Mediterranean Archaeology and Archaeometry
2024, 24(3), 1195
ISSN:2241-8121
https://www.maajournal.com/ **Research Article**

The Impact of Museum Exhibition Experience Service and Virtual Simulation Technology on the Conservation of Textile Cultural Relics

Tiantian Tang [1,2], Haiming Li [3*], Zhicheng Zhang [4,5], Sang Won You [6], Haiying Chen [7]

[1] PHD candidate, Daegu University, South Korea
[2] Lecturer, School of Art and Design, Suzhou City University, Suzhou, China
[3] Professor, College of Fine Arts, Suzhou University, China
[4] PHD candidate, Daegu University, South Korea
[5] Lecturer, School of Design and Art, Suzhou City University, China
[6] Professor, Daegu University, South Korea
[7] Associate Researcher, School of Fashion, Wuhan Textile University, China
* **Corresponding Author:** sudalizheng@sina.com

Citation: Tang, T., Li, H., Zhang, Z., You, S. W., & Chen, H. (2024). The Impact of Museum Exhibition Experience Service and Virtual Simulation Technology on the Conservation of Textile Cultural Relics. *Mediterranean Archaeology and Archaeometry, 24*(3), 271–284. 10.5281/zenodo.13702896

ARTICLE INFO

Received: 13 Nov 2023
Accepted: 18 Jan 2024

ABSTRACT

In order to improve the protection of textile cultural relics in museums, this paper takes three textile cultural relics displayed in Soochow University Museum as an example. First of all, the textiles displayed in the Soochow University Museum were collected, and the stone blue cloud pattern damask women's robe, the long robe with eight auspicious symbols jacquard satin, the stone blue jacquard satin embroidered open-front women's robe with figural motifs and the moon White peony pattern woven brocade edged women's robe were selected as the research objects, and the UT ROV 3D scanner (USA), OU HA LONG solar film measuring instrument AL-618 (China), PEAK 1209 SA0 (Japan) and PEAK 1006 SA0 (Japan) were used to measure, and the measurement indicators included: the warp and weft state of the silk thread, the color of the dye, the size of the vulnerability, etc., and the relevant data were recorded. Then, according to the relevant data, the simulation display is carried out to achieve the purpose of textile cultural relics protection. The results showed that: 1) the damage degree of the three textile cultural relics was large, and the damaged area was 1*5 mm^2~10*60 mm^2; 2) the blue dye was polygonum, the yellow was gardenia, the black was hemp oak, and the red was saffron, all of which were plant dyes, and was matched with alum and other components; two of the textiles have good transparency, and the light transmittance reached 22%; 3) the warp and weft lines were relatively complex, mainly horizontal, longitudinal and oblique. Therefore, strengthening the museum exhibition experience service and reusing virtual simulation technology can protect textile cultural relics.

Keywords: Museums, Exhibition Experience Services, Virtual Simulation Technology, Textile Cultural Relics.

INTRODUCTION

The textile cultural relics in the museum are the important cultural heritage of the Chinese nation, so it is of great value and significance to attach importance to the protection of China's textile cultural relics. Moreover, people should also realize that at a time when the effective protection and inheritance of Chinese cultural heritage is being severely challenged, the protection and inheritance of textile cultural relics by the society can not only play a certain role in the protection and inheritance of the history of Chinese civilization and art and culture, but also leave a valuable ideological legacy for the cultural construction of future generations. Some scholars believe that in the process of virtual reproduction of ancient Chinese textiles, it is necessary to analyze the production

process, process and textile characteristics of textiles, so as to simulate more accurately and reduce the damage to the original textile items (Chai, Cui, & Niu, 2022). Some scholars believe that the application of non-destructive spectroscopy technology such as infrared spectroscopy can discover the distribution of warp and weft lines of textile items through the irradiation of light, measure the thickness of warp and weft lines, and keep warm, so as to achieve non-contact and non-damage monitoring (Chen, Ma, & Zhang, 2023; Elsayed, Shabana, Elmitwalli, Rashad, Sreenivasaprasad, & Mabrouk, 2023; Abdelrahim, Elnagar, & Mohamed, 2020). Similarly, some scholars have conducted an in-depth analysis of non-destructive infrared spectroscopy, believing that infrared reflection, or the refraction of light, will be more effective in measuring the toughness and fine density of textiles, and more accurately reflect the characteristics of textiles, so it is recommended to use infrared and other spectra, as well as the frequency of reflected light for detection (Fan, H. Wang, K. Wang, Z. Wang, & Zhen, 2022). Under the strategies of social participation and scientific protection, people should actively attach importance to the protection of textile cultural relics and push it to a higher level. In this way, the value and significance of textile cultural relics protection can be realized. In the actual practice process, people will find that the museum exhibition experience service and virtual simulation technology can have a very positive impact on the protection of China's textile cultural relics. Based on this, this paper concludes that the combination of museum exhibition experience service and virtual simulation technology will lead the audience to better participate in the analysis and research of textile cultural relics, and improve the audience's understanding and awareness of all aspects of the details, structure and historical and cultural heritage of textile cultural relics. In this way, it can improve the public's attention to the protection of China's textile cultural relics, and improve the dissemination of relevant textile cultural relics information and culture, and is conducive to the protection of textile cultural relics and historical and cultural inheritance, so as to help future generations know, understand and carry forward Chinese traditional culture.

THEORIES RELATED TO MUSEUM EXHIBITIONS

Exhibition Experience Service

For the protection of textile cultural relics in China, the museum exhibition experience service is a very effective way to publicize, which can deepen the public's awareness and understanding of textile cultural relics, and improve their attention to the protection of textile cultural relics. The museum exhibition experience service refers to providing a series of value-added services for the audience in the process of museum exhibitions, so that the audience can obtain a richer and more diverse and hierarchical visiting experience. While the general museum exhibition service focuses on the display of exhibits and text explanation, the museum exhibition experience service is different, which will provide visitors with a more interactive, immersive and personalized viewing experience through innovative and diversified forms and multimedia technology (H. Hu et al., 2023).

In general, the museum exhibition experience encompasses the following aspects:

Multimedia interactive technology. Multimedia interactive technology uses a variety of multimedia devices, such as projections and screens, to present the audience with rich and dynamic audio-visual effects. With the help of electronic screens tour guide equipment, etc., a variety of display methods are presented to the audience. These include images, video, audio, and more. Based on this, the audience can see a more intuitive background of cultural relics, historical stories, etc. In this way, the audience's awareness and understanding of the significance of cultural relics will be enhanced (X. J. Hu et al., 2023).

Interactive installations and gamification elements. Set up interactive devices and sensors for visitors to encourage positive interaction with the exhibits. For example, through touch screens, buttons, sensors and other technologies, the audience will effectively interact with the virtual textile relics, and rotate, zoom in, drag and so on, so as to better understand the relevant information and stories of textiles. In addition, the exhibition hall can also add some gamification elements to guide the audience to join the exhibition, so as to enhance the audience's interest and interactive experience (Le, Jin, Ding, & Guo, 2022).

Virtual reality and augmented reality. With both technologies, it is possible to give the audience a truly immersive experience. By allowing the audience to wear VR headsets, glasses equipment, etc., the audience will be fully integrated into the virtual world, so as to deepen their feelings and understanding of the dynastic background and cultural background of textile cultural relics. The use of augmented reality technology allows the audience to add virtual content and information to the actual exhibition scene with the help of mobile phones, tablet devices, etc., so that the audience can enjoy richer and more interactive display content (J. Liu et al., 2021a).

Guided tours and educational activities. Professional guided tours and educational activities allow visitors to appreciate the textile relics first-hand and deepen their understanding. The tour guide can patiently explain the

historical background and cultural significance of textile relics (J. Liu et al., 2021b), production technology and other knowledge content for visitors. In addition, museums should also organize some corresponding lectures and interactive exhibitions, etc., through these educational activities, so that visitors can have a deeper experience of the process of protection and inheritance of cultural relics.

Through the museum's exhibition experience service, visitors will learn about the historical and cultural significance of Chinese textile relics in a more dynamic and interesting way. In this way, the audience will be more actively interested in the conservation work. At the same time, it will also strengthen people's ability to appreciate textile relics and cultural protection awareness. In order to improve the exhibition experience of museums, museums should actively use the latest technological means to provide audiences with a more realistic and participatory exhibition experience. In this way, the further protection and inheritance of textile cultural relics can be promoted.

Virtual Simulation Technology

Virtual simulation technology is a technology that uses computer models and algorithms to model and simulate actual systems and processes, so as to simulate and represent the behavior or characteristics of the system. It uses numerical models (K. Liu, Zhao, & Zhu, 2022), physical laws, experimental data, etc. to carry out calculations and simulations, so as to help people understand and understand the operating status and performance of the system. At the same time, provide people with targeted optimization strategies. At present, virtual simulation technology has been applied to various industries, such as medicine, transportation, engineering, museum exhibitions, etc. At the same time, people can use the results of computer-generated simulations to enhance their understanding and awareness of various real-world systems, and improve them. Virtual simulation technology includes multiple parts: model construction, algorithm calculation, simulation display and other parts. In order to facilitate people to understand the virtual simulation technology and form a certain understanding of it, this paper will make a specific introduction to the various components of the virtual simulation technology. For example, how they work and how they function.

Steps of Virtual Simulation

Model construction: Model construction is a basis for the application of virtual simulation technology, and its fundamental purpose is to use physical laws, mathematical models, experimental data, etc., to describe and describe a practical process or system of simulation objects. At this stage, people should select appropriate mathematical methods and modeling tools according to the specific process, system characteristics and requirements (Peng & Zhou, 2023), and construct a corresponding mathematical model. Moreover, in the process of constructing this mathematical model, it must be ensured that it is consistent with relevant physical laws and empirical data, as well as with other methods, such as mechanics or fluid mechanics, statistical analysis, neural networks, and genetic algorithms (Su et al., 2022).

Algorithmic calculations. After the model is constructed, people need to use reasonable calculation algorithms to calculate these mathematical models. Based on the actual situation and needs, people need to use a variety of solution methods and optimization algorithms to complete the calculation. For example, common algorithms, finite element methods and iterative solving.

Simulation demonstration. Simulation display is the process of using images or videos, animations, real-time simulations, etc. to show simulation results to users. Using visualization technology, people should directly transform the simulation process into perceptible visual and sound effects, so that users can directly observe and understand the simulation results. In this way, users can effectively interact with the simulation system in a virtual environment, and adjust the parameters of the system status in real time, observing and analyzing the system. Based on this, people will be able to make final decisions based on the simulation results, or optimize them.

Functions of Virtual Simulation Technology

First, analysis and prediction function: using the mature mathematical model and algorithm calculation method, people can analyze and predict the system or process through virtual simulation technology. For example, in the protection of textile cultural relics, people can use virtual simulation technology, combined with the material data and test results of textile cultural relics, to build a mature model and algorithm, and use them to carry out specific predictive analysis. For example, using the known temperature and humidity data, people can analyze and predict the degradation rate and change trend of textile cultural relics in a specific environment in the future through virtual simulation technology, and provide reasonable guidance and optimization measures for the effective protection of textile cultural relics.

Second, damage analysis and assessment. Virtual simulation technology will provide services for digital model scanning and reconstruction of textile artefacts, for example, effective analysis and evaluation of damaged

parts of textile artefacts. In the virtual environment, the specific damage conditions of textiles are simulated to identify various problems such as fiber breakage or wrinkles, loose sand lines, etc., and analyze the impact of these damage conditions on textile relics.

Third, the repair plan is simulated and verified. When repairing the damage to textile cultural relics, virtual simulation technology will simulate and verify the effects of various restoration schemes. For example, people can use the method of building textile restoration models to simulate various materials, processes, methods, etc. In this way, it is possible to predict the impact of individual restoration options on the appearance and structural integrity of textile relics, long-term conservation effects, etc., and to optimize the best options (Sun et al., 2021).

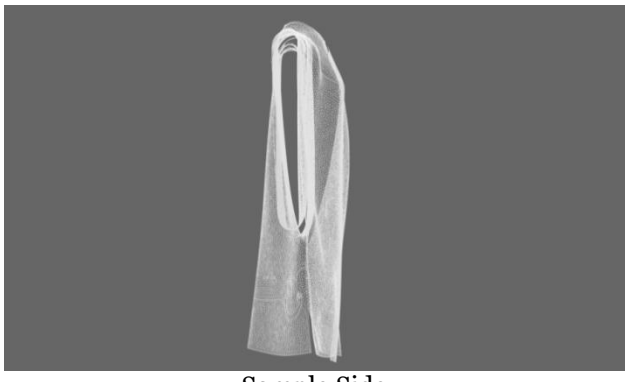
RESEARCH OBJECTS AND METHODS

Research Objects and Methods

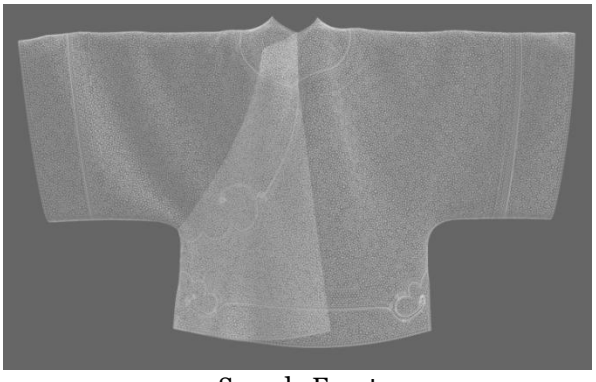
This paper takes three textile relics displayed in the Soochow University Museum as an example. First of all, the textiles displayed in the Soochow University Museum were collected, and the stone blue cloud pattern damask women's robe, the long robe with eight auspicious symbols jacquard satin, the stone blue jacquard satin embroidered open-front women's robe with figural motifs and the moon White peony pattern woven brocade edged women's robe were selected as the research objects, and the UT ROV 3D scanner (USA), OU HA LONG solar film measuring instrument AL-618 (China), PEAK 1209 SA0 (Japan) and PEAK 1006 SA0 (Japan) were used to measure, and the measurement indicators included: the warp and weft state of the silk thread, the color of the dye, the size of the vulnerability, etc., and the relevant data were recorded. Then, according to the relevant data, the simulation display is carried out to achieve the purpose of textile cultural relics protection. Among them, UT ROV 3D scanner (USA) is mainly to obtain the 3D effect of textiles, and reproduce the 3D model, so as to provide model data for the later three-dimensional display of textiles. The Infrared Measuring Instrument Model 300 obtains a heat map of the textile to determine the thickness of the textile and provide contour data for 3D scanning. The handheld microscope is mainly to observe the warp and weft direction of the silk thread in the textile, as well as the thickness of the silk thread, and combine it with infrared scanning data to determine the contour line of the textile and improve the accuracy of 3D scanning.

Textile Design

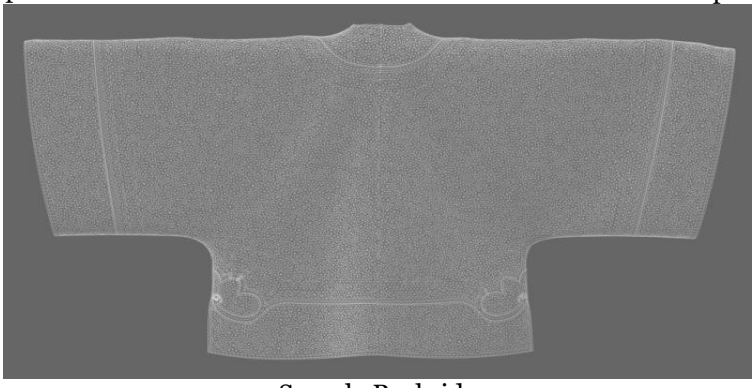
In order to further analyze the three textile relics, it is necessary to 3D scan the displayed items and utilize Computerized Lockstitch Operating 3D software to construct the three-dimensional shape of the samples, facilitating a more effective digitization process, as shown in Figure 1.



Sample Side



Sample Front



Sample Backside

Stitching of Different Materials

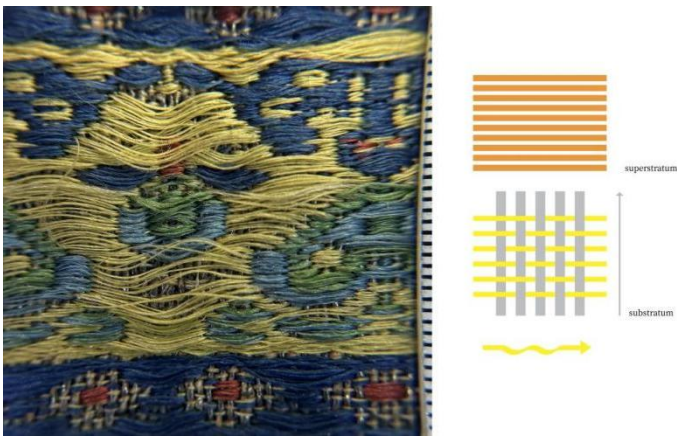
Figure 1. Three-dimensional Figure of the Moon White Peony Pattern Woven Brocade Edged Women's Robe

As can be seen from Figure 1, the side of the moon White peony pattern woven brocade edged women's robe has a loose design, which can be worn as everyday clothing, and the style of the clothing is relatively luxurious and intricate. The moon White peony pattern woven brocade edged women's robe is woven from three materials: silk, linen and cotton, but it is mainly silk. The black colour of the cuffs is cotton, The body of the robe, collar, lapel edge, cuffs and hem are all about embroidery edge decoration. As a result of the Han Chinese women's clothing popular fashions, women's clothing is luxurious and complex. During this period, the horseshoe sleeves of the original flag dress were gradually replaced by the straight and wide sleeves of the Han Chinese. The black part of the picture is the sleeve. Sleeve pulling is the clothing sleeve end of the splicing decoration, the production method is generally in the short and wide cuffs, plus connecting with the clothing fabric of different colours of the sleeve head, knotted sleeve head from the inside to the outside of the layer by layer turned out. Sleeve head set with exquisite strips, so that the clothes look more layered, more gorgeous. The weaving lines of the moon White peony pattern woven brocade edged women's robe are relatively coarse, which is in line with the wearing habits of the nobles of the Qing Dynasty.

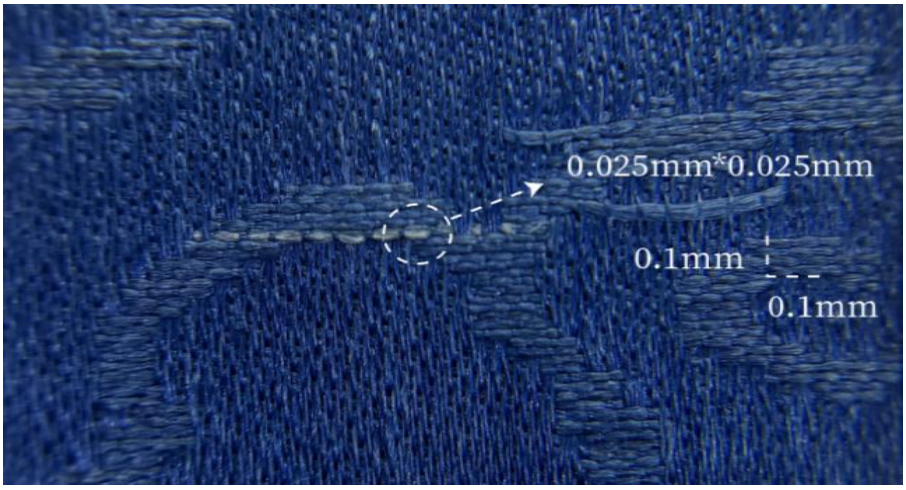
Weaving Design of Textiles

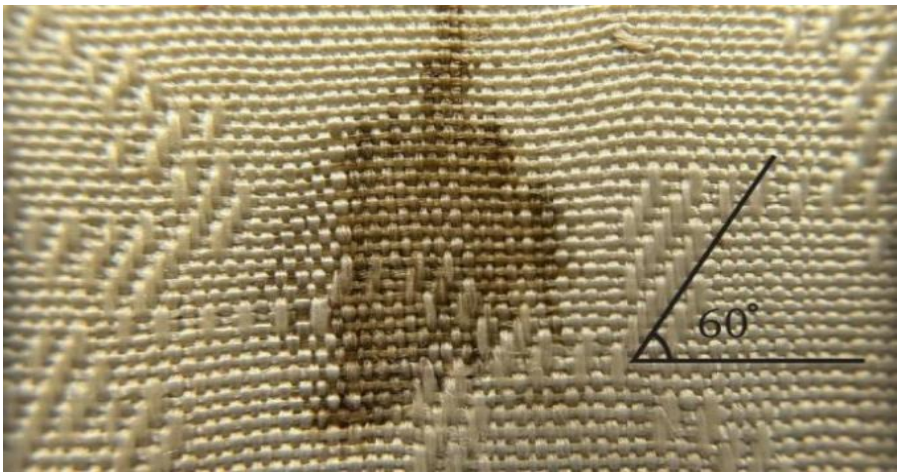
The sample textiles collected in this paper mainly use three weaving methods, namely cross mode, horizontal and vertical mode, and complex staggered mode, and the durability and comfort of each method are different, as shown in Figure 2.

Horizontal Fiber System



Complex Interleaved Ways





Crossover Mode

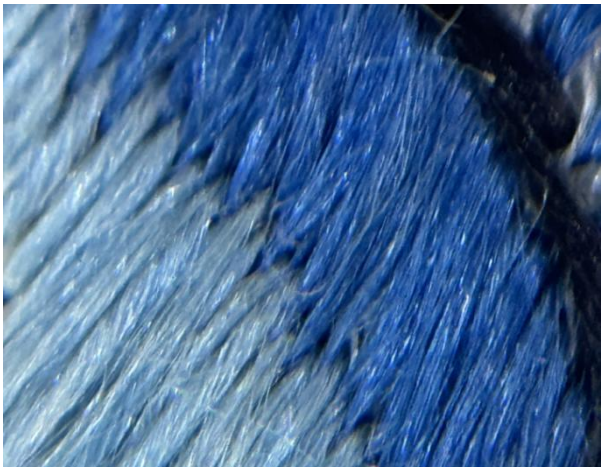
The Overall Distribution of Latitude and Longitude Lines and the Temperature Distribution

Figure 2. The Weaving Patterns of Different Samples

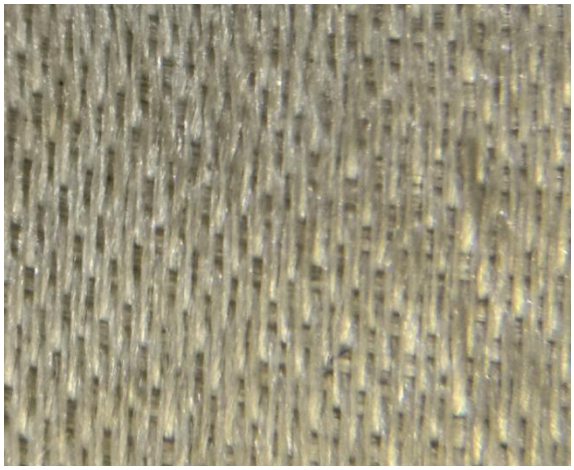
From the analysis results in Figure 2, it can be seen that the stone blue cloud pattern damask women's robe mainly adopts the horizontal Fiber System. The long robe with eight auspicious symbols jacquard satin is mainly woven using crossover mode weaving, plus twill weft brocade weaving method, and the horizontal width of the interweaving is 0.025 mm. The Moon White peony pattern woven brocade edged women's robe adopts a weaving method of crossover mode and horizontal threads with a twill weft brocade at a cross angle of 60°, primarily to accommodate the intricate style. The stone blue jacquard satin embroidered open-front women's robe with figural motifs adopts a complex staggered way, From the organizational structure perspective, it appears to be a 90° shift similar to twill warp brocade, utilizing the interchanging layers of weft threads to showcase the floral pattern, which not only presents a certain angle of warp and weft, but also runs through the complex staggered line, mainly to meet a variety of styles and improve comfort. Therefore, the textile samples of Soochow University Museum are diverse, and they should be digitally compiled according to the weaving method of the samples.

Dyeing Materials for Textiles

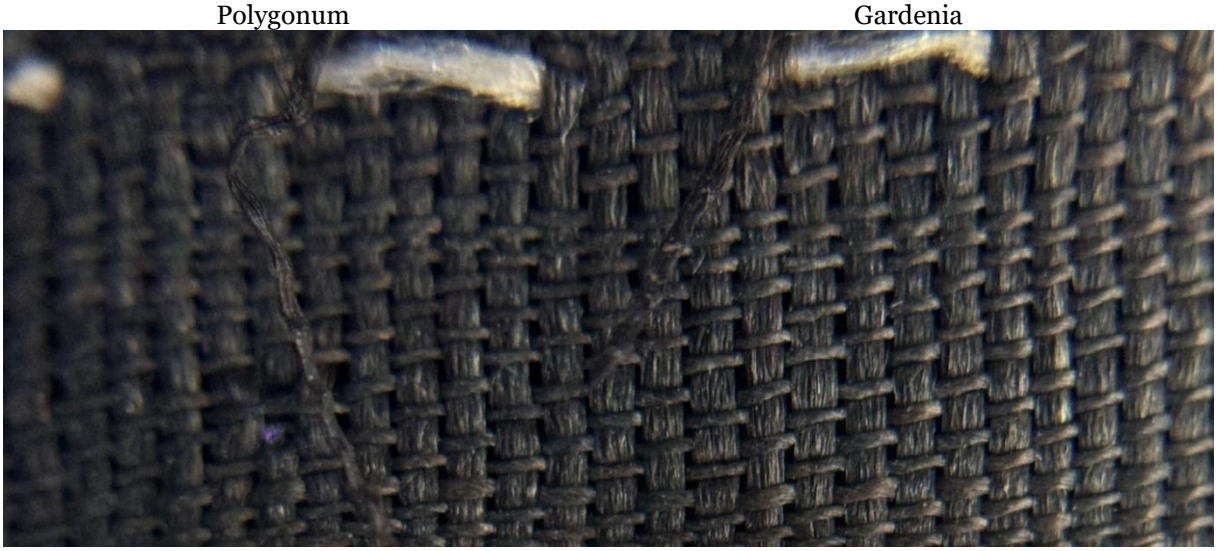
Chinese textile cultural relics have a long history and profound cultural connotations, so their value is unlimited. In China's textile cultural relics, there are often rich materials and patterns, and craft wealth, which carry the unique elements and historical and cultural memory of the Chinese nation. Therefore, Chinese textile cultural relics are not only the classic heritage of national craft aesthetics. In order to better protect textiles, the dyed material of the textile is analyzed, and the specific results are shown in Figure 3.



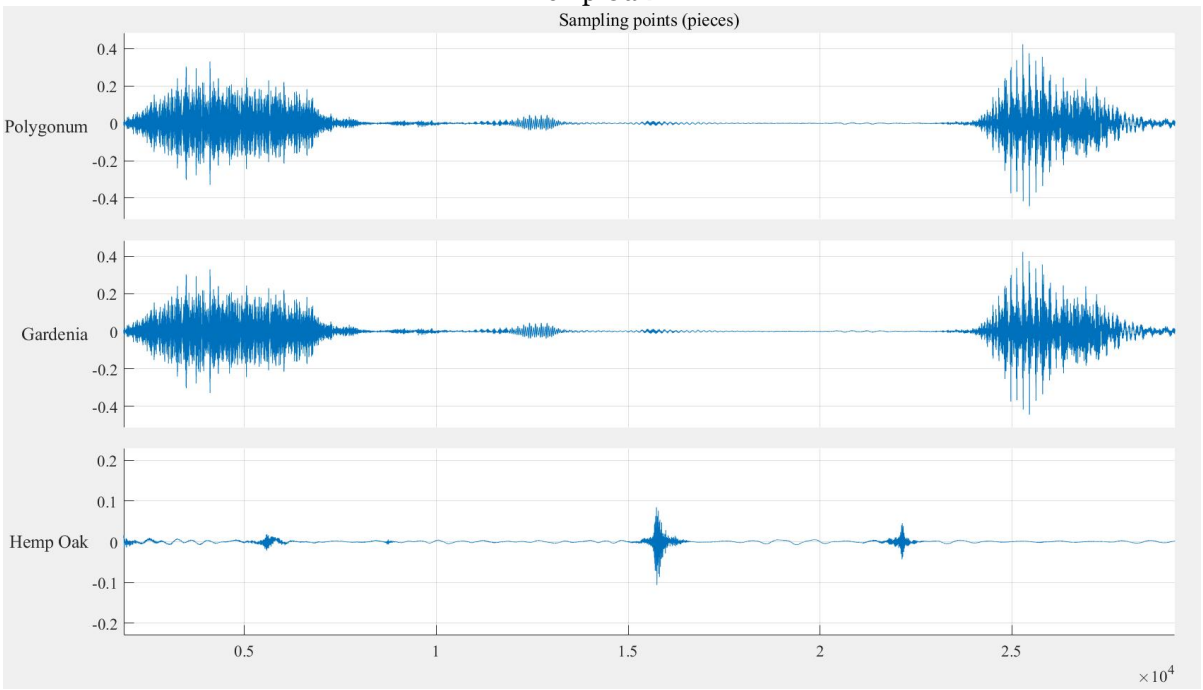
Polygonum



Gardenia



Hemp Oak



Color Signals for Different Sampling Points

Figure 3. Basic Dyes of the Sample

According to the test in Figure 3, it was found that the basic dyes of the stone blue cloud pattern damask women's robe, the long robe with eight auspicious symbols jacquard satin, the stone blue jacquard satin

embroidered open-front women's robe with figural motifs and the moon White peony pattern woven brocade edged women's robe were mainly alum, polygonum, gardenia, hemp oak and saffron, and the proportion of dyes is increased according to the requirements of blue, yellow, black and red. Therefore, it is necessary to label the dye components of textiles in detail and include them in the conservation database to increase the level of experience of museum exhibitions. Among them, there are certain differences in the patterns and textile patterns of different dyes, so it is necessary to classify the details of the age and textile cultural relics, build the museum exhibition information system, and better display the museum textiles.

Light Transmittance of Textiles

Since the textiles in the museum cannot be lifted or placed, it is necessary to obtain data on the thickness of the textiles by indirect methods. In this paper, the light transmittance is used to provide support for the later virtual simulation. Since the virtual simulation is a 3D reproduction, the thickness data directly reflects the front and back widths of the textile fabric, as well as the thickness of the single layer of the fabric. Therefore, it is necessary to compare the light transmittance of textiles. The transmittance of textiles in the Qing Dynasty has always been an evaluation index of textile technology, so the virtualization of textile cultural relics should also increase the transmittance test, and the specific test results are shown in Figure 4.

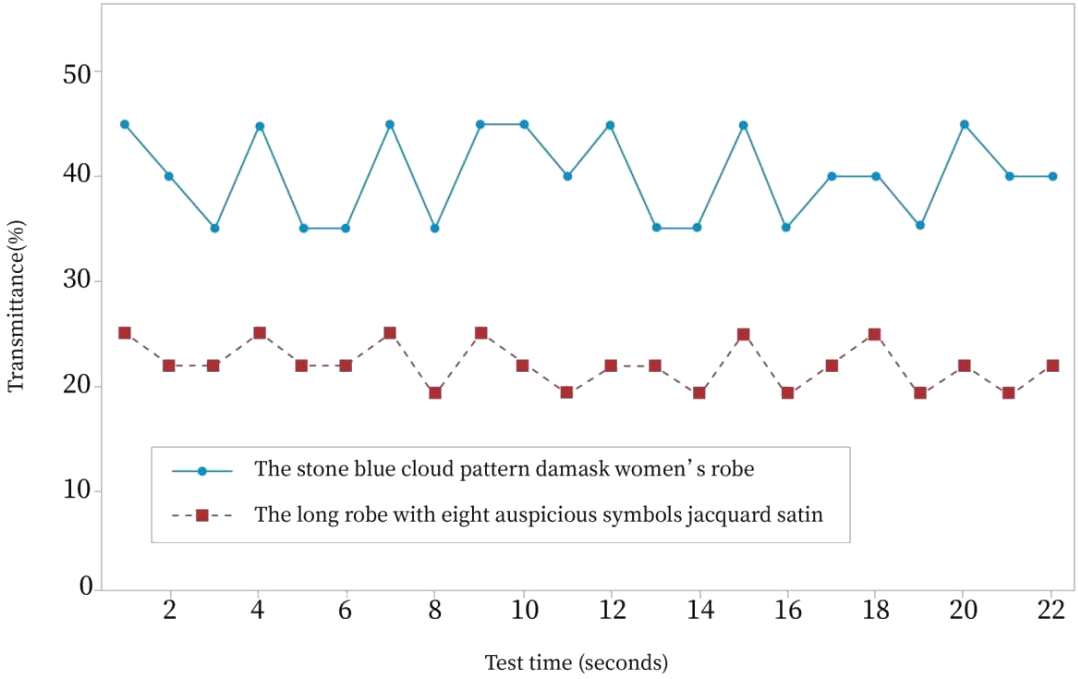


Figure 4. Light Transmittance of Different Textiles

From the test results in Figure 4, it can be seen that the stone blue cloud pattern damask women's robe and the long robe with eight auspicious symbols jacquard satin is higher, both of which are greater than 22%, and the specific light transmittance is shown in Table 1.

Table 1. Specific Light Transmittance of Different Textiles

Textile contents	Location	Transmittance (%)	Temperature (℃)	Damage area (mm²)
The stone blue cloud pattern damask women's robe	Surface	40	23.42	5*12
	Central	40	24.32	10*60
The long robe with eight auspicious symbols jacquard satin	Surface	22	23.22	1*5
The stone blue jacquard satin embroidered open-front women's robe with figural motifs	Surface	0	23.52	3*7
	Lining	0	23.96	2*5
The moon white peony pattern woven brocade edged women's robe	Surface	0	23.23	10*5

Note: The transmittance is obtained based on the data of the OU HA LONG solar film measuring instrument AL-618 test.

The temperature in Table 1 is the data measured by the Bosch Infrared Measuring Instrument Model 300, the transmittance= (the infrared tester data /the ambient temperature)*100, and the damaged area is obtained based on the observation results of the handheld microscope. Among them, the light transmittance of the dark flower robe is higher, but the infrared test temperature is also higher, indicating that the workmanship process of the textile is better, mainly because the process adopts a cross method, which not only improves the beauty of the textile, but also enhances the cold resistance of the textile. The test results of the stone blue jacquard satin embroidered open-front women's robe with figural motifs were similar to those of the moon white peony pattern woven brocade edged women's robe, but the stone blue cloud pattern damask women's robe was inversely proportional, indicating that the workmanship of the textile was too complex and affected the heat retention of the garment. At the same time, the test results show that there is a certain amount of damage in the test sample in 1, and the damage position is mainly located in the middle of the textile, and the area is between 5*12 mm^2~10*60 mm^2, indicating that the wear resistance of the textile is poor. To this end, when the Soochow University Museum conducts virtual simulation, it is necessary to focus on the data description of the central location, so as to enhance the realism of the museum's exhibition experience. In view of the above analysis, this paper analyzes the experience service factors of textile cultural relics in museums, and obtains the results in Table 2.

Table 2. The Experience Service of Textile Cultural Relics

	Simulation technology	**Vision**	**Hearing**	**Understand**	**Match between virtual and reality**	**Dynamics**	**Result normality**
Color	3.412	1.126	3.031	0.002**	91.206 ~ 95.619	0.288	F (3,5)=0.673, p=0.605
Sculpt	-0.169	0.453	-0.373	0.709	91.056 ~ 93.719		
Principle	0.877	0.758	1.158	0.247	90.608 ~ 92.363		
Cultural connotation	-1.069	0.937	-1.141	0.254	92.905 ~94.768		
Dependent variable = service experience							

It can be seen from Table 2 that the virtual simulation technology of museums has a high matching degree of visual, auditory and comprehension, which is more than 90%, and the results are highly holistic and universal. Among them, color and principle belong to quantitative data, so their values are positive, and modeling and cultural connotations are subjective, so they are negative values. Therefore, simulation technology, hearing and comprehension are the main factors to improve the service experience, and color, shape and connotation are the core to improve the virtual construction of museums.

THE IMPACT OF MUSEUM EXHIBITION EXPERIENCE SERVICES AND VIRTUAL SIMULATION TECHNOLOGY ON THE PROTECTION OF TEXTILE CULTURAL RELICS

Digital Reconstruction can Reduce the Exposure Time of Textiles

In the process of protecting textile cultural relics, virtual simulation technology can play a practical impact, for example, 3D scanning and modeling technology, are part of virtual simulation technology, through their application, will realize the digital reconstruction of textile cultural relics, because they are the necessary tools for digital reconstruction. Specifically, people can use 3D scanners to carry out non-contact 3D scanning of textile relics, so as to present accurate digital models of textile relics to people. Such a digital reconstruction will have a new role in effectively protecting, displaying, passing on textile relics, and conducting comprehensive research on them. In the process of starting 3D scanning, people should place the textile artifact on the platform of the scanner, and then use laser technology, structural technology, etc., to complete the scanning (Van Strydonck, 2021), so that the surface shape and feature data of the textile artifact to be scanned can be quickly and accurately obtained. And, form a high-resolution 3D model. At the same time, people also need to consider how to obtain accurate material feature information, so people need to use spectral cameras and near-infrared cameras to complete auxiliary acquisition work, and then achieve this purpose. After the 3D scan is completed, the scan data

is directly converted into a digital model after a series of processing (Wei et al., 2021). For example, the point cloud data processing and optimization are completed first, and the mesh model and texture mapping are reconstructed. Based on the above steps, people will obtain a more realistic digital reconstruction model of textile relics with high precision.

The Digitization of Materials can Deeply Analyze the Value of Cultural Relics

For the protection of textile cultural relics, in addition to reconstructing the shape of textile cultural relics, virtual simulation technology will be able to effectively achieve the digital expression and protection of the material characteristics and woven structure of textile cultural relics. The material characteristics of textile cultural relics generally include fiber composition and texture, and its weaving structure basically involves weaving methods, patterns, patterns, etc. When digitally expressing the material characteristics of textile cultural relics, people need to carry out spectral scanning of various fiber materials through spectral analysis instruments, and then record the reflectance and absorption rate of each band. In this way, the fiber composition results under the spectral information can be identified, and at the same time, it can be effectively correlated with the 3D model, and then the digital expression required for the material characteristics of textile relics can be realized. In contrast, the digital expression of the woven structure of textile relics is significantly more complex. For example, people should first complete high-resolution observation and analysis of textile relics, such as patterns and weaving methods (Wu et al., 2022). Based on basic manual observation, people can use virtual simulation technology, combined with superior image processing and calculation methods, to achieve semi-automatic or automatic pattern recognition, and reconstruct the weaving structure of textile relics. In this way, the reconstruction effect of the woven structure can be comprehensively improved, the accuracy and reliability of the reconstruction work can be improved, and the protection and research of textiles can be promoted.

The Textile Database can Realize the Sharing of Exhibits

In order to be able to preserve and manage the results of the digital reconstruction of textile cultural relics in place, and to achieve further inheritance, it is necessary to establish a digital model database and file management system. The first is the digital model database, which can effectively store the digital model and related data of textile relics. Then, textile relics can be classified and organized, and effective retrieval can be achieved. Therefore, people will be better able to study and protect textile relics, and query and access their related data. The file management system links the digital model and other important information, such as attribute descriptions and expert appraisal reports, and organizes and manages them. By establishing a complete archival management system, people will be able to trace their sources as well as historical and attribute information more quickly, and provide a reasonable basis for further protection and research of textile cultural relics. The establishment of a digital model database and a dedicated file management system will facilitate further research and analysis of textile relics, and can provide a platform for cooperation between relevant experts and scholars. In addition, by taking advantage of the sharing and dissemination of digital information, people will be better able to protect and pass on textile relics and push them to a higher level.

Virtual Display Technology to Improve the Audience's Experience of Textile Cultural Relics Exhibition Service

Virtual display technology can make the textile relics exhibition experience service have more innovative ways to enhance the experience of the audience. In the past, the exhibition of textile cultural relics was more traditional, and basically, it was displayed through physical display, but because of the particularity of textile cultural relics, their protection and display often faced many restrictions and challenges. If the organizer can use virtual simulation technology to carry out the exhibition, it can provide the audience with more diverse and immersive exhibition forms without fully exposing the physical object. For example, people can use virtual reality technology to achieve effective applications and achieve innovative purposes (Xiao et al., 2021). For example, visitors are allowed to wear virtual reality headsets (VR headsets) that allow them to enter an innovative virtual environment and interact with textile relics up close. Through the effective combination of 3D models and audio-visual effects, visitors can enjoy high-definition, realistic textile images in virtual reality. In addition, it can provide more angles of display (Zhang et al., 2022). At the same time, visitors can learn a lot about the history of textile artefacts. For example, in a museum exhibition experience service that combines virtual textile technology, visitors can experience the weaving process of ancient China, observe the entire weaving process, and carefully understand and understand the historical and cultural background of Chinese textile relics. In addition, augmented reality technology is also used to realize the exhibition of textile relics. For example, AR applications provided by various devices, such as mobile phones and tablets, can be used to correspond and overlap the images of virtual textile relics with the textile relics in the exhibition hall. In this way, visitors will be able to observe the virtual images and text explanations displayed on the exhibits by taking pictures with their cameras and viewing them on their devices. In this way, visitors will be able to deeply understand the characteristics and connotations

of textile relics, and use the effective interaction between virtual and real to obtain a better visiting experience.

Utilize Virtual Simulation Technology to Increase Audience Engagement

Virtual simulation technology can enable visitors to better participate in the museum exhibition experience and enhance interaction. For example, by using interactive technology and combining multimedia elements, the organizers will create a more engaging and engaging exhibition experience service. First, handheld devices and interactive desktop devices can be used to allow the audience to effectively interact with virtual textile relics. For example, the effective combination of museum exhibition experience and virtual simulation technology can be used to hold an exhibition of textile relics. Based on this, visitors will rotate, enlarge, and tilt the textile relics through various gesture control methods, so that the audience can truly appreciate their details and textures. In this way, the audience will have a strong sense of participation, and will be able to further observe, learn, and explore, and then get a better exhibition experience, and secondly, the audience can also interact with the virtual textile relics through their own body movements with the help of somatosensory equipment and motion detection technology. For example, in the virtual experience of the museum's exhibition, visitors can wear special body sensing devices and use special depth camera equipment to simulate the manual operation of weaving textile relics and experience the feeling of textile relics floating in the air. In this way, visitors will have an immersive experience and learn more about the weaving process and characteristics of textile artefacts.

Influence on Education and Research on Textile Cultural Relics

After the combination of virtual simulation technology and museum exhibition experience services, it can be applied to the education and research of textile cultural relics, so that students can better carry out learning and research. For example, teachers can use the combination of virtual simulation technology and museum exhibition experience services to take students through the process and show students the various details and characteristics of textile relics. In this way, students and researchers can deepen their understanding of the history and background, materials and techniques of textile relics. In the related displays, students can also learn about and touch various textile relics through virtual simulation technology, and understand their characteristics and uses. In addition, virtual simulation technology can also simulate the actual operation process, so teachers can use it to allow students to develop a certain degree of operation and creative ability from various textile processes such as weaving and dyeing. In this way, students will be able to deepen their awareness of the conservation of textile relics from a variety of learning resources. In terms of research, teachers can also deepen students' exploration of the historical background, craftsmanship and cultural connotation of textile cultural relics through the combination of virtual simulation technology and museum exhibition experience services, so as to improve the inheritance and protection effect of textile cultural relics. By simulating the weaving structure and dyeing methods of textile relics, people will learn more about traditional craft techniques and understand the ancient Chinese textile weaving methods. At the same time, people can also use it to study the historical development and changes in textile cultural relics.

It is worth mentioning that virtual simulation technology can also support the scientific comparison and analysis of the styles, patterns and patterns of various textile cultural relics, so as to provide effective clues for scholars' academic research (Zhou et al., 2023). In short, virtual simulation technology will be applied to a certain extent in the museum exhibition experience of textile relics. Through effective display and interactive experience, virtual technology will show the characteristics and styles of textile cultural relics, and improve the exhibition value of textile cultural relics. In this regard, the audience will have a more intuitive contact with the textile relics, and can get a certain exhibition experience. In addition, virtual simulation technology can also promote the effective protection of textile cultural relics and deepen the depth of related research, so as to promote the further promotion and inheritance of textile culture.

SUMMARY

Museum exhibition experience services can have a certain impact on the protection of textile cultural relics. The museum exhibition experience service can provide the audience with a highly attractive and authentic viewing experience through a variety of display methods and educational methods, and then improve the audience's interest and awareness of the protection of China's textile cultural relics. Based on intuitive explanations and storytelling, the audience will better remember, recognize and understand the historical background and cultural background of Chinese textile cultural relics, production skills, etc. In addition, the museum exhibition experience service can also be actively combined with other means, such as music and dance, so as to improve the audience's appreciation of Chinese textile relics. At the same time, virtual simulation technology will also have a direct impact on the protection of textile cultural relics. Virtual simulation technology can be applied to the museum's exhibition experience service activities, and present the audience with more high-definition, more diverse, more

angle, and more realistic images of textile cultural relics. In this way, the audience can intuitively feel the texture and details of Chinese textile relics, and observe various details of textile cultural relics. Using virtual simulation technology, the exhibition hall can also show the characteristics and craftsmanship of textile cultural relics to the audience, so that the audience can really grasp the details of some textile cultural relics, and then deepen the audience's understanding of textile cultural relics. In this way, it can stimulate the audience's awareness of the protection of textile cultural relics, and is conducive to the further protection and inheritance of textile cultural relics. At the same time, this can also cultivate young people's awareness of the protection of Chinese cultural heritage, and improve their cultural connotation, which in turn will deepen the further protection and inheritance of Chinese textile culture in the future.

Project Funding

This work was supported by the National Social Science Fund Art Program in 2021,. 21BG124

REFERENCES

Abdelrahim, S. A., Elnagar, K., & Mohamed, A. E. R. (2020). Analytical study and conservation processes of late period limestone canopic jar: Case study. *Scientific Culture*, *6*(1), 25-38. doi: 10.5281/zenodo.3483985.

Chai, J., Cui, R., & Niu, L. (2021). Study on the technological process and artistic characteristics of ancient Chinese Zhuanghua Silk Fabric. *Fibres & Textiles in Eastern Europe*, *29*[4(148)], 105-111.

Chen, D. M., Ma, L. L., & Zhang, X. M. (2023). Application progress of non-destructive spectroscopy on conversation of cultural relics. *Spectroscopy and Spectral Analysis*, *43*(2), 334-341.

Elsayed, Y., Shabana, Y., Elmitwalli, H., Rashad, Y., Sreenivasaprasad, P., & Mabrouk, N. (2023). Analytical assessment of some essential oils against common fungi isolated from Egyptian heritage Part I: Textiles and oil paintings. *Scientific Culture*, *9*(3), 113-125. doi: 10.5281/zenodo.8244949.

Fan, Y., Wang, H., Wang, K., Wang, Z., & Zhen, G. (2022). Multi-output least-squares SVR spectral reflectance reconstruction method based on adaptive optimization in multi-scene. *Acta Photonica Sinica*, *51*(2), 0230003.

Hu, H., Shi, J., Qi, Z., Li, H., Huang, X., & Ji, J. (2023). Flammability and flame spread behavior of common fuels in Chinese historical buildings: An experimental research. *Combustion Science and Technology*, *195*(16), 3947-3964.

Hu, X. J., Arifu, Cai, H. Q., Ani, Y., Xu, Y. C., Su, Y. M., & Kang, X. J. (2022). Tang remains from the Keyak Khduk Beacon site in Yuli County, Xinjiang: Xinjiang Uyghur Autonomous Regional Institute of Cultural Relics and Archaeology. *Chinese Archaeology*, *22*(1), 65-76.

Le, W., Jin, G. W., Ding, J. J., & Guo, Z. M. (2022). Analysis of coating components of gilt brass nails in the Hall of Mental Cultivation (Yangxin Hall) of the Palace Museum. *Chinese Journal of Analytical Chemistry*, *50*(9), 1407-1414.

Liu, J., Li, Y., Hu, D., Xing, H., Chao, X., Cao, J., & Jia, Z. (2021a). A new method for the conservation of ancient colored paintings on ramie textiles. *Heritage Science*, *9*. https://doi.org/10.1186/s40494-021-00486-4

Liu, J., Xing, H., Wang, J., Cao, J., Chao, X., Jia, Z., & Li, Y. (2021b). A new reinforcement method for the conservation of fragile, double-sided, printed paper cultural relics. *Heritage Science*, *9*. https://doi.org/10.1186/s40494-021-00597-y

Liu, K., Zhao, J., & Zhu, C. (2022). Research on digital restoration of plain unlined silk gauze gown of Mawangdui Han Dynasty Tomb based on AHP and human-computer interaction technology. *Sustainability*, *14*(14), 8713.

Peng, X., & Zhou, J. (2023). Double-faced shading effect digital jacquard fabric with a weft-backed and warp-wadded structure. *Textile Research Journal*, *93*(3-4), 795-806.

Su, M., Li, S., Lu, Y., Yang, L., Duan, Y., Xiao, K., . . . Liu, X. (2022). Developing a digital archive system for imperial Chinese robe in the Qing Dynasty. *Frontiers in Neuroscience*, *16*, 971169.

Sun, G., Mei, S., Lu, X., Wang, Y., Zheng, Y., & Huang, W. (2022). The excavation of a neolithic site at Jingtoushan in Yuyao, Zhejiang: Zhejiang Provincial Institute of Cultural Relics and Archaeology; Ningbo Municipal Institute of Cultural Heritage Management; The Hemudu Site Museum of Yuyao City. *Chinese Archaeology*, *22*(1), 1-16.

Van Strydonck, M. (2021). Gedateerde heiligen: 30 jaar 14C-onderzoek op relieken en aanverwante objecten, een overzicht [Outdated saints: 30 years of 14C research on relics and related objects, an overview]. Volks-kunde, 122(2), 339-355.

Wei, L., Ma, Y., Guo, Z., Ding, J., Jin, G., Gu, A., & Lei, Y. (2022). Application of advanced analytical techniques in organic cultural heritage: A case study of ancient architecture relics in the Palace Museum (Beijing). C*oatings*, *12*(5), 636.

Wu, L., Zhu, W., Li, Z., Li, H., Xu, J., Li, S., & Chen, M. (2023). Urushiol modified epoxy acrylate as UV spray painting oriental lacquer ink. R*SC advances*, *13*(2), 1106-1114.

Xiao, W., Xian, Y., Yu, C., Wang, Y., Sun, L., & Li, Y. (2023). Microinvasive analysis of textile relics from an ancient Silk Road turquoise mining site. *Science China Technological Sciences*, *66*(8), 2286-2296.

Zhang, W., Huang, Y., Liu, J., Han, X., Chen, A., Sun, Z., & Yin, J. Q. (2023). Shandong liaocheng shan shan huiguan cai hua hongse yanliao fenxi [Analysis of red pigments of color paintings from the Shan-Shan Guildhall in Liaocheng, Shandong]. *Spectroscopy and Spectral Analysis*, *43*(4), 1134-1139.

Zhou, X., Guo, Y., Shi, L., Han, Q., Lin, C., Zhang, L., . . . Zhang, W. (2023). Degradation pathways and mechanisms insight of indigo and shikonin with experiments and quantum chemical calculations. *Dyes and*

Pigments, *218*. https://doi.org/10.1016/j.dyepig.2023.111455