

Written Historical Sources on shipbuilding and the archaeological study of a post-medieval Mediterranean shipwreck: the *Gagliana grossa* case study

Mauro Bondioli – Mariangela Nicolardi – Irena Radić Rossi

Abstract: During the excavation campaigns conducted on the Gnalić shipwreck dated to the late 16th century, problems pertaining to the documentation, interpretation and graphic representation of the hull's structural elements were addressed. A project was launched with the aim of finding a solution that combines archaeological data with iconography, archival documents and written sources about shipbuilding. Using 3D graphic technologies, the idea was to sketch the probable shape of the entire hull and update it as the excavations proceed. Archaeologists should always be able to monitor the progress made in the study of the ship in this way.

Keywords: Renaissance shipwrecks, written historical sources, virtual modelling, shipwright, knowledge, archaeological methodology

The different implementation sequence phases usually recommended by nautical archaeology manuals for the study of a shipwreck also include the hypothetical reconstruction of the original hull structure (Steffy 1994: 214–234; Pomey, Rieth 2005: 142–149). A study can be taken into consideration only when there is an opportunity to find an accessible wreck in a good state of preservation, from which sufficient data, both quantitative and qualitative, may be obtained. Should this occur, analysis and interpretation of all structural data documented during the excavation may be initiated. Subsequently, one should proceed to the remodelling of elements that indicate deformations and then to an attempt to integrate the fragmented or entirely absent components.

A procedure that aligns with preliminary indications was formulated as far back as 1976 on the basis of the work done in the first symposium on *Sources and Techniques in Boat Archaeology* held in Greenwich with the aim of obtaining a plan for the hull in compliance with the rules dictated by modern naval architecture (McGrail 1977: 205–232; Crumlin-Pedersen 1977: 163–177; 2004: 44).

It is clear that this extremely complex procedure should be able to encompass as much of the ship's entire surviving structure as possible to ensure maximum reliability of the final results. This is the reason why current archaeological procedures only comply with its execution *a posteriori*, that is, at the conclusion of the excavation campaigns when all data have been collected.

However, even in the presence of a wreck that potentially meets all necessary requirements, it may not be possible to secure sufficient documentation in a reasonable time and with available financial support in order to develop a complete and reliable reconstruction hypothesis. As a rule, all that remains in such cases is to proceed and attempt to document the wreck as much as possible and as accurately as possible using all available means.

This is certainly the case of the Gnalić wreck, located in the waters of the Pašman Channel facing the Dalmatian coastline south of Zadar, near the rocky islet of the same name. It is, as archaeological and historical studies have long shown, a large merchant ship with a burden of 1,200 *botti* (ca. 700 tons) built in Venice between 1567 and 1569 and shipwrecked between the end of October and the beginning of November 1583 during a voyage to Constantinople (Radić Rossi *et al.* 2021).

When excavations were definitively resumed in 2012 after brief and intermittent investigations conducted between 1967 and 1973, the difficulties associated with an archaeological site that covered an extensive area and showed con-

siderable stratigraphic complexity became evident immediately. It was further apparent that it would be long before it could be investigated in its entirety and that, in any case, it would never be possible to recover the entire hull from the depth of roughly 30 meters at which it lies. Nor was it conceivable to dismantle all of the hull's structural elements to conduct a more accurate examination after their recovery.

With these preliminaries, it was difficult to envision the possibility of developing a reliable hypothetical reconstruction of the entire hull's original shape as indicated in the archaeology manuals. At best, it would have only been possible to draw up an archaeological map of the site and accord particular attention to the best-preserved areas and those structural details that attracted the greatest interest. On the other hand, there was an awareness of the rare opportunity to study the only historically documented record of one of the largest ships in the Venetian merchant fleet at the height of its maritime trade in the sixteenth century.

In the continuation of the excavation campaigns, as the slow and methodical work proceeded from the aft sector of the wreck towards its central section, the hull's structural composition became increasingly legible. At the same time, however, any attempts to obtain useful information for reconstructing the hull shape from 3D photogrammetry or measurements taken directly at the wreck and from the few recovered – albeit often fragmented and corroded – timbers were futile. In fact, despite the progressive accumulation of considerable data, these always seemed insufficient to reach any conclusion that was not connected solely to carpentry techniques.

Given the complexity of the situation and the slow nature of conventional techniques, the risk was that we would never be able to achieve the desired results within a reasonable time. Thus, before the commencement of the 2018 excavation campaign, the decision was made to experiment with a different approach.

In fact, if it was obvious from the standpoint of excavation methodology that adherence to the same criteria of systematicity and precision employed up to that point should continue, it was nonetheless equally evident that the traditional system of collecting the necessary data had been proven excessively slow and ineffective. It was, therefore, necessary to rethink the documentation system from a completely different perspective. In other words, the question was whether or not there was a possibility of achieving the same objective of obtaining the most plausible hypothesis on the reconstruction of the original shape of the entire hull but with a significantly lower quantity of data, better if reduced to that most strictly essential.

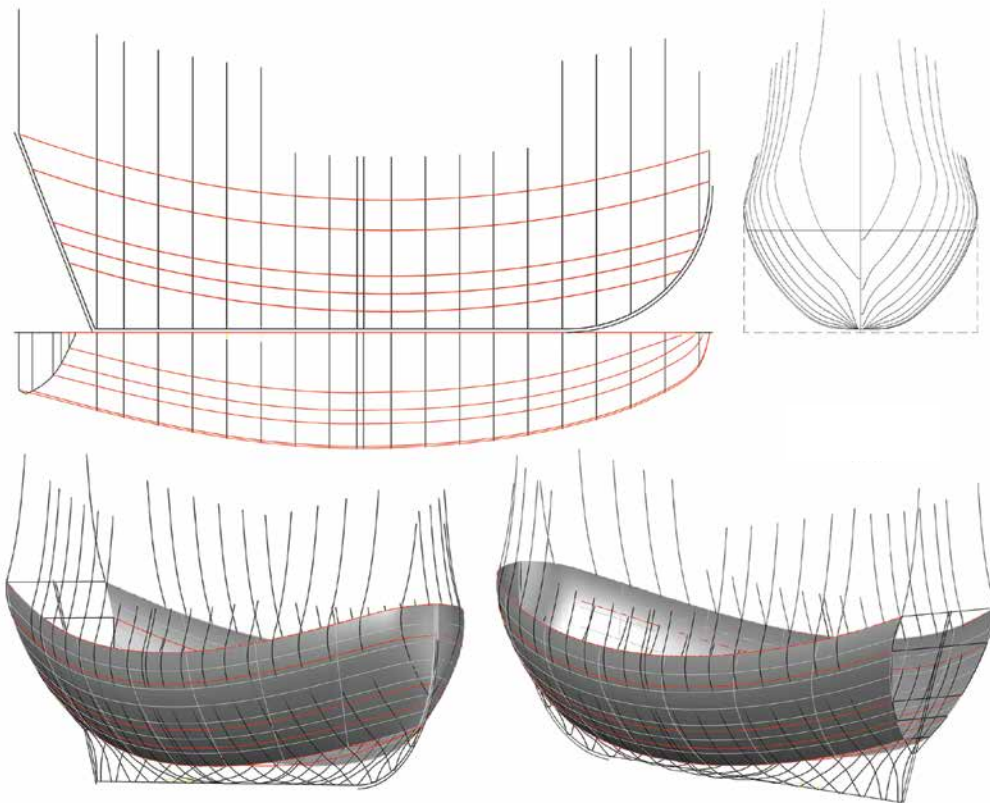


Fig. 1 Hypothetical 3D sketch of the original hull form of the Gagliana grossa

Among the various possible solutions, ultimately the decision was made to make use of historical and iconographic sources in order to create a 3D graphic model that outlined the hypothetical shape that the hull may have had at an imagined point in time close to the date of its construction (Fig. 1). With the indispensable support of photogrammetric data, this model would have to be continuously updated and adapted, in line with new information acquired as the excavations progressed. The aim was to create a tool capable of:

- guiding and organizing the collection of data based on a rational criterion, aimed at identifying in the wreck those conspicuous points that late 16th-century shipbuilders themselves considered fundamental to the design and creation of hull shapes;
- guaranteeing control of the documentation process by monitoring the progress achieved in the study of the hull shape by updating the data and making the subsequent changes to the hypothetical construction plan (Fig. 2).

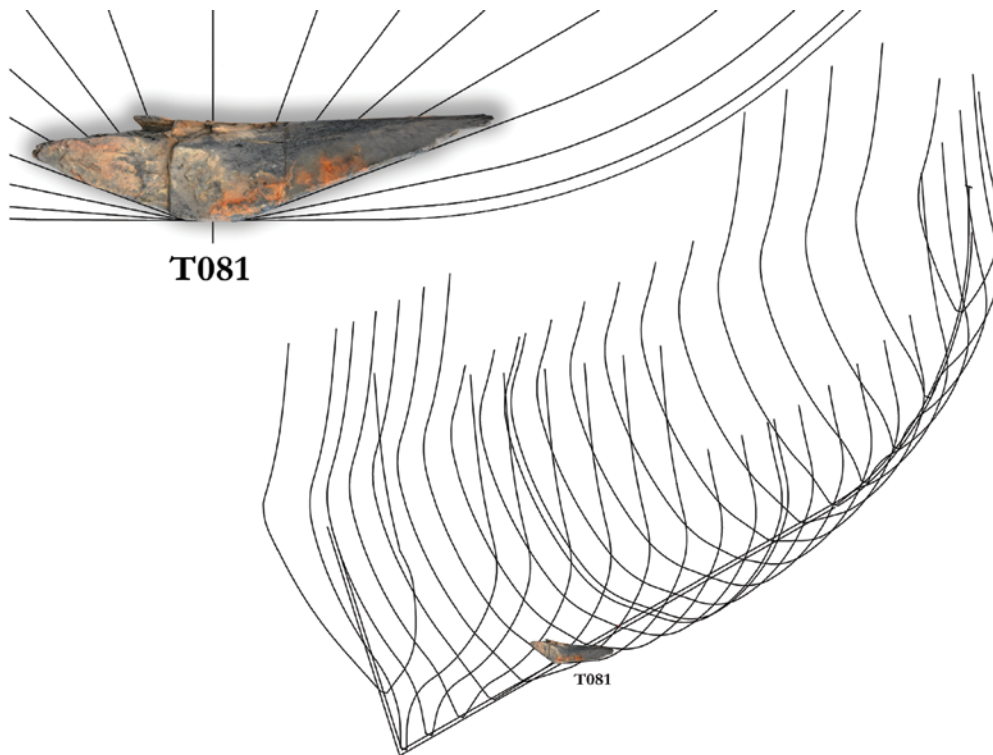


Fig. 2 Update of hull lines based on updated archaeological data

Obviously, the key to the project's success lay in attaining the correct combination between the level of knowledge of late Renaissance Venetian naval architecture contained in archival documents and the actual archaeological data obtained from the wreck. The idea, however, was not to directly combine the archaeological study of the Gnalici wreck with a particular historical document,¹ but rather to compare it to the results of broader systematic research encompassing all available sources, not only Venetian, with the aim of extrapolating two types of information:

- the general design methods used by that era's shipbuilders to formulate a hypothesis about which of these could have been used in the construction of the Gnalici vessel;²
- the dimensional data and construction rules, proportional or geometric, pertaining to Venetian ships of that period, in order to incorporate them into a statistical analysis to obtain reference parameters for the reconstruction.

¹ For example, the manuscript treatise written by the Franciscan father pre' (an abbreviation of priest) Todaro de Nicolò, known by the improper title *Istruzione sul modo di fabricare galere* (Lane 1934: 24–49) or the anonymous *Misure di navilii* (Nicolardi 2014: 239–244).

² In Venetian naval architecture, the design process of modifying the frame shape was completely different from that described, for example, in the sources of the Iberian geo-cultural area, especially in the hauling down operations of the futtock mould (Rieth 1996: 47–48, 136–138). On the other hand, since the 14th century, Venetian masters were already familiar with various reduction methods, such as the geometric or mathematical methods involving the incremental triangle (based on the triangular numbers of Nicomachus of Gerasa), half-circle (or half-moon) and circle (or full-moon) (Bondioli 2017; Rieth 1996: 66, 86). At the end of the 16th century, however, the *pavion* (narrowing triangle with planes parallel to the base) and the *scoto* (narrowing triangle with planes oblique to the base) were already known in Venice (Rieth 1996: 62, 64, 74; Boudriot 1987: 19).

In essence it was a question of developing a research action plan that reversed the conventional paradigm, ensuring that the study was dictated by our knowledge of ancient naval design techniques and not the other way around. It was a theoretical solution which in any case would not have influenced the canonical archaeological procedures in any way, as it would have been an alternative and non-substitutive path from the standpoint of the shipwreck's historical interpretation. In fact, by continuously modifying the hypothetical graphic model following the objective evidence contained in the material evidence of the finds, the principle of the prevalence of archaeological sources over historical sources would never have been broken. Written testimony would therefore always remain confined to a secondary and complementary role:

“... il ne fait aucun doute que cet apport, plus ou moins important selon les cas, des sources écrites représente l'une des dimensions méthodologiques originales de l'archéologie navale médiévale. Pour autant, il ne s'agit pas d'inverser le processus de la recherche en privilégiant a priori cette documentation écrite et en affectant aux sources archéologiques une valeur de complément illustratif. Ce sont les données archéologiques acquises lors de la fouilles qui, fondamentalement, conduisent ici l'interprétation historique de l'épave” (Pomey, Rieth 2005: 182).³

However, before proceeding with the development of the 3D graphic sketch, it was necessary to draw up a detailed documentation protocol based on in-depth documentary research into available written sources, both manuscripts and printed matter, in order to create a database⁴ containing at least:

- the main dimensions of the hull:
- main proportional rules;
- keel length between the surmarks;
- rakes (sternpost, stem);
- heights (sternpost, stem);
- width of the transom;

measurements and geometry of the master frame: breadth (*bocca, reggia, tolda*) and depth (*puntale*) at the decks, the floor (*fondo*) between the surmarks (*poselesi*) and length of the bottom to be narrowed (*piano*); arcs of the futtocks (*valangin de la bocha, valangin de la regia, valangin de sora*) (Fig. 3);

- the main design rules of the whole-moulding system, applied from the midship to the tailframes (*cai di sesto*) of sternpost and stem,⁵ and their related dimensional values⁶:
- narrowing (*partison del fondo*);
- rising line (*stella*);
- widening and sliding down (*partison del ramo* and *scorer del sesto*).

To facilitate its use, the database should have been as simple as possible and therefore contain only the most essential information, such as those listed above. In this way the 3D graphic model would have been continually updated, avoiding unnecessary complications due to the insertion of data, not expressly necessary in the theoretical developmental phase of the sketch.⁷ In fact, it should not be forgotten that any variation introduced in the design would have entailed a series of interconnected modifications which would have involved the hull's entire shape. However, that was a negligible inconvenience if the experimentation employing the new method had actually achieved positive results.

The final processing of the 3D graphic model would necessarily also have to incorporate data pertaining to the hull's structure only if a definitive conclusion of the excavations had been drawn for whatever reason and at whatever

³ “... there is no doubt that this contribution of written sources, more or less important depending on the case, represents one of the original methodological dimensions of medieval nautical archaeology. However, it is not a question of reversing the research process by prioritizing this written documentation and assigning a complementary illustrative value to archaeological sources. It is the archaeological data acquired during the excavations which, fundamentally, here leads to the historical interpretation of the wreck” (Pomey, Rieth 2005: 182).

⁴ The database would have been created by attributing an alphanumeric code to each dimensional indication or design rule contained in the documentary sources, useful for organizing the data into groups and classes. This is the method already adopted previously in the synoptic study of the construction sources of 15th century galleys, which proved to be fundamental to the graphic interpretation of the information (Bondioli 1999: 70–73).

⁵ Through the application of these design rules, shipbuilders were able to design hull shapes between the tailframes of the sternpost and stem. The missing shapes were obtained empirically through the use of long longitudinal ribbands called *maistre*.

⁶ With these data it would perhaps have been possible to attempt the reconstruction of the original moulds and their incremental marks (*partison*), brilliantly defined by E. Rieth as the tools of “conception non-graphique des careens,” i.e. the “*maitre-gabarit, la tablette et le trebuchet*” (Rieth 1996).

⁷ To further simplify the graphic model's sketch, it was not even necessary for it to contain information pertaining to the upper parts of the ship, as they were now considered to have disappeared or were so collapsed, eroded and fragmented that they would never have been the subject of a useful archaeological comparison

level of progress it had reached up to that point. In anticipation of the latter, the documentation protocol should have contained a timber database of technical carpentry details observed during the excavations in addition to the actual dimensions of each discovered wooden object. Information would have been added to the data collected during the historical-documentary research phase within the limits of available documentation.⁸

Once the collection of the necessary data has been completed, the most important structural element of the entire hull, the master frame, would be recovered. In fact, the precision of measurement necessary for the correct initiation of study of the ship's forms could be accomplished only through the direct study of the profile of the floor timber (*corba de mezo*) and the first futtock (*forcame de prima man*).⁹

We are perfectly aware of the enormous difficulties of dialogue between historical and archaeological sources, that is, between our assumed knowledge of Venetian shipbuilding and the reality of material evidence which we will confront in this project. However, we are also fully aware of the fact that the hull remains from the Gnalić site will never be fully recovered, and that in the future, if we will have adequate resources, many more excavation campaigns will be needed before we will arrive at the final data. For these reasons, we are convinced of the need to try an alternative method of collecting the information needed to formulate a hypothesis for the reconstruction of the original shape of the hull. Only time will tell whether or not this different methodology will be successful.

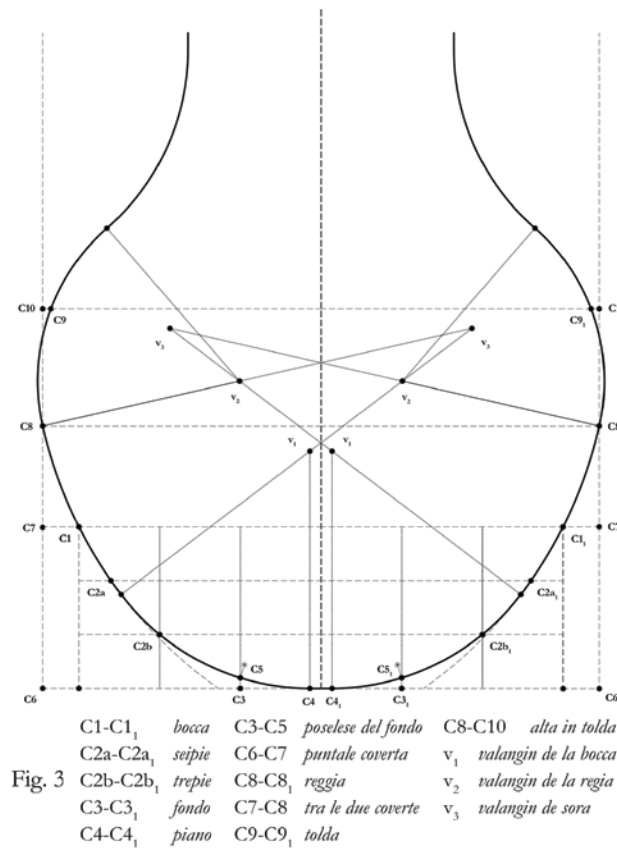


Fig. 3

Alphanumeric classification of the measurements and geometry of the master frame contained in Venetian written sources and the associated graphic interpretation

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⁸ An example is the discovery of a notarial deed in the State Archives of Venice dealing with the purchase of the oak timbers by the ship owners listing the dimensions of the timbers necessary for the ship's construction.

⁹ The authors hope that this recovery will take place soon after the delays caused by the Covid 19 pandemic and other setbacks which have fortunately been overcome.

References

- Bondioli, M. 2017. The Libro di navigar. A new treatise on Venetian shipbuilding from the 14th Century. In A. Gawronski, A. van Holk, J. Schokkenbroek (eds), *Ships and Maritime Landscapes. Proceedings of the Thirteenth International Symposium on Boat and Ship Archaeology, Amsterdam 2012*. Eelde, Barkhuis Publishing: 215–223.
- Bondioli, M., Penzo, G. 1999. Teodoro Baxon e Nicola Palopano protti delle galee sottili. L'influsso greco nelle costruzioni navali veneziane della prima metà del XV secolo. *Archeologia delle Acque* 1.2: 67–80.
- Boudriot, J. 1987. La conception des vaisseaux royaux sous l'Ancien Régime. *Neptunia* 169: 9–24.
- Crumlin-Pedersen, O. 1977. Some Principles for the Recording and Presentation of Ancient Boat Structures. In S. McGrail (ed.), *Sources and Techniques in Boat Archaeology*, [BAR Supp. Series 29]. Oxford, British Archaeological Reports: 163–177.
- Crumlin-Pedersen, O. 2004. Nordic Clinker Construction. In F. M. Hocker, C. A. Ward (eds), *The philosophy of shipbuilding. Conceptual approaches to the study of wooden ships*. College Station, Texas A&M University Press: 37–63.
- Lane, F. C. 1934. Venetian naval architecture about 1550. *The Mariner's Mirror* 20 (1): 24–49.
- McGrail, S. (ed.) 1977. *Sources and Techniques in Boat Archaeology*, [BAR, Supp. Series 29]. Oxford, British Archaeological Reports.
- Nicolardi, M. 2014. Misure di navilii. Un nuovo documento di costruzione navale veneziana della seconda metà del XVI secolo. *Navis* 5: 239–244.
- Pomey, P., Rieth, É. 2005. *L'archéologie navale*. Paris, Éditions Errance.
- Radić Rossi, I., Nicolardi, M., Bondioli, M., Batur, K. 2021. *The Shipwreck at Gnalić. A Mirror to the Renaissance World*. Oxford, Archaeopress.
- Rieth, E. 1996. *Le maître-gabarit, la tablette et le trébuchet. Essai sur la conception non graphique des carènes du Moyen Age au XXe siècle*. Paris, Editions du CTHS.
- Steffy, J. R. 1994. *Wooden ship building and the interpretation of shipwreck*. College Station, Texas A&M University Press.