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"VIRTUAL EMONA" ON DLIB.SI USING 3D TECHNOLOGIES

Abstract. Digital Library of Slovenia - dLib.si is a web portal for free accessing to digital and digitized library materials and virtual exhibitions. This paper is describing the use of 3D technologies in development and preparation of exhibition Virtual Emona. The title is related to Roman settlement Emona (Colonia Iulia Emona), which was located on a place, where present city of Ljubljana, the capital of Slovenia, is lying today. Content of the exhibition in 3D form will be public accessible on dLib.si and it will be linked to other resources about Emona on the same web portal. The beginning phase of the project includes 3D digitization of the model of archaeological site NUK II and 3D digitization of some artefacts, found on the mentioned site. NUK II consists of four Emona's insulas (building blocks) and crossing of two roads between them; under the road which ran in direction E-W, laid a cloaca. In late Roman period three of four researched insulas (XVII, XIII, XXVII) were thermal city baths. The project of Virtual Emona was formed in cooperation with the owner of dLib.si web portal, National and University Library of Slovenia, Museum and galleries of Ljubljana, which keeps and interprets archaeological artefacts, and with 3D technologies implementator, IB-PROCADD company. Virtual exhibition is already in realization process.

Keywords: 3D technologies, 3D digitization, digital library, virtual exhibition, Emona.

1. Introduction

The project of virtual exhibition titled Virtual Emona was initiated by the National and University Library of Slovenia (NUK), the owner of digital library dLib.si, which is organizing thematic virtual exhibitions on web portal. In autumn 2009 The Ministry of Culture of the Republic of Slovenia, in accordance with Strategy of Development of Information Society in the Republic of Slovenia - si2010 and vision of e-contents, determined NUK as the national aggregator of cultural e-contents. Virtual Emona represents a pilot project of an exhibition in 3D environment.

The content of virtual exhibition is related to the heritage of the Roman city of Emona, ancient predecessor of modern Ljubljana, namely to research results of archaeological site NUK II. The remains of the Emonian city baths were found in the immediate neighborhood of the NUK building, on a place where the NUK II building is in plan to be built, as its librarian activity has overgrown current space. In the future library building, an incorporation of archaeological findings is planned. The investment of new building is currently stopped for many reasons, yet information-communication and 3D technologies are enabling us to deliver

a part of Emona heritage on the internet already today, and present findings of mentioned site to broad public.

On site NUK II archaeological researches were taking place in the first decade and in the 60's and the 90's of the 20th century, the last one in 2008. In the year 1998, for the exhibition Incorporation of archaeological findings into building of National and University Library and its immediate environment, a model of archaeological findings was made. The model was made by Peter Ogorelec and co-workers on order of the Ministry of Education, Science and Sport of the Republic of Slovenia. [1] The model was improved in the year 2001 (date of the model composition, written on the model, is 2001). Today the model is kept by NUK, and archaeological objects and documentation from mentioned site are kept by The City Museum of Ljubljana, Museum and galleries of Ljubljana, which is, as a regional museum of broader Ljubljana region, besides The National Museum of Slovenia, responsible for keeping and interpreting the Emonian heritage.

For the necessity of virtual exhibition the IB-PROCADD company, which is recognized by the implementation of 3D technologies into various fields of human activities in Slovenia and South Eastern European Region, 3D digitized and prepared the model of the archaeological site and nine small artefacts for internet publishing. The paper describes starting phases of development and preparation of virtual exhibition, with the emphasis on digital shape sampling and processing (DSSP) of 3D data of archaeological heritage content. In conclusion we are focusing on wide concept of virtual exhibition and future possibilities of data usage.

2. Cultural heritage in virtual environment

The internet development enabled that today we can access information faster and from all parts of the globe. Information can include multimedia contents and we can reach them in an interactive way. In addition 3D technology tools also enable a spatial component, which is significant for cultural heritage contents, as it offers qualitative experience and better presentation to the website users. Online heritage contents contribute to knowledge spreading, gained widespread recognition in the world, and consecutively to tourism increase. It is well known that tourism is one of the most powerful branches. Cultural tourism is nearly impossible without the internet today. Jerome C. Glenn talks about Tele-tourism circle, where “discovering a culture via internet in cyber space” and “visiting the culture in physical space” is reciprocally rotating. [2] Therefore “virtual exhibition serves as an excellent marketing tool for attracting visitors to the physical exhibition.” [3]

“Virtual space can also be one of the methods for preserving older cultures” [2], adds Glenn. On one side we have a cultural tourism paradox, on the other side we know, that close to many archaeological parks museums are arising, where heritage is quality presented, and the “actual” contents are protected and hidden from tourist crowd. We need to realize, that every visit to an archaeological site, as well as the climate influences of unprotected sites, accelerate the physical decay of a heritage.

3. Digital Library of Slovenia - dLib.si

With implementation of digital information and communication technologies librarian activity has gained new impulsion, and at the same time it is spreading on the internet. Internet users, who access it via computers and mobile phones, have Digital Library of Slovenia - dLib.si, public web portal for free accessing to digital and digitized library materials and virtual exhibitions (Figure 1), on their disposal.

3D scanned models will be published in two ways: as independent digital objects with metafile description and as the whole, united in virtual exhibition. With help of portal browser user will be able to walk around the model of archaeological location. Passing with mouse through 3D scanned model, individual archaeological artefacts will appear and will be placed based on appropriate location on model. When a user sees 3D scanned model of individual object, also metafile description will appear. The description will contain title, year of creation and specifications. At the exhibition also a short description of Emona male and female inhabitants life stories will be presented.

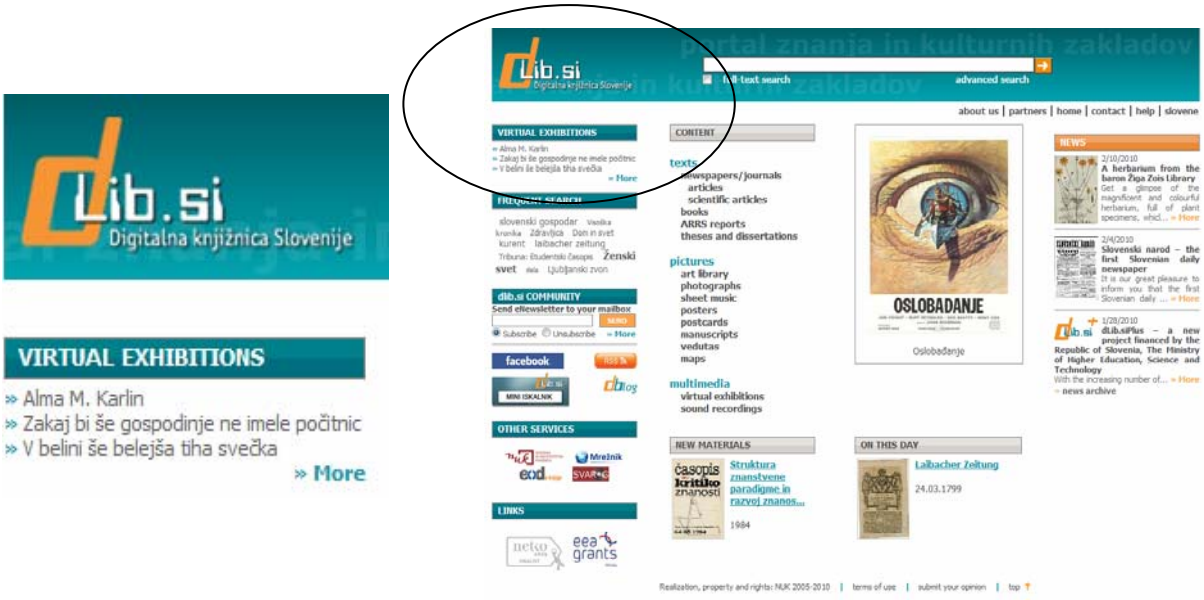

Figure 1: Web portal dLib.si

4. Roman Emona and content frame of the exhibition

In the first decade of the 1st century on the area of the present Ljubljana centre, on the left bank of the Ljubljanica river Romans raised their colony Iulia Emona. Regarding to the almost a century ago found stone, we know, that Emona already existed in the second half of the year 14 or at the beginning of the year15 [4] and we know that emperors Augustus and Tiberius built a large public building in the city, maybe – as predicted by J. Sasel reconstruction of the inscription [5] – walls with towers. Emona flourished from the 1st to 5th century. The city had a rectangular plan with central square, forum and system of rectangular intersected roads, between which were the buildings. [6] In the west-east direction under the roads, cloacas, larger canalization canals, which drained away the water to the Ljubljanica River, were running. Emona was enclosed with walls with towers, in spots with one or two moats filled with water. Some districts outside the walls were also settled. [7] As a Roman colony, Emona had a comprehensive belonging territory, for which it was the administrative, political, economic and cultural centre. From late 4th to the late 6th century Emona was also a bishop's diocese. The Roman Empire slowly decayed in the period between 4th and 6th century. Authority became more and more decentralized, communication between individual parts of the empire got weak and the Roman administrative system slacked. Life in Emona died away after the first half of the 6th century. [8]

Archaeological site NUK II (Figure 2) consists of four remained Emonian insulas (XVII, XIII, XXVII, XLVI), "apartment units, separated with roads at all four sides [1]" and crossing of two roads between them. Under the road which ran in direction E-W, laid a cloaca. In the late Roman period three of the four researched insulas (XVII, XIII, XXVII) were thermal city baths. In insula XXVII "in the first centuries of existence were above all apartments and workshops. In the late ancient period, in the end of 4th and in the first half of 5th century it became a part of recreational-amusement complex of the insulas XVII and XIII." [9] Arrangement of large heated spaces, bathroom equipment and small objects, like more than thousand coins form that period, bear witness that insula XIII was a part of recreation complex. "Coins were probably a share of large saving, which an owner lost or buried together with dices and chips, and were later on, because of different interventions, scattered into soil to 3 m² vast area." [9] Frescos in insula XVII from the 1st century bear witness to the greatness of the apartment building. This insula was, as well as others, united to bath complex in the late ancient period. "Central point of the building indubitably was a thermal bath with extension of 50 m² surface areas and depth of nearly 1.60 m. Around the bath large rooms paved with mosaics were arranged. Some of them were heated and resembled recreation spaces in public buildings. That confirms also a large public lavatory from the same period in the uttermost northwest corner of the building." [9] On site NUK II large number of archaeological artefacts have been also found: all sorts of clay (oil lamps) and glass vessels, coins, dices and chips.

Figure 2: Archaeological site NUK II
(Photographs by: Damjan Snoj, Aleš Ogorelec Archive MGML)

5. 3D technologies

Tools and processes of 3D technologies enlarge the effect of presentations of the contents on the internet, which today we mostly experience via flat two-dimensional screens. For a long time known phrase, that a picture says more than thousand words, is nowadays supplemented with the phrase, that a 3D model says more than thousand pictures.

Human perceives the environment in three dimensions. A whole process is running through watching with both eyes that see a picture in different colour hue. Brains combine both received pictures in a way that enables us to imagine environment in a spatial way. "People tried to transform this phenomenon into working by different techniques, all by the same designation – 3D." [12] "We can discuss three-dimensional (3D) as a part of computer

graphics after the moment when digital computer machines became capable enough to mathematically simulate perspective into flat plane." [10]

3D technologies can be defined as technologies, which enable a 3D phenomenon. They combine hardware, software and all processes, enabled by mentioned equipment. In practice among 3D technologies we consider 3D scanning and 3D scanners, 3D printing and 3D printers, 3D modeling, rendering and 3D computer graphics software, 3D viewers … We will discuss more about practical use of 3D technologies in the following section, where we are describing the starting phases of preparation of the Virtual Emona exhibition.

6. Project: Virtual Emona – 3D digitization and preparation of 3D scanned models for internet viewing

6.1 Project Introduction. Project of Virtual Emona represents the developmental project of preparation of the 3D virtual exhibition that will be accessed over dLib.si (www.dlib.si). As it is written at the beginning, this paper first describes phases from digital shape sampling and processing (DSSP) of data for internet publishing: 3D digitization, scan editing, texturing and exporting to appropriate file format. For exhibition preparation at first 3D digitization of the content was needed – model of the archaeological site NUK II and some artefacts from mentioned site. All 3D models need to be in appropriate file format for web publishing, as well as textured for better presentation.

6.2 Equipment

1) 3D laser scanner: ZScanner 800;
2) Laptops: Packard Bell, Hewlet-Packard;
3) Software: ZScan 3.1, Geomagic Studio 11.SR2, Photoshop 7.0, Magics 14.0, Rhinoceros 4.0, 3D PDF from Rhino V2.0;
4) Other equipment.

6.3 Aims. Emonian heritage is presented in museum environment in The National Museum of Slovenia and in The City Museum of Ljubljana which is managing also the archaeological parks in the wide centre of Ljubljana, where Emona was laying. Transference of heritage from physical to virtual environment of digital library d.Lib.si will bring the archaeological content via internet also to visitors from distant access. Cultural e-contents on World Wide Web are important for local public as well as for widespread recognition of Slovenian heritage in the world. Easier access to heritage contents is assured also to people with special needs.

6.4 Methods and results. 3D digitization of the archaeological site model and 3D digitization of museum objects from mentioned area were, because of different location of objects and terms, running separately. As model is kept by NUK, its digitization ran there (Turjska Street 1, Ljubljana). Objects are kept by The City Museum of Ljubljana, so 3D digitization ran in museum (Gosposka Street 15, Ljubljana).

Internal measures of the site model in scale 1:50 are 2017 x 1698 mm (without frame), height difference is 97 mm. At first it was needed to place a net with glue sticked reflective targets placed on the model, so that the scanner can position in space. Handheld laser 3D scanner ZScanner 800 works with ZScan 3.1 software, which generates polygonized surface in STL (Stereolithography / Standard Triangulation Language) file format in real time. Thus we avoided the step of generating point cloud to (STL) surface. In Geomagic Studio 11.SR2 software scanned data was edited to watertight model (Figure 3).

For preparing the model (scanned object) and its 3D scanning 10.5 h were needed, for editing data to watertight surface 20.83 h. Time of digitization process depends on size and complexity of the object and its texture. Equable and matte surfaces can be captured easier and faster. If an object is not complex, we can 3D scan with lower resolution, which accelerates the process because of the smaller amount of data that the software needs to process. For faster processing scanned data, 3D scanning was divided into 11 scans, which means, that the archaeological site model was saved in 11 different files, which were, during editing process, united to one scan (3D scanned model) with closed watertight surface. For faster and easier further manipulation of the 3D model and its texturing, file was reduced from 5.7 million of polygons (STL format – 1125 MB) to 1.7 million (STL format – 86 MB), which is still sufficient for un-deformation of details.

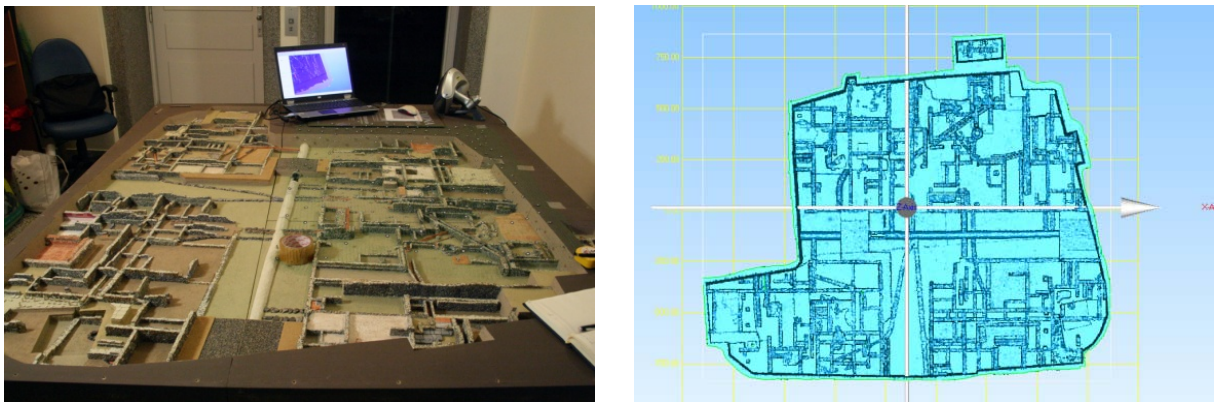

Figure 3: Model of NUK II prepared for 3D digitization (left) and closed surface of digitized model (right)

Nine archaeological objects were 3D digitized: part of amphora, four clay oil lamps, one bronze oil lamp, weight, appliqué and incense burner. For 3D scanning of small objects net is not needed, it is enough, that position targets are arranged over black grounding, on which we set an object. Uncontact scanning of the surface assures safe object handling, which is significant for heritage contents. Small artefacts scanned in resolution of 0.25 mm³, while the site model was scanned in 0.29 mm³ because of its physical largeness.

All nine objects were digitized in 7.75 h, for one object from 0.5 to 1.25 h was needed. Data editing to watertight surface was accomplished in 8.25 h, for one object from 0.25 to 2 h was needed. Digitization of some other smaller and larger object is also planned.

Examples of bronze oil lamp processes of texturing, exporting to 3D PDF and 3D printing of copy are shown. Oil lamp was important object of Roman everyday life. On site NUK II large number of clay lamps, as well as more precious bronze oil lamp was found. With lamps on olive oil Romans lighted houses, cottages and palaces over the whole Empire. By the shapes of all are similar, as their shape was defined by function: oil lamp needed to have space for oil, small hole for oil filling and small hole for wick. Motifs of figures from myths, erotic scenes, gladiators, animals and flower patterns were popular. Roman oil lamps from Emona were similar to other Roman lamps found hundreds kilometres away.

Along the oil lamp in size of 90 x 62 x 56 mm, its lid in size of 41 x 45 x 31 mm was found. Both objects were 3D scanned separately, edited to watertight surface and textured. For digitization and editing to textured model 9 h were needed, 7 h from that for texturing,

which ran in Geomagic software for scan editing, where the process is performed directly on 3D model. Geomagic exports map as PNG, JPEG, BMP and does not enable manipulating with photographs directly in UV map, like animation software does. UV map describes 2D net of the 3D model. Coordinate points of net are linked up with mesh points of 3D model. For texturing the oil lamp 20 different photographs (just sharpen parts) were used. Studio photographs were made extra for texturing process, because they need to be recorded orthogonal to the object and from different views, which is not a condition for documenting the museum objects, where usually three photographs are enough. All photographs need the same hue and lightness; otherwise edges between individual photographs are too visible. Larger depth sharpness is welcome, as it reduces a number of photographs that we use. Finished files of oil lamp and lid were saved into standard VRML (Virtual Reality Modeling Language) file format. We can save both parts into one file, but in simple 3D viewers we cannot view them and turn around objects independently (Figure 4).

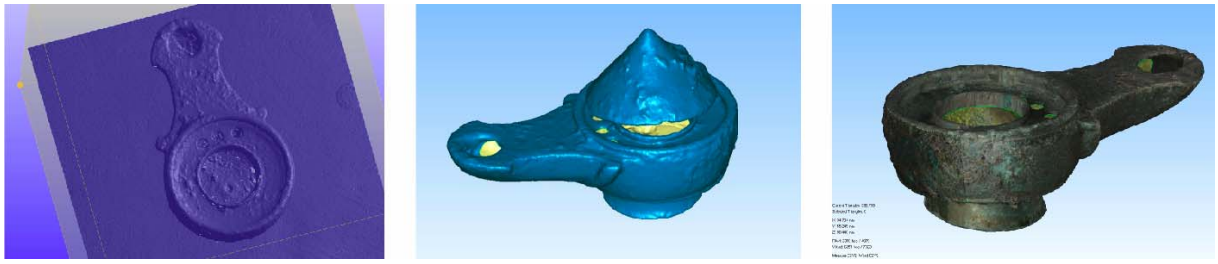

Figure 4: Original scan of oil lamp in ZScan (left),
watertight STL (middle), texturing process (right) in Geomagic.

On the internet we can find free 3D viewers for VRML files with basic interactive functions, which do not need huge computer virtual memory for their working. We decided to use widened and standard PDF (Portable Document Format) file format for viewing the 3D models on the internet. The reason was in the fact that dLib.si uses the same format for viewing the 2D documents, and PDF also supports the interactive 3D data. File format is standard by ISO/IEC 32000-1:2008. [12] VRMLs of lamp and lid were exported to Rhinoceros 4.0, over plug-in 3D PDF from Rhino V2.0 files in PDF were generated. Files can be viewed in Adobe Acrobat (from version 7 ahead). 3D PDF enables turning of the object, zoom in and zoom out, changing of background colour and different types of lightening (Figure 5). Export from VRML to PDF assures smaller file, thus oil lamp was in VRML 47.15 MB large, in 3D PDF 11.34 MB; lid is reduced from 14.2 MB in VRML to 4.73 MB in 3D PDF. As regular PDF file, 3D PDF can be uploaded to a computer or send via e-mail. Here we also need to mention the copyright of a heritage object. As professional photographs on the internet are protected by reducing resolution, we decided something similar to reduce number of polygons of 3D model. By this process we manually “deform” file to be unused for copy with 3D printers or similar machines.

The very idea of 3D digitization of the object assures that 3D model can be used for documentation, archiving, conservation-restoration and better heritage communication. With added texture model gains on recognition and interpretation. Every watertight object can be printed with 3D printer, other additive machine or CNC system. For promotion and presentation purposes of Emonian heritage, we made a copy of bronze oil lamp and its lid by

3D printer ZPrinter 450. 3D printed model is also an excellent tool in museum pedagogy. File checking for 3D printing ran in Magics 14.0.

Figure 5: Bronze oil lamp (left), virtual presentation of 3D digitized oil lamp in 3D PDF (right)

Figure 6: 3D printed copy of bronze oil lamp

7. Conclusion

On 3D technologies based virtual exhibition on Roman Emona, especially if set on the internet, offers a much easier access to the heritage contents to its users than the traditional museum instruments. Greater representation and interactivity are enriching the presentation of cultural heritage. It enables more precise insight into the object to the expert publics, and a stronger experience of the cultural contents to the general ones.

The beginning phase of the developmental project Virtual Emona is offering a ground for an exhibition, in the range of which a walk through the model of site NUK II and acquaintance with several archaeological objects is planned. At the same time 3D documented material is suitable for archiving and presenting several 3D models in the dLib.si multimedia collection, also in connection to Europeana. Momentarily the project is limited only to the archaeological site NUK II, but in the future it can be broaded to a wider Emonian or Slovenian heritage. The ‘opening’ of the Virtual Emona exhibition falls in with the exhibition Emona – the Myth and the Reality, that will be taking place in The City Museum of Ljubljana

from May 2010 till the end of the year. And we must not forget the year 2014, which will be denoted with the honouring of 2000th anniversary of Roman Emona.

Besides the quality capture and better data processing, according to the faster and faster 3D technologies, some other changes are also promising, i.e. changes with receiving the representing contents, that are momentarily shown in the direction of stereoscopy, auto-stereoscopy and hyper reality. Stereoscopy is known for a long time now. Its problem is above all in the fact, that for experiencing the actual 3D space, we need to have special (polarized, anaglyphic…) glasses. Auto-stereoscopic screens on the other hand enable the experience of 3D effect also without glasses.

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