"DIGITAL HERITAGE" THEORY AND INNOVATIVE PRACTICE

Y. He[a], Y. H. Ma[b] *, X. R. Zhang

[a] Tsinghua Heritage Institute for Digitization, Beijing 100085, China - heyan@thid.cn
[b] Tsinghua Heritage Institute for Digitization, Beijing 100085, China - mayinghua@thid.cn
[c] Tsinghua Heritage Institute for Digitization, Beijing 100085, China - zhangxianru@thid.cn

Commission VI, WG VI/4

KEY WORDS: Digital heritage, cultural heritage, digitization, innovative practice, "Digital Yuanmingyuan"

ABSTRACT:

"Digital heritage", as defined in this paper, is the integration of cultural heritage with digitization technology ("cultural heritage + digitization"), and of digital knowledge with research. It includes not only the three conventional aspects of cultural heritage digitization—digital collection and documentation, digital research and information management, digital presentation and interpretation—but also the creation and innovative use/application of the digital content (cultural heritage intellectual property/IP, experiential education, cultural tourism, film and media). Through analysis of two case studies, the Palazzo Valentini in Rome, Italy, and the Old Summer Palace (Yuanmingyuan) in Beijing, China, the paper assesses the concept of "digital heritage" and proposes a conceptual framework to capture recent developments and future prospects with regard to the industry.
.

1. "DIGITAL HERITAGE" THEORY

In the age of globalization and in the face of today's fast-paced consumer society, the identification and interpretation of historical information and cultural value embedded in the cultural heritage of a country/nation-state has become the key for establishing both self and national identity.. Many countries have raised the protection of cultural heritage from the level of "state action" to "national strategy".

Recent developments in the field of science and technology have fundamentally changed the way people communicate and disseminate knowledge, and revolutionized the traditional industries. New digital information technologies, which exceed the limitations placed on heritage protection by traditional methods, provide powerful tools for heritage recognition, protection, presentation, and communication that may solve many of the present problems of monument preservation. This, however, calls for a radical change of perspective on how we use cultural heritage—and poses questions that are crucial important for the future development of the field (State Council of the People's Republic of China 2016). How should we handle the relationship between heritage "protection" and "usage"? How to judge and screen "appropriate techniques"? What type of services does technology provide for heritage? How to provide service in general? How can we make this service innovative? The answers to these questions are rather complex but build on the same simple principle: we should go back to the original concept of monument preservation—to protect the traditional history and culture.

1.1 Definition of "Digital Heritage"

Digital Heritage is a new concept that originated in the digital age. It has three meanings: 1) unique resources and information with long-term value and significance produced by digital means (i.e. "digital born resources of lasting value"); 2) property rights of resources in the virtual space (i.e. "inherited virtual property"); 3) utilization of "cultural heritage" and "digitization" (i.e. "cultural heritage + digitization").

1.1.1 Valuable Digital Heritage: In 2003, UNESCO released the "Charter on the Preservation of Digital Heritage", which defines "digital heritage" as "made up of computer-based materials of enduring value that should be kept for future generations (UNESCO 2003). Digital heritage emanates from different communities, industries, sectors and regions. Not all digital materials are of enduring value, but those that are require active preservation approaches if continuity of digital heritage is to be maintained." Digital heritage is common heritage (used by the public) that is likely to become more important and more widespread over time. The original, although in digital format, must be protected and conserved.

1.1.2 Inheritable Virtual Property: In 2005, in the United States, a lawsuit about accessing the online account of a deceased person brought attention to the digital information that exists in the virtual networks/the internet. "Digital heritage" has then been referring to the web-based rights and assets that can be passed on to the next generation, including: account and passwords of QQ and Email, data stored on cloud drive, online personal photo album, virtual currency and equipment of online game users, etc. Western countries began to incorporate this idea into the concept of inheritance, and the major tech companies such as Facebook and Google has started to provide the related services. This particular interpretation of Digital Heritage is clearly different from the definition provided by the UNESCO. Nevertheless, results of the search engines reveal a much higher public interests towards Inheritable Virtual Property than the Valuable Digital Heritage.

---

* Corresponding author

1.1.3 Digitized Cultural Heritage: Since the 90s, digital technology has been widely used in the protection, research, communication and management of cultural heritage sites, and has achieved outstanding results. "Digital Heritage is a new concept originated in the Digital Age. Today, this terminology carries three different connotations: 1) Unique resources and information with long-term value and significance produced by digital means (i.e. "Valuable digital resources") 2) Web-based rights and assets in the virtual space (i.e. "Inheritable virtual property"); 3) Integration of "cultural heritage" and "digitization" (i.e. "Digitized cultural heritage". The term "Heritage Digitization" was often used, as the early application of digital technology in the field of cultural heritage has been focusing on documentation, data analysis, rehabilitation and revitalization through digital means, permanent storage of heritage information, and web-based public dissemination (Wu 2006).

In 2012, the 2nd Symposium on Cultural Heritage Conservation and Digitization held in Beijing (CHCD2012) was entitled "e-sharing culture heritage". The term "digital heritage" was used for the first time referring to digitization in the field of cultural heritage. The virtual reconstruction of the Old Summer Palace and the mobile-based applications of the "Digital Yuanmingyuan" project attracted the attention of scholars from home and abroad. The 2013 and 2015 Digital Heritage International Congress held by UNESCO identified five major types of digital heritage (archaeological / architectural heritage, intangible cultural heritage like traditional folk culture, moveable cultural relics and museums, ancient books and archives, internet and new media with digital artistic and creative content) and six working areas (digital recording and acquisition, display and visualization, digital content management and analysis, digital heritage related policies and standards, preservation of digital heritage resources, solution and application) (International Congress on Digital Heritage. 2013). The discussions covered a wide spectrum of topics, including theoretical research, technological innovation, practical case studies and equipment development. The 2015 conference consisted of a series of related events, including seminars, an exhibition and competition, and the 270 submitted works from various disciplines (information science, archaeology, art and interdisciplinary fields) showed that the word "digital heritage" has now been used in a generic way to cover all aspects of "cultural heritage", going beyond the original meaning of "digitization". This paper will be discussing the emerging field of "digital heritage" following this wide definition.

1.2 Industry Development Status Analysis

The application of digital technologies in the field of cultural heritage started early in the West. Both application object and methodology had undergone a process of development and reached the advanced state nowadays. Such advancement is depended on both the evolution of computer-related technologies and the expanding vision of heritage conservation. Nowadays, a comparable development in the field of heritage digitization can be observed in China, with many aspects now at the same level as the West.

Following the advancement of photogrammetry and computer visualization technologies, digitization of cultural heritage went from 2D to 3D, and now even 4D. The division between those realities are not definite, with many aspects been overlapped and interrelated. From the point of view of IT development, the forms of application and dissemination of the digitized cultural heritage had had three different stages, namely, local storage, network sharing and mobile interaction.
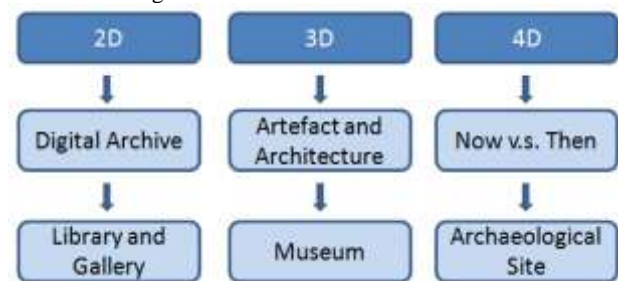

Figure 1. Evolution of heritage digitization corresponded to the development of the computer visualization technology
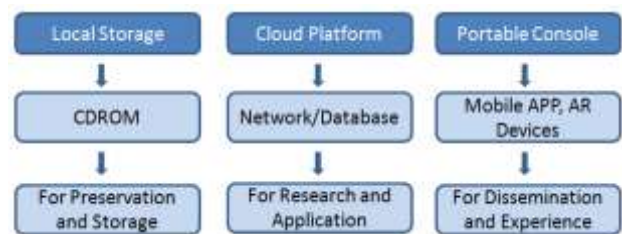

Figure 2. Evolution of heritage digitization corresponded to the development of internet technology

At present, digital cultural heritage work is divided into three parts but still belongs to what we may call "mechanical" digitization: digital documentation, research management, and display/visualization and interpretation. Digital recording technologies include remote sensing aerial radar, photogrammetry / image modelling, 3D laser scanning, infrared / multispectral image exploration, underwater measurement and detection — with experts trained in the fields of surveying and mapping. Digital management technology research covers the fields of disaster prevention and monitoring, monitoring and protection, computer simulation, analysis database / information management platforms such as BIM—with experts trained in the fields of computer graphics. Digital display/visualization and interpretation includes technology website creation / interactive network, 3D modelling & processing & animation, light / projection / holographic imaging, virtual reality / augmented reality—with experts trained in the field of multimedia.

Often, the scholars and professionals engaged in cultural heritage and the digital technology companies are employed on a project basis and rely on project-based funding. This has made it difficult to form a theory, but in very broad terms, digitization of cultural heritage faces the following problems:

1.2.1 Unclear Objectives: At present, heritage site and museum managers in China are concerned with the role of digital technologies in solving problems that exist in the field of monument protection in general. But what problems can digitalization solve? What kind of help can digitization provide for the work of local cultural heritage workers? There is a lack of information and awareness, followed by a lack of understanding and expertise. Heritage site and museum managers in China simply follow the trend and mechanically use digital technologies without exploiting its potential—that means they rely on new technologies and methods, hoping to continuously upgrade their digital equipment, but they do not understand how these technologies could serve to improve the protection and interpretation of the cultural heritage. This leads to a waste of manpower, material, and financial resources, and deviates from the essential purpose of implementing new technology in the field of heritage conservation.

1.2.2 Self-absorbed Ostentatiousness: A Chinese saying goes: "Seeing things but not people" (*jian wu bujian ren*), and in the figurative sense, "ignoring the human factor and seeing only the material factor". (Here, "things" refers to the physical substance of cultural heritage and material entity in modern engineering, and "people" to ancient and modern people.)
Cultural heritage is the material witness of a certain culture and society in history, and it should be perceived through material remains. But because of many reasons, all too often, objects are taken out of context and displayed only as isolated pieces, without respect for the continuity and timelessness of information. These objects without sufficient provenance are difficult to understand for the uneducated public/non-expert audience. The design policy of digital products is short sighted, and such products cannot meet the actual demand of the user, providing no tools for "learning" or "user-friendly" experiences. At the same time, the current system of funding in China is often limited to tangible objects and leaves no room for the creation, protection and visualization of the intangible works. Better allocation of resources, supporting policies, and an ease of social pressure to make economic profit are necessary to make the positive change.

1.2.3 Devoid of Content and Insufficient Business Cooperation: Although many Chinese heritage sites and museums set up digital exhibitions, their display of objects often lacks logic, and neither matches nor fits the content—not least because first, a touch screen was designed and installed and only then the content of the screen was decided. Additionally, someone else's original design ideas are borrowed, or the design is simply copied from another's work. This leads to a lack of content depth and the user's inability to understand the site or the object.
Today, facing the increased needs from the public on topics related to history and culture, There has bene a substantial growth in the implementation of digital technologies in the field of cultural heritage, for example, in form of historical themed animation movies shown on site, or in form of "innovative cultural products" in digital format. Unfortunately, most of them lack creativity and originality and fail to create intellectual property i.e. a distinguishing characteristic feature firmly associated with the object or site (trademark), resulting in homogenous/look-alike products superficial in content terms.
It is important to remember that the protection of the digital content should not interfere with or even replace the protection of the physical monument and site, but should promote a new way for public dissemination, as well as for the effective and adequate commercialization of cultural resources.

1.2.4 Lack of Common Consciousness and exceptional design in the Industry: Digital heritage is the result of various technologies and disciplines, and demonstrates a great adaptability to the changing needs (different situations and types). The industry should utilize this potential and carry out extensive investigation and diversified application, but because of the rapid industrial development, in reality the situation is often very different. Many institutions and companies compiled "technical specifications" and "operation procedures" to facilitate standardization and systematization of cultural heritage protection. The authors reviewed several of these manuals that were written from the perspective of technology but not culture. The industry still lacks a common consciousness for the whole: technology is not a goal on its own, but a simple tool for creativity and the protection, documentation, visualization, and interpretation of cultural heritage. What we need now is first a specification of the problems, then top-level product design, next the formulation of working standards, and finally, in accordance with these standards, norms and regulations, the execution of practical solutions.

2. CASE STUDIES

2.1 Palazzo Valentini

The archaeological remains of ancient Roman houses uncovered beneath the Palazzo Valentini (b. 1585) in downtown Rome are now on a permanent display, and this is a very good example of heritage display and interpretation (Palazzo Valentini 2017). The project (of about 3 million Euro) started in 2007. The first phase was completed in 2012 and the second phase, in 2014. Additionally, a Roman bath was discovered and excavated there; this part is relatively small but rich in content. Based on the in-depth research of the site as a whole, the museum revived the history of the site by using digital projection technology. The 90-minute tour provides a detailed explanation of the significance of the site and its features: the visitor can enjoy the laser light show while listening to the audio guide that is equipped with a central controller. This creates a strong contrast to the incomplete status of the empty and lifeless site that gives the visitor an unforgettable emotional experience.

The project has gained high recognition among both professionals and laymen since its opening three years ago. It is, for example, included in many three-day tours of Rome, and ranked sixteenth in the evaluation of a tourism website (that lists a total of 1044 Roman attractions) (Trip Advisor 2017). Tourists often book several months in advance. The Palazzo Valentini is open 6 days a week and offers eleven tours, each limited to 15 people (12 Euro/Person). Due to the relatively wet ground, the laser projector bulbs need to be replaced every 2-3 months; annual operation and maintenance costs about 600.000 Euro; annual ticket revenue is about 620.000 Euros, with basically covers the maintenance costs.

2.2 Digital Yuanmingyuan

"Digital Yuanmingyuan" is the world's first mega IP (Intellectual Property, such as Disney) based on cultural heritage research. It underwent the whole chain innovation of "scientific research—product creation—reaching out to industry", establish a platform where culture meets technology,

experts meets the public, and business meets the industry. Characterized in innovation, systematic framework and sophisticated research, Digital Yuanmingyuan has attracted attentions and praises from both home and abroad.

In the past ten years, the team of "Digital Yuanmingyuan" completed 67 of the 110 scenic areas in the Old Summer Palace (60% area restoration) and analysed possible changes over a period of 300 years (195 chrono-spatial units). This includes the areas depicted on the *Forty Views* of the Chinese Garden and the twenty copperplate engravings of the Western Buildings (Xiyanglou). Several databases were built, including the YMY Chinese architecture standard component library, the plant material library, the indoor material library, and the Western Building component library. More than 30 tourism-oriented digital products were developed, including a mobile navigation system in the form of VR (Virtual Reality) glasses that provide a 360-degree immersive experience, a virtual roaming system for the internet, ARG (Augmented Reality Game) as part of the middle-school curriculum, holographic models, AR (Augmented Reality) postcards, 3D digital reconstruction movies and animation films. Additionally, exhibitions were held at the archaeological site of the Old Summer Palace and at many other sites at home and abroad, all of which received good feedback. Through intellectual property investment, the company "Beijing Re-Yuanmingyuan Co., Ltd." was established in 2014.

2.2.1 Work Organization

A. Multi-professional, Inter-disciplinary Team: The completion of a large-scale scientific research projects requires a firm and rigorous approach, patience, and a good long-term work plan. The team of Digital YMY team consists of representatives from all of the fields engaged in digital cultural heritage, ranging from professionals engaged in humanities (archaeology, architecture, art, history) to engineering and technology (3D modelling, VR/AR technologies, visual arts, database construction, network engineering); different stages however might need different experts. Our decade-long work formed a group of young scholars dedicated to the theoretical study and practical preservation of cultural heritage that goes beyond the borders of the traditional.
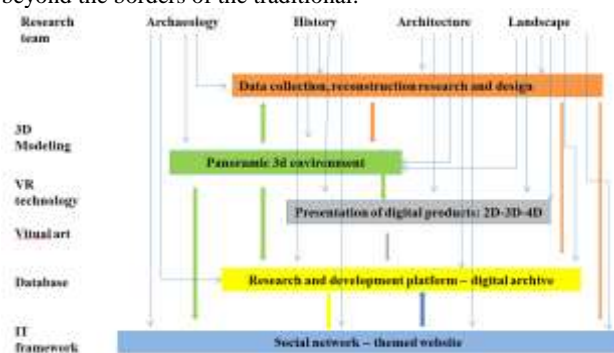

Figure 3. A multidisciplinary team

B. Organized Workflow: The digital reconstruction of the Old Summer Palace is divided into 4 stages (subdivided into 12 steps): information collection— historical research and restoration design—3D scenic area construction— publication/release and maintenance/update (dissemination & maintenance)
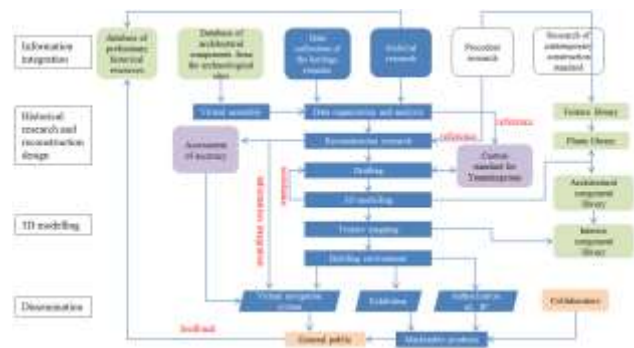

Figure 4. Digital Workflow Data collection

2.2.2 Research-based Digital Content

A. Composition of Historical Space-time: During the process of digital reconstruction, we established a four-dimensional model (view of history) that integrates both the space and the time. The evolution process of each scenic area is captured through chrono-spatial units; each unit revives the condition of the site at a particular point of time and together they show the overall evolution of the site. "Space", i.e. the "Three gardens of Yuanmingyuan", is divided into 110 scenic area units, and "time", i.e. from the early 18th century to present, into 13 time units. Today, the digital reconstruction for 6 of these chronological periods is completed, including early- Qianlong (1736-1755), mid- Qianlong (1756-1775), and late-Qianlong (1776-1795) periods, Jiaqing period (1796-1820), early Daoguang period (1820-1830), Daoguang and Xianfeng period (1820-1861) and the period of the garden as an archaeological park (second half of the 20th century) (Yan 2010).

B. Heritage Site Information Record: The digital reconstruction is based on research and the collection of relevant material about the Old Summer Palace. This contains two aspects: first, through the study of historical documents, archives, relics, and excavation reports, identify, record, and store information; second, through the site survey and mapping, obtain and document information. Due to the different professional background of the team members, every object provides a wealth of different information, and thus, requires the team members to carry out comprehensive mapping and documentation on site. This can supplement the archaeological report and moreover, provides first clues for archaeological interpretation. For example, in 2014, we used ground-penetrating radar at Haiyantang, one of the Western buildings, to determine the positions of the water pipes under the ground.

C. Computer-generated Component and Spatial Simulation Models: Sometimes digital and virtual restoration must start from scratch (off-site office work). For example, we used point cloud data obtained through 3D laser scanning of the physical remains to generate individual component models. Then, we placed them, as close as possible, at their original position in three-dimensional space and assembled them virtually, taking into account the characteristics of data processing and relevant historical information. Next, we set up a collection of three-dimensional components and, after adding textual and visual information, established a component library that allows performing and displaying query results.

Some parts of a building might lack information, and this is when the digital modelling comes in handy. It allows maximum trial and error, which leads to relatively complete and reliable

results. For example, the copperplate engraving of Haiyantang suggested that the second floor of the core building consisted of five sections, but an old photograph depicted only four segments. We used the actual dimensions of the existing column base to create two digital column models, one with four segments and another one with five segments. A comparison of the 3D models with the photograph (same angle) revealed that the column should only have four segments.

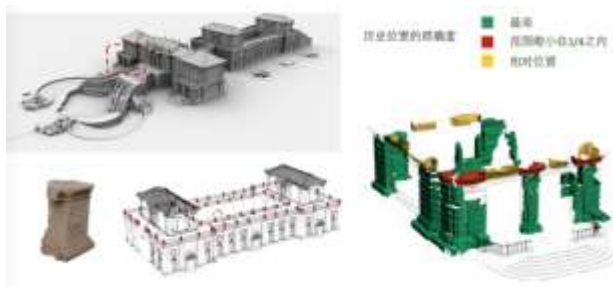Figure 5. Western Building component library

Figure 6. Virtual assembly of Haiyantang

Figure 7. Comparison of the digital model and the historical photograph from the same perspective

D. Re-discovery of Colours: The Western-style ruins of the Old Summer Palace were rich in colour, ranging from white to yellow and blue. Built of stone, these buildings were not painted but, according to Chinese tradition, decorated with colourful glazed ceramic tiles of fanciful (Baroque and Rococo) shapes. Up to present, we identified 90 component types and confirmed the location of 18 components. But the colours of these glazed tiles did not match with the colour scheme from the old photographs. By using RGB colour channels to experiment with the colours, we discovered that the "dark" coloured components in the old pictures were in fact yellow, and the "light" coloured component were blue. A photography expert explained that the blue RGB colour filter that produced such results was not used at that time. Thus, the colour divergence probably stemmed from the colour-rendering agent of the

photographer. Such virtual test helped us to restore the colours of the glazed building components of the Western Buildings correctly.

Figure 8. Terra cotta fragments from the Western Complex stored at the warehouse

Figure 9. Decorative components from the balusterade at the third level of the main building of Xieqqu,

Figure 10. Experiment of the RGB Channel

E. Qing-dynasty Architectural History: The architecture of the Old Summer Palace is unique and creative in terms of overall layout, proportional design of buildings, construction technology, and decoration. *Yuanmingyuan neigong zeli* records many methods that differ from the conventional building style of the Qing dynasty. The early, middle and late Qing dynasty possesses its own distinctive characteristics. It is thus possible to identify the design rules of each period through comparison with the Yangshi Lei Archives, *Yuanmingyuan neigong zeli*, *Forty Views*, and old photographs in combination with the measurements of the archaeological remains and art objects on site, and to establish and operate computerized material libraries.
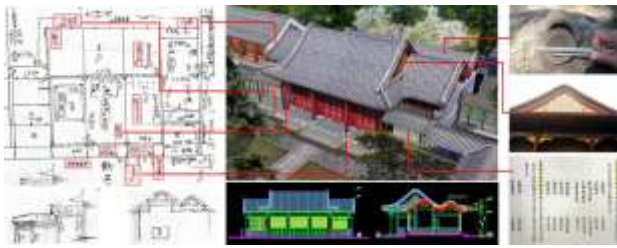
Figure 11 Digital reconstruction of traditional buildings by referring to Yangshi Lei Archives and *Yuanmingyuan neigong zeli*

F. Precision and Accuracy Assessment: Digital reconstruction is based on actual field measurements and must meet digital construction standards. This rule applies not only to the digital models of the current state of the site but also to the restoration design of hidden or lost parts of a building. The spatial quality that becomes evident in the 3D models then, in turn, enriches and supplements the digital reconstruction. For example artificial rockery uses three-dimensional stones to simulate the actual stacking process of the stones—for example, the garden behind the Wenyuange consist of more than 1500 individually designed rocks—and this achieves a reality-like landscape effect.

Figure 12   More than 1500 3D rocks to simulate the piling up of the rockwork

Digital reconstruction models depend on the degree of detail and the thoroughness and accuracy of the material, and are judged against the standards set by our team. The standards for digital reconstruction are objective and transparent; they address the accuracy of the virtual model and build on rigorous academic principles. This includes detailed documentation in order to guarantee the performance and allow for modifications at a later point in time.

2.2.3   New Digital-born Products: We have developed the full potential of digital heritage to combine the various fields, branches and sectors interested, and, in accordance with the digital content, synthesized the three concepts of "basic information management—digital scenery construction—dissemination of cultural information". As a result and with the help of VR, AR, navigation services, mobile internet, and networking and cloud technologies, we have created 30 new cultural heritage experience modes (available on-site + online + offline) that allow a more comprehensive and a more intuitive way of heritage interpretation.

A. Mobile Navigation on Site: The core of the mobile tourist guide to the Old Summer Palace is as follows: Placing the degrade ruins (current state) and the revived splendor (original state at a particular period in time) with their extremely dissimilar means of expression side by side creates a string contrast and provides a direct emotional site experience. In 2012, the iPad app "Re-YMY" (Chinese version) was launched and this application reached the first place of the bestseller in the Apple Store. In 2015, the mobile tourist guide, "Digital YMY" v1.0, for smart phones was launched and is now available at the site. In 2016, the "Digital YMY" v2.0 and "Virtual reality glasses" completed the beta period and were launched to the public.

C. International Presence of China: As a showcase for systematic research, restoration design and digital exhibition of Chinese cultural heritage, the Digital Yuanmingyuan project approaches the (educated) public at home and abroad. We organized or participated in international activities in more than ten countries including the United States, England, France, Germany, Italy, Russia, Greece, and Spain.

D. Worldwide Webservice and Social Media: In addition to the webpage "Digital YMY" Web2.0 (visited by more than 500.000 users), we established, maintain and operate an account in China's most popular computerized social network (WeChat), an online shop, a digital reconstruction movie, and the English version of the "Re-YMY" app. Our digital heritage products are used as part of the course material at leading higher learning institutions at home and abroad including the University of Washington, University of California, and University of Pennsylvania.

2.2.4   Intellectual Property Rights as Basis for Business Development: Since the launch of the "Digital YMY" project, the total investment in R & D reached 60 million RMB. The "Digital YMY" company was responsible for 85% of the investment. In 2014, Tsinghua University (as part of its policy to invest in intellectual property rights) and Haidian District (Administration) jointly set up the "Digital Yuanming Technology & Culture Co. Ltd." The company holds restoration IP and the revenue value reached 40 million RMB, which is why it was named among the top ten Chinese copyright holders. At present, it is aim to further enlarge the cooperation platform using IP authorization derived from digital movies, animation games, books, travel souvenirs and a series of follow-up industry, promote the development of cultural exchange and dissemination of knowledge and cultural tourism, research, protection and development of nurturing cultural heritage.

3.   SYSTEM FRAMEWORK OF "DIGITAL HERITAGE"

3.1   Content of "Digital Heritage"

Digital heritage combines cultural heritage with the natural environment and the human activities in this environment. It includes archaeological sites, architectural monuments, intangible heritage like folk traditions, cultural relics, ancient books and museums, and creative art products with digital content. It reflects the local rural settlement as well as the urban fabric, and can be applied to building clusters (palaces, temples, residential houses) and gardens as well as to a single building or building component. It covers different time periods from pre-history to present days and even the future.
The significance of digital heritage lies not in the use of digital technologies. Rather, it plays a decisive role in the development of our digital society through openness, flexibility and the ability to continuously exchange information (sharing ideas via internet platforms and social media). Therefore, the creation and

spread of digital heritage is different from traditional (mechanical) methods of monument conservation.

This study builds on the assessment of cultural heritage values—through interdisciplinary discussion of history, archaeology, cultural relics and museology, architecture, urban planning and other related fields, identifying and recognizing core heritage values for research, protection, display and interpretation—to expand our knowledge, using heritage records, restoration research, digital modelling technology, and transform the research results from archaeology and related sciences into digital format. Based on the analysis of consumer/user feedback, continue to promote technological innovation, rapid integration of existing resources, synthesizing all kinds of results, and create user-friendly interfaces, innovative forms, creative cultural products that provide rich experience, state-of-the-art cultural heritage exhibitions and information transfer modes, exploiting the educational function of cultural heritage to create a new more shared heritage culture.

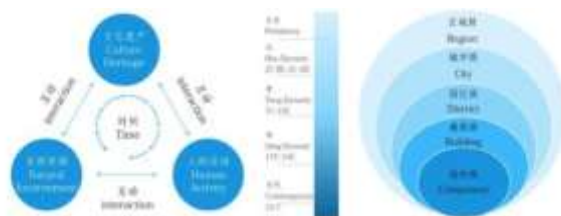Figure 14 Future developing trend of the Digital Heritage

Figure 13 Research subject of the Digital Heritage

"Digital heritage" should go beyond the traditional concept of "digitized" cultural heritage. A more adequate definition will beusing modern technologies to build an open platform for dialogue, exchange, and cooperation between the fields of archaeology, history, art, data information programming and engineering (rather than having content and form scattered across several fields), producing rich-cultural, high-tech products that aim at a high emotional quality of experience and high value-added services for users/consumers, bringing historical heritage back into modern daily life and continuing the legacy of cultural heritage.

"Digital Heritage" should have the characteristics of both "heritage digitization" and "digital data". Heritage digitization has great value and significance for contemporary people and future generations in terms of long-term protection and conservation, relies on new especially digital-born resources that are produced, disseminated, applied, and preserved as important information data and innovative forms of representation. This can provide more opportunities for cultural heritage research, communication, education and training and sharing.

It is needless to say, not all results of digitization possess heritage value. Simple replication—insufficiently researched data that is perhaps only scanned into the computer and put together digitally—is not authentic in terms of cultural heritage values for the public, even if it uses the same technologies and capable of producing dazzling expressions.

3.2 Work Ethics of "Digital Heritage"

3.2.1 Authenticity and Academic Standards: Digital heritage should adhere to rigorous academic standards and be as close as possible to the measured data and the most accurate academic research. Digital models should follow the original construction methods and principles to reflect the accurate size and other attributes of the original model. They should not just emphasize the visual effect and pursue an appealing appearance to lock the awe-struck consumer/user into a reverie. Only in this way, can historical authenticity be achieved. Authenticity is determining the quality and content level of digital heritage and digital heritage products.

3.2.2 Strong Heritage Identity for an Emotional Site Experience: Digital heritage should follow the principles of heritage identity and information dissemination but without appearing as too academic, too artificial, monotonous and no fun. Because most monuments are non-moveable property, key for both protection and visualization is the site itself that should provide an immersive experience and make visitors feel a direct connection with the heritage site. This stimulates feelings especially in case of "revived" ruins or historical events of a bygone era that come to life again, like in the Chinese opera that emphasizes meaning visually ("great pity", "great happiness"). Therefore, in accordance with the original site, digital heritage should re-create a spatial model of the original topographic features that embodies the core of heritage values and the diversity and variety of socio-cultural history. The goal is to evoke feelings in the audiences through the most advanced scientific and technological means and to provide the public with products that show a high degree of cultural and artistic taste, technology, emotion, and value.

3.2.3   Choice of Appropriate Technology in accordance with Form and Content:

Digital Heritage is a complex construct that results from creative transformation. Taking a multi-disciplinary and multi-perspective approach, the form of digital heritage should follow its content, and the applied technologies should be carefully selected on the basis of their appropriateness (and not just to gather, for the benefit of the state-of-the-arts, all new technologies). The use of technology must be consistent with the accompanying research, heritage protection principles, and interpretation and management strategies; only in this way can we guarantee support and protection of cultural heritage in a direct, accurate, and quick way that allows sharing heritage experience and knowledge across borders. The applied technologies are subject to the design, the design is subject to experience, and experience is subject to content.

3.2.4   Sustainable Value-based Development:

The role of cultural heritage does not end at the protection of the physical remains of cultural heritage. Rather, regardless of their (degraded) condition, these monuments and sites are full of vigour and vitality that is of practical benefit to the modern customer/user/spectator. The past can serve the present if cultural heritage takes the path towards innovation and national and regional specialisation i.e. a new and distinct specification through innovative and creative transformation in the context of globalization. With the rapid advancement of digital communication and internet technologies, the display of and interaction with cultural heritage is becoming wireless through a cloud-based system—for example the iCloud storage and computing service that allows its users to store data on remote servers and share and send data to other users. Today, cutting-edge technologies such as 3D scanning, digital modelling, virtual reconstruction, holographic projection, augmented reality, mobile internet, and 3D printing create a user-friendly diverse cultural experience without affecting the physical site and structure of monuments. This, then, bridges the communication gap between the past and the present and between "things" and "people", solving the problem posed by the Chinese saying mentioned above.

3.3   Conclusions

3.3.1   Transformation of Scientific Research Achievements and Creation of Original Digital Content:

We must end the subordinate relationship between the cultural heritage and the digital technologies, and regard them as two organic units that are complementary and dependent upon one another. Such marriage is capable to create a series of national treasures that suits the atheistic taste of a new era. Then, cultural heritage can become the versatile, spreadable, for core values, characterized by flexibility, They are both contributing to the development of a new aesthetic quality of national culture, and since the meaning of cultural heritage is flexible and subject to change, they may contributing to the dissemination of Asian culture around the world.

3.3.2   Technology Integration through Local Projects:

Digital heritage provides variegated practical solutions, not least because the situation of cultural heritage differs widely according to its type and region. The specific needs and requirements for digital heritage must be tailored to each project according to the site-specific conditions. Then, an inter-disciplinary (and often inter-cultural) team should be formed to select and implement the most appropriate innovative technology.

3.3.3   Complexity and Cross-border Innovation:

Digital preservation and innovation of cultural heritage requires knowledge and skills. To ensuring its success, A structure should be set up to provide the framework for action and coordinates the work, This includes an expert system of talented persons who should 1) be familiar with the culture, be creative and experienced in innovative design and (digital) technology 2) understand the design concept, familiarize themselves with the cultural relics of the specific site, balance digital technology requirements with artistic thinking 3) come from different fields and be professional in their own fields. They need a forward-looking vision, a deep understanding of heritage conservation work, and a high level of design capability, because they should master human and content resources and manage new concepts, technologies and market opportunities (in the cultural sector).

3.3.4   Cross-cultural Exchange and Inter-disciplinary Communication Platform:

The ultimate goal of digital heritage is to provide a communication platform between the academia and the society, which also serves for resources integration, international exchange, and youth education. This will stimulates international corporations and allow experts in digital technology, archaeology, museology, history, architecture (and other related fields) to gather in one place and exchange ideas about scientific research and its digital interpretation, visualization and educational and effective uses. Together with leading institutions from home and aboard, we aim to integrate culture and technology, experts and the public, business and industry, and to enhance the development of a global digital heritage industry that is rooted in science.

ACKNOWLEDGEMENTS

REFERENCES

International Congress on Digital Heritage. 2013. Marseilles, France. http://www.digitalheritage2013.org/ (10 Jun. 2017)

Palazzo Valentini. 2017. Italian version. Rome, Italy. http://www.palazzovalentini.it (10 Jun. 2017)

State Council of the People's Republic of China, 2016. "Guidelines of the State Council on further strengthening cultural relic work". Number 17 (4 Mar. 2016). Beijing, China.

Trip Advisor. 2017. Chinese version. http://www.tripadvisor.cn/Attraction_Review-g187791-d2179620-ReviewsLe_Domus_Romane_di_Palazzo_Valentini-Rome_Lazio.html (10 Jun. 2017)

UNESCO, 2003. Charter on the Preservation of Digital Heritage. General Conference, 32nd Session. Chinese version.

Wu, J., Wang, Y. and Dai H., 2006. "Technical Construction of a Cultural Heritage Digital Application Platform". *Application Research of Computers* 8, pp. 41-44.

Yan, H. 2010. "Practice of Re-Yuanmingyuan." *Proceedings of the 1st International Symposium on Cultural Heritage Conservation and Digitization* (Beijing: Zhongxi shuju, 2010), pp. 16-31.