

Visualizing shipbuilding features through textual evidence: the case of the 19th century Aegean brigs

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Abstract: Brig was the predominant ship type constructed on the island of Syros, Greece, the main shipbuilding centre of the Aegean, during the 19th century. To gain insights into the Mediterranean shipbuilding technology of the period, a project was conducted aiming to retrieve and analyse shipbuilding data from contracts concerning brigs built between 1832 and 1857 in Ermoupoli's shipyards. The information was used for the creation of a digital model. This research highlighted the challenges encountered in examining archival sources, as well as their potential as unique resources for understanding the technology and anthropology of shipbuilding.

Keywords: brigs, Aegean, shipbuilding contracts, digital reconstruction

1. Introduction: the brig

During the 19th century, maritime trade and shipping in the Mediterranean were organized through international merchant networks that concerned mainly bulk cargo transportation (Harlaftis 2001: 85–86). The Aegean and Ionian islands, actively involved in these networks, maintained their own shipyards. The most important among them were in Ermoupolis, the capital of the island of Syros, and the commonest type of ship built in its shipyards was the brig (Delis 2010: 344).

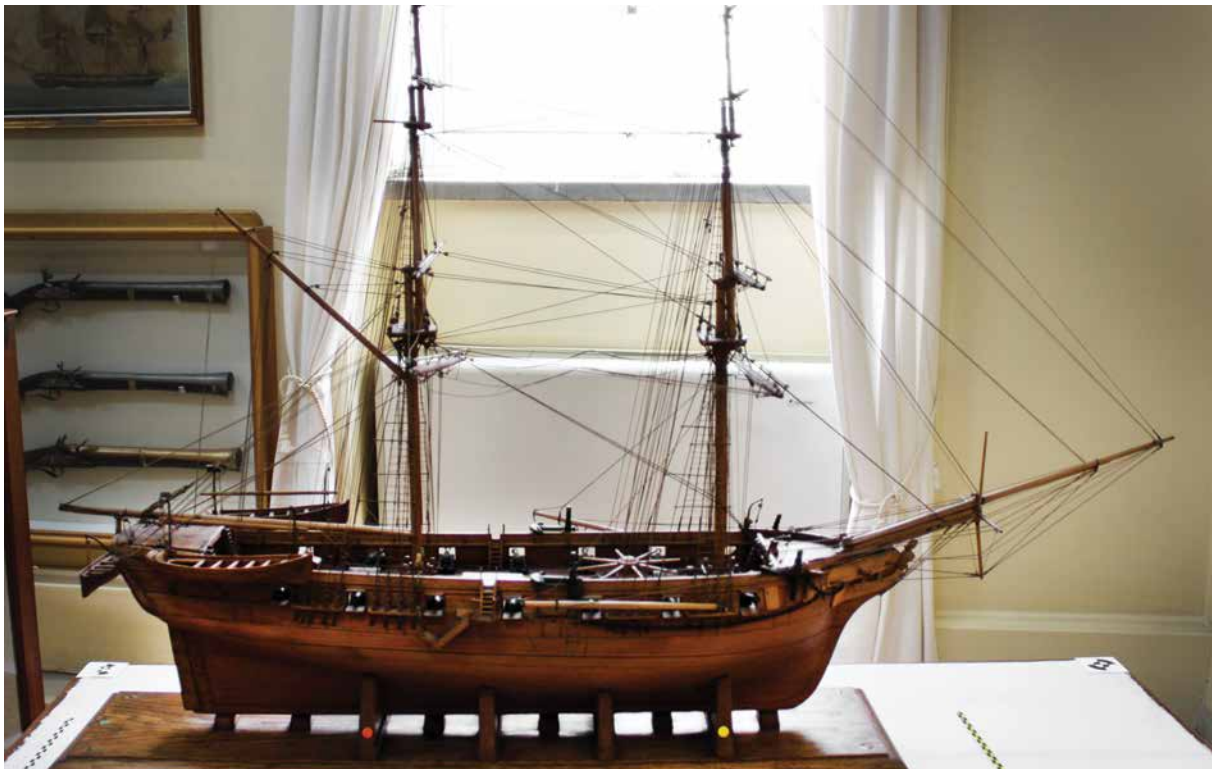


Fig. 1 The model of the brig ARIS (1818), exhibited at the National Historical Museum of Greece, Athens. ARIS is a karavoskaro with inclined transom (photo A. Evripidou, with the permission of the National Historical Museum of Greece)

Brigs were square-rigged vessels with two masts and dominated the Mediterranean waters during the 19th and early 20th centuries (Moore 1925: 45–59) (Fig. 1). This type of rigging, a distinctive feature of brigs, was most probably originally influenced by North European maritime traditions, i.e., full - rigged vessels, with square sails, able to perform fast and low-cost long-distance voyages. Mediterranean shipbuilding traditions, however, were more diverse and developed a large variety of ship types with specific particularities (Konstantinidis 1954; Moore 1970; Kanellopoulos 1983; Damianidis 1998).

Nineteenth century paintings (Tzamtzis 1972: Fig. 65; Harflaftis 2002: Fig. 3) illustrate brigs in the Aegean with three to five sails on each mast. Brig rigging could be applied on several hull types. The most common one in the 19th century is known as *karavoskaro* ('καραβόσκαρο' in Greek) (Damianidis 2014: 329–330). From the 1850s onwards, when the mold – loft designing method was introduced, the morphological characteristics of the brigs changed (Damianidis 1998: 153). Following the international trends, they seem to have become smaller, without false gun ports, and with less decorative elements. Also, the original double or S-shaped curvature of the stempost became hollow, and a counter stern replaced the transom (Delis 2014: 54).





















No	NAME	SHEER PLAN OUTLINE	CROSS SECTION AT M.B	CAPACITY (in tons)
1	AYIOS DIONISIOS			162
2	DIMITRIOS			180
3	BBIKOV			210
4	CANTITO			244
5	NELSON			263
6	EISODIA TIS THEOTOKOU			265
7	PANAYIA TIS AKATHISTOU			271
8	MARIS ATH. VALLIANOS			284
9	MARIGO			293
10	MARIDA			400

Fig. 2 Sections and capacities of the nine ships described in the examined contracts

These general morphological features are known mainly from paintings, as no construction plans have been preserved. This, coupled with the rarity of excavated shipwrecks, created a blurry picture of the construction details of brigs. In this context, archives become a valuable source of information. During the 19th century, ship construction involved several types of documents, such as shipbuilding contracts, contracts of raw material purchase, and title deeds. This paper provides a brief summary of the research conducted on nine such contracts for brigs, built in Ermoupoli's shipyards between the years 1832 and 1857¹. Eight of them were provided by the General State Archives, the Cyclades' Prefecture, Syros,² while one, published by Tzamtzis (1987: 28–30), belongs to the private collection of Spyros Manousakis.

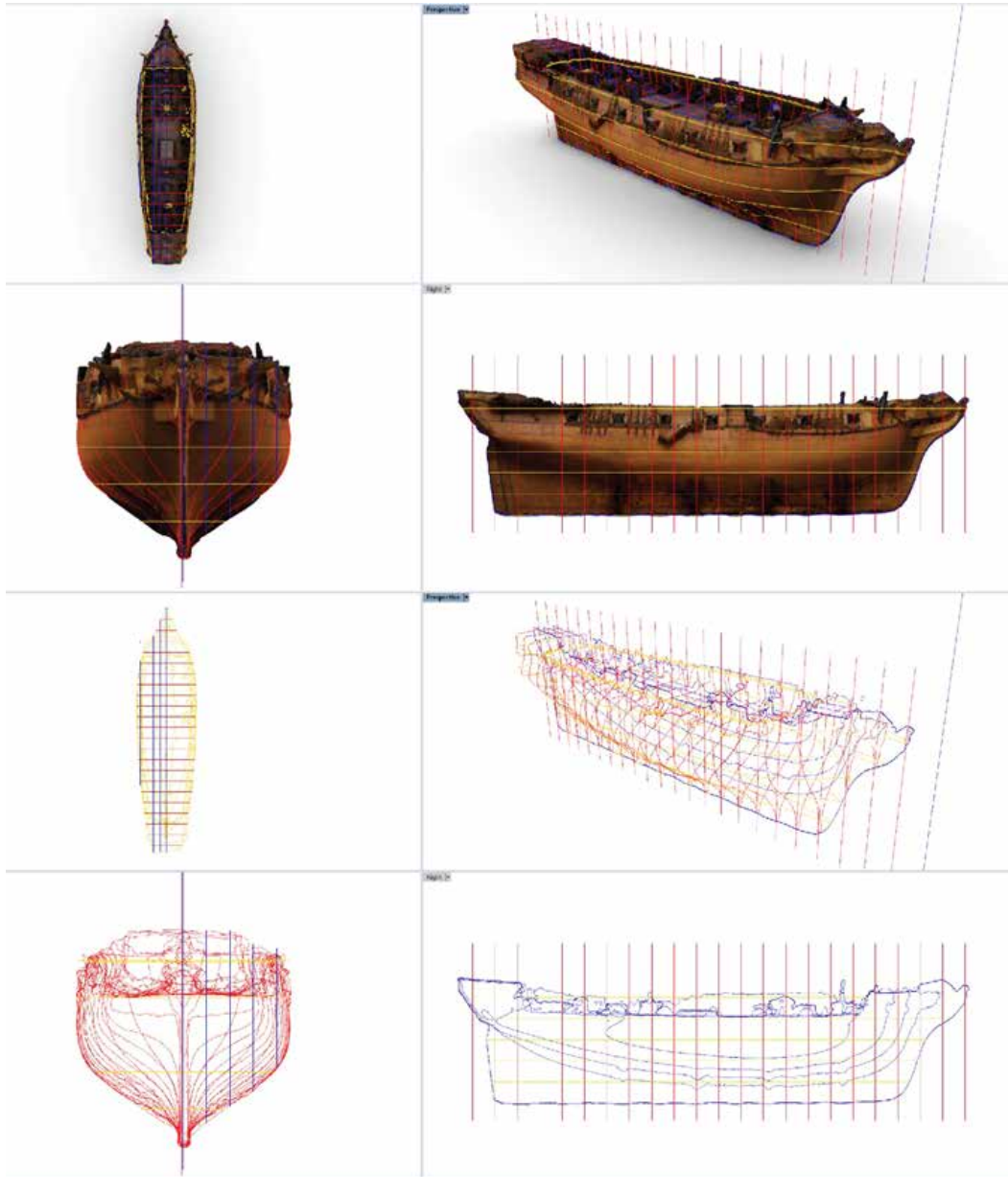


Fig. 3 The top, front, side and 3D view of the digital model of the Brig ARIS, (processed by A. Evripidou, in Rhino 3D software)

¹ This research was part of Andri Evripidou's master's thesis, entitled *Visualizing shipbuilding features through textual evidence: the case of the 19th century brigs*, which was submitted and successfully defended in December 2020 (MA Programme *Field Archaeology on Land and under the Sea*, Department of History and Archaeology, University of Cyprus).

² The eight unpublished documents (contracts and title deeds) provided by the General State Archives were the following: ΓΑΚ/ΑΝΚ Σύρου, Συμβ. Ανδρέας Δαβίδ, *Λυτά έγγραφα*, αρ. 907, 25/05/1834 (vessel ΑΥΙΟΣ ΔΙΟΝΙΣΙΟΣ); (2) ΓΑΚ/ΑΝΚ Σύρου, Συμβ. Ανδρέας Δαβίδ, *Λυτά έγγραφα*, αρ. 7090, 13/05/1838 (vessel ΔΙΜΙΤΡΙΟΣ); (3) ΓΑΚ/ΑΝΚ Σύρου, Συμβ. Ανδρέας Δαβίδ, *Λυτά έγγραφα*, αρ. 7568, 18/08/1838 (vessel ΚΑΝΤΙΤΟ); (4) ΓΑΚ/ΑΝΚ Σύρου, Συμβ. Ανδρέας Δαβίδ, *Λυτά έγγραφα*, αρ. 21283, 04/08/1848 (vessel ΝΕΛΣΟΝ); (5) ΓΑΚ/ΑΝΚ Σύρου, Συμβ. Ανδρέας Δαβίδ, *Λυτά έγγραφα*, αρ. 19206, 21/02/1847 (ΠΑΝΑΥΙΑ ΤΙΣ ΑΚΑΘΙΣΤΟΥ); (6) ΓΑΚ/ΑΝΚ Σύρου, Συμβ. Ανδρέας Δαβίδ, *Λυτά έγγραφα*, αρ. 30178, 14/08/1857 (vessel ΜΑΡΙΣ. ΑΤΗ. ΒΑΛΛΙΑΝΟΣ); (7) ΓΑΚ/ΑΝΚ Σύρου, Συμβ. Ανδρέας Δαβίδ, *Λυτά έγγραφα*, αρ. 26722, 29/07/1853 (vessel ΜΑΡΙΓΟ); (8) ΓΑΚ/ΑΝΚ Σύρου, Συμβ. Ανδρέας Δαβίδ, *Λυτά έγγραφα*, αρ. 19657, 27/06/1847 (vessel ΜΑΡΙΔΑ).

2. Reading the contracts as construction plans

One of the project's objectives was to retrieve metric information of specific structural timbers and their positioning in the hull, in order to create a digital model. The nine contracts that were selected for this project concerned probably *karavoskaro* with inclined transom, since most of them referred directly to the transom or the stern's decoration. They were ships of different capacities and basic dimensions (Fig. 2). Since no construction plans of Aegean brigs have been preserved, the model of the well-known brig ARIS (1818) (Konstantinidis 1954; Adamopoulou 2014; Nikolaou 2014), now at the National Historical Museum of Greece, was photogrammetrically recorded, and was used for the reconstruction of all hull lines (Figs 1, 3).

A challenge faced during the project was the full comprehension of the contracts' original text. The terminology used by the shipwrights was expressed in *katharevousa*, i.e., the official language of the Greek state at the time, but spelling mistakes and the use of some rare terms and expressions of the shipwrights created comprehension problems. For example, some contracts referred to a longitudinal element, called *gyali koutouki* (γιαλί κουτούκι) which is not known from other sources. It was a notch-shaped timber, placed under the shelf clamps. It was running along the sides of the hull, from the stern's bulkhead to the bow's stempost, and was attached on the hanging knees of the beams (Fig. 4).

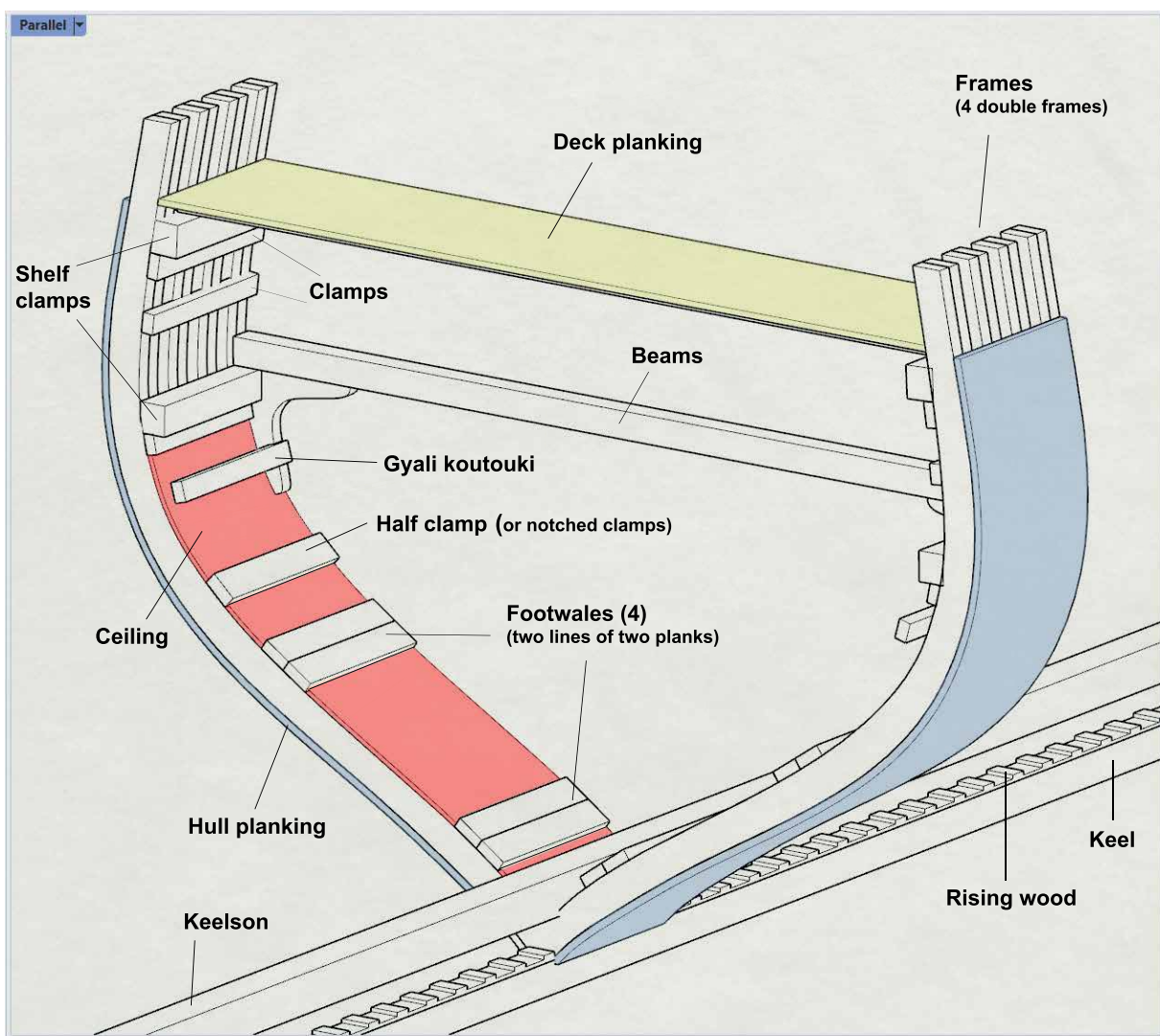


Fig. 4 A 3D mid-section, created by the data selected from the contract of the ship CANTITO, which illustrates the main structural parts of the ship. Colors indicate the different ship's planking: hull in light blue, ceiling in red, and deck in yellow (drawing: A. Evripidou)

The structure of the contracts follows more or less a standard descriptive order, similar to the main steps of ship-building. Specific kind of information is given as follows: (i) the names of contributors, the vessel's type (brig) and its basic dimensions; (ii) the hull's structural elements (i.e., keel, frames, keelson, stringers, shelf clamps, beams and ledges, planking) and superstructures (i.e. the captain's cabin, catheads, canopy, skylight, galley, belfries etc.), which occupied the longest part of each contract; (iii) construction expenses and the shipbuilders' wages; (iv) caulking, nailing and launching equipment; and (v) the dates of the contract's signature and the ship's delivery.

2.1. Measurements and dimensions

The ship's tonnage was not mentioned in the contracts. For some of the brigs, it could be found in their title deeds or historic registers. For the sake of consistency, however, all provided measurements were converted into meters and English feet, and then capacities were recalculated accordingly, using a formula for single decked ships (Delis 2010: 88) (Table 1):

$$L.O.A. \times M.B. \times M.D.$$

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L.O.A. (Maximum Length); M.B. (Breadth on the mid-frame); M.D. (Depth from the keelson to the deck)

No.	Ship Name	Dimensions in the Contract			Dimensions in the Title Deed		
		Contract Unit	Meters (m)	Foot (ft)	Title Deed Unit	Meters (m)	Foot (ft)
1	AYIOS DIONISIOS	L.K. = 21 cubits M.B. = 22 barrels M.D. = 11 barrels	L.K. = 19.2 M.B. = 6.7 M.D. = 3.35	L.K. = 63 M.B. = 22 M.D. = 11	L.K. = 21 2/3 cubits M.B. = 22.5 barrels M.D. = 11.5 barrels	L.K. = 19.8 M.B. = 6.9 M.D. = 3.5	L.K. = 65 M.B. = 22.5 M.D. = 11.5
2	DIMITRIOS	L.K. = 20 cubits M.B. = 22.5 barrels M.D. = 12.5 barrels	L.K. = 18.3 M.B. = 6.9 M.D. = 3.7	L.K. = 60 M.B. = 22.5 M.D. = 12.5	L.K. = 21 cubits M.B. = 22 barrels + 6 fingers M.D. = 12 barrels + 6 fingers	L.K. = 19.2 M.B. = 6.85 M.D. = 3.95	L.K. = 63 M.B. = 22.5 M.D. = 13
3	BIBIKOV	L.K. = 22.5 cubits M.B. & M.D. (not indicated)	L.K. = 20.6 M.B. & M.D. (not indicated)	L.K. = 67.6 M.B. & M.D. (not indicated)	L.K. = 24 cubits M.B. = 22.5 ft M.D. = 13 ft	L.K. = 21.9 M.B. = 6.9 M.D. = 4.0	L.K. = 71.9 M.B. = 22.5 M.D. = 13
4	CANTITO	L.K. = 23 cubits M.B. = 25 barrels M.D. = 14 barrels	L.K. = 20 M.B. = 7.6 M.D. = 4.3	L.K. = 65.6 M.B. = 25 M.D. = 14	L.K. = 24 cubits M.B. = 25 barrels M.D. = 14.5 barrels	L.K. = 21.9 M.B. = 7.6 M.D. = 4.4	L.K. = 71.9 M.B. = 25 M.D. = 14.5
5	NELSON	L.K. = 23 cubits M.B. = 25.5 barrels M.D. = 14 barrels	L.K. = 21.0 M.B. = 7.8 M.D. = 4.3	L.K. = 68.9 M.B. = 25.6 M.D. = 14	Not found		
6	PANAYIA TIS AKATHISTOU	L.K. = 23 cubits M.B. & M.D. (not indicated)	L.K. = 21 M.B. & M.D. (not indicated)	L.K. = 68.9 M.B. & M.D. (not indicated)	L.K. = 24 cubits M.B. = 25.5 barrels M.D. = 14 barrels + 4 fingers	L.K. = 21.9 M.B. = 7.8 M.D. = 4.4	L.K. = 71.85 M.B. = 25.5 M.D. = 14.5
7	MARIS. ATH. VALLIANOS	L.K. = 84 ft M.B. = 24 ft M.D. = 13.25 ft	L.K. = 84 ft M.B. = 24 ft M.D. = 13.25 ft	L.K. = 25.6 M.B. = 7.3 M.D. = 4.0	L.K. = 87 ft M.B. = 24 ft M.D. = 13.25 ft	L.K. = 26.5 M.B. = 7.3 M.D. = 4.0	L.K. = 87 M.B. = 24 M.D. = 13.25
8	MARIGO	L.K. = 73 ft M.B. = 26 ft M.D. = 14.5 ft	L.K. = 73 ft M.B. = 26 ft M.D. = 14.5 ft	L.K. = 22.3 M.B. = 7.9 M.D. = 4.4	L.K. = 73 M.B. = 26 M.D. = 14.5	Not found	
9	MARIDA	L.K. = 28 cubits M.B. = 28 barrels M.D. = 16 barrels	L.K. = 25.6 M.B. = 8.5 M.D. = 4.9	L.K. = 84 M.B. = 28 M.D. = 16	L.K. = 28.5 cubits M.B. = 28 barrels M.D. = 16.5 barrels	L.K. = 26.1 M.B. = 8.5 M.D. = 5.0	L.K. = 84 M.B. = 28 M.D. = 16.5

Table 1 The ships' basic dimensions, as indicated in the respective shipbuilding contracts and their title deeds.

The basic dimensions of the ships were indicated in the contracts as follows (Fig. 5):

- Length (L.K.): keel's length, measured between the keel-posts scarf joints (bow to stern). In the shipbuilding contracts, this dimension is defined as 'the distance from one rabbet to the other' (*από ασσόνη σε ασσόνη*). Although the word *ασσόνης*, as it is used in current terminology (Damianidis 2014: 391) means rabbet, it does not make sense here: the distance between rabbets can only be the thickness, not the length of the keel. Therefore, we suggest that this word must have had a different meaning in the contracts. Conventionally for this project, we considered the keel's length as the distance between the two keel-post scarf-joints.

- Breadth (M.B.): breadth of the widest frame, measured from the external side of the frames.
- Depth (M.D.): depth of the mid-ship frame, measured from the bottom of the deck beam to the top of the keelson.

The main ship parts described in the contracts, are the following:

- The keel (*καρίνα*). The word usually refers to one board, not the entire keel structure comprised of scarf jointed

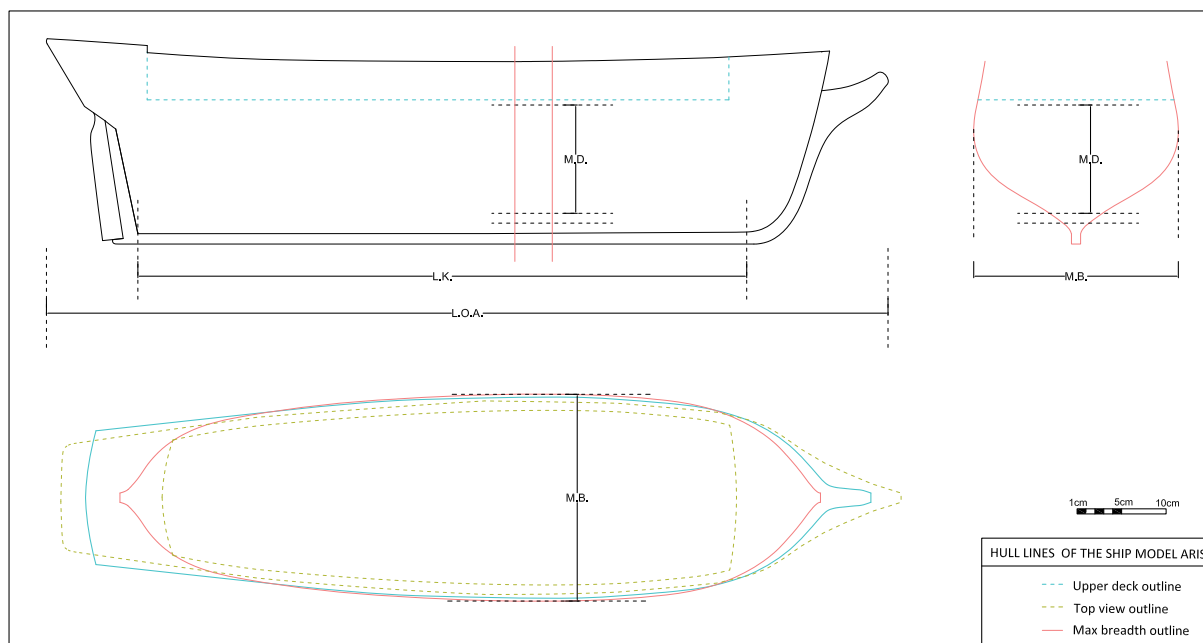


Fig. 5 The basic outlines and dimensions of the ship model ARIS (drawing: A. Evripidou)

pieces. The molded side was always bigger than the sided. In larger ships, a rising wood was fixed on top of the keel, and a false keel is often mentioned.

- The stem and sternposts (*ποδοστάμιο*) have the same size as the keel, in cross-section.
- Double framing (*στραβοξυλη* or *πόστες*) was described in all contracts. The number of the frames was seldom mentioned but could be approximately estimated, using their dimensions (cross-section), the distance between them, and the keel's length; such an estimation was attempted with the contracts of CANTITO, PANAYIA TIS AKATHISTOU, and MARIS. ATH VALLIANOS. In these cases, the number of frames was calculated according to the L.K., so the number was correlated only with it. In some cases, it was mentioned that frames were spread out between the bow's and stern's cant frames named in contracts as *ρεπίδια*. Since we do not know the number, or the room-and-space distance of the cant frames, however, the estimated results represent the maximum number of frames, not necessarily the actual quantity.

The average room-and-space distance was 15.2 cm. However, it the frames' data and the L.K. For example, DIMITRIOS had 50 frames, 22.8 cm sided, and L.K. of 18.3 m. According to the following formulas the distance between frames is 14 cm:

$$50 \text{ (frames)} \times 0.228 \text{ m} = 11.4 \text{ m (total width of frames)}$$

$$18.3 \text{ m (L.K.)} - 11.4 \text{ m} = 6.9 \text{ m (total length of room-and-space)}$$

$$6.9 \text{ m} / 49 \text{ (gaps between the 50 frames)} = 0.14 \text{ m (room-and-space)}$$

- The keelson (*σωτρόπι*) was composed of one board or two scarfed joined timbers. It is always larger than the keel, mainly square in section.
- The number of stringers or footwales (*στραγαλιές*) varied from four to six on each side. The way they were divided per side was not specified, in the contracts.

- Shelf clamps (*κουρζέτο/α*) were positioned below decks. Larger ships had two or three shelf clamps under each deck; those of the lower deck were slightly smaller than those of the upper (main) deck.
- Clamps (*λούροι*) had a complementary role to shelf clamps and were usually positioned below them. Their size was similar to the footwales and they were sometimes named as half-clamps or notched-clamps (*μισοκούρζετα* or *χαρακτά*) (Delis 2010: 185).
- Beams and ledges or half beams (*καδένες, παγκάτσες, σμπάγια, καμάρια*): There were less beams than ledges. Their number and pattern could be only approximately estimated if we knew the sided measurement of both beams and ledges, the beams number, the in-between distance of ledges and the keel's length. For example, in AYIOS DIONISIOS contract, if we assume that beams were extended throughout the keel, then the formulas below estimate that the ship had 45 ledges:

$$10 \text{ beams} \times 0.114 \text{ m (beam's length)} = 1.14 \text{ m (total length of beams)}$$

$$19.2 \text{ m (L.K.)} - 1.14 \text{ m} = 18.06 \text{ m (total length of beams' gaps)}$$

$$18.06 \text{ m} / 9 \text{ (gaps between the 10 beams)} = 2.0 \text{ m (distance between beams)}$$

$$2.0 \text{ m} / [0.0855 \text{ m (ledge)} + 0.266 \text{ m (distance between ledges)}] = 5.7 \approx 6 \text{ (times that ledges and their in-between distance feet in the in-between beams' distance} = 5 \text{ ledges between two beams)}$$

$$\text{Total number of ledges} = 5 \times 9 \text{ (gaps between the 10 beams)} = 45$$

The positioning and dimensions of beams were also related to the frames data. For example, in CANTITO each ledge was responding to each double frame, while in MARIS ATH. VALLIANOS beams were placed every two double frames (Fig. 6).

- Planking: contracts refer to the first planking timbers, as well as the wales or external shelves (*τζ(σ)άπες*), whose number varied from six to ten on each side. The thickness of ceiling planks (*φέδρωμα*) as well as of the deck and hull planking (*στράβαις*) is always indicated.
- The bulwark (*παραπέτο*) is composed of the gunwale (*κουπαστή*), the lower gunwale or waterway (*τρυπητή*) and the plank sheer (*ζωνάρια*). It is described as double or single, but it is only the planks' thickness that was agreed in the contracts. The number and position of the breast hook knees, and the knees is also recorded.

The division of the ships' compartments, their superstructures, and equipment are only mentioned briefly. The brigs' interiors were divided by bulkheads in the middle of the hold, the captain's cabin to the aft part, and the sailors' room to the fore of the vessel. Regarding the superstructures and equipment, reference is made to the catheads, canopy, skylight, galley, belfries, hatchways, channels, rudder, wheel or the tiller, bits, hawses, catheads, figureheads, capstan and the windlass.

For the reconstruction of the ship's plans in this study, the following information was recorded about each structural component:

- the dimensions of their cross-section,
- their number and
- their place in the ship's structure.

Not all contracts, however, contained consistent information for all components and sometimes the way they were described was insufficient. Only one contract, for the ship CANTITO, had comprehensive information that allowed for the creation of a 3D mid-section as well as of the longitudinal and transversal parts. However, the dimensions of the clamps, the planking and the gunwale, which were not comprehensive in CANTITO's contract, were taken from PANAYIA TIS AKATHISTOU, which was a ship of similar tonnage.

The 3D mid-section of the 3D photogrammetric model (Fig. 2) was produced based on ARIS hull lines, then processed in Rhinoceros (Rhino 3D) software; twenty-one transversal, five longitudinal and five horizontal sections were taken for the hull, profile, and half-breadth plans respectively. As the model's surface was not very smooth and the section lines were rough, they were exported and reworked in AutoCAD software, where the final plan was designed and used for the final visualization of the brigs.

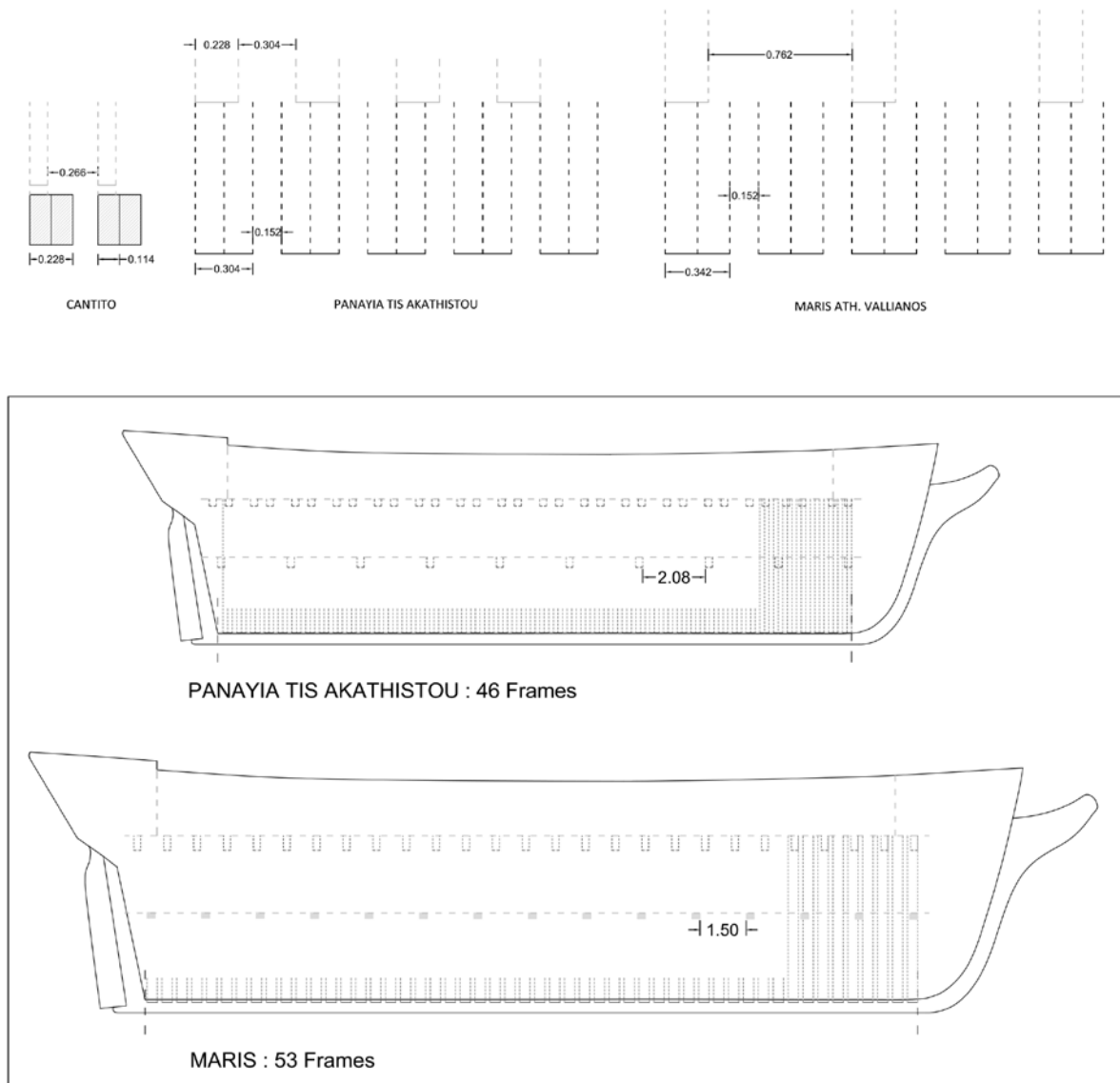


Fig. 6 Top: the relation of beams (green color) and frames positioning of the three ships; CANTITO, PANAYIA TIS AKATHISTOU and MARIS ATH. VALLIANOS, and their in-between distance. Bottom: Sections showing the number of frames and the estimated positioning of the beams, according to frames placement (blue color in PANAYIA, blue and grey in MARIS) (drawings: A. Evripidou)

3. The people behind the contracts

The specific technical information in the contracts provided useful insights into the conception phase of vernacular shipbuilding. It seems that both contracting parties, i.e. the shipowner and the shipwright, were familiar with the technical specifications described in detail, and they agreed that these elements would guarantee the quality of the end product, i.e. the ship. For example, the length of the ship was defined by the keel and its bulk was related to the M.B and M.D. The owners were probably satisfied that agreement on these components could ensure the size of their ordered vessel. Apart from the ship's size, the number and size of timbers required for the ship's construction were also defined in the texts, possibly to secure the economic investment in necessary raw materials, from the part of the shipwrights.

The realization phase depended highly on the empirical knowledge of the shipbuilders. Thus, the number of frames was not specified, perhaps because the shipowner trusted the shipwright to make the final decision on this. Their number remained flexible and was finalized based on the final length of the ship. Their construction details, however, were considered crucial for the ship's integrity and had to be agreed in the contract. Similarly, the exact positioning of the longitudinal reinforcing elements was also not defined, because either it was yet another decision left to the shipbuilder to make, or it was a well-known detail, unnecessary to be described in a legal document. What was important and was

indicated in the contract was their thickness, which determined how much they could add to the ship's ability to resist water or wind strains.

The final structure was most probably perceived in the minds of the shipwrights, during and not necessarily before the construction. Characteristic of this process is the fact that the final dimensions stated in the title deeds of the brigs are often different from the ones in the contracts (Table 1).

With all these uncertainties taken into consideration, it is not a surprise that the data from the contracts could not have led to a comprehensive and precise reconstruction of the brigs in question. Visualization of archival evidence, however, opened a challenging path towards a more concise comprehension of the *chaîne opératoire* and the Aegean nautical traditions in the 19th century.

4. Conclusions

The pre-modern vernacular shipbuilding in the Aegean is a challenging topic that remains poorly studied. The project that was briefly presented above was a first attempt to approach archives as a source of archaeological information, since the physical remains of the wooden vessels have not been preserved. Brigs were used as a case study and their contracts have provided valuable insights into the technological and anthropological context of Aegean shipbuilding during the 19th century.

Acknowledgements

The authors express their gratitude to the Honor Frost Foundation for the financial support of this research. Special thanks are also owed to the General State Archives, the Cyclades Prefecture, Syros, for kindly providing copies of the eight contracts under study.

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