

Digital Heritage: Digital Sculpting, Cyber-Archiving and Education

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Figure 1: Bishamon-ten, Esoteric deity of Todaiji Temple in Nara, Japan.

Abstract

The paper explores the tangible and intangible aspects of digital heritage in conservation, and the utilization of computer graphics technology to broaden the format of narrative and messaging of cultural heritage preservation. Digital sculpting and projection mapping are the main technical aspects to explore the story of digital heritage for further protecting, educating and consolidating "building dwelling thinking" through digital heritage preservation.

Keywords: digital sculpting, cyber-archiving, projection mapping, digital heritage,

building dwelling thinking

Concepts: • Social and professional topics → Professional topics → Computing education → Computing education programs → Information technology education

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1 Digital Sculpting and Digital Documentation in Heritage Restoration

Software on the market nowadays provide easy access to digitally sculpting or documenting the physical objects. Digital sculpting depends on the artist's sense, techniques, and experiences towards the anatomic precision, form, balance, and motion. Sculptors' movements further extend to performance, then transforms into motion sculptures...etc., like never-ending echoes. Compared to digital sculpting, digital documentation rationally and precisely

conserves the digital data, analyze the complex forms or damaged parts, and rebuild the real subjects in the virtual world, such as photogrammetry or laser scanning.

These documentation methods are widely adopted and with easier solutions simply by mobile phone cameras and software. Back in the days when the Virtual World Heritage Laboratory led the Digital Sculpture Project (2009-2013), it focused on the complexity of famous sculptures and utilizes 3d laser scanning to restore the point cloud data from the sculptures. The project's attention to the "neglected area of the digital humanities"¹ and cultural significance, shows the uniqueness of the Digital Sculpture Project. The selected sculptures, ranging from Alexander to Laocoön, inherit the richness of form and context. Digital documentation of sculptures, through the earlier efforts, integrates into heritage preservation and consistently applies to heritage information projects.

When discussing heritage conservation, authenticity is the guideline of the process. To maintain the original status of the heritage, paying attention to details and reversibility helps to prevent further damage to the cultural properties when applying materials or methods. The knowledge to keep the authenticity of the heritage are accumulated by traditional conservation techniques. Mr Makino Takao, the founder of Kibi Conservation Studio² in Japan, restores damaged Buddhism deities and sculptures. After dissembling and photo documentation phase, traces of the previous restoration contained inside the wooden deities silently reveal clues of classic restoration techniques for damaged cultural objects.

As for the contemporary conservators, they embrace digital technologies such as CT(MRI), Inferred and X-Ray scanning in the process. Those technologies provide non-intrusive monitoring to collect and share data. The data further helps to analyze the status of the material within and enables establishing visualizations and replicas as references. In some cases, replicas further become part of the heritage object after restoring, or even replace the original cultural object.

¹ The Digital Sculpture Project.

² Kibi Conservation Studio for Cultural Objects

Multiple facts jeopardize the conditions of heritage: temperature, moisture, lights, natural disasters, political issues, human-made damages...etc., including theft. Japan, for example, cases of deity theft keep increasing in recent years. Starting from 2010, Students of Wakayama Technical High School, utilize 3D printing techniques to re-create Buddhist deity statue for local temples like Seitaiji to prevent possible theft. [Figure 2] Shimane Museum, the local institution, helps to collect the original wooden deity statue of Seitaiji Temple. Digital documentation of the deity contributes to restoring not only the tangible worshipping object, but also the intangible religious belief.

In China, the restoration of Thousand Hands Goddess, part of the Chongqing Dazu Rock Carvings, further examines the usage of 3D printing for heritage conservation. The 3D printed model, made in 1:3 proportion to the original³ [Figure 3], becomes the reference for the restoration team during the process. Some 3D-printed parts are also blended with authentic heritage item in the process as well. [Figure 4]

Mr Yabuuchi Satoshi, a traditional sculptor and professor at Tokyo University of the Arts, works on both personal sculpture work and wooden Buddhist deity restoration. In his research towards the restoration of damaged wooden Buddhist deities⁴, 3D-printed parts are also directly integrated with authentic heritage objects. The usage of digital techniques in recovery process becomes the crucial aspect of research and restoration work to preserve the reversibility for future study.



Figure 2: 3D-printed deity at Seitaiji Temple, Japan. Image courtesy 3ders.com and Seitaiji Temple



Figure 3: 3D-printed reference and Thousand Hands Goddess restoration in progress. Image courtesy 3ders.org



Figure 4: Thousand Hands Goddess restoration in progress. Image courtesy 3ders.org

2 Innovative Techniques for Narrative and Messaging: Buddha Statues of Bamiyan for Example

Digital documentations and other innovative technologies conserve or restore cultural heritage while the heritage object wholly or partially exists. Buddha statue at Bamiyan village, on the other hand, was fully destroyed by the Taliban in 2002. The standing Buddha statue was totally torn down after the explosion. Only broken bricks and the empty cave get left at the site. These remains and fragments inspire Professor Michael Jansen, Director of the RWTH Aachen Center for Documentation and Conservation, to visualize Buddha statues of Bamiyan Valley by projection mapping and digital CAVE (Cave Automatic Virtual Environment). The destroyed deity gets to reincarnate digitally in the 2010 exhibition:

“The precision and high density of the laser scan measurements capture the geometry with all delicate details (remaining original clay plaster and carved rock surface) and facilitate the production

³ 800-year-old Buddhist statue restored with help of 3D printing.

⁴ p.80. 篠内佐斗司. 壊れた仏像の声を聴く-文化財の保存と修復.

of a textured 3D model from which detailed 2D plans (section, views) in almost all directions can be produced. Beside the niche model a 3D virtual reconstruction of the original figures has been generated from historic photo documentation showing the Buddha figures before their destruction. All data has been processed for the presentation in an immersive 3D virtual environment (CAVE) at the Virtual Reality Centre at RWTH Aachen University.”⁵

Projection mapping, along with restoration, can be further utilized in narrative and messaging for cultural heritage. yU+co, one of the sponsors for Dunhuang cave art exhibition in earlier 2016, creates the projection-based installation in the opening of Dunhuang cave art exhibition at Getty Museum, LA⁶:

“In addition to the experience of entering full-scale replica caves, visitors can also take an immersive VR tour of cave 45... It gives a more volumetric or immersive experience than regular VR, using a special 360 degree dome shader. It was a year-long process to merge the 2D photographs and merge them into the 3D geometry for the entire cave.”⁷

Collaborating with Getty Conservation Institute on the narrative, yU+co, the company which is famous for its creative storytelling in films and advertising, creates a “fluid experience” in the physical environment other than heritage site. In this case, projection mapping, along with CAVE and VR, stimulate the spirit of spiritual and restoration care in the public exhibition. It also reveals the fluidity of digital heritage among culture, region, innovation, and identity. Interactivity and ubiquity allow virtual contents to penetrate the “concrete forest” of everyday routine and allows the voice of conservation to be heard.

3 Digital Preservation and STEM Education

The early 2016 Silk Road exhibition in LA is among many of the restoration projects and renowned institutions that Dunhuang Academy collaborates with global wide. In fact, Getty Conservation Institute, the Courtauld Institute of Art, Tokyo National Research Institute for Cultural Properties...etc., various institutions are among the collaborators in the ongoing digital Dunhuang project.⁸ From moisture and micro-weather monitoring of the caves to tourist capacity analysis of the sites, collective efforts dedicate to this great conservation process.

Regarding Academia in China, State Key Laboratory of Information Engineering in Surveying, Mapping and Remote Sensing of Wu-Han University has been leading to establishing the database of Dunhuang cave paintings. Various inputs from photogrammetry, laser scanning, drone photography can be analysed, textured and mapped by in-house software. Governmental institutions like Institute of Remote Sensing and Digital Earth (RADI), Institute of Geodesy and Geophysics, Shenzhen Institute of Advanced Technology (SIAT) equip with research, technology and experience to conduct the restoration project in epic scale.

Even with the collective devotion, cultural heritage continues facing the threat of human activities ranging from vandalism, theft to wars. For the humanistic care towards digital heritage conservation, education is the key to cultivating and raising awareness for heritage preservation. With the joint efforts of academia, governmental organizations and industry, the finalized projects can transform into education plans. These real-world projects provide insights and practice to enhance students' awareness of cultural heritage and global issues. The first-hand information also becomes learning resources to consolidate the awareness of heritage conservation, and the contents range from digital storytelling to computer aided drawing and cyber-archiving. [Figure 5] These practical projects can also transform into STEM curriculum (Science, Technology, Engineering, Mathematics). Students can get to comprehend the intangible values of heritage (method, techniques, context) and further cherish the existing yet endangered tangible cultural properties.

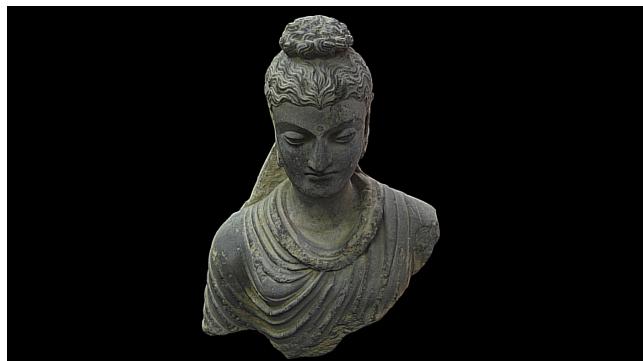


Figure 5: Photogrammetry documentation of Gandhāra style carved grey schist Shakyamuni and Bodhisattva (gilt).

Apart from instrumental usage, digital heritage technologies also provide a gateway for students and researchers to conduct projects for learning and studying. Good practices of conservation, ranging from cultural objects to the entire architectures or heritage sites, can be further revitalized by digital narrative and storytelling. In the latest animation released by Dunhuang Academy China, the research team gets inspired by the digitized painting in cave 254, and creates animation film based on the famous Buddha story

⁵ Jansen, Michael. “Virtual reality for a physical reconstruction? The Bamiyan Buddhas in Afghanistan”.

⁶ Opening ceremony of "The Cave Temples of Dunhuang, Buddhist Art on China's Silk Road.

⁷ Bringing the Ancient Theater of the Silk Road to Los Angeles.

⁸ The International Dunhuang Project.

“Attack of Mara and Great Departure” [Figure 6]. Mr Chen Hai Tao and Mrs Chen Qi, directors of the animation, integrate the rich imageries of Mogao Cave 254 [Figure 7] into storytelling and animated infographics. The analysis of cave painting, the infomotion intro of Great Departure, and artistic expressions of the Buddhism story along the Silk Road, make the piece with more profound meanings. The follow-up premiere and workshops at Beijing in late 2016, further revitalize the original contents in the heritage site and dedicate to the general public and higher education.

Diverse forms of depicting Mara attack and Great Departure can also be found along the Silk Road all the way back to 2-3 Century in Peshawar, Pakistan. The same story was told by the Gandhāra style Narrative Relief made of grey schist. Through the photogrammetry documentation [Figure 8], the relief gets cyber-archived and able to be described through diverse media and forms, such as 3D viewer or VR mode. [Figure 9]



Figure 6: Animation film of Mara Attach and Great Departure directed by Mr Chen Hai-tao and Mrs Chen Qi. Image courtesy Dunhuang Academy



Figure 7: Original cave painting of Mogao Cave 254 utilized in animation. Image courtesy Dunhuang Academy



Figure 8: Photogrammetry documentation of Gandhāra style Narrative Relief.



Figure 9: Detail of Narrative Relief with wireframe view.

4 "Heritage Is Our Child" - Building Dwelling Thinking

In May 2016, the cracking sound was heard from former Central Police Station – “one of the 16 historic buildings in the 150-year-old compound”.⁹ It partially collapsed to the ground in Central, Hong Kong. Defects including cracks in the walls, termite infestation, and the usage of substandard bricks, are believed to be the causes of collapse. Coincidentally, this collapsed Married Inspectors’ Quarters in the Central Police Station complex, was earlier selected as one of the five locations calling for public proposals in Lumières Hong Kong event. The event chooses five historical buildings in Hong Kong Island as inspirations for projection-mapping performances at the façades. The original intention to raise awareness of heritage sites overshadows by the collapse incident that jeopardizes public safety, and the effort of the metropolitan city to dwell with cultural heritage gets questioned.

Therefore, monitoring, managing, and maintaining the status of tangible heritage sites, not only examine the sustainability of cultural properties, but also help to pass on the knowledge of aesthetic values, historical significance, and awareness of maintenance to the general public and future generation.

To restore the cultural objects, such as wooden deities, optical technologies, and computer graphics visualisation enable restorers

⁹ South China Morning Post. September 7, 2016

to investigate, analyze and repair. For heritage sites, HIM (Heritage Information Management) becomes the methods to observe and visualize :

“...the roofs, walls, floors and other character-defining elements – of historic buildings...Heritage project team members are from multiple disciplines. They should have a holistic view of the site, an in-depth understanding of the historical value, and adopt a minimum intervention to historic buildings... Ideally, the surveys should be carried out with minimum scaffolding and physical disruptions...BIM technology provided a complete solution for recording, presenting and visualising the building information... the final survey products include 2D drawings, 3D models and animation clips.”¹⁰

Technically examining the cultural heritages or endangered monuments is challenging, yet to investigate and preserve fragile cultural properties under crossfire of war zones or hostile areas, takes more courage and responsibility, such as the dedications of Mr Liang Sicheng and his wife, Lin Huiyin during the World War Two. Together they documented and preserved hand-drawn data, texts, and photographs of wooden Buddhist deities, wooden carpentry temples, and numerous heritage sites over China. Efforts in the contemporary era can also be found in Bamian projection mapping, and the multi-nation delegations at Peshawar, Afghanistan to research Gandhāra period heritages.

As former UNESCO Regional Advisor Dr Richard A. Engelhardt mentions in the conversation towards cultural heritage conservation in Pakistan: "Heritage is your child. You have to nurture and take care it."¹¹ For its future potential of documentation, visualization and education, digital heritage can not be valued just as the commodity. Digital heritage needs to be treated as the extension of culture.

5 Conclusion

Mr Wu Liang Yong, the student of Mr Liang Sicheng and award-winning architect for his revitalization project of Beijing Ju'er Hutong in 1993, expressed his idea of "genius loci in general" between culture, history and living condition:

"The culture of architecture comes from a local accumulation of history. It manifests itself among the built forms and in day-to-day living, exerting a voiceless influence on the experience and behaviour of the inhabitants. In a sense, it is the soul of our cities, towns and villages."¹²

Culture heritage has its memories accumulated with time. The memories of culture become the collective resources of the human existence and symbolize the uniqueness of civilization. It enriches our culture by living in the world. History and narrative might vary due to the transfer of regimes, yet the culture remains and echoes in daily living. Through the assistance of digital technologies, preservers and restorers get to hear the echoes from the cultural heritages. These echoes will continue to be received if we keep it flow around the cultural objects, heritage sites and natural environment.

Contact Information

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