Exploring a Relic's History Through 3D Digitization

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Abstract. This paper discusses how 3D digitization of cultural properties and modern interactive methods can help museums disseminate, educate and share the rich history, culture and civilization of museums' collection more effectively than traditional methods which used visual boards.

Keywords: 3D, Digitization, 3D Scanning, Touchscreens

1 Introduction

As society becomes more educated and affluent as a whole, consumers nowadays want to be more engaged and are demanding more comprehensible information than before. The roles of museums have expanded over time into the social aspects of supporting community development and shaping community identity, however, the traditional roles of museums in collecting, storing, preserving, exhibiting, educating and sharing rich collections still remain very important.

Although informational placards and visual boards related to the artefacts are frequently installed in museums, their quantity and sizes are often restricted by the limited space within the museum, inhibiting the amount of information to be displayed. For history to be communicated effectively to visitors, it is necessary to have alternate forms of information conveyance. Hence, there is a need to explore better methods of disseminating information more effectively to enhance museum education.

The purpose of museum education is to enhance the visitors' understanding and appreciation of the rich history of the unique museums' collections. Therefore, it is critical that museums devote enough resources to strengthen their core function of history research and presentation of museums' collection to complement the function of museum education.

The authors will attempt to share in this report, their experiences in the development and successful implementation of several 3D interactive museum educational projects across various Chinese museums.

1.1 Objectives of the paper

This paper discusses the importance of raking deeper into the historical background of museum collections, developing entertaining interactive content and engaging 3D technologies to curate museum collections. This paper also aims to share the experiences of the authors on utilizing 3D data technology in exploring and presenting the

rich background history of museum collection thus enhancing visitors' understanding and appreciation of museum collections.

2 The 3D Data Acquisition Process

2.1 2.1 3D Data Acquisition – 3D Scanning

It entails the acquisition of 3D data through the engagement of scanning equipment both laser and structured light. The process will be performed from several angles till the object is entirely captured. The dataset encompasses highly dense point clouds which form the basis for 3D artefact modelling.

Fig. 1. 3D scanning in action

2.2 High resolution photography

The process involves the acquisition of texture and exact color information under strict lighting conditions for purpose of texture mapping.

Fig. 2. High resolution photography in action

2.3 3D Optimization and Modelling

3D data in the form of point clouds are converted to polygons. The original 3D data is very large in size. 3D data is optimized to enable the final model to run on normal computers. The optimized model is then texture mapped using high resolution photographs.

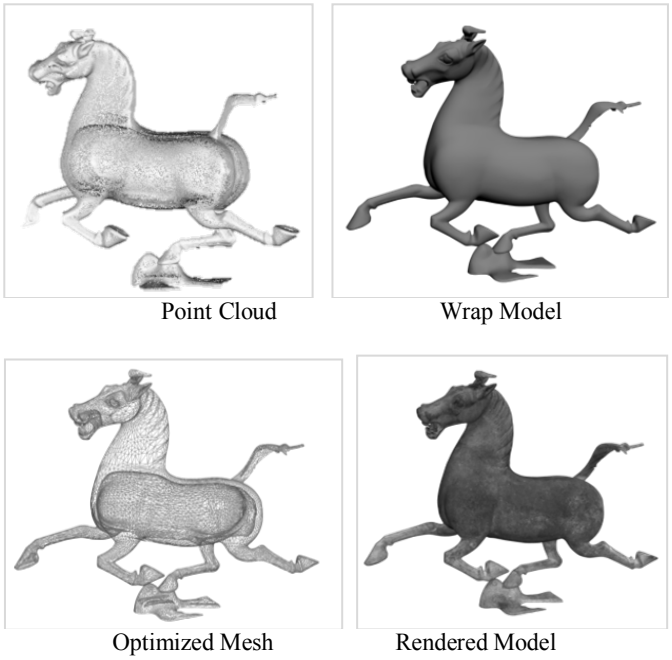

Fig. 3. 3D modelling and data optimization

3 Content Creation and Presentation

The content of exhibitions and its mode of presentation have a mutual impact on each other. It is essential to conduct extensive research into the history of the cultural objects, use them and develop entertaining and yet informative contents and at the same time, explore compatible methods of display in order to spark critical thinking and maintain dialogue with the audience. The report will illustrate few successful examples where content creation and 3D display methods are employed seamlessly to entice and impress the audience during their visits to the museum.

3.1 The Time Machine – Restoration of the Terracotta Warriors

The Terracotta warriors are considered one of the greatest archaeological discoveries of the 20th century. The fact that all warriors differ in size and physical traits including facial expressions, the intricate designs on their armors, their physical appearances

and body postures, provided valuable sources for research into the military, cultural, economic situation and history of the Qin dynasty

However, unknown to many, the human sized terracotta warriors were originally colored in various shades of red, green, blue and purple. When the warriors were excavated and exposed to the atmosphere, the color coating on the warriors oxidized rapidly leaving behind a dull and earthly texture on their surface. To preserve their original texture of the remaining figures, authorities decided to preserve the remaining warriors be leaving them left buried in the vaults. By doing so, the secret of the colored warriors remain a secret to many of us.

In one of the exhibition, the original beautiful and colorful state of the warriors was revealed for the very first time. 3D display was used to restore the glorious state of the warriors.

Fig. 4. Scanning of the body of a Terracotta warrior

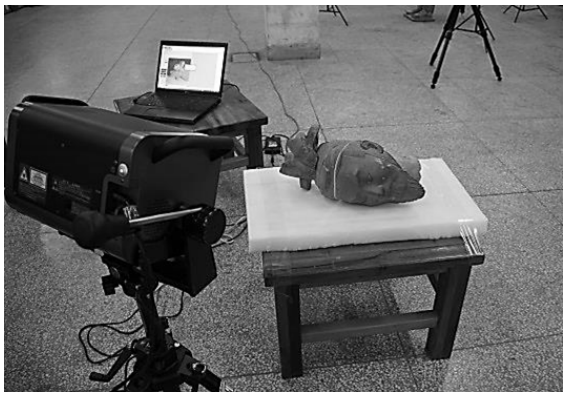

Fig. 5. Scanning of the head of a Terracotta warrior

Engineers first performed 3D scanning to produce high resolution 3D models of the warriors. After thorough research through interviews, acquiring photographs from the

museum and data obtained from scientists, under the supervision of the archaeologists, the warriors were meticulously restored to their original colored state using 3D modelling. A computer program was specially developed to allow visitors to experience for themselves on a 4K resolution touchscreen, the transition from a dull looking warrior to a beautifully colored figure. Response was overwhelming and positively received. The exhibition won a national award for "the best exhibition of the year".

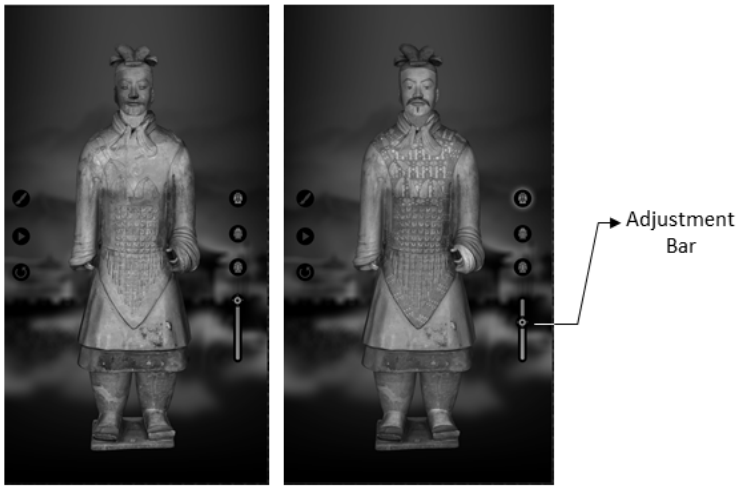

Fig. 6. The Terracotta warrior in transition to its original colored state

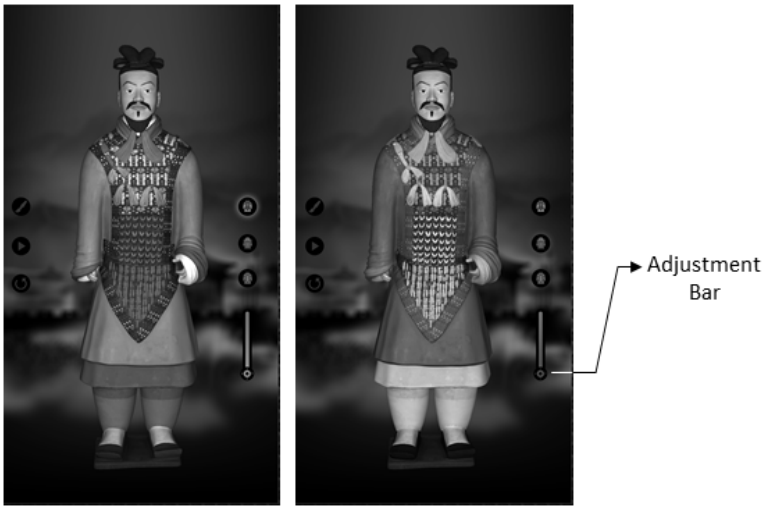

Fig. 7. Final various colored states of the Terracotta warriors

Fig. 8. Content installation onto an 84 inch touchscreen

Fig. 9. Actual touchscreen at exhibition site

In this example of restoration display, utilizing a digital mode of exhibition entails the following advantages.

1. The different originally colored versions of the Terracotta warriors can all be displayed on one screen sparing visitors the need to move from one placard to another.
2. By allowing visitors to view the transition from one colored version to another, they can observe the effects almost instantly without the need to do comparisons. Visitors do not need to spot differences by reading through rows of display placards.

3. Several forms of digital content such as text, audio and videos can be easily added any time to impress and engage visitors. Such is the flexibility of digitalization.

3.2 Quiz Time – Maintaining Dialogue and Inculcate Critical Thinking

Perhaps one of the best methods to inculcate critical thinking and maintaining continuous interaction with museum visitors is to develop programs that combine the elements of pleasure and learning. Quizzes and puzzles can help achieve that while at the same time increase the attractiveness of exhibitions.

The two main benefits of incorporating quizzes as part of museum education are that

1. quizzes help students to learn in a more interesting manner
2. quizzes are more effective in information retention

Fig. 10. Scanning of the gold mask in action

At the Jinsha Site Museum in Chengdu, quizzes are designed to aid in learning History. The origin of the golden mask at the Jinsha Site Museum had always been a mystery. Due to the lack of record, archaeologists were unable to determine precisely the actual origin and functions of the golden mask. Was the golden mask a bi-product from the fusion of ancient India and Asia culture or did it originate from ancient Chengdu itself? Was the golden mask a tool used during religious rituals? Was it a symbol of royalty or just simply a burial accessory? Questions were many.

Fig. 11. Quiz interface

Fig. 12. Quiz in the running

Being the prized artefact and symbol of the Jinsha culture, the museum decided to let the visitors vote and to decide for themselves what they think and wish the mask to be. The authors and their team helped to develop a quiz and questions were directed to the visitors via touchscreens. The 3D model can also be enlarged and manipulated in any angles to allow museum visitors to appreciate the intricate details on the mask and the workmanship of their ancestors.

The quiz triggered a chain of debates among the museum visitors whether old or young. Results were consolidated in real time and revealed to the visitors every time a vote was casted. The quiz not only aroused interest among the visitors, it also gave the visitors a sense of empowerment and ownership.

Fig. 13. Touchscreens with quizzes installed at the entrance of the museum

Fig. 14. Visitor interacting with the quiz

3.3 Look Closer! – Virtual Tour

Museums are paying increasing attention to the needs of individual visitors. At major museums in China, extensive printed and electronic support materials in different languages are often provided. However, information through audio or prints may not be effective when it comes to appreciating very large and detailed artefacts. This is because large sized artefacts are often barricaded and visitors can only view them

from a distance. As a result, visitors cannot relate the narrative information to the physical artefact. One such example is the wooden carved Guanyin statue at the Chinese National Museum.

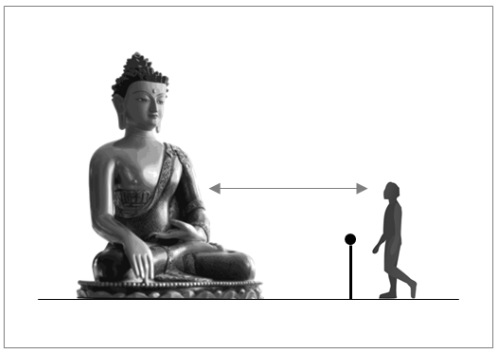

Fig. 15. Viewing large Artefact from a distance

To resolve this issue, the authors and their team decided to create an automated high resolution and close-up virtual tour of the wooden carved Guanyin statue. Virtual tours are often used to let visitors tour major buildings or heritage site online. Reason being that the datasets derived using 360 degrees panoramic photography are very smaller compared to those acquired through laser scanning and so, they can be posted online for visitors to interact with. Such method will not produce very high resolution views when it comes to appreciating movable artefacts.

In our project, we engaged 3D laser scanning method and computer programming to produce a virtual tour instead.

Fig. 16. Guanyin Buddha statue scanning in action

The project entailed extensive discussion with the various stakeholders from museum curators to museum visitors, to ascertain the details and areas of interest. After which, an instructional script detailing where virtual cameras should be stationed and defining how each camera approaches the statue was generated. Thereafter, instead of using ready-made market available 3D modelling soft wares (where scenes were mostly rasterized in advance) to produce the animation, the team create the virtual tour using

customized computer programming and employing real time rendering in conjunction with powerful GPUs to give the statue a more realistic view.

The virtual tour guided and led the visitors to areas of details automatically. Visitors to the museum can now appreciate the intricate details on the artefacts and the superb workmanship of the craftsmen during that period while, at the same time, listen and relate to the information provided by the audio guides.

Fig. 17. Snapshots of the animated virtual tour of the Guanyin Buddha statue

The advantages of creating the virtual tour using real time rendering are that it provides:

1. the capability to create more realistic 3D animation
2. the flexibility to edit the script and properties such as the illumination, cameras projection, shadows etc.
3. the simplicity and flexibility to modify and interact with properties to recreate another virtual tour
4. the speed to preview simulation and create final animation.

3.4 Look It Floats – Functional Display

There are many means for museums to communicate information to visitors. Placards and visual boards form the bulk of them. There are times when space becomes a luxury and there is just no space for the museum to install too many visual boards.

The next example will illustrate another museum exhibition that combines novel content development with an innovative presentation methodology – the transparent screen.

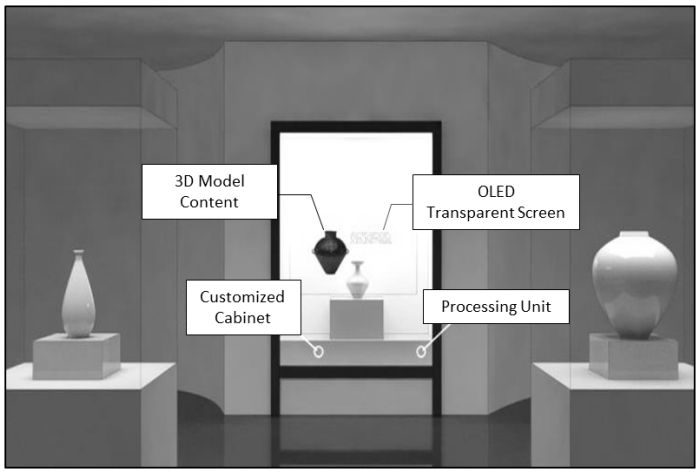

Fig. 18. Transparent screen at concept stage

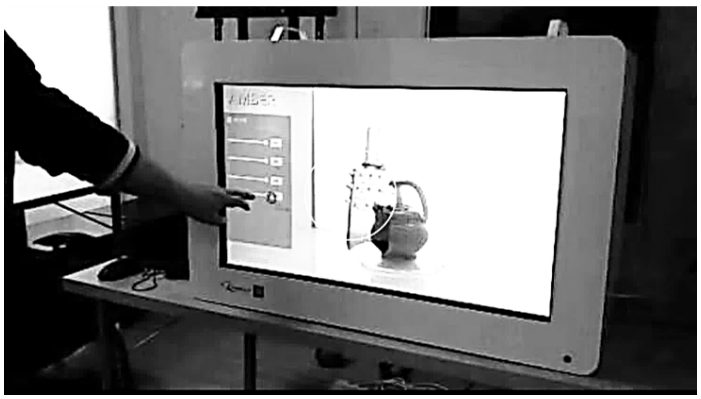

Fig. 19. Testing of 3D big data on transparent screen sample

Although transparent screen has already been used commercially to market consumer goods, there has been no reported use of it in museum display especially of 3D content. This is because 3D content encompasses big data and this requires tremendous processing power to run them. Thus, the underlying most important task is to optimize

the 3D data to a level that can be run on normal processing units with minimum data loss. It requires the combination of 3D modelling techniques and powerful computer algorithms to achieve this uphill task.

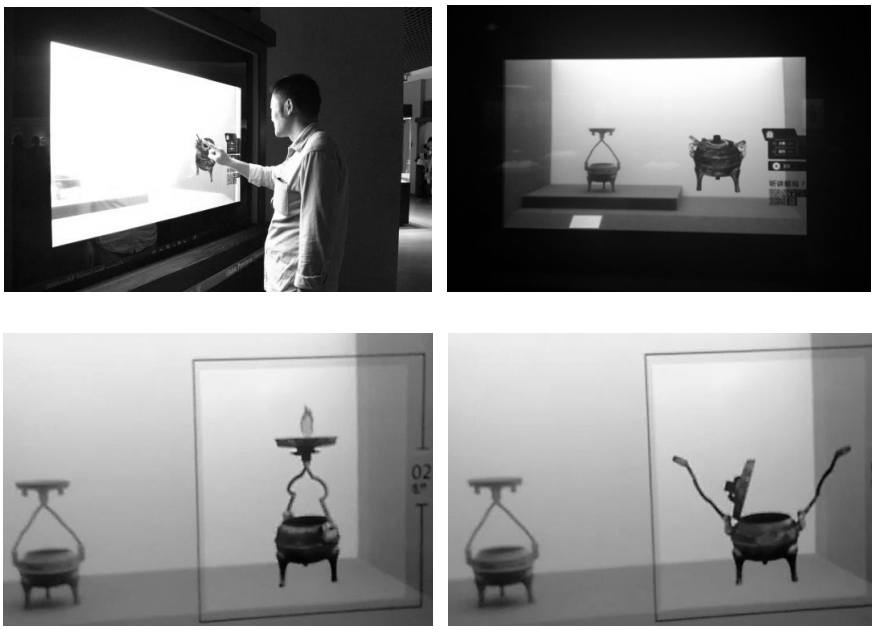

Fig. 20. Actual installation at the Gansu Provincial Museum

In this example, what it seemed like a normal Bronze Urn turned out to be actually a portable outdoor light source. The team did a research and created an animation of the actual function of the bronze pot and projected it just next to the physical object on the transparent screen.

The transparent screen concept offers several benefits.

1. By displaying the critical information close to the physical artefact, it directly connects the visitor to the artefact and thus helps enhance understanding and inculcates a sense of attachment.
2. It helps to save valuable space within the museum by omitting the need to display space consuming visual boards.
3. It is capable of displaying several types of content including text, audio, animation and interactive 3D models. All these information when combined, provides a very mind engaging experience for museum visitors.
4. The contents can be easily edited, changed and recreated as and when needed.
5. Innovatively appealing thereby enticing visitors to take a closer look.

4 Conclusion

As a unique intermediary between the historical objects and museum visitors, the quality and the efficiency of educational programs play an important role in transferring knowledge to the general public.

In light of museums being cultural, knowledge and educational centers, museum curators have often emphasized the benefits of interactivity in museum education but it remains uncertain as to what contents should be considered, how should the contents be exhibited and what levels of interactivity should be achieved in order to create effective and entertaining ways for visitors to gain new knowledge and skills.

The authors have highlighted that innovative historical contents development and the method of exhibition are mutually dependent. The effects of interactivity on museum education can be augmented if the multi-faceted background of artefacts were explored deep enough to provide sufficient contents for more effective mind engaging interactivity design. For example, in the Terracotta Warriors project, the team instigate public interest by restoring their original colored states, something that is lesser known to the public. To further enhance user participation, visitors can interact directly with the color transformation and manipulate the 3D model of the Terracotta warriors. In yet another example of the bronze pot, many visitors left the museum amazed by the wisdom of our ancestors after they have learnt that the Bronze Urn doubled up as a portable outdoor light source. The lasting impression on visitors was achieved with a smart combination of novelty animation creation and an innovative use of a transparent screen.

In conclusion, the authors wish to emphasize that with creative content development and engaging compatible exhibition methods, the end product will definitely be well received and its effects will be a feast to the eyes.