

A study of Cultural Heritage Management and Contents Utilization based on state-of-the-art Digital Archaeology

(Abridged English-language report based on an extensive report in Korean)

Inhwa Choi

National Research Institute of Cultural Heritage, Cultural Heritage Administration, Republic of Korea

Introduction

State-of-the-art technologies are used in various fields around the world. New technologies are also leading to significant changes in the cultural heritage sector. Korea is currently developing new technologies and content for cultural heritage management and research. The Korean content industry market is worth \$87 billion and is growing annually. Cultural heritage is an important national content resource that uses new technologies but in a rather uneven manner. It is thus generally agreed in this sector that the diverse technologies available at present and about to be developed in future need to be applied more effectively to each field of cultural heritage to expand the scope of research, management, and utilization.

The aim of this research project is to investigate advanced cases related to digital cultural heritage in the UK and Europe and to understand global trends. Accordingly, I have investigated the policies, regulations, and a range of cases of practical application to cultural heritage sites and museums in the United Kingdom and the European Union (EU) to benchmark good examples that may be emulated and adapted for Korean cultural heritage management. In addition, based on these case studies, I have developed suggestions for practical plans applying various technologies to Korean cultural properties.

The relevant policies are “Culture is Digital (2018)” in the UK, and “A New European Agenda for Culture (2018)” in the EU. Both suggest strategies to encourage research and the application of digital technology to cultural heritage, utilizing them as a stepping stone for economic growth. In addition, there are laws, acts, and ethical guides to protect data and copyright as well as active data usage for the public.

In connection with this project, I have visited about 80 museums and sites in the UK and Europe. Among them, 20 cases in seven countries have been selected as excellent examples for the Korean cultural heritage sector to emulate.

Case studies by country and the main technologies they apply

UK

- Stonehenge (Multimedia)
- National Museum Cardiff (AR)
- Museum of London (Multimedia)
- The Roman Bath (Hologram)
- National Army Museum (Multimedia, Interactive Experience)

- Coventry Transport Museum (Multimedia)
- National Maritime Museum (Multimedia)
- War Memorial Museum, London (Multimedia)
- London Mithraeum Bloomberg Space (Immersive Experience)
- Jorvik Viking Centre (MR_Smell, Time ride)
- Mary Rose Museum (Projection mapping)
- The D-Day Story (Pepper's Ghost)



Figure 1. Pepper's Ghost Technology in D-Day Story



Figure 2. Immersive Experience in London Mithraeum

Germany

- Pergamon museum Das Panorama (360° Immersive Experience)
- Natural History Museum (AR)
- The German Spy Museum Berlin (Interactive experience),



Figure 3. AR of Natural History Museum in Germany

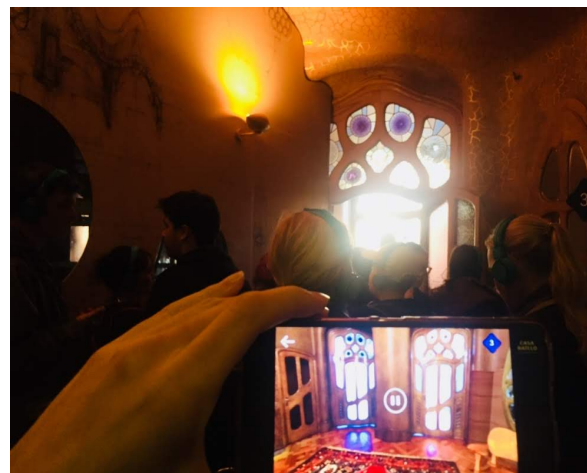


Figure 4. AR of Casa Batllo in Spain

Spain

- CASA BATLLO (AR)
- Podziemia Rynku Museum (Multimedia)

Iceland

- Reykjavik City Museum
- The Settlement Exhibition (Motion Sensor media table)

Norway

- Stavanger Museum (Storytelling, Hologram)

France

- France Musee de la Romanite (AR, VR, Multimedia, Projection Mapping, Immersive experience)

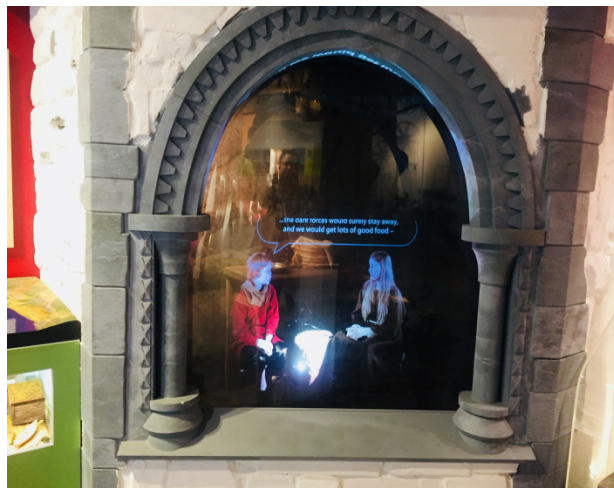


Figure 5. Hologram of Stavanger Museum in Norway

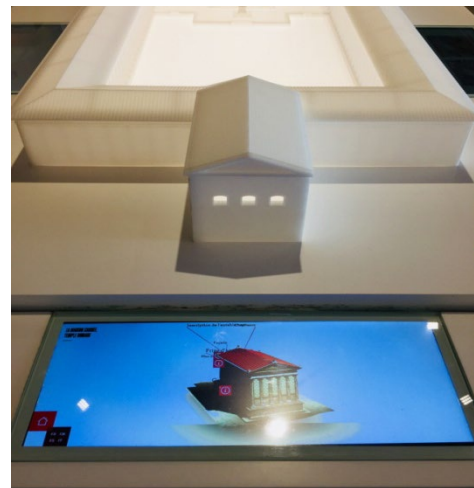


Figure 6. 3D Modeling of France Musee de la Romanite

Research Results: Main Technologies Applied

My research has shown that the new technologies most commonly used for cultural heritage in the UK and Europe are Augmented Reality (AR), Virtual Reality (VR), Mixed Reality (MR), machine learning, deep learning, data and text mining (Big data), Lidar, 3D scanning, modeling, printing, multimedia (hologram, peppers ghost, projection), mobile applications and the semantic web. See table below for a list of case studies by main technology applied.

	Technology	Name of Case (Organization, Developer)
1	Virtual Reality (VR)	<ul style="list-style-type: none"> • Sandby borg project (Linnaeus University, Kalmar County Museum) • Berlin Wall: The Virtual Reality Experience (Newseum) • Kivik Grave VR (Osterleus Museum, Lund University)
2	Augmented Reality (AR)	<ul style="list-style-type: none"> • SPAIN CASA BATLLO • Museum ExplorAR: A living guide to the galleries (National Museum Cardiff) • Berlin natural history museum
3	Mixed Reality (MR)	<ul style="list-style-type: none"> • Dead Man's Nose (DMN) project in Moesgård Archaeological Trail, Denmark (Stuart Eve) • Jorvik Viking Centre • FRANCE Mont-Saint-Michel HOLOLENSE 2 • (Musée des Plans-Reliefs, Museum of History and Industry in Seattle + Microsoft)
4	Artificial Intelligence (AI)	<ul style="list-style-type: none"> • The Voice of Art with IBM Watson (Pinacoteca de São Paulo Museum)
5	Machine Learning Data Mining	<ul style="list-style-type: none"> • Detecting bone trade by machine Learning (Huffer, D. and Graham)
6	Deep Learning Lidar	<ul style="list-style-type: none"> • Automated detection of archaeological objects in LiDAR data (Verschoof-van der Vaart, W.B. and Lambers)
7	3D	<ul style="list-style-type: none"> • Underwater 3D Scan Drone (Blueye Robotics in Norway) • Measuring Usewear on Pottery through high-resolution 3D laser scanning (Banducci, L.M., Opitz, R. and Mogetta) • Palmyra, The Triumphal Arch 3D Printing (Institute for Digital Archeology)
8	Application	<ul style="list-style-type: none"> • ArchAIDE (Anichini, F. et al) • iDig for excavation site (Bruce Hartzler, Georgios Verigakis) • Arch-I-Scan (Tyukin, I., Sofeikov, K., Levesley, J., Gorban, A.N., Allison, P. and Cooper)
9	Multimedia	<ul style="list-style-type: none"> • Information Visualization by Projection& Audio System <ul style="list-style-type: none"> ◦ Museum of London, Mary Rose Museum, D-Day Story • Virtual Restoring by projection mapping

		<ul style="list-style-type: none"> ○ The Roman Baths, France Musee de la Romanite, Das Panorama ● Interactive experience <ul style="list-style-type: none"> ○ National Army Museum ● Hologram <ul style="list-style-type: none"> ○ The Roman Baths, Stavanger Museum
10	Sementic Web	<ul style="list-style-type: none"> ● Europeana, Ariadne, Arches, German Digital Library, CLAROS, Gotenburg City Museum
11	Immersive Experience	<ul style="list-style-type: none"> ● Pergamon museum. Das Panorama ● London Mithraeum Bloomberg Space

Recommendations for Cultural Heritage Management in South Korea

Of the technologies listed above, MR, AI, Machine Learning, and Deep Learning technologies have not been attempted in South Korea, so these are good examples to try and apply on Korean cultural heritage sites.

In addition, in South Korea, Lidar is mainly used for scanning topography. It is considered to be suitable for surveying and monitoring such as DMZ (Demilitarized zone) and ancient cities in forests, as Lidar can filter away vegetation, but not for other applications.

Furthermore, the virtual restoration and storytelling of cultural properties using multimedia such as Projection Mapping and Pepper's Ghost, and Immersive Experience techniques such as London Mithraeum and Peragamo Museum: Das Panorama in Berlin are considered very effective.

Based on these cases studies, I have suggested specific plans on how to apply new technologies on certain Korean Cultural Properties by type of technology. These recommendations can be classified into the separate categories of cultural heritage research, recording, preservation, restoration, management, and utilization (see table below).

	Plans
Research	<ul style="list-style-type: none"> ○ Deep Learning automated Remains & Relics Identification ○ Machine Learning artifacts classification ○ 3D scan artifact research ○ Research of historical materials(text) through text mining
Recording	<ul style="list-style-type: none"> ○ DMZ and old city survey and monitoring using Lidar ○ Automatic classification of metadata
Restoration	<ul style="list-style-type: none"> ○ 3D modeling simulation & restoration ○ Virtual restoration using projection mapping

	<ul style="list-style-type: none"> ○ Reconstruction of historical sites using 3D printing
Management	<ul style="list-style-type: none"> ○ AI chatbot (Interactive messenger) ○ Investigation of illegal cultural property transactions ○ Cultural heritage Big data
Utilization	<ul style="list-style-type: none"> ○ Immersive experience ○ Interactive VR experience <ul style="list-style-type: none"> - Traditional instrument playing, Dance, Martial Arts ○ Interactive VR excavation experience ○ Restoration of interior cultural properties through AR ○ 5G Heritage Trail & Exhibition ○ Cultural heritage exhibitions with Hololens ○ 3D modeling storytelling life in history ○ Cultural heritage 3D printing experience

Conclusion

Differences in research environment of digital cultural heritage between the UK, Europe, and Korea have been identified through this research.

First, the content highlighted at cultural heritage sites and museums in the UK and Europe are focused on historical facts and storytelling. This includes showing how people lived at the time and what historical events happened. Meanwhile, in Korea the content is mainly composed of information on chronology or history of cultural sites and objects.

Secondly, digital cultural heritage is a field of study in the UK and Europe. Accordingly, research papers, development of programs, and content are often conducted in academia. Meanwhile, most digital cultural heritage projects in Korea are collaborations with companies or engineers with related digital technologies.

Third, in the UK and Europe some universities have curriculums and degree courses in digital cultural heritage. There are online and offline classes for digital archaeology such as GIS, 3D Modeling, Lidar, Remote sensing, and the likes. Meanwhile, in Korea only few classes such as on the handling of drones and photo scans are held by the National Research Institute of Cultural Heritage in Korea.

Fourth, in recent years the United Kingdom and Europe established policies and revised laws related to digital cultural heritage. In South Korea, the Cultural Heritage Administration has a plan to announce a master plan and policy in 2020.

Fifth, there are many experts in digital cultural heritage research in the UK and Europe. Even archaeologists often learn the latest technology to program or develop applications and content. Meanwhile, Korean researchers usually rely on specialized companies and engineers.

Lastly, based on these differences and case studies I would like to suggest five policy proposals for Korean Digital Cultural Heritage:

1. Setting the future direction for Cultural Heritage utilization using digital technology
 - a. Focusing on restoration of people's lives (storytelling)
 - b. Applying technology that best contextualizes and shows cultural property
 - c. Active use of open platforms such as social media and YouTube
 - d. Contents development for the disadvantaged groups
 - e. Driving public engagement
2. Establishing Comprehensive Plan, Guidelines, and Infrastructure
3. Training in Digital Skills
4. Investing in related Research and content Development
5. Continuous evaluation and improvement

All in all, proper use of digital technology enables us to research, restore, manage cultural heritage more efficiently and scientifically in Korea. I hope this research helps applying new technologies in the field of Korean cultural heritage and potential future developments of digital archaeology. The final report will be referenced in government policies and practices.

Acknowledgements: This research was supported by the Korean Government fellowship. I am deeply indebted to the researchers and Cultural Heritage specialists at the over 80 institutions around the UK and the EU that I visited. I would not have been able to conduct my work without their generous support. I would also like to thank the School of Archaeology, University of Oxford, and all of its faculty, researchers, administrators, and students for supporting me during my research, in particular Dr Anke Hein for being my host and mentor during my two years at Oxford.