

Study on the Application of Digital Modeling Technology in Museum Cultural and Creative Design

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Abstract: In recent years, the field of cultural and creative products in museums has developed rapidly, making positive contributions to enhancing the popularity of museums and increasing their economic benefits. Digital modeling, combined with technologies like 3D printing and virtual reality, allows museums to create precise, efficient reproductions of cultural relics, overcoming the limitations of traditional materials and manual craftsmanship. This innovation not only enhances the accuracy of replicas but also facilitates global sharing and dissemination of cultural heritage through digital platforms. The study also emphasizes the cross-border opportunities digital technology offers, enabling museums to collaborate with various industries, such as fashion, gaming, and virtual collectibles, expanding the market and audience for cultural products. Furthermore, digital modeling enhances the interactive experience of museum visitors, making cultural heritage more accessible and engaging. The integration of these technologies contributes to the sustainability of museums, providing new avenues for educational and commercial purposes. Overall, digital modeling technology plays a pivotal role in cultural revitalization, enhancing both the artistic and commercial value of museum products, and fostering a new era of global cultural exchange and innovation.

Keywords: Culture and Creative Design; Digital Modeling Techniques; Application Research.

1. Introduction

In the digital age, the application of advanced technologies in cultural and creative industries is becoming increasingly important. Museums, as vital institutions for the preservation and dissemination of cultural heritage, are embracing digital transformation to enhance their exhibition practices and engage wider audiences. Traditional museum operations, which have long relied on physical materials and manual craftsmanship for the reproduction and display of cultural artifacts, face challenges in adapting to the demands of a fast-paced, technology-driven world. Digital modeling technology, including 3D printing, virtual reality, and digital sculpting, offers a solution by enabling museums to create precise, scalable, and interactive replicas of historical artifacts, significantly improving the efficiency of the design and production processes.

Digital modeling allows for a high degree of freedom in the creation of museum products, overcoming the limitations of traditional materials and methods. It also offers opportunities for cross-media integration, where different artistic forms and materials can be synthesized to produce innovative, multidimensional museum products. This technology not only improves the quality and accessibility of museum exhibits but also provides a platform for expanding cultural heritage into new markets, including virtual environments, online platforms, and the growing sectors of NFTs and digital collectibles.

As the demand for high-quality cultural experiences rises, museums are increasingly recognizing the importance of digital technologies in both preserving cultural heritage and creating innovative cultural products. By integrating digital tools into their design processes, museums are able to offer more personalized, interactive, and immersive experiences for visitors. This research aims to explore the role of digital modeling technology in the development of museum cultural products, examining its impact on creativity, production efficiency, and the global dissemination of cultural heritage.

It also looks at how museums can leverage these technologies to stay relevant in an increasingly digital world, ensuring that cultural preservation continues to thrive alongside modern technological advancements.

2. Museum Cultural and Creative Products and Digital Modeling Techniques Overview

2.1. Museum Cultural and Creative Products

A museum is a non-profit, permanent institution serving the society and accessible to the public. It undertakes crucial tasks such as collecting, conserving, researching, and exhibiting various cultural relics, artworks, and even intangible cultural heritages. Beyond presenting diverse collections, museums offer the public opportunities to comprehend history, appreciate art, and perceive the wisdom of our predecessors. They bear significant missions and serve the public with the purpose of education. In the context of the development of the new era, the roles and functions of museums are constantly undergoing transformation. Currently, museums have developed new and diversified functions and platforms with strong interactivity on the basis of traditional display models. Regarding exhibition methods, museums pay greater attention to the public's perception, adopt a considerate and welcoming stance, and utilize modern technologies and innovative approaches to provide the audience with a novel visiting experience.

Cultural and creative products, namely cultural creativity, refer to the re-interpretation and re-creation of existing culture to bestow it with new characteristics and values. Cultural and creative products are the outcomes of this innovative culture, adding new contemporary connotations to traditional culture through innovative forms. In this process, cultural and creative products themselves have become significant carriers of cultural dissemination.

Museum cultural and creative products are developed within the public service system of museums, drawing upon

the rich historical resources and cultural accumulation of museums. They are transformed into products that possess both artistic and commercial values through innovation and new contemporary interpretations, achieving the activation and inheritance of culture. At present, museums are receiving increasing social attention, and people's demand for high-quality cultural consumption is on the rise. In 2024, there were multiple phenomenal sales cases of museum cultural and creative products, making "museum cultural and creative products" a hot topic. Hence, "museum cultural and creative products" were selected as a cutting-edge research focus in museum studies in 2024 and were defined by the First National Committee for the Standardization of Museum Terminology as: Museum cultural and creative products are cultural and creative consumer products developed and produced by museums based on the resources at their disposal, which can convey ideas and symbols and are in line with people's lifestyles.

From the perspective of museums themselves, along with the development of social welfare, an increasing number of museums have begun to offer free admission. Against this backdrop, museum cultural and creative products may become an indispensable and important economic pillar for the sustainable development of museums. With the influx of high-quality cultural products into the market, museums also expand their social influence through such cultural carriers and fulfill their educational functions on a broader market platform.

2.2. Digital Modeling Techniques

Digital modeling technology, to be precise, refers to a method of presenting objects in a digital virtual space within a computer environment by leveraging the computer's digital information processing technology. In this digital virtual space, we have the ability to freely construct the shape of objects and perform directive editing on them. The physical characteristics, structure, and geometric form of objects existing in the real world can all be transformed into digital data for expression in a computer system. Although compared with traditional manual modeling, digital modeling technology cannot provide people with a direct experience of the real touch of objects, nor can it intuitively allow people to feel the personal experience brought by the scale of objects in the real environment, yet, under the current technological background, these shortcomings relative to manual modeling can be completely overcome.

In the 1960s, with the initial development of computer technology, the engineering field was the first to introduce computer-aided design, or CAD systems. CAD technology was mainly applied in the industrial and architectural fields for drawing, and compared with manual drawing, it could improve the accuracy and efficiency of drawing completion. By the 1970s, with the continuous improvement of computer graphics theory and the gradual enhancement of hardware performance, three-dimensional digital modeling technology began to gradually emerge. Engineers started to attempt to convert the geometric features of objects into data and apply them to model construction. After the 1980s, digital modeling technology entered a stage of rapid development. Relying on the rapid iteration of hardware, personal computers began to be widely popularized, and graphics display technology also improved. Correspondingly, three-dimensional modeling software (such as AutoCAD, SolidWorks, etc.) began to gradually penetrate into the industrial and design fields after

having hardware support that matched their performance. Designers in the new era only need to define basic elements such as vertices, edges, and faces in the virtual space to be able to construct object models with considerable detail and hierarchy. With the support of 3D printing and numerical control processing technology, designers can successfully break the boundary between the virtual and the physical, achieving the goal transformation from conceptual design to actual production.

3. Research on the Necessity of Applying Digital Modeling Technology in Cultural and Creative Products

3.1. Digital Modeling Technology Enhances Production Process Optimization

In the actual production process, the application of digital modeling technology has transformed the traditional way of making cultural and creative products. In the past, cultural and creative products often relied on manual carving, hand replication, and traditional mold making. Not only was the production cycle long, but the efficiency was also difficult to guarantee. There were often subtle differences between each product, making it hard to meet the requirements of consistency and precision for large-scale production. Nowadays, by using laser scanning, high-definition photography, and 3D modeling technology, museums can precisely capture every detail of cultural relics and convert them into high-fidelity digital models. Such digital models serve as accurate blueprints for product production. Subsequently, modern manufacturing equipment such as 3D printers and CNC machines can be directly used to quickly replicate the shapes of cultural relics. After undergoing processing and post-decoration, the final products are both faithful reproductions of the original and possess modern aesthetic appeal.

This digital process not only significantly shortens the cycle from design to production but also reduces errors caused by traditional manual operations. Enterprises can mass-produce products based on digital models, ensuring high consistency in shape, texture, and color for each product. This improves product quality and reduces the rate of rework. At the same time, digital data can be stored in databases, serving as valuable resources for future product development. Designers can directly improve and innovate based on existing models when launching new products, forming a production system that continuously self-improves and iterates. As a result, while enhancing production efficiency, enterprises are also constantly reducing production costs, driving the overall manufacturing process towards automation, standardization, and intelligence, greatly strengthening their foothold in the fierce market competition.

3.2. Data-Driven Supply Chain Collaboration and Product Iteration

The promotion of digital modeling technology not only optimizes individual production stages but also drives the coordinated development of the entire supply chain. Modern enterprises are increasingly emphasizing information-based management. By establishing a full-process digital platform covering design, manufacturing, and sales, they achieve information sharing and seamless integration among all links.

Through this platform, enterprises can monitor the production progress, quality status, and inventory levels of products in real time and promptly adjust production plans based on market feedback. This not only enhances the speed of responding to market changes but also enables more accurate understanding of consumer demand dynamics. Every data point in the production process becomes an important basis for enterprise decision-making, helping management quickly identify potential issues and formulate effective improvement plans, thereby ensuring that products are always manufactured to high standards.

At the same time, through in-depth analysis of consumer purchasing behavior and feedback information, enterprises can quickly capture market trends and design preferences, providing a clear direction for new product development. The digital platform not only makes product design and manufacturing more transparent and controllable but also enables rapid product iteration. Designers can adjust the shape, function, and decorative elements of products based on user data, and then quickly generate new samples using digital models. After trial production verification, they can be officially launched to the market. Such a feedback loop significantly shortens the cycle from concept design to market launch, allowing products to keep up with fashion trends in a timely manner and meet consumers' pursuit of personalization and fashion. This data-driven supply chain management model and product update mechanism not only optimize internal operational efficiency but also establish a complete set of scientific and agile market response systems for enterprises, thus maintaining a leading edge in competition.

3.3. Integration and Enhancement of Digital Marketing and Brand Building

The breakthrough of digital modeling technology in the production of cultural and creative products has brought about a brand-new opportunity for enterprises in marketing and brand promotion. By means of high-definition digital models, virtual exhibition halls, and holographic displays, enterprises can present their products and the cultural connotations behind them in an extremely attractive form, breaking away from the traditional marketing methods of single flat pictures or text descriptions. Through online platforms, social media, and e-commerce channels, consumers can directly appreciate every detail of the products and experience their cultural stories in a virtual space. This interactive and immersive experience not only enhances consumers' trust and interest in the products but also makes the brand image more distinct and vivid.

At the same time, the application of digital marketing methods has enabled brand promotion to no longer be limited by geographical boundaries. Through Internet platforms, products and brands can quickly expand to the global market. Enterprises can precisely target their audience through data analysis and formulate personalized marketing strategies based on the needs of different groups, achieving precise matching of content push and product recommendations. As consumers participate in interactions, online evaluations, and social sharing, brand reputation is continuously accumulated and spread, forming a good brand effect. Moreover, digital means can also help enterprises carry out cross-border cooperation, combining museum cultural and creative products with other industries (such as fashion, home furnishings, and electronic products) to jointly create new products with cross-border charm. This not only enriches the

product line but also injects new vitality and competitiveness into the brand.

In terms of brand building, enterprises can better convey the historical and cultural background and innovative concepts of the brand through digital display and interactive marketing, forming unique brand identifiers and cultural symbols. Consumers not only experience the high quality and exquisite craftsmanship of the products when purchasing them but also feel the cultural value and emotional resonance conveyed by the brand. The data feedback and user interaction from digital marketing platforms also provide valuable information for subsequent adjustments to brand strategies, enabling enterprises to continuously improve in the fierce market competition and form a unique brand competitive advantage, thereby promoting the healthy and sustainable development of the entire cultural and creative industry.

4. Analysis of the Application of Digital Modeling Technology in Museum Cultural and Creative Products

4.1. Digital Modeling Technology Enhances the Precision and Efficiency of Cultural and Creative Design in Museums.

Digital modeling technology has brought revolutionary changes to the production of cultural and creative products. Its primary advantage lies in freeing designers from the constraints of physical materials in traditional craftsmanship, fundamentally liberating their creative imagination. In the past, traditional artisans, when working with physical materials such as stone, jade, and metal, had to consider the physical properties of these materials, such as hardness, texture, and density, which directly affected the malleability and detail expression of their works. For instance, when making small stone seals or jade carvings, artisans had to spend days or even longer observing the internal textures, micro-cracks, and natural flaws of the stone to determine the best carving plan; once the material broke or was damaged during the carving process, they often had to start over, which wasted time and increased costs. The introduction of digital modeling technology, through the use of high-precision scanning equipment, structured light, and laser 3D measurement techniques, digitizes every detail of cultural relics, generating high-resolution 3D data models. These data models not only perfectly reproduce the appearance features of cultural relics but also preserve the original information of the relics in a non-destructive way, providing a reliable basis for subsequent virtual restoration and reproduction. Digital models allow designers to precisely adjust each detail in the computer, modify carving marks or add complex textures, thereby breaking through the physical limitations of traditional materials and creating more dynamic and creative modeling effects.

In the production process, digital design has significantly enhanced manufacturing efficiency and product consistency. By using digital models, the traditional repetitive processes of carving, grinding, and correcting have been simplified to model modifications and automated generation within software, greatly reducing the time from design to mass production. Designers can experiment with various design schemes multiple times in a virtual environment, and through functions such as symmetrical carving, copy-pasting, and

batch adjustment, achieve rapid iteration and optimization of the model. This approach not only saves a considerable amount of labor costs but also reduces the risk of errors caused by physical processing. At the same time, the storage and sharing of digital models enable products to be quickly transformed into standardized data that can be replicated multiple times, thus facilitating large-scale customized production. Whether it is one-click scaling of product dimensions or local modifications in details, digital modeling ensures that each product maintains an artistic style while achieving high precision and uniformity. Due to this unparalleled flexibility and accuracy, digital modeling technology has become an indispensable part of today's cultural and creative product design, providing strong technical support for the modern transformation of traditional cultural elements and playing a significant role in improving overall production efficiency and reducing costs.

In addition, digital modeling technology not only optimizes production processes but also promotes the formation of innovative production models. Through digital platforms, designers and manufacturing enterprises can establish a closed-loop system from prototype design, sample trial production to mass production, achieving seamless information connection at each stage. Digital models can not only be quickly adjusted internally but also shared across departments and enterprises, thereby collaboratively optimizing the supply chain and production processes. This data-based production model significantly shortens the entire product development cycle and provides flexible space for the personalized customization of cultural and creative products. When consumers customize personalized cultural and creative products, they can directly select and adjust design elements on the digital platform to create unique artworks. The production advantages brought by digital modeling technology, such as high precision, repeatability, low error rate and high adaptability, not only meet the contemporary market's demand for high-quality products but also help enterprises establish stable and unique brand images in the fierce competition, thereby winning more market share and discourse power in the global cultural and creative industry.

4.2. Digital Modeling Technology Can Integrate Multiple Artistic Expression Methods.

Another highlight of digital modeling technology in the design of cultural and creative products lies in its cross-media integration capability. It can integrate the visual characteristics and artistic expression methods of different materials in a virtual space, thus achieving an organic combination of tradition and modernity. Traditional cultural and creative products usually rely on the texture of a single material, such as the natural grain of wood carvings, the steady texture conveyed by stone carvings, or the firm and cold appearance of metal works. However, each material has its inherent limitations and it is difficult to present multiple visual effects simultaneously. Digital modeling technology breaks this bottleneck. Designers can simulate the characteristics of various materials in a virtual environment and superimpose multiple effects in the same work. Take the work "Dud" by American artist Jama Jurabaev as an example. On a digital platform, he used advanced 3D tools to display the soft folds of fabric, the delicate texture of skin, and the cold luster of metal parts. These effects are difficult to achieve simultaneously in traditional carvings. Designers can freely

combine and adjust the parameters of virtual materials according to different creative needs, achieving diverse expressions from glass-like transparency to metallic reflection, thereby adding unprecedented visual layers and artistic expressiveness to cultural and creative products.

In the process of cross-media integration, digital modeling technology builds a bridge between traditional craftsmanship and modern design. Although traditional craftsmanship has a profound historical accumulation, it often appears conservative due to its single means of production. By using digital modeling and virtual rendering, designers can retain traditional aesthetic elements while breaking through the limitations of traditional craftsmanship in material expression. For instance, in traditional stone carving, designers often find it difficult to achieve fine and dynamic texture processing. However, digital modeling software allows designers to simulate multiple visual effects beyond the stone material texture, such as water flow, flames, or energy light effects, making the works maintain the stability of historical culture while possessing the dynamism and vitality of modern technology. Through virtual tools for texture overlay and color gradient, designers can preview various material effects in real time and adjust them according to creative needs. This digital integration not only endows the works with richer expressiveness but also enables traditional elements to rejuvenate with new artistic life in modern cultural and creative products.

Meanwhile, digital modeling technology has also promoted the organic integration of traditional handcraft techniques and digital processes, enhancing the artistic expression and cultural charm of products. Although digital sculpting offers extremely high precision, it may sometimes appear overly mechanical and perfect in certain details, lacking the warmth and natural traces found in traditional handcrafted art. To address this shortcoming, designers often employ hand-painting, aging techniques, and post-processing for texture, enabling digital works to present fine lines while retaining the unique texture brought by handcrafting. For instance, Chinese prototype artist Rolandteller, in his work "Eroded - Skeleton Knight", successfully created an artistic effect that blends the ancient and the modern by combining digital sculpting with traditional hand-painted finishes. He applied an aging finish to the metal parts of the model to simulate the rust and wear that metal undergoes over time, allowing the work to maintain the precision of digital sculpting while adding the traces of time and a sense of artistic life. The complementary nature of digital technology and traditional craftsmanship has opened up a new creative path for cultural and creative products, making them not only visually striking but also capable of conveying profound cultural connotations and historical emotions, meeting the market's demand for high-quality and diverse products.

4.3. Digital Modeling Technology Facilitates Cross-Cultural Communication and IP Expansion.

Digital modeling technology not only brings breakthroughs in product manufacturing and process integration, but also holds significant importance in cultural dissemination and intellectual property (IP) expansion. Traditional cultural products are often constrained by physical circulation and geographical limitations, making it difficult for them to quickly expand into the global market; however, digital means endow cultural content with the ability to transcend

time and space for dissemination. Through digital modeling and virtual exhibition platforms, cultural and creative products can present cultural stories and artistic essences in new forms, attracting consumers from different countries and regions. Taking the "Shanghai Jing Spirit Beasts" series as an example, this series of products reinterprets mythological elements from the "Shan Hai Jing" with the aid of digital modeling technology. Designers have boldly deconstructed and modernized traditional totems in a virtual environment, allowing traditional cultural symbols to appear in the market in a brand-new form. This digital expression method not only accurately conveys cultural connotations but also stimulates consumers' curiosity and participation enthusiasm, thus paving the way for the internationalization of cultural products.

Meanwhile, digital technology provides a brand-new platform for the cross-border extension of cultural heritage and IP. High-quality digital models and virtual exhibits generated by digital modeling technology can be rapidly disseminated worldwide through new channels such as the Internet, the metaverse, and NFTs. Many cultural and creative brands showcase and sell their products through online platforms, not only breaking geographical barriers but also achieving wide dissemination through social media and e-commerce platforms. For instance, Xu Zhelong's collection series "I'm angry!" gained global attention quickly after completing its digital model through international art platforms and digital exhibitions, and subsequently collaborated with renowned model studios to launch multiple versions, forming rich IP extensions and cross-border collaborations. Through such digital platforms, cultural heritage can be commercially operated and cross-border collaborations can be carried out in a brand-new way, not only enhancing brand awareness but also creating more business opportunities and revenue models for the modern transformation and market promotion of traditional culture.

In addition, digital modeling technology has unique advantages in promoting cross-cultural communication and the integration of the cultural industry. With the help of digital tools, museums and cultural and creative enterprises can repackage traditional culture in a digital way, creating cultural IPs with international appeal. Virtual exhibitions, digital archives, and online interactive platforms enable global audiences to experience art styles and historical stories from different cultural backgrounds online, thereby deepening mutual understanding and appreciation of different cultures. For example, in digital exhibitions, not only are the exquisite details of cultural relics displayed, but also through multi-language explanations, interactive Q&A, and virtual experiences, visitors from different cultural backgrounds can obtain customized information and experiences. Such a cross-cultural communication model not only promotes cultural exchanges among countries but also provides strong support for traditional culture to go global. By continuously expanding digital platforms and application scenarios, cultural and creative products can achieve diversified promotion in the international market, and at the same time,

enhance brand competitiveness through digital marketing methods, thereby promoting the comprehensive upgrading and sustainable development of the cultural industry in the context of globalization.

5. Conclusion

This study has examined the transformative role of digital modeling technology in the design and creation of museum cultural and creative products. Through the integration of advanced digital tools such as 3D modeling and virtual reality, museums are now able to overcome the limitations of traditional materials and techniques, enabling them to produce high-quality, interactive replicas of cultural artifacts. These technologies not only enhance the precision and efficiency of the production process but also open new avenues for global cultural exchange, as digital creations can be shared across borders and platforms.

The ability to blend traditional cultural elements with modern digital media has expanded the creative possibilities for museums, allowing them to engage broader audiences and increase accessibility. Additionally, by leveraging these technologies, museums are forging cross-industry collaborations with sectors such as gaming, fashion, and virtual collectibles, thereby expanding the market and commercial potential of cultural products. This innovative approach not only enhances the artistic and commercial value of museum offerings but also contributes to the sustainability and continued relevance of museums in the digital age.

While digital modeling technology has significantly enhanced the potential for cultural preservation and innovation, it is important for museums to address challenges related to intellectual property, ethical considerations, and the evolving demands of digital audiences. In the future, museums should continue to balance technological advancement with cultural sensitivity, ensuring that digital transformation complements rather than overshadows the preservation of heritage. Ultimately, the integration of digital modeling technology represents a pivotal step in the modern revitalization of museum practices, paving the way for more dynamic, interactive, and accessible cultural experiences.

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