

# Application of 3D Digitization in Cultural Heritage Preservation

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**Abstract.** This paper discusses the importance of engaging 3D scanning technology to preserve China's cultural properties. The paper also aims to share the experience of Amber Digital Solutions Company (Amber in short) with using 3D data technology in cultural exchanges, restoration programs and interactive presentations during exhibitions. Several case studies are presented.

**Keywords:** Digital Museum, Digitization, 3D artefact, Cultural Preservation.

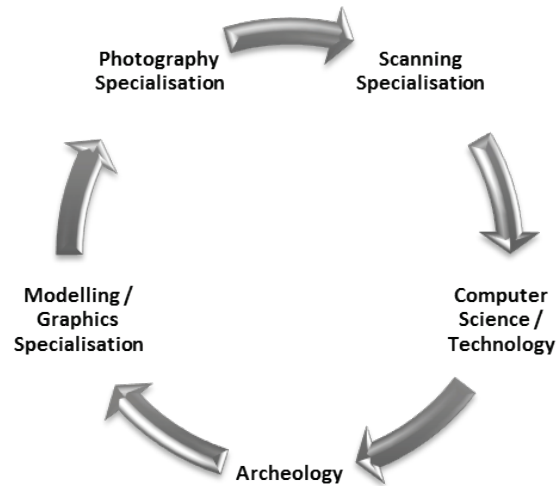
## 1 Introduction

As digital technology evolves, 3D digitization is fast becoming the norm for preserving cultural objects in China. This is because it provides easier access and significantly reduces the need for actual physical retrieval. Simply put, 3D digitization is the capturing of the volumetric digital representation of the heritage object. Such representations can be used for preservation, restoration, access and scholarly academic research purposes study. 3D digitization requires the engagement of several disciplines ranging from 3D scanning, photography, 3D modelling, computer technologies and even knowledge in cultural studies.

3D digitization offers several advantages.

1. Provides permanent record of complete valuable 3D data including dimensions, texture, condition for archival and management
2. Facilitates sharing of resources among museums. Each museum can focus on their area of expertise t hence over lapping of research areas can be minimized.
3. Provides portable platforms for dialogue opportunities both domestically and overseas
4. Permanent record of valuable 3D data for unexpected disaster recovery
5. Provides accurate data for research studies – Most convenient & effective way to learn about prehistoric societies and humanities is to use computer archaeology. This process is known as post-excavation analysis and is usually the most time-consuming and space consuming of the archaeological investigation.
6. The old school thinking of museum being merely a storage place for objects are slowly replaced by the new concept of a recreational and knowledge based Centre -

Versatile data applications to multimedia productions, education programs, packaging, research and cultural missions.



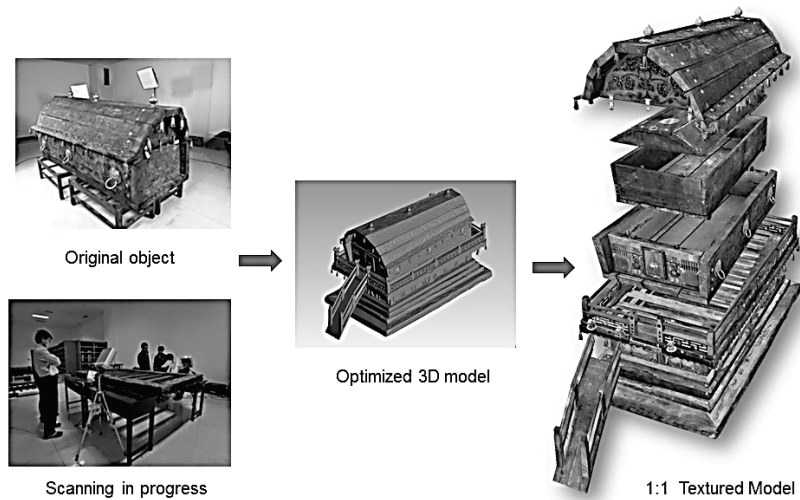
### 1.1 Objectives of the paper

This paper discusses the importance of engaging 3D scanning technology to preserve China’s cultural properties. This paper also aims to share the experiences of Amber Digital Solutions Company (Amber in short) on utilizing 3D data technology in cultural exchanges, restoration programs and interactive presentations during exhibitions.

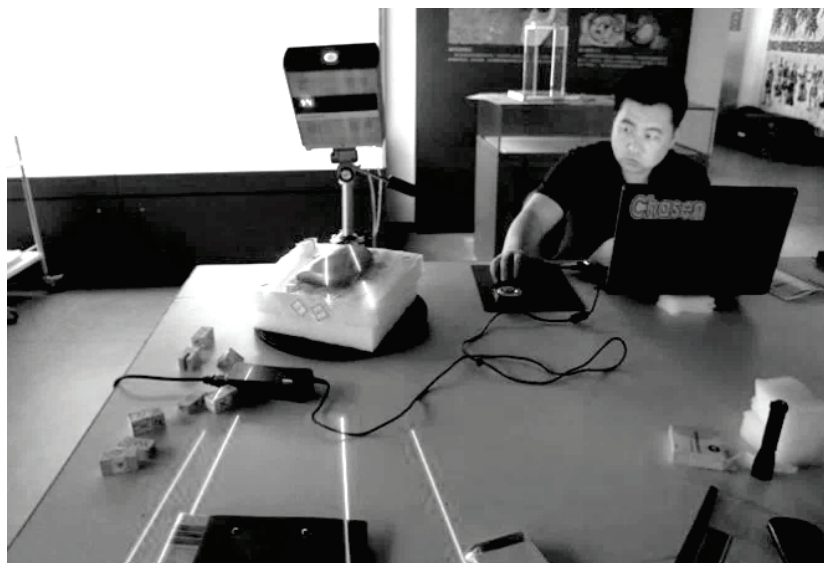
## 2 The 3D data acquisition process

### 2.1 3D Scanning

Acquisition of 3D data through 3D scanning – It involves the acquisition of 3D data through the engagement of several types of scanning equipment. The process will be repeated from several perspectives till the entirety of the object is accurately captured. The dataset encompasses highly dense point clouds which form the basis for 3D artefact modelling.



**Fig. 1.** 3D Digitization at a glance



**Fig. 2.** 3D scanning in action

## 2.2 High resolution photography

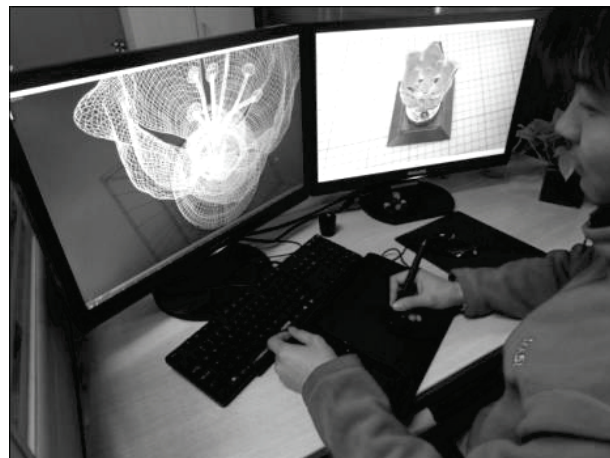
Hi Resolution Photography – The process involves the acquisition of texture and color information. Hi-resolution photographs are taken of each relic under the strictest lighting conditions for purpose of texture mapping.



**Fig. 3.** High resolution photography in action

### **2.3 3D modelling and data optimization**

3D data in the form of point clouds are converted to polygons. Data optimization is also performed so that the final model can be run on normal computers. The final model is finally textured using high resolution photographs.



**Fig. 4.** 3D modelling and data optimization

## **3 Applications of 3D Digitization Data**

3D data are very versatile. They can be used in many downstream applications as stated below:

### 3.1 Digital Exhibitions

Digital Exhibitions – Museums must derive creative solutions in order to attract and serve non-traditional museum goers particularly in how they communicate and partner with the community. 3D data provides the best means to display fragile relics in exhibitions. In addition, 3D data increases the range of possibilities for the museums in enhancing access to the mass audiences.



Fig. 5. A digital exhibition of cultural artefacts

### 3.2 Cultural Exchanges

3D data provides a portable platform for dialogue between museums both domestically and globally. As digital models can be viewed on the screens, the actual exhibits need not be physically retrieved for review anymore. The ease of sharing will encourage more exchange programs.

### 3.3 Academic Research

3D digitization captures the accurate geometry of the relic and converts it into a digital format which can be sectioned, measured, and manipulated spatially. By reducing the need to study cultural objects physically, the risk of damage to the object of study is significantly minimized.

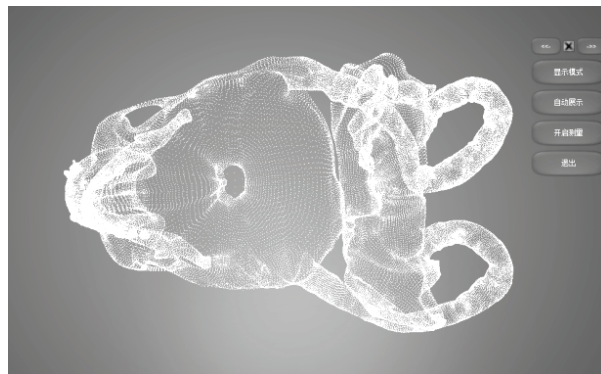
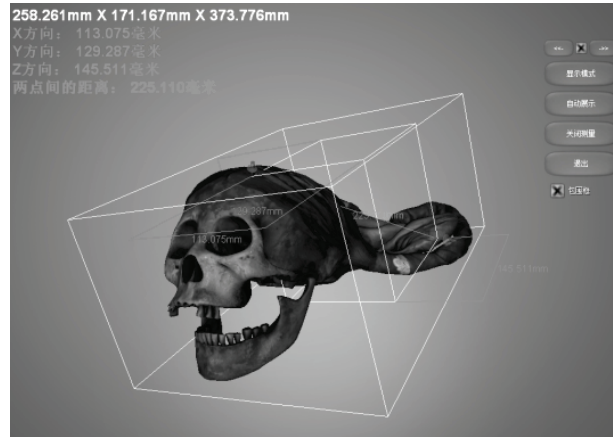
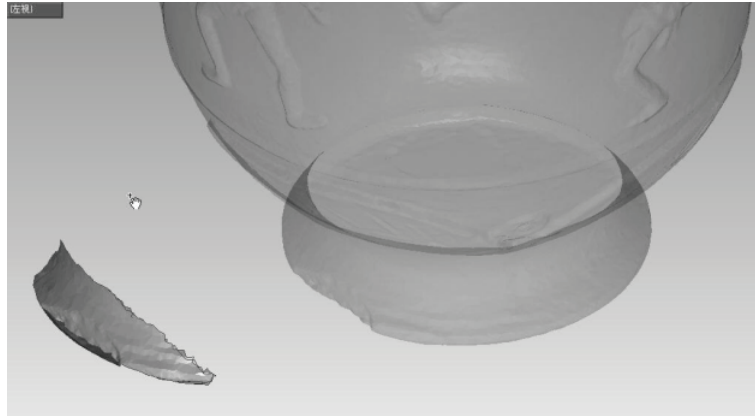


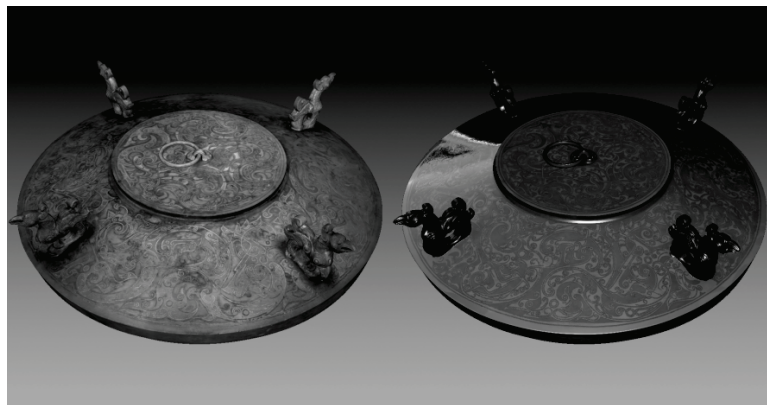
Fig. 6. Screenshot of an analysis platform

### 3.4 Restoration

3D data provides valuable 3D information for disaster recovery and restoration. 3D data can be used to reconstruct missing parts of exact match wholly or partially. They can also be used to restore a part to its original status digitally.



**Fig. 7.** Reconstruction of a missing part using 3D data



**Fig. 8.** Texture restoration of artefact using 3D data

### 3.5 Non-Contact Packaging

Following a 3 dimensional scan of the relic, the accurate 3D profile can be used to design fully customized and reusable packaging. The perfect fit of the CNC-cut packaging provides an effective shock dampening capability.

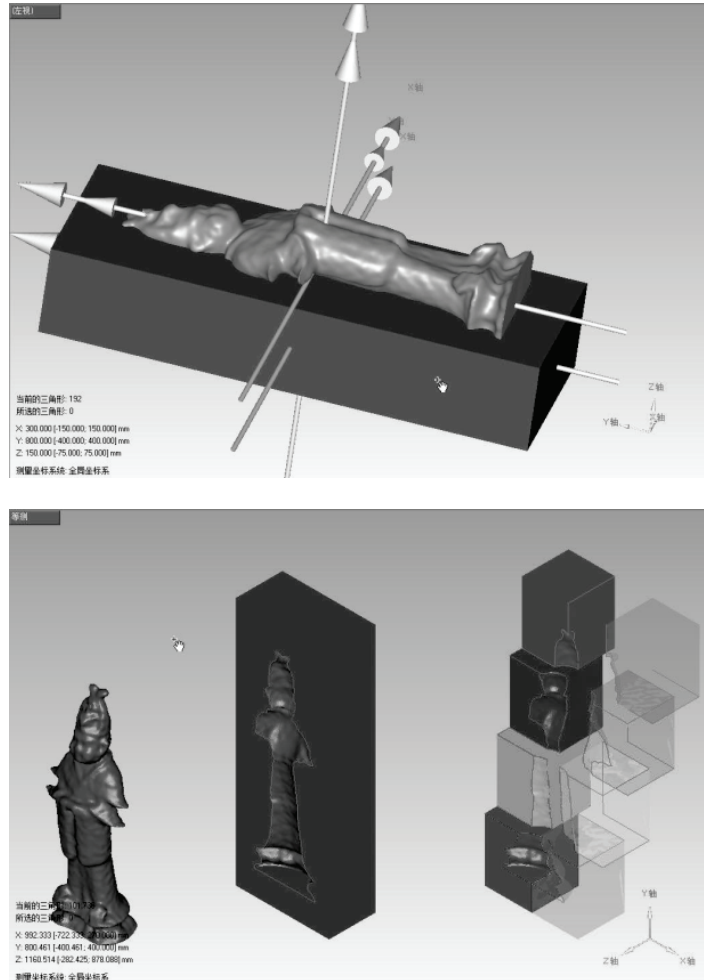


Fig. 9. Non-contact packaging design using 3D data

## 4 Case Studies

### 4.1 Digital Exhibitions

Culture and heritage plays a significant role in engagement with local communities and in international relations. Understanding the culture and heritage and jointly preserving them helps build enduring relationships which are founded on sustainability, mutual respect, tolerance and long term commitment.

In October 2014, an exhibition of Chinese Han relics, 'The Splendor of the Han Dynasty, the Rise of the Celestial Empire', opened at the Guimet Museum in Paris to mark the 50th anniversary of Sino-French diplomatic ties. The exhibition is co-hosted



by China's State Administration of Cultural Heritage and France's Musee National des Arts Asiatiques Guimet. In conjunction, Amber's 3D interactive system of cultural relics was also revealed during the opening ceremony of the exhibition.



**Fig. 10.** The opening ceremony presenting the Amber3D Interactive System was attended by Chinese Deputy Minister of Culture, Li Xiaojie, French Foreign Minister Laurent Fabius and French Culture Minister Fleur Pellerin, as well as other officials and celebrities from both countries.

Another example of a 3D digital exhibition in showcasing true 3D digital representations of the most valuable Khitan's relics excavated in Inner Mongolia was held in Singapore in October 2012. The exhibition lasted for 10 days over at 2 locations – Jurong Regional Library of Singapore and the National University of Singapore. Visitorship hit 15 thousand. Among the treasures of silverware, jade ware, opals, amber, crystal, chinaware, perhaps the most significant discovery in recent 20 years was the Tomb of the Liao Dynasty. Behind the Tomb hid a rich history and culture of the Khitan's ethnic group. It was hoped that by unveiling the Liao Tomb and its treasures, the public would then be introduced to a lost but yet one of the most important dynasties of the China history.



**Fig. 11.** An engineer of Amber company guiding the public on the use of the touchscreen during a digital exhibition at the Jurong Library, Singapore



**Fig. 12.** An exhibition in Singapore attempted to explore the history and culture of Liao dynasty, one of the most exciting dynasties of Inner Mongolia of the Autonomous Region of People's Republic of China

#### **4.2 Cultural Exchanges**

Besides reinforcing social cohesion among the diverse communities, the promotion of heritage has also become one of the main drivers for China's economic development. The conservation and preservation of heritage has boosted the economic progress of several related sectors such as preservation, urban redevelopment, creative industry, digital media and cultural tourism. Indeed, the promotion of heritage in diversity has helped build a more cohesive peaceful and productive China.

In 2014, as part of the national policy to exert China's cultural influence and her soft power globally, 36 national cultural treasures from 10 Chinese museums were digitized and showcased for the first time to the world audience in the form of high resolution 3D models. Due to the high cultural value and fragility of the cultural relics, 3D models were unarguably the best mode of presentation.



**Fig. 13.** Liu Yandong, member of the Political Bureau of the CPC Central Committee, vice premier, and member of the Leading Party Members' Group of the State Council reviewing the Amber's 3D Interactive System at the China Cultural Centre at Paris



**Fig. 14.** Inauguration ceremony of the China Cultural Centre by Mr Liu Yunshan, member of the Standing Committee of the Political Bureau of the CPC Central Committee and member of its Secretaria



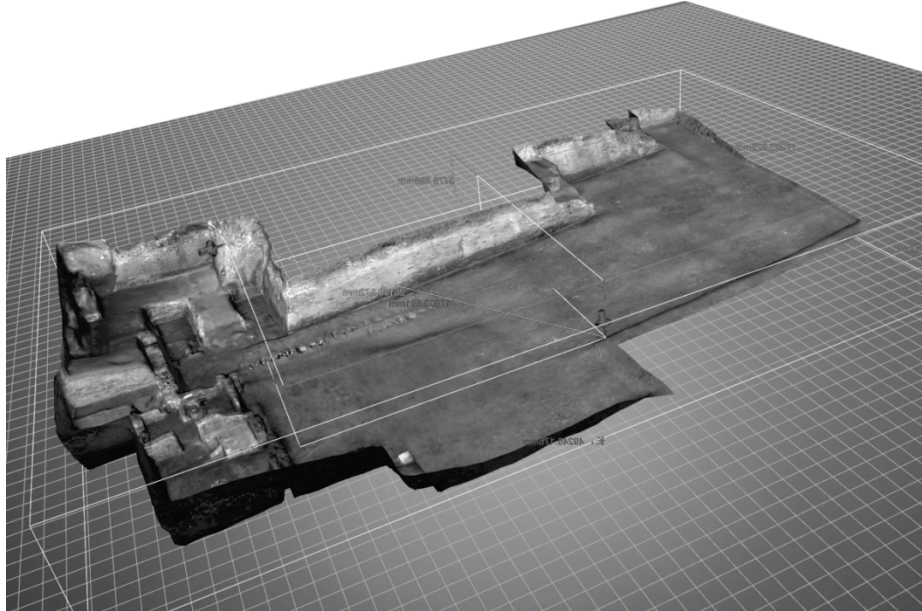
**Fig. 15.** In conjunction with the opening of the China Cultural Centre in Laos, Amber's 3D Interactive System was revealed as part of the main attraction at the centre. The opening ceremony was officiated by Head of the Publicity Department of the Communist Party of China (CPC) Central Committee Liu Qibao, Deputy Prime Minister of Laos and other officials from both countries.

### **4.3 Preservation and Conservation**

#### **4.3.1 3D Digitization of Xanadu heritage site.**

The site of Xanadu houses the remains of Kublai Khan and his legendary summer capital of the Yuan Dynasty. The capital is square in layout measuring 2.2km on each side. It comprises an "Outer City", and an "Inner City". Located in the autonomous region of Inner Mongolia and on the route between the former Mongolian capital Karakorum and the Han center Dadu (Beijing), the city exhibits a unique mix of both the Mongolian and Han Chinese cultures.





**Fig. 16.** A 3D view of the one palace of the Xanadu site

3D scanning commenced in the chilly winter month of Oct 2011. Long range scanners were used to acquire spatial data while portable scanners were employed to capture detailed 3D data concurrently. The ultra bright daylight hindered the scanning operation. The task of Scanning was performed in the dark between the last and the first light of the day. Equipment had to be kept warm against the cold to optimize working condition. Due to the size of the site th thus limiting the scanning range of the scanners, the team improvised a reference marker system specially for this project.

A fully textured high resolution 3D model of the entire site was delivered on a viewing platform with full measuring capabilities.

#### **4.3.2 Tianjin Museum.**

Measuring at only 16.3cm tall, the neck of the vase is beautifully decorated with blue palm-leaf patterns while the broader adomen was adorned with beautiful brush-works of peonies and pheasants. The bright colors and intricate designs suggested that this was a highly allenging task during the period under the reign of Emperor Qianlong.



**Fig. 17.** A 3D model of the “Yu Hu Chun” Vase



**Fig. 18.** Expanded view of the painting on the vase

Digitization of another 14 cultural objects (mostly porcelain) was conducted between Mar to Apr 2012. The high reflective index of the porcelain objects impeded both our scanning and photography operations. Presenting and preserving the porcelain nature of the 3D models posed yet another challenge to our team.

#### **4.4 Non-contact packaging**



**Fig. 19.** The pictures above illustrated our packaging project for the World Buddhist Forum held at Wuxi, China



**Fig. 20.** The pictures above illustrated our packaging project for the Capital Museum, Beijing, China, 2009

## **5 Conclusion**

3D Digitization will be a highly sought-after trend for future cultural heritage preservation program. It made possible the wide reach to masses of audience due to its ease of information retrieval, mobility, maximum capacity (data storage instead of physical objects) and security (original artefacts untouched). It serves as a bridge between history and future, younger generations.

