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Digitising Wrecks on the Foreshore: The Case of a Seventeenth-Century Wreck in Brittany, France

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Abstract

Studying archaeological sites on the foreshore gives rise to its own set of specific problems. Historical wrecks buried in the sands at intertidal zones usually come to our notice through natural erosion or human activities, or both. Such threats affecting the sites can also accelerate their deterioration, even their obliteration. Intertidal wrecks are evidently a precious and irreplaceable testimony of maritime heritage, and yet they are very fragile. It is a real challenge for researchers to find adequate ways to study them.

One such study undertaken in France focused on the small tonnage ship known as Erquy-les-Hôpitaux on the Brittany coast. This was a small coaster, which carried mainly lime mortar and foundered in the seventeenth century.

In 2015 DRASSM, France's Underwater Archaeology Research Department, conducted a special study of this wreck in order to define and assess various approaches to collecting archaeological data. The first phase of the study looked at three-dimensional digitisation techniques. Generating a 3D model of the wreck enabled the archaeologists to continue their studies after the excavation, and in greater detail. It also proved to be a valuable asset for presenting the project to the general public.

Most foreshore sites of archaeological interest are subject to the action of the tide, a constraint which requires archaeologists to rethink their usual methods for working on land or underwater. They also have to define technological tools that allow them to document artefacts effectively and in a short period of time, in particular, the merits of 3D laser scanning compared to photogrammetry.

Keywords

Wreck, coaster, 17th century, foreshore, digitisation

Introduction

The foreshore is a zone situated at the interface between the land and the sea. While its configuration may vary from one coast to the next, its value as an abundant repository of our maritime heritage is considerable. It contains sites from every age, such as submerged megalithic tombs, Palaeolithic settlements, fish weirs, cemeteries for the drowned whose religion was unknown, wrecks of ships and aircraft, and so on.

These remains face a double threat which consists, on the one hand, of coastal erosion, human-made constructions and safety works; and, on the other, of looting from, in particular, detectorists who at best

damage sites if they do not destroy them forever (Poudret-Barré 2013: 127–36).

Background

Ships that have beached during storms or because of technical failure often find themselves entombed within the sands of these intertidal zones. Surveys are, of course, carried out at such locations but they are perfunctory and rare for want of suitable tools for the job, and the capacity to document artefacts in between tidal movements.

DRASSM, a department of France's Ministry of Culture and Communication, is responsible for underwater

archaeological research at the national level. It has, for many years, been looking at technological solutions and, above all, methods that can ensure surveys and studies of sites lying in intertidal zones. For this reason, in 2014 DRASSM launched in France, on the coast of Brittany, a long-term programme to try out a range of methods and solutions on a series of wreck sites.

The first of these wrecks is known as the Erquy les Hôpitaux. Discovered along the Breton coast in 2002, the wreck underwent an initial survey the same year but had to wait another twelve years before a further study of the site was conducted. Since 2014 the site has become a testing ground for excavation methods that could be suitable for intertidal zones, in particular the deployment of three-dimensional recording techniques. Excavations on the wreck were directed by Olivia Hulot and Marine Jaouen (DRASSM) in collaboration with Eric Rieth (CNRS).

Constraints

The wreck is 9 m long, 3 m wide and completely buried in the sand in an area of the beach which gets submerged at high tide. After stripping the surface mechanically, the remains were uncovered by hand.

The excavation strategies deployed were adapted to the constraints of the surrounding environment, in particular a nearby river—the Islet—which flooded the site on numerous occasions. To get around this, we installed drainage channels and a soakaway which, in conjunction with a pump, displaced the excess water from the centre of the hull to a point further down the beach. Between each tide window we protected the structures from the pounding waves and the encroaching sediment by covering them entirely with plastic tarpaulins which were held in place by sandbags.

In addition to the usual manual recording techniques, we tested two digital methods:

Laser Process

First, data was acquired in the field through the use of a FARO Focus 3D-X-330 scanner. It was operated by a technician from the Conservatoire Numérique du Patrimoine Archéologique de l'Ouest, which is based in Rennes, Brittany. The technician completed seven measuring sessions, each lasting ten minutes. In total, we devoted two hours to laser surveying. We processed the data using SCENE software which allowed us to generate a point cloud, while the rendering was done with Unity 3D.

Where this laser method encountered problems was in the mirror effect (Figure 1) created by the ground water which, during the measuring sessions, rose

progressively and could not be discharged. This constraint interfered with data acquisition and, unsurprisingly, had significant repercussions for the accuracy and detail of the resulting point cloud. In view of the length of time required for the acquisition, this method had to be rejected.

Photogrammetry Process

The second digitisation method under consideration involved taking a series of 3D photographs—done by a professional photographer—of the remains, in compliance with certain criteria, the principal ones being:

- Photos must overlap with at least four other photos by sixty to seventy percent of their surface and be spaced approximately fifteen degrees apart;
- Photos must contain metre sticks to allow for determining scale and calculating errors; and
- Photos must be free of shadows.

One of the 3D images comprised 885 separate photographs, which, once processed with the software Agisoft PhotoScan, produced a dense point cloud for the wreck. The mesh resulting from the dense point cloud gives a 3D model or, in the case of the Erquy wreck, a 2.5D model because the underside of the hull was not digitised. Texture can be added to the point cloud, it being calculated from the photomosaic of the model. Errors are calculated from standardised reference points placed on the ground, and this enables the model to be adjusted to scale.

The 3D model is georeferenced with help from topographical points that are determined during the excavation and used to generate a digital model of the terrain (Hulot *et al.* 2015). A vertical, azimuthal projection of the 3D model provides an orthophotograph of the remains. The planimetrics of the remains were obtained by vectorising the orthophotograph of the site (Figure 2).

Contributions from GIS

Importing this post-excavation process into a GIS project, in this case QGIS, saves a considerable amount of time when working in the field during low-water windows.

The planimetric view of the site, obtained from the orthophotograph and imported into a GIS project, allows the archaeologist to make a spatial analysis of the data. Thus, all the components of the hull, including treenails and metal nails, can be vectorised piece by piece and joined to an attribute table. This table allows the user to generate planimetrics that highlight the

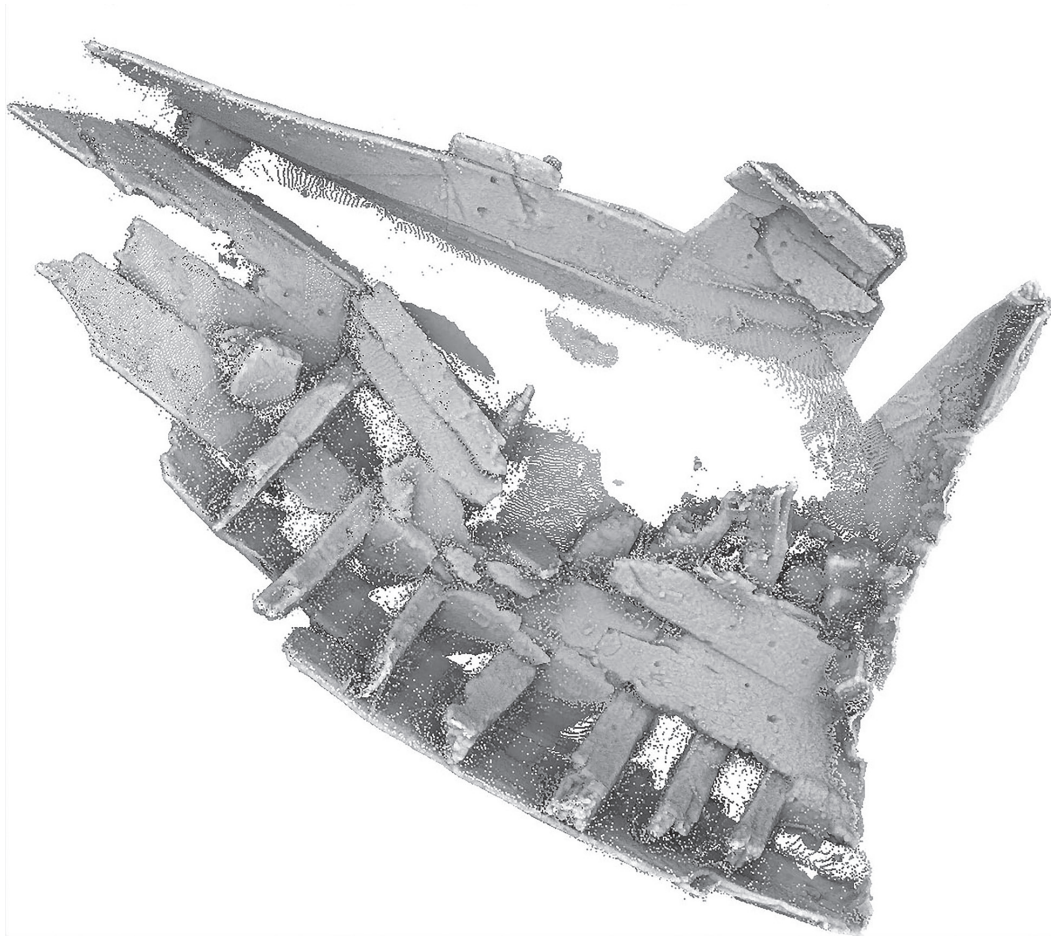


Figure 1. Mirror effect with laser process (Y. Bernard/Université Rennes 1).



Figure 2. Orthophotography of the wreck (Service 3D).

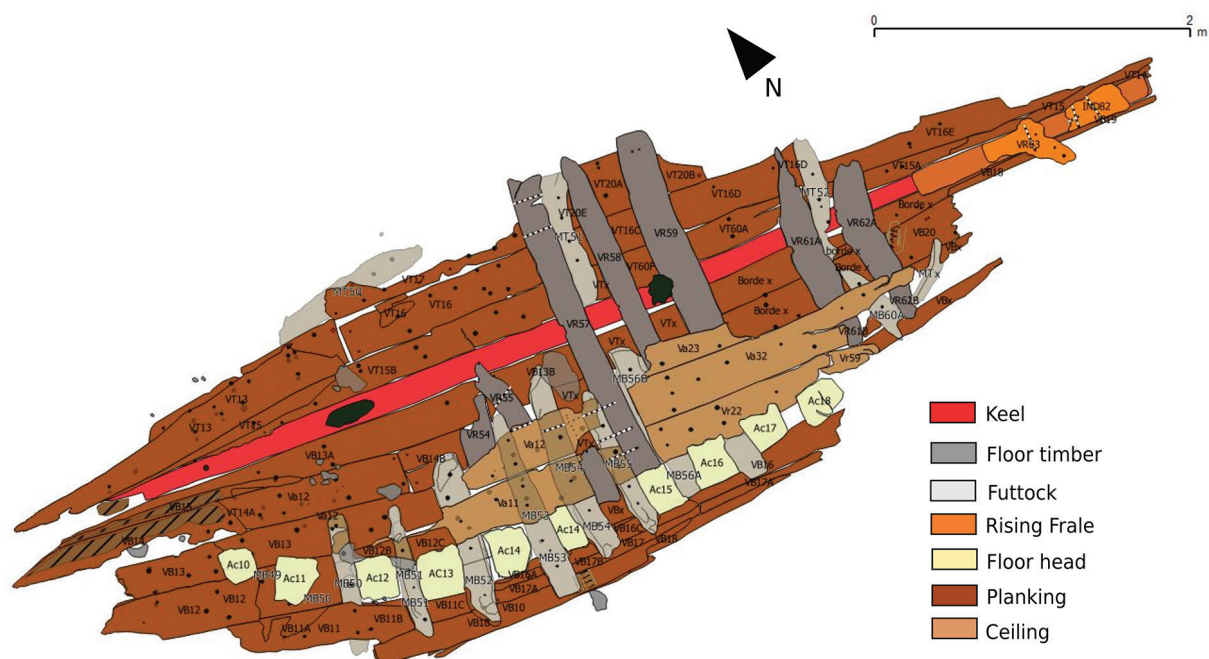


Figure 3. Vectorisation of the hull (MCC/DRASSM).

conserved items according to their type (keel, floor, plank, and so on) or depending on their material (Figure 3).

Importing the digital model of the terrain into a GIS project also allows the user to generate cross-sections and longitudinal sections (Figure 4). When we compared the measurements of the sections obtained from the post-excavation work with those obtained in the field, the results were very satisfactory. That said, interpreting the results of the manually obtained sections is clearly easier because the archaeologist can analyse the features in greater detail.

Archaeological data

When we analysed the design of the wrecked ship we discovered some very unusual architectural features, which make it a unique archaeological find. For example, all but one of the floor timbers were not fastened to the keel. In addition, except for two, none of the futtock timbers was fastened to a floor timber. These unusual design features of the Erquy wreck cannot be described in terms of 'primitive frames' or even 'primitive planking'. For the moment, without another archaeological example of this type of vessel, it is difficult for us to determine whether we have stumbled on an isolated case or are dealing with architectural features that are characteristic of some regional shipbuilding tradition.

The dimensions of the vessel have been estimated as follows: she was 9m long, had a 3.38m beam, and an

approximate tonnage of nine. This suggests she was a small coaster involved in regional trade. Sailing in waters bordered with numerous sandy shores, the Erquy vessel was built for beaching both empty and laden. Wheat, firewood, slate tiles and lime were typical products of the Breton hinterland and undoubtedly constituted the main cargoes for the coaster as she worked to and from the great shipping hub in the region that was Saint-Malo (Le Bouëdec 2008: 9–37).

Wood Analysis

For the wooden components of the wreck Catherine Lavier of Paris 6 University identified the species used and dated them by dendrochronology. Elm was predominant in the ship's frames and planking, although some of the frames were made of oak. Only the keel was made of beech. The construction timbers were felled in the autumn of 1628 and were probably put to use the following year. Environmental periods were determined for the felling of the timber used in the frames and the barrels.

Restitution of the hull shape and sails

By analysing and interpreting the data from the 3D reconstruction, we were able to reconstruct the vessel's lines. We chose Rhinoceros 3D software, which has already been used by many international teams, to aid us in our subsequent study of the hull (Figure 5).

Three-dimensional drawings of the architectural elements are essential if the archaeologist is to analyse

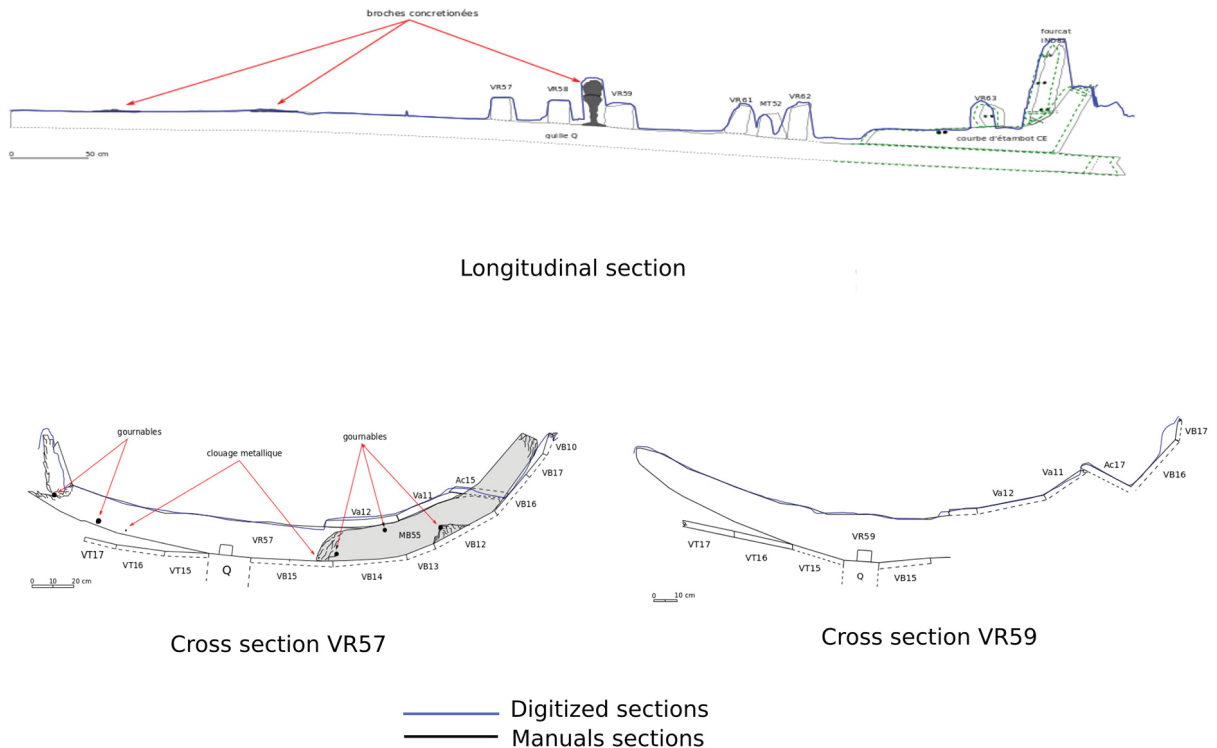


Figure 4. Comparison of manual and automatic cross-sections (MCC/DRASSM).

distortions piece by piece. In the case of the Erquy wreck, we made twelve cross-sections at characteristic points. These uncorrected sections were then placed on the keel in order to reproduce the shape of the hull as it was at the time of excavation. This allowed us to visualise the lines of the ship's bottom.

By modelling the stem we were able to appreciate the rake of the bow. The initial rake of the sternpost was reconstructed thanks to the skeg of the keel and the curve of the existing part of the sternpost. The waterlines were then established. These lines, which define the 3D shape of the hull, allowed us to reconstruct the lines plan for the ship after much refining.

Finalising the wreck's lines plan helped us formulate hypotheses concerning the ship's mast and sail plan. Despite our efforts being hindered by the absence of any keelson or mast step, the fact that one of the floor timbers had a heavier section than the others allowed us to be confident of the mast's position.

We were also able to compare this data with a few rare written sources, as Pâris (1882) Forfaix (1788), Morineau (1763) or more precisely an anonymous album (1679) of drawings, which shows various inshore and offshore vessels that worked the Atlantic coasts. This source is both contemporary with the wreck and geographically

coherent with our study. It depicts only one type of rigging: square sail. From this premise, two hypotheses are suggested: the vessel could have been single-masted or two-masted, the latter comprising a foremast and a mainmast (Figure 6).

Conclusion

Somewhat more accurate, the laser system could provide a significant amount of measurements and a higher density of points for the point cloud than the photogrammetric technique. However, these advantages are to be weighed against the practical issues that arise from the laser technique. For this, the following should be taken into account:

- The cost of the equipment;
- The deployment time required in the field—more than twice the time is needed for an equivalent coverage via the photogrammetric way; and
- The relative complexity of the whole process from the acquisition to the restitution.

It is most likely this last point that led us to prioritise the photogrammetric method, since it can be used single-handedly by any archaeologist and photographer skilled enough to follow simple rules of acquisition, and does not require the enlisting of any technical specialist

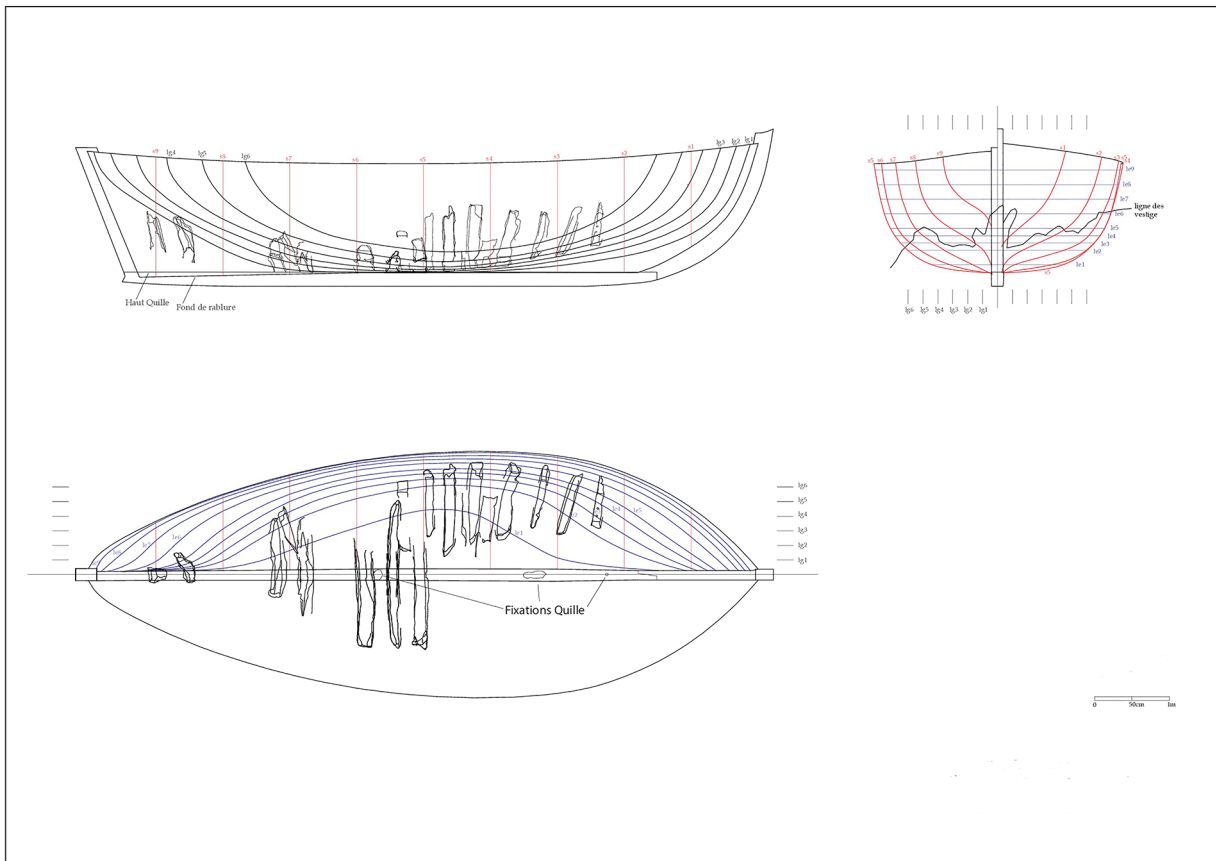


Figure 5. Reconstruction of the vessel lines (S. Bertoliatti).

specifically trained to be deployed on fieldwork during the acquisition phases. The delivery products can also be managed by archaeologists provided they learn to use software such as Agisoft PhotoScan, which are more commonly being used in archaeology.

Three-dimensional digitisation from photographs is a useful tool for both documenting and analysing—post-excavation—wrecks found on the foreshore. It also helps communicate the archaeologist's work to the wider world. In addition, we were able to present one of the models on the platform Immersia at Rennes 1 University in Brittany. Measuring 10 x 3 x 3 m, Immersia is one of the largest virtual reality rooms in the world.

Since the trials on the coaster of Erquy-les-Hôpitaux, other studies have been carried out on wrecks situated on the foreshore of France's coasts and these confirm, if confirmation were necessary, the essential contribution 3D digitisation techniques make to the study of archaeological remains in intertidal zones.

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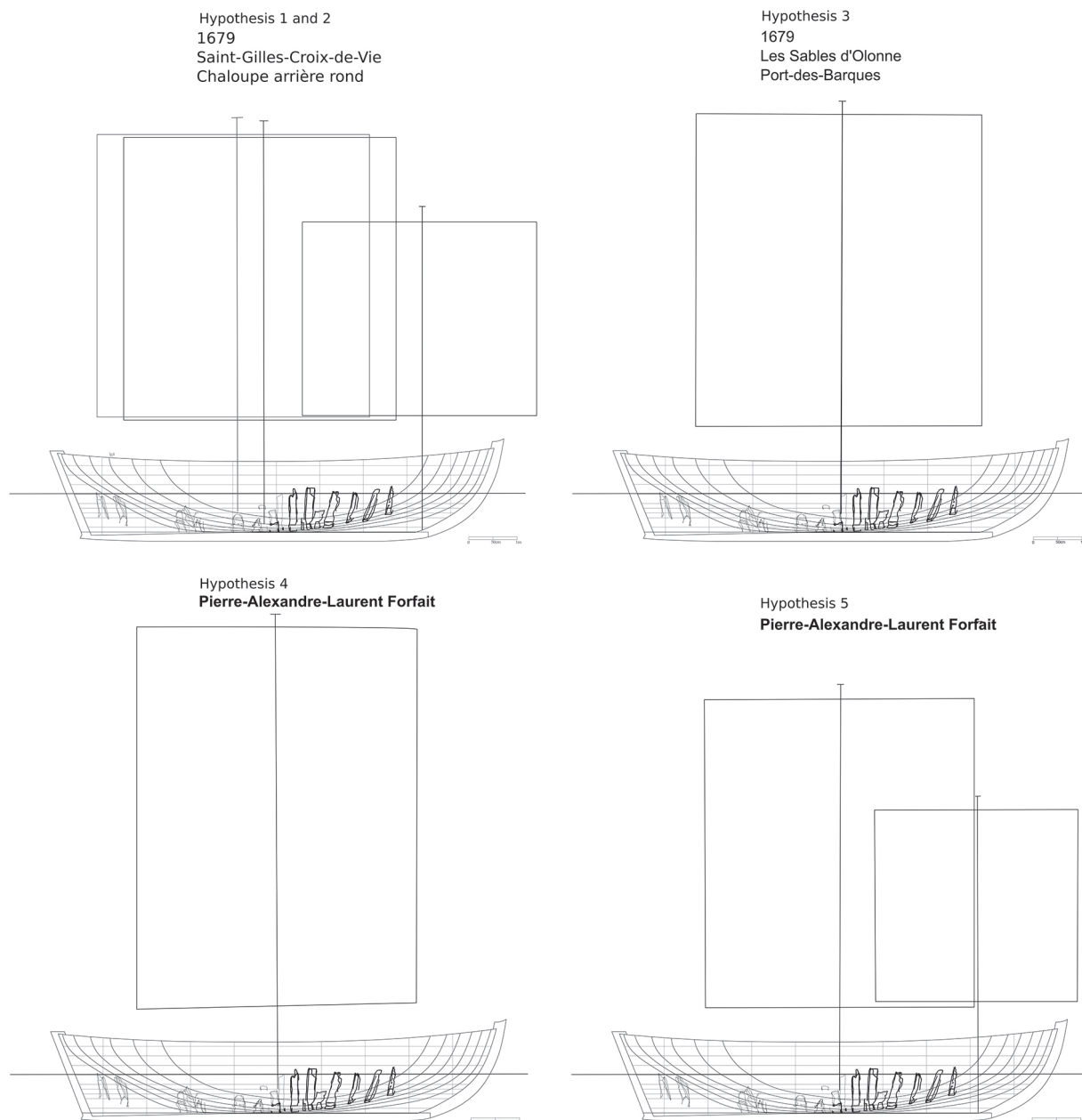


Figure 6. Hypothesis of the hull's shapes and sails (CNRS/DRASSM).

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