Survey Results

Question No.	**Survey Item**	**Mean Score**	**Standard Deviation**
Q1	How was your experience in learning the shadow puppetry production process through the mini program?	4.21	0.73
Q2	Did the mini program spark your interest in shadow puppetry culture?	4.35	0.65
Q3	Are you satisfied with the overall interface design of the mini program?	4.12	0.82

Note. 1 = Highly Dissatisfied; 5 = Highly Satisfied. Data compiled by the author.

Most participants successfully completed the character assembly task and expressed positive feedback about the overall experience. Some users, however, encountered confusion during interface switching and showed uncertainty when trying to access AR content, suggesting a need for clearer navigation cues and enhanced compatibility. Additionally, a few participants mentioned that while the visual design was attractive, the cultural background descriptions of the character components could be more informative.

Table 31 summarizes the feedback from 40 users, using a 5-point Likert scale to evaluate their experience in four dimensions: navigation, component operation, cultural understanding, and overall satisfaction. The results show high satisfaction with the visual interaction and creative process, while AR-related usability and cultural depth received relatively lower ratings, reflecting the system's current limitations and potential directions for improvement.

Table 31
Results of Offline Usability Testing

Item Evaluated	**1 (Very Poor)**	**2 (Poor)**	**3 (Neutral)**	**4 (Good)**	**5 (Excellent)**	**Mean Score**
Interface navigation clarity	1	2	6	18	13	4.00
Component selection and assembly experience	0	2	5	17	16	4.18
Cultural background understanding	3	5	12	13	7	3.53
Overall usage satisfaction	0	1	6	19	14	4.15

Note. Collected and compiled by the author.

Overall, the offline testing confirmed the usability of the Digital DIY Hengshan Shadow Puppetry Application in a realistic usage scenario. It also identified valuable areas for improvement, including improved cultural narration, AR performance compatibility, and user onboarding optimization.

This section contains some multiple-choice questions about the production and content of Hengshan shadow play, with the goal of testing students' understanding of the production, character design, and color-related content of the play. The audience groups' performance was evaluated using this set of pre-test and final-test questions (Table 32).

Table 32

Hengshan Shadow Play Knowledge Assessment Questions

#	Level	Question
1	Easy	In which dynasty did shadow puppetry first originate?
2	Easy	What kind of light source is usually used to illuminate the shadow puppets during shadow puppet performances?
3	Easy	What materials are usually used to make shadow puppets?
4	Medium	What structure does the joint connection of shadow puppet characters mainly rely on?
5	Medium	What is the tool used to control the movements of characters in shadow play?
6	Hard	Which one is a traditional pattern element commonly used by shadow puppet characters?
7	Hard	Regarding the artistic design of shadow puppet character headdresses, which of the following statements is correct?
8	Hard	Which of the following comments on the way Hengshan shadow play characters and patterns are expressed is the most accurate?

Note. Developed by the researcher.

Tables 33 shows the Pre and Post test scores from each group.

Table 33
Results of the Pre and Post-test Scores

Subject	Pre-Test Score	Post-Test Score
1	4	6
2	5	6
3	4	7
4	3	4
5	6	8
6	5	7
7	4	6
8	5	7
9	4	6
10	6	8
11	5	7
12	3	5
13	5	6
14	4	5
15	4	6
16	6	7
17	5	6
18	3	5
19	5	6
20	4	6
Average	**4.5**	**6.2**

Note. Collected and compiled by the researcher.

In the tests, most users correctly answered questions Q2, Q5, and Q6 because donkey skin is common knowledge in shadow puppetry and most people can guess it correctly even without in-depth knowledge (Q2). They are also familiar with traditional Chinese visual symbols (Q5), and colors are commonly encountered and popular in primary and secondary school courses (Q6).

Most participants answered incorrectly questions Q1, Q3, Q4, and Q8, because historical details require specific learning to obtain (Q1), patterns are visual details

that are difficult to accurately judge without specific observation experience and specific learning (Q3), and process structure knowledge is highly professional and difficult to master without DIY or watching tutorials (Q4). Finally, a thorough understanding and study of the Hengshan shadow puppet design style is required, which can only be achieved through DIY experience (Q8).

The average score before using the DIY application was 22.5/40 (about 56.25%), and most of them could only answer common sense questions; after use, the average score increased to 31/40 (about 77.5%), indicating a significant improvement in their grasp of in-depth knowledge such as structure, pattern, and cultural design.

The findings indicate that users can learn relevant information about Hengshan Shadow Play using the Hengshan Shadow Play DIY digital creation system, but the score improvement is not immediately apparent. Users cannot fully comprehend the content and thus cannot study thoroughly, resulting in poor learning outcomes. The lack of knowledge popularization may impede participants' learning, which could be the primary reason for the limited score improvement.

As a result, experts recommend that the historical background and production materials of Hengshan Shadow Play be added to the software interface, allowing users to learn new knowledge, integrate knowledge with the software, make connections, and achieve the goal of education.

4.6 De-Sync Exhibition

In addition to audience and expert testing of the digital application, the project was exhibited at the De-Sync Intersection exhibition, which took place at TCDC from May 21 to 25, 2025. In it, the researcher applied a combination of digital and physical DIY techniques to the Hengshan Shadow puppet (Figure 72-75).

Figure 72

DIY Hengshan Shadow Puppet at De-Sync Intersection Exhibition

Note. Photographed by the researcher.

Figure 73

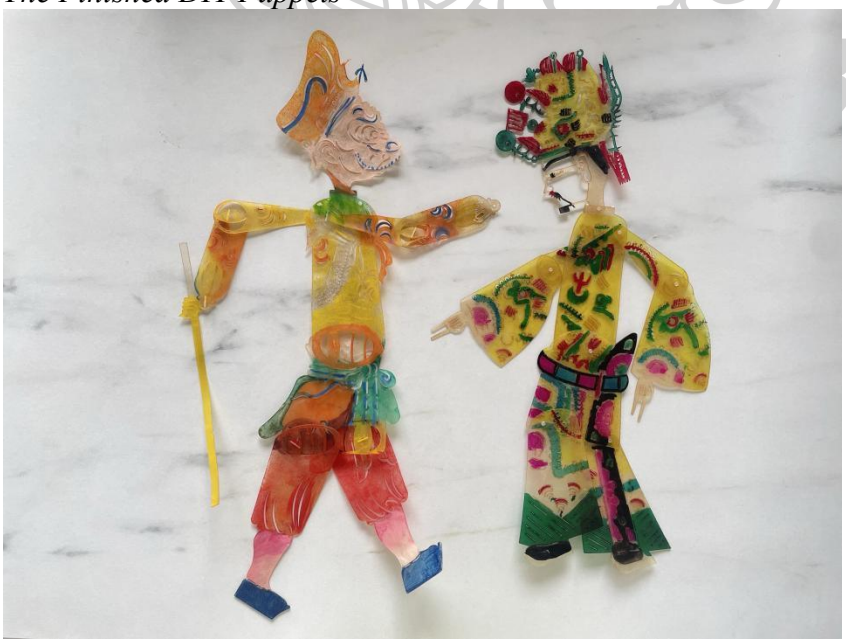
Audiences trying the DIY Hengshan Shadow Puppet at De-Sync Intersection Exhibition

Note. Photographed by the researcher.

Figure 74
A DIY Puppet in Progress

Note. Photographed by the researcher.

Figure 75
The Finished DIY Puppets



Note. Photographed by the researcher.

The combination of online interaction and offline DIY practice offers an effective model for engaging with intangible cultural heritage. Online platforms provide accessible knowledge and design tools, while offline crafting reinforces understanding through hands-on experience. This dual approach bridges theory and practice, allowing users to explore cultural elements digitally and then apply them physically.

More results from the dual-DIY approach are shown in Figure 76

Figure 76
Physical DIY Hengshan Shadow Puppet Results

Note. Photographed by the researcher.

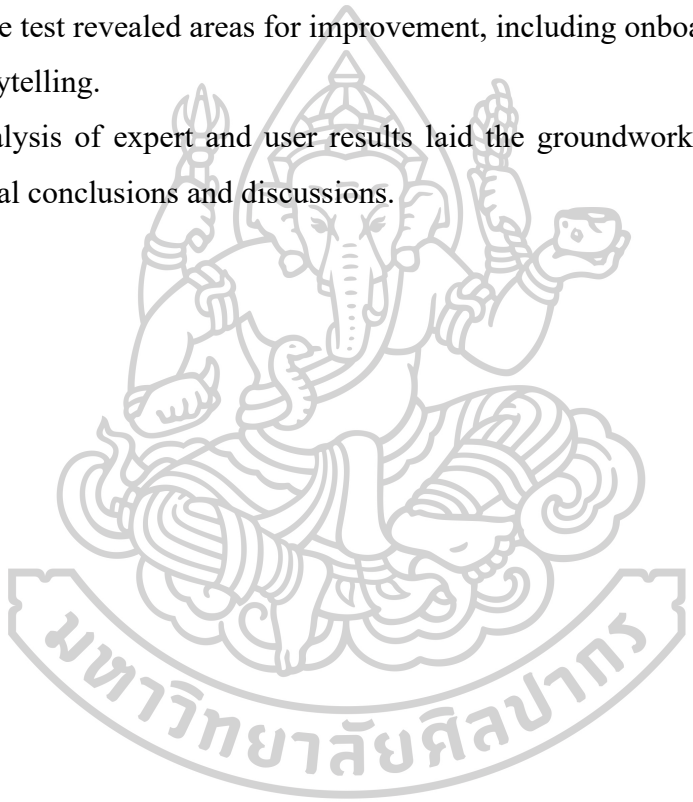
4.7 Chapter Summary

This chapter covered the implementation and design of the DIY shadow puppetry mini-program. The system creates a unified experience flow by integrating cultural knowledge, creative assembly, and immersive display using modular functional planning. Each module was carefully designed to meet the needs of its users, combining visual interaction with educational elements. The DIY character assembly and AR projection modules, in particular, reflect the system's emphasis on creative freedom as well as cultural embodiment.

Expert interviews provided valuable professional insight into the system's usability, interface style, and content depth. Suggestions include improving the clarity of cultural explanations, refining interface design to balance tradition and modernity, and improving AR interaction scenarios. These inputs validated the design's rationality while revealing potential optimization spaces for cultural communication effectiveness.

Offline user testing validated the system's basic usability and user interest. Most participants completed tasks smoothly and were pleased with the DIY process. However, the test revealed areas for improvement, including onboarding guidance and cultural storytelling.

The analysis of expert and user results laid the groundwork for the subsequent chapter's final conclusions and discussions.



CHAPTER 5
CONCLUSIONS AND DISCUSSIONS

This chapter summarizes the core results of this study and explores its value and applicability in the digital education of intangible cultural heritage from both theoretical and practical dimensions. Through the integrated analysis of system design, technical implementation, user testing and expert interviews, this study verifies the role of the Hengshan Shadow Play DIY system in enhancing users' cultural cognition and interactive experience, and also points out the issues of digital intangible cultural heritage platforms in communication paths, interface logic and cultural communication. In addition, this chapter also discusses the further optimization of system design and communication strategies based on the problems found during the system development process.

5.1 Conclusions

5.1.1 Core Knowledge of the Hengshan Shadow Puppetry

The 8-step production process of Hengshan shadow puppetry captures a wealth of traditional knowledge that is critical for preserving and adapting to the digital age. By systematically mapping each traditional step—selecting leather, preparing materials, sketching, carving, painting, ironing, and assembling—to corresponding digital DIY implementations, we not only preserve the original craft's integrity but also make it more accessible, interactive, and adaptable for modern creators. This core knowledge establishes a structured framework for creating a Digital DIY system that values cultural authenticity while encouraging hands-on creativity with digital tools. It demonstrates that incorporating these traditional processes into a modern, interactive platform is both feasible and essential for preserving and reimagining the Hengshan shadow puppetry tradition for future generations.

5.1.2 The Digital Approach to DIY

To create a Digital DIY Hengshan Shadow Puppetry Character Creation system, the core knowledge gained from expert interviews and audience questionnaires is essential. The findings point in a clear direction for system architecture, functional

design, and user experience, emphasizing a balance of cultural preservation and modern interactive learning. Key Takeaways for Development Direction are

1. Cultural Authenticity with Digital Adaptation

The system must highlight the local and regional aspects of Hengshan shadow play. To avoid distortion, DIY parts should follow traditional proportions and structural logic, using a "layer + logical restriction" method to allow for creative freedom within limits. The production process should properly incorporate "simulation + simplification" of actual shadow play techniques. This ensures that cultural rationality is balanced alongside user operability.

2. User-Centered and Engaging Learning Path

The learning experience should be phased and progressive, with step-by-step visuals and text supplemented by voice feedback to increase the sense of ritual and motivation. A "replay mechanism" is suggested to enhance self-directed learning. This is consistent with the constructivist theory of learning, which emphasizes active user participation. Given that the primary audience is young people, specifically teenagers and young adults, the system must be visually appealing and creatively expressive.

3. Intuitive and Visually Simple Interface Design

The interface should use modern neutral tones with subtle traditional graphic textures, rather than overly vivid cartoon imagery. Visual simplicity and function orientation are essential, with traditional elements such as cloud patterns and paper-cut borders used to reinforce cultural identity. The navigation structure should maintain single-page task logic unity and consistency in the "enter-operate-export" process to improve overall operation efficiency. Clear transitions between "DIY creation" and "AR display" are essential for avoiding cognitive dissonance.

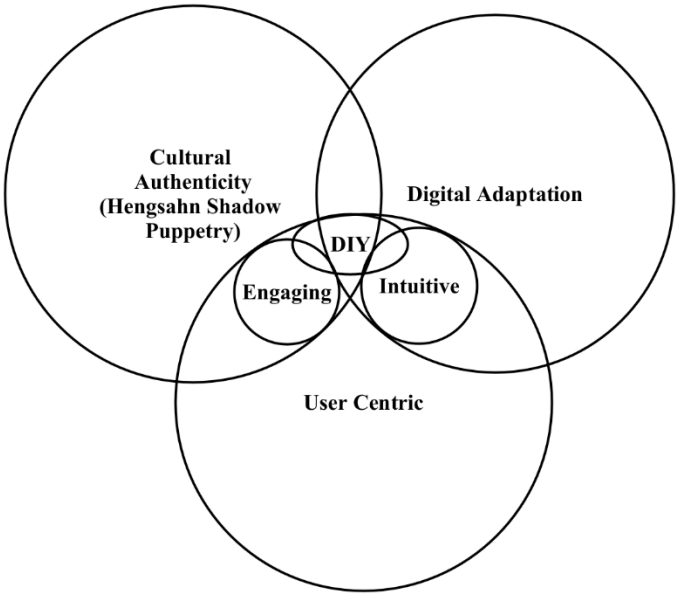
5.1.3 The Innovation of the Digital DIY Hengshan Shadow Puppetry Character Creation

This system's most distinctive design innovation is the implementation of a "user-led" content output path. Unlike traditional passive viewing learning methods, the Hengshan shadow puppet DIY platform encourages users to participate in role reconstruction while learning and create their own roles by freely matching shadow puppet components such as the head, body, arms, and feet. Users recognized this method, which sparked their desire to create and participate in cultural activities.

At the same time, the system incorporates design concepts such as combining traditional visual symbols with modern aesthetics in the interface style, character style setting, and module jump logic. For example, role presets like "festival style" and "military general style," combined with simple and intuitive operation paths, lower the user's learning cost while increasing the system's adaptability and dissemination. In the future, the system can broaden its functions in "creative sharing" and "secondary processing" to achieve a closed-loop design from cultural learning to cultural reproduction.

The development of a Digital DIY Hengshan Shadow Puppetry Character Creation system should be guided by a careful balance of traditional art principles and modern digital interactive design, as shown in Figure 77.

Figure 77
The Model for Digital DIY Hengshan Shadow Puppetry Character Creation



Note. Developed by the researcher.

This entails taking cultural authenticity into account when designing digital models, creating an engaging and progressive learning path, creating a clean and culturally resonant interface, and emphasizing immersive and DIY functionalities, all while bridging traditional practices with modern digital tools to facilitate cultural dissemination.

5.2 Discussions

A comprehensive analysis of the Hengshan Shadow Puppetry DIY system's development and testing process reveals that digital dissemination of intangible cultural heritage has certain advantages in terms of improving users' cultural cognition and participation experience. Users can obtain intuitive traditional cultural content through the operation interface, character assembly, and AR display, completing the

internalization and transformation of knowledge during the interaction. This digital participation method of "learning by doing" differs from traditional graphic displays and static museum visits, demonstrating the vitality of cultural communication.

According to the user test results, the DIY module scores highly in terms of operational freedom and creative fun, indicating that the visual and structured component construction method can effectively stimulate users' creative motivation. At the same time, users provided positive feedback on the overall style and usability of the system interface, particularly the interface's design tendency toward "simplicity and traditional integration," which is consistent with contemporary users' aesthetic expectations for traditional culture.

However, the system's ability to display AR and present cultural backgrounds is still limited. Some users reported that they had high expectations for the AR usage environment, and the display form was relatively static, making it difficult to develop long-term appeal. Furthermore, the transmission of some cultural knowledge remained at the level of shallow information prompts, with insufficient narrative and situational guidance, resulting in users completing the operation but lacking a thorough understanding of the history and value of the shadow puppets. This demonstrates that intangible cultural heritage digital education still necessitates more sophisticated design strategies for integrating technology and cultural content.

This system has achieved preliminary results in the digitization and interactivity of intangible cultural heritage education, but it also reflects the tension between "technical packaging" and "cultural core". As a result, in future system iterations, more effective cultural narrative mechanisms and dynamic interaction methods should be investigated further in order to realize the user's transformation from "operation tools" to "understanding culture" and to improve the system's educational depth and cultural ductility.

5.3 Research Limitations

Although this study systematically completed the overall construction and preliminary testing of the Hengshan shadow puppet DIY system, and obtained positive feedback in terms of user experience and cultural communication, there are still several limitations in the following aspects.

First, the range of cultural materials selected by the system is relatively limited. This project mainly revolves around nine typical shadow puppet characters, which can represent some of the style characteristics of Hengshan shadow puppets, but it is still single in terms of subject matter, character type, performance scene, etc., and it is difficult to fully cover the cultural depth and historical diversity of Hengshan shadow puppets. This limits the content richness and educational extension of the system to a certain extent.

Secondly, the system test is mainly concentrated in the offline field operation link, and the sample source is mainly from users in specific regions and age groups, and fails to cover a wider group, especially the adaptability to the middle-aged and elderly groups and users with non-local cultural backgrounds is still lacking in sufficient verification.

Thirdly, from the perspective of technical implementation, the AR module is still in the initial functional stage, and its display effect mainly stays in static model binding and simple interaction, lacking more vivid action performance and user feedback mechanism. There is still room for optimization in terms of multi-device compatibility, spatial perception accuracy, network loading stability, etc., which is difficult to meet the cultural performance needs in complex usage scenarios.

Finally, in terms of cultural narrative expression, the current system is still mainly based on brief pictures and texts and free combinations by users, lacking a structured storyline and semantic guidance mechanism. This makes it difficult for some users to further understand the historical evolution, folk background and aesthetic value behind shadow play after completing the DIY operation, thus limiting the depth and durability of cultural learning.

5.4 Comparing with Other Studies

In comparison to this study and case analysis, existing practice cases are provided to help understand how digital cultural products present traditional art and serve as a source of design inspiration. Case studies can reveal deficiencies in the current digital cultural system in cultural communication and interactive design from various perspectives (such as user experience, visual style, interaction method, and

educational effectiveness), such as serious homogeneity and a lack of deep participation.

While case studies offer valuable insights into current practices and highlight common challenges in digital cultural systems, this study takes a more targeted, user-centered approach by creating an interactive DIY system. By actively involving users in the creative process and aligning digital interaction with traditional craft logic, the system provides a new approach to immersive cultural learning and long-term heritage transmission.

Both existing case studies and this research have similar goals of promoting cultural heritage through digital means, engaging younger users, and improving learning through interactive design. While their approaches and levels of user involvement differ, they share a commitment to reimagining traditional culture for the digital age.

5.5 Future Research Prospects

This study uses Hengshan shadow puppetry as its central object to investigate the expression and dissemination of intangible cultural heritage in digital interactive systems, and it confirms the role of DIY component creation and AR display in promoting user cultural cognition and participation behavior. However, digital inheritance of intangible cultural heritage remains a complex and systematic issue, and future research can be expanded upon the following aspects.

First, the research objective can be expanded to include other local and representative intangible cultural heritage projects, resulting in a more universal "culture + interaction" model. Shadow puppetry has strong visual and symbolic characteristics, making it suitable for modular disassembly and interactive reproduction. This system model can be applied to other folk intangible cultural heritage projects such as paper-cutting, New Year paintings, fabric art, and opera masks to investigate the differences and similarities in user cognition and participation modes across cultural objects.

Second, in terms of technical paths, more intelligent perception and generation technologies can be implemented to improve the system's adaptive and creative support capabilities. For example, by combining a large language model, the intelligent explanation and semantic expansion of the character's background content

can be realized; by integrating voice recognition and natural language dialogue, the system can guide users to complete cultural learning tasks in a question-and-answer manner; in terms of character creation, it is also possible to try to introduce image generation algorithms (such as Stable Diffusion, etc.) to assist users in rapidly

Furthermore, the research methodology can be refined. The current survey primarily relies on questionnaires and expert interviews. In the future, behavioral data collection (such as click paths, dwell time, interactive hot spots, etc.) and A/B testing methods can be used to quantitatively optimize the user experience process; additionally, a multi-round interview mechanism can be established to dynamically track user usage habits and cultural cognitive changes, allowing for a longitudinal evaluation of the cultural inheritance effect.

Finally, in terms of system communication strategy, future research can focus on the development of platform mechanisms and the cultivation of cultural communities, as well as the promotion of intangible cultural heritage digital content from one-way communication to co-creation and sharing, forming a user ecological closed loop of "creation-display-communication-evolution" and realizing the living inheritance of cultural memory in digital space.

APPENDIX

Appendix A.
IOC Invitation Letters

No.8610/ 4529

Faculty of Decorative Arts, Silpakorn University
Na Phra Larn Rd., Phra Borom Maha Ratchawang
Phra Nakhon, Bangkok 10200 Thailand

6th September, 2024

Subject: Invitation to be an inspector of research tool quality

Dear Prof. Emeritus Wattana Chudhavipata

Miss He PEIHAO is a graduate student ID 660420031 student in Design at the Faculty of Decorative Arts, Silpakorn University. Currently, she is conducting his thesis study entitled : Do-It-Yourself (DIY) Digital Character Creation of Hengshan Shadow Play. In this regard, Graduate School, Silpakorn University would like to invite you to inspect the quality of research tools for the student.

Your kind assistance and academic contribution is much appreciated.

T. Jiarakun

(Dr. Thanatorn Jiarakun)
Dean of Faculty of Decorative Arts,
Silpakorn University

Contact to : info.decsu@gmail.com
Tel. +662-221-5874, +662-221-5832

No.8610/ 4527

Faculty of Decorative Arts, Silpakorn University
Na Phra Larn Rd., Phra Borom Maha Ratchawang
Phra Nakhon, Bangkok 10200 Thailand

6thSeptember, 2024

Subject: Invitation to be an inspector of research tool quality

Dear Asst. Prof. Paniti Keowsawat

Miss He PEIHAO is a graduate student ID 660420031 student in Design at the Faculty of Decorative Arts, Silpakorn University. Currently, she is conducting his thesis study entitled : Do-It-Yourself (DIY) Digital Character Creation of Hengshan Shadow Play. In this regard, Graduate School, Silpakorn University would like to invite you to inspect the quality of research tools for the student.

Your kind assistance and academic contribution is much appreciated.

T. Jiarakun

(Dr. Thanatorn Jiarakun)
Dean of Faculty of Decorative Arts,
Silpakorn University

Contact to : info.decsu@gmail.com
Tel. +662-221-5874, +662-221-5832

No.8610/ 4526

Faculty of Decorative Arts, Silpakorn University
Na Phra Larn Rd., Phra Borom Maha Ratchawang
Phra Nakhon, Bangkok 10200 Thailand

6th September, 2024

Subject: Invitation to be an inspector of research tool quality

Dear Asst. Prof. Thammasak Aueragsakul

Miss He PEIHAO is a graduate student ID 660420031 student in Design at the Faculty of Decorative Arts, Silpakorn University. Currently, she is conducting his thesis study entitled : Do-It-Yourself (DIY) Digital Character Creation of Hengshan Shadow Play. In this regard, Graduate School, Silpakorn University would like to invite you to inspect the quality of research tools for the student.

Your kind assistance and academic contribution is much appreciated.

T. Jiarakun

(Dr. Thanatorn Jiarakun)
Dean of Faculty of Decorative Arts,
Silpakorn University

Contact to : info.decsu@gmail.com
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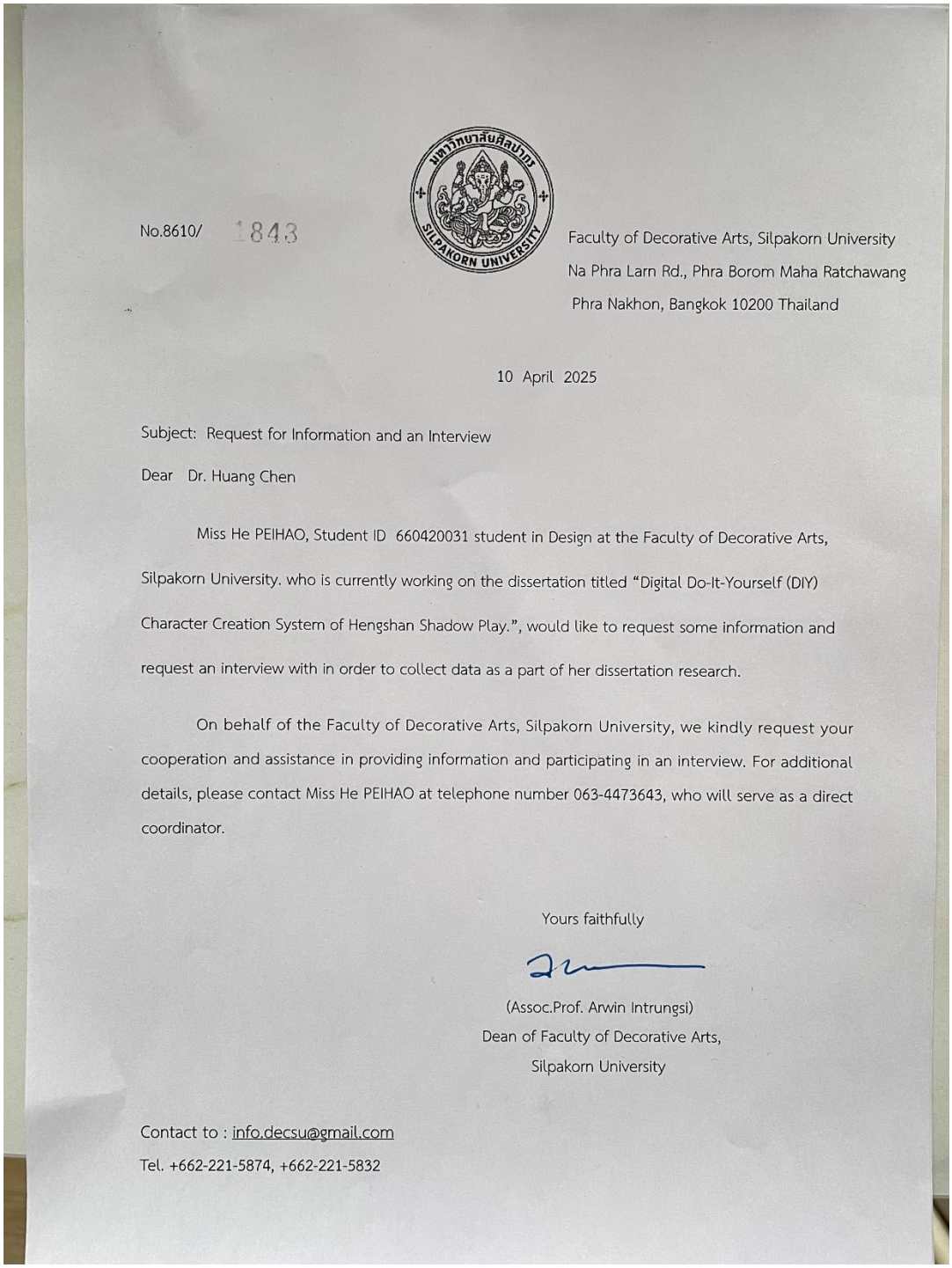
Appendix B.

Expert Invitation Letters



No.8610/ 1843

Faculty of Decorative Arts, Silpakorn University
Na Phra Larn Rd., Phra Borom Maha Ratchawang
Phra Nakhon, Bangkok 10200 Thailand

10 April 2025

Subject: Request for Information and an Interview

Dear Dr. Huang Chen

Miss He PEIHAO, Student ID 660420031 student in Design at the Faculty of Decorative Arts, Silpakorn University. who is currently working on the dissertation titled "Digital Do-It-Yourself (DIY) Character Creation System of Hengshan Shadow Play.", would like to request some information and request an interview with in order to collect data as a part of her dissertation research.

On behalf of the Faculty of Decorative Arts, Silpakorn University, we kindly request your cooperation and assistance in providing information and participating in an interview. For additional details, please contact Miss He PEIHAO at telephone number 063-4473643, who will serve as a direct coordinator.

Yours faithfully

(Assoc.Prof. Arwin Intrungsi)
Dean of Faculty of Decorative Arts,
Silpakorn University

Contact to : info.decsu@gmail.com
Tel. +662-221-5874, +662-221-5832

No.8610/ 1841

Faculty of Decorative Arts, Silpakorn University
Na Phra Larn Rd., Phra Borom Maha Ratchawang
Phra Nakhon, Bangkok 10200 Thailand

10 April 2025

Subject: Request for Information and an Interview

Dear Dr. Zhao Nianci

Miss He PEIHAO, Student ID 660420031 student in Design at the Faculty of Decorative Arts, Silpakorn University. who is currently working on the dissertation titled "Digital Do-It-Yourself (DIY) Character Creation System of Hengshan Shadow Play.", would like to request some information and request an interview with in order to collect data as a part of her dissertation research.

On behalf of the Faculty of Decorative Arts, Silpakorn University, we kindly request your cooperation and assistance in providing information and participating in an interview. For additional details, please contact Miss He PEIHAO at telephone number 063-4473643, who will serve as a direct coordinator.

Yours faithfully

(Assoc.Prof. Arwin Intrungsi)
Dean of Faculty of Decorative Arts,
Silpakorn University

Contact to : info.decsu@gmail.com
Tel. +662-221-5874, +662-221-5832

No.8610/ 1838

Faculty of Decorative Arts, Silpakorn University
Na Phra Larn Rd., Phra Borom Maha Ratchawang
Phra Nakhon, Bangkok 10200 Thailand

10 April 2025

Subject: Request for Information and an Interview

Dear Mr. Wang Donglin

Miss He PEIHAO, Student ID 660420031 student in Design at the Faculty of Decorative Arts, Silpakorn University. who is currently working on the dissertation titled "Digital Do-It-Yourself (DIY) Character Creation System of Hengshan Shadow Play.", would like to request some information and request an interview with in order to collect data as a part of her dissertation research.

On behalf of the Faculty of Decorative Arts, Silpakorn University, we kindly request your cooperation and assistance in providing information and participating in an interview. For additional details, please contact Miss He PEIHAO at telephone number 063-4473643, who will serve as a direct coordinator.

Yours faithfully

(Assoc.Prof. Arwin Intrungsi)
Dean of Faculty of Decorative Arts,
Silpakorn University

Contact to : info.decsu@gmail.com
Tel. +662-221-5874, +662-221-5832

No.8610/ 1839

Faculty of Decorative Arts, Silpakorn University
Na Phra Larn Rd., Phra Borom Maha Ratchawang
Phra Nakhon, Bangkok 10200 Thailand

10 April 2025

Subject: Request for Information and an Interview

Dear Mr. Yuan Chunming

Miss He PEIHAO, Student ID 660420031 student in Design at the Faculty of Decorative Arts, Silpakorn University. who is currently working on the dissertation titled "Digital Do-It-Yourself (DIY) Character Creation System of Hengshan Shadow Play.", would like to request some information and request an interview with in order to collect data as a part of her dissertation research.

On behalf of the Faculty of Decorative Arts, Silpakorn University, we kindly request your cooperation and assistance in providing information and participating in an interview. For additional details, please contact Miss He PEIHAO at telephone number 063-4473643, who will serve as a direct coordinator.

Yours faithfully

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Dean of Faculty of Decorative Arts,
Silpakorn University

Contact to : info.decsu@gmail.com
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No.8610/ 1837

Faculty of Decorative Arts, Silpakorn University
Na Phra Larn Rd., Phra Borom Maha Ratchawang
Phra Nakhon, Bangkok 10200 Thailand

10 April 2025

Subject: Request for Information and an Interview

Dear Mr. Ouyang Xinnian

Miss He PEIHAO, Student ID 660420031 student in Design at the Faculty of Decorative Arts, Silpakorn University. who is currently working on the dissertation titled "Digital Do-It-Yourself (DIY) Character Creation System of Hengshan Shadow Play.", would like to request some information and request an interview with in order to collect data as a part of her dissertation research.

On behalf of the Faculty of Decorative Arts, Silpakorn University, we kindly request your cooperation and assistance in providing information and participating in an interview. For additional details, please contact Miss He PEIHAO at telephone number 063-4473643, who will serve as a direct coordinator.

Yours faithfully

(Assoc.Prof. Arwin Intrungsi)
Dean of Faculty of Decorative Arts,
Silpakorn University

Contact to : info.decsu@gmail.com
Tel. +662-221-5874, +662-221-5832

No.8610/ 1836

Faculty of Decorative Arts, Silpakorn University
Na Phra Larn Rd., Phra Borom Maha Ratchawang
Phra Nakhon, Bangkok 10200 Thailand

10 April 2025

Subject: Request for Information and an Interview

Dear Professor Qiu Zhitao

Miss He PEIHAO, Student ID 660420031 student in Design at the Faculty of Decorative Arts, Silpakorn University. who is currently working on the dissertation titled "Digital Do-It-Yourself (DIY) Character Creation System of Hengshan Shadow Play.", would like to request some information and request an interview with in order to collect data as a part of her dissertation research.

On behalf of the Faculty of Decorative Arts, Silpakorn University, we kindly request your cooperation and assistance in providing information and participating in an interview. For additional details, please contact Miss He PEIHAO at telephone number 063-4473643, who will serve as a direct coordinator.

Yours faithfully

(Assoc.Prof. Arwin Intrungsi)
Dean of Faculty of Decorative Arts,
Silpakorn University

Contact to : info.decsu@gmail.com
Tel. +662-221-5874, +662-221-5832

No.8610/ 2806

Faculty of Decorative Arts, Silpakorn University
Na Phra Larn Rd., Phra Borom Maha Ratchawang
Phra Nakhon, Bangkok 10200 Thailand

23 June 2025

Subject: Request for Information and an Interview

Dear Mr.Bao Yu

Miss He PEIHAO, Student ID 660420031 student in Design at the Faculty of Decorative Arts, Silpakorn University. who is currently working on the dissertation titled "Digital Do-It-Yourself (DIY) Character Creation System of Hengshan Shadow Play.", would like to request some information and request an interview with in order to collect data as a part of her dissertation research.

On behalf of the Faculty of Decorative Arts, Silpakorn University, we kindly request your cooperation and assistance in providing information and participating in an interview. For additional details, please contact Miss He PEIHAO at telephone number 063-4473643, who will serve as a direct coordinator.

Yours faithfully

(Assoc.Prof. Arwin Intrungsi)
Dean of Faculty of Decorative Arts,
Silpakorn University

Contact to : info.decsu@gmail.com
Tel. +662-221-5874, +662-221-5832

No.8610/ 2807

Faculty of Decorative Arts, Silpakorn University
Na Phra Larn Rd., Phra Borom Maha Ratchawang
Phra Nakhon, Bangkok 10200 Thailand

23 June 2025

Subject: Request for Information and an Interview

Dear Dr. Khongthat thongphun

Miss He PEIHAO, Student ID 660420031 student in Design at the Faculty of Decorative Arts, Silpakorn University. who is currently working on the dissertation titled "Digital Do-It-Yourself (DIY) Character Creation System of Hengshan Shadow Play.", would like to request some information and request an interview with in order to collect data as a part of her dissertation research.

On behalf of the Faculty of Decorative Arts, Silpakorn University, we kindly request your cooperation and assistance in providing information and participating in an interview. For additional details, please contact Miss He PEIHAO at telephone number 063-4473643, who will serve as a direct coordinator.

Yours faithfully

(Assoc.Prof. Arwin Intrungsi)
Dean of Faculty of Decorative Arts,
Silpakorn University

Contact to : info.decsu@gmail.com
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No.8610/ 2808

Faculty of Decorative Arts, Silpakorn University
Na Phra Larn Rd., Phra Borom Maha Ratchawang
Phra Nakhon, Bangkok 10200 Thailand

23 June 2025

Subject: Request for Information and an Interview

Dear Assist. Prof. Donlaporn Srifar

Miss He PEIHAO, Student ID 660420031 student in Design at the Faculty of Decorative Arts, Silpakorn University. who is currently working on the dissertation titled "Digital Do-It-Yourself (DIY) Character Creation System of Hengshan Shadow Play.", would like to request some information and request an interview with in order to collect data as a part of her dissertation research.

On behalf of the Faculty of Decorative Arts, Silpakorn University, we kindly request your cooperation and assistance in providing information and participating in an interview. For additional details, please contact Miss He PEIHAO at telephone number 063-4473643, who will serve as a direct coordinator.

Yours faithfully

(Assoc.Prof. Arwin Intrungsi)
Dean of Faculty of Decorative Arts,
Silpakorn University

Contact to : info.decsu@gmail.com
Tel. +662-221-5874, +662-221-5832

Appendix C.
Design Expert Interviews' Transcript

Researcher: How well does the system preserve the core values and visual characteristics of Hengshan shadow puppetry?

Expert 1: Overall, I think it can preserve the values and image of Hengshan well, but it still lacks the storytelling to lay the foundation for the general public to understand what it is, what its roots are, and what its significance is.

Researcher: Does the system include all necessary features (DIY, learning module, performance mode, etc.) to support both education and entertainment?

Expert 1: It is complete enough. However, if you want users to be interested and continue to study this art and culture knowledge, you should add more

Researcher: Do you think the DIY character design module encourages creativity and cultural engagement among users? Why or why not?

Expert 2: The character design module promotes creativity and cultural engagement among users as they understand the patterns, colors, costumes, and accessories present in a culture and incorporate them into their app-based activities.

Researcher: Does the system effectively convey knowledge about the history, characters, and techniques of Hengshan shadow play?

Expert 2: The work can convey knowledge about the history, characters and techniques of the Heng San shadow puppetry performance well.

Researcher: From your perspective, how effective are the AR and digital interaction features? Are there areas needing optimization?

Expert 3: Users can directly manipulate shadow puppet characters and simulate traditional shadow puppet performance movements, which is an experience that cannot be achieved through traditional static displays.

Researcher: How likely is it that this system can attract and retain users, especially younger audiences?

Expert 3: Shadow puppetry has a unique aesthetic language and cultural connotations, which just meets the young users' interest in "Oriental aesthetics" and "national style".

Appendix D.

Research Dissemination

Certificate of Contributions

He Peihao and Gomesh Karnchanapayap

Entitled

Digital Innovation Directions to Pass on Hengshan County Shadow Play

Has Contributed To

The 2025 - 17th International Conference on Knowledge and Smart Technology (KST)

February 26 - March 1, 2025

@Royal River Hotel, Bangkok, Thailand

Organized by

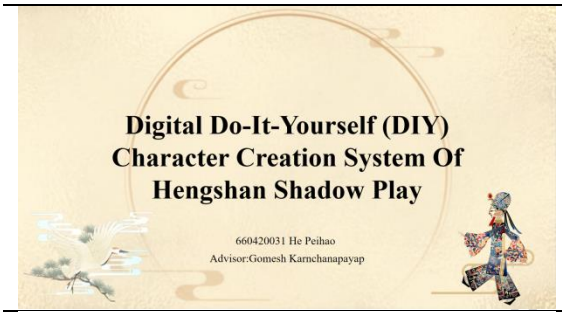
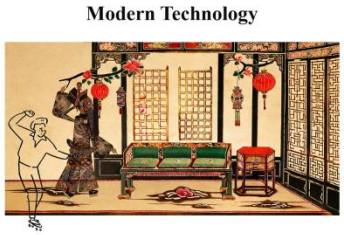
IEEE Thailand Section (Computer Chapter) and Faculty of Informatics, Burapha University, Thailand

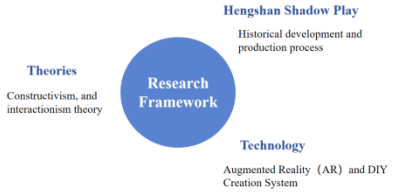
Pusit K

Pusit Kulkasem
Dean of Faculty of Informatics,
Burapha University

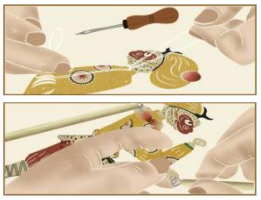
Appendix E.

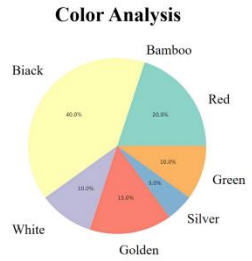
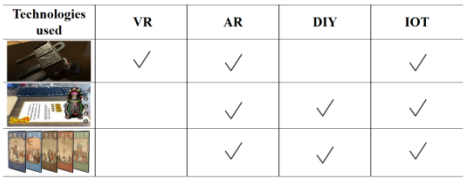
VIVA Presentation

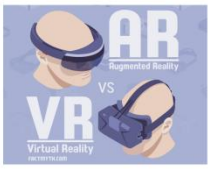
Side	Presentation Script
	Good afternoon everyone,my name is He Peihao.The research topic I want to report is Digital Do-It-Yourself (DIY) Character Creation System Of Hengshan Shadow Play.
	Hengshan shadow play is an art form that uses small figures made of animal skins to tell stories under the lights. It is one of China's intangible cultural heritages.
	Now short video software is becoming more and more diverse, young people are less and less willing to watch shadow play, and shadow play is gradually disappearing.
	So, can modern technology protect and innovate shadow play and attract more young people? This is the question we want to explore.
	I have 3 research objectives. 1、To study the production process of Hengshan shadow play. 2、To explore how DIY methods and digital technology can support the preservation of Hengshan shadow play. 3、To develop and evaluate a DIY innovation for Hengshan shadow play.

Side	Presentation Script
1.Hengshan shadow play 2.Ways of using digital technology for heritage protection	To achieve this objectives, I used literature review and case analysis, first exploring the historical and artistic significance of Hengshan shadow play; second, using digital technology for heritage protection.
Research Framework 	My research framework composed of Hengshan shadow play, theory and technology.
Research Methods 	I used a mixed research method, is expert interviews and questionnaires.
	Hengshan shadow play is a local traditional drama in Hengshan County, Hunan Province.
Shadow Play Inheritor 	Hengshan shadow play has gone through a long period of development to this day.These are the inheritors of shadow play.

Side	Presentation Script
 01 Select leather	This is the production method of shadow play. First, select leather,Choose cowhide, which should be of moderate thickness, soft and transparent.
 02 Scrape leather	Second, Use a knife to scrape off the grease and impurities from the cowhide.
 03 Tide leather	Third, Use damp cloth to wipe cowhide, Then press it with wooden board.
 04 Draw	Fourth, Use water-based pen to draw.
 05 Carve	Fifth, Use carving knife or chisel tools to carve.

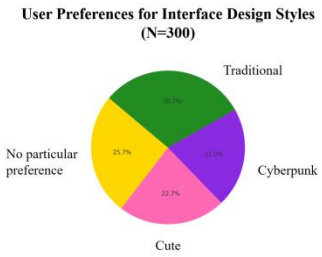
Side	Presentation Script
 06 Color	Sixth, Use brush to color, often used colors are red, black, green and orange.
 07 Iron	Seventh, Wrap the shadow play parts with cloth and iron them flat.
 08 Bind	Eighth, Find the right bone location, knot the line. Put on the iron ring, put on the bamboo rod.
 Sun Wukong	These processes can create a complete shadow play character.
	This is my material analysis.

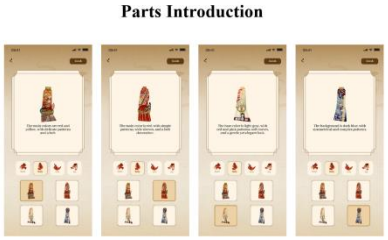
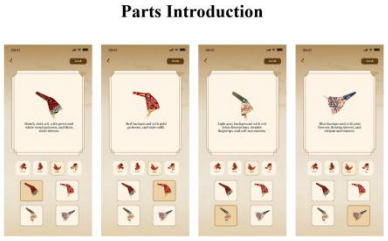
Side	Presentation Script
	And colors analysis of shadow play characters.Because the production process is so complex and difficult that it' s hard for everyone to learn it, so I want to use digital technology to show how to learn and create Hengshan shadow play.To this end, I decided to study the following 3 cases.
1.Chinese Bronze Wares: A Gamified Virtual Reality Museum 	The first one, Chinese Bronzes: A Gamified Virtual Reality Museum, This project uses virtual reality technology to simulate the process of pottery production, allowing learners to learn in a virtual environment and avoid complex and dangerous operations, significantly improves efficiency and safety.
2.Augmented Reality Chinese Cultural Clay 	The second one is Augmented Reality Chinese Cultural Clay. This project uses 3D scanning and modeling methods to develop a digital display system that provides an immersive interactive experience, promotes cultural heritage, and increases interest.
3.“Digital Sponsor” NFTs of Dunhuang 	The third one is the Dunhuang “Digital Sponsor” NFT. This project is based on the Mogao Grottoes in Dunhuang and converting cultural heritage into cultural and creative products, such as blind card boxes, through AR technology, this gamification element is the key to attracting audiences.
	Here are the technogies used in the 3 cases.

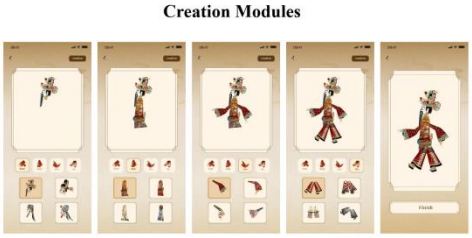
Side	Presentation Script
 	However, there are also problems such as high cost, complex technology, and the elderly cannot accept it, so we need to balance traditional craftsmanship and modern technology.
Conceptual Framework Digital Realities (VR / AR) Hengshan Shadow Play DIY Learning System Increase participation and satisfaction	Digital realities provides an opportunity to protect Hengshan shadow play, using the DIY learning system to attract young peoples, and increase user participation and satisfaction.
IOC 	This is my IOC.
Interview with AR Experts  **Tang Rui** Currently the director of the Digital Media Art Department of the School of Art at Jiangxi University of Finance and Economics. 1、Scan shadow puppet characters in separate parts (head, body, limbs). 2、Combine parts during interaction to enhance dynamic movement. 3、Help users understand how shadow puppets are assembled.	Next,is Interview with AR Experts.The first expert suggestion is recommended to combine shadow play characters by parts when scanning to enhance the dynamic interaction ability of shadow plays and let users understand the combination process.
Interview with AR Experts  **Huang Chen** Head of the Digital Media Program at the VR Industry College of Jiangxi University of Finance and Economics, Doctor of Arts. 1、Add sound effects and visual aids for better learning. 2、Create a more immersive shadow puppetry experience. 3、Make the learning process more engaging and enjoyable.	The second expert suggestion is can provide sound and visual assistance to help users learn and experience the fun of shadow play in a more immersive way.

Side	Presentation Script
Interview with Design Experts  1、Introduce each part of the shadow puppet to show its unique style. 2、Use UI design that reflects shadow play elements. 3、Enhance visual appeal and cultural connection through design. **Qiu Zhitao** Professor and Master Supervisor at the School of Packaging Design and Art, Hunan University of Technology	This is Interview with Design Experts.The first expert suggestion is recommended to introduce each part of the shadow play, and the UI design should also be related to the shadow play elements.
Interview with Design Experts  1、Use a Chinese-style interface with traditional design elements. 2、Ensure the user experience is complete and runs smoothly. **Zhao Nianci** PhD, The Chinese University of Hong Kong	The second expert suggestion is The interface style is recommended to be a Chinese style that integrates traditional elements. The usage process should be complete and smooth.
Interview with Hengshan Shadow Play Experts  1、Provide simple and easy-to-read guides on the shadow play production process. 2、Help users understand and learn through clear instructions. **Ou Yangxinnian** Provincial-level inheritor of Hengshan shadow play	This is Interview with Hengshan Shadow Play Experts.The first expert suggestion is The production process of shadow play can be introduced in simple and easy-to-understand manuscripts for users to learn from.
Interview with Hengshan Shadow Play Experts  1、Add more detailed explanations about each part of the shadow puppet. 2、Help users better grasp the structure and meaning of the designs. **Wang Donglin** Provincial-level inheritor of Hengshan shadow play	The second expert suggestion is The user don't understand the design of the shadow play. It is recommended to add more explanations on the shadow play part.
Interview with Hengshan Shadow Play Experts  1、DIY style can be modern and youthful.Avoid designs that are too cartoonish. 2、Keep the traditional texture and elements of shadow play. **Yuan Chunming** Municipal-level Hengshan Shadow Play Inheritor	The third expert suggestion is DIY can be youthful, but it shouldn't be too cartoonish. It should retain the traditional texture and elements of shadow play.

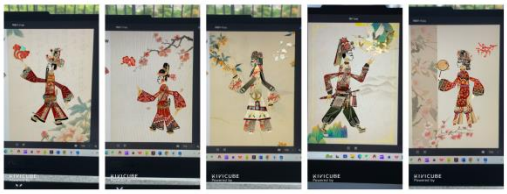
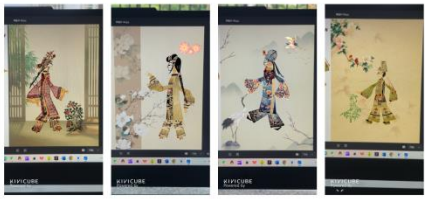
Side	Presentation Script
	This is my keywords mentioned in the questionnaire.
First Draft 	Next, start the first draft design in figma.
Cyberpunk Style 	I first designed three interface styles for them to choose from.cyberpunk style
Cute Style 	Cute style.
Traditional Style 	Traditional style.

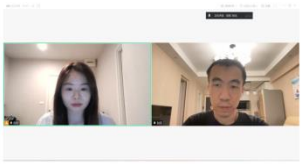
Side	Presentation Script
	The data suggests that users prefer visual styles that feel familiar and reflect their culture, showing that traditional design is important in cultural systems.
	The data results show that users prefer traditional style.
	Next is my design part, this is my icon design.
	This is my navigation modules selection, users can choose learn or create or AR.
	This is my learning modules.Users can learn the steps of making shadow puppetry.

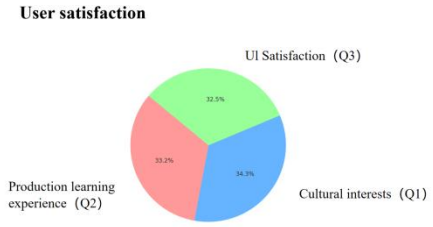
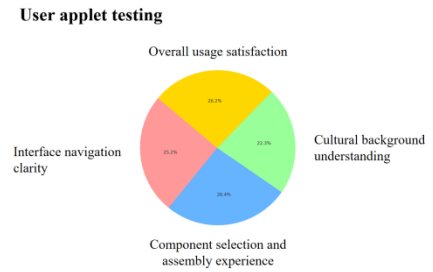
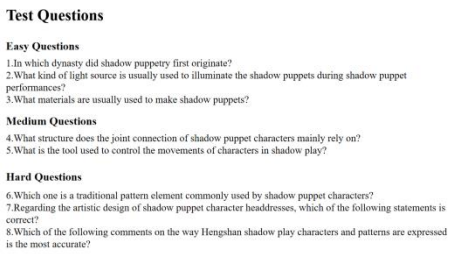
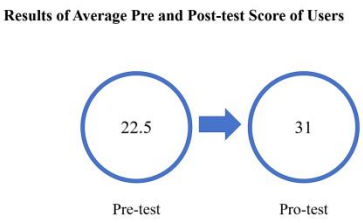
Side	Presentation Script
	
	Parts introduction of head.
	Body.
	Arm.
	Leg.

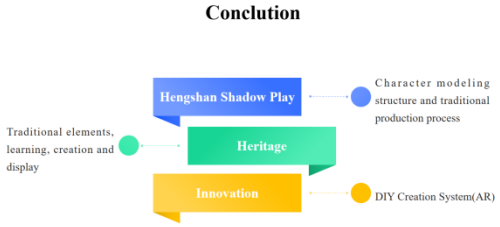
Side	Presentation Script
	This is the character creation modules. Users can click on the corresponding position to form a complete shadow play character,and can display part of the character.
	This is the other result of DIY of other character parts.
	
	This is my AR modules.
	I have 9 characters.

Side	Presentation Script
Characters 	
Backgrounds 	9 backgrounds.
Props 	And props.
Options 	Here are 9 options for AR scanning composed of backgrounds and props.
Options 	

Side	Presentation Script
Options 	
Character Parts Breakdown 	In this part, you can see the disassembly diagram of the shadow play characters.
Character Parts Breakdown 	
AR Display 	This is my AR display,users can scan characters from background images.
AR Display 	

Side	Presentation Script
Expert comments of innovation  Suggests adding Zoom function to view image detailsand descriptive voice over to enhance completeness. Assist. Prof. Donlaporn Srifar Phd. Mass Communication Technology. Rajamangala University of Technology Phra Nakhon.	This is expert comments of innovation,the first expert suggests adding Zoom function toview image detailsand descriptivevoiceover to enhance completeness.
Expert comments of innovation  Add the style and meaning of character style design to deepen user understanding. Dr. Khongthat thongphun Department : Animation and Visual Effects. College of Art, Media and Technology. Chiang mai university.	The second expert suggests add the style and meaning of character styledesign to deepen user understanding.
Expert comments of innovation  Suggests simulating traditional control methods (e.g., rods for arm movement, sliding gestures) to improve immersion. Mr. BaoYu Jilin Animation Academy.	The third expert suggests uggests simulating traditional control methods to improve immersion.
User satisfaction survey questions (1=Dissatisfied,5=Satisfied) 1. How was your experience using this mini program to learn about the production process of shadow puppetry? 2. Did this mini program spark your interest in shadow puppetry? 3. Are you satisfied with the interface design of the mini program? 4. What problems did you encounter when using the mini program? Do you have any suggestions for improvement? (Please explain)	This is my User satisfaction survey questions.I have 4 questions.
User satisfaction survey 	These photos are user satisfaction survey.

Side	Presentation Script
	There were 40 participants in this evaluation, and the content satisfaction scores of the applet designs were 32%、33%、34%.
	These photos are user applet test.
	and the applet usability test scores are 22%、25%、26%、27%.
	Next is my test Questions,8 questions divided into three levels: easy, medium and hard.
	The average score before use was 22.5 and most of them could only answer common sense questions; after use, the average score increased to 31, which significantly improved their grasp of in-depth knowledge such as structure, pattern, and cultural design.

Side	Presentation Script
	The system integrates Hengshan Shadow Play,Heritage, and Innovation by combining traditional elements and character modeling with modern tools to enhance learning, creation, and display.
	This is my cetificate of contributions。Is KST-2025 international conferences.
	Thank you for listening.

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