Virtual Open-Air Museum of Wrecks in the Gulf of Gdańsk. 3D digitalization of underwater archaeological sites.

Tomasz Bednarz Ph.D.

National Maritime Museum in Gdansk (Poland)

80-283 Gdańsk, ul. Ołowianka 9-13, t.bednarz@nmm.pl

Abstract

In 2015, National Maritime Museum in Gdansk (NMM) have launched the "Virtual Open-Air Museum of Wrecks in the Gulf of Gdańsk". This website presents photogrammetric 3D models of wrecks from the Gulf of Gdańsk created in the NMM since 2013. Museum have developed an effective system aimed at compilation of records of underwater objects which has made it possible to create the 3D models featured on the website. Apart from their aesthetic qualities, the featured 3D models of wrecks constitute careful copies of the objects and make it possible to create sections, projections and animation of any kind. The website now contains thirteen 3D models of wrecks with their descriptions, photo and video documentation. By the end of 2018, NMM is planning to post on the website www.wsw.nmm.pl eight more wrecks from the Gulf of Gdańsk and more wrecks in the next years.

Main text

1. The project

Since 2013, the National Maritime Museum in Gdansk (NMM) has been developing an innovative method of underwater documentation creating photogrammetric 3D models wrecks from the Gulf of Gdansk.

In 2015, we have launched the "Virtual Open-Air Museum of Wrecks in the Gulf of Gdańsk". This website presents photogrammetric 3D models of wrecks from the Gulf of Gdańsk created in the NMM since 2013. The Wrecks come from the fifteenth to the nineteenth century. All wrecks were excavated by the NMM and the artefacts from them now are on the museum exhibitions.

NMM have developed an effective system aimed at compilation of records of underwater objects which has made it possible to create the 3D models featured on the website. Due to application of specific computer programmes of the SfM (Structure from Motion) category, we have developed an effective system aimed at compilation of records of underwater objects which has made it possible to create the 3D models featured on this

website. Apart from their aesthetic qualities, the featured 3D models of wrecks constitute careful copies of the objects and make it possible to create sections, projections and animation of any kind. Moreover, the models serve as an effective tool for monitoring and protection of underwater cultural heritage. The Wrecks can be viewed in three dimensions using virtual reality googles. In the nearest future, we have an ambition to compile archaeological records of all wrecks, both wooden and metal, occurring on the bottom of the Gulf of Gdańsk under the "Virtual Open-Air Museum of Wrecks in the Gulf of Gdańsk".

The website now contains thirteen 3D models of wrecks with their descriptions, photo and video documentation. At present, NMM inventories subsequent wrecks of 7 wooden objects from the Gulf of Gdanskand the remains of the Polish "Wicher" destroyer. The results of these activities will be published on the website of the "Virtual Open-Air Museum of Wrecks in the Gulf of Gdansk" (www.wsw.nmm.pl) at the end of 2018. "Virtual Open-Air Museum of Wrecks" website will contain a total of 21 models of underwater archaeological sites.

As a part of the inventory of each wreck the following actions have been performed: photogrammetric 3D documentation, photomosaic (top view), photographic documentation, video documentation, drawing documentation, sampling of wood for dendrochronology (allows to specify dating of objects), sampling of wood for physical examination, which allow to determine the degree of degradation of archaeological wood from the wreckage construction, relative to modern wood. Important parts of the project are photogrammetric 3D models of all underwater objects presented under the frame of "Virtual Open-Air Museum of Wrecks ". Beyond 3D models, each wreck contains: construction descriptions, research descriptions, dating (chronology of the object), provenance, drawings, photographs, films, all information and multimedia related to the object, as well as bibliographic data.

The advantages of 3D photogrammetric documentation of underwater archaeological sites are: short time needed to perform underwater photographs compared to the traditional method of underwater drawing (time shorter by 50%), high accuracy and detail of mapping the individual elements of wrecks, the ability to perform throws, cross and longitudinal sections and create their drawings documentation at any point of the object, creating of visually stunning animations and presentations for the exhibition and educational purposes (dissemination of knowledge in society about the underwater archaeological heritage)

3D models are a form of archiving objects over a given period of time and can be used to monitorthe degree of preservation of underwater objects. In case of observing any

changes on the site, re-model of the object can be done and compared with the initial one (overlapping). Monitoring of changes refers to both: the environment and human activities.

The concept of the project is in accordance with the recommendations of the UNESCOConvention on the Protection of the Underwater Archaeological Heritage. The methods used in the project allow documenting wrecks, in non-invasive way, using latest technology and monitor the state of preservation of underwater objects, as well as determine the impact of man and the environment on specific objects. This contributes to the effective protection of the underwater archaeological heritage.

2. Photogrammetric 3D documentation of the underwater objects

Preparation of the 3D documentation of each wreck was preceded by a series ofprior actions associated with the cleaning of object`s construction by the ejector. One of the activity that precedes shooting is the distribution of Ground Control Points (GCP) on the wrecks. On each object from 3 to 5 GCP were placed. Every point was properly measured including the distance between other points, the depth below sea level and its azimuth. Points can be assigned to the correct geographic locations in WGS-84 system. GeoTiffs derived from the multi-beam probe were also used to measure and determine geographic positions. Beside this in 2017 we used USBL MicronNav system for divers to geographic positioning and orientation of the underwater sites.

The photographic records for 3D models of wrecks were mainly compiled with the use of a Nikon D7000 camera with a Nikkor 10 – 24 lens in an Ikelite waterproof housing fitted with two Big Blue continuous light lamps, 15 000 lumens each.Each subsequent photo covered 60 – 80% of the area covered by the preceding photo. The photographs were made from the distance of approx. 1 meter from the object by moving along and across the site in order to acquire a full coverage of the object. The horizontal visibility under water did not exceed 1 - 2 meters. From 4 thousand to 18 thousand of images for each wreck had to be made. 3D models were mostly created in Agisoft Photoshop.

The PhotoScan programme is used to export georeferencing data in the form of a numeric model of the terrain (Digital Elevation Model (DEM)) which makes it possible to create bathymetric plans of wrecks, as well as GeoTiff photo mosaics on any plane. This data can be used in the GIS software, such as Global Mapper, Site Recorder or Qgis, and due to the information contained in the software it is possible to conduct precise measurements, as well as create cross-sections and projections of the site.

Fig. 1. 3D photogrammetric model of the 18th century wreck W-27 “De Jonge Seerp”. Archive NMM.

Fig. 2. Ortophotoplan of the 17th century wreck F53.30 “Glass wreck”. Archive NMM.

Bibiliography:

- T. Bednarz, *Badania archeologiczne legendarnego Porcelanowca z Zatoki Gdańskiej.* In: B.Możejko (ed.), *W Epoce Żaglowców. Morze od Antyku do XVIII wieku, 2016*: 227- 236. Gdańsk.

- T. Bednarz (in print), *Wirtualny Skansen Wraków Zatoki Gdańskiej. Wirtualny Oddział Narodowego Muzeum Morskiego w Gdańsku.* Gdańsk: NMM.

- T. Bednarz, J. Różycki (in print),*Research of the wrecks in the Gulf of Gdansk using photogrammetric 3D documentation.* ISBSA 14. Gdańsk.

- T. Bednarz (in print), Research of the seventeenth-century "Glass Wreck" using photogrammetric 3D documentation. The project "Virtual Open-Air Museum of Wrecks in the Gulf of Gdańsk", IKUWA 6, Fremantle (Australia).