3D in Museum? 3D models for museum usage? Procedures, technologies, possibilities, and challenges of 3D digitization for cultural heritage institutions

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It cannot be denied that 3D scanning and printing has been on the rise for the last two decades. For cultural heritage institutions as well as for the creative industries, 3D models present a valuable tool for displaying, researching, and understanding cultural heritage objects in a new and innovative way. However, these new technologies also entail increased responsibilities: In recent years, the museum sector has been facing not only the challenge of creating, managing, making accessible, and preserving their analogue content but also their digital knowledge capital. The conference on "3D models for museums?" that took place in Berlin on January 26, 2015 critically examined the benefits and challenges posed by forms of 3D-capture, 3D-processing, and the enrichment of those models with metadata information and their integration into museum environments. The AthenaPlus project - dealing among others with different aspects of the reusability of cultural heritage content - was one of the co-organizers of the conference. Eleven presentations by mostly German but also other European representatives of diverse cultural and technical competence centres introduced recent projects looking into different application areas of 3D technologies. Thomas Bremer, professor for game design and experience design at the University of Applied Science Berlin (HTW) as well as professor Monika Hagedorn-Saupe, deputy-director of the Institute for Museum Research Berlin (SPK), welcomed lectures and audience and moderated the conference. Thomas Bremer stressed the immense importance of 3D models for cultural heritage institutions. Thanks to the rapidly developing 3D technologies, research and cultural heritage institutions can now create accurate records of individual objects and even monuments without exposing fragile objects to danger of damage. With the help of image manipulation, objects can be enlarged and rendered in various modes of representation, and missing parts can even be reconstructed easily. For experts and amateurs alike, 3D models present a fascinating way of visualizing the past and apprehending the significance of cultural heritage objects, historic sites, and monuments. The precise documentation and sustainable preservation of valuable objects is a further advantage of the 3D technology.

Four Berlin museums – the Berlin Replica workshop, the Märkisches Museum, the Spandau Citadel, and the Museum Neukölln – already benefit immensely from the advancing 3D technologies and the research carried out in this field[1]. Samuel Jerichow, graduate engineer and employee at the 3D Lab of the Technical University Berlin (TU) presented the promising cooperation projects between the Technical University and Berlin museums. At present, plaster casts held at the Berlin Replica workshop are 3D scanned and printed. The 3D prints of 16 Greek sculptures will be used for the reconstruction of the Tea Room of the Berlin City Palace that will reopen in 2019, and house the Humboldt-Forum. At the Märkisches Museum, 3D virtual models of historic Berlin city maps are produced that will enable museum visitors to stroll among others through the neo-classical Berlin. For the exhibition "Enthüllt. Berlin und seine Denkmäler", a 3D model reconstruction of Albert Speer's megalomaniac vision for the city of

Germania was created. The virtual representation can be viewed by visitors through an immersion experience provided through a head mounted display. At the Museum Neukölln, 99 museum objects were 3D scanned and printed to provide visitors with the opportunity to touch and explore the different surfaces of museum objects that are generally forbidden to be touched.An important thematic priority of the conference included the usage of 3D scanning technologies in the field of archaeology. The time-consuming procedure of sketching archaeological artefacts can be (and already is) replaced by different 3D scanning methods. 3D scanning is capable of rendering the surface of an object in a high resolution, making visible even the most subtle textures of an object that would otherwise be hidden to the human eye. The Archaeological Heritage Office in Saxony uses 3D scanning for documentation and reconstruction purposes since 2004. More than 10,000 archaeological artefacts excavated in Saxony in the past years have been 3D scanned so far. The measuring data obtained from different artefacts can thus be compared and used for typologisation. In the future, the Archaeological Heritage Office is planning to display its 3D virtual models also in a portal on its official website.

The spectacular excavation of the gold hoard of Gessel, Germany in 2011 and the usage of 3D scanners to uncover and graphically present the treasures from the Bronze Age was topic of the lecture by Bernd Rasink, archaeologist at the State Office for the Preservation of Historical Monuments in Lower-Saxony. During the construction of the Northern European Gas pipeline, a prehistoric hoard was located in the ground and stamped from the earth in a 60cm x 60cm solid block. By the help of different image methods (X-ray CT) the inner structure of the block was uncovered. 117 pieces of gold jewellery were hidden inside the lump of earth. A computer-based 3D model was developed which was then used to print a 3D replica of the gold hoard. This 3D model not only helped to document the original finding situation but also simplified the uncovering of the gold pieces from the block.

From 2012 to 2014 the Ethnological Museum Berlin (SPK) was involved in a project dedicated to the digitization of historical and contemporary musical instruments from South Asia using multi-perspective imaging[2]. Results and achievements of this project were presented by Andreas Richter, researcher at the Ethnological Museum. CT and 3D photography was used to digitize approximately 430 musical instruments, the majority of them coming from the Sourindo Mohan Tagore collection, amassed in Calcutta around 1900. The virtual data (multi-perspective images and metadata) allows for studying the processing of construction materials, cultural practices reflected in the use of the instruments (patina, marks caused by playing), aesthetic principles and craft techniques, for the purpose of dating the instruments, something which would otherwise be impossible without costly on-site research. A database will be established which will form the basis for historical reconstructions and, to a limited extent, for the repair / rebuilding of damaged or destroyed instruments.

Vanessa Boschloos and Hendrik Hameeuw from the Royal Museums of Arts and History, Brussels talked about the pur-pose, advantages, and pitfalls of the so-called portable light-dome system, a reflectance imaging and 3D modelling method based on three main steps: acquisition, digitization, and viewing[3]. The acquisition device, the actual dome is equipped

with a 5 million pixel camera that records 260 differently lit pictures of the object placed underneath it. Afterwards the data is calculated into one virtual file. It is during this process that the characteristics – colour and orientation – are determined for each pixel based on the principles of photometric stereo. The viewing of the data is made possible via different viewer programs that have the ability to virtually relight the surface from any chosen direction, to rotate, to zoom and to apply a set of filters which extract or emphasize particular characteristics. In addition, the viewer programs make it possible to visualize the topography as well as plot distances and the height profile along any chosen random line along the surface. Thanks to this technology, objects with a complex surface such as Sumerian clay tablets with inscribed texts and impressed seals, or antique coins, can be digitized within an hour.

A further interesting cooperation presented during the conference is the interdisciplinary MOSYS-3D project, a collaboration of the University of Applied Science Berlin and the Prussian Cultural Heritage Foundation Berlin[4]. Arie Kai-Browne, landscape archaeologist at the HTW, introduced the aims of the research project: different aspects of 3D documentation, ranging from the acquisition of 3D-data, automating pre- and post-processing steps, and finding new ways for visualizing these types of data sets for knowledge transfer and scientific research are tackled. As test case objects, archaeological finds from the Ancient Samarra that are housed in the Museum of Islamic Art Berlin are used to demonstrate the potential but also the challenges of high-resolution 3D documentation. The Abbasid city of Samarra is one of the largest archaeological sites of the ancient world. Large numbers of the Samarra artefacts were excavated under the supervision of Ernst Herzfeld between 1911 and 1913, and brought to Berlin. The finds include over 90 ornamented stucco panels, fragments of painted wooden objects, glass and stoneware, as well as pottery. The development of a robotic system that combines a robotic arm and a close range 3D scanning device enables a time-efficient and flexible recording procedure. In addition to the 3D digitization of the archaeological artefacts, the historical context information of the objects are also being documented on the basis of the CIDOC Conceptual Reference Model. Another promising application currently being developed by the HTW is the recontextualisation of the digitized objects by displaying them within their original location. A game engine linked to a database is utilized to reconstruct selected historic buildings from the excavation site in Iraq; within the reconstruction, digitized objects such as ornamented stucco panels are positioned according to the documentation. This interactive real-time environment thus facilitates a new understanding of the historical context of the archaeological finds.

The ongoing project ZooSphere, a tool for automated spheric image capturing and interactive 3D visualization of biological collection objects run by the Natural History Museum of Berlin, was presented by Alexander Kroupa. Within the project, 10,000 insect drawers and 10,000 specimens from the collection of the Natural History Museum are being digitized. Furthermore, special spheric image capturing methods for the visualization of small objects are being developed. The preservation of big data sets is another aim of the project. It is planned to set up an international repository and web hub for high-resolution image sequences of biological specimens that will increase the visibility and

accessibility of biological collection objects to the public and scientists alike.

Other presentations delivered in the conference dealt with the following topics:

- Alexander Henning (HTW Berlin), Low-Cost 3D digitization of museum objects;
- Prof. Dr. Dieter Fritsch (University of Stuttgart, Institute for Photogrammetry), 3D Reconstruction for everyone;
- Marinos Ioannides (Cyprus University of Technology), Challenges and potentials of 3D documentation and research for the cultural heritage sector;
- Martina Trognitz (DAI), 3D isn´t simply 3D – Presentation about the long-term storage of 3D data.

Altogether, the projects presented at the conference in Berlin demonstrate that 3D technologies are changing and will continue to change the way people interact with artefacts and objects in museum collections. The passive role of the museum visitor as a mere spectator is shifting to a more active, investigative role. Thanks to 3D printed models, objects can now be explored differently: they can be touched, felt, and handled. The 3D technologies make it possible to manipulate objects, compare objects in a cross-disciplinary manner, zoom into interesting details that would otherwise be hidden to the eye, measure parts of the object, and even reveal elements of the object that cannot be seen from the outside. Moreover, museum collections are no longer necessarily bound to a certain place; they can be brought into homes, classrooms, and laboratories all over the world without exposing the actual object to any danger of damage. For digital documentation and preservation of historical artefacts, 3D technologies present a valuable tool as well. However, despite all the enthusiasm about the advancing 3D imaging and visualization technologies, there are still a lot of problems and challenges waiting to be tackled. Complex, standalone software that is incompatible with the standard browsers and mobile devices severely limits the accessibility of 3D digitized objects, which is why going forward 3D data has to be rendered in a standardized format. In addition, the long-term preservation of huge amounts of data sets is still a question that is not yet satisfactorily solved. Nonetheless, high quality, thoroughly enriched 3D models of cultural heritage masterpieces certainly present highly engaging content for all sorts of users.

Arlene Peukert , Stiftung Preussischer Kulturbesitz (SPK). Germany

1. Schwandt Hartmut, Weinhold Joachim (2014). *3D Technologies for Museums in Berlin. EVA Tagung* 2014. http://www.bcs.org/upload/pdf/ewic_ev14_s19paper2.pdf (03/2015).

2. Further information about the research project can be obtained on the website of the Ethnological Museum Berlin (SPK): http://www.smb.museum/en/museums-and-institutions/ethnologisches-museum/research.html (03/2015).

3. Hameeuw Hendrik (2014). *Portable Light Dome System, from registration to online publication within the hour*. KU Leuven KMKG – MRAH. https://portablelightdome.files.wordpress.com/2014/12/portable-light-dome-system-from-registration-to-online-publication-within-the-hour_1-1.pdf (03/2015).

4. Brandhorst Susanne, Bremer Thomas et al. (2013-2015). *MOSYS-3D. Mobile, modular System for 3D documentation of cultural heritage.* Brochure HTW Berlin.