3D RECORDING OF WOODEN ARTIFACTS FROM SHIPWRECKS BEFORE THE PHYSICAL RESTORATION

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The fragility of organic artifacts in presence of water and their volumetric variation caused by the marine life on or surrounding them lead to the need to measure their physical dimensions right after their extraction from the seabed. In an ideal context, it would be appropriate to preserve and restore all the archaeological elements rapidly and with the latest methods. Unfortunately the large number of artifacts makes the cost of the operation prohibitive for a public institution. For this reason, many public laboratories are resorting to digital technologies for documentation, restoration, display and conservation. In this poster, we illustrate the experience of the University of Salento in this area of archaeology using 3D imaging technology. The interest originates from the need to develop a protocol for documentation and digital restoration of archaeological finds discovered along the coast of Torre S. Sabina (BR) Italy. Digital modelling using 3D imaging technology (e.g. 3D laser scanners for the acquisition) facilitates detailed studies of artifacts without direct contact with the fragile surfaces and also offers innovative analysis tools. These tools range from the possibility to zoom in order to examine and measure tiny details of the surface to the detection of marks left by tools. Furthermore, the possibility of creating sections of the artifact without destroying it, ensuring the reproducibility of the archaeological find using rapid prototyping technology and offering the opportunity to study remotely and virtually bring about a new way of understanding our past and hence open a door into that past for future generations.

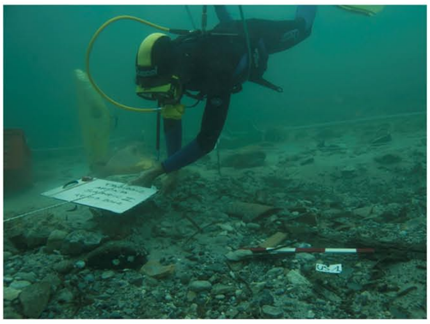

Fig. 1. The underwater site of Torre S. Sabina.

Fig. 2. The the artifact, along with other fragments of smaller sizes, is immersed in fresh water inside a special tank. The water is changed on a regular basis.

Fig. 3. Minolta ® Vivid 900 that was used for the 3D laser scans.

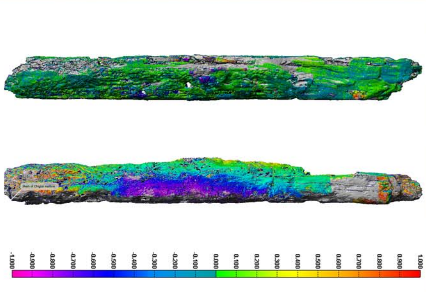

Fig. 4. Colour coding showing the dimensional variations between morning and afternoon.

The University of Salento, Italy, has been conducting numerous underwater archaeological surveys along the Ionian and Adriatic coast of Salento. In the last 20 years, 550 isolated finds and 88 wrecks have been uncovered. Many of these sites are composed of organic materials. For instance, wooden specimens once recovered from the seabed would have naturally deteriorated through desiccation, bacterial and fungal decay, and wood-boring organisms if not for appropriate conservation and restoration operations. Even after a first consolidation treatment they still require frequent and continuous monitoring before their final consolidation, i.e., reinforcement or stabilisation. The techniques of wood restoration are expensive and usually irreversible. Therefore, they do not always yield the best results. We considered it necessary to record and document the size of the organic specimens at the "time" of their recovery using 3D digital imaging technology.

Three-dimensional (3D) digital technology applied to the restoration of wooden cultural heritage artifacts is not a new practice, nor is its application to relics found in an underwater excavation. In our case, however, it was necessary to prepare a protocol to be applied to materials requiring immediate restoration. The first experiment was on a large wooden fragment (110 cm long, 12 cm wide and between 6.5 and 10 cm high), probably an element of the axial carpentry. Radiocarbon dating gave a chronological window of 510-350 BCE (with a probability of 65.4%) and 300-200 BCE (with a 20.8% probability).

A Minolta ® Vivid 900 laser scanner was used to acquire 3D images of the artefact. The presence of "noisy" areas and of surface deficiencies in the digital 3D model indicated that the artefact had suffered important dimensional changes throughout the day of the acquisition. To determine with certainty whether the dimensional changes were caused by the progressive dehydration of the artefact or by a mechanical cause e.g. the handling or crushing of the wood under its own weight, we have decided to carry out tests on a smaller sample (approx. 15 cm. in length) that detached from the rest of the main artefact of interest. The creation of the 3D models of that sample was performed with a high resolution laser scanner from ShapeGrabber®. This scanner is equipped with a rotating base which allows 3D scans all around individual artefacts in a completely automatic way which minimizes the handling time with fragile artefacts.
On the first day, five series of scans, at intervals of two hours were performed. Each series consisted of 12 individual scans in automatic mode. In the following days two scans at an interval of approximately 6 hours were performed. Temperature and humidity were constantly monitored but not controlled. To aid in the tests, a verification object of known size and shape was added in the field of view near the artifact in order to constantly verify the equipment.

The weight of the sample was 848 g just after extraction from the water and after water was drained. The test was finally concluded eight days after the start. The sample artefact was still wet and weighed now only 264 g.
Over a period of 7.5 hours in the first day, the dimensional variations appeared uniform. The average dimensional variations that the wood has suffered amounted to around -0.6 mm. In some points instead, where they were already clear fractures present, the wood has continued to have positive displacements (bulging). These values are consistent with those seen on the large wooded relic, and confirmed that in a day, due to the evaporation of water, there has been a general decrease in volume, although modest (-0.6 mm), of the relic itself, in proximity to the more or less deep fractures. The changes that occurred in the following days instead were much greater.

The application of 3D technology to underwater wooden artifacts has proved to be very useful. With regard to the specimens from the boat of S. Sabina, the operation has allowed us to confirm quantitatively the progressive decrease in the volume of wood extracted from the water, something which is already known, but has allowed us to determine the time frame within which one can operate out of the water without the artifact suffering significant morphological changes, i.e., typically hours using our set-up at the University.
This information is useful, for example, to schedule 3D survey and restoration. Thanks to this work, we are in a better position to start defining a protocol to follow for all waterlogged wooden artifacts requiring documentation and restoration. The restoration will be carried out after a complete 3D survey at high resolution and consolidated specimens can be resubmitted to a 3D scan to monitor any changes in form and size as a result of the consolidating treatment performed. As noted by many authors, 3D imaging does not provide a complete picture. The examination of artifacts should be done by a wood specialist. Therefore, 3D imaging should not be seen as a substitute for the conservation and curation of wooden artifacts, but remains a valuable tool. Indeed, this technology provides tools that facilitate detailed studies of artifacts without direct contact with the fragile surfaces and also offers innovative analysis tools. The tools range from the possibility to zoom in order to examine and measure tiny details of the surface to the detection of marks left by tools. Furthermore, it offers the possibility of creating sections of the artifact without destroying it and a way to reproduce archaeological finds using rapid prototyping technology. The solution identified for virtual restoration has given us the chance to experience new fields of application of 3D laser surveys and processing. This solution has opened up the possibility of extending the virtual restoration to new forms of dimensional analysis and to ensure remote fruition of the artifacts. This offers an opportunity to study remotely and virtually bring about a new way of understanding our past and hence open a door into that past for future generations.

ACKNOWLEDGEMENTS
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REFERENCES

Bandiera, A., Alfonso, C., Auriemma, R., & Di Bartolo, M. (2013). Monitoring and conservation of archaeological wooden elements from ship wrecks using 3D digital imaging. In Digital Heritage International Congress (pp. 113-118).

Fig. 5. Test sample positioned on top of a control object and on a rotating stage to automate the 3D scan acquisition phase.

Fig. 6. The test sample. Its weight was 848 g when it was extracted from the water tank and drained of excess water. The test was concluded after eight days from the start day. The test sample was still wet and weighed now only 264 g.

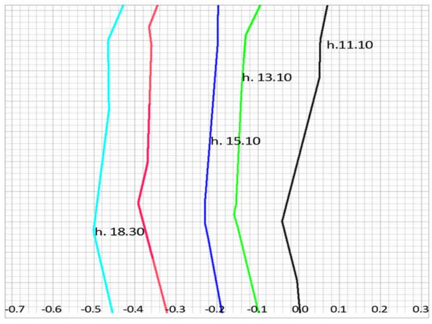

Fig. 7. Dimensional variations on some profiles acquired during the whole day.

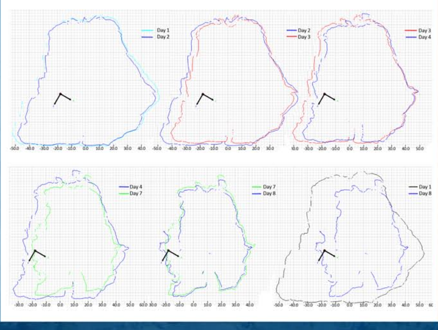

Fig. 8. Typical dimensional variations that took place over a period of 8 days. (Typical sections were used here to illustrate the changes).

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