*The Madrague de Giens ship and the photogrammetry from the past: completing the study of an exceptional roman wreck*

In 2019, thanks to a grant from the White Levy Program for Archaeological Publications, the Centre Camille Jullian team has undertaken a project in order to complete the study and publish the final report on the iconic excavation of the Madrague de Giens wreck, almost fifty years after the first dives on the site.

Indeed, if the first campaigns have been published in a monography in 1978, the data from the last five years of excavations remain either unpublished or scattered in various articles, often focused on specific aspects of the excavation. The resumption of the study therefore corresponds to a collective will to publish an important and unseen part of the documentation while seeking to complete both the study of the cargo, the study of the ship and to purpose a reconstruction of the ship.

To achieve these objectives, we have identified five complementary areas of work that are the subject of our presentation today:

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* First of all, it was necessary to carry out a complete study of the small ceramic material, which had not been studied in depth previously, beginning with the crew belongings to end with the important quantity of tableware transported alongside the amphorae.

DIAPO 3

* Considering the very important photographic collection it appeared necessary to digitize the photographic font composed of more than 11'000 negatives

DIAPO 4

* In order mainly to attempt to generate a photogrammetry of the site from the digitized negatives using in particular the stereophotographic coverage carried out between 1972 and 1982

DIAPO 5

* Considering the new data given by both the ceramic study and the new phtogrammetric documentation, it seemed necessary to precisely relocate all these discoveries on the wreck in order to perceive specific areas within the cargo, dedicated to certain amphorae or to other goods, as well to distinguish particular spaces on the ship such as the kitchen. In order to improve this recontextualization we have produced a GIS including all the elements of the cargo.

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* It is this same photogrammetry, combined with the original 2D documentation, that could allow us, in the end, to complete the architectural study and to reintegrate the cargo into the final 3D reconstruction of the ship. This leading eventually to complete the reconstruction of the shape and structures of the ship in order to specify the dimensions and the precise tonnage of this exceptional merchantman.

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Before coming back in detail on these five major points of our study, it is perhaps necessary to recall some essential points of this excavation which took place in the south of France, between 1972 and 1982, not far from the peninsula of Giens, in front of the small port of La Madrague which gives its name to the wreck.

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Excavated during 10 years by the team of the Centre Camille Jullian with the support of the DRASSM, the excavations revealed the remains of an important merchant ship from the middle of the first century BC.

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The site extends over nearly 40 m in length and with a tumulus composed of at least three levels of dressel 1 amphora, the excavation is thus broken down into 8 sections allowing to cover almost the entire boat. Two zones were left untouched by any excavation.

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Given the importance of the deposit, the excavation work was divided in two during each campaign, with a first phase dedicated to the cargo…

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… then a second dedicated to the study of the boat.

From these eleven campaigns remain today an impressive quantity of data only partially published.

DIAPO 12

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DIAPO 13

Regarding the digitization of the photo negatives, the work was realised, under the supervision of archaeologists and photographers of the team, by a private company specialised in digitization of photos and videos of various formats. From a more technical point of view, it will be noted that all of these scans (performed with a resolution of 35 cm x 35 cm, 300dpi, RGB 8bits) represent around 500 GB of data that were distributed various formats for a total of 10171 photos.

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There were several goals for this digitization. If one of the major objectives was to try to generate new photogrammetric calculations based on the set of stereoscopic photographs taken between 1972 and 1982, the digitization was also very important on several other aspects.

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These photos illustrate the underwater excavation but also a large part of the collection of ceramic material recovered during the excavation. This is particularly valuable data. Indeed the ceramic material from the excavation has been the subject of several thefts while in storage, which resulted in some serious gaps in the documentation. The digitization of this daily photographic coverage therefore allows us to complete our data.

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This is the case, for example, for the oil lamps which were particularly affected by these burglaries: 25 lamps are listed in the inventory books, but only one lamp was spared and conserved today. The study of this class of object can be completed after the photos and inventory journals. This is just one example that illustrates the importance of digitizing this huge photographic collection.

All these photos should soon re-join the Madrague de Giens photographic fund in the photo library of the Centre Camille Jullian and will be freely available online.

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As we just said, part of the photographic documentation preserved concerns shots intended for stereophotogrammetry restitution using stereoscopic pairs. We wished to exploit this documentation by using modern technology, i.e a photogrammetric software based on dense correlation point cloud. The objective was to obtain a three-dimensional representation of the photographed areas and then derived productions (ortho-photos, Digital Elevation Models).

A first inventory of the negatives carried out for the periods between 1972 and 1975 counts 50 covers, for approximately 400 shots. The number of images for each cover varied initialy from 3 to 15 images but often the shots taken from various angles are also usable for the photogrammetric calculation.

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Beginning with the 1975 campaign, when the central part of the hull was finally visible, we first tried to verify the coherence between our reference plan (naval architecture plan) and a first photogrammetric calculation. The ortho-image from this first calculation was then compared to the reference plan in order to verify the correct superposition of the results.

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Although errors and inaccuracies related to the different survey methods persist, as you can see here with details of the 2021 photogrammetry put in relation with the planimetry established in 1975, the results were encouraging.

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We have therefore applied the method to all the photos of the different campaigns. We thus obtain, just for the hull but not the cargo, 10 sets of photos with 18 to 44 images per cover, for a total of 267 photos.

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It's worth to note that the result is not only an orthophography but a real three-dimensional model. If the final result obviously does not reach the standards of current three-dimensional documentation, we can however be satisfied with the result obtained which allows to specify the surveys previously made on the wreck.

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We now come to the work on the GIS.

The general objective was to reposition the material discovered during the ten annual excavation campaigns (1972-1982), in order to replace precisely the cargo and to identify significant sets like the kitchen or the personal belongings of the crew.

We initiated this work with a careful examination of the excavation archives from the excavation notebooks and operation reports to the plans, stereophotogrammetric covers, photographs, handwritten notes, sketches and furniture inventories.

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Facing the important quantity of objects discovered during the excavations, the excavation teams had set up a method of planimetric location of the material that we kept as a guideline. Initially, only the most significant elements were positioned: the most voluminous objects (mostly amphorae), were labelled underwater and therefore identifiable on the stereophotogrammetric plans and the numerous photographs. The rest of the finds having been located in relation to these well referenced materials are therefore positioned and integrated into the GIS in a second phase. Like this small ceramic which has been repositioned in relation to amphoras n°300 and 305, clearly visible on the various plans and photographs

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 From a methodological point of view, the positioning of the objects is done as follows

- the work is carried out by year, one excavation campaign after another, starting with the objects of the lower layer (in contact with the hull of the ship) and successively going up into the upper layers;

- if one or more planimetries are available, they are georeferenced and integrated into the GIS;

- the objects are positioned in priority in relation to the visible naval architecture (on plans and photographs), then, the rest is in relation to the plans, photographs, inventory data and sketches of the excavation books.

The positioning of the objects remains relatively precise. However, even if we cannot guarantee an absolute positioning of the objects, the overall logic is preserved.

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We have so far repositioned nearly 2700 amphorae and 270 smaller objects. Among them, it's worth to note that the elements that can be interpretad as part of the kitchen, like the fragments of tegulae, the bricks as well as the bread bell are all relocated on the forward port side of the ship.

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The last objective pursued during our present research project concerns the completion of the reconstruction of the shapes and structures of the boat. This work was initially based only on the original 2D documentation produced between 1972 and 1982. However, as for the ceramics, it was obvious that some data remained unexploited and allow today to do a much more detailed work.

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It is in particular with regard to the numerous samples made on the wreck: between 1975 and 1982, no less than 7 fragments of the wreck were cut up and brought to the surface for analysis and precise documentation. The study of these fragments is today largely unpublished and brings a great number of details on the construction of the ship.

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We have therefore chosen to model precisely in 3D these different samples in order to integrate them into the reconstruction work.

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This reconstruction, which begun with the combination of the original 2D data, is now greatly improved by the 3D of the samples and the new photogrammetry produced in 2021.

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As of today, the reconstruction is still in progress and enter its last phase. The new lines of plan are finalized and the reconstitution of all the elements of the ship are in progress;

This reconstruction work, in continuation with the ceramic study and the GIS, should soon allow us to measure very precisely, the weight of the ship, the importance of the cargo and to put in light the various living spaces of the ship.

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