

Study of Cultural Heritage and Digital Preservation: The case of Murals of the Northern Yue Temple

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ABSTRACT

The Beiyue Temple murals represent a significant cultural heritage that faces preservation challenges due to aging and limited accessibility. This study addresses these challenges through digital preservation methods while exploring their historical and cultural significance. The purpose of this research was to: (1) explore the social and historical origins and cultural value of Beiyue Temple murals, and (2) investigate the digital preservation and dissemination of Beiyue Temple murals. This study adopts qualitative research methods to study the literature and collect field data through surveys, interviews, observations, group discussions and seminars. From the information provided by a group of 40 people, this analysis is based on the objectives and results that are presented in a descriptive analysis. First, the cultural value and historical development of the Beiyue Temple murals are a national mountain worship site in ancient China. It has rich historical and cultural connotations and has an important impact on local culture and spiritual life. At present, the walls of Beiyue Temple have been aging for hundreds of years, and the murals are severely damaged. At the same time, the geographical location is remote and government investment is limited. There are few studies on the protection and dissemination of Beiyue Temple murals, and there is a lack of systematic protection and dissemination theory. The exquisite murals of Beiyue Temple are used in digital technology to spread and understand the art of Beiyue Temple murals. The teaching design combines digital acquisition methods and the production of digital animation to make its boring courses interesting. Learners learn through digital media, which as our results showed, makes it more convenient and effective to obtain information and attract young people.

Key words: Mural Conservation, Dissemination, Culture, Digital Technology, Beiyue Temple

INTRODUCTION

Murals are defined in the Encyclopedia Britannica as a distinctive form of painting that is inherently integrated with architecture. By manipulating color, design, and theme, murals have the power to dramatically alter the perception of architectural space. This close relationship between mural art and architecture has, since ancient times, served as a reflection of social, religious, and patriotic themes (Encyclopaedia Britannica, 2023). Murals involve the use of painting, carving, and other techniques to create images on natural or artificial walls, primarily on the interior and exterior surfaces of buildings. As an integral part of architecture, murals achieve a harmonious blend of architectural functionality and artistic expression through the interaction between the structure and the artwork. Beyond their role in conveying ideas, murals also serve decorative and aesthetic purposes, making them an important element of the architectural environment. Chinese murals boast a rich history spanning 5,000 years and can be broadly categorized into cave murals, tomb murals, temple murals, and palace murals. The Beiyue Temple

murals discussed in this article are a quintessential example of temple murals.

Beiyue Temple is located in Quyang County, Hebei Province, China, at the eastern foot of the Taihang Mountains. Known as the Beiyue Ancestral Temple during the Han Dynasty, Beiyue Temple serves as a place of worship for Mount Heng, one of the Five Sacred Mountains of China. As an ancestral temple dedicated to Hengshan, Beiyue Temple holds a significant place in Chinese religious worship and carries profound historical and cultural importance. The temple houses more than 200 stone tablets, which were inscribed from the Northern Wei, Northern Qi, Tang, Song, Yuan, Ming, and Qing dynasties to the early Republic of China. These tablets are not only valuable historical artifacts but also crucial for studying ancient Chinese sacrificial culture (Song, 2021).

The overall layout of the Beiyue Temple measures 542 meters from north to south and 321 meters from east to west, covering a total area of 173,982 square meters, with a building area of 3,803 square meters, and approximately 300

square meters dedicated to murals. On February 24, 1982, Beiyue Temple was designated as part of the second batch of national key cultural relics protection units by the State Council of the People's Republic of China, under document number 34 (State Council of the People's Republic of China, 1982). The murals on the east and west walls of the main hall hold immense historical and artistic value. These murals are masterfully painted, large in scale, and relatively well-preserved. They depict historical events, cultural scenes, and aspects of daily life in ancient society, offering insights into the customs, social systems, and religious rituals of the time, thus holding significant research value. The mural on the east wall, titled "Clouds Rising and Rain Falling," and the one on the west wall, titled "All Nations in Peace and Tranquility," each measure eight meters in height and 18 meters in length.

In the 1980s, Fan Jinshi, the director of the Dunhuang Research Institute, introduced the mural preservation concept of "digital murals." This approach aims to utilize digital technology to digitize murals for "permanent preservation and sustainable use, allowing humanity to share these precious cultural heritages" (Chen & Fan, 2016). Digital technology involves using digital cameras, video cameras, scanners, and other acquisition equipment to digitally record and preserve cultural artifacts. The digital collection of murals is a non-contact, non-destructive process that allows for the digital capture and analysis of a mural's image, color, texture, and other characteristics. This information is then digitally processed to ensure accurate preservation. In the context of big data, digital media has become a widely adopted communication method across various aspects of life. Utilizing digital media for communication can effectively promote the development of local culture (Chen & Fan, 2016).

The advent of digital technology can overcome information barriers, allowing for comprehensive storage of cultural resources through digital preservation techniques and the reconstruction of cultural heritage landscapes. By employing processes such as information extraction, classification, and labeling, various cultural digital resources are integrated into original data sets. Through modeling and other techniques, the conceptual information embedded in cultural heritage is meticulously encoded and cross-referenced. Through leveraging technologies like blockchain, a rich repository of data resources is developed, facilitating the transformation and dissemination of material heritage into a digital state. By studying the painting techniques and artistic characteristics of murals, and integrating relevant research and practice, one aims to cultivate students' skills in the digital collection, production, and dissemination of murals. This approach not only combines the protection and dissemination of murals but also involves a thorough exploration of their production processes and restoration methods. Utilizing 3D animation technology, one can preserve and protect artworks that might otherwise be lost. Through modern digital media, these art forms will be transformed into valuable teaching resources, effectively transferring knowledge and achieving the primary goal of this study.

RESEARCH OBJECTIVES

The objectives of this study were:

- To explore the social and historical origins and cultural value of the Beiyue Temple murals
- To investigate the digital preservation and dissemination of the Beiyue Temple murals

RESEARCH METHOD

To address the first research objective, we conducted an in-depth analysis and compilation of the historical origins, cultural values, and cultural identity of the Beiyue Temple murals. This involves explaining the long-standing cultural and historical background, as well as the significance and identity of the Beiyue Temple and its murals.

We began by studying relevant literature on the historical context of Beiyue Temple, including key concepts, theories, and previous research. This review serves as a foundation for guiding the research and analyzing the results. Next, we explored the local cultural heritage of Beiyue Temple by collecting data from both literature sources and field surveys. The research area included Beiyue Temple and its surrounding communities, where relevant information was gathered to create materials for analysis. Then, the tools were developed, and research methods were specified. Data collection involved multiple instruments and methods as follows:

1. Surveys: Administered to 130 temple visitors
2. In-depth interviews: Conducted with 15 local experts and cultural practitioners
3. Focus group discussions: 3 sessions with 8-10 participants each
4. Workshops: 2 sessions conducted over 4 days each, as follows:
 - Workshop 1: Digital documentation techniques (2 days)
 - Photography and scanning techniques
 - Digital data management
 - Workshop 2: Digital preservation methods (2 days)
 - 3D modeling techniques
 - Animation development

The research involved 40 students from the School of Mural Fine Arts:

- 8 first-year students
- 12 second-year students
- 8 third-year students
- 12 fourth-year students

Next, the relevant volunteers were recruited to participate in the project, with meetings held to explain their roles and responsibilities. The research focused on compiling images for display, engaging young student volunteers, and offering courses to those interested. Forty students majoring in mural painting from the School of Mural Fine Arts were involved in this project.

Data collection was categorized into historical and archaeological documents to understand the Beiyue Temple's context. This phase included writing content for teaching media, outlining steps for creating these materials, and preparing for the analysis of research objectives. We gathered

and analyzed data to address the research questions, presenting findings as part of a digital media design process to ensure data accuracy. This step was crucial for presentation preparation in order to present the research outcomes. We organized and analyzed the content according to the research questions, compiling a comprehensive list of findings. The research data was presented in both descriptive and analytical formats. The final step involved publishing the research paper in an internationally recognized journal, summarizing the findings, and writing a detailed research report that aligned with the research objectives.

RESULTS

First, the research delves into the social and historical origins of Beiyue Temple by examining its historical development and influence on local cultural activities. This includes analyzing historical records, architectural styles, mural techniques, and painting styles. The study explores the evolution of the Five Mountains sacrificial culture, the specific role of Beiyue in these rituals, and the history of sacrificial worship. Additionally, it considers the impact of Beiyue Temple on the cultural activities and daily life of the local community.

Second, the research analyzes the murals from the perspectives of style and content, focusing on the depiction of characters, the use of color, and the composition of the artworks. It investigates the development and changes in restoration techniques across different dynasties. Utilizing Saussure's semiotic theory of signifier and signified, the study interprets the cultural value of the Beiyue Temple murals. It examines the artistic and cultural significance of these murals, emphasizing their content characteristics and the symbolic meanings conveyed through symbols, images, and colors. This includes elements such as costumes, color schemes, and animal totems, all of which are used to convey the central themes of China's sacrificial culture: praying for favorable weather and bountiful harvests, as well as the symbolic representation of peace and prosperity.

Third, the digital acquisition of murals involves the use of advanced technology to efficiently and securely preserve the Beiyue Temple murals in digital format. Specifically, the Sinarback 86H professional camera is employed for this purpose, equipped with a high-quality CCD image processor tailored for capturing flat objects (Figure 1). Each static image generated contains approximately 288MB of data, equating to about 48 million effective pixels. These images are then post-processed using a Dell Graphics Workstation 7680 with a professional display, effectively addressing the challenges of splicing large mural images. Using Adobe Photoshop, individual sections of the murals are seamlessly stitched together to form complete images (Figure 2). This approach significantly enhances both the quality and efficiency of the image capture process compared to traditional methods. Additional equipment used in this process includes infrared levels, photography lights, camera brackets, laser rangefinders, light meters, color cards, and elevators (Hu, 2022).

The digital collection of murals involves the comprehensive digitization of various elements such as images, colors, and textures, which can then be repaired and restored using



Figure 1. The digital collection site of the mural

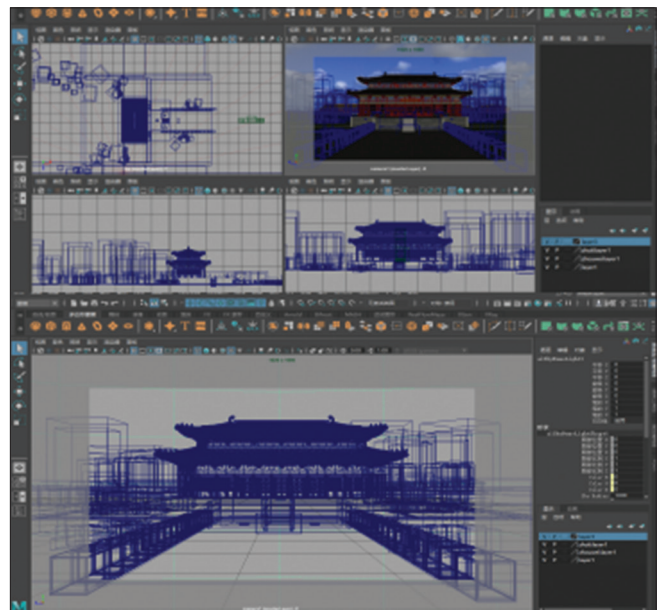


Figure 2. Adjustment of the digital data of the mural

digital technology (Wu et al., 2023). This technology offers innovative methods for the protection and preservation of the Beiyue Temple murals. For instance, by storing the original appearance of the Beiyue Temple murals in digital media, they can be easily accessed for research and preservation purposes. The creation of a digital database for these murals provides a valuable reference model for the protection of ancient murals, while digital restoration helps to maintain their original appearance. Digital preservation and backups can effectively prevent the loss and destruction of these valuable artworks.

Furthermore, this digital data not only facilitates the dissemination of the Beiyue Temple murals but also highlights their artistic value, offering the public a more convenient and immersive way to appreciate them. This approach creates favorable conditions for the wider promotion and distribution of mural art. Additionally, the digital database serves as a valuable resource for scientific research and teaching, allowing for easy consultation and contributing to the ongoing preservation and dissemination of murals. By integrating three-dimensional animation technology, these digital

images can enhance the promotion of murals and provide students with rich educational media. Animation technology can also play a crucial role in preserving and safeguarding works of art that are at risk of being lost (Figure 3).

Development Process of Digital Animation of Beiyue Temple Murals

The latest version of 3d Max was chosen for the production of 3D animations. Mastering this software is challenging, requiring students to invest significant time and effort into learning and practice. The creation process primarily involves animation concept design and model production, which includes several key components: (1) scene construction, (2) combining building components, (3) scene roaming in architectural animation, and (4) setting up lighting and rendering models. Given the current challenges and preservation needs, creating 3D animations with unique artistic value can address the issues related to disseminating Beiyue Temple culture. As a powerful restoration tool, 3D animation can capture every detail, from spatial layout to physical restoration, through systematic editing and model creation. By integrating design elements into a virtual environment and setting up camera paths, realistic virtual representations of the buildings and murals can be produced. The final animation is assembled through teamwork, resulting in 3D animation data that is ultimately compiled into a video and distributed to the public, fulfilling the goal of cultural dissemination.

Throughout the production process, theories from semiotics, communication, computer science, and image design were integrated to recreate the Beiyue Temple in digital animation form. The Beiyue Temple Hall, as the primary spatial element, was meticulously restored in both design and construction. This included detailed components such as arches, columns, roof ridges, floors, walls, murals, and doors and windows, resulting in a virtual reality representation of the Beiyue Temple Hall. This tangible representation imbues the work with a profound sense of space. The constructed scene allows for almost limitless variations, creating a sense of space that balances the concrete with the ethereal qualities of murals, and offering boundless opportunities for imagination and artistic expression.

From the perspective of tradition and modern development, the ancient mural art of Beiyue Temple can be culturally recognized in contemporary social life, providing good dissemination conditions for the promotion of Beiyue Temple sacrificial culture and injecting new means and methods into its dissemination. This innovation is both a respect for tradition and a modern response to cultural identity, achieving cultural identity through innovative development. In addition to these benefits, the students of Hebei Academy of Fine Arts were taught knowledge. There were 40 students in total, including eight first-year university students, one and two second-year students, eight third-year students, and twelve fourth-year students. All students had a basic understanding of murals. This group of students mastered certain relevant knowledge through the study of digital technology and mural art. Figure 4 shows the 3D animation of temple murals as educational material for student groups.

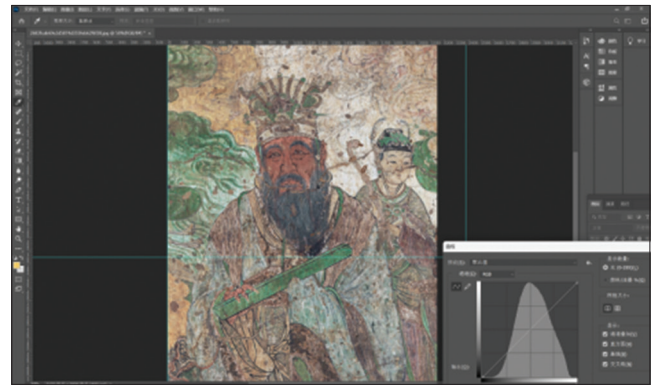


Figure 3. Animation production process



Figure 4. Video QR code

DISCUSSION

The results of the study are consistent with the concepts, theories and research results, and are also consistent with the purpose of the study. Combined with the research findings on the digital dissemination and preservation of Beiyue Temple murals, the results are discussed as follows.

Discussion According to the Objective of the Study

The digital communication and protection of Beiyue Temple murals are developing slowly at this stage. According to survey statistics, the average number of tourists per day is about 130, and the number of visitors per year is 30,000. Therefore, digital means are used to supplement, improve, enrich the protection, and disseminate knowledge of Beiyue Temple murals. It further helps to diversify its dissemination methods, and adapt it to the development needs of the times. Only by formulating the problems of digital media dissemination and protection, and using the dissemination advantages of digital media technology, can one deepen people's understanding of the cultural connotation of Beiyue Temple murals. This helps the public to recognize the value of murals, and ultimately plays a role in it being accepted by the general public without being restricted by space and time, as well as realize the cultural identity of the Beiyue Temple (Santos & Lima, 2021). Based on research objectives one and two, the author sorted out the current status

of the research on the historical value and dissemination protection of Beiyue Temple as well as the problems found in the investigation. The author focused on the cultural perspective, constructed a three-dimensional animation work with architectural mural content containing unique artistic and cultural value, and solved the corresponding problems. With the conceptual theory of semiotics and communication as the core and computer science as the support, a theoretical model of digital 3D animation in the dissemination and protection of Beiyue Temple murals is constructed. This helped in providing new thinking and practice for the application of digital media in the protection and dissemination of cultural heritage, thereby promoting the digital inheritance and protection of local cultural heritage. From the perspective of art and culture, the author creates 3D animation works with his own cultural characteristics to solve the problem of cultural identity. It provides new ideas and practices for the application of digital media in the protection of the murals. It is the application of digital media in the dissemination of cultural heritage, which is suitable for learning and study by mural lovers located far away from Beiyue Temple.

Beiyue Temple has a history of thousands of years. It was an important place at which ancient Chinese emperors worshipped, imbuing to itself a lofty status. The murals of the main hall, as an important part of historical buildings, not only record the religious beliefs and cultural traditions of a specific period, but also reflect the local folk customs. It has a history of 1,500 years since it was moved to its current location during the Northern Wei Dynasty. During this long period of time, Beiyue Temple has undergone 19 major and minor repairs from the Tang, Song, Yuan, Ming and Qing dynasties to the present. The "Monument of the Lord of Beiyue in the Great Tang Dynasty," erected on March 26, 721 AD, contains text based from which it can be inferred that the existing murals already existed when the prime minister of the Tang Dynasty repaired the Beiyue Temple (Yuthavong & Bunluechokchai, 2020).

This study employs Saussure's semiotic framework of signifier and signified as its research methodology. Through the lens of the "signifier" in Saussure's semiotics, the murals of Beiyue Temple can be analyzed, not only as retainers of the Tang Dynasty's painting style, but also as bearers of stylistic elements from the Yuan and Ming Dynasties, introduced during subsequent restorations. As the oldest preserved murals in the sacrificial buildings of the Five Mountains, they hold significant historical value. The painting language is articulated through the symbol's image readability, where symbols serve as mediums for conveying experiences. These symbols do not rely on imagination, but express ideas through emotions derived from perception. Meng and Zhao (2018) argues that these murals are rich in historical and cultural connotations, playing a significant role in cultural heritage and social development, making them worthy of in-depth study and preservation. Within the Beiyue Temple, the murals serve to promote Yue Temple worship. As integral parts of this historic structure, they capture the religious beliefs, cultural traditions, and societal outlooks of a particular era, providing valuable insights and information for future

generations to understand the past. This approach to analyzing and preserving cultural artifacts through semiotic frameworks and digital technologies aligns with recent research in the field of art education and cultural heritage preservation. For instance, Gu and Laoakka (2024), in their study "Digital innovation in Anhui Phoenix painting art: Transforming educational literacy in the new era," explore how digital innovations are reshaping the landscape of art education and cultural preservation, particularly in the context of traditional Chinese art forms. Their research, published in the *International Journal of Education & Literacy Studies*, examines the intersection of digital technology and traditional art practices, focusing on the Anhui Phoenix painting art. The study highlights how digital innovations can enhance educational literacy in art education, providing new ways to understand, appreciate, and preserve traditional art forms. This approach resonates with the efforts to digitally preserve and disseminate the murals of Beiyue Temple.

By using semiotics to analyze the features and symbolism of the characters depicted in the murals, one can explore their artistic expression through elements such as color, composition, lines, and attire. Observing and studying these sacrificial murals allows one to gain a deeper understanding of the religious beliefs, lifestyles, and artistic aesthetics of the people of that time, aiding in a more comprehensive interpretation of history. As historical relics, these murals offer a precious glimpse into the past, serving as a crucial window for future generations, and facilitating the preservation of historical knowledge and the transmission of culture.

New Knowledge Discovered

First of all, a variety of instruments and equipment were used in the digital acquisition process of the murals. Namely, the operation of digital cameras, lighting equipment and image synthesis equipment was mastered during the study.

1. Image file acquisition method: After the previous equipment metering and digital acquisition photography equipment adjustment, a large-format technical camera was used to collect the plan from the left to the right as planned.
2. Color control: Accurate color restoration is not only important for the true reflection of the mural itself, but also helpful for the later splicing, which makes the splicing work easier to a large extent.
3. Stitching and post-production: Color management equipment is used to calibrate the texture and details of all working displays, and stitch partial images in an orderly manner according to the plan, so that the collected images are consistent with the real images.
4. Image Clarity: The details of the mural must be clearly distinguishable at the original resolution. The digital image of the entire mural should be sharp and not blurred or out of focus. It must maintain complete, uniform, and consistent clarity, with a minimum pixel resolution of 400 DPI.
5. Image color: The final image maintains consistent light intensity throughout the entire frame, and the full-frame variation of light intensity is controlled within 10%. The

exposure of the final mural image can clearly distinguish the various colors and details in the mural image.

With digital acquisition technology, murals can be accurately recorded, preserved and disseminated, providing important tools and means for the protection of art and cultural heritage. Relying on the study of mural painting techniques and artistic characteristics, the digital acquisition of Beiyue Temple murals is carried out to master first-hand information, and digital three-dimensional technology is used to establish a digital museum to promote Beiyue Temple murals. Its purposes are to dig out the deep intrinsic value of murals, keep pace with the development of Beiyue Temple murals, take the road of digital development, promote the progress of local culture, analyze the difficulties encountered in the development of cultural tourism in combination with actual conditions, and find solutions.

Secondly, the synthesis and editing stages of 3D animation are particularly crucial. The complexity of the aesthetic presentation impacts the audience's ability to quickly comprehend the visual information conveyed by the animation and its script. Hence, adjusting the editing time of key scenes during post-production is essential. The design of 3D animation—including lens effects, backgrounds, and lighting—requires a strong visual design sense. Post-production editing and synthesis are critical for achieving the desired animation effects, involving tasks such as color correction, special effects creation, audio processing, and synthesis to ensure that the final product meets the expected visual and auditory standards.

Additionally, establishing virtual reality scenes can facilitate the dissemination of murals. Computer-generated virtual panoramic simulations can replicate real-world environments based on visual and auditory inputs, or create entirely artificial environments. This immersive experience allows users to interact with virtual objects or spaces in various ways, leading to a deeper understanding and appreciation of the murals. Zhang and Ismail (2023) assert that using 3D modeling and animation technology to visualize ancient buildings can enhance public engagement with historical architecture and art. This approach not only facilitates a more comprehensive understanding of the murals' original context but also enables viewers to explore intricate details that might be difficult to observe in person. By leveraging these advanced visualization techniques, researchers and educators can effectively bridge the gap between past and present, making cultural heritage more accessible and engaging for diverse audiences.

A View from this Study

The dissemination and protection of murals are increasingly extending beyond professional circles to engage the public. Protecting murals is a social responsibility that requires broad participation and widespread attention to foster public involvement and communication across various domains. Without this engagement, cultural heritage risks becoming disconnected from societal life and may not be effectively protected. Therefore, it is crucial to harness the power of communication in cultural heritage protection by using

digital media to regularly share information about Beiyue Temple murals. This approach involves compiling and disseminating knowledge for both mural professionals and enthusiasts, aligning with Liu's views (2021).

Artistically processed three-dimensional animations, utilizing virtual or augmented reality technologies, blend historical depth with futuristic technology. This integration enhances the immersive experience of cultural heritage dissemination and stimulates students' interest in exploring history. Despite challenges in production technology, 3D animation has undeniably transformed the field of cultural relics' protection and restoration. It is anticipated that in the future, 3D animation will play a pivotal role in harmonizing scientific and technological advancements with humanistic values, as noted by Lin Yuankang (2024).

CONCLUSION

Beiyue Temple murals are works of art with a long history, rich cultural heritage and exquisite paintings. In view of their importance, the State Council of the People's Republic of China has listed them as the second batch of national key protected heritage treasures. However, in practice, the scope of dissemination is limited, and the public lacks understanding of murals. Through a more detailed discussion of the dissemination and protection dilemma of Beiyue Temple murals, this study can find that its inheritance must be innovatively developed in line with the development needs of the times. By leading students to collect digital data of murals, establish digital preservation and produce related digital animation videos, the dissemination methods of Beiyue Temple murals can be enriched. They have participated in the digital collection and animation production of murals and have learned much regarding relevant knowledge and dissemination methods. This has provided students with opportunities for hands-on practice, dissemination of mural knowledge and has enabled them to learn digital technology. After that, students have applied the learned technology to the protection of other murals, which has been helpful for the digital preservation and dissemination of these other murals.

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