

# DIGITAL SERVICE DESIGN FOR MUSEUMS BASED ON DATA CURATION

*Take the construction of One-stop online digital platform of the Palace Museum as an example*

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**Abstract** – with a collection of more than a million works and an early start in informatization, the Palace Museum manages a large number of cultural artifacts and digital assets. At present, the Palace Museum is committed to improving the active management of its digital content. In particular, the Museum aims to strengthen the long-term preservation of digital content to meet the preservation and utilization challenges brought about by the phenomenal growth of its digital content. This paper analyzes the top-level design, implementation, and evaluation of the Palace Museum's one-stop online digital platform through the concept of data curation and the DCC curation lifecycle model. The analysis discusses the positive role that digital curation plays in practice for digital content production, preservation, and service and provides a reference point for other museums.

**Keywords** – Data curation, Digital content, One-stop digital service of the Palace Museum, Curation lifecycle, Network information resources

**Conference Topics** – Exploring the New Horizons; Enhancing the Collaboration

## I. INTRODUCTION

The proliferation of media technologies has enabled digital content to be widely circulated on the internet, and as a result, network information resources have been generating at a high rate. During their digitalization work, Chinese museums have gradually found that their ability to preserve network information resources has not fully kept pace with the production of digital content and services. It is difficult to analyze and reuse the

overloaded and complex digital content effectively and comprehensively. To some extent, this difficulty has also hindered the efficacy of the long-term preservation and the sustainable use of network information resources.

According to the latest statistics, the Palace Museum has more than 1.86 million sets of cultural artifacts and manages both the cultural artifacts and their digital assets. Digitization first began at the Palace Museum around the 1990s. In the past 20 years since the launch of the official Chinese website ([www.dpm.org.cn](http://www.dpm.org.cn)) in 2001, the Palace Museum has accumulated an abundance of digital content and built multiple media platforms to use and present it, such as mobile Apps, Weibo, WeChat, etc. The digital content is important network information resources of the Palace Museum and characterized by their vast quantity, scattered, and variegated types of data and their frequent iterations. Through its practice and research in recent years, the Palace Museum has found that the traditional passive mode of preservation is unable to ensure long-term preservation and sustainable use of digital content. Improving preservation capabilities has become the main point of work for data management at the Palace Museum. Following the evolution of digital content, the Palace Museum has been improving its model of digital preservation to meet the challenge of long-term preservation and utilization. In particular, the data curation theory related to digital

preservation is an important direction for improvement on preservation capability. Special attention is given to digital technologies, strategies, and other activities in the design process of digital services.

## II. LITERATURE REVIEW

With the accelerating development of internet technologies and the outburst of the COVID-19 pandemic, network information resources have penetrated all aspects of social life and become an important conduit for people to acquire information. However, several characteristics of network information resources make it difficult for them to be accessed in long-term: a) network information resources are vast in number, quick in growth, but lacking in unified management; b) the link relations of web pages are constantly changing; c) updating iterations might cause the loss of data; d) the degradation of digital technology makes data obsolescent [1-2]. Many organizations face the challenge of how to curate network information resources timely and accurately, while simultaneously ensuring their long-term availability.

In a report from 2003, the National Science Foundation (NSF) proposed that systematic and effective data management measures should be established or strengthened to address the risk of information loss. Furthermore, the solution should be made chiefly through data curation [3]. Meanwhile, the American Council of Learned Societies (ACLS) pointed out that traditional data management work lacks a fully functional management system, whereas the introduction of data curation can make up for this lack and expand the research on digital management systems design [4]. As data curation is defined by the Digital Curation Center (DCC), the active management of data can safeguard the long-term value of data and reduce the threats of digital obsolescence [5]. Zhang Zhixiong et al. argued that the complexity of digital assets and the deluge of data are difficult to manage through traditional preservation work, and that active management activities in data curation should be carried out to maintain, preserve, and add value to data [6]. Some Chinese scholars such as Tang Ziyu [7] and Jiang Lili et al. [8] sampled 20 and 28 foreign data curation platforms respectively to study new data services that are built through data curation, where they found data curation conducive to data management for organizations. From these

researches, data curation is a protective measure for improving digital assets management. Data curation is believed to be a continuous process with a greater emphasis on the data curation lifecycle. It involves perpetual actions and fosters collaborations and aims at adding value to the data. Therefore, data curation performs a more active role in the long-term data management and preservation [9].

Similar to libraries, museums are cultural institutions that consider providing data service and ensuring the long-term preservation of data as their central work. In 2002, Seamus Ross proposed at the Digital Data Curation task force meeting, formed by Professor Tony Hey, that data curation is critical to management work at museums and concerns conservation, preservation, and access at its core [10]. Anna Maria Tamaro et al. suggested that, in the context of the integration of libraries, archives, and museums, it is necessary to converge multiple disciplinary knowledge to achieve long-term data preservation and strengthen data curation [11]. The American Association of Museums defined the crux of data curation in museums as the management of digital assets since digital assets are crucial to protecting the physical collection at museums and educating the public [12]. Museums and libraries in China face similar challenges in resource digitization and digital services, according to statistical numbers. When the terms "Data Curation/Digital Curation," or "数据监护/数据监管/数据策管/数据管护/数据策展" [data guardianship/supervision/curatorship/custodianship/curation] were used as keywords to search in CNKI, an academic research database in China, approximately 217 related papers (retrieved on May 5, 2021) can be retrieved. This number indicates that research and practice in libraries have improved the digital service to some extent by adopting data curation theory. However, if the same keywords are applied together with another keyword "博物馆" [museum], the CNKI only yields two valid papers in Chinese (retrieved on May 5, 2021). This number shows libraries in China have conducted more research on data curation, while museums in China have done relatively less research on it.

As mentioned above, the key to a successful data curation that realizes long-term preservation and value-added of data features two aspects: a) the data curator is a professional with interdisciplinary knowledge and manages actively and continuously throughout the data lifecycle, and b) an effective data curation requires the support of a functional data

curation platform to provide data services in a visual format. In China, there is relatively little research on data curation in museums. To some extent, it shows that the practice of data curation as well as the research on it cannot be applied generally to museums. Referencing the concept of data curation, the Palace Museum has found that the long-term preservation of complex and diverse online digital content is challenging due to the lack of active data curation. The main reason for this difficulty is the collaboration barriers. Previously at the Palace Museum, the digital services design team carried out the maintenance work like the content's iteration, since it is the most familiar with digital content produced. Meanwhile, the data preservation team was responsible for the preservation. Correspondingly, the focus of the digital service design for digital content tends to favor front-end planning and rarely involves the production and preservation of data. Under this relatively separated working structure, the division of duties and the differences in specialties lead to insufficient communication among the teams involved in the lifecycle of digital content, which then leads to the data being curated ineffectively. As a further result, data loss, data unavailability, and other issues might threaten long-term data preservation. In order to manage these hidden threats, using the data curation's lifecycle theory to perfect the digital service design has become a crucial idea for the Palace Museum when improving its data preservation and value-added capabilities.

### III. DIGITAL SERVICE DESIGN FOR MUSEUMS BASED ON DATA CURATION

The DCC-based definition of data curation discussed in this paper refers to the long-term management and preservation of digital content, involving the maintenance, preservation, and increase of data value throughout its lifecycle; Digital service design mainly discusses the development work phase of digital products based on user experience and digital content design as the core. The proposal for data curation reminds institutions of that all relevant teams need to cooperate from the creation of data when developing data curation and preservation strategies, as well as to manage the lifecycle of data scientifically, in order to achieve the long-term preservation and utilization of digital content. This development responds to the need of museums to focus not only on the quality of digital services but also on data curation. In this manner, in

addition to being utilized at present, the digital content can be authentically duplicated, reused, and receive added value in the future. For network information resources management, it is necessary to investigate the users, control the quality of digital services, and formulate reasonable masterminding of digital content. Meanwhile, it is equally necessary to preserve and maintain data effectively and formulate management rules for digital content. Digital services, human resources, technologies, and many other sectors are required to intervene the project, so the data curator receives greater demands from these sectors. Professionals are required to not only possess interdisciplinary knowledge and a strong specialty but also cooperate closely with others [13].

The visualization and management of data curation are achieved through developing and constructing data curation platforms. However, for the current situation of Chinese museums in general, the construction of data curation platforms remains at its beginning stage due to budget, personnel, and technical constraints. Nonetheless, it is urgent to begin the management of network information resources as soon as possible. The focus of digital content service design is to study user needs and front-end media development. Through engaging with the DCC curation lifecycle model and interdisciplinary analysis and research, this paper introduces the one-stop digital service design at the Palace Museum as a practical example. Then, it discusses how digital curation is used to join forces of the various teams in the digitization sector at the Palace Museum to provide data services. Lastly, this paper considers how data curation can affect the network information resources management positively through prompting full lifecycle actions, sequential actions, and occasional actions [14].

#### A. *A Data-Curation Based Digital Service Design Model*

Digital service design is generally related to the front-end curation of the digital content, including 13 stages in three phases of work: top-level design, implementation, and evaluation. At a more detailed level, the top-level design phase includes project initiation and evaluation, marketing research, requirements planning, prototype design, etc. The implementation phase includes scheduling, progress supervising, communicating, testing, refining requirements, and other implementation tasks. The evaluation phase includes problem review, data

analysis, user survey, and planning for future iterations. Data curation-based digital service design has positive effects on the management of network information resources. For example, an audience-oriented digital service design can better understand the needs of users, which can, in turn, maximize the audience's participation in the data-related policy-making process. Digital service design also requires constant communication and coordination among

various teams, so it can connect the front-end and back-end to ensure a smooth progression of the digital project. Furthermore, digital service design has accumulated much practical experience in producing and utilizing digital content that can be integrated into or applied onto data curation work. Lastly, digital service design is outstanding at content conversion and can fully extract data value to provide reference information.

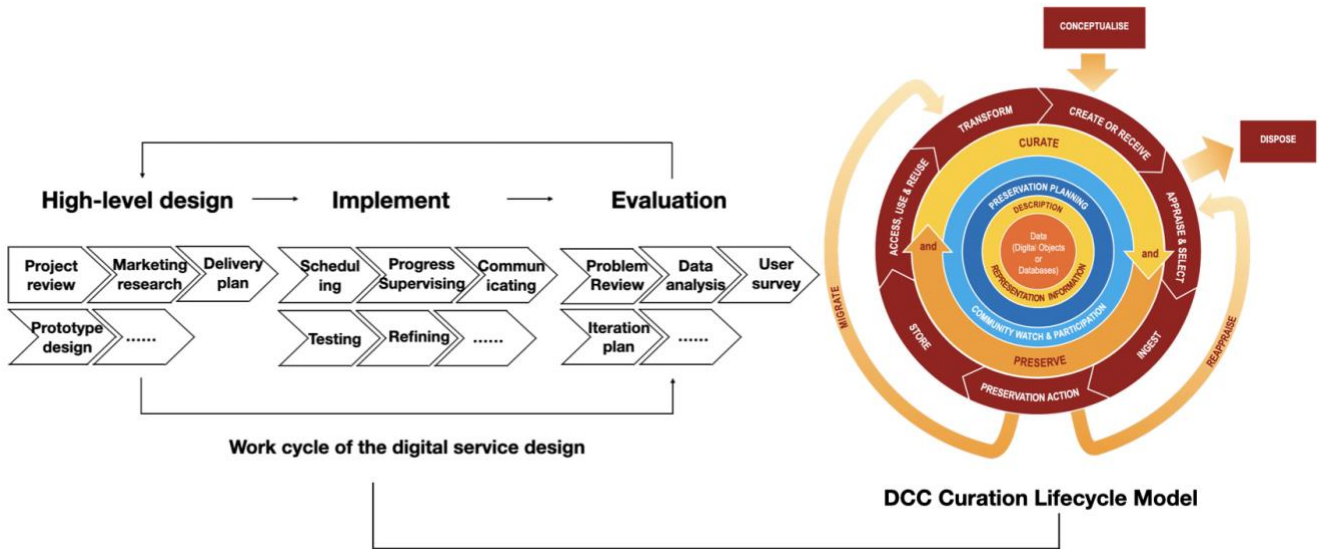


Figure 1: A digital service design model based on data curation

The above clarification of the work phases of digital service design and the framework of data curation allows the concept of data curation (as defined by the DCC) to be integrated into the digital service design cycle. This integration forwards a data service design model particular to digital content (Fig. 1) [15]. Currently, there are some researches on data curation in libraries of China, and the librarian is mainly responsible for the specific management work. In contrast, museums are still in a stage of urgent further development in terms of data curation, and there is a temporary lack of specialized professionals to carry out this work. In most cases, the management and analysis of specific data are mainly carried out by the one who uses the data, and digital service designers in museums are those who use the data most to produce digital content. The advantage of digital service designers work on data curation is their work involves data utilization, management, maintenance, and preservation. In this process, they build close cooperation with data-related teams and are familiar with users' requirements. Furthermore, the user experience design also can better play a role in multiple steps of

the data curation lifecycle, as the data is mainly serving users at the end. Therefore, this model is based on the actual work cycle of digital service design combining with the data curation lifecycle and explores the data curation that might be applied to the work step of digital service design when using the data. By improving data management, it might enhance the long-term utilization, preservation, and value of data. This seems to be a possible solution for Chinese museums to curate digital content under current conditions. The following sections will analyze how this data curation-based model performs through examining the three phases involved in building the Palace Museum's mobile one-stop digital service: top-level design, plan implementation, and summative assessment.

### B. Top-level Design of Digital Service

The top-level design of digital services in museums is mainly the curation and design of the digital content, with special attention paid to developing standard documents for digital services. Once the lifecycle model of data curation is integrated into it, the top-level design needs to

develop data curation protocols in the meantime. Since digital service design is the most familiar with the digital content and the audience's need to access and for use, digital service design personnel should participate in the data curation protocols as soon as the digital content is being created. This participation includes developing preservation plans and policies, specifying metadata standards, and ensuring the practicality of the standards and policies. In doing so, digital service design can develop more systematic and effective management measures for the scattered and vast amount of digital content on the web, reduce threats to data loss and obsolescence, and boost the data value. The data lifecycle model's mapping reflects actions in two full lifecycles of preservation planning, description, and information representation [16].

### 1. Preservation Planning

Before the production of digital content, the design of a user-oriented experience is required in connection with the content's evolutions amid the rapid technological renewal, to ensure the quality of digital services and operational efficiency. The Palace Museum has a wide range of online digital content but is scattered across a diversity of mediums and digital technologies (TABLE I). The maintenance of data and the cumbersome process of iteration are imminent challenges. Researches on technologies and analysis of statistical numbers<sup>1</sup> have shown that WeChat mini-programs (the following might be abbreviated as the mini-program) attract the largest number of netizens and are the most frequently used product in China. Thus, the Palace Museum has attempted to integrate and categorize its core digital content through this new media tool to construct a one-stop digital service called the "Digital Palace Museum" WeChat mini-program. This mini-program has promising potential to stimulate the vitality of data by quickly meeting and scientifically managing the user needs for obtaining, filtering, and using the information. In addition to user experience and other service considerations, however, while the Palace Museum's one-stop digital service was being developed, it was also concluded that the current situation of data management should be improved.

TABLE I:

Digital Content that used in the "Digital Palace Museum" Mini-program

Title	Media platforms	Main Features
Digital Cabinet of Curiosities (数字多宝阁)	Website	Appreciating the collection objects at the Palace Museum in 3D
Digital Collection Online (数字文物库)		Searching information of the Palace Museum's collection by category
The Panoramic Palace Museum (全景故宫)		Taking a virtual tour of the Palace Museum
Painting Masterpieces in the Palace Museum Collection (故宫名画记)		Navigating high-resolution images of paintings of the Palace Museum
Exploring architectures (探索建筑)		Learning the Palace Museum's architectures with images and introductions
Palace Virtuality (V 故宫)	Mobile Applications	Perceiving spatial configuration of architectures with three-dimensional models of the Palace Museum
365 Days of Masterpieces (每日故宫)		Information on one masterpiece of the Palace Museum per day through text, pictures, and videos
The Palace Museum Exhibitions (故宫展览)		Bringing the offline exhibitions of the Palace Museum online, presenting information about the exhibition halls and exhibits
600 Years of the Forbidden City (紫禁城 600)		Introduction to the architectural knowledge and the historical facts of the Palace Museum
The Palace Museum Multimedia Guide (玩转故宫)		A light and quick guide service for visitors to the Palace Museum
The Palace Master Builders (口袋宫匠)	WeChat Mini-program	Gain knowledge of architectures and

<sup>1</sup> The WeChat mini-program was launched in 2017, the "sub-application" built within the WeChat App. The mini-program can be considered as a kind of "Light App" that aims to offer convenient services, easy access, and simple navigation to improve the customer experience, which became a trend in Apps

development. By the end of 2018, WeChat app users had exceeded 600 million, with an average daily active user of 230 million, most of which were from mini-programs that accounted for 72%, and 30% of users browse information every day by navigating mini-programs.

		collections of the Palace Museum in a game
The Official Account of the Weibo	Social Media	News release on the Palace Museum as well as other cultural knowledge
The Official Account of the WeChat	Social Media	News release on the Palace Museum as well as other cultural knowledge

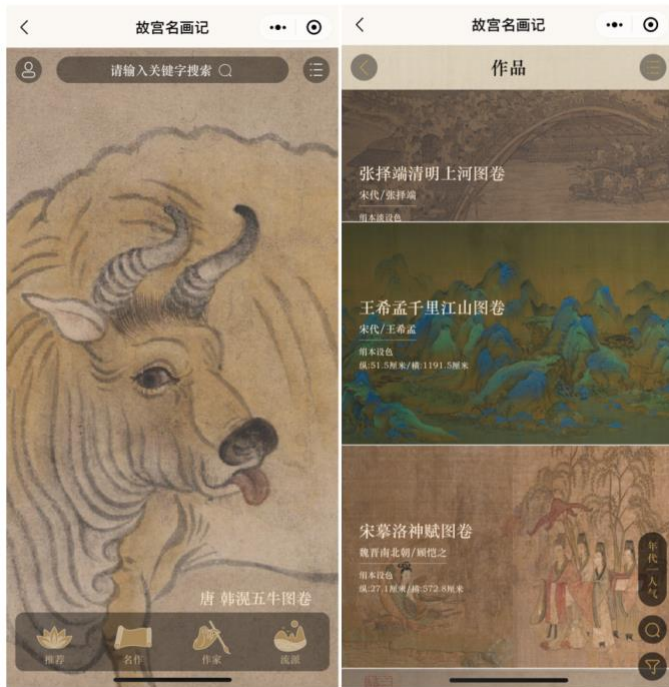
Since digital service design undertakes the research duty at the project's early stage and is thus more familiar with the digital content's service environment and the usage scenarios, it is vital for the digital service design personnel to collaborate with working teams throughout the full lifecycle of the digital content's production to develop the content's management protocol. In this way, the protocol can best clarify specific user needs, provide scientific guidance for different stages in data curation lifecycle, and ensure the quality of production. The design of the Palace Museum's one-stop digital service began with research that located an extensive demand among users for information, high-resolution images, and multimedia presentations of the museum's collection and architecture. Based on these needs, the general plan for integrating existing digital content into the one-stop digital service is twofold: a) combine collection and architectural information, their related images, audio, video records, and other digital contents central to users' interest to be maintained and retrieved in a unified manner, in order to improve utilization efficiency and optimize user experience; b) further the standardization of digital services and related data curation management by regulating the data interface management and establishing unified logs for each platform.

## 2. Description and Information Representation

After the Palace Museum's digital content is organized and operational procedures developed, the next step for the "Digital Palace Museum" mini-program is to standardize the data interface by repackaging and pluginizing existing digital content access and developing a central retrieval module for those data. Since the digital content of the Palace Museum are distributed across various digital media, horizontal information retrieval and utilization

engine are needed to provide a one-stop search service. In the description and information representation stage, the top-level digital service designer needs to construct the indexes and fields for digital content with different attributes, following the survey result of user searches as guidance. Alternatively put, the designer should participate in formulating standards and descriptions for metadata.

In the design of the Palace Museum's one-stop digital service, the metadata field standards and descriptions referenced the museum's metadata standards of the Collections Information Management System and Digital Assets Management System. After a comprehensive evaluation, an extraction-integration-reuse plan is formulated to achieve unified management of metadata. Take the mapping relationship of objects information's metadata fields among the Collections Information Management System, the Digital Collection Online, and the "Digital Palace Museum" mini-program as an example. The Collections Information Management System has developed relatively fixed metadata standards for collections and architectures of the Palace Museum. Those fixed standards are referenced by the Digital Collection Online in building its own metadata fields of the objects' basic information. In the Place Museum's one-stop online digital platform, the mini-program directly extracts and reuses the metadata fields of the Digital Collection Online, where the metadata standards and descriptions remain unchanged from those of the Collections Information Management System. This linked design enhances data management efficiency because the underlying data system is the only one that requires maintenance whereas metadata standards and descriptions are always consistent across the link. Furthermore, the data link enables the metadata to be used as a unique identification field, providing specialists and users with an accurate and efficient index. For the Palace Museum collection's highlights, the metadata of their images mainly comprises the basic information, such as name, dynasty, artist, medium, dimensions, etc. (Fig.2). The digital service design requires advice and assistance in developing metadata descriptions, joint research on data repository construction, and collaboration in data upload, retrieval, and submission.



朝代 Period	数量 Amount	画派 School	数量 Amount	题材 Genre	数量 Amount	字段 Field	例子 Example
Wei, Jin, Southern and Northern Dynasties	2	Shanghai	44	Landscapes	277	Title	<i>The Night Revels of Han Xizai</i>
Sui	1	Four Wu Masters	2	Flowers and Birds	186	Period	Five Dynasties (906-960)
Tang	13	Four Yuan Masters	27	Figures	110	Artist(s)	Gu Hongzhong
Five Dynasties and Ten Kingdoms	6	Zhejiang	13	Religious	8	Medium	Ink and Colors on Silk
Song	96	Wu	76	Zoological	20	Dimensions	Height: 28.7cm; Width: 335.5cm
Jin	1	Songjiang	13	Historical	19	Format	Handscroll
Yuan	75	Four Monks et al.	34	Ladies	1		
Ming	179	Four Wangs et al.	57	Genre	4		
Qing	241	Court	38	Scenic Figural	4		
Modern-Contemporary	16	Eight Jinling Masters Yangzhou	7				
Total	630		312		629		

Figure 2: Metadata Description of Collections

### C. Implementation of Digital Service Design

The main duty of the implementation phase in digital services design is to communicate and collaborate with the various teams to implement specific tasks. The focus is to ensure the delivery is punctually made and compliant with regulations. When combined with the lifecycle of data curation, digital services design needs to comprehend or manage the data status at the same time. The working teams involved in the Palace Museum's one-stop digital service design include the digital image production team, the collections information system and management team, the artifacts digitization team, and the digital service team that provides assistance to digital content curated by specialists and users. In this process, the data infrastructure in the back-end supports the front-end's data retrieval and curation. If attention is only given to the front-end, data preservation or data quality might be somewhat overlooked. Then, when the digital content is prepared for iteration or for different media technology, data adaptation might cause the digital content unable to be presented or utilized in the long term. In order to ensure the long-term quality of data, the digital service design needs to participate in every stage of data production,

strengthen collaboration between teams, advance the progress of each team's work, adjust and update requirements documents according to specific implementation conditions, and pay attention to the orderly and effective maintenance of data, securing that it can be accessed and shared in the long term. The mapping in the lifecycle model involves full lifecycle actions, such as community watch and participation, sequential actions, and occasional actions [17-18].

#### 1. Community Watch and Participation

Due to the vast range of network information resources and the great variety of media technologies that the public is used to, different data structures are generated when digital content is presented across different digital platforms. The profusion of data structures here may lead to information sharing difficulties. Digital service design is adept at the online transformation of content and crucial for connecting user needs to product requirements. Well-researched on user-friendly and data-sharing-friendly media platforms, digital service design can play an active role in setting data exchange standards and in providing reference information and practical advice on how to realize data sharing across different media platforms.

The design of the Palace Museum's one-stop digital service is complex because the design aims to connect the digital service to Apps, HTML5 pages, WeChat mini-programs, and other digital media. After researching the advantages and disadvantages of each media platform, the WeChat mini-program was selected as the host platform. It can open up the scene entrance for many types of digital media [19], which ergo allows most of the current digital content of the Palace Museum to be integrated. Due to its high compatibility, the WeChat mini-program is capable of reusing the data with quick and low-cost techniques and empowering the data transfer and sharing from multiple digital media. Consequently, the WeChat mini-program provides a solution to the information silo among various platforms and standardizes the data interface of various digital contents. In the development of data access solutions, the mini-program does not present each digital content simply and directly. To eliminate the fragmentation between sections and digital content and to enhance the user experience, the core information of each digital content is integrated into the native user interface of the one-stop digital service. For example, the "Appreciation" section of the "Digital Palace Museum" mini-program includes information from different digital platforms. The data of paintings in the "Appreciation of paintings" section is sourced from the "Painting Masterpieces in the Palace Museum Collection" website, the cultural artifacts' data in the "Artifacts Library" sections from the "Digital Collection Online" website, and the three-dimensional data in the "Duobaoge" section from the "Digital Cabinet of Curiosities" website (Fig. 3).

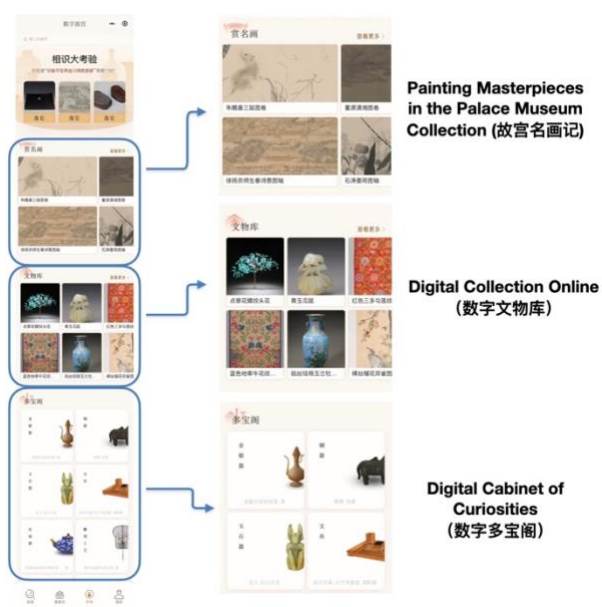


Figure 3. The "Digital Palace Museum" mini-program "Appreciation" section page display

Once the existing digital content is conjoined, the mini-program provides a unified experience. This unified experience not only allows for a more flexible display of digital content in the front-end but also a clearer logic of the mini-program itself. This unified digital content experience can facilitate the multi-dimensional access and retrieval of collections information, in addition to ensuring the usability of the digital content, the specification of the techniques, and the value of the user [20].

## 2. Sequential Actions and Occasional Actions

In practice, digital service design at this stage involves developing and updating demand plans and synchronizing information with back-end teams, according to the implementation problems and feedback from all parties. The detailed implementation work like data processing and storage is usually carried out directly by the Palace Museum's collections information management team and digital assets team. In this process, the lack of comprehensive communication between the front end and the back end, or the information asymmetry on digital content production planning can limit the application of data to a specific media platform or system. Moreover, digital content iterations might render the data unavailable. In this case, since the digital content is not flexible enough to be utilized in the front end in the long term, the further use of the digital content requires additional steps to re-process, migrate, store and access the data and increases the digital content production cost due to the extended work and time cycle. In an environment where user needs are increasing and online information is constantly being updated, quick response to changes in the front end is a key measurement to the competitiveness of digital services for museums. As the digital content enters the implementation phase, it is vital for the digital service design to strengthen cooperation with the back-end, pay close attention to data quality, and raise awareness of data management.

The sixth and seventh layers of the DCC curation lifecycle model are the "sequential actions" and "occasional actions," which are primarily a series of specific tasks performed around the data [21]. According to the implementation and the improvement plans from the digital services design, these two layers are in a continuous cycle of optimizing data quality to a state where it can be



accessed and shared for added value over time. At the data processing stage, data appraisal and format management are clarified in order to secure data accessibility and compatibility in the media platform. In this implementation phase of the Palace Museum's one-stop digital service design plan, access to data is achieved mainly through the API interface. The digital service design has consulted the results of user research and participated in the formulation of the data grid, storage paths, etc., in order to realize the functional operation of the database [22]. As the result, as the data are more organized and effective, retrieving information from multiple systems and platforms also becomes more efficient. Through accessing data, the content from the database can be reused in the interface developed independently by the mini-program with flexible forms of presentation. Eventually, the implementation phase of digital services design can standardize the use of data interfaces for each digital content and improve data security.

#### D. *Evaluation of Digital Service Design*

The evaluation phase summarizes the digital service design output. The focus is on examining usage, reviewing project issues, and planning the next step for optimizing digital services. Combined with data curation, the digital service designer needs to collect, manage, and evaluate the data situation in the summative work at this stage in order to ensure that the stored digital content can be continuously applied and reused. It is thus necessary for the digital service design team to strengthen its collaboration with the data production, processing, storage, and other management teams, to provide users with personalized utilization and discovery, to jointly develop a user-oriented data service from the bottom up (including but not limited to the design team's participation in data collection and correlation and user experience and improvement), and to ensure the feasibility of the whole design. In the lifecycle model, this series of actions maps onto the full lifecycle action of curate and preserve, as well as the sequential actions [23].

##### 1. *Curate and Preserve*

Once the digital content is launched online, the digital service design team at the Palace Museum summarizes and evaluates the user behavior data

and develops the next steps for iteration. For example, in the first month of launching the "Digital Palace Museum" mini-program on 16 July 2020, the mini-program received over 3.2-million visits and over 1.2-million visitors. These data show that half of the users visited the collection pages in the mini-program at least twice. There is a clear user stickiness since the number of loyal users accounted for 40% of all users. The average length of user visits was 3.01 seconds, with fun interaction inertia lengthening the visiting time.

The core of user behavior data analysis is to add value to the data, meaning, to increase the functionality of data, and to avoid unusable data being preserved in the database for a long time. In addition to publishing and sharing the digital content in the process of digital service design, performing the analysis allows data from user behavior research to be linked to the preservation development plans and provides personalized scenarios for data use. This linkage guarantees the digital service design's participation in the data management and preservation processes, makes data more orderly and effective, and increases the external utilization of digital content.

##### 2. *Sequential Actions*

During the evaluation phase of the digital services, user experience research utilizes questionnaires in addition to analyzing data generated from the digital content. In the case of the Palace Museum's one-stop digital service, a questionnaire<sup>2</sup> was sent to the public from July to September 2020 to evaluate the effect of the "Digital Palace Museum" mini-program. Compared to other museums' digital content in China, the public is the most aware of the digital content produced by the Palace Museum, at around 59%. Users that are aware of and have experienced the digital content responded that the quick access to cultural artifacts at the Palace Museum and the online one-stop digital content tour are the core reasons why they prefer this mini-program. Their response supports the high page views and utilization rate. The questionnaire shows that 89% of the public believes the "Digital Palace Museum" can be considered as an open door to the public's understanding of museums and related cultural artifacts.

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<sup>2</sup> The questionnaire research was conducted in Tier-1, New Tier-1, Tier-2, Tier-3 and Tier-4 cities in China, people aged 18-60, with a base of 1,000 survey respondents.

The above research also reveals that the number of users accessing conjoined digital content on the WeChat mini-program far exceeds the user number for stand-alone digital content on different media platforms. First, the multiplicative growth of the page view and visits-per-capita reflects a higher user loyalty and satisfaction with accessing digital content through the mini-program. Second, the questionnaire shows that many users are satisfied with the comprehensive range of knowledge information, the type of media technology, the seamless and convenient experience, and the creative form of cultural artifacts of the mini-program and that they are therefore willing to recommend it to others. This result suggests that a user-oriented digital service design that takes a bottom-up and statistically-driven approach is a competitive design. Again, in order to improve the service design plan according to the interaction effect between users and the digital content, the collaboration of all teams is required in every phase of the data curation lifecycle.

#### IV. CONCLUSION

To improve the preservation of digital content and digital services online, the Palace Museum has developed a one-stop online digital platform, the "Digital Palace Museum" WeChat mini-program. It aims to integrate the vast digital content that have been created in the past, are being created now, and will be created in the future into a large digital repository. At the same time, to prevent data loss and ensure long-term data accessibility, a data curation-based new digital service design was developed. The method of data curation was applied to the process of planning, implementing, and appraising the digital content. Related to the practical example of the "Digital Palace Museum" mini-program, one of the solution of temporary lack of the digital content management in museums in China might be: First, targeted at responding to needs and guided by data curation, the design team participated in the formulation and adjustment of the metadata system and processing mode of various digital contents and provided a unified plan for data interfacing. These actions made separated digital content interlinked and easier to be preserved together. Second, the design team raised awareness of data curation in digital service design and closely collaborated with data preservation and management teams to improve data abilities, such as retention and reuse. In effect, the design has

repaired the information silo with its comprehensive attention to each digital content. Third, the design team performed statistical research and evaluation work that added value to data and provided points of reference for the sustainability of digital content. The Museum's new digital service design serves as a bridge not only between the digital content and the public but also among different working teams involved in the project. With its research on users, markets, and media platforms in the front-end, the design team participated in the curation of the data lifecycle in the back-end by assisting and advising on plans for each stage of data curation. The design emphasizes the curatorial goals such as the value-added, sharing, long-term use, and preservation of data.

By doing so, in the nine months since the launch of the mini-program, the cumulative number of visitors has now reached over 3.8 million. 69% of visitors understand that they are able to experience the virtual tour of the Palace Museum, view architectures online, and access a wealth of digital services in the one-stop service. 71% of users enjoy the mini-program because they can quickly learn about the Palace; 68% of users browse online and access the information they need without in-person experiences; 65% of users browse cultural artifacts through advanced technologies. Results of the Palace Museum's one-stop digital services research are concrete evidence suggesting that the integration of digital curation into museums' digital service design has a positive effect on the management of network information resources and can improve the quality of digital services as well as the value-added effects of digital content. However, in practice, due to the lack of relevant theoretical research, practical infrastructure, and technical support in museums, it needs to be recognized that the promotion of data curation is still peripheral to data service design, that the evaluation system is highly subjective, and that the data lifecycle management is only an extension from the requirement planning at this moment. Data curation demands high expertise, digital literacy, and a comprehensive skill set. All those factors mentioned above pose challenges to the integration of data curation into digital service design. In the future, as media technology continue to develop, the Palace Museum will keep on exploring suitable media environments for conjoining digital content, heightening the awareness of long-term preservation when providing digital service,

improving the corresponding digital content preservation mechanism and timely storage of dynamic data, and ensuring the perpetual and sustainable utilization of network information resources as well as their preservation.

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#### REFERENCES

- [1][6][9] Zhang Zhixiong, Wu Zhenxin, et al. Analysis of the Difference Between Digital Curation and Digital Preservation [J]. *Data Analysis and Knowledge Discovery*, 2014, 30(1).
- [2] Kang Liping. Exploring the collection and preservation of network information resources[J]. *Inside and Outside Lantai*, 2019, 240(03):12-13.
- [3] Atkins D E, Droegemeier K K, Feldman S I, et al. Revolutionizing Science and Engineering Through Cyberinfrastructure[R]. 2003.
- [4] American Council on Learned Societies. Our Cultural Commonwealth: the Final Report of the American Council of Learned Societies Commission on Cyberinfrastructure for the Humanities and Social Sciences[R]. 2006. Available at: [www.acls.org/cyberinfrastructure/OurCulturalCommonwealth.pdf](http://www.acls.org/cyberinfrastructure/OurCulturalCommonwealth.pdf).
- [5] Digital Curation Centre. What is Digital Curation [EB/OL]. [2018-03-10].<http://www.dcc.ac.uk/digital-curation/what-digitalcuration>.
- [7] Tang Ziyu, Ou Shiyan. A Survey and Analysis of the Foreign Data Curation Platforms[J]. *Digital Library Forum*, 2019, 179(04):39-49.
- [8] Jiang Lili et al. Research on Service Modes of Data Librarian in Foreign Academic Libraries[J]. *Library and Information Service*, 2015, (17) : 56-61.
- [10] Macdonald A, Lord P. Digital Data Curation Task Force: Report of the Task Force Strategy Discussion Day[EB/OL]. [2013-11-24]. [http://www.jisc.ac.uk/uploaded\\_documents/CurationTaskForceFinal1.pdf](http://www.jisc.ac.uk/uploaded_documents/CurationTaskForceFinal1.pdf).
- [11] Tamaro, A. M. , M. Madrid , and V. Casarosa . "Digital Curators' Education: Professional Identity vs. Convergence of LAM (Libraries, Archives, Museums). " *Communications in Computer & Information Science* (2012).
- [12] American Association of Museums. Curators Committee, Code of ethics for curators (2006), [http://www.curcom.org/\\_pdf/code\\_ethics2009.pdf](http://www.curcom.org/_pdf/code_ethics2009.pdf).
- [13] Harvey, R., Bastian, J.: Out of the Classroom and into the Laboratory: Teaching Digital Curation Virtually and Experientially In: IFLA WLIC Conference Puerto Rico, (2011), [https://www.ifla.org/files/assets/hq/publications/ifla-journal/ifla-journal-38-1\\_2012.pdf](https://www.ifla.org/files/assets/hq/publications/ifla-journal/ifla-journal-38-1_2012.pdf).
- [14][16][17][23] Chen Yao, Wu Zhenxin. Comparison and analysis of preservation cost models based on long-term preservation criteria[J]. *Research on Library Science*, 2016, 000(011):53-60.
- [15] Digital Curation Centre. DCC Curation Lifecycle[EB/OL]. [2018-03-10].<http://www.dcc.ac.uk/sites/default/files/documents/publications/DCCLifecycle.pdf>.
- [18][21] Zhou Manying, Fu Lu. The Comparative Research on Data Curation Lifecycle Models[J]. *Library Science Research & Work*, 2018(9):34-37.
- [19] Guo Binbin. The Progressive Direction of Internet Communication in the Scene Perspective: WeChat Mini Program Scene Inlay and Ecological Layout as an Example[J]. *View on Publishing*, 2020, No.375(21):68-70.
- [20] Yan Xue. Job Responsibilities and Capacity of Data Librarians Abroad[J]. *Information Science*, 2021,39(01).
- [22] Xu Hongchang. Analysis of the Application of Computer Software Data Interfaces[J]. *Computer Knowledge and Technology*, 2021, v.17; No.2:56-57.