

« The Firm and The Sea : Chains, Flows, and Connections ».

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«*Caulkers, Caulking, Luzzatto and the Mariegola dei Calafati : An Ignored And  
Fundamental Factor of The Venetian Arsenale*»

Hello everyone and **many thanks to** Roberto Giulianelli for the help he gave me in reference to this session.

The speech, I will present, concerns the organization of the work inside the calafati's corporation (caulkers), together with Christophe Austruy who will develop the theme for later periods and with other archival sources.

The caulkers were skilled workers who benefited from a significant prestige within the *arsenalotti* society, that is to say the workers of the Venice arsenal, who were considered the first form of great enterprise in the Western world.

This according to the indications offered by Frederic Lane in his History of Venice, which for the first time has led a reflection in this direction.

The starting points of my investigation are the capitulars of the caulkers (skilled workers, divided into two categories: the workers involved in fixing the planks and those involved in filling the seam in between planks with oakum) as found in the Gino Luzzatto archive.

Luzzatto has been the father of Italian economic history and teacher for several years until his death in Cà Foscari, as well as author of a prestigious economic history of Venice in the Middle Ages. He put careful attention to the caulkers' Guild (in Marciana archives) and did not hesitate to transcribe long parts of the documents that interested him. He scrupulously noted details in the margin as in the case of the leader caulker master, where he wrote his special attributions.

From the historiographical point of view after years dedicated to the land investment, the attention of the venetian historian has returned to focusing on the dynamics of the maritime questions and this in tune with the international framework.

Just think of the summer school organized by the association of Labour history dedicated to seafarers, at the French-Italian colloquium that with Laube from Brest University we are organizing in Venice and that will follow in Paris and Bordeaux, dedicated to arsenals or archaeological excavations in the port of Yenikapi.

This proposal falls within this framework as well as being part of my studies on Gino Luzzatto and his idea of economic history that I have been carrying out for several years.

It should be noted that Luzzatto has never dealt directly with the subject of the arsenal, while in various studies he examined the shipbuilding problems also with reference to the interests of the patriciate.

But as he wanted to review the work of Lane on shipbuilding, Luzzatto investigated in archives archival research in order to have an extension of the subject.

Moving as a good medievalist he wanted to deepen the *mariegola dei calafati* (the guild of caulkers, quasi never studied till now) whose rules allowed him and us all to study the theme of the work organization within the society of *arsenalotti* (arsenal workers).

In this community of skilled workers, they disposed of substantial rights such as having apprentices (fanti) or transmitting their experience to their own children or nephews.

This habit in the Venetian society tended with time to become more and more widespread in all professional fields, hindering as consequence any possibility any form of social renewal and mobility, and factor of technological conservatism.

The document transcripts are numerous in the archive Luzzatto deposited by the niece Evelina Polacco to the Bec, the library of the faculty of economics of Cafoscari.

This was Luzzatto's way of working that advanced new hypotheses in the economic history of Venice only after careful analysis of the archive at the Marciana library or at the Querini.

The transcription of the mariegola brings to the margin the comments of the historian.

The study of the document should probably be interpreted in the direction of the basic idea that the small middle-sized entrepreneur forms the strength of the Venetian economic society rather than by the large, as could be the great patrician merchants dedicated to the large market.

In this sense the dimension of the caulkers is seen in a horizon linked to the subsistence of the artisan family, therefore in a socio-economic approach that started from the bottom.

Luzzatto approaching indirectly the study of the arsenal wanted to grasp the opportunity to study this technician army employed in the great shipyard, more or less the same working class in all cities, whose economic objectives were not related to the capital of the great shipowners or the great merchants, he studied specifically.

But in a dimension linked to a professional activity underlying the economic and human dynamics of a pre-industrial reality.

The caulkers were part of the generic definition of arsenalotti, and a quick examination of rare inventories of the sixteenth and seventeenth fortunately came to light, allowing to say that their economical status, was close to that of the alboranti (those who took care of the “alberi maestri” and rudders), perhaps one of the highest status of the arsenalotti.

The dowries of the daughters or wives seemed to be quite high. So much that in the dowry of a woman the Guazzo’s book, a Civil Conversation book, appeared.

Of course, in many cases the dowries included worn or broken clothing as well as the objects inherent to the furnishing of a house, which is confirmed as poor and miserable, but there is no lack of contrary examples.

As evidenced the presence of the Guazzo underlines a vision of highly autonomous women from an economic point of view.

Let's not forget that if Robert Davis defined the world of the arsenal as a world characterized by a male presence, a deeper analysis of the numerous archival documents has highlighted a female presence among the workers and this is at the level of simple sail repairers or processing of hemp.

But also their significant presence into skilled works: it has even registered the presence of a woman that was prota, detaining and using managerial functions in his work.

**« *The Firm and The Sea : Chains, Flows, and Connections* ».**

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**Caulkers, Caulking, Luzzatto and the Mariegola dei Calafati : An Ignored And Fundamental Factor of The Venetian Arsenale <sup>1</sup>**

The problem Gino Luzzatto faced was not a very basic one almost a century ago on October 1925 when he decided to study the *Mariegola dei calafati* in the Marciana Library<sup>2</sup>. Caulkers and Caulking were a little bit away and outside from the main stream brilliant Venetian history of the 15<sup>th</sup> and 16<sup>th</sup> centuries<sup>3</sup>.

The questions he was asking were entirely new; ground breaking; and remain so, for even today conventional maritime history focuses on the big questions of shipbuilding as an industry and naval architecture in its grand designs (even in archaeology) rather than on Luzzatto's apparently humble subject, caulking and caulkers noted by Paola LANARO in his biography<sup>4</sup>.

But it was at the time a fundamental activity occupying a huge economic sector across not only the entire Venetian empire, but the Mediterranean and Atlantic. More generally world-wide, any country or empire that sustained a shipbuilding industry employed thousands of these workers<sup>5</sup>.

1. I would like to thank Maurice AYMARD for his constant suggestions, ideas and attention, Paola LANARO for the collaboration we built and Carol RUTTER for more than an ordinary reread.

2. BNMV, Mariegola dei calafati, Ms It Cl VII, N°560 (7501) and Scholars list, at the first places with LANE Frederic C cf LANARO Paola « Gino LUZZATTO Storico de l' Economia Veneziana » in « Atti del Convegno Gino Luzzatto, storico dell'economia, tra impegno civile erigore scientifico », LANARO Paola (Ed.), Venezia, Ateneo Veneto, 5-6 novembre 2004, in «Ateneo Veneto», 2005, n°1, p. 50. In this latter book an exhaustive bibliography of Gino LUZZATTO: CARACAUSI Andrea «Gino Luzzatto. Bibliografia», in «Ateneo Veneto», 2005, n. 1, pp. 161-225.

3. « ma anche a quelli relativi a uffici minori (...) comunque poco frequentati dai ricercatori; in questa direzione svolse un faticosissimo lavoro, schedando "a tappeto" una infinità di notizie e informazioni, LANARO Paola, « LUZZATTO Gino », Dizionario Biografico degli Italiani, TRECCANI, Volume 66, 2006 and

4. cf note 2.

5. LUZZATO Gino, « Per la storia delle costruzioni navali », Studi in Onore di Camilo Manfoni, 1925, pp.381-400.

And in Venice ship caulking was considered as a main economic activity which was structured in several branches (planks fixing, traditional caulking, products, etc.). Caulking was seen as so crucial to Venice that caulkers were not permitted to leave the city. And in case of moving they were liable to arrest, imprisonment and banishment<sup>6</sup>.

His legendary Arsenal from the 14th till the beginning of the 18<sup>th</sup> century constituted one the determinant factors of the Venetian economy and his shipbuilding industry. It was determinant for caulking and so the best place to observe them.

There are, of course, many reasons why, across the 19th and 20th centuries, such a basic activity as caulking disappeared from shipbuilding as an industry and from the attention of academic study in industrial countries<sup>7</sup>. Today caulking is mostly a hobby for wooden ships amateurs as boat builders - though still a main activity in countries that rely and keep on traditional ships built in wood.

Till now very rare researchers have been investigating and following Luzzatto's focus for caulkers and caulking. The questions he asked need to be re-opened. That is our object in this paper. By returning to Luzzatto's topic we want to analyse and understand its crucial significance in the history of caulking and shipbuilding in Venice.

Looking first at the basic elements of the caulkers' employment and at the social conditions that governed their lives will equip us to understand the central importance of caulking in the Venetian Arsenal's shipbuilding enterprise and its critical position in the full range of the Republic's global maritime activities, geopolitical and military issues. When the Serenissima and the Arsenal needed to build new ships units or renovate old ones units, with a basic point, the case of the *galea sottile*, light war galley.

### **I. From caulking to the venetian definition**

First, some definitions to fix the framework of caulking. To 'caulk' a boat generally speaking means rendering the wooden hull watertight by preventing water damages on planks and inside the boat. Boerio's reference dictionary of Venetian usage gives this definition and insists on this dimension « *Ristoppare i navigli, cacciando stoppa a forza di maglio nei commenti or in qualunque parte potrebbe penetrar*

6. BMQS, CL IV, C XXX, Mss N° 151, Lodoli « Il Cuore Veneto Legale », f°107v, 108r, etc.

7. JAL Auguste, « Glossaire nautique », Firmin Didot, 1848, entry Calfat, p.388 JAL Auguste, « Glossaire nautique », Firmin Didot, 1848, entry Calfat, p.388.

*l'acqua*»<sup>8</sup>. William Henry Smith's 19th century Sailor's Word-book expands the entry on 'caulking' to detail its methodology:

«Forcing a quantity of oakum, or old ropes untwisted and drawn asunder, into the seams of the planks, or into the intervals where the planks are joined together in the ship's decks or sides, or rends in the planks, in order to prevent the entrance of water. Afler the oakum is driven in very hard, hot melted pitch or rosin is poured into the groove, to keep the water form rotting it. Among the ancients the first who made use of pitch in caulking were the inhabitants of Phaecia, afterwards called Corfu (...)»<sup>9</sup>

(Corfu was the main island of Venetian empire with Creta after the lost of Cyprus in 1570, and up until the end of the Republic in 1797).

From antiquity many techniques were developed, and many tools and products (oakum, old ropes, etc.) were used to fill the seams between wooden planks and protect them for rendering hulls watertight<sup>10</sup>. A wooden ship that isn't caulked can't float and therefore can't serve for any maritime purpose, in parallel his ability and speed at sea depend on an optimal caulking.

But these two initial definitions didn't exactly match and cover the caulking activity in the *Serenissima* and the *Arsenale*. Caulking and caulkers were strictly organized and divided in two different technical and social categories. The first ones were the *calafati da figger*, caulkers for fixing the planks on the skeleton and the second ones were the *calafati da maggio*, caulkers for blocking the spaces in between the planks with oakum<sup>11</sup>. Luzzatto focusing on traditional definition didn't mention this difference.

In fact these two different activities corresponded to steps in the industrial processes of building new ships or renovating them: at the mid-end and end for the first one and as central operation for the second one. In both cases, they were made by various and numerous tasks organised in logical phases<sup>12</sup>.

8. BOERIO Giuseppe, « Dizionario del dialetto veneziano », 1829, entry Calafatare, p.85.

9. Fonts : Smyth William Henry, *The Sailor's Word-book: An Alphabetical Digest of Nautical Terms, Including Some More Especially Military and Scientific ... as Well as Archaisms of Early Voyagers, Etc.*, Blackie and Son, 1847, Entry Caulking, p.173.

10. BASCH Lucien, «Note sur le Calfatage», *Archeonautica*,6, 1986, pp. 187-198, Aufan Robert, « Production et commerce de la poix en aquitaine, du moyen age au XVIIe », in « Histoire des produits résineux landais: goudrons, poix et brays gras depuis l'Antiquité », en Buch, Born et Marensin - Société historique et archéologique d'Arcachon et du pays de Buch, 1990.

11. FERON Patrick, « Le geste du maître Calfat, milieu, outils, techniques » in BOUILLON Didier, GUILLERME André , MILLE Martine & PIERNAS Gersende « Gestes techniques, techniques du geste », Presses Universitaires du Septentrion, 2017, pp. 130 - 132.

12. «notions de chaînes opératoires décomposables en "phases, opérations, actes et gestes"» and « active frames » notion developped by Lucien BASCH in 1972 to understand the possible mixed role in between the skeleton and the planks in POMEY Patrice, RIETH Eric, «L'Archéologie Navale», Editions Errance, Paris, 2005, pp. 20-34.

Also both workers categories were sure to be employed in the Arsenal, to have work in all ships production politics of the Venetian State.

In case of building new galleys both categories were employed but not at the same step of production, while in case of renovating ships the *calafati da maggio* were much more solicited. It depended on the state of the galley hulls turning back to the shipyards of the Arsenal and on his politics of building new ships. In fact as a lot of common maintenance didn't affect and didn't suppose huge interventions on planks the traditional caulking was more in use in peace times.

## **II. The caulkers significance, the Arsenale, and the Serenissima policy: Luzzatto's elements.**

Luzzatto first drew attention in his article, a century ago, immediately to the sheer numbers of caulkers in the city and in his close islands at the beginning of the 15<sup>th</sup> century. He mentioned following the Mocenigo's testament the number of 3 000 in Venice. Given that the total population of Venice at that time was between 180,000 and 200,00<sup>13</sup>, and that 70-80% of that population was in employment (giving a labour force of between 125,000 and 160,000), that figure of 30,000 caulkers means that 2 to 2.5% of the total population was involved in the trade (by comparizon in the french car industries 440 000 workers were employer for a total workforce of 26,8 millions in 2011/2012 a rate of 1,6%).

Focusing only on those employed in the Arsenale itself in the *longue durée* from the beginning of the 16th to the end of the 17th centuries, Robert Davis underlined the importance of caulkers, some 600 of whom were formally enrolled there between 1538 and 1629(or close to)<sup>14</sup>.

Amongst the «*arti maggiori*» of the Arsenale according to Ruggiero Romano caulkers held the first places quasi equal to carpenters in numbers. Most of times they were second slightly inferior to them at the beginning of the 16th century 693/652 in 1538 and 541/512 in 1641.<sup>15</sup> But in 1591 they were superior.

These numbers show how completely these two classes of workers dominated the shipbuilding industry in Venice, yet no one had studied the crucial part caulkers played in the Republic's economic and cultural history. To fill this gap, Luzzatto began by looking at the institutions and social practices that ordered the working lives of caulkers in Venice.

He noted the Seranissima's policy to manage this crucial sector, She regularised various laws and employment practices that would ensure and maintain always a high

13. LUZZATTO, « Per la storia delle costruzioni navali », p.38, <http://venus.unive.it/macellosangiobbe/popolazioneve.htm>

14. DAVIS Robert C., «Shipbuilders of the Venetian arsenal: workers and workplace in the preindustrial city», Johns Hopkins University Press, 1991, Table 1.1 Major Guildsmen in the Arsenale, 1503 and 1696.

15. ROMANO Ruggiero, « Aspetti economici degli armamenti navali veneziani nel secolo XVI », p.54.

potential of skilled caulkers, trying to keep for the Arsenal a kind of available reserve in all circumstances<sup>16</sup>.

The first pillar was a strict residence and anti-immigration policies backed with a lot of tough sanctions. These were established very soon from the beginning of the 14th century<sup>17</sup>. Regular decrees of the Venetian Senate forbade caulkers and carpenters to leave Venice except under special circumstances, outside their necessary assignment to war galleys where they sailed as part of the technical crew.

The residence policy was also promoted by giving to masters good salaries and social perks. While most appeals to the Senate for salary review among the general labor force in the 15<sup>th</sup> and 16<sup>th</sup> centuries were turned down, the Venetian authorities regularly rewrote and could increase their wages, an evident privilege among all workers classes<sup>18</sup>. As they disposed of a wide freedom for working in *either* the city's private shipyards or in its public service Arsenal at the same time, they could choose the best deal in function of various elements whom financial gains were not the last. This constrained the Senate to a mixed policy coercive to obligate them to work in the public shipyards<sup>19</sup>.

The Serenissima allowed new rights, as noted LUZZATTO, to the masters caulkers to take on long-term apprentices, they were authorized to have one or two youths of not less than 14 years of age. But to enhance the power and status of their own families, they were permitted to take on their sons and nephews, to begin their apprenticeship much sooner than in the general case at ten years old<sup>20</sup>.

This anti-immigration policy established from the 15th and the 17th centuries laid out in detail the conditions and the cases governing a caulker's temporary remove from Venice: duration, location, sanctions if he failed to return, etc. as expertise of a merchant round ship or a galley, having to repair them, missions in arsenals of the empire, in harbours, etc.

A second pillar was laid down in order to deal with periods of dearth of masters, in time of plague, natural disasters, migrations, etc.<sup>21</sup> The Senate provided new legislations breaking with no hesitation the historical fundamental difference in between *calafati da figger* and *calafati da maggio* and enforcing them to be able to manage both techniques<sup>22</sup> even if masters were actively opposed to these new measures. Even by breaking the corporation regulations governing the duration of apprenticeship to reach the grade of

16. BNMV, Ms It Cl VII, N°560 (7501), Mariegola dei Calafati, f°25r.

17. BEC Università Ca Foscari, Archives LUZZATTO, Biblioteca Economia, Busta I B, 21b, f°20.

18. BEC Università Ca Foscari, Archives LUZZATTO, Biblioteca Economia, Busta I B, 21b, f°20.

19. AYMARD, « Strategie di cantiere », in TUCCI Ugo & TENENTI Alberto (Ed), Storia di Venezia. Il mare, vol. XII, Enciclopedia TRECCANI, pp. 267-273.

20. BEC, idem and BMCV, Ms It Cl VII, N°560 (7501), Mariegola dei Calafati, f°17r, BMCV, Mariegola dei Calafati, Cl IV N°214, f°17r, 17v.

21. ASV, Collegio, Relazioni Finali di Ambasciatori e Pubblici Rappresentanti, N°57, Relazione Arsenal Giovanni Priuli.

22. BMQS, CL IV, C XXX, Mss N° 151, Lodoli « Il Cuore VenetoLegale », f°108v.

master<sup>23</sup>. Shortening the time meant producing master caulkers more quickly or even immediately.

At last when the Arsenale had to respond to public procurements of the Senate and had to put in production a huge quantity of galleys. His decrees could break the regular hierarchical organisation of the work « *a giornata* » rule by the chief of the caulkers master for dealing directly with caulker masters in a contract called « *sopra di sè* », underlined by Maurice Aymard<sup>24</sup>. It stipulated only the outsourcing of specific operations (non crucial for the ship) into the shipyard but many times with virulent critics from senators focusing on the inferior quality of work whereas others on speed.

But La Serenissima never hesitated to look for solutions to these issues outside the city, in the big Laguna, in the empire, Dalmatia, Greek islands, etc. attracting or forcing workers to move to Venice.

Indisputably this politics was a great success if we look the galleys production level that could reach in between 1400 and 1600 the Venetian Arsenal - the numbers of galleys built there compared with the numbers built by its rivals in the Mediterranean, the Spanish and the Ottoman Empires<sup>25</sup>. Ennio CONCINA noted the Venetian did not care about ottoman shibbuilding according to a Venetian ambassador who judge theirs galleys not at all well built « *storte or disproportionate* »<sup>26</sup>

In fact, the success that produced many so opportunities for the Arsenal's skilled workforce meant that the Senate had to enforce restrictive policies to keep labour in Venice. And these active politics of the Senate could be interpreted as a protection against a kind of brain drain, avoiding skilled workers migrations or trying to reduce incentives to go abroad, especially to Istanbul as Maurice AYMARD insisted<sup>27</sup>.

Although we don't have sufficient data for evaluating fully these migrations we do have some very accurate interesting indications. A dispatch from a Venetian ambassador of Istanbul reports that the Ottoman aimed to attract in first skilled workforce

23. DAVIS Robert C. « Shipbuilders of the venetian Arsenale (...), p.38.

24. AYMARD Maurice, « Strategie di cantiere », in TUCCI Ugo & TENENTI Alberto (Ed), Storia di Venezia. Il mare, vol. XII, Enciclopedia TRECCANI, p. 276.

25. AYMARD Maurice, idem, p. 260 & 261, LANE Frederic C. « Navires et Constructeurs à Venise », SEVPEN, Paris, 1965 (2ème Ed), Statistics Table.

26. CONCINA Ennio, « La costruzione navale », in TUCCI Ugo & TENENTI Alberto (Ed), Storia di Venezia. Il mare, vol. XII, pp. 236.

27. Analyse of Maurice AYMARD after the presentation of Christophe AUSTRUY and Paola LANARO « Calfats et Calfatage : force fondamentale et méconnue de l'Arsenal de Venise au XVIe. L'étude de la Mariogola des calfats de Gino Luzzatto », Séminaire « Économies, sociétés et cultures du monde méditerranéen, XVe-XXe siècle », Maurice Aymard « 19 mars 2018, EHESS.

as caulkers and carpenters from Venice<sup>28</sup>. Another indication show that these migrations could lead caulkers from Mediterranean to Atlantic Arsenals as in the *Clos des Galees* in Rouen which welcomed genovesian caulkers taking out of the Mediterranean a new caulking technique and process<sup>29</sup>.

But all of these temptations from abroad empowered the caulkers conditions and gave them leverage to negotiate with La Serenissima for improved their incomes and living conditions by threatening not only to work out of the city but even to live « il vivere in terre aliene<sup>30</sup>.

Moreover caulkers did have very symbolic prominent place in the heart of the city on the basilica's façade of San Marco in the central square. Every one could see that prominence represented and evaluate their role for the empire.

At the base of the great arch over the main door, on the left, the art of the caulker is sculpted in stone. The scene represents a caulker under a ship working with a carpenter above (both *arti* -guilds were founded more or less at the same time in the early 13th century). But remarkably, if traditionally carpenters are seen as the dominant in shipbuilding, here caulkers are given positional priority over carpenters: they are the first represented. If we read this sculpture from the bottom up so we encounter our caulker first. (but caulkers and carpenters could be seen as part of the same group of shipbuilders cf infra<sup>31</sup>)

This lead us to understand why caulkers where so notable and indispensable in the shipbuilding industry and so for the Venetian economy and power.

### **III. Caulkers and Caulking vital for ships**

Caulking was and so has to be understand as an essential phase in the shipbuilding process for as long as ships have been made of wood while the modern maritime naval studies, studies of shipbuilding, of naval architecture and of naval archaeology have ignored it. They did not approach the problem and so let these production sequences a side.

Traditionally such studies focusing for the firsts on output: numbers of ships produced by a nation, or in an arsenal or a single shipyard; the physical characteristics of these ships, their dimensions, capacities, range, modes of propulsion, etc. and for the seconds they looked mainly at the construction process: from the beginning to the sequence where the main structure or hull is completely planked or at specific issues of

28. CONCINA Ennio, « L'Arsenale della Repubblica di Venezia », Electa, 2006 (Ed.n° 2),

29. CONCINA Ennio, « L'Arsenale della Repubblica di Venezia », Electa, 2006 (Ed.n° 2), BASCH Lucien, « Note sur le Calfatage : la chose et le mot », Archaeonautica, n°6, 1986, pp. 187, 188.

30. «non vadano a cercar il vivere in terre aliene» BNMV, Ms It Cl VII, N°560 (7501), Mariogola dei Calafati, f°6or.

31. JAL Auguste, « Glossaire nautique », Firmin Didot, 1848, entry Calfat, p.388 and POMEY Patrice, RIETH Eric, «L'Archéologie Navale», Editions Errance, Paris, 2005, pp. 20-34.

construction arising from marine archaeology - such as the position of a galley's central rowers <sup>32</sup>.

As caulking sequences come midway through the shipbuilding process and right at the end, they were the last operation performed on the hull, just before the ship was fitted out and launched into the sea. Consequently they were the first to be blamed if a military or commercial ship were not seaworthy, or if its range was limited by water penetration through its planks. They were the first to be blamed, too, when long ships as light war galley known as the *galea sottile*, for instance just out of the Arsenal were not able to glide through the sea at high speed.

And yet, given their importance, their role and significance are almost totally ignored<sup>33</sup>. By exception. Auguste Jal in 1848 in his famous *glossaire nautique* dedicated a full page to the caulkers <sup>34</sup>. Noted even by Lucien BASCH a century after who underlined their possible belonging to the shipbuilders group.

But more accurately, however, Basch identified the particular Venetian process of caulking and how it was organised logically around the two axes that set out the different progressive sequences of the work performed by the two different caulkers groups : the *calafataggio da figger* and the *calafataggio da maggio* (Patrick FERON basic study on caulking didn't underline and investigate this difference<sup>35</sup>).

Behind a strict division of labour operated matched with the different tasks along the production process. In the Arsenale four main groups were identified and involved in the process: carpenters, caulkers, oar-makers, masts and rudder makers.

The shipbuilding process in Arsenal could be laid out with some hypothesis

<b>Sequence/Step</b>	<b>Operations Class</b>	<b>Worker Class</b>
	<i>Shipbuilding process</i>	Masters =M
1	Keel & Stem & Stern (order & construction lines)	Carpenters (M)
2/3	Frames (order : 3 main & 1/5 & filling timbers)	Carpenters (M)
2/3	Stem & Stern Frames (order?: 1/5 & filling timbers)	Carpenters (M)
4	Beam (order ?)	Carpenters (M)

32. for example in the GARDINER John (Ed.) « Conway's history of ship. The Age of the Galley. Conway's History of the ship », Gardiner John (Ed.), Chap. 12, Londres, 1995 »

33. For example Gerard TELLIS, Stav ROSENZWEIG, «How Transformative Innovations Shaped the Rise of Nations: From Ancient Rome», Anthem Press, 2018.

34. JAL Auguste, « Archeologie Navale », p.435 carpenters for fixing and assembling firmly planks.

35. FERON Patrick, « Le geste du maître Calfat, milieu, outils, techniques » in BOUILLON Didier, GUILLERME André , MILLE Martine & PIERNAS Gersende « Gestes techniques, techniques du geste », Presses Universitaires du Septentrion, 2017, pp. 129-140.

5/6	Hull Planking (order ? : from or to, galboard strake)	Fixing Caulkers (M)
5/6	Deck Planking (order ?)	Fixing Caulkers (M)
7/8/9	Rowing structure (order : bacalas & yoke & outrigger & gangway )	Carpenters (M)
7/8/9	Prow & Poop Structures	Carpenters (M)
7/8/9	Interior Room fittings	Carpenters (M)
9/10	Filling Hull Seams	Malleting Caulkers (M)
9/10	Filling Deck Seams	Malleting Caulkers (M)
<i>End of shipbuilding process Fitting Out Process Process Beginning?</i>		
11	Rowing post (order : bench & stretchers & oarlocks)	Basic Carpenters
12/13 (7/8/9)	Rudder structure (order: Axial & lateral, etc.)	Masts Masters
12/13	Sailing structure & deck fittings (order : masts, espar, etc.)	Masts Masters
14/15/16	Anchors	Storemen
14/15/16	Sails & Ropes	Storemen
14/15/16	Oars (order: oarlocks & stroppa)	Storemen
17(12/13)	Weapons (order : heavy artillery, side arms)	Storemen
18	Sea Biscuit	Storemen

Table: construction of the author – Sources: Annexe

The original process of the caulking was to put the caulkers at very crucial sequences for the ship (our table amplifies their role 5/6 and 9/10). Their first operations, fixing the planks on the skeleton, was directly associated with the work of the carpenters because the calafati da figger were the ones who had to adapt the planks to the curved form of the frames, for progressively covering the entire skeleton.

Also the calafati da figger had to master the planking simultaneously in two dimensions: following every horizontal curved lines of planks from the stern to the stem and trying to form very regular vertical curved lines with the planks progressively fixed one under or upper the other from the keel to the deck<sup>36</sup>. The planks configuration was obtain certainly by using bending technique.

36. CM58, « Planing a plank », 2003, Winterton Boat Building and Community Museum, Newfoundland and Labrador, Canada, <http://newfoundlandshipbuilding.com/shipbuildingtoday/winterton/images.htm>

Given the natural deformations that occur in wood, from the skeleton and from the planks, before and during the shipbuilding process this was no easy task. The *calafati da figger* had to manage these variations by making multiple attempts depending on the qualities of family Pinaceae used and to take care of the atmospheric conditions along the process before the planks could be finally fix.

Then, to get an optimal careen it was also necessary to combine the action of the *calafati da figger* with this of the second class of caulkers, the *calafati da maggio*. To build homogeneous and impenetrable *walls* with numerous wood pieces in the carvel-built process, the operations consisted first by filling firmly the seams in between the horizontal planks with an oakum string (or old ropes untwisted and shredded). And second by rendering this joint watertight and solid, using various sealers whose basic ingredient was pitch. This joint could dry and became tough but enough elastic to block the water<sup>37</sup>.

The success of this technical operation, to get an hermetic and water-dynamic hull, was directly linked not only to the well known traditional caulking the '*mallet*' caulking, the *calafataggio da maggio*, but from anterior operations (cf supra) made by the other unrecognised *planks fixing* caulkers which had to build regular inter-space planks whom edges had to be perfectly « *beveled depending on the shape of the hull at each point* »<sup>38</sup>.

This explained why caulkers could be considered shipbuilders in reason of their capacity to rule crucial sequences in the mid-end shipbuilding process till the launching. In the Arsenale, not only carpenters were *capi d'opera* (master of work). So could caulkers and sometimes reaching paramount in quantity of galleys built<sup>39</sup>.

In fact caulking and caulkers refer directly to the shipbuilding conception. As scholars and overall archaeologists have shown, the ship could be conceived or projected either starting from the inside or from the outside structure, which are *skeleton first* or *shell first* (without excluding mix of both technique). In the first case, the skeleton, the keel, the frames, etc. are the starting point and the master carpenters take the lead as architects and builders of the ship while in the second case these are the planks, the planking of the hull, etc. and the caulkers are leaders.

Moreover, the importance of traditional caulking grew as the shipbuilding industry changed in the Arsenale of Venice. First when the production of new galleys decreased slowly at the end of the 16<sup>th</sup> after the victory of Lepanto in 1571, a clear inflexion shift (the last major sea battle fought only between the two biggest fleets of rowed galleys «Christian and Muslim»), the need of maintenance grew<sup>40</sup>. Though the shipyard did not need the same number of *calafati da figger* (planks fixing caulkers) but traditionnal

37. FERON Patrick, « Le geste du maître Calfat, milieu, outils, techniques », idem, p.132.

38. idem note 33.

39. More than 100 galleys for Franco da Brescia around 1510, BMCV, Gradenigo Dolfin N° 170, f°61v.

40. BNMV Ms It Cl VII N°1745 B (9640 B) f°13r, f°34v.

caulkers were needed for renovation, reparation work, etc., checking-up the vessels watertight. Second, the same effect and scenario were repeated when the Arsenale phase out its traditional warships, from galleys especially light war galleys to line vessels, because of their much more longer an superior lifetime than this of the galley. The ship age exceeded 20 years while for the light war galleys it was in between 5 to 10<sup>41</sup>. This led to a drastic fall in the numbers of new ships built and consequently, to a drop in the activity for the *calafati daf figger* and in their numbers.

## Conclusion

Key factors of success for leading powers as the Serenissima was between 1400 and 1600 rely often on a set of invisible elements, largely invisible to the backward gaze of subsequent history whom caulking and caulkers are typical examples. Their importance did not depend on any one element, but a set of factors, social, cultural, economical, etc. that match with these technical.

Caulking and caulkers histories are exactly at the point of the abyssal difference between their weight in every day life economy from the 14<sup>th</sup> to 17<sup>th</sup> (called by Braudel «histoire du quotidien»<sup>42</sup>) and their inexistant place in the historical studies (without considering the links they had with others sectors).

Moreover the brilliant repetitive history on crucial events, glorious, battles, galleys successes, mythical arsenal, etc. always tends to recover an history at a low level or to oriented it.

But without the humble caulker Venice would have had no glorious maritime history, no extraordinary commercial success; would never have attained the dizzying heights of wealth and power it achieved. The great significance of an ignored sector could be approach with numerous variable focus on time and scale, from quantitative to qualitative methods whom coherent links are signs of a deep history.

## Annexe : Shipbuilding process

Numerous sources are at the base of this study : authors, archives, and especially working sessions with Mauro BONDIOLI. Also we give only few references.

41. BMCV, Gradenigo, N°193/I, « Navi fabbricate nel Arsenale di Venezia dal 1687 al 1797 », ASVE, Padroni e Provveditori all'Arsenale, N° 546, DRACCHIO Baldiserra, Ricordi al intorno del Arsenale.

42. BRAUDEL Fernand, « La Méditerranée et le monde méditerranéen à l'époque de Philippe II » : Tome 1, « La part du milieu » ; Tome 2, « Destins collectifs et mouvements d'ensemble » ; Tome 3, Les Evènements, la politique, les hommes », Le Livre de Poche, LGF, Paris, 1993, Armand Colin, Paris, 1949 (1ère Ed.), et 1966.

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ASV, Miscellanea di Carta Appartenente ad Alcuno Archivio N°2, N°7

ASV, Provveditori all Armar, N°240

ASV, Collegio, Relazioni Finali di Ambasciatori e Pubblici Rappresentanti, N°57

### BMCV :Biblioteca del Museo Correr

BMCV, Mariogola dei Calafati, Classe N°IV

BMCV, Gradenigo, N°193/I, N°193/II

BMCV, Gradenigo, N°170

### BNMV : Biblioteca Nazionale Marciana

BNMV, Ms It Cl VII, N°560 (7501), Mariogola dei Calafati

BNMV, Ms It Cl VII, N° 1745B (9640 B)

### BECUCF : Biblioteca di Economia Università Ca Foscari

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