EXPLORATION AND EMPIRE: ICONOGRAPHIC EVIDENCE OF IBERIAN SHIPS OF DISCOVERY

A Dissertation

by

KATIE MICHELLE CUSTER BOJAKOWSKI

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

May 2011

Major Subject: Anthropology

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Approved by:

Chair of Committee,	Kevin Crisman
Committee Members,	Donny Hamilton
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ABSTRACT

Exploration and Empire: Iconographic Evidence of Iberian Ships of Discovery.

(May 2011)

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This dissertation research project focuses on maritime exploration during the Age of Discovery and the vessels that were the technological impetus for this dynamic era that ultimately led Christopher Columbus to the New World and Vasco da Gama to India. Little is known about the caravel and the nau, two ships which defined this era of global expansion; archival documents provide scant information regarding these vessels and to date there are only a few known archaeological examples. The caravel and the nau became lasting symbols of the bourgeoning Portuguese and Spanish maritime empires and are featured prominently in contemporaneous iconography.

This dissertation bridges the gap between the humanities and sciences through the statistical analysis of the caravel, galleon, and nau in the iconographic record. As one of the first intensive uses of iconography in nautical archaeology, the study analyzed over 500 images using descriptive statistics and representational trends analysis in order to explore the two research questions posed, Are the ships represented in the iconography

accurate? and Can iconography provide information on constructional characteristics of these vessels that will determine typology, evolution, and design changes? Gauging the accuracy of the ship representations was fundamental to establishing this study's validity. The artists creating these images were not shipwrights or mariners and thus this research was not limited to the technological and constructional aspects alone. The dissertation addressed technology as a cultural symbol in order to understand how and why cultures attach such powerful and important symbolism to technology and adopt it as an identifying feature.

On a broader level, this dissertation proved that iconography is a viable data source within nautical archaeology. The representational trends and general construction proportions analyzed in the iconographic record did provide an ample amount of information about the different ship types to greatly assist in the reconstruction of a caravel, galleon, or nau. The vast quantities of new data generated using these methodologies have the potential to significantly advance the study of these three ship types when paired with current and future archaeological evidence.

DEDICATION

This dissertation is dedicated to my husband, Piotr, our daughter, Zofia, and our son that is on his way. I could not have completed this dissertation without the support of my husband and the motivation of my children.

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Faculty, friends, and family members have helped me to complete this dissertation. I would like to express my gratitude to these individuals for their support and assistance. The members of my dissertation committee, Kevin Crisman, Donny Hamilton, Suzanne Eckert, and April Hatfield, have generously given their time and expertise to better my work. I thank them for their contribution and their good-natured support. I also want to thank my family for the endless support they provided me during the long process of writing. It would have been next to impossible to write this dissertation without the help and guidance of my husband, Piotr.

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CHAPTER I

INTRODUCTION

1.1 RESEARCH OBJECTIVES AND PARAMETERS

Nautical archaeology is more than the study of seafaring technology; it also entails an examination of the ambitions and motivations of individuals and nations engaged in trade, exploration, and colonization. Ships can serve as symbols of national pride and of the human drive to look beyond the known world and discover the unknown. This dissertation will focus on the 15^{th}- and 16^{th}-century Age of Discovery and Expansion defined historically from the capture of Ceuta in Northern Africa in 1415 to 1580 when Spain annexed Portugal after King Sebastian I died heirless. Little is known about caravels and naus, the two ship types associated with the era of European global expansion, but their unique blend of Mediterranean and Northern Europe characteristics facilitated the exploratory voyages. These ships became popular symbols of the Portuguese and Spanish maritime empires and were widely featured in contemporary iconography; because these vessels continued to be portrayed after 1580, iconographic sources from the entirety of the 15^{th}, 16^{th}, and first half of the 17^{th} centuries are included in this study. This dissertation will rely primarily on Portuguese and Spanish sources, with a secondary use of other European sources.

This dissertation follows the style of *International Journal of Nautical Archaeology* (*IJNA*).

The iconographic record can help archaeologists with the difficult task of defining the caravel and the nau as ship types, identifying these vessels in the archaeological record, and in understanding their regional variations and temporal evolution. Although several 16th-century Iberian shipwrecks have been archaeologically excavated – the Emanuel Point Wreck (Smith, 1998), the Molasses Reef Wreck (Keith, 1987), the Highborn Cay Wreck (Oertling, 1989), and the Western Ledge Reef Wreck (Watts, 1993; Bojakowski, 2007) – at present there is no way to conclusively identify them as the remains of any particular type of vessel. Contemporary written records broadly describe the sailing qualities of these ships, as well as their general construction and appearance. The information gathered from this line of evidence, however, is not enough to identify a caravel or a nau in the archaeological record; archival records and iconography document the ships above the waterline and the archaeological remains are predominantly parts of the hull below the waterline.

I propose that the systematic use of the iconographic record to procure data on construction and rigging details can permit informed conjecture on the lines and appearance of these vessels, projecting what is known about the upper hull into the unknown lower hull. Likewise, the evolution and typology of construction characteristics can be better understood by determining representational trends in the iconography and by using descriptive statistical analysis. As this is one of the first studies in the field of nautical archaeology to intensively use iconography for the purposes of determining Post-Medieval ship design and construction, several theoretical considerations must be posed. Gauging the accuracy of the ship representations is fundamental to establishing this study's validity as the artists were not shipwrights.

On a broader level this study will seek to demonstrate that, when used correctly, iconography is a viable source of data for use within nautical archaeology. There is also considerable potential for increasing our knowledge of ship design theory in the 15th and 16th centuries, a time that directly preceded the wide-spread use of shipbuilding treatises and formally drafted lines. This research is not limited to the technological and constructional aspects alone: interpreting symbolism is also central to this work. In Portugal and Spain, the caravel and nau have historic and cultural significance as symbols of a past Golden Age. This dissertation will address the conceptualization of technology as a cultural symbol to understand how and why societies attach such powerful and important symbolism to technology and adopt it as an identifying feature of their culture.

Research Questions and Hypotheses

The first research question and hypothesis will determine whether or not iconographic sources can provide enough data to identify typological construction characteristics and temporal evolution of the *caravela latina*, *caravela redonda*, *caravela de armada*, as well as the galleon and the nau. Additionally, due to the lack of theoretical and methodological considerations regarding the use of iconography as a source of data, the second research question and hypotheses will test whether or not it is possible to determine the accuracy of caravel and nau depictions.

RESEARCH QUESTION 1: Can iconography provide information on construction characteristics of each of the three caravel types, the galleon, and the nau that will determine typology, evolution, and design changes?

> ***Hypothesis 1A: The iconography indicates different construction and rigging characteristics for each of the three caravel types as well as the galleon and the nau.***

> ***Hypothesis 1B: The construction characteristics of the three types of caravels will be proportionally more similar to the contemporary galleon than the nau.***

> ***Hypothesis 1C: The iconography indicates a temporal evolution for each of the three caravel types as well as the galleon and the nau.***

As stated previously, the construction details of the caravel, the galleon, and the nau are poorly known due to the lack of archaeological evidence, thus other sources of data are needed. The hypotheses are based on one such source, the iconographic record. A list of construction characteristics is to be determined through representational trends in the iconography. They will then be statistically analyzed to establish the proportional relationships between each of the characteristics for the three types of caravels, the galleons, and the naus. These characteristics are expected to eventually permit informed conjecture on the lines and appearance of these vessels in further studies. This research project will determine if iconographic sources can provide enough data to identify construction characteristics and temporal evolution for the *caravela latina*, *caravela redonda*, *caravela da armada*, as well as the galleon and the nau. Additionally, this project will establish a foundation for testing whether these construction characteristics can lead to the identification of the ship types among known shipwrecks.

Hypothesis 1A: The iconography indicates different construction and rigging characteristics for each of the three caravels as well as the galleon and the nau.

Determining the construction details of these vessels will enable archaeologists to better understand a typical range of size and features of the ships and the variation between and within each type. This knowledge is important to identifying shipwrecks in the archaeological record as it could potentially differentiate between a caravel, a galleon, or a nau. If this hypothesis is correct then it is expected that: 1) There will be statistically significant differences in the range of proportional hull sizes and features for the *caravela latina*, *caravela redonda*, *caravela da armada*, as well as the galleon and the nau. 2) There will be statistically significant differences in the rigging configurations for each of the vessel subtypes.

***Hypothesis Rejection*:** This hypothesis will be rejected under the following conditions: 1a) There are not enough features represented in the iconography to determine the construction or rigging characteristics of each vessel type. 1b) There is not a statistically significant difference between the construction or rigging characteristics of each vessel type.

Hypothesis 1B: The construction characteristics of the three types of caravels will be proportionally more similar to the contemporary galleon than the nau.

Establishing comparative construction characteristics and general proportions can potentially lead to a better understanding of the contemporary role of the galleon. While ample attention has been given to the galleon as a ship type, the true distinction between the larger of the caravels, the *caravela redonda* and the *caravela da armada*, and galleons has rarely been questioned nor has it been ascertained.

If this hypothesis is correct then it is expected that: 1) There will be a statistically significant relationship between the *caravela redonda* and the *caravela da armada*. 2) The *caravela redonda*, the *caravela da armada*, and the galleon will have a statistically significant distance from the nau.

Hypothesis Rejection: This hypothesis will be rejected under the following conditions: 1) The representational trends analysis indicates numerous differences in the presence and absence of important construction characteristics of the two caravel types and the galleon. 2) There is no statistically significant proportional relationship between the two caravel types and the galleon. 3) The galleon has a similar or greater proximity to the nau than to the two caravel types.

Hypothesis 1C: The iconography indicates the temporal evolution of each of the three caravels as well as the galleon and the nau.

The degree to which these ship types changed over the course of their use is implicit in terms of the differentiation of the *caravela latina*, *caravela redonda*, and the *caravela da armada*. It is assumed that as the function of the caravel evolved, so did its construction and appearance. This is too limited a view, however, and more information is needed to analyze the typology of the caravel as a ship type. Currently the study of 16th- century Iberian seafaring technology is limited by the predominant use of historical records because there is not enough evidence to precisely determine the commencement of the *caravela latina*, the *caravela redonda*, and the *caravela da armada* as well as certain construction features on the caravels, galleons, and the naus. The artistic record preserves these details in a more effective manner than the written word.

If this hypothesis is correct then it is expected that: 1) The hull construction of each of three caravels and the nau will become larger and more complex through time. 2) The rigging of the three caravels, the galleon, and the nau will become larger and more complex through time. 3) There is a temporal correlation between the growing size and complexity of the caravels and the evolution of the caravel as a type.

Hypothesis Rejection**:** This hypothesis will be rejected under the following conditions: 1) There is no statistically significant difference in the size and/or complexity in the construction of the hull. 2) There is no statistically significant difference in the size and/or complexity of the rigging. 3) There is no linear evolution of the caravel vessel types in the iconography.

Research Question 2: Are the ships represented in the iconography accurate enough to be of use to the researcher?

> ***Hypothesis 2A: The accuracy of some of the depicted caravels, galleons, or naus can be determined using art-historical background research on the artist.***

> ***Hypothesis 2B: The accuracy of the depicted caravels, galleons, and naus can be deduced by determining the technical accuracy of secondary ships in the iconography.***

> ***Hypothesis 2C: The use of stock images in the representation of the caravels, galleons, and naus can be determined statistically by examining proportions of principal features.***

In the preliminary examination of the iconography inaccurate images were easily identified due to limitations in medium or overly stylized representation; however, the majority of the images need further scrutiny to determine accuracy. Due to the lack of theoretical and methodological considerations regarding the use of iconography as a source of data, two hypotheses will test whether or not it is possible to determine the accuracy of the depicted caravels, galleons, and naus. The third hypothesis will test whether or not multiple depicted vessels within one source of iconography are stock images.

Hypothesis 2A: The accuracy of some of the depicted caravels, galleons, or naus can be determined using art-historical background research on the artist.

This hypothesis is based on the expectation that accuracy can be determined for some of the iconography by an art-historical examination of the role of the artist as well as the position of the depicted ship within the artwork. When the artists and their works are historically documented it is possible to establish whether they were known to conduct research on the subject and if their work tended to be true to the nature of the subject. An additional consideration addressed in this hypothesis is the placement of the ship within the artistic composition; is it in the background or the foreground and what is the relation of the ship to the predominant subject?

If this hypothesis is correct then it is expected that: 1) Art historical research of the known artists will indicate if they researched and accurately portrayed subject matter. 2) There is a strong correlation between the accuracy of the depicted ship and the predominant subject matter of the artwork. 3) The placement of the ship within the foreground or background of the art will determine accuracy.

***Hypothesis Rejection*:** This hypothesis will be rejected under the following conditions: 1a) There is not enough documented information on the artist to determine their credentials. 1b) There are poor or overly stylized depictions by artists with strong credentials. 2) There are poorly depicted or overly stylized ships that are the predominant subject.

Hypothesis 2B: The accuracy of the depicted caravels, galleons, or naus can be deduced by determining the technical accuracy of secondary ships in the iconography.

Art-historical research is not available for a majority of the iconography and thus it is necessary to rely on archaeological means to determine accuracy whenever possible. This hypothesis is based on the premise that accuracy can be deduced by determining the precision of secondary ships in the iconography. Most iconographic sources portray more than one vessel type and it is common to have a caravel, galleon, or a nau depicted next to contemporary ship types for which we may have both archaeological and archival evidence. It is assumed that if the artist correctly depicted these secondary ships, then the representation of the caravel or the nau is also accurate. Only secondary ships that have correlated archaeological, archival, and iconographic evidence will be used.

If this hypothesis is correct then it is expected that the accuracy of known secondary ships will in part determine the accuracy of the depicted caravels, galleons, and naus.

***Hypothesis Rejection*:** This hypothesis will be rejected under the following conditions: 1a) There will not be enough historical or archaeological information for the secondary ships. 1b) A significant number of vessels will be poorly or overly stylized even when the secondary ships are accurately portrayed.

Hypothesis 2C: The use of stock images in the representation of the caravels, galleons, and naus can be determined statistically by examining proportions of principal features.

This hypothesis is based on determining whether or not multiple depicted vessels within one source of iconography are stock images. A limitation in the use of iconography within nautical archaeology is the uncertainty of whether artists were depicting a stock image of the vessel repeatedly or if each representation constitutes a specific ship. This consideration affects the validity of the representational trends of the first research question and needs to be established so that during analysis stock images do not account for a higher percentage of the representational trends than they should.

If this hypothesis is correct then it is expected that: 1) Vessels depicted by the same artist that were original productions will show a statistically significant range of proportion. 2) The statistical range of proportionality of suspected stock images of vessel types of one artist will be significantly smaller than depicted vessel types from several different artists.

***Hypothesis Rejection*:** This hypothesis will be rejected under the following conditions: 1a) Depicted vessels will not show a statistically significant range of proportionality, but be visually discernable as different vessels based on presence or absence of construction features. 1b) There will not be a significant difference in the ranges of proportionality of ships from the same artist than ones from several different artists.

CHAPTER II

HISTORICAL CONTEXT OF IBERIAN CARTOGRAPHY AND SEAFARING IN THE AGE OF DISCOVERY

2.1 IBERIAN SEAFARING IN THE AGE OF DISCOVERY

A nationalized naval effort did not develop until the borders of Portugal were defined in 1297 during the reign and under the guidance of Dom Dinis (1297-1325) of the Portuguese branch of the House of Burgundy (Livermore, 1967: 86). In preparation for this, Dinis ordered the vast pine forests of Leiria, in central Portugal, to be sowed in order to build merchantmen and warships and began a national forestry policy to provide a continuous wood supply for naval construction (Figueredo, 1926: 50). Shortly thereafter, Dinis put in place numerous measures ensuring the successful development of a naval force as well as an expanded maritime knowledge. This included the creation of Lisbon University with an emphasis on the study of astronomy and the continued protection and encouragement of Portuguese shipping and navigation (Cortesão and Mota, 1960: xxviii). Lisbon soon became the busiest port of call between the Mediterranean and Northern Europe.

At the beginning of the 14th century, following the death of Admiral Cogominho of the Portuguese fleet, Dinis engaged in the difficult process of restructuring the navy. In 1317, he hired the Genoese Manoel Pezagno who served Portugal for several decades and was succeeded by his son Lanzaretto (Figueredo, 1926: 50). Dinis contracted

Pezagno with the expressed obligation that he must always have under his command 20 Genoese men who were experts on the sea and competent to act as masters and pilots (Cortesão and Mota, 1960: xxviii). Dinis required Pezagno to reorganize and modernize the navy introducing techniques and tactics already in use in the maritime republics of Italy, Catalonia, and Majorca. Most importantly, he also charged him with the task of introducing innovations in nautical cartography (Hespanha, 1997: 128). These events were necessary precursors to the later voyages of discovery implemented by the Avis Dynasty. The House of Avis began when Dom João I (1385-1433) an illegitimate son of Pedro I (1357-1367) defeated the Castilian army in 1385. João I and his successors in the Avis Dynasty expanded the initial work of Dom Dinis and created a maritime empire.

The Portuguese voyages of discovery began with the military capture of Ceuta in Northern Africa in 1415, initiating a decades-long exploration down the western coast of Africa and concluding with the discovery of Brazil and the sea route to India at the beginning of the sixteenth century (Scammel 1981: 226). The Portuguese were ideally suited to initiate the voyages of discovery due to their geographic location, a strong maritime tradition, and national political unity. Portugal's geographic location was an advantageous position as the region was at the center of trade between Europe and the Mediterranean for centuries (Smith 1993: vi). This position allowed the Portuguese to incorporate ship design technology from both areas and to interact with merchants and sailors from whom they could expand their knowledge of seafaring. This integration of regional technology and knowledge expanded upon an existing maritime subsistence tradition into a seafaring empire. The people and the sea became intertwined and remain so to this day. Fishermen, sailors, and workers in auxiliary maritime activities became the backbone of the country. The coasts were lined with ports and people receptive to the idea of sea explorations; their own personal motives of harvesting new fishing grounds or finding a source of trade items created a united maritime entity.

This pursuit of fishing and trade alone would not have sufficed; it was the deliberate actions and planning on the part of the Portuguese royalty that ensured the explorations. The succession of strong kings in the House of Avis supported the development and continuation of a maritime tradition, first under Dom João I (1385-1433), Dom Duarte (1433-1438), Dom Afonso V (1438-1477), and Dom João II, (1477-1495) who was succeeded by his first cousin Dom Manuel I (1495-1521) after leaving no male heir. The second and third sons of Dom João I, Princes Pedro the duke of Coimbra (1392-1449) and Henry the duke of Viseu (1394-1460) were also very active in pursuing the voyages of discovery. Prince Pedro reportedly traveled "the seven parts of the earth" and combined an interest in geography and history with governmental practices while Prince Henry succeeded his father to the position of Grand Master of the Order of Christ and was considered the patron and guiding organizer of the voyages of discovery. The Order of Christ bore the expense of the voyages of exploration as the wealthy monastic military order had succeeded to the property of the Knights Templar after the Bull of 1319 initiated by Philip the Fair of France condemning the Templars as heretics (Figueredo, 1926: 51).

The core of the Portuguese national unity was embedded in the eight centuries of struggles with the Moors, which ended with the *reconquista* in the 13th century (Smith

1993: 3). This sense of nationalism reached its height in the beginning of the fifteenth century; while the rest of Europe was fighting old dynastic rivalries, as well as new international and religious contentions, Portugal was free from strife (Diffie 1960: xiv). Dynastic dissension in Spain did not end until the marriage of Isabelle and Ferdinand in 1469 and Italy never regained initiative at sea because of the continuing maritime war between Venice and Genoa in the 13th and 14th centuries. Likewise, the One Hundred Years War (1337-1453) left widespread destruction in France and the Wars of the Roses (1455-1485) kept the English fighting each other; it was only after these wars that England and France could take seriously to the sea. In contrast, Portugal's relative peace allowed the nation to concentrate on non-military activities and free its resources for other pursuits, in this case maritime exploration.

If geographic location, a seafaring heritage, and national unity provided the means to explore, economic and religious motives provided the incentives. Following Marco Polo's journey in the 13th century, the Orient opened to European markets and provided a constant supply of luxury items. However, a significant problem arose when the fall of Constantinople to the Turks in 1453 created a bottleneck effect on the trade routes. The Portuguese government was well aware of the monetary potential of a sea route to the Orient bypassing traditional Mediterranean routes, which not only could open new markets, but also would guarantee a monopolistic status for the country. Since the cost of obtaining these luxury items through the traditional routes was slowly draining the coffers of Europe, the continent was concurrently running out of gold.

The purchase of luxury items from the East increased as the production of gold and precious metals fell steadily from the mid 14th century (Marques, 1972: 139). This enticed traders and merchants to look outside the continent for gold suppliers. It was known from Arab caravans that gold was available in Africa in the Upper Niger and Senegal rivers with the two possible ways to obtain it (Boxer 1969: 19, Morison 1978: 353). The first way was to secure control of North African entrepots, while the second was to get to the sources of gold south of Islamic Africa; both avenues motivated the Portuguese voyages of discovery (Marques, 1972: 139).

Religious motives were evident in the Portuguese crusade to convert infidels and, in their view, the *reconquista* of Muslim territories in Africa was a solemn right and duty, as this land was once a Christian possession (Diffie 1960: 26). Strategy and religion combined in pursuing an alliance with Prester John, a mythical priest and king who would be a natural Christian ally in the Muslim world and who could aid in the religious conversion of Muslims and control of the markets (Boxer 1969: 20). The Portuguese believed Prester John to be a powerful ruler and because of this a papal bull was released in 1455 granting the King of Portugal exclusive trading rights with the inhabitants of newly discovered lands (Boxer 1969: 7; Livermore, 1967: 128). These motives did not come into existence simultaneously; as time and space were crossed, they were defined and redefined and all are pertinent to the understandings of the nature of the Portuguese maritime expansion. The Portuguese could not have successfully completed the voyages of discovery, however, without the advanced ships, sailing rigs, and navigational tools they possessed.

Iberian Ships of Discovery

Barcha and *Barinel*

There is no direct mention of ship types used for the very earliest voyages down the West African coast, at least prior to the expedition to Cape Bojador in 1434. Gomes Eannes de Zurara, court chronicler to Prince Henry states that from 1434 to 1441 the ships employed in exploratory voyages were mainly the *barcha* and the *barinel* (Zurara et al, 1896: 27-38). These early exploratory vessels "destroyed mariner's myths about unchartered waters near the Tropic of Cancer" and thus played a significant yet hardly recognized role in the Age of Discoveries (Smith, 1993: 37). The voyage of Gil Eannes is a case in point. Eannes was a squire to Prince Henry on whose command he sailed in 1433 to reconnoiter the western coast of Africa to Cape Bojador; he did so in an armed *barcha*. Eannes retraced the coastal routes of previous captains to the Canary Islands at which point he took captives and returned home. It was the groundbreaking efforts of Eannes and other early explorers that fueled the continuation, as well as the success, of subsequent expeditions.

It took another 12 years and 15 voyages, however, to finally round Cape Bojador (Smith, 1993: 37). Insight into the common beliefs surrounding Cape Bojador is provided again by Zurara in the *Chronicle of the Discovery and Conquest of Guinea*:

> So the Infante…begun to make ready the ships and his people…although he sent out many times, not only ordinary men, but such as by their experience in great deeds of war were of foremost name in the professions of arms, yet there was no one who dared to pass that Cape of Bojador…And to say the truth this was not from cowardice or want of good will, but from the novelty of such a thing and the widespread rumor about this Cape…And although this proved to be

> deceitful…there was a great doubt as to who would be the first to risk his life in such a venture. How are we, men said, to pass the bounds that our fathers set up, or what profit can result to the Infante from the perdition of our souls as well as of our bodies...For, said the mariners, this much is clear, that beyond this Cape there is no race of men nor place of inhabitants…and the sea so shallow that a whole league from land it is only a fathom deep, while the currents are so terrible that no ship having once passed the Cape will ever be able to return (Zurara *et al*, 1896: 27-38).

The 15th voyage was accomplished by Gil Eannes, who with much encouragement from Prince Henry eventually doubled Cape Bojador in the same *barcha* and found the coast was not the hostile land he imagined. Eannes' success prompted Prince Henry to outfit and send another vessel, this time a *barinel*, under the command of his cupbearer Afonso Gonçalvez Baldaya, who was to accompany Eannes in his *barcha* further down the African coast. The two exploratory vessels paired for the first time in the historical records sailed 50 leagues (278 km) beyond Cape Bojador where, upon the shore, they found footprints but no dwellings. On their return Prince Henry told Baldaya:

> As you have found traces of men and camels, it is evident that the inhabited region cannot be so far off;…therefore I intend to send you there again, in that same barinel, both that you may do me service and increase your honor (Zurara *et al*, 1896: 27-38).

He did as Prince Henry bade him, venturing some 120 leagues (667 km) beyond Cape Bojador in 1436 (Smith, 1993:37).

The *barcha* and *barinel* are not as widely recognized as the caravel and the nau, but their place in this history of the voyages of discovery is no less important. As seen from the passages recounting the voyages of Eannes and Baldaya the *barcha* and *barinel* took mariners to the end of their world and then beyond into the unknown. Yet, there is even less known about the *barcha* and *barinel* than their more famous contemporaries.

The clinker built *barcha* was common in Portugal in the 14th and 15th centuries and was similar to the fishing boats working along the North-western coast of Africa (Elbl, 1985: 435; Unger, 1987: 232). The earlier *barcha* of the 14th century appears to have been a one masted vessel. By the end of the next century, however, *barchas* were three masted ships capable of more extensive voyages much like the one undertaken by Gil Eannes to Cape Bojador. The *barcha* was probably of some 25 to 50 tons with a length between 21 and 27 meters, a width of around 8 meters, and a length to breadth ratio of approximately 3.5 to 1. They were partially decked, carried a crew of up to 15 men, and were principally sailing vessels though equipped with oars (Unger, 1987: 232). *Barinels* were clinker built and rigged in a similar fashion, but were larger and of heavier construction than the *barcha*, necessitating an increase in crew size (Smith, 1993: 37). The *barinel* was between 60 to 90 tons and like the *barcha* was capable of propulsion by sails and oars (Elbl and Rahn Phillips, 1994: 92).

The objectives of the early voyages down the West African coast were to discover large areas of seas and land for which square-rigged ships such as the *barcha* and *barinel* would have been appropriate (Barker, 1992b: 435). As the voyages extended further south, these vessels proved to be slow and unwieldy and it became necessary to sail these vessels west into the Atlantic to avoid beating into the wind and against the currents on the return voyage. The heavily planked, square-rigged, and oared *barcha* and *barinel* were not designed for such sailing thereby considerably slowing the exploration of Africa (Smith, 1993: 37). Likewise, the difficulties of coastal navigation beyond Cape

Bojador also required vessels of smaller size and lower tonnage that were able to find anchorages and shelter in the shallow coasts of West Africa (Elbl, 1985: 550).

The caravel's maneuverability, speed, and shallow draught made it the preferred vessel over the *barcha* and the *barinel* which were unsuitable for inshore exploration. This is attested to by the fact that the latter two were employed for less than a decade after Cape Bojador was rounded. It is generally assumed that these two ship types were discarded due to the superior characteristics of the caravel and nau. Another consideration in the abandonment the *barcha* and the *barinel* was the amount of trust the captain and crew had in the ship to return them safely home. Taking into account the inherent hazards of exploration, they were unlikely to sail into these unchartered waters in vessels in which they had no confidence. As noted in Zurara's account of passing Cape Bojador to explore unknown shores, there was a very real fear surrounding these voyages. Alouise da Cadamosto, an explorer employed by Prince Henry to reach the 'southern seas' of Africa and, in fact, being the first to accomplish this feat, wrote of this continuing intimidation in his self-penned account:

> Thither year by year the said lord Infante sent his caravels which wrought such loss to the Moors that he urged them each year to advance further. At last they reached a promontory called Cape de Non…Because it was found that those who rounded it never returned…So the said lord…determined that the following year, with the favor and aid of God, his caravels should pass this Capo de non (Crone, 1937: 3).

Although the apprehension continues there is a marked difference in the tone of the account of Cape Bojador opposed to that of Cape de Non. To argue that this is only because a caravel was used in the later discounts the possibilities that with experience and further voyages the sailors grew more confident. It is entirely possible, however, that better technology also played a significant psychological role in these expeditions.

There is no explicit explanation in archival documents for the Portuguese changing ships. Historians and archaeologists alike have suggested possible reasons for the adoption of the caravel on later voyages. However, Richard Barker (1992b: 435) states that there was no uniquely successful form of ship designed to undertake Iberian exploratory ventures and that ships were used primarily because they were readily available or within the financial means of the promoters. Nonetheless, even if caravels were an instance of opportunistic use of existing technology, their sailing characteristics were still advantageous to the task at hand. The caravel certainly was both financially and readily available, but it can be argued that if they did not have favorable sailing attributes, their use for exploration would have been extremely limited and most likely abandoned as was the case with the *barcha* and the *barinel*. Another consideration regarding this statement is that almost any ship could have made the voyage down the coast of Africa, but few would have made the trip home safe.

The Caravel

The era from the mid-15th to mid-16th centuries is commonly referred to as the century of the caravel and is marked by Portuguese exploration, conquest, and colonization of the coastal regions of Africa and lands around the margin of Indian Ocean. Throughout this century the evolution of the caravel was driven by a shift of vessel function from exploratory vessel to cargo carrier to armed man-of-war, resulting in three basic types of caravels; *caravela latina*, *caravela redonda*, and the *caravela de armada*. It was the exploratory period of the caravel that was the most remarkable, however, for they took part in almost every major expedition of discovery. By innovative combination of construction and rigging characteristics from the Mediterranean (lateen sails, frame first hull construction, and flush laid planking) and Northern Europe (heavier construction, stern rudder and flat transom), these vessels accompanied Iberian explorers in charting the western coast of Africa (Gay and Ciano, 1996: 75). They were part of all four of Christopher Columbus' fleets to the New World and served as scout ships in the early East India voyages including the fleets under Pedro Cabral in 1500-1501 and Vasco da Gama in 1502 (the first to reach India). Caravels were also used to reconnoiter the northern and eastern coasts of South America and in 1519 one caravel, *Santiago*, accompanied Ferdinand Magellan's expedition (Elbl 1985: 93).

The early caravels had a shallow draft that was useful for riverine and coastal commerce and this feature of the caravel quickly inspired their adaptation as exploratory vessels (Smith 1993: 38). The *caravela latina* was a longer, lighter version (on average exceeding 50 tons, 20-30m in length, and 6-8m in breadth) of Mediterranean round ships with a forward raking main, mizzen, and fore masts rigged with lateen sails on long yards, a small, low sterncastle that ran nearly to the main mast, no forecastle due to the length of the main yard, and a flat transom and stern mounted rudder (Smith 1993: 39). The *caravela latina* was designed for speed and windward performance; the shallow draft allowed the caravel to enter into uncharted bays and inlets, the lines of the hull produced a faster vessel with reduced leeway drift, and the lateen sails allowed the sailors to tack closer to the wind which proved vital for the return trip to Lisbon (Barker 1992b: 434-436, Duffy 1955: 49). As the voyages increased in length and duration, design changes were incorporated producing first the *caravela redonda* and then the *caravela da armada*.

Modified to mount square sails on the main and fore masts, the *caravela redonda* had a larger tonnage capacity that signaled the caravel's evolution from an exploratory vessel into a cargo ship (Elbl, 1985: 93). Likewise, with the addition of heavy cannon and subsequent construction adaptations to counter the inherent stability problems (for example, a squared and beamier sterncastle with slight tumblehome), the *caravela de armada* seems to have become a light man-of-war designed to be used as a scout vessel for the fleets bringing valuable cargo from the East back to Portugal (Smith, 1993: 43, Elbl, 1985: 97, Cipolla, 1965: 80).

The Nau

At the beginning of the 16th century the Portuguese Crown shifted from an exploration of sea routes towards colonizing newly discovered territories and securing maritime dominance in the Indian Ocean. Bartolomeu Dias' famous voyage in which he rounded the Cape of Good Hope (1487-88) was significant for two reasons: he brought back a projected path to India and he declared that the caravel was not suitable for this trip (Domingues, 1998: 37). The lengthy routes of the *Carreira da India* necessitated a vessel that was stouter with more cargo capacity and a larger crew than that of either the *caravela redonda* or the *caravela de armada*. The nau design met these needs while still retaining some of the favorable sailing characteristics of the caravel. A seaworthy, full-rigged ship suitable for the 18-month round-trip voyage to India the nau was first used by Vasco da Gama during his voyage of 1497-99. Naus were large (over 100 tons) cargo carriers with square-rigged fore and main masts with topsails, lateen-rigged mizzens, and bowsprits fitted with deep spritsails (Smith, 1993: 46).

After the first voyages, the tonnage of naus employed in the *Carreira da India* quickly increased to 400-600 tons in order to facilitate the growing demand for goods from the East, support a crew for the lengthy round trip voyage, and to withstand rough seas and repel attacks. The advantages of such vessels were expressed by Fernando Oliveira in his treatise, *O Livro da Fabrica das Naus*:

> Long voyages must require large ships: for small ones will not cover the expense. The long voyage will require many victuals: the which, if the ship be small, will take the entire ship, and no room will be left for merchandise…Also because small ships are not as safe on this voyage as are the large…from the seas and from the robbers. The sea on this voyage requires large ships…which will defend herself better against robbers than the small: for the large carries more people, and more guns to defend herself: and it is but the majesty of the large that affrights the enemy, who will not dare to attack... (Domingues, 1998: 45).

It is clear from the words of Fernando Oliveira that the purpose built naus for the *Carreira da India* were designed based on economics and defense. It is also apparent that the Portuguese systematically and consciously utilized and discarded vessels as their needs changed such as the discontinued use of the caravels employed for exploration. The construction of naus was modified throughout the 16th century, adopting wider stern panels, lowering the forecastles and increasing in size up to 1,100 to 1,200 tons of displacement (Castro, 2005a: 111). This enormous size met the two requirements of carrying enough cargo and victuals and intimidating enemies who might attack during the voyages.

2.2 EARLY MODERN CARTOGRAPHY AND PORTUGAL

Cartography as a discipline started with the ancient scholar Claudius Ptolemy, whose basic principle was that all geographic features should be determined by the theoretical linking of terrestrial locations to astronomical observations, and the Greek Marinus of Tyre, who found a way to realistically portray features on a plane surface using equidistant-rectangular projection. Their progress remained the pinnacle of this science for well over a millennia (Cosgrove, 1992: 66; Skelton, 1964: 33). In the Middle Ages, Ptolemy and Marinus were forgotten and geographers were more concerned with the distribution of tribes of Israel as well as the location of terrestrial paradise; however, the rediscovery of Ptolemy's *Geography* and its translation into Latin in 1406 and its publication in 1475 are benchmarks in the development of European cartography (Relaño, 1995: 49). The recovery of Ptolemy coincided with the start of the Portuguese exploratory voyages down the west coast of Africa after the capture of Ceuta in 1415. Cartographers used Ptolemy in the Renaissance tradition of referring to the classical scholars; however, there were irrefutable discrepancies between the Ptolemy’s geographic claims and the direct knowledge gained by the Portuguese mariners and pilots which contradicted the old models and raised theoretical and practical questions (Relaño, 1995: 50; Cosgrove, 1992: 66). In the second half of the 15th century maps began to be printed and before the century ended European navigations reached America and India by sea.

The predominant form of medieval cartography was the simplistic T-O maps in which scholars endeavored to reconcile the biblical contradictions that hounded medieval geographers; the O is the inhabited world while the T represents the tripartite schema of Asia, Africa, and Europe, the two arms are the rivers Tanais dividing Europe and Asia and the Nile dividing Africa and Asia (Woodward, 1985: 511). This religious preoccupation of the medieval cartographers is due to the fact that cartography and geography remained the business of the Church until the 15th century when Portugal initiated the production of state sponsored charts. However, a new era of European intellectualism begun in the Medieval Renaissance of the 12th and 13th centuries was marked by new knowledge of the Greeks and Arabs and the spread of universities (Haskins, 1927: vii).

Late-medieval Europeans wanted to know more about the world in which they lived. Old classical and medieval works were translated and the Iberian Peninsula massed enormous amounts of specialized knowledge. The cooperative work between Christians, Jews, Arabs, the '*Libros del Saber de Astronomia*' (book of astronomy), was translated into Spanish for the King of Castille along with descriptions on how to make astrolabes, quadrants, armillary spheres, and clocks (Cortesão and Mota, 1960: xxiii). There are only two cartographic or geographic manuscripts from the late 13th and 14th centuries the first of which, *Arbor Scientiae* (Tree of Science) in 1295-96 is by Raymond Lull who refers to cartography, navigation, and instrument making (Skelton, 1964: 65). The second is by Marino Sunto whose manuscripts were illustrated by the charts of Petrus Vescante including a world map (c. 1320) that depicts a circum-navigable Africa which is an important development that is highly suggestive considering the seafaring events of the 15th century (Cortesão and Mota, 1960: xxiii).

Medieval maps of the world, *mappae mundi,* created mostly in monasteries continued to be used for quite some time; however, with portolan charts, the cartographic representation of the world progressed to a new level and medieval speculation and fantasy gave place to scientific cartography based on experiment and observation (Cortesão and Mota, 1960: xxvi). Portolan charts were vital for longer voyages which necessitated navigational aids and functioned through the use of rhumb lines which radiated from a determined center in the directions of the winds thereby enabling the pilot to chart a course (Skelton, 1964: 64). They were clear and accurately drawn on a consistent distance scale but not projection; although the placements of headlands, rivers, and harbors and markings of rhumb lines and the compass roses were invaluable to contemporary seafarers, they were only useful for short passages within the limits of dead reckoning (Parry, 1966: 16).

The appearance of the portolan chart towards the end of the 13th century is yet unexplained, but it is thought to have been used in the Mediterranean along with a magnetic compass and traverse board for dead reckoning (Kelley, 1979: 18). Some scholars speculate that maps of the Greek Marinus had the character of a portolan and Genoese and Venetians frequently traveled in the eastern Mediterranean and could have easily acquired copies. Marinus' maps were still in use in the middle of the 10th century shortly before it is thought the first portolans were made. Another suggestion is that charts and compasses diffused from the Arabs in the 11th century after the Normans conquered Sicily. The Arabs knew of Marinus charts by the 12th century to which they added Rhumb lines (Cortesão and Mota, 1960: xxvi).

The introduction of nautical cartography as a craft with professional map-makers occurred in 1311 based on the first dated chart made by Petrus Vesconte in Genoa (Skelton, 1964: 63). The first portolan charts were created for the trading networks of Genoa and Venice in the Mediterranean and from this point on navigation and cartography were inseparable.

These were compass-based charts created by the use of Arabic magnetic needles adopted by Europeans; however, there is no contemporary information on how to use them (Cortesão and Mota, 1960: xxvi). The first known portolan chart, the Pisan Chart, is thought to date to the 12th century; however, beyond this chart there are only historic references (Randles, 1988: 115). When St. Louis crossed the Mediterranean in 1270 during the crusades, it is recorded that the pilot showed him a chart with their position. Additionally, in Raymond Lull's late 13th-century manuscript, a reference states that in order to measure distances at sea, mariners have charts, dividers, magnetic needles, and the pole star (Cortesão and Mota, 1960: xxvi).

Cartography advanced in the beginning of the 14th century with Marco Polo's travels and cartographers added new regions of the world to portolans of the Mediterranean basin. Iberian expeditions during the second part of the 14th century produced a substantial improvement in the knowledge of the north-western coast of Africa. The Dulcert chart of 1339 depicts most of the Middle East and for the first time the Canaries and several other Atlantic islands. The whole of the Canary and Madeira archipelagos were first recorded in the Medici Atlas (1370) and the Azores appear in their proper position bearing Portuguese names in a chart made by a Venetian cartographer around 1475 (Cortesão and Mota,1960: xxvi).

At the same time that cartography was expanding alongside geographical information, the Majorcans developed an important school of cartography that was of great consequence to the birth of Portuguese cartography. The Catalan atlas of Charles V (1375) by Majorcan Abraham Cresques is the first scientific and comprehensive world map representing the latest discoveries down the coast of Africa as far south as the Canary Islands (Hespanha, 1997: 128). Charts depicting maritime trade were easily represented using the portolan chart; however, the voyages of discovery lead by Prince Henry occurred in places outside of the scope of portolan charts leading to innovations in cartography. Pilots quickly found that the portolan system of navigation was inadequate during these north-south voyages because of accumulated errors in the reckoning of distance (Randles, 1988: 115). The depicted world had to be enlarged along with the new geographical discoveries. Portuguese seeking to rectify this new problem enlisted the help of Master Jacome de Majorca about whom nothing is known except his name and origin. Master Jacome taught Portuguese cartographers how to effect this enlargement of the world according to the Italian traditions used in Majorca and Cataluña.

The geographic exploration also tested the limits of known navigational techniques and as the voyages approached the equator, the unknown had to be overcome and conquered. Maritime navigation changed from relying on the sailor’s instinct and knowledge of the environment to scientific methods. New developments in navigation started in 1462 with the calculation of latitude from the height of the pole star, followed in 1484 by using the height of the sun at midday to determine latitude (Parry, 1966: 17). For celestial navigation, the Portuguese used astrolabes and quadrants to measure the height of stars and the sun, cross-staffs for navigation under the Southern Cross, and compasses to obtain reliable coordinates (Figueredo, 1926: 58). Nautical charts began to reflect the celestially determined coordinates in the last decades of the 15th century and the new geographic discoveries were situated at their correct latitudes whereas the latitude of the Mediterranean region was several degrees too high and remained just as it was depicted in medieval charts (Randles, 1988: 116). The new method of incorporating celestial latitude transformed the portolan chart into the quadratic plane chart, with parallels and meridians drawn at right angles. This remained the dominant form of navigation in the 16th century (Randles, 1988: 116).

Portuguese pilots quickly mastered these navigational techniques and learned the geographical characteristics of new regions. When the Portuguese reached the Far East in the beginning of the 16th century, they were presented with different navigation and cartographic methods and knowledge and found new ways to incorporate information of known, yet unseen lands as well as those they visited. The Portuguese with some difficulty managed to integrate the Spanish discoveries of the Pacific coast of America. The accumulation of geographic, hydrographic, and navigational information was taken back with each ship that returned to Lisbon and the rapidity of the voyages required the constant tabulation, assimilation, and representation of the data (Brotton, 1997: 48).

This increasing need for quick assimilation of knowledge led to the development of a Portuguese school of cartography towards the end of the 15th century which was defined by the following characteristics: the use of cylindrical projection; the scale of latitudes, drawn at first in the lateral meridians; the use of league-marks to correct mistakes in the degrees of latitude, which is equivalent to the system of increased latitudes; the division of the equator into leagues; the depiction of the boundary line of the treaty of Tordesillas in 1494; and greater attention to the winds, seas, and coasts than the continents (Figueredo, 1926: 55). At the beginning of the sixteenth century, the Portuguese also established one of the first bureaucracies, *Casa da Mina*, to regulate and supervise geographic knowledge. The *Casa da Mina* in Lisbon was the state institution regulating imports, maintaining trade monopolies, and imposing taxes; however, within this bureaucracy was housed the hydrographic offices which employed numerous experts (i.e., astronomers, pilots, ship's master, cartographers, etc) to control maps and charts as well as navigational instruments and methods of calculations (Turnball, 1996: 9). The purpose of these offices was to ensure state control of the incoming knowledge of the discoveries, and it represented a systematic attempt to standardize tables and instruments in order to revise and maintain consistency in the licensed charts and to certify practitioners (Turnball, 1996: 7). From this nationalization of cartography, maps became weapons of empire building as much as guns or warships. Cartography was then used by nations to legitimize the conquest and the maintenance of territory (Harley, 1989: 282).

Cartography Creates Intrigue and Shapes the Imagination

Cartographic knowledge was considered privileged information. In attempting to monopolize it, Portugal, like Spain and many other European nations, was known to have a policy of secrecy, *siglio*, as many foreign navigators and sailors were employed in the exploration of Africa (Harley, 1989: 284). Portuguese authorities carefully safeguard the originals of maps which were kept in the *Armazem de Guine e das Indias* adjoining the *Casa da India* in Lisbon and only the commanders of each ship were given copies (Hespanha, 1997: 140). To ensure the successful containment of knowledge, sailors were forced to remain silent ‘under pain of death’ and foreign vessels were prohibited from sailing along the west coast of Africa (Kimble, 1933: 653). The Portuguese dealt severe penalties to those who sailed into West African waters or violated the policy of secrecy and revealed knowledge to spies (Figueredo, 1926: 47). The Treaty of Alcáçovas (1479) gave the Atlantic region south of the Canary Islands, including Guinea with its gold, to Portugal. This effectively put an end to the hostilities with Isabelle and Ferdinand; however, it did not stop aggressive espionage by Holland, Italy and other European countries (Hespanha, 1997: 129). Dom João II, who was the main instigator of the policy of secrecy and the most active at preventing leaks of information, promptly monopolized the commerce of Guinea for the crown thereby enticing interested foreigners to collect any and all geographic information about the rich region to subvert this domination of trade (Kimble, 1933: 653).

This strict policy of secrecy most likely accounts for the missing information on early cartography. It can also be explained by the rapid evolution of cartographic knowledge and navigational techniques such as the introduction of astronomical methods to obtain latitudes. Scholars have speculated that obsolete or outdated charts were disposed of as new ones were created; there was no concern about keeping them for the sake of posterity (Hespanha, 1997: 140). Likewise, political motives led to geographical falsifications by cartographers (examples of this include the coast of Brazil and the western opening of the Straits of Magellan); the lack of valid geographic information and too much imagination led to geographic absurdities (i.e., the pre-exploration depiction of the west coast of America above California). The Portuguese continually altered maps so that lands would appear to be within their territorial rights demarcated by the papal treaty; North America was moved to the east and the Moluccas to the west (Figueredo, 1926: 56). Political falsification of maps has occurred throughout history and the cartographer has to be viewed as part of these power relations as they were not independent artists or technicians; rather, they were subject to power relations and geopolitical circumstances that led to imposed map specifications (Harley, 1989: 287).

The most notable work in the history of Portuguese cartography and one of the best examples of cartographic espionage is the anonymous Portuguese planisphere, commonly known as the Cantino Chart of 1502, which was smuggled from Portugal by the spy Alberto Cantino for Ercole d'Este, Duke of Ferrara (Figueredo, 1926: 56; Brotton, 1997: 23). The anonymous cartographer helping Cantino produced a beautiful copy of a map which almost certainly was kept in the *Armazem de Guine e das Indias* in Lisbon. The Cantino Chart contained the results of direct observations obtained during the voyages of Vasco da Gama (1497) and Pedro Cabral (1500); it also depicts the first knowledge of the Brazilian coast by the exploratory expedition of Gonçalo Coelho (1501) (Hespanha, 1997: 130). Geographical and commercial information from beyond the Indian Peninsula to the Chinese coast was included on the Cantino Chart. This chart illustrates what the Portuguese knew about contemporary oriental trade, the positioning by observed latitudes of conspicuous geographical hazards, the notion that the Tordesilhas demarcation cut into South America a few degrees above the equator, the rapidity of cartographic surveys made using astronomy, and lastly the ability of Portuguese sailors to collect diverse geographical and cultural information (Hespanha, 1997: 130).

The Portuguese voyages added greatly to the geographical knowledge of the world, leaving contemporary cartographers to deal with two different and often contradictory sources belonging to different intellectual traditions: what the classical authorities said and what modern mariners and pilots claimed to have seen (Relaño, 1995: 50). The knowledge of pilots was incorporated into maps along with occasional testimonials to validate the information. Fra Mauro created a map that included southern Africa on which the legend reads:

> Many opinions and writings are found asserting in the southern part the water does not surround this habitable and temperate zone; but we have many witnesses to the contrary, and above all those that his majesty the King of Portugal has sent with his caravels to discover and see with their eyes...and they made new charts of that navigation, and gave new names to rivers and coasts, capes, harbors of which I have had a copy; and if anyone contradicts this that they have seen with their eyes, all the more impossible to agree with or believe those who have left in their writings not what they have seen with their eyes, but have thought to be so (Cortesão and Mota, 1960: xxxi).

The lack of direct experience with the geography of the African interior led Renaissance mapmakers to fill the vacuum with the only sources available to them: Ptolemy and the Christian missionaries to Abyssinia (Relaño, 1995: 52).

Maps showed at once the extraordinary variety of the newly discovered world and the world as a singular whole (Binding, 2003). Maps are never value free images, however, for they provide a way of conceiving and articulating the world. Europe, for example, was often projected as the center of the world. The maps that have survived the ages are often those created for Royalty or rich patrons and include elaborate decorations; they are accompanied by decorative title pages, lettering, cartouches, vignettes, dedications, compass roses, and borders. Monumental arches are an expression power, the globe and armillary sphere are associated with royal dedications, portraits of royalty and coats of arms are incorporated into the design are royal emblems (Harley, 1989: 297-98). The images included on maps allowed Europeans to see the marvels of the new world, effectively shaping their imagination. The development of the printing press and the resultant dispersion of maps and cartographic iconography had a profound effect on how Europe as a whole, and not just the privileged, visualized the New World.

The advancements of nautical science, the incoming geographic data, and the development of schools of cartography changed cartography during the voyages of discovery. Mapmaking grew from a medieval form of decorative art when the lack of scientific and geographic knowledge allowed the cartographer fill the gaps with artistry and imagination, to a Renaissance fusion of art and science (Rees, 1980: 62). At this time, not only were the cartographers painters but so were the engravers, woodcutters, and printers; it was only during the course of the Renaissance that terminology was created to distinguish paintings from maps (Rees, 1980: 60).

CHAPTER III

EARLY MODERN PORTUGUESE ART AND EUROPEAN MARINE PAINTING

Painting in the 16th century was a complex interaction between practitioners, patronage, and different schools of art and intellect. There was also a political dimension. As a result, the genesis of marine painting, with its implicit relationship to the maritime activities of the Portuguese and other European nations, cannot be truly understood without reflecting upon the underlying international conditions of its emergence. Although it is not feasible to address all the factors here, it is important to briefly review some of the principal sources on 16th century maritime art and the small collection of English-language sources on Portuguese art as seen through the prisms of the Italian Renaissance, Portuguese politics and art, and the Dutch initiation of the maritime school of painting in general.

The paucity of research on Portuguese art and artists in the 16th century is a restrictive factor in understanding the iconographic record; which, in many instances, leads to indeterminate associations between the artists and the works of art. Thus, the potential to directly relate the iconographic record to the artistic record is greatly diminished, if not completely absent. The only means left is to account for how and why the iconographic record was created by placing it within the political and economic trends that shaped the creation of art in Portugal during this time and the roles of known artists within this process.

3.1 THE EMERGENCE OF PORTUGUESE PAINTING IN THE 15^TH^-CENTURY

Although it was once believed that Portugal as a country was rich in architecture but poor in painting, it was recognized starting with the re-discovery of Portuguese paintings in the early 20th century, that there did exist a Portuguese school of art in the 15th and 16th centuries (Prestage, 1910: 341). In most countries, a golden age of art usually coincides with a period of economic prosperity and increased nationalism; this was true of Portugal in the early modern period. By most accounts, its golden age of art occurred at the close of the 15th and early part of the 16th centuries, an epoch commonly referred to as the Age of Discoveries during which art mirrored the sudden expansion and rapid decline of the Portuguese maritime empire (Robinson, 1866: 5). In this chapter, 15th and 16th-century art in Portugal is viewed through the foreign painters present in the various royal courts of the House of Avis, and through Portuguese painters in Europe, all of which was part of the complex interaction of European artists. The Portuguese imported their artists at the same time they exported the riches from the East.

Under the reign of João I (1385-1433) of the Avis Dynasty, Portuguese art was still embedded in the Gothic tradition through French models that influenced illuminated manuscripts and the practice of painting and frescoes on wood. In the first half of the 15th century there was a prevalence of imported paintings as well as foreign painters working in Portugal (e.g. Anthony Florentine, Master Jácome) or visiting the country (e.g. Jan van Eyck) (Pereira, 1996: 47). By the end of the century, however, Portuguese patrons began to import paintings, predominantly from the prosperous artistic environment of Flanders. Flemish artists quickly found Portugal a profitable foreign market for their books and fine arts (Robinson, 1866: 7).

Dynastic ties and the early development of maritime commerce with Flanders had a pronounced influence on Portuguese art (Dieulafoy, 1913: 328). In 1428, the Flemish painter Jan van Eyck visited Portugal for a month as a part of a diplomatic mission and was commissioned to paint a portrait of the daughter of João I, Infanta Isabel, who was to marry (by proxy) Philip of Burgundy on 25 July 1429. Jan van Eyck was in Lisbon and Avis from December 1428 to February 1429 and was specifically chosen by the King because of the maritime relations between the two countries (Dieulafoy, 1913: 328). It is commonly believed that van Eyck's visit contributed to the growing appreciation of Flemish painting by Portuguese clients, the accumulation of which is seen in the illuminated *Livros do Horas*. Some art historians suspect that van Eyck also influenced the training of several Portuguese painters who moved away from painting or frescoes on wood (Pereira, 1996: 48). It is generally accepted that van Eyck greatly inspired a new style of painting in Portugal, which was augmented by the artists who traveled abroad and by Flemish artists who settled in Portugal (Barker, 2003: 3).

Flemish activity in Portugal was so prevalent that by the beginning of the 16th century, it is difficult to distinguish between Flemish and Portuguese works of art. This is particularly true given that most these were painted anonymously or collectively by a school of artists, but also collaboratively between Portuguese and Flemish artists who influenced each other, prompting the assimilation of northern and southern aesthetics (Rodrigues, 2000: 111).

Additionally, there were painters of Portuguese origins who worked in Italy, like Álvaro Pires de Èvora who resided there from 1411-1434 and was trained in the Pisan tradition in Toscania and showed great attention to the innovations in drawing and spatial concepts of the Gothic artists of Florence (Pereira, 1996: 48). Likewise there was João Gonçalves who was active in Firenzi's Badia from 1436 -1438. Gonçalves was sent to Florence by Dom Duarte and there he developed a close relationship with the Portuguese born Abbot D. Frei Gomes who had strong ties with the House of Avis. Gonçalves produced a series of frescoes for the Florentine abbey, the Cloister of the Orange Trees, depicting episodes in the life of the Order's patron St. Benedict and are reminiscent of Fra Angelico who was reported to have been his teacher. They reveal "a less strident palette, aware of new concepts of spatial structure which permitted a facility and taste for narration" (Pereira, 1996: 50).

Nuno Gonçalves, the royal painter to Dom Afonso V (1438-81), is considered to be one of the most important Portuguese painters and the only Portuguese Renaissance master. Gonçalves' most important work includes the *Painéis de Sao Vicente de Fora*, which was first attributed to him by Francisco de Holanda (Smart, 1972: 114). Gonçalves was appointed as a royal painter on July 20, 1450 and it is speculated that he worked in this position until 1492, but only gaining prestige around 1470 when he became the Head of Public Works in Lisbon (Dieulafoy, 1913: 328). Although recent scholarship suggests similarities between Gonçalves and Catalonian or Italian schools, he was undoubtedly influenced by Flemish and Burgundian masters. In any case, Portuguese artists retained individuality which is characterized by a pronounced ethnical type and scale of color (Dieulafoy, 1913: 329). Gonçalves traveled with the Royal expedition to conquer Arzila and Tangiers (1471) in North Africa in order to sketch the events for the tapestries (Pastrana Tapestries) commissioned by Dom Afonso V to commemorate his deeds.

The reign of Dom Afonso V was marked by chivalrous values and a crusading ideology. Afonso V was known for his avid patronage of the arts and letters and it is believed that in addition to traditional religious motives for commissioning paintings born out of his crusading zeal, he also wanted to celebrate those who participated in the conquests (Prestage, 1910: 347). The initial crusading spirit of Afonso V eventually gave way to the growing mercantilism that resulted from expansion, and the short reign of João II (1481-1495) was marked by the centralization of the power of the monarchy. This new ideology culminated in the reign of Dom Manuel I (1495-1525), in which the king as the prevailing merchant was the center of power in the Portuguese world (Pereira, 1996: 73).

The Manueline Tradition and Portuguese Art in the 16th Century

Dom João II was the last direct successor of the House of Avis and the throne was inherited by Manuel who was Duke of Vizeu and the Grand Master of the Order of Christ (Dieulafoy, 1913: 316). Dom Manuel I (1495-1525) dominated the operations of Portugal's new empire and created a court based on the aggrandizement of royal power in the urban space which included notable architecture such as the Monastery of Jerónimos and the Torre de Belem and processions involving elephant, rhinoceros, and jaguars brought from exotic lands. Manuel I was the predominant sponsor of art, and during his 26-year reign he deliberately set an example for the aristocracy, religious orders, and wealthy merchants (Rodrigues, 2000: 110).

Manuel's patronage stimulated a renewal of Portuguese architecture and the importation of artists from Castille, Aragon, Flanders, Italy, Germany, and France along with their innovative concepts and techniques. The Portuguese artistic tradition termed Manueline was actually a syncretic rather than a synthetic school influenced by the combination of the late Gothic, Mudéjar style, Northern European and Spanish Plateresque imports, and the early Renaissance (Kubler and Soria, 1959: 101). Manueline aesthetic became an intense mixture of structure, decoration, and ornamentation without a real differentiation between them which created a local color and a distinctive and striking national character (Robinson, 1866: 7). The opulence of this period was due to the rapid influx of gold but it was also a gesture of gratitude to the Order of Christ, whose emblems were reproduced on buildings and in art (Dieulafoy, 1913: 317).

The Renaissance tradition did not reach Portugal or influence Portuguese artists in any significant way until the end of Manuel's reign. In fact, the Manueline tradition dissolved the preceding Gothic tradition, preparing the way for the Renaissance (Pereira, 1996: 93). The first allusions to the Renaissance, *ao romano* or Roman-like work, were documents from the stone masons working on the Monastery de Jerónimos in 1514 who were commissioned to add certain classical motifs. This reference, although indicating clear knowledge of the Renaissance, does not imply the Gothic influence of Manueline art was thus abandoned. Rather, this is a clear example of the artistic syncretism that characterized the Manueline tradition (Pereira, 1996: 99). The foreign artists commissioned by Manuel I, or as a result of his influence, increased along with the ‘economic euphoria’ of the maritime discoveries and it was against this background of a Gothic dominated Manueline tradition that new Renaissance forms from Italy, France, and Spain were introduced; the Renaissance was first and foremost seen in painting.

Manueline painters are defined as those who either worked for Manuel I or those who worked in Portugal during his reign but are not necessarily linked with the artistic school, such as Jorge Afonso at the beginning of the 16th century and his successor Gregório Lopes (1566-1640). These painters exhibit Renaissance essentials; however, architectural elements within the paintings remained Manueline in style. Franciso Henriques of Flemish origins (active 1503-1518) retained a Northern-European influence in his work while Vasco Fernandez (active 1501-1542) was unmistakably a Renaissance painter, but with clear undertones of Flemish Mannerism (Smart, 1972: 212). Henriques was married to the sister of Jorge Afonso and it is assumed he immigrated to Portugal at the end of the 15th century (Pereira and Falcão, 1998: 35).

The first generation of Renaissance painters include the anonymous Master of 1515 (Jorge Afonso) and the Master of Lourinhã (Álavaro Pires), who was probably the painter responsible for introducing a Renaissance influence in Lisbon. While the second generation was a group of painters who worked in a workshop under the name Masters of Ferreirim - Gregório Lopes, Jorge Leal, Cristóvão de Figueiredo, and Garcia Fernandes whose partnership dates to 1533-34 (Pereira, 1996: 14). The works attributed to the Master of 1515 (Jorge Afonso) who was the royal painter to Dom Manuel I and Dom João III (1504-1542) were executed with technical perfection. They exhibit balance in composition, brilliant colors, complex settings, and landscape details indicative of the traditional Flemish repertoire demonstrating that the painter was influenced by Northern European Renaissance (Smith, 1968: 199). Álavaro Pires was a royal painter from 1504 to 1539. Pires was known for his use of small formats and landscape painting as a context for the pictorial narrative the importance of which is viewed as the primary factor in initiating Renaissance style into Portugal. Jorge Afonso was succeeded by Gregório Lopes (1490-1550) who began painting by 1513 and was not only his pupil of but his son-in-law (Smith, 1968: 199). The Masters of Ferreirim, who remained faithful to the Renaissance manner of their predecessors, began to move towards the new Mannerism. Some scholars believe this second generation of painters is also the beginning of Mannerism in Portugal with identifiable elements such as: 'allegorical densification of compositions, the anatomical deformations through exuberant or prolonged figures, and the theatricalization of gestures and artificial flow of clothes' (Pereira, 1996: 186).

Mannerism was defined from 1560's onward, however, with the theories of Francisco de Holanda and the return of Portuguese students from Italy. Although de Holanda himself was largely unaware of his separation from Renaissance aesthetics when he identified drawing with the metaphysical idea, transforming painting into a 'cosa mentale' (a mental thing), he became one of the important theoreticians of Mannerism in the 16th century (Pereira, 1996: 190). Francisco de Holanda was a typical

16th-century humanist. He was the son of an internationally famous Dutch-born illuminator and painter, Ántonio de Holanda, who later resided in Portugal as a royal artist. He considered himself a Portuguese subject and in the late 1530's de Holanda was sent to Rome by the king to familiarize himself with Italian art. In Rome he met Michelangelo, who would play the central role in four dialogues, *de Pintura Antigua*, on painting that de Holanda finished in 1548 which are his best-known work and are thought by some to represent contemporary intellectual thoughts in Portugal (Smith, 1968: 201).

Francisco de Holanda does not focus on the theory of aesthetics; rather he clearly addresses the interrelated questions of the nature and value of art as it exists in the world, as well as the nature and role of the artist (Sousa, 1978: 45). In his prologue dedicated to Dom João III, he underscores his doctrinal intentions, saying: "Since I am held by some to be ashamed of being a painter, I have determined…to show how honorable and noble a thing is the art of painting, and how useful and valuable it is to the State" (Sousa, 1978: 45). His work details eighteen famous contemporary painters including the Portuguese painter Nuno Gonçalves, of whom he describes:

> He has all the truth of the Flemish masters, and in addition can make us feel the Christian idealism which inspired the early discoveries. Moreover, he is a great colourist… His mastery of light and shade and his technique are both in advance of the time. If he obeyed any foreign influence it was rather Italian than Flemish, but in any case very slight, for his work, as we know it, is characteristically Portuguese (Prestage, 1910: 348)

There is sufficient evidence that a Portuguese artistic school emerged out of the strong influence of Renaissance artists from the North and Italy. Though there are very few Portuguese artists compared to other European nations at the time and even fewer surviving or accounted for works of art, enough remain to indicate conclusively that within Portugal there was an elementary school of painting with its own character (Prestage, 1910: 348).

Portugal was still a prosperous nation when Dom João III (1525-57) succeeded to the throne and his pious character provided a strong foundation for devotional painters and artists. Although the lavishness of the Manueline born-of-prosperity style was retained, there was a definite rupture from the culture and ideology of Dom Manuel I in whose court there was a resistance to the Italian Renaissance (Rodrigues, 2000: 111). The Manueline style was not mere royal patronage, but a direct result of Manuel's sense of aesthetics. As a result, the death of the man also brought the death of the artistic movement (Lees-Milne, 1960: 145). Although the Renaissance movement reached Portugal at the end of the 15th century, it was only during João III's reign that the classical elements of the Renaissance infiltrated Portuguese taste and style (Bury, 2000: 105). Starting from 1530 the hesitant growth of Italian influence can be viewed through the 'antique' ornamentation and Roman architecture that was integrated into paintings (Rodrigues, 2000: 113). Although the adoption of renaissance art by João III's court and Portuguese humanist circles resulted in a group of artists abandoning the traditional style, that was not a revolution. The presence of Gothic influence remained strong until the 17th century, up to the point where the pervasive "ancient manner" was ridiculed even in de Holanda's manuscript (Robinson, 1866: 9). The relationship between Italians and the Portuguese was that of teacher to pupil, which was true of most of their interactions in maritime science and shipbuilding in the Avis dynasty.

Dom Sebastião I (1557-78) who succeeded João III continued the royal status of patrons of art; however, an Eastern bias was more present than ever before and its influence was clearly visible on furniture, embroidery, and ornamental art, all of which were imported as part of the trade in Eastern luxuries (Robinson, 1866: 10). The Portuguese empire declined under Sebastião I, and the king himself lost his life in a misguided attempt to conquer Morocco. The fatal blow to Portuguese art was the short reign of Cardinal Henry (1578-1580) after whose death Phillip II of Spain invaded Portugal and established Spanish dominance. Over the next 60 years Lisbon sank to the level of a provincial city (Robinson, 1866: 10).

Maritime Symbols in the Manueline Period

The patronage of Dom Manuel I in painting and other art fields, and his promotion of specific iconography in architectural and ornamentation, was to become a form of political propaganda. This is seen in the iconography and in the formal exuberance that prevails in the images (Rodrigues, 2000: 110). The royal architects of Manuel I's court, Mateus Fernandes, Diogo de Boytac, and brothers Diogo and Francisco de Arruda, essentially created the Manueline architectural style. It was the Arruda brothers who added a profusion of decorative elements and in doing so invented an iconography for the Portuguese maritime empire (Kubler and Soria, 1959: 102). Diogo de Arruda was the most talented and inspired of the Manueline architects. His striking and deliberately representational decoration included seaweed, coral, cables, pulleys, floats, and armillary spheres, and made no attempts to blend with the architecture to which it was applied (Lees-Milne, 1960: 151).

The Royal symbols of Manuel I (a heraldic sphere, a royal crown and shield, and the initials of the King) had a preeminent place within Manueline art and architecture, but they are also Christian symbolism of the Resurrection, of Eucharist, or of Sanctifying Grace, as well as geometric motifs of Romanic or Gothic origins (half spheres, tressings, framing schemes). Again the idea of syncretism in the Manueline tradition is summarized nicely by Pais da Silva who wrote of monumental architecture:

> in portals, windows, eyes, misulae, baladchines, chapitels, archvaults, cornices, thresholds, shield of arms, pillar and column basis – as well as in baptismal cups and tombs – artists deal with the traditional repertoire of Final Gothic (heraldic insignia, plants, dragons, etc.), of the Lombardian Renaissance (chimeras, chandeliers, grotesques, medallions, etc.) and of the Manueline with a vigor, a robustness, a light-shadow play, a feeling for volumes and a both Naturalist and Surrealist vision that were unique in Europe (Pereira, 1996: 108).

This pantheon of religious and royal icons, however, is juxtaposed with maritime symbols, which are either ignored or emphasized in relation to those of Christianity depending on whether one chooses to see Manueline style predominantly comprised of maritime or Christian symbolism (Pereira, 1996: 107). It is surprising, however, that scholars have not paid attention to the obvious connection between the two; art is never distanced from politics and power. The symbolism of the voyages of exploration is rooted within the 'Portuguese Crusades,' which may not reflect actual historical events, but unequivocally explains the national mentality of the time.

In a modern world in which religion thinly veils economic and political ambitions it seems unnecessary to point out that religion is never separate from power which is strongly reflected within the iconography of the 16th century. Couched within a 15th- and 16th-century religious framework is not only the bourgeoning humanistic idea of man and nation, but also the literal vehicle for power – the ship – and to a lesser extent the exotic foreign raw materials and goods that are the source of this power. This is not unique to Portugal: other European maritime empires have always prominently depicted their ships. Although the form and extent to which they are represented varies – the Venetian and Genoese galleys, the Scandinavian long boats, the Hanseatic cog, the Portuguese caravel and nao, the English carrack, to the Dutch fluit became unstated national or institutional symbols.

3.2 16TH-CENTURY MARINE ART

Maritime art emerged in the 16th century as economic and political power began to overshadow earlier religious dominance. It was a century marked by the consolidation of nation-states and the delineation of political borders, religious strife, and reformations. In essence, it was the first time something in addition to religion, and arguably beyond religion, was creating European identity. The Portuguese began to incorporate more ship iconography into their art as wealth and power accumulated under Dom Manuel I. Likewise, as the Dutch Empire displaced the Portuguese initiating its own golden age, a northern artistic trend turned into an artistic school. Marine painting was to become one of the "most important and innovative contributions" of the Dutch golden age (Russell, 1997: 212). Like the Portuguese, Dutch maritime power was both economic and political, the expansion of which coincided with the increase in production of marine painting and the 'emergence of a national awareness and self-confidence closely linked to seafaring' (Goedde, 1989: 109). Seascapes were embellished with sailing vessels and of ships in storms which reflected not only the wealth accrued during these ventures but also the dangers they encountered along the way (Goedde, 1986: 139).

Ship symbolism is the natural predecessor to maritime painting. The Portuguese added ships superfluously to religious art that were not necessary to the thematic composition; rather, these were strong cultural symbols that were incorporated to the existing artistic tradition embedded within religion. Likewise, for Northern Europe the introduction of a maritime artistic school coincided with the flourishing economies of 17th-century Holland and then in 18th- and 19th-century England, during which time the artistic representations of ships reached an art form in and of itself. The Dutch succeeded where the Portuguese failed on both the economic and artistic landscape. The Dutch had a growing artistic genre based in realism and the appearance of seascapes was possible here, and not in Portugal, because of the economic prosperity and social ascendancy of the middle-class town oligarchies and the absence of church commissions which changed the nature of patronage and the selection of artistic themes (Goedde, 1989: 111). Marine paintings often became "public monuments to the prosperity and victory resulting from the policies of the ruling classes, and the five admiralty boards, the town governments, the States General, and the Dutch East India Company were all early patrons of seascapes" (Goedde, 1989: 109). Whereas in Portugal, patronage was a royal affair and the crusading atmosphere of the Age of Discovery ensured that art remained deeply embedded in religion.

The beginnings of maritime art in the 16th century, however, are not readily understood and the natural connections to not only the northern landscapes and the emphasis on realism but also the artistic techniques advanced through the Renaissance must first be explored. Art historians contended for many years that marine paintings were preceded by Dutch landscapes. It is now recognized that it is the opposite and marine painting developed more than two decades before landscapes (Russell, 1983: 1). Dutch landscapes excelled because they had first done so with seascapes (Keyes, 1990: 1). Additionally, optical realism and painting based on personal visual observation is traditionally ascribed to Renaissance philosophy; however, this was achieved by the Northern artists particularly in their seascapes decades before any developments occurred in Italy (Russell, 1983: 3). The first northern artist to study Italian art and understand the underlying theories and basic aims of the Southern Renaissance was Albrecht Dürer (Gardner *et al*, 1975: 561).

At the end of the fifteenth century, Dürer traveled from Nuremburg to Italy to begin his years as a journeyman; he remained in Venice until his return to Germany in 1495 (Minott, 1971: 7). During his journey to Italy, Dürer produced watercolors of the lakes and rivers in the Alps that he viewed along the way (Russell, 1983: 3). Although Dürer later became famous as a northern artist and was well-known in the celebrated humanist circles, the Renaissance principles he learned in Italy were more “a means to further his technical ends in measurement, perspective, and proportion” (Minott, 1971: 9). His inherent northern inclination for precise naturalism remained a solid presence in his work and his artistic theories and principles are illustrated by Dürer’s own words:

"Depart not from nature in your opinions, neither imagine that you can invent anything better…for art stands firmly fixed in nature, and he who finds it there, he has it" (Gardner *et al*, 1975: 563). The Italians noticed the naturalistic achievements of the northern artists and the first Venetians to realistically portray water follow Dürer's stay. In the paintings of Giovanni Bellini there are often seascapes in the background and Vitore Carpaccio, in his painting of the story of St. Ursula, depicted shipping scenes which clearly illustrate that he was aware of the subtleties of optical effects produced by water (Russell, 1983: 8).

The contribution of Dürer, Bellini, and Carpaccio coincided with the early works of Joachim Patinir, who was the first great northern landscape and seascape painter. Patinir's marine scenes were popular throughout Europe and his unintentional legacy is the phenomenon of the calm sea in the worst of storms. Patinir created such a powerful aesthetic of the calm sea, that artist retained it even when it was inappropriate to the composition (Russell, 1983: 11). This modest beginning of marine painting was based on not only creating seascapes and adding ships to the thematic composition, but more importantly depicting them realistically. The concept of realism remains the main focus and driving force of marine art in the 16th and 17th centuries as the genre expanded into prints and cartography, as well as perfecting the naturalistic rendering of ships in paintings whose composition became more complex.

Throughout the 16th century, ships were increasingly depicted in prints of panoramic views of European cities and major ports made by woodcutting or engraved metal plates. One of the earliest engraved prints was a bird's eye view of a cityscape created by Cornelis Anthonisz in 1544; it is considered more of a map than a picture, but is a powerful image that is seen as a prototype of 17th-century maritime prints (Cordingly, 1997: 33). Anthonisz was also an accomplished navigator and cartographer, nautical skills he acquired by sailing as a mate during his youth. It was through this experience and his abilities as a natural observer that he produced views of Dutch vessels that are considered generally accurate (Keuning, 1950: 51). Engraving was applied to the production of maps, charts, and globes by the cartographer Abraham Ortelius of Antwerp who first used copper engraving for his atlas *Theatrum Orbis Terrarum* of 1570 (Cordingly, 1997: 33). However, decorative details such as ships, exotic lands, peoples, flora, and fauna, as well as sea monsters were often hand painted with watercolors on the printed maps.

It was a series of engravings by Frans Huys prepared in 1561 and published in 1565, however, which were the true forerunners of maritime prints and paintings. Huys' engravings of ten ship types were based on drawings made by Pieter Bruegel the Elder. In the discussion of the development of marine art it is important to note that Bruegel created these works with the expectation that someone would buy his art. Likewise, Huys engraved these same drawings with the intention to profit by publishing them, both of which suggest the emergence by the mid-sixteenth century of a market for marine art, or in this particular case, ship illustration (Unger, 1991: 83).

Bruegel had previously painted ships as part of a realistic background that contrasted with an allegorical foreground (seen is his famous painting The Fall of Icarus) (Lindsey and Huppé, 1956: 382). Like the ships in The Fall of Icarus, the ships depicted in Bruegel's prints are alive with movement, which illustrates his interest in the intricate details of rigging and indicates his awareness of how vessels and sails reacted under different weather conditions (Cordingly, 1997: 67). Of all 16th-century artists, Bruegel took the most care to accurately represent the sea and vessels. His ship print series shows that his interest in ships is functional and not just symbolic. Bruegel's drawings stand in contrast with the artists who simply painted a ship more as an idea or meaning than an operational ship (Unger, 1991: 83).

Although, Bruegel was the first to master the depiction of a ship in a stormy sea, the realism preached by Dutch artists was accomplished first by Hendrick Cornelisz Vroom. Widely regarded as the father of maritime painting, Vroom developed seascape and ship portraiture into an independent artistic genre. Beginning in the 1590's, Vroom effectively created a market for seascapes and received lucrative commissions from the Dutch East India Company, various Admiralties, and harbor cities (Cordingly, 1997: 68; Russell, 1997: 213). Additionally, he designed the 'Armada 'Tapestries', commissioned by Lord Howard of Effingham and the 'Middelburg Tapestries' for the Province of Zeeland (Brown, 1986: 64).

In spite of the excellence of Bruegel's ships and seascapes, the painting of ships was not yet part of a recognized tradition. Vroom had to 'invent a new pictorial language' enhancing common Dutch motifs (e.g. sea, shore, low horizons, cloud-filled skies) with his ships, which was later adopted and adapted to suit the needs of landscape painting (Russell, 1983: 1). Vroom credited with forging a new style of painting naval scenes and battles, is also noted for his meticulous attention to vessel details and in particular rigging. Vroom's ships, however, are similar in appearance to the warships of Bruegel with as much or greater detail and accuracy (Unger, 1991: 91). In his youth, Vroom was employed in Italy by Cardinal Ferdinand de Medici to paint ships and harbor scenes. On his return to Holland in 1591, he was already known to Carel van Mander who commented on the desire for naturalism in paintings and recommended that Vroom study nature. Before achieving naturalism, however, fundamental stylistic problems of depicting ships sailing in the open sea or close to harbor had to be addressed (Brown, 1986: 64). In order to realistically paint the sky, clouds, and weather; Vroom was one of the first artists to go to the beach in order to observe ships and weather conditions. In his preparation for the Middleburg tapestries, Vroom reportedly sailed in a storm near Zierkizee to appreciate the true experience of sailors; it was said of him that:

> Vroom, who is very skilled in rendering ships and improves daily…Not only does he understand the construction of ships, their ropes and rigging, the direction of the winds, the sails and other relevant matters, but he also excels in all other aspects, such as backgrounds, landscapes, cliffs, trees, skies, water, waves, castles, villages, towns (Brown, 1986: 67).

Such details were not addressed by artists prior to Vroom including basic concepts such as having the ships sailing with the same wind and illustrating the movement of wind through the movement of clouds, sails, flags, and waves; Bruegel in his engraving *Sixteen Ships* has each ship sailing under its own wind within the same composition (Brown, 1986: 67). The technical and artistic success of 17th-century Dutch marine paintings is due to lessons learned in the previous century, which is nicely summed up by Willem van de Velde the Younger who insisted that 'whatever you do, observe carefully the direction of the wind and the sun' (Brown, 1986: 70). The father-son combination of Willem van de Velde the Elder who was a ship draughtsman and Willem van de Velde the Younger who was an accomplished marine painter brought marine painting to a new level in the mid 17th seventeenth century. The desire for realism was the precursor for technical accuracy and the extensive knowledge that can be gleaned from the 17th-century creations of Dutch marine painters such as the van de Veldes (Unger, 1991: 92-93).

Although there is no direct connection between Dutch marine painting as a formalized genre and the previous iconic use of ships in Portuguese art, together they illustrate the economic, social, and political factors behind the emergence of marine art. And never far behind these explanations is the underlying symbolism involved in the depiction of ships. In Dutch seascapes, ships are the 'vehicles that embody human ingenuity in the world of movement and change' and the triumph of human engineering that allows man to harness and combat the elements (Goedde, 1989: 165). They are also symbols of expansion, wealth, power, and the toils and happiness of a life lived on the water.

CHAPTER IV

THEORETICAL AND METHODOLOGICAL CONSIDERATIONS IN THE ICONOGRAPHIC ANALYSIS OF SHIPS

4.1 DEFINING ICONOGRAPHY

Nautical archaeologists have generally defined ship iconography as the artistic representation of ships with the implicit understanding that these ships hold symbolic value to the societies which depicted them. Although, many scholars have successfully adopted and adapted the concept of studying icons from the field of art history, some do not have a working definition of iconography or an understanding of its academic origins; the resulting confusion leads to disinterest at best and disregard at worst. Erwin Panofsky (1962), a historian of the Italian Renaissance, provides a three tiered interpretive model for the analysis of iconography within the history of art: pre-iconography, iconography, and iconology. Panofsky's iconological method, although recently contested in light of more modern scholastic advances and its questions about applicability outside the Renaissance, has been the theoretical foundation in art history for the twentieth century (Hasenmuller, 1978: 290). Traditionally art historians define iconography as the study of the subject matter or the meaning of art. The meaning of a work of art is generally found within the artistic motif. An enumeration of the motifs is considered by art historians to be a pre-iconographical description of the art or the first step in studying iconography (Panofsky, 1962: 5). Whereas the next step in the study of iconography is the iconographical description. The iconographical description deals with the secondary subject matter which is the specific themes or concepts manifested in images, stories, and allegories (Panofsky, 1962: 5).

The intrinsic meaning of the art is discovered through the underlying contemporary principles which reveal, amongst other things, the basic attitude of a nation and a period (Panofsky, 1962: 7). An iconological study or a deeper iconographical analysis identifies the symbolic values behind the motifs, images, stories, and allegories. An iconological analysis is therefore the discovery and interpretation of symbolic values of which the artist was probably not conscious. Correct identification of motifs is necessary for a meaningful iconographical analysis just as the correct analysis of the symbolic values is necessary to an iconological analysis (Panofsky, 1962: 8).

In a simplistic manner, Panofsky's method can be applied to studies of ships as icons. The pre-iconographical study recognizes ships as one of the motifs within the artwork whereas the iconographical description recognizes its thematic role in the overall composition. The deeper iconological study of the artwork concerns the interrelation of all the motifs and themes. To achieve this, it is necessary to first understand the ship as an iconographical motif which is ultimately manifested in the story or allegory depicted in the image. Thus, we must understand how ships became icons and the underlying symbolism of the ship.

4.2 THE SHIP AS A SYMBOL

The concept of the ship as a symbol is a growing discussion within the field of nautical archaeology and is slowly filling in the void of theoretical applications in the study of seafaring. In these studies the symbolic interpretation of ships is often separated from the practical affairs of seafaring, however, effectively creating a divide between two elements that essentially have a symbiotic relationship. Scholars have proposed that specialized beliefs grow out of everyday concerns through ritualization (Humphrey and Laidlaw, 1994; Ballard, *et al*, 2003: 398). Seafaring is a dangerous occupation and historical and ethnographic studies of seafaring are full of accounts of ritualistic behavior and beliefs on the part of sailors. Examples of this span the entire history of seafaring from the placing of occuli on the bows of ancient ships, to the early modern belief that the presence of women on ships was bad luck, to the 20th-century ceremonial rites involved in the launching of canoes in the Trobriand Islands (Malinowski, 1932: 147). Symbolism is a logical extension of ritualization and specialized beliefs and through this process the symbolic nature of ships can be argued to have developed.

Others scholars such as Cederlund (1995) and Ballard and colleagues (2003) suggest that the cultural foundation of ship symbolism is embedded within socio-economics. Cederlund (1995: 9) proposes that the ship has always retained a strong symbolic value because of the central position it has held in the economic systems of many societies. As Ballard and colleagues (2003: 398) points out “it seems hardly surprising that societies whose daily lives may have involved travel by sea should have chosen the ship as a symbol.”

These two arguments illustrate the divide between symbolic interpretation and the practical affairs of seafaring. The symbolism of ships is seen as either a product of ritual behavior or socio-economics when, in fact, both are symbiotically related. Ritualistic behavior and subsequent specialized beliefs are only present because seafaring was central to daily life. Likewise, the strong symbolic values that developed out of the ship's socio-economic position can be defined as specialized beliefs. Therefore, the one does not exist without the other. If ships were not vital to the daily life of seafaring societies there would have been no need to construct symbolic meaning around them.

In an attempt to make these intuitively true statements valid, Zbigniew Kobyliński (1995: 9) considered several questions regarding the cultural and psychological nature of symbols and the evidence that ships were used symbolically. Symbols are culturally created and maintained, hence archaeologist are often faced with the challenge of determining if a material object had symbolic meaning to the past culture (Kobyliński, 1995: 11). Bayburin, a Soviet ethnologist, proposed two mechanisms for determining the meaning of techno-utilitarian artefacts, a category which includes ships: "the moving of things in space and time", and "the distortion of the pragmatics of an artefact" (Kobyliński, 1995: 11). Kobyliński suggests that based on this rationale, if the presence of ships or boats or the pictorial representation of them differs from its recognized techno-utilitarian function as a means of transport, these ships had a semiotic or symbolic meaning.

Although this is easily recognized in the prevalent ship burials of prehistoric and early medieval Northern Europe as well as in the tombstones and stelae with incised boat images, it is more difficult to apply this concept to the art of early modern Europe. Later European artists had access to more complex media such as manuscript illuminations, engravings within printed books, maps, paintings, sculptures, and metal works. In the latter two categories, the ship can be considered in a definitively symbolic way as architectural decorations where they are not presented in their traditional function. The previously-listed media categories, however, often depict ships in their utilitarian function either under sail or at anchor. Maps and charts have an inherent technical function, but many of those containing images of ships were designed for royal or other wealthy patrons and were never used on board ships.

Likewise, the occurrence of ships in illuminations, engravings, and paintings also corresponds to traditional functions, but they are typically not the main subject and instead have an illustrative or, I would argue, a symbolic role within the composition. This argument reflects Panofsky's definition of iconographical and iconological studies in which the motifs identified in the former are part of the theme or story of the latter. Their presence within what can be considered high culture or the fine arts automatically places them outside a utilitarian role. Comparatively more resources were used to create artwork in early modern Europe than is recognized by modern standards. Art was the prerogative of the nobility and the wealthy and images created within artwork are intentional and meaningful.

The questions of why ships became symbols and how to find evidence that ships were used as symbols are essentially subjective and the answers are often conclude in speculative argumentation. To an extent, scholars have to accept intrinsically logical arguments as working truths because societies, both modern and ancient, do not always objectively analyze their own symbols or record descriptions of them for posterity.

The Ship as a Symbol in European Art

The ship is a powerful symbol in European art that has been continually present from ancient seafaring in the Mediterranean region through to the modern world (Villain-Gandossi, 1979: 169). In order to understand why ships hold symbolic power it is necessary to contextualize them within the artwork of the period under study. Throughout the Middle Ages and until the very late 16th century the sea provided symbolic imagery used primarily in conjunction with religious subjects that signified a changing and unstable world. A stormy sea represented the dangers and difficulties experienced in life while a ship implicitly guided by Christ came to represent the Church itself (Villain-Gandossi, 1979: 169). There is a maritime paradox within this religious symbology of the sea which Joe Flatman (2004: 1281) describes: while the sea was still seen as chaotic and uncontrollable, medieval Christians began to view it in a more positive fashion as a symbol of Christ's guiding hand in an uncertain world.

At the start of the post-medieval era and the Renaissance artistic and humanistic movement, technology and economics again had an effect on the symbolism of the ship. The printing press diminished the art of manuscript production and the illuminated ship was replaced by engravings within the printed book. The growing positive view of the sea was reinforced by the rise of mercantile seafaring empires throughout Europe (Flatman, 2004: 1281). The ship became less of a symbol of Christ's guiding hand in an uncertain world and more a reflection of the growing prosperity, the economic and social possibilities, and the resources brought to societies through their seaborne trade and discovery.

Religion dominated art through the Middle Ages and into the Renaissance, and this relationship of religious themes and the symbolic imagery of the sea and ships is one explanation for their prevalence in the artwork. However, in a political context associated with the consolidation of the modern, centralized state, ships came to symbolize the bourgeoning empires and their growing power. Ships themselves were known to be signs of not only economic success but military strength and it is reasonable that this symbolism would extend into their representation in art. Naval ships throughout Europe were built to be structurally imposing and heavily armed to radiate an image of strength. The individual pieces of armament as well as the ship itself contained highly ornamental elements intended to convey a sense of power and wealth. To echo Ballard and colleagues (2003: 398), it is logical that not only those who make their living by the sea, but also those who conduct war at sea and expand their resource base and power by crossing foreign waters would add symbols of their ships in the artistic record. In Renaissance Europe, the use of ships as symbols was first associated with religion, and then grew into a reflection of economic and political power.

4.3 INHERENT PROBLEMS IN THE ANALYSIS OF ICONOGRAPHY

Problems of Determining Technical Accuracy

The inherent problem associated with using iconographic evidence of nautical technology to bridge the gap between art and archaeological science stems from the fact that most artists were not shipwrights or sailors. Problems with technical accuracy are evident from the start and there are many examples in early Christian art where realism gives way to symbolism (Villain-Gandossi, 1979: 169). In the Middle Ages, artists generally had little knowledge of perspective and regardless of their artistic medium few worked in traditions that were concerned with realism (Friel, 1995: 18). However, starting in the 15th- and 16th-century maritime art tradition, ship depictions show greater attention to details. Moreover, the understanding of perspective became more developed starting in the 15th century, although according to Ian Friel, “these too are not without their contentious aspects” (Friel, 1995: 18). The natural limitation of the art form on which the ship is depicted also had an effect on the accuracy of proportions and perspective (Villain-Gandossi, 1979: 172-174). This is seen in a study of medieval town seals shown on coins; distortion was an inevitable occurrence, but many included credible details and the majority does not appear ill-proportioned (Friel, 1995: 21).

Another problem related to the use iconography is that of schematism and stylization of an object, which is a means of simplifying forms by only expressing their most characteristic elements (Villain-Gandossi, 1979: 174). In nautical art this often affects such elements as the numerous standing and running rigging lines, which impede the overall visualization of the ship. Unfortunately, rigging is not frequently discussed within the archival record, and rigging elements are rarely found in the archaeological record. Problems of proportionality and distortion, however, will be more apparent to a scholar of nautical archaeology than to one of art history. Stylization is more often caused by the artist's intentional or unintentional error; the artist was more concerned with completeness, clarity, or elegance of design than factual precision (Humphreys, 1978:79). Humphreys uses a charming story of Matisse to remind scholars that the artist is not an invisible or benign force in the creation of iconography and should not be treated as such in its interpretation. Matisse rebuked a visitor who was criticizing the apparent lack of realism in one of his nudes to which he replied: 'Madam, you seem to be making a mistake. What you are looking at is not a woman: it is a picture' (Humphreys, 1978: 79).

Additionally, some artists used their own stock images of ships consistently throughout their work while others tended to copy images from other sources (Friel, 1995: 19; Barker, 1992b: 442). The general practice of reproducing earlier images of ships while introducing even more schematism and stylization started with the spread of printing drawings, engravings, and paintings (Casado Soto, 2001: 139). Friel (1995:19) suggests that the solution to dealing with these associated problems is to not rely on one pictorial source or type, but to examine representational trends or the repeated occurrence of construction features in the images. Ellmers and Hagedron also note that it is necessary to use 'the greatest possible number of different depictions of the same ship-type' regardless of the precision or revelatory nature of any given source (Ellmers, 1972: 13).

The primary problem of determining the technical accuracy of artistic depiction of ships has led many to disregard iconography as a whole. Another approach to dealing with the problems of inaccuracy involves determining the natural limitations of this line of evidence, but realizing that there is innate accuracy in most images. This statement needs to be qualified as there are many examples of iconography in any period and culture that are recognizable as being ridiculously-inaccurate. This concept applies to the iconography that has been identified by trained scholars as plausible and logical for it is an unfortunate fact that we do not always know if our judgments are founded in reality unless complete shipwrecks are discovered. Training which includes multiple lines of evidence - archaeological, written, and pictorial – can teach maritime archaeologist to identify logical proportions and configurations in the hull construction and rigging.

Artists rarely are fortunate enough to be able to create art for the sake of art; in the post-medieval era they often had a patron or were commissioned to produce a work of art. This suggests that they fulfilled the customer's demand which during this time included more realistic and proportionate subjects as discussed previously. The artist, to be successful or merely to be paid, had to satisfy the audience and/or patron; thus ships that were depicted had to be recognizable as types with which viewers were familiar.

This section delineates the inherent problems of using iconography and the inaccuracies that might be introduced by the artist. Burningham and de Jong (1997:288) state, however, that "as with caricatures, many relative dimensions will be accurately represented even though the overall form is distorted." Specifically, as with caricatures there are certain features that have to be represented to make the ship identifiable as a caravel, galleon, or nau. In addition to these features there are details of ship construction and rigging just as there are general trends in the iconography waiting to be discovered.

Problems of Applying the Iconographic and Archival Data to Shipwrecks

Keith Muckelroy (1978: 233) suggested that "while pictorial evidence may often be most helpful in considering individual ships, for general trends the written sources must be paramount." However, just as artistic depictions could be error-ridden, there are similar problems of determining accuracy in the written record. Shipwrights were often illiterate and prone to oversimplifying the technicalities of what they were describing to the writers of contemporary treatises. Likewise, the written record is littered with ancient and obsolete terms which can be difficult to interpret without a visual aid and there is more emphasis on the unique than the ordinary (Muckelroy, 1978: 233). Both documentary and pictorial sources are subject to two filters – the contemporary recorder and the modern interpreter (Muckelroy, 1978: 215). Likewise, it is necessary to consider how to relate these sources of data to an individual shipwreck or to a ship type.

Ellmers' study of medieval ships and shipping illustrates the three lines of evidence used in developing typologies: artefacts, iconography, and documents (Ellmers, 1972). Brad Loewen in the forward of his translation of this article states that the significance of Ellmers' work is that it addresses the unique methodological problem that historical archeologists face in analyzing ships, which is to “identify or generate basic points of comparison among these three lines of evidence” (Loewen, 2005).

When the comparison of material and iconographic sources is limited to simple physical description, it is not necessary to find the object’s meaning as visual recognition becomes the correspondence between the object and the pictorial representation. The practical problems associated with iconography occur quickly. As precise depictions of ships created by skilled model-makers and draughtsman are only available for relatively recent centuries; everything earlier must be approached through the artists’ sensibility, which is expressed in differing degrees of stylization (Ellmers, 1972: 13; Loewen, 2005).

Ships in medieval iconography are usually represented in a profile view, resulting in the absence of the breadth or transversal structures and the projected proportions of the side view do not always correspond to real objects (Ellmers, 1972: 13; Loewen, 2005). This divergence between two lines of evidence – iconography and archaeology – illustrates simultaneously the difficulties of using iconographic images and the importance of finding an appropriate way to use it. Vessels are normally depicted in their natural setting, water, and only the structure above the waterline presented. Archeological remains of post-medieval vessels usually consists of only the bottom with very little of the hull surviving past the turn of the bilge, leaving little or nothing that can be compared to the iconography. The upper works of archaeologically-reconstructed shipwrecks are therefore almost always copied from artistic representations. It is the missing overlap of the two sources which accounts for the difficulties of actually applying iconographic data to shipwrecks. This disconnect does not negate the use of iconography, however, it merely highlights the need for a method to merge the natural projection of lines from the bottom works to the upper works and vice versa. To accomplish this, we first need to better understand iconography as a source of valid data.

Ideally the iconographic images of ships would be used in conjunction with archaeological data and archival documents. However, the relationship between these three lines of evidence is complicated; as such, Ellmers established a basic methodology to compare iconographic, archaeological, and written sources. Two visual representations – object and icon – are more readily identifiable than an object to a written description. The root of this problem is that the relation between the designation, the word, and what is being designated, the ship, is rarely directly provided to the reader; to connect the two, typical features of a ship 'according for which it was named or known by its contemporaries' has to be understood (Ellmers, 1972: 14; Loewen, 2005). The typical features of a ship type must be established and these are rarely mentioned outright in the texts. Ships are often distinguished by their rigs in documentary sources but rigging related artefacts found in shipwrecks are usually limited to a few disassociated blocks or deadeyes, hardly the complete rig. Although deadeyes and blocks are useful as general indicators of the rigging, they do not always distinguish between the number and types of masts and sails. Additionally, there is an issue between archaic nomenclature for particular features and their modern equivalent, which is further complicated in the Middle Ages by the concurrent use of Latin and popular terms (Ellmers, 1972: 14; Loewen, 2005).

Ellmers (1972: 14; Loewen, 2005) identifies four methodological classifications for comparing material and archival data, the first two of which are based on the existence of ‘contact sources’ which bridge the gap between a word and an object; the last two are developments upon the prior two. The first group is those few objects for which the correlation between the object and term is made clear due to its being specifically mentioned in a known text. Secondly are the descriptions that are so complete that they allow for the recognition of certain key features which then lead to positive identification of an archaeological find. The difference between these ‘contact sources’ are that the characteristic features are provided through the object in the first case and the text in the second (Ellmers, 1972: 14; Loewen, 2005).

The third grouping is those finds for which iconography serves as a bridge between the object and the description, if and when the depiction is proven to be a certain ship type based on archival documentation. The fourth approach is a process of elimination for situations in which all but one of the ship types have been identified archaeologically or for an instance of closed cultural zones where only one ship type is known and only one is found; however, this has never happened in the real world. Comparison is not possible in these last two approaches as they are only really achievable after the criteria of the first two have been satisfied (Ellmers, 1972: 14; Loewen, 2005).

The comparison of written and iconographic sources is similar to those just outlined for that of the material and written due to the fact that the artistic depiction is a representation of the object and therefore subject to the same methods of comparison by four means: annotated pictures; texts with precise, sufficiently detailed descriptions of the object; objects already identified; and the process of elimination (Ellmers, 1972: 15; Loewen, 2005). For post-medieval ship types, there is a strong correlation between the written description and the iconographic record. The sailing qualities and rigging of the caravel and the nau are firmly established in both sources; however, they cannot yet be directly correlated to the archaeological record.

The work of both Muckelroy and Ellmers is vital to understanding the difficulties of relating iconographic, archival, and archaeological sources to each other. While they expand on the differing strengths of these relationships and begin to offer a tenable set of guidelines, neither presents a clear methodological approach. Casado Soto contends that before anyone attempts to interpret and use iconography as a reliable source of information a disciplined approach needs to be created. This begins with a delineation of the information that must be obtained about an image: the circumstances under which it was made, the identity of the author (and artist) and his professional background and skill, the date of execution, and whether the image is an original rendering or a copy. Additionally, images must be subjected to synchronic and diachronic comparisons of related images (i.e., "same cultural background") and with those from periods directly preceding and following the one in question. Finally, parallel information derived from iconography, archaeology, and written documents is considered valid and can be used to highlight discrepancies and similarities (Casado Soto, 1998: 140).

In a final note of caution, Casado Soto (1998: 140) warns that scholars should not confuse these different approaches, as each has its own specific methodology that must 'be respected' and depending on the quality and reliability of the information from each, 'greater or lesser authority must be attributed to the three of them.' In essence, he is stating that even when the data gathered from artistic sources is legitimated through its comparison with archaeological remains and written documents, it is still not to be considered as dependable as the latter two lines of evidence. Although it is apparent that Casado Soto is predisposed to excluding iconographic sources from most archaeological studies, there are useful critiques embedded within his arguments.

Maritime scholars have often expounded the difficulties of using iconography and not used their knowledge and training to offer solutions. As shipwreck excavations become prohibitively expensive other sources of information need to be utilized to their full extent. Pictorial evidence cannot be ignored because we have not yet developed effective tools for analyzing their content.

4.4 TOWARDS A THEORETICAL STANDARDIZATION OF ICONOGRAPHY

Problems of interpretation and validity have limited the use of iconography as a source of data within nautical archaeology. The analysis of iconographic images requires a shrewd application of judgment. There also needs to be a standardization of questions applied to iconography through which scholars can begin building guidelines for properly using this source of data. A solid theoretical approach is vital, but must be used judiciously until overarching universals in interpreting the depicted ships in the artistic record can be determined.

This lofty goal can only be reached by first placing a shipbuilding tradition within an artistic and historical context. The reasons why a culture decided to place importance on seafaring technology and retain it within the written or artistic record needs to be thoroughly researched and understood. It will not be possible to identify the symbolism of the ship in art without an understanding of how and why it is there in the first place.

Proposed Theoretical Questions for Defining the Boundaries of Iconography

The standardization of questions to be applied to the iconographic record requires a tenable set of guidelines for the study of icons in seafaring traditions. The questions, or guidelines, outlined below were developed for this particular dissertation. These questions have not yet been tested on any data set outside of the dissertation, nor applied to any other historical seafaring context, but their applicability can be tested in other studies resulting in their adoption, revision, or discarding.

Question 1: What are the Cultural and Geographic Boundaries of the Iconography?

Defining the boundaries of the iconography was one of the most important questions addressed within this dissertation. Determining what constitutes iconography as well as what is “Portuguese Iconography” is a far more complex than generally realized. To answer this question, it is necessary to consider the role of the patron, the artist, and the audience, all of whom at this time in Portuguese history could be of different nationalities. Each of these three characters interacted in the process of creating art and their importance in the determination of identity is open to debate as it is unavoidably a subjective process. The study of human artistic endeavors and the symbolism they contain is rarely assisted by objective rules. We must rely on 'experts;' however, those who study the history and archaeology of ship construction are rarely experts in art and symbolism and vice versa.

The iconography used in this dissertation is primarily from contemporary manuscripts, maps, and paintings all of which were presumably created with the support from Portuguese patrons. This supposition holds true for art created for the Portuguese Crown, such as the maps produced by monarchy-controlled cartographic schools and royal manuscripts detailing the exploits of individual kings. In these cases, the patron was also the audience. Likewise, the donation of paintings to Churches was commonly a result of Royal or noble patronage.

Less certain, however, is the attribution of certain works of art to an artist. During the high point of their wealth and maritime empire the Portuguese often imported artists from Italy or Northern Europe as there were few defined schools of Portuguese artists. Europe at that time was embedded in the Renaissance artistic movement and artists were highly mobile, leaving their own countries to seek masters who could expand their knowledge.

Attribution is additionally complicated by the common practice in artistic or cartographic schools of having the students fill in background or minute details (which would often include ships). It is likely that even with extensive archival research, the identities of these students would remain a mystery and not enhance the classification of the iconography. The situation is further convoluted by the fact that throughout the ensuing centuries, works of art are sold (or stolen) and knowledge of their origins, artists, patrons, and audiences is lost. The art is then attributed to a nationality using the subject matter or to an artist using style and techniques, but its provenience is often a "best guess."

Given these complications, it is difficult to truly define an icon as Portuguese, or any other nationality, and a requirement to do so would severely limit research using iconography. In an attempt to simplify the matter, is reasonable to classify the art as Portuguese if two of three criteria (patron, audience, and artist) are known. In this dissertation it is more common that the patron and the audience are clearly identified as Portuguese. It is difficult to discern the identity of the artist and the artistic school in which they were trained. This is less important in the study of icons as the art was intended for a patron and audience, and the symbology had to be implicitly recognizable to them. These ships were depicted as symbols for the Portuguese if they were not illustrated by Portuguese artists.

Question 2: What are the Temporal Boundaries of the Iconography?

The temporal boundaries of the iconography are generally defined by how long a particular ship type was used. These boundaries, however, should be indicative of the approximate starting and ending dates of the use of the ship for the specific purposes which led to its becoming a dominant symbol in the culture. The Portuguese caravel was originally a small fishing vessel that was later employed in the exploration of the West

African coast in the middle of the 15th century. Although the caravel was not used in this capacity for voyages to the East after the beginning of the 16th century, the Portuguese continued to explore parts of South America and the New World in these ships for the next several decades. Fleets of naus, accompanied by the *caravela da redonda* and *caravela da armada*, were the cargo carrier for the *Carreira das Indias* during the 16th century. Naus and the trading caravels may not have carried the strong symbolism of exploration, but they were equally as revered for their role in the creation and expansion of Portuguese maritime empire. Evidence suggests that the depiction of caravels and naus in art did not really start until the mid 16th century. Iconography from the first half of the century is generally found on maps that charted the latest explorations, territorial acquisitions, and sailing routes. Cartography was a political statement as much as a creative work of art.

The emergence of the caravel and nau as icons begin in the 16th century at a crucial point when Portuguese scholars with nationalistic and idealistic motives were rewriting the history of the Discoveries as well as role of Prince Henry 'the Navigator.' In the mid-16th century, long before the romanticized title of 'the Navigator' was added to the Prince's name in the 19th century, there was a concerted effort by historians and scholars to recreate Henry into a national hero. Beliefs about the man and his works created at this time remain to this day (Randles, 1993: 21). Prince Henry's role in the discoveries was transformed from strong royal backing of voyages and astronomical learning into more active participation that included the creation of a school of exploration and hydrography at Sagres in the early 15th century.

I do not believe that it is coincidence that during this national revival of a quickly fading Portuguese golden era that caravels and naus, the instruments of past successes, became prevalent in the artwork over the next century. It is precisely at this time and for this purpose that these ships became icons which symbolized the wealth and grandeur of Portugal in the later part of the 15th century and the beginning of the 16th century. Proving this hypothesis would entail collecting far more evidence of Portuguese idealization of the past, a task which is beyond the scope of this dissertation. For this research, however, it remains an intriguing speculation about why depictions of caravels, galleons, and naus begin to appear with regularity at the beginning of the 16th century and only became widespread around the mid-century.

Modern Portuguese scholars have suggested that the earthquake of 1755 (followed by a tsunami and fire that nearly demolished Lisbon) may account for the lack of earlier ship representations. This may explain the absence of some items but does not account for the fact that representations of caravels, galleons, and naus dated from the second part of the 16th century to the mid 18th century survived. Acts of nature tend to destroy randomly, not selectively.

Temporality is also part of the larger question of cultural retention of symbols. Delineation of temporal boundaries is really an exercise in determining how long ships were accurately portrayed. This consideration is dependent upon the culture in question and the power of the symbolism of the ship itself. Was it important that the vessels were realistically depicted, or would an abstraction of them suffice? If realism was valued, then the ship as a symbol may have been accurately reproduced for a significant period of time; however, it is still a matter of placing an arbitrary line in history with those dated before being considered generally reliable and those after highly questionable.

The placement of this temporal stopping point is far more pragmatic than theoretical as it is often determined by the data. The iconography used in this dissertation appears to be fairly consistent and accurate through the mid 17th century. Although this is past the general use of the caravel and well into the decline of the nau, there are more engravings and paintings available from 1550 to 1650 than during the previous century. The Age of Discoveries is traditionally defined as the period from the capture of Ceuta in Northern Africa in 1415 to 1580, when Spain annexed Portugal after Dom Sebastian I died heirless. An iconographic study limited to these temporal boundaries would be hampered by the lack of representations in the 15th and early 16th centuries, yielding iconographic evidence that mostly dated to the middle decades of the 16th century.

Question 3: What are the Artistic Boundaries of the Iconography?

The artistic boundaries of the iconography are a factor of the medium in which the ship is depicted as well as the quality of the image. Artists have represented ships on different artistic mediums; some are conducive to this type of study, while others render the image indecipherable. Ships drawn or painted on a flat surface (e.g., paintings, manuscripts, and maps) are less constricted by the medium than those found on ceramics, metal decorative objects, architectural elements, or sculpture. The curvature of ceramic objects (e.g., jars, bowls, or plates) often leads to a distorted image of the ship as the artist struggles to represent three-dimensional structures on a curved two-dimensional plane. There are very few ceramic objects with ship representations from this time period and it is likely due to the popularity of Portuguese *azulejos* (painted ceramic tiles). *Azulejos* began with the Islamic influence in the Iberian Peninsula and the oldest surviving tiles are often of a geometric design. Those from the 16th and 17th century are more indicative of European tastes; however, ships do not begin to appear on the *azulejos* until the 18th century.

The three-dimensional representations of ships include silver table decorations or food containers, which are often stylized to the point of abstraction. While architectural and sculptural elements are of varying quality. Architectural elements, which in this data set are primarily stone Manueline decorations, have proven to be the more reliable and less stylized than ceramics or sculpture. Although, these ships are created as three-dimensional illusions (intended to provide the viewer with the sense of sculpture) they are actually two-dimensional reliefs. Thus far, in this dissertation, it holds true that three-dimensional ship representations, along with those depicted in mediums with excessive curvature, are not reliably represented. This evidence suggests that the complex curvature and lines of an actual ship are beyond the skills of the artist who, albeit arguably familiar with ships, did not envision the overall vessel in the way a shipwright would.

Proposed Theoretical Questions for Determining the Quality of the Iconography

The quality of the iconography can only be established by determining if the ship is represented in a logical and realistic manner. The following series of primary and secondary questions are designed to create an objective process by which the quality of the iconography can be discerned. The first question to be addressed is whether or not Portuguese artists of this era could depict vessels with some level of technical accuracy. To answer this question on an individual level would entail looking at the archival documents for each artist which is addressed below in the primary and secondary questions. One aspect that some scholars fail to consider is that these ships were a common sight in the Tagus River (which connected Lisbon to the Atlantic Ocean) and along the extensive Portuguese coast. At that time, ships were the most advanced form of transportation technology. The unlikely artist who had never been on or seen a ship would merely go down to the Tagus River and view the numerous vessels at anchor. Thus, it is a logical assumption that, within reason, artists could accurately depict these ships much as an artist today can depict a modern ship or an airplane. These artists may not actually understand the structural details or even how the ship works, just as most people do not really understand the thorough workings of an airplane. This should not prevent a skilled artist, however, from creating an accurate artistic representation.

Question 1: How Can the Quality of the Iconography be Determined?

Determining the quality of the work of art can be a valuable tool to the researcher. In an ideal situation, the artist is known and conducting art-historical research and answering the first question about their artistic credentials and background would lead to enough information to establish the quality of the iconography. The historic records would contain enough details to recognize if it was a single artist or a group working within a workshop as well as their artistic training. We would be able to fully understand if the artist was acknowledged as a person who researched their subjects and was true to the nature of the object or prone to stylized or romanticized representations.

In most cases this level of archival research on artists is overly idealistic. For this dissertation, there is little information available about Portuguese artists and most of the iconography cannot be accredited to particular artists. When an art-historical approach fails, another method of determining quality is needed, namely one that is specific to the field of nautical archaeologists. The secondary questions are the first approach to defining this required methodology. By looking at the ship itself in the iconography, nautical archaeologists can overcome the inherent limitations that have deterred most from using art as a source of data.

Question 2: How Can the Quality of the Representation of the Ship be Determined?

The second question is designed to ascertain the quality of the iconography by analyzing the general representation of the ship as well as the construction details. Examining the role of the ship within the artwork is fundamental to this approach. When ships are the principal subject, there is a high level of accuracy and detail. This rarely occurs in Portuguese iconography which was created in period when religious themes prevailed. Nonetheless, the relationship between the ship and the subject of the artistic work is important in determining why the ship was depicted in the first place. On a broad level, this often comes back to the concept of ships as symbols, but also the practical matter of the position of the ship within the overall composition. The placement of the ship in the foreground often indicates a more reliable source of details whereas those in the background should be subjected to further scrutiny. This argument is based on the simple fact that ships depicted in the foreground tend to be larger with more visible details, while those in the background are naturally smaller with more obscured details. The discrepancy in the level of detail between the ships that are placed in the foreground and those in the background of the same painting is significant. The ships depicted in a larger scale can provide a wealth of information including small details such as people or pikes in the crowsnest readied for battle, rudder chains on the stern panel, clearly painted heraldic shields, or intricate rigging elements. The ships shown in the background, however, may only have the most rudimentary characteristics of a vessel such as masts and sails with no rigging, castles, or defined decks.

Another useful guideline is analyzing the complexity of the representation and the style in which it was portrayed. Complex representations of ships depicted with numerous construction and rigging components should be considered far more dependable sources of information than a vessel that is portrayed with just enough details to be identifiable as a certain ship type. Similar to the argument made about the placement of the ship in the composition, artists who created a ship in such a manner was undoubtedly either more familiar with sailing vessels or paid more attention to the subjects they painted. Additionally, there is the need to identify those images that are subjected to artistic license. The determination of inaccuracies introduced by the artist is difficult because the Portuguese had a relatively insignificant artistic tradition and a poorly understood shipbuilding tradition. Although, many artists did represent ship with surprising complexity, attention to details, and in a seemingly accurate manner; some of them relied more on imagination than reality.

Images that are either constricted by the medium in which they were depicted, overly stylized, or a clear product of artistic license tend to be easily recognizable. However, others straddle the line between a reasonable depiction of a particular type of vessel and one that is merely a generic representation of a ship. When only limited information is known about the artist and the image, it becomes necessary to look at the details of the ship. It is then the task of a nautical archaeologist or historian to determine whether or not these details are supported by known reliable archival sources and portrayed in a logical manner. Although archaeologists and historians may not fully understand the nuances of artistic techniques or be able to attribute a work of art to a particular artist, those who study the construction and sailing properties of sailing vessels are trained to notice unfounded details and illogical arrangements or proportions.

Another means of ascertaining quality, in the absence of solid background information on the artist and shipbuilding tradition, is to examine auxiliary vessels. Caravels, naus, and galleons were often depicted vessels about which we possibly have relatively more archival, pictorial, and/or archaeological evidence. Although, it can reasonably be stated that artists may have had more familiarity with some ships versus others, it can just as logically be assumed that if they painted one ship accurately they did so with the others.

4.5 RESEARCH METHODOLOGY

Data Collection and Evaluation

This investigation of the iconographic representations of caravels, galleons, and naus began in 2002 at which time an inquiry into 97 museums, castles, and churches throughout Portugal was sent. The parameters for contacting these institutions were based on the criteria if these were known to have collections from the 15 - 17th centuries or the building itself was built in that period in order to account for iconography within architectural features. Of the institutions contacted, 17 responded stating they had iconographic material or sent images. Initial research was conducted in these institutions as well as in additional museums in England, France, Spain, and the Azores Islands. I photographed the iconography in the museums when possible and at other times purchased high resolution copies of the artwork. During this research stage, I also investigated the literary collection in the Centro Nacional de Arqueologia Náutica e Subaquática whose support greatly facilitated access to many national institutions. In all, over 500 depictions of ships were collected from the institutions or located through literary sources.

In the summer of 2005, I designed a preliminary investigation of archival resources within Portugal and conducted primary research in the following national archives and libraries: Instituto dos Arquivos Nacionais Torre do Tombo, Bibliotecca Nacional de Lisboa, and the Arquivo Histórico Ultramarino. This research was continued in 2007 in the Instituto dos Arquivos Nacionais Torre do Tombo with particular emphasis on the *Casa Forte* collection of rare 15th- to 17th- century manuscripts access to which is limited and strictly regulated. In the same year, I also investigated iconographic sources housed in the British Museum, British Library and the National Maritime Museum in Greenwich in order to complete the data set.

The immense amount of images collected presented many practical challenges including the creation of a methodological classification system that would interact with the theoretical considerations (Figure 1) as well as the consolidation of sources. Many sources were identified by different scholars using variations of the official name as well as some that included only a small portion of the original source showing only the vessels. The images were then subjected to the proposed theoretical questions for defining the boundaries of iconography as described in the previous chapter, and the data set was filtered by the geographic, temporal, and artistic limitations.

The second set of theoretical questions regarding the quality of the iconographic source and the individual ship types proved the most difficult and necessitated a shrewd application of judgment. Throughout the data processing, sources as well as individual representations within a source were discarded after being judged too stylized or simplified to be included in the representational trends and statistical analysis. It should be emphasized that images that are either constricted by the medium in which they were depicted, overly stylized, or a clear product of artistic license tend to be easily recognizable. It is the iconography that straddles the line between a reasonable depiction of a particular type of vessel and one that is merely a generic representation of a ship that are contentious. It becomes necessary for the scholar to look at the details of the ship to

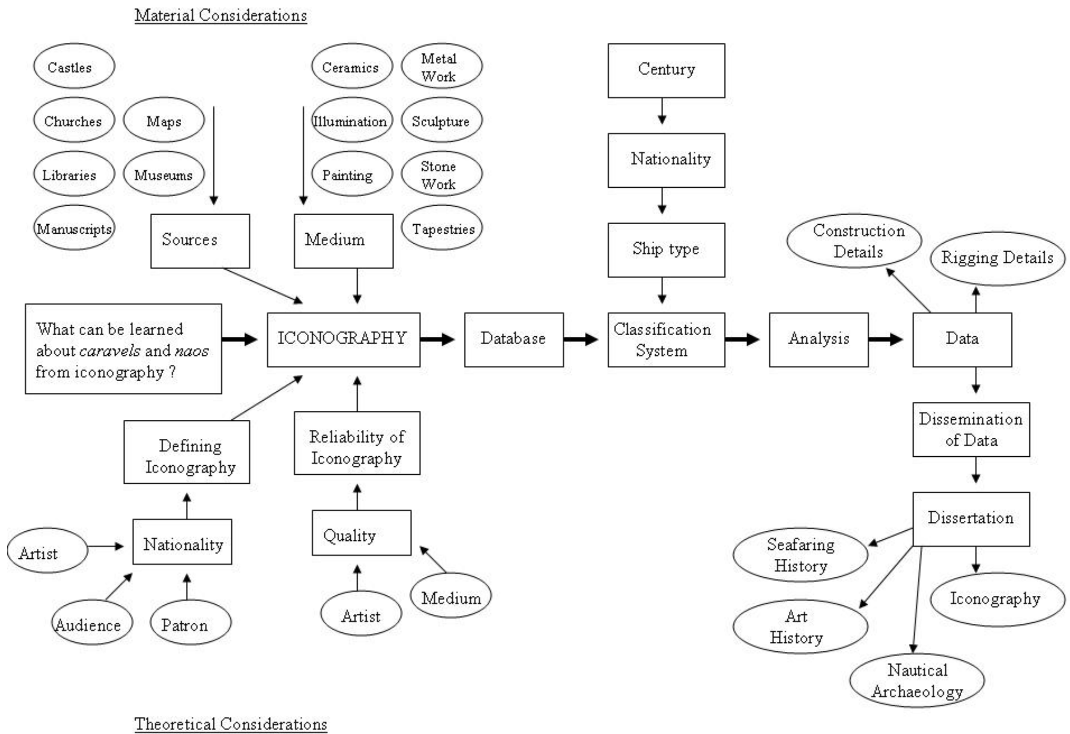


Figure 1: Material and theoretical considerations in the iconographic analysis.

determine whether or not these details are supported by known reliable archival sources and portrayed in a logical manner and to notice unfounded details and illogical arrangements or proportions. The images determined to be within a reasonable range of variation in quality and accuracy were then analyzed using the representational trend and multivariate morphometrical statistical analysis methods. Through these two processes, the sources which are, in fact, moderately stylized or erroneous in their depictions will be statistically or visually apparent to the scholar.

Representation Trends Analysis

Representation trends analysis first established by Friel (1995) is adopted as one of two primary methodologies in this dissertation based on the notion that the solution to dealing with the inherent problems of iconography is to examine the repeated occurrence of construction features in the depictions of ships. Representational trends can also determine the technical evolution of ships, which is evidenced by Friel's unpublished iconographic study of over 200 images of medieval Hulks currently held in the vast archives of the National Maritime Museum at Greenwich, England. Temporal changes were found in the collection of images, and more importantly the study proved through the use of archival evidence these modifications were a reflection of actual technical change (Friel, 1995: 21).

The representational trends method is likewise inherent in Villain-Gandossi's (1979) study on the iconography of early post-medieval ships from the 9th – 15th centuries. Her presentation at the International Symposium on Boat and Ship

Archaeology in Greenwich, England and subsequent article was one of the first practical applications of iconography. In her research, Villain-Gandossi (1979: 101) proposed a typology of ships found in the iconographic record according to form and silhouette (e.g., the ship with a mast or the ship with superstructures). Her interpretation of the ships in the illuminations led to a better understanding of the evolution of certain elements of the ships including the hull shape, steering apparatus, superstructures, and rigging.

This study provides an important glimpse of the results of this methodological approach and a summary of important comparative data from northern European shipbuilding in the 9^{th} – 15^{th} centuries. Her brief conclusions suggest that after a short period of two-masted ships with square sails from 1460-1480, three-masted vessels came into widespread use. Two decades later at the start of the 16^{th} century, the main mast was the largest mast and made of a single timber; however, subsequent depictions indicate that the masts evened out in size, were of composite construction, and each was supported by separate shrouds (Villain-Gandossi, 1979: 101). Villain-Gandossi posits that the arteman (fore mast) and mizzen masts should have been introduced together, which will be discussed further in the image analysis and conclusion. She also states that in a general survey of maritime iconography for all of the 16^{th} century, there are no significant changes in her proposed typology providing an interesting foundation from which to compare the conclusions of this dissertation (Villain-Gandossi, 1979: 102).

The two diachronic studies differ in that Villain-Gandossi created a typology of medieval ships whereas Friel studied a single medieval ship. Both proved, however, that through this methodological approach, it is possible to discern temporal construction changes. It is expected that by using this method in addition to statistical analysis, results similar to those of Friel's analysis of construction characteristics and Villain-Gandossi's ship typologies can be achieved.

It is necessary, however, to expand the foundation of representational trends analysis and clearly define how it is used as a methodological approach. The method as used in this dissertation is also based on Hagedron (Ellmers, 1972) and Ellmers (1972) both of whom argue that it is essential to use the greatest possible number of different depictions of the same ship type. However, I do not concur with their general belief that all depictions should be used regardless of the accuracy or revelatory nature of any given source. As such, the decision was made to use accurate sources of iconography from all European sources and not just Portuguese art. This research proposes to look at the representational trends of 542 ships, chosen from a dataset of numerous works of art, a majority of which contain examples of different ship types (refer to Appendix 1 and 2 for the catalog of iconographic images and provenience).

Representational trends will be assessed by the presence or absence of predetermined construction and rigging features as well as by country of origin and date when possible. The list, which is presented in Appendix 3, was primarily composed of characteristics from the literature, along with features noticed in preliminary observations while working with the iconography. It is expected that this checklist of construction features will provide a list of features encountered within the iconography, and by showing when construction changes came into popular awareness indicate the evolution of hull features and rigs. This study of representational trends will constitute the preliminary analysis of the data and the resultant information will then be compared to the statistical analysis.

Descriptive Statistical Analysis

It is anticipated that representational trends in the iconography and descriptive statistical analysis of the hull and rigging proportions will provide a set of construction characteristics for the three types of caravels (*caravela latina, caravela redonda,* and *caravela da armada*) as well as the galleon and the nau. The standard representational trends analysis is based on the presence and/or absence of a feature as well as the date of the representation. Whereas descriptive statistics analyzes: the placement and rakes of all masts; mast and yard dimensions; and the dimensions of the sterncastle, forecastle, and waist. The histogram graphs produced from the statistics provides a visual representation of the sample distribution and the standard deviation with easy to comprehend graphs.

The resulting information on the typological features and the temporal evolution of caravels, galleons, and naus will enable a more specific set of identifying characteristics to be established for these ship types. The logical projection of these features to the lower portion of the hull, which is not depicted in the iconography, may help identify ship types in archaeological studies of structural remains, which are typically the remains of the lower portion of the hull, sometimes together with concretions containing remains of iron rigging and armament elements.

The result of any iconographic study will be generalities. Methodology enables the scholar to interpret the generalities in order to make informed conjecture about the particulars. Representational trends and general construction proportions analyzed in the iconographic record have a potential to provide enough information about the ship type thereby establishing correlating evidence from which to reconstruct a shipwreck.

CHAPTER V

REPRESENTATIONAL TRENDS ANALYSIS OF SHIP TYPOLOGIES, RIGGING CONFIGURATIONS, AND SAIL AND YARD SETTINGS IN THE ICONOGRAPHY

Representational trends analysis can determine ship typologies and the technological evolution of ships through temporal changes found in the data set of images. The results can be compared to archival records to provide a logical basis for answering if these modifications were, in fact, a reflection of actual technical change. Representational trends were assessed by the presence or absence of 164 predetermined construction and rigging features on 542 ships, and by the date of the image. The list of construction and rigging features tabulated in this analysis is presented in Appendix 3. The list was composed primarily of characteristics mentioned in contemporary literature, as well as features observed while working with the iconography. For glossary of ship terminology or definitions of features analyzed in this dissertation, refer to seminal work by Richard Steffy (1994).

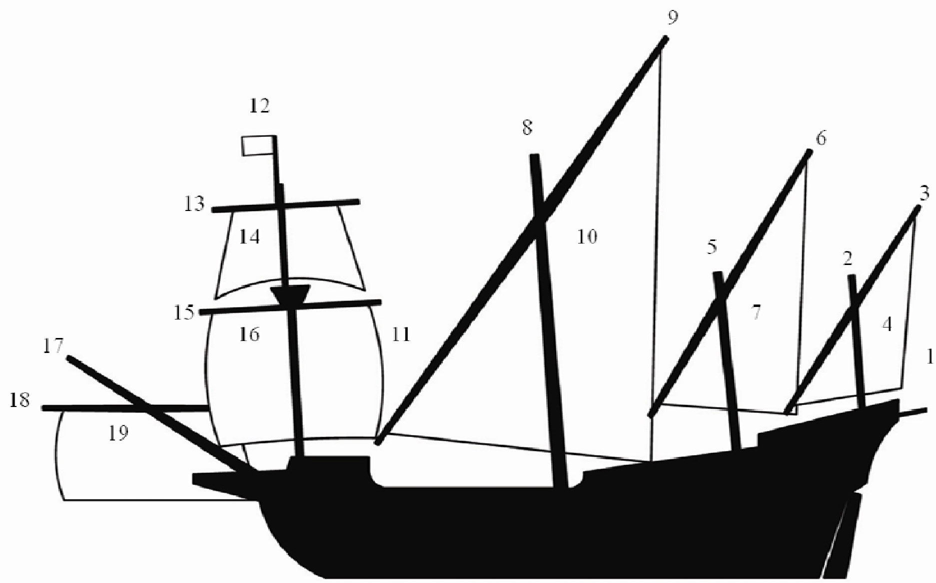
5.1 REPRESENTATIONAL TRENDS ANALYSIS OF SHIP TYPOLOGIES

The direct relationship between caravels, galleons, and naus is currently unknown and modern scholars are at a disadvantage when they attempt to assign direct ancestry of one ship type to another because there is simply not enough evidence to back their claims. It is only possible to infer general proportional relationships between caravels, galleons, and naus but it should not be forgotten that they are only suppositions. A better typology of this seafaring tradition is needed before such an advanced analysis can occur. The typologies and evolution of caravels and galleons are not well understood and is often a confusing mix of different names for essentially the same ship. For this reason, the archival classification of these two ship types will be explored in more depth here while the description of the naus in Chapter II is considered sufficient; refer to Figures 2 and 3 for a description of caravel and galleon mast, yards, and sails.

Archival Evidence of Ship Typologies

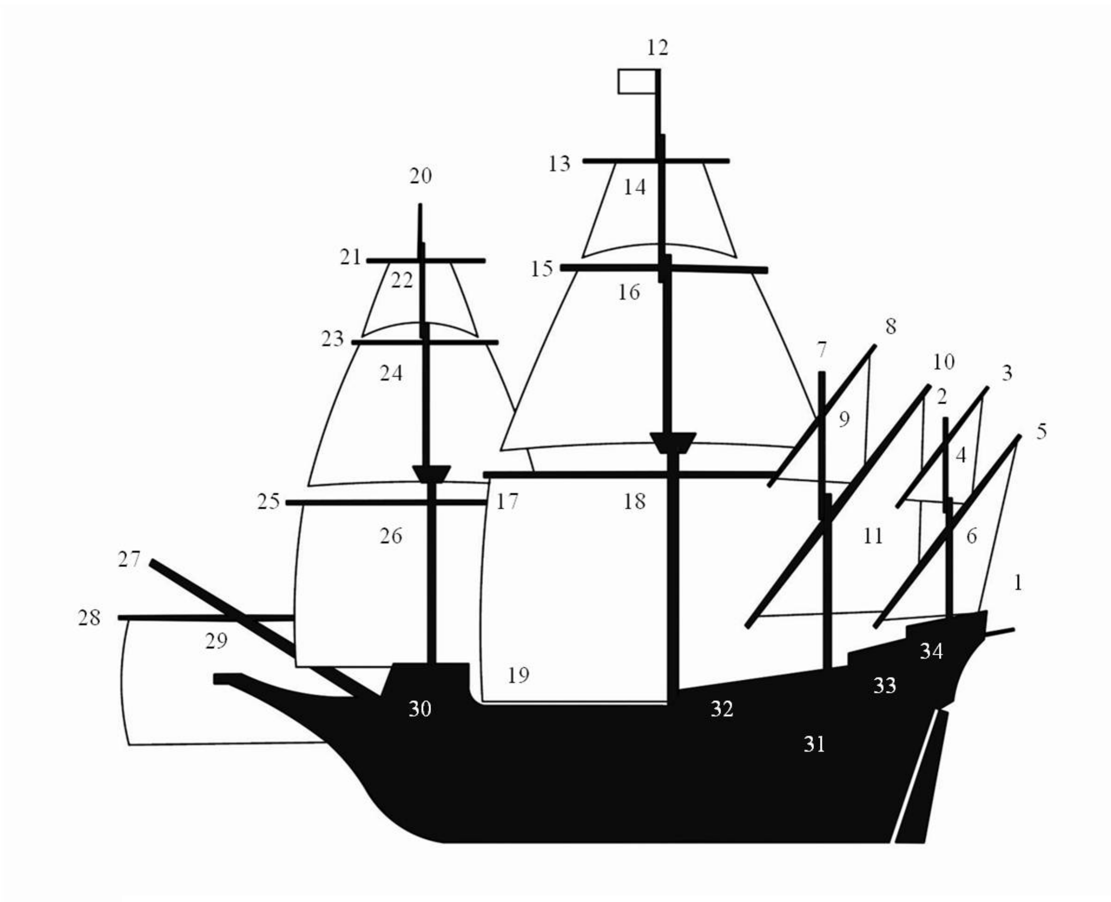
The primary sources used in this analysis are 16th- and 17th-century Spanish and Portuguese treatises including: the works of Diego García de Palacio; Manoel Fernandez; the *Livro Náutico* of unknown authorship; Tomé Cano; and Fernando Oliveria. Diego García de Palacio whose *Instrucción nauthica para el buen uso y regimiento de las naos, su traza y govierno* was the first Spanish treatise on shipbuilding published in Mexico in 1587 (Bankston, 1986). Although this is a general manuscript on navigation, the fourth book includes a section on the design of hulls, masts and spars, rigging, and sails that was particularly useful in this reconstruction.

The *Livro Náutico* is a late 16th-century compilation of manuscripts of unknown authorship regarding the organization of the regiment 1588 Spanish Armada vessels outfitted in Lisbon; of particular interest is the section concerning the building of a 500-ton India nau (Castro, 2005b: 110-111). The early 17th century (1616) *Livro de Traças*



1. Lateen Sail
2. Bonaventure Mast
3. Bonaventure Yard
4. Bonaventure Sail
5. Mizzen Mast
6. Mizzen Yard
7. Mizzen Sail
8. Main Mast
9. Main Yard
10. Main Sail
11. Square Sail
12. Fore Mast
13. Fore Topyard
14. Fore Topsail
15. Fore Yard
16. Fore Sail
17. Bowsprit
18. Spritsail Yard
19. Spritsail

Figure 2: Diagram of caravel masts, yards, and sails.



1. Lateen Sail
2. Bonaventure Mast
3. Bonaventure Topyard
4. Bonaventure Topsail
5. Bonaventure Yard
6. Bonaventure Sail
7. Mizzen Mast
8. Mizzen Topyard
9. Mizzen Topsail
10. Mizzen Yard
11. Mizzen Sail
12. Main Mast
13. Main Topgallant Yard
14. Main Topgallant Sail
15. Main Topyard
16. Main Topsail
17. Main Yard
18. Main Sail
19. Square Sail
20. Fore Mast
21. Fore Topgallant Yard
22. Fore Topgallant Sail
23. Fore Topyard
24. Fore Topsail
25. Fore Yard
26. Fore Sail
27. Bowsprit
28. Spritsail Yard
29. Spritsail
30. Forecastle
31. Sterncastle
32. Half Deck
33. Quarter Deck
34. Poop Deck

Figure 3: Diagram of galleon masts, yards, and sails.

de Carpintaria, attributed to the Portuguese shipwright Manoel Fernandez, details the construction of a variety of vessels and includes lists of dimensions for India naus (Fernandez, 1989). Tomé Cano's *Arte para fabricar, aparejar naos de guerra y merchant*, published in Seville in 1611, describes a nau of 12 *codos* of beam (6.90 m) including a dialogue on all the proportions required for good performance (Cano and Dorta, 1964). Padre Fernando Oliveria's *Livro da Fabrica das Naus* of 1580 is a translation of his Latin *Ars Nautica* (Barker, 1992a). Although no rigging is mentioned in this manuscript it was useful for defining the general appearance of naus.

Caravels

Historians agree that during the Portuguese explorations caravels had evolved into the three basic types: *caravelas latinas* with two, three, or four lateen-rigged masts as well as *caravela redondas* and *caravela de armadas* both of which were rigged with a square foremast (Elbl, 1985: 544). During the 16th century, the caravel as a ship type included these subtypes as well as the original small fishing vessels from which they evolved. Unfortunately, in modern scholarship the rigging configurations of caravels in general and the different subtypes in particular are overly generalized from the scant historical descriptions. The archival record rarely mentions constructional or technical details that are of interest to nautical archaeologists. To obtain this information, it is necessary to research the iconographic record, which explains why scholars present such varying and sometimes conflicting characteristics of caravels; they tend to view a select few images without regard to the whole range of data available. In essence, they are inferring the different caravel subtypes from only a few iconographic sources. Their conclusions are then projected onto different time periods in the development of this ship type. In reality, most of the characteristics described in modern literature are generally correct, but the small-scale application of the iconography to the historic record only provides only an approximate idea of the vessel without actually expanding our knowledge of the caravel. Modern scholars do not realize, or fail to emphasize, the fact that iconographical representations predominantly date to the 16th century, whereas the caravel developed and diversified in the 15th century. Therefore, an attempt will be made to not only clarify the constructional and rigging details of the various types, but also to accurately associate what is seen in the iconographic record to what is described in the archival documents.

Caravelões and *Caravel Pescarezas*

Two smaller caravels, *caravela pescarezas* and *caravelões*, are mentioned in the archival documents throughout the 15th and 16th centuries. These small caravels tended to be open boats with one mast and had a shallow draft that was useful for riverine and coastal commerce, qualities which quickly led to their adoption as exploratory vessels (Smith 1993: 38; Elbl and Rahn Phillips, 1994: 92). It is known that *caravela pescarezas* were introduced in the 13th century, were common to Portuguese fisherman by the early 15th century, and that their use continued into the 16th century (Elbl, 1985: 17-38). During the 15th century, the *caravelõe* was used in Portugal, the Atlantic islands, and off the coast of Africa. Adapted primarily for coastal sailing they reached East Africa and

India by the 16th century and also became the most common vessel on the Brazilian coast in the 16th century (Moura, 1991: 192).

Caravelões were small caravels of 40-50 tons with two or three lateen-rigged masts that had a single deck but in some cases had an added quarter deck thereby creating a sterncastle. Oars were used for auxiliary propulsion and *caravelões* could carry light artillery (Moura, 1991: 190; Elbl and Rahn Phillips, 1994: 95). The *caravelõe* is described in both the *Livro Náutico* and the *Livro das Fabrico das Naus*, and the latter illustrates both larger *caravelões* with castles and smaller versions without superstructures. According to the *Livro Náutico*, a very small *caravelõe* differs from the *caravela pescarezas* by the existence of a full-length deck (Elbl, 1985: 157).

Caravelas Latina

The lateen-rigged caravels, *caravelas latinas*, emerged in the 14th century as small one- or two-masted vessels of less than 30 tons with a single deck, and a length to beam ratio around 5:1 (Elbl, 1985: 25). Although the caravel grew larger from the onset of its use for the purposes of discovery in the 1430's until its decline during the mid 16th century, the initial *caravela latina* was most likely the size of the *caravela pescarezas* (Smith 1993:38). Historians have varied opinions about the characteristics of the typical *caravela latina* used for exploration in the 15th century. According to Barata (1989: 120), the *caravela latina* ranged in size from 25-50 tons, had two or three lateen-rigged masts, longer yards distinct to the Portuguese model, a low forecastle to accommodate the main yard passing over the stem, and was fully decked with two decks in the sterncastle and a flush main deck. Although Barata is considered the Portuguese expert on this subject, his description of two- and three-masted caravels having a low forecastle is a point of contention which will be discussed in the analysis of caravel forecastles. Other scholars maintain that two- and three-masted caravels did not have a forecastle and had a low sterncastle that ran nearly to the main mast (Elbl and Rahn Phillips, 1994: 92).

The diversification of the caravel began with the voyages of discovery and the *caravela latina* steadily grew in size through the 15th century reaching up to 180 tons; however, the "interplay in the proportions in caravel design did not allow for greater tonnage" (Barata, 1989: 120). The size of the caravel reflected a European trend, based on the decline of shipping in the mid- to late-15th century, that favored smaller, faster, and more versatile ships that required less time to load and unload and had access to numerous ports. This preference for smaller vessels lasted until about 1550 at which time there was a temporary shift to larger vessels and the use of caravels ebbed until their revival in the late 16th and early 17th centuries when the pendulum swung back to smaller vessels (Elbl and Rahn Phillips, 1994: 96).

The caravel did not remain a constant type and as the exploratory voyages progressed throughout the 15th century, the defects in the design and in the lateen rigging of the caravel were revealed. The lateen sails, all positioned in the fore-and-aft axis of the vessel, caused pronounced heeling in brisk winds. Likewise, the characteristic long yards made tacking a difficult process which the Portuguese eventually overcame by shortening the yards, setting them nearly upright, and hanging the yard permanently on the same side of the mast, thus eliminating the need to maneuver the yard over the masthead when coming about (Parry, 1966: 22; Elbl, 1985: 58). These changes to the lateen yards caused a loss of sail area, which was compensated by stepping another mast, and so the three-masted caravels appeared by the beginning of the 16th century. Parry (1966: 22) states that this third mast was the mizzen mast; thus, implying that the original two masts would be a main and a foremast. As discussed later in this chapter, however, the iconographic evidence contradicts Parry. A four-masted *caravela latina* is considered a natural, yet rare, variation of the rig based on the iconographic record (in particular on the *Lendas da India* by Gaspar Correia) (Elbl,1985: 165).

Caravelas Redonda and *Caravelas da Armada*

The long lateen yards of the *caravelas latinas* prohibited an increase in the number of lateen-rigged masts. This limitation in sail area was matched by a deficit in cargo capacity which became vital as voyages increased in distance and trade was established. As a result, three-masted *caravelas latinas* were replaced starting in the second quarter of the 16th century by the four-masted *caravela redonda*, a vessel characterized by a square-rigged foremast (Barata, 1989: 120). Although the limitations of an all lateen-rigged vessel were noticed by the 1480's, Elbl (1985: 162) maintains that the design trend set in after Bartolomeu Dias' 1486-87 voyage in which he used a caravel with a square foremast. Likewise, this rig was used by Columbus who re-rigged the *Nina* at the Canary Islands during his 1492 outbound voyage and Vasco da Gama during his 1502 voyage to India when he sailed east under square rig then reverted back to all-lateen once he reached the Indian Ocean (Edwards, 1992: 428; Elbl, 1985: 163; Elbl and Rahn Phillips, 1994: 93).

The *caravela redonda* was the dominant form of caravel through the 16th and early 17th centuries. It had one or two decks in the sterncastle; lateen-rigged bonaventure, mizzen, and main masts; and a square foresail and fore topsail (Barata, 1989: 120; Parry, 1966: 22; Elbl and Rahn Phillips, 1994: 93). The *caravela redonda* followed a change in the nature of the Portuguese voyages from explorations in the early- and mid-15th century to fleets of trading vessels in the Atlantic in the last decade of the 15th century and into the waters of the Indian Ocean as the 16th century started. These large fleets employed caravels as escorts for the larger cargo-carrying naus (Parry, 1966: 23).

The *caravela redonda* gradually transformed into the *caravela de armada* from its inception through to the early 17th century (Smith, 1993: 43). By the middle of the 16th century, Dom João II purposely placed artillery in the caravels, creating a type of warship that effectively displaced the galley (Barata, 1989: 120). The arming of caravels by Dom João II and others indicates that the *caravela da armada* was increasingly employed by the state as a defense vessel or scouting ship for convoys. The Portuguese distinguished an advise boat for transmitting orders as a *caravela mexeriqueira* (talebearer) which was a small vessel of 16 to 20 tons commonly used throughout the 16th century (Smith, 1993: 43; Elbl and Rahn Phillips, 1994: 97).

The *caravela da armada* was relatively larger than both the average *caravela latina* and *caravela redonda* with a length to beam ratio of 2.9:1 and a tonnage up to 200 tons (Barker, 1992b: 437). It had the same rig as the *caravela redonda*, however, with a square foresail, fore top sail, and lateen sails on the main, mizzen, and bonaventure masts (Elbl and Rahn Phillips, 1994: 97). The *caravela da armada* was modified to create a better artillery platform and had more beam to the length of the ship and a full sterncastle with more pronounced tumblehome which helped counteract the stability problems that arose with the introduction of heavy armament on decks (Smith, 1993: 43).

Galleons

Galleons are not mentioned as vessels used in the Portuguese discoveries; rather, they appear later in the 16th century when warships become vital to protect trade routes and distant territories. Portuguese galleons are depicted alongside caravels and the naus in the iconography and differentiating between these vessels is difficult (which is the basis for their inclusion in this study). For the purpose of this analysis, the galleons are considered auxiliary ships. To better understand the construction of caravels and naus, however, it is necessary to analyze the relatively few galleons in the dataset. Unfortunately, there is significantly less archival documentation for the Portuguese galleon than the caravel and nau. Only a few scholars who have written about 16th-century European galleons in general and the literature concentrates on English and Spanish galleons with a heavy emphasis on those used in the Spanish Armada in 1588. Despite the fact that the origins and evolution of the galleon are obscure, it is known that vessels called *galeones* were used on the southern and eastern coasts of the Iberian Peninsula as early as the 13th century and by 1530 the Iberians as well as the Italians used full-rigged galleons (Elbl and Rahn-Phillips, 1994: 99). By 1570, the term commonly designated what is now thought of as a typical galleon, but the precise specifications and meanings still varied by country (Guilmartin, 1994: 158). Although there were many national variants that arose in Europe in response to differing needs of individual countries, galleons were primarily used by the Spanish, Portuguese and Venetian mariners and had certain features in common including a strongly braced hull, a narrow stern, a forecastle lower than the typical nau, and a beak below the bowsprit belying its origins from the medieval galley (Elbl and Rahn-Phillips, 1994: 98-99). The durable galleon designed for use in open seas was the result of the same blending of northern and southern European shipbuilding characteristics that produced the full-rigged nau, as well as the caravel.

According to Barata (1989: 328), the Portuguese galleon is mentioned in the archival records for the first time in 1521 and represented in the iconography in 1519; he also contends that the Portuguese galleon is the first square-rigged ship conceived and built exclusively for warfare. Before 1550, only the tonnage of Portuguese galleons is mentioned in the archival documents and there is no technical data listed. Barata (1989: 330) maintains that the design of the galleon began between the end of the 15th century and the beginning of the 16th century and from that time on the galleons essentially did not change as these ships retained their proportions, dimensions, and methods of construction for a very long period of time.

The Portuguese originally conceived of the galleon as an instrument for warfare on the high seas far from naval bases, thereby producing a ship with proportions, dimensions, and features distinct from those of the nau and constructed along contemporary principles of design for warships such as galleys (Barata, 1989: 328). The Portuguese galleon was significantly longer, lower, and faster than the nau; however, it was slightly broader which could have allowed for more sail area or could have been a response to heavier armament that was intended to increase stability (Barker, 1992b: 438). According to Guilmartin (2002: 160), the galleon combined "the full-rigged ship's seaworthiness and maneuverability under sail with the war galley's effectiveness as a gun platform." There is no design relationship between the galleon and the galley, however, and the ship type has a similar nomenclature only because it fulfilled the warlike functions of the galley (Barata, 1989: 167).

Galleons ranged from 300 to 1000 tons and had a length to beam ratio of 3.2:1 to nearly 4:1 making it slimmer than the nau which had a 3:1 ratio. They were more seaworthy than the naus, however, and had more cargo capacity than the caravel (Guilmartin, 2002: 158-59). Portuguese galleons in general had a slightly smaller tonnage ranging in size from 200 up to 500-600 tons (Barata, 1989: 330). The galleon had two fully planked decks that carried artillery, a half deck, quarter deck, and a poop deck in the stern castle and a forecastle that was lower than after structure, giving the vessel a characteristic "crescent profile," and a prominent beak below the bowsprit. They were typically ship-rigged with a mizzen, main, and fore mast as well as a bowsprit; however, larger galleons were four-masted with the addition of a bonaventure mast aft of the mizzen (Guilmartin, 2002: 158). The bonaventure and mizzen were both lateen-rigged, while the main and fore carried square main sails and topsails to which topgallants were added in the 17th century (Elbl and Rahn-Phillips, 1994: 114). The existence of two lateen-rigged masts in the stern was not exclusive to the galleon and was also seen on naus beginning at the end of the 15th century, but it was much less common than the standard three-masted ship rig with only one lateen mast (Barata, 1989: 335).

The Confusion between Caravels, Galleons, and Naus

The general consensus is that both the galleon and the nau could have a three-masted ship rig or a four-masted rig with an additional bonaventure mast. To ascribe a ship type to any particular vessel in the iconography, it is necessary to look at hull form in addition to the rig. Vessels that have a three-masted ship rig with both high stern and forecastles are naus while those with a low forecastle and a prominent beak are galleons. Although the same criteria can be applied to the four-masted ships, it appears that it is more common for a galleon to have four masts as there are only a few naus with a bonaventure mast. Further compounding the problem is a claim by Elbl (1985: 166) that the presence of square sails on caravels started in the mid-15th century and gained popularity at the beginning of the 16th century. He also asserts that caravels could be rigged square on both the main and the fore masts and lateen on the mizzen and bonaventure masts (Elbl, 1985: 166). The basis for this “hotly disputed and frequently misrepresented” caravel variant is a ship in the port of Valenqa in Duarte D’Armas’ *Livro das Fortalezas* (1509) which has no forecastle, a low sweeping sterncastle, and no topmasts (Elbl, 1985: 166). The ship in question (designated as MA03.08 for this study), as well as a similar three-masted version in the same manuscript, MA03.09 (which appears to have a very small forecastle) have neither beaks nor other distinguishing characteristics for any of three ship types (Figures 4 and 5). They have been labeled galleons in this study because the hull and rig have little in common with naus, and there is no other precedent for square main sails on caravels. It is possible that these two ships represent a rare caravel variant, but they are both from the same source and there is nothing in the archival, iconographical, or archaeological records to corroborate the existence of such a caravel. Furthermore, there is no other ship that has a foremast and does not have a forecastle in the entire dataset. Rather, it is more likely that they are poorly rendered galleons or given the date of the manuscript (1509) there is a possibility that they are very early versions of the galleon.

Elbl and Rahn-Phillips (1994: 99) describe the true nature of the problem: hull forms and rig configurations of ship types in the 15th century were varied and flexible and not rigidly defined. Furthermore, the full-rigged ship developed along several paths, with each type meeting the particular needs and circumstances of the region or market it served. The late 15th and early 16th centuries were an innovative period for Iberian ship design, so it is not surprising that the early years of galleons as well as the exact relationship between ship types are not clearly known. There are differing opinions on the evolution of the galleon which has tremendous bearing on our understanding of the caravel and the naus. After years of studying iconography, professor Edward Garcia decided that the caravel was the direct ancestor of the Spanish galleon (Rahn- Phillips,

Figure 4: MA03.08. From *Livro das Fortalezas.*

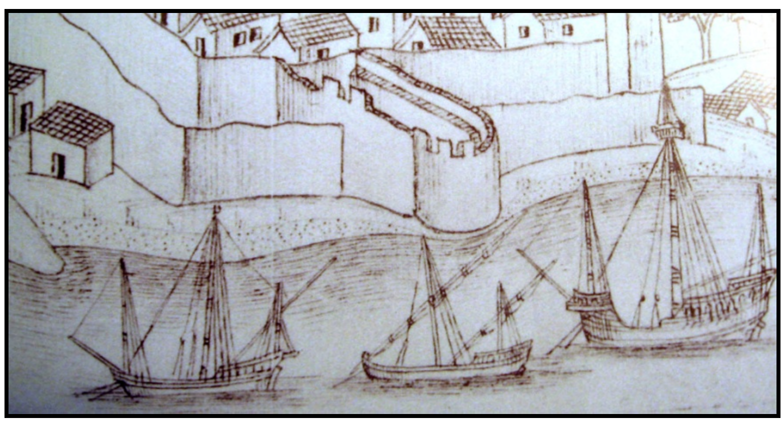


Figure 5: MA03.09 (Ship on Left). From *Livro das Fortalezas.*

1983: 7). Spanish galleons had a very similar profile to the caravel with the characteristic beakhead below the bowsprit but were considerably larger. According to Rahn-Phillips (1983: 7) in contemporary Spanish iconography there are vessels that could be either *caravela redondas* or small galleons in a map of the world sent from Seville to London in 1527. Likewise, in the Portuguese tapestry of Tunis (1535) there are similar galleons and caravels; however, this source was not included in the study because of the inherent limitations of tapestries as a material source and the way in which the ships are depicted did not allow them to be fully analyzed (Delmarcel, 1999:136). These sources provide more evidence that the ships shown in Duarte D'Armas' 1509 *Livro das Fortalezas* have a higher probability of being galleons than caravels or naus.

There are also proponents of the idea that galleons evolved from naus rather than caravels because some 14th-century Castilian *naos* lacked prominent forecastles (Rahn-Phillips, 1983: 7). Likewise, Barker (1992b: 438) states that it is often suggested that the Portuguese galleon was a modified nau designed more for warfare than trade. The problem of determining the evolutionary relationship between caravels, galleons, and naus will be explored throughout the representational trend and statistical analyses. Based on the limited information on galleons as a ship type and lack of consensus on how they relate to caravels and naus, it is essential that this study examines these three types together.

5.2 REPRESENTATIONAL TRENDS ANALYSIS OF RIGGING CONFIGURATIONS AND SAIL AND YARD SETTINGS

Caravel Rigging Configurations

The rigging of caravels is critical for defining this ship type. Caravels are distinguished from naus and galleons in the iconographic record primarily by their rig, profile, and the proportions of the castles. Furthermore, the rig configuration is considered the typological marker between the *caravela latina* with lateen rigged masts and the *caravela redonda* with its addition of a square rigged foremast. The *caravela da armada* is not as well understood, however, as some scholars interpret the name as indicating the presence of armament on board, while others consider it to be no more than a fleet ship with little difference from the *caravela redonda*.

In this examination of caravel rig variation, the bonaventure and foremast are the keystones of change. There are four basic rigging types present in this caravel dataset based on the number of masts and the combination of sail types. There are also a few rig configurations that are not common and possibly the product of artistic license; all configurations are listed individually in Appendix 6. There are 109 caravels (with all masts visible) in the representational trends dataset ranging in date from 1485 to 1616. These caravels are separated into four basic groupings based in rig types found in the iconography. The first rig type represents the small *caravela pescarezas*, while the second and third rig types are the traditional classification of *caravela latinas* and the fourth is the *caravela de redondas* and *caravela de armadas* (the distinction between the last two will be explored in as much detail as possible).

The relatively uncommon first rig type (N=2) is the one-masted caravel with a lateen main mast, believed to be a small fishing vessel or *caravela de pescada*. The two illustrations of this caravel are dated to 1509 and 1572, which indicates that it was retained throughout the 16th century (which is verified in the archival record). Although this caravel type was not used in the voyages of discovery, it was a precursor to later exploratory and trade caravels.

It is more likely that the second rig type, the two-masted caravel (N=39) with a lateen-rigged mizzen and main mast, represents the first caravels used and adapted for exploration. The two-masted caravels illustrations are from 11 different sources with a date range of 1500-1598; nine of these sources date before 1535 (principally 1510-1530). The other two sources are from the last three decades of the 16th century. There is gap in representations of two-masted caravels between 1535 and 1572. There is a high probability that this gap is explained by the ending of the century of the caravel (1430's to the 1530's) and the resurgence of caravel use in the 1570's when smaller ships once again became popular (Elbl and Rahn Phillips, 1994: 96). There is an atypical variant of this rig with a lateen main and foremast; however, this rig is only seen on one ship. The iconographical evidence shows that 97.4% (38 out of 39 vessels) of the two-masted caravels have mizzen and main masts, which are clear indications that Parry was incorrect in his statement that the third mast added was a mizzen (Parry, 1966: 22). The iconography conclusively shows that first mast was the main mast while the second mast added was the mizzen.

The third rig type is three-masted caravels (N=13) with lateen-rigged bonaventure, mizzen, and main masts. Again, it should be noted that the Parry's argument is flawed as the third mast added was the bonaventure and the foremast appears only much later with the four-masted rig. The three-masted caravels are from seven sources with a date range of 1500-1588 and corroborate the pattern discussed for the two-masted caravels: five sources date before 1540 and two sources are from 1572-88. This again appears to agree with the archival record of the historically known period of use, retirement, and re-use of smaller caravel types. There is one variant of the three-masted caravel rig (N=1) with a lateen mizzen and main mast and a square foremast from the 1538-1540 *Roteiro de Joao Castro* (MA13.16); the fore yard is significantly shorter than the lateen-rigged yards and the sail is depicted as square. Although this source is considered generally reliable, it is not possible to ascertain whether the artist was showing a valid rigging configuration or made an error. Another three-masted caravel illustration found in the 1616 *Livros das Tracas de Carpentaria* (MA20.02) shows a vessel with a mizzen, main, and foremast, but this was excluded from the primary representational trends analysis of the third rig type. This ship illustration depicts the openings of the masts through the deck planking but not the masts themselves, and so it is not possible to determine if they were lateen or square rigged. The later date of this manuscript and lack of other 17th-century comparisons in the dataset demand a cautionary approach to the analysis of MA20.02.

The fourth type is the typical rig of the *caravela redonda* which is a four masted caravel with lateen bonaventure, mizzen, and main masts and a square fore and fore topmast. This group was subdivided into caravels with a square fore topmast (N=47) and those without (N=5) in an attempt to determine an approximate date for the introduction of the fore topmast. The four-masted caravels without a square fore topmast are from four sources with a date range of 1500-1565, while those with a square fore topmast are from 14 sources with a date range of 1485-1593. It is apparent from the number of caravels without a fore topmast represented in different sources that this is probably a valid rigging configuration and not the product of artistic license. Likewise, the overlapping date ranges suggest that they co-existed with the addition of a fore topmast being the normal rig and the exclusion of the topmast being a less common variant. Of the 18 different sources for both types together, there are 16 which date after 1538 to 1543 and the other two date from 1485 to the early 16th century.

When we examine the date ranges of the later sources, we find eight vessels from 1538-1566 which indicate that these larger mixed rig caravels were introduced and utilized during the 16th century's intermediary period when larger ship types dominated, but before the preference for smaller ships was once in vogue. Thus, it appears that these ships did not disappear and were, in fact, used through the 16th century.

The two earlier sources depicting four-masted caravels are more difficult to explain. The first source dated to 1485, *Il Compasso de Navigre* (MA01), is an Italian source depicting a Portuguese caravel which is identified by a flag on the main mast with the characteristic cross of the Order of Christ (Figure 6). The hull of the ship is fairly stylized and more representative of an Italian *cocha* with a straight stem. However, as it was depicted with a rare perspective view of the bow it is difficult to discern whether

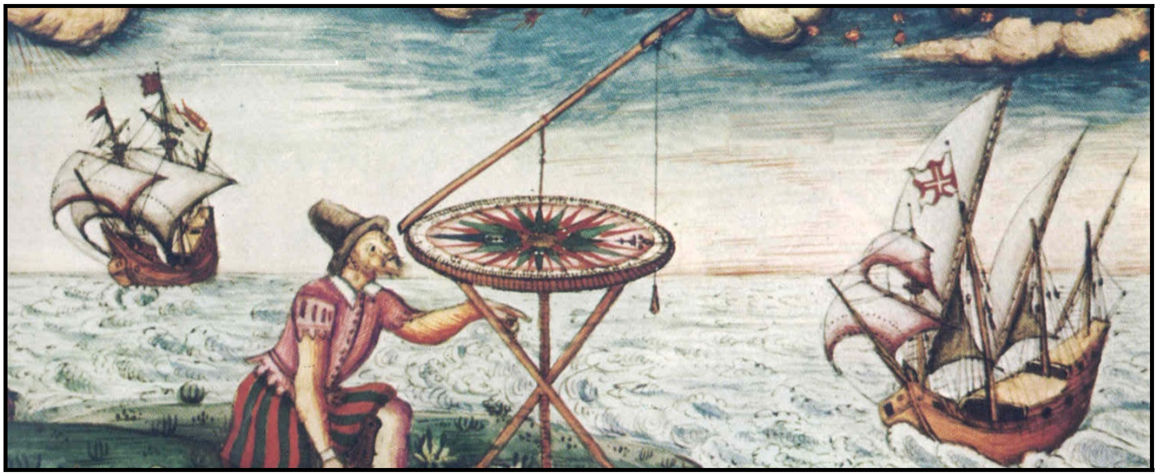


Figure 6: MA01; the caravel (MA01.02) is shown on the right. From *Il Compasso Da Navigre*, 1485.

this is the source of stylization or if the artist used what he knew best, the hull of the *cocha*, and added the identifying features of the Portuguese rigging and flag. Similarly, the nau shown in the background would normally be described as a *cocha* if it were not for the rigging. The decision to include this source was heavily debated and based on the possibility of finding more iconography of caravels dating to the 15th century for comparison of the hull. Until then, this source is considered ambiguous. The second source is the Portuguese manuscript *Leitura Nova* (MA06) dated between 1500-25; however, given that it could not be dated more precisely, it is possible that this is an early representation of the rig.

There is a variant of the four-masted caravel (N=1) with a lateen rigged bonaventure, mizzen, main, and foremast. This rig only occurs on the caravels (CA27.05) in a Linschoten print of Angra Bay on the island of Terceira in the Azores which is dated to 1583-88. I believe this is artistic error rather than an actual variation of rig type, but it is possible that this type of four-masted all-lateen caravels existed but were not popular.

The iconography provides a more defined timeline for the introduction and primary use of these different caravel rig types. Based on rig types alone, it is evident that the one-masted caravels are the *caravela pescarezas* and the three-masted caravels are the *caravela latinas*; however, it is not possible to distinguish between the two-masted *caravela latinas* and potential *caravela pescarezas* or *caravelões* as well as between the *caravela redonda* and the *caravela da armada* without viewing the presence or absence of castles, the shape of the stem, and the constructional proportions.

Caravel Sail and Yard Settings

Sail and yard settings of the caravels, galleons, and naus are absent from the literature, yet this information is vital to our understanding of the ship rigs. It is unlikely that this sort of data could ever be provided by a reconstructed shipwreck. Determining typical sail and yard settings lends a greater understanding of how the ships sailed, but also their favorable sailing qualities or potential deficiencies. Analysis of sail and yard settings is structured by the different rigging configurations for all the ship types. For each vessel, it is also correlated with the position of the yard (raised or lowered), the sails (furled or unfurled), and the context of the ship itself (anchored, sailing, in battle, or wrecking). Only the vessels with every mast, yard, and sail (including the bowsprit) showing were used in the analysis. As such, the sample size is less than that of the rigging configuration analysis. It is often easy to infer the presence of a yard by seeing only the yardarms; yet, without a visible sail it is impossible to conclude whether it is furled or unfurled. Determining the presence or absence of the upper sails is even more complicated since these spars are usually short and it is difficult to determine whether they are shown with furled sails on the yard or if the yards had no sails bent on at all. When possible (particularly for the lower masts) it is indicated if there is no sail set on the yard.

The entire representational trends analysis for caravel sail and yard setting can be viewed in Appendix 7. The analysis is also presented as groups of settings in Appendix 8, which are labeled by the number of masts, the type of ship, and the setting (i.e., the designation 1C-1 is for the first setting group of the one-masted caravels). The largest groupings of sail and yard settings for each ship type are illustrated in figures throughout the chapter. These are the vessels chosen from the iconographic record to represent individual groups.

A total of 108 caravels were used in the representational trends analysis of the sail and yard settings. These produced larger groupings because lateen yards are nearly always raised and the upper spars are usually limited to the square-rigged masts. Additionally, the caravel’s relatively simple rigs generate far fewer options in rig settings whereas the more complex galleons and naus are divided into many smaller groupings due to minute changes. In general, there is a clear and logical division between ships at anchor and those that are sailing. The artists consistently depict vessels under sail with waves lapping alongside the ship even when the sails are not visibly filled with air, while those at anchor often have anchor cables extending forward of the bow or no sails raised.

The one-masted caravels (N=2) were easily separated into the ship at anchor (1C-1) with furled lateen main mast and the vessel (1C-2) under sail (Figure 7). The two-masted caravels (N=40) at anchor are divided into four groups with exactly half the sample represented at anchor and the other half under sail. The largest grouping (2C-4) shows 17 caravels with both the mizzen sail and the main courses furled and raised, which is the most common anchorage setting (Figure 8). One vessel (2C-2) has both yards lowered and another (2C-3) has the mizzen yard raised and the main yard lowered. The third caravel (2C-1) has a lateen-rigged main mast and foremast; however, there are no yards or sails on either mast. Although the absence of yards and sails are rare in this

Figure 7: One-masted caravel under sail (1C-2). From *Livro de Fortalezas*, 1509.

Figure 8: Two-masted caravels under sail (2C-6) and at anchor (2C-4). From Brauni's *Civiatis Orbis Terrarum*, Vol. 1, 1572.

Figure 9: Two-masted caravels under sail (2C-5). From *Retable de Santa Auta*, 1520.

dataset, they do exist for each ship type. It is unknown if this is factual and the yards and sails were removed or if the yards were actually lowered and the artists mistakenly depicted them otherwise. It is unusual to have every yard removed from a ship and, in particular, lateen yards, which were far more difficult to handle due to their extraordinary length. There is only one other ship, a nau, which is missing the lateen yard from the mizzen mast.

The two-masted caravels under sail are fairly evenly divided between two groups with a third variant (2C-7) which does not have a yard or sail on the mizzen, but the main sail is unfurled and raised. The largest group (2C-6) with 10 vessels has both the mizzen and main lateen sails unfurled and raised while the second group (2C-5) with nine vessels is sailing only under the main course (Figures 8 and 9). The three-masted caravel illustrations (N=14) show only three vessels at anchor and the remaining 11 are under sail. Those at anchor formed a single group (3C-1) with the bonaventure, mizzen, and main mast yards raised and the sails furled (Figure 10). There are five groups of vessels under sail, the largest of which 3C-2 (Figure 11) is comprised of five vessels sailing under the main course with the bonaventure and mizzen yards raised and the sails furled**.** There are two vessels (3C-3) with the mizzen and main yards raised and the sails unfurled, one ship (3C-4) with the bonaventure and main yards raised and the sails unfurled, and the remaining two (3C-5) sailing under the bonaventure, mizzen, and main sails (Figures 12 and 13).

The four-masted caravels (N=52) are divided into three different rigging configurations and altogether have 26 groupings. There are six groups at anchor, one

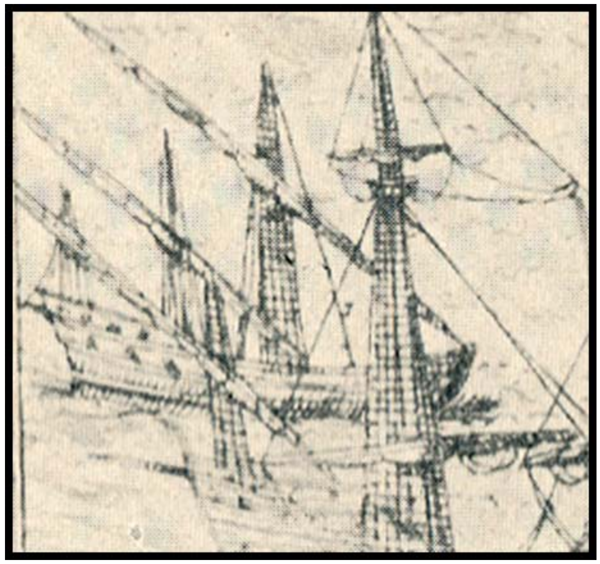


Figure 10: Three-masted caravel at anchor (3C-1); in background.
From Brauni's *Civiatis Orbis Terrarum*, Vol. 1, 1572.

Figure 11: Three-masted caravel under sail (3C-2). From Lopo Homem-Reneis' Atlas Miller, 1519.

Figure 12: Three-masted caravel under sail (3C-3). From *Chronica de Dom Afonso Henriques*,1515-1525.

Figure 13: Three-masted caravel under sail (3C-4). From Brauni's *Civiatis Orbis Terrarum*, Vol. 1, 1572.

group is a combination of ships at anchor and in battle, three groups are in battle, one group is a combination of ships in battle and under sail, and the other 15 groups are under sail. Due to the large number of groupings in this section only the largest representing the three categories (at anchor, under sail, and in battle) will be discussed; the remaining groups can be viewed in the respective appendices. The first rigging configuration is a caravel at anchor (4C-1) which is rigged with lateen sails on the bonaventure, mizzen, main, and fore masts; all yards are raised and sails are furled including the bowsprit.

The second rigging configuration is the four-masted caravels with three lateen masts and a square fore mast which has one group at anchor (4C-2) with the bonaventure, mizzen, and main yards raised and the sails furled, but the fore yard is only half raised and there is no spritsail or spritsail yard. Seven caravels have half-raised main yards, two have half-raised fore yards, and three have both spars half-raised; altogether, the practice of leaving the main and fore yards half-raised when at anchor accounts for roughly 11% of the dataset indicating that it was a common practice. The remaining three caravels of the second rigging configuration are under sail; these caravels have all four yards raised and sails unfurled and are separated by the presence of an unfurled spritsail in one group (4C-3) and the absence of spritsails and its yard in the other (4C-4).

The third rigging configuration is the four-masted caravels with a lateen-rigged bonaventure, mizzen, and main and a square-rigged fore and fore topmast. There are four groups at anchor, which have the lateen yards raised and the sails furled. The difference between these groups is the setting of the fore and fore topmasts yards. Three of the groups have the fore yard half-raised and fore course furled. The fourth group (4C-11) has the fore yard completely raised, the fore topyard lowered, and both sails furled (Figure 14). Of the first three groups at anchor (all have the fore sails furled); the fore topyard is raised on one (4C-9), half-raised on a second (4C-10), and lowered on the third (4C-8). There is no predominant setting of the fore mast yards for the anchored caravels in this rigging configuration which foreshadows the settings of all foremast yards in the iconography.

There is one group (4C-5), which has one ship at anchor and another in battle with the same sail and yards setting (Figure 15). The bonaventure and fore yards are raised and the sails furled, while the fore topyard is lowered and the sail furled; there is no spritsail or corresponding yard. Interestingly, the mizzen and main courses, which are in the process of being furled, are depicted with men on the yards taking in the sails; there are no foot ropes (which are a 17th-century invention) and the men appear to be straddling the yard at seemingly impossible angles. The furling of sails is seen in two other groups of caravels in battle. The first group (4C-7) has a raised bonaventure, mizzen, and fore yard with furled sails and a lowered fore topyard with a furled sail; the main course is in the process of being furled by men atop the yards. The second group (4C-6) has the mizzen and main course being furled, a bonaventure yard that is raised with the course furled, a lowered fore topyard with a furled sail, and a half-raised fore yard with an unfurled sail. The last group of caravels in battle (4C-13) has raised bonaventure and mizzen yard with furled sails, a lowered fore topyard with a furled

Figure 14: Four-masted caravel at anchor (4C-11). From *Roteiro de Joao Castro*, 1538-1540.

Figure 15: Four-masted caravel in battle (4C-5). From *Memória das Armadas*, 1566.

topsail, and a main yard that is raised with a furled course, as well as a half-furled fore course on a half-raised fore yard. The half-furled sails appear to be brailed and hanging from half-raised yards and only the fore courses are resting on the forecastle while the main courses are suspended off the deck. This vessel is from the 1524 fleet of the *Livro de Lisuarte de Abreu* (MA15) and this sail setting, including the lateen sails, is repeated throughout all the ships in battle on the two folios representing that year (Abreu, 1992).

Although the caravels under sail are separated into 13 groups, two groups account for 52% of those in the third rigging configuration; hence, these are the most common sail and yard settings. The largest group (4C-19) has 11 caravels sailing under a mizzen and main course with a raised bonaventure and fore yard with furled course, a lowered fore topyard with a furled topsail, and no spritsail or spritsail yard (Figure 16). Whereas the second largest group (4C-15) of five caravels is sailing under the main and the fore course with raised bonaventure and mizzen yard with furled sails, a lowered fore topyard with a furled topsail, and no spritsail or spritsail yard (Figure 17). The remaining 11 groups are populated by one or two vessels each and vary mostly in the sail and yard setting of the fore mast and the fore topmast (Appendix 8). This general trend of a few common sail and yard settings with several variations is continued in the three- and four-masted galleons and naus. The amount of variation in the sail and yard settings is further increased by the presence of bonaventure and mizzen top masts as well as main and fore topgallant masts.

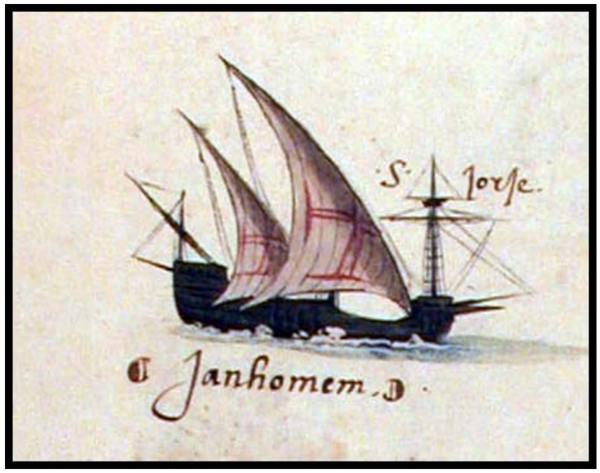


Figure 16: Four-masted caravel under sail (4C-19). From *Memória das Armadas*, 1566.

Figure 17: Four-masted caravel under sail (4C-15). From *Memória das Armadas*, 1566.

Galleon Rigging Configurations

There are 34 galleons in the representational trends dataset ranging in date from 1500 to 1616, which are separated into two basic groupings based on rig types found in the iconography. The galleons as well as the variants of the rigging configurations are listed in Appendix 9. The first rig type is the three-masted galleon (N=14) with a lateen-rigged mizzen and square-rigged main and fore masts. In contrast to Barata's claim that the galleon was first depicted in 1519, the date range of the images is from 1509 to 1616. These three-masted galleons were identified based on the presence of a prominent beak, lower castles, and a crescent-shaped profile. Of the three-masted galleons, four ships have a lateen-rigged mizzen and square-rigged main and fore masts, but do not have any upper masts. This appears to be a common configuration as the illustrations date from 1509-1574 and are from three different sources. Additionally, there are seven galleons (from five different sources) which have the typical ship rig including a main topmast and a fore topmast. There is also one galleon from a source dated to 1519 with a fore topmast, but without a main topmast. It seems much more common for the main topmast and fore topmast to appear together and this variant may be simply artistic error. The galleons with upper masts appear in 1519 and are consistent in the iconographic record through the end of the 16th century. There is only one galleon, dated to 1552, that has a lateen-rigged mizzen topmast along with square-rigged main and fore topmast. The presence of a mizzen topmast is rare for the entire data set and it is present on only one other galleon in the four-masted group. In the 1616 *Livros da Tracas da Carpentaria*, there is one three-masted galleon (MA20.02) and another four-masted galleon

(MA20.03) that do not have masts present. On the first image, there are only openings on deck for the mizzen, main, and fore mast while the second image has partial lower masts.

The second rig type is the four-masted galleon (N=20) with lateen-rigged bonaventure and mizzen masts and square-rigged main and fore masts. The most common rig configuration of this group also includes main and fore topmasts (N=11). This standard four-masted rig is seen in the iconography starting with an image dated to the first quarter of the 16^{th} century and continues throughout the century. There is one four-masted galleon from 1519 that does not have any upper masts and another dating at the beginning of the 16^{th} century that only has a main topmast, but not a fore topmast. It appears that smaller four-masted galleons were used in the beginning of the 16^{th} century with minimal use of upper masts. Starting in the third and fourth decades, the larger typical rigging configuration dominated through the end of the century.

The remaining four-masted galleons (N=6) have more complex rigs with the varying presence of main and fore topgallants as well as bonaventure and mizzen topmasts. Topgallant masts are only present on six galleons, three of which only have a main topgallant while the other three have both main and fore topgallants. The first use of topgallants on galleons dates to 1538, but their presence seems to be common throughout the 16^{th} century. Of the three galleons with both main and fore topgallant masts, two have lateen-rigged mizzen topmasts and one also has a bonaventure topmast. Lateen-rigged mizzen topmasts are present on three galleons and have a date range from 1538 to 1558 coinciding with the intermediate period of preferred large vessel use. The bonaventure topmast is only found on one galleon from 1538 to 1540 and with its mizzen topmast and main and fore topgallant masts seems to represent by far the most complex rig of the entire dataset.

Galleon Sail and Yard Settings

The sail and yard settings for the galleons are highly variable and unlike the caravels and the naus there is no clear dominant group; rather, the settings are essentially individualized to the particular ships. There were 23 galleons used in the representational trends analysis of the sail and yard settings which are listed individually in Appendix 10 and by groupings in Appendix 11. There are four different rigging configurations for the three-masted galleons and a total of 10 groups. Nine of these groups are single ships with specialized sail and yard settings and the tenth has a population of three galleons. The first rigging configuration has galleons at anchor with lateen-rigged mizzen and square-rigged main and fore masts. The first galleon (3G-1) has a lowered mizzen and fore yard with furled sails and a furled spritsail; however, the main course is half-furled and half-raised. This ship (C14.04) is oddly depicted with the main course resembling a lateen sail. Nonetheless, the presence of halyards attached to both ends of the yard, a feature found only on a square sail, excludes such a possibility. While it is a standard modern practice while at anchor to set one aft sail, whether fully or only partially unfurled, in order to keep the vessel pointing into the wind and thus reducing the chances of broadside waves rocking the ship, this vessel has conflicting details and seems to be the product of artistic license and should be disregarded as a valid rigging variant. Two other galleons have all the sails furled and no spritsail evident and vary in the positioning of the yards. The first (3G-4) has all raised yards while the second (3G-2) has a raised mizzen, half-raised main, and a lowered fore yard. The last galleon in this rigging configuration (3G-3) has a raised mizzen yard, lowered main yard, and does not have a fore course or fore yard set.

The second rigging configuration for the three-masted galleons which have the addition of a fore topmast consists of one vessel that is sailing under the main course only and has a raised mizzen yard with a furled sail and a lowered fore yard and fore topyard with furled sails. The third rigging configuration is the typical ship rig and is comprised of five groups of galleons depicting vessels at anchor, in battle, and at sea. There is only one galleon at anchor (3G-6) which has raised mizzen and spritsail yards with furled sails, half-raised main and fore yards with furled sails, and lowered topyards with furled sails (Figure 18). The galleon depicted in battle (3G-7) is fighting under all sails except for the mizzen and the spritsails, which are furled (Figure 19). This sail and yard setting is fairly consistent with the one caravel in similar circumstances which has all sails unfurled (Figure 14). The three-masted galleons in the last two groups are all sailing under the mizzen and main courses, but differ in the setting of the fore mast and fore topmasts. The most common sail and yard setting (3G-8) has the fore course unfurled and the topyards lowered with furled sails; there is no spritsail (Figure 20). The galleon in the second group (3G-9) is sailing under the main topsail in addition to the mizzen and main course, but has a lowered fore topyard with a furled sail and is missing the fore yard altogether. The last rigging configuration for the three-masted galleons is

Figure 18: Three-masted galleon at anchor (3G-6). From *Lendas Da India de Gaspar Correa*, 1538-1550.

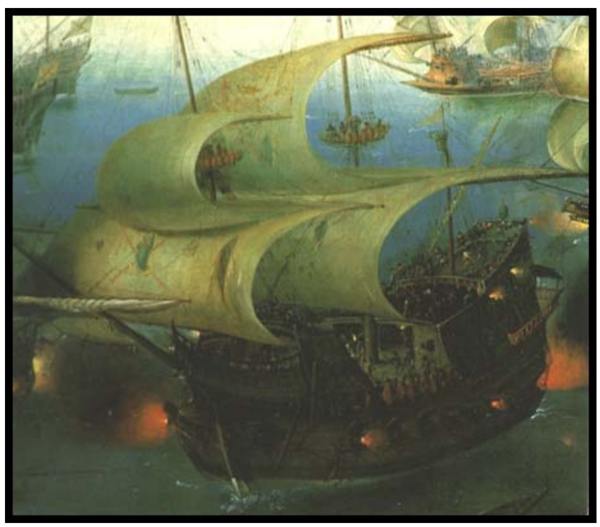


Figure 19: Three-masted galleon in battle (3G-7). From Vroom’s Portuguese Galleon, 1593.

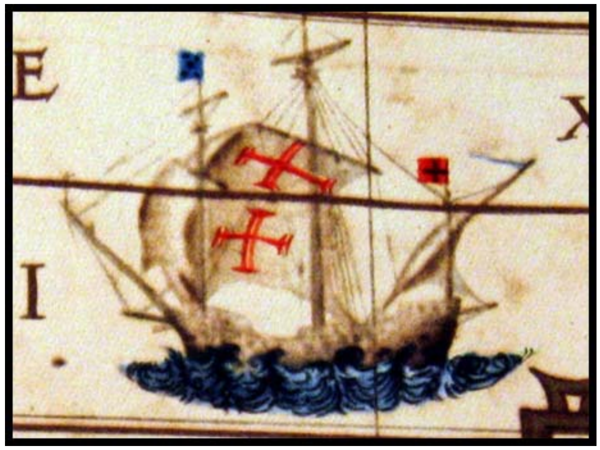


Figure 20: Three-masted galleon under sail (3G-8). From Lopo Homem-Reneis' Atlas Miller, 1519.

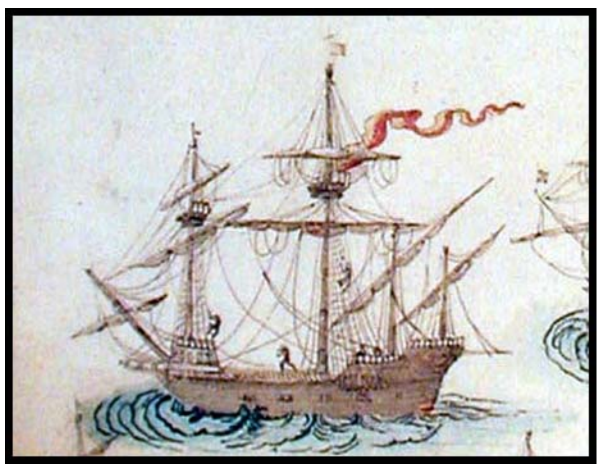


Figure 21: Four-masted galleon at anchor (4G-3). From *Roteiro de Joao Castro*, 1538-1540.

comprised of a single vessel which has a mizzen topmast. This galleon (3G-10) is sailing under the mizzen, main, and fore courses, as well as the main and fore topsails; however, the mizzen topsail and the spritsail are furled.

The four-masted galleons are equally individualized and there are seven different rigging configurations separated into 14 groups; 13 groups consist of a single ship and the last group has four galleons. As such, the sail and yard settings for the four-masted galleons will be considered as a single group and discussed together. Of the four-masted galleons at anchor, only one vessel (4G-1) has an unfurled sail (the main course) and on all other galleons the sails are furled. The bonaventure and mizzen lateen yards are raised while the topyards and topgallant yards are predominantly lowered. There are four groups (4G-2,4,5, and 10) which have the main and fore yards half-raised while the rest of the groups have these yards completely raised (4G-3; Figure 21). There are two four-masted galleons engaged in battle, one (4G-9; an English galleon) is fighting under all sails while the other (4G-6) only has the main and fore courses and the main topsail unfurled (Figure 22).

There is only one four-masted galleon (4G-8) that is sailing under all sails, while the rest have a varying combination of different sails unfurled. Three galleons are sailing under the bonaventure sail and fore course, two of which also have the main course (4G-11) and the main topsail (4G-13) unfurled. The last four-masted galleon (4G-7) has a sail setting that is strikingly different from the other galleons with only the bonaventure sail and fore course unfurled and the mizzen yard and main and fore topsail yards raised (Figure 23).

Figure 22: Four-masted galleon in battle (4G-9). From the Painting of the Spanish Armada in the National Maritime Museum, end of the 16th century.

Figure 23: Four-masted galleon under sail (4G-7). From *Mapa de Diogo Homem*, 1558.

Nau Rigging Configurations

There are 292 naus in the representational trends dataset ranging in date from 1485 to the end of the 16th century which, like the galleons, are separated into two basic groupings based on rig types and variants within the combination of sail types (Appendix 12). Only naus that have every mast visible, or where the presence of every mast could be inferred from a partial sail or yard, have been included. The analysis was more problematic for the naus than the caravels and galleons as there are proportionally more examples with sails obscuring the masts.

The first type are the three-masted naus with the typical ship rig (N=250) with a lateen-rigged mizzen mast and a square-rigged main mast, main topmast, foremast, and fore topmast. The date range of the images, from 1485 to 1600, shows its consistent usage throughout the period of study. There are two naus from the *Livro de Fortalezas* of 1509, which do not have a main and fore topmast and 16 naus with only a main topmast mast and not a fore topmast. Four of these naus without a fore topmast, which are from two different sources dated to 1509 and 1510, only have the main topmast but do not have an associated topsail yard or rigging for a sail, while the other 12 naus have a main topmast and date from 1509 to 1547. From this evidence, it appears that vessels with a rigged main topmast were common throughout the first half of the century and the unrigged main topmast was an early variant soon abandoned for the advantages of having a main topsail. The fore topmast appears to have a similar start as it is unrigged on four naus dating from 1517 to 1579; however, during the same time period, it is a part of the ship rig as well as the more complex variants.

Main and fore topgallant masts are present on only one nau from 1525. Three other naus dating from 1535 to 1570 have only the main topgallant mast; two of these vessels also do not have yards on the fore topmast. Additionally, there are two naus that have both main and fore topgallants as well as a mizzen topmast, which is lateen rigged on the nau from 1535-70. The other nau, from 1573-1603, is depicted without yards and is considered a product of artistic license or error. Topgallant masts are present on six galleons, three of which have only a main topgallant and the other three have both main and fore topgallants. The first use of topgallants on naus (1525) predates the galleons by a decade. Although they are seen throughout the 16th century on both ship types, they do not appear to be common. It is important to note that it was previously thought by Carla Rahn-Phillips that topgallants were introduced in the 17th century which is clearly not the case in Portugal (Elbl and Rahn-Phillips, 1994: 114).

Two naus from 1582 to 1590 are entirely square-rigged with a mizzen mast, mizzen topmast, main mast, main topmast, and fore mast. There is one other nau with a square-rigged mizzen and mizzen topmast from 1595, another with a lateen-rigged mizzen and square-rigged mizzen topmast from 1573-1603, and two naus with lateen-rigged mizzen and mizzen topmasts without yards from 1588 to 1598. All of these have square-rigged main masts, main topmasts, fore masts, and fore topmasts. Two galleons (dated to 1552 and 1589) have lateen-rigged mizzen masts and topmasts. It is clear that the combination of lateen-rigged lower mizzens and either an unrigged, square-rigged, or lateen-rigged mizzen topmast is more common and dates to the second half of the 16th century. The use of a square sail as a course on a mizzen mast is a rare occurrence dated to the end of the 16th century and was possibly an errant configuration as an entirely square-rigged mizzen would negate the inherent effectiveness of the lateen-rigged mizzen mast to change the tack. Likewise, both sources are dated closely together and are from two Portuguese cartographers, which suggests the possibility of copying.

The second rig type is the four-masted nau with the majority (N=6) with lateen-rigged bonaventure masts and mizzen masts and square-rigged main masts, main topmasts, foremasts, and fore topmasts all dating from 1519 to 1568. There are two variants of the four-masted nau, one without a fore topmast from 1510 and one without a main and fore topmast from 1558-1561. Nonetheless, the latter is likely the product of artistic error as it was depicted at the top of the page and the artist appears to have run out of room for the upper masts. Moreover, this rig variant is not supported by any other source and it is the only four-masted vessel in the manuscript.

The three-masted ship rig was consistently used throughout the 16th century. The three-masted variants with simpler rig configurations date to the first four decades of that century, the more complex rigs to the last three decades, and there was an intermediate period where the only major change is the addition of topgallant masts. Four-masted naus, however, are split between the 1510-20's and the 1550-60's suggesting that this larger nau was an experiment during the early period of large ships before the 1530 to 1570 period when larger ships were preferred and again near the start of the later period. The three-masted naus and both the three-masted and four-masted galleons do not follow this pattern of preference; hence, it is likely that the versatility of the ship rig could accommodate a very wide range of tonnage and vessel types. Likewise, there is relatively little deviation within the rigging configurations of naus; the variants account for only 13.2% of the sample.

Nau Sail and Yard Settings

The three-masted naus were similar to the caravels in their sail and yard settings, for the majority exhibited a high degree of consistency. This was not true, however, for the more complicated rigs with topgallant masts, which along with the four-masted naus are highly irregular like the galleons. There were 227 naus used in the representational trends analysis of the sail and yard settings. These are listed in Appendix 13 by individual ships and in Appendix 14 by groupings. There are eight different rigging configurations for three-masted naus the first of which (3N-1) is a single vessel without any topmasts. This nau is anchored with only the mizzen yard raised and its sail unfurled, a setting which assisted in controlling the direction of the moored vessel, while the main and fore sails are furled and the yards are lowered.

The second rigging configuration has an additional main topmast and is separated into eight different groups, three of which are anchored and the remaining five are under sail. The most common sail and yard setting for naus at anchor (3N-4) consists of five vessels which have raised lower yards with furled sails, a lowered main topyard with furled sails, and no spritsail. While all the vessels are sailing under the main and fore courses, only four of the five naus have the mizzen course unfurled. Furthermore, two out of three with main topmasts have the main topsail unfurled. The group with the highest population (3N-8) is comprised of two naus sailing under all the sails except for the spritsail which is furled.

The third rigging configuration associated with 53 different sail and yard settings is the standard ship rig. There are 19 groups of naus at anchor, two of which represent the most common settings. The first group (3N-15) consists of 12 naus which have all sails furled, differently positioned yards, and no spritsail (Figure 24). Here, the mizzen yards are raised, while the main and fore yards are half-raised and the topyards lowered. The second group also has all of the sails furled while the mizzen, main, and fore yards are raised and the topyards are lowered. There are two naus at battle, one of which (3N-36) has the main and fore yards raised and sails set while the rest of the yards are raised and the sails are furled. The other nau (3N-31) is fighting with only the main and fore courses unfurled and brailed on half-raised yards while the mizzen yard is raised and the rest of the yards are lowered (Figure 25).

The naus depicted under sail are numerous and exhibit a large degree of variation with a total of 151 vessels in 33 groupings. Only those groups which account for over 5% of the total sample are described here; the remaining variants can be found in Appendix 13. The largest group (3N-63) consists of 47 naus sailing under all sails including the spritsail while the second largest group (3N-40), with 19 naus, has a furled fore topsail and lowered topyard and a furled mizzen course and raised yard (Figures 26 and 27). The next largest group (3N-49) is comprised of 11 naus sailing under the lower courses while the topsails are furled with lowered yards; there is no spritsail (Figure 28). The next group (3N-57) includes 10 naus with all sails unfurled and yards raised with the

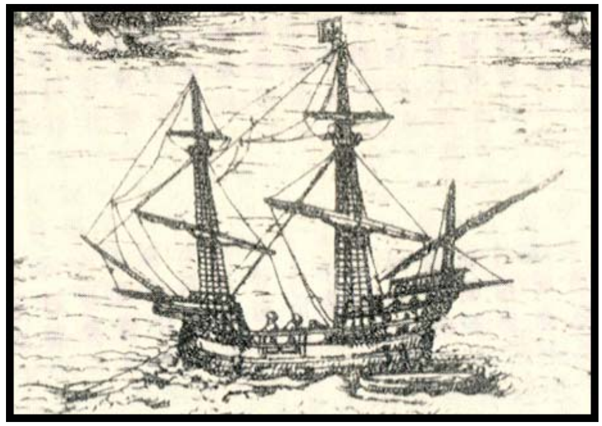


Figure 24: Three-masted nau at anchor (3N-15). From Brauni’s *Civiatis Orbis Terrarum*, Vol. 1, 1572.

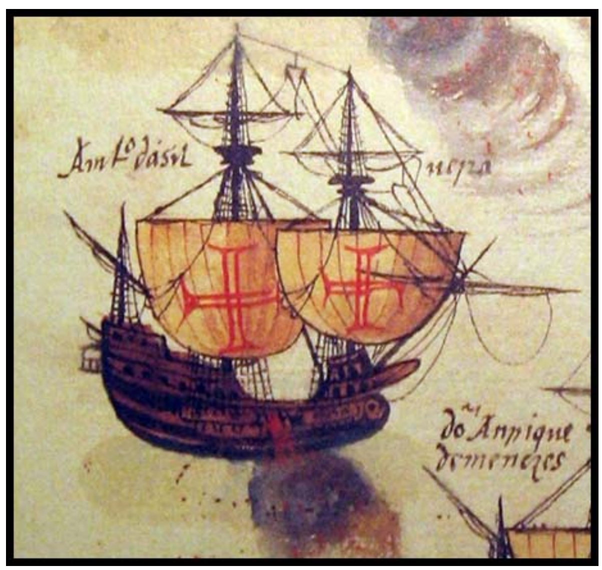


Figure 25: Three-masted nau in battle (3N-31). From *Livro Lisuarte D'Abreu*, 1558-1561.

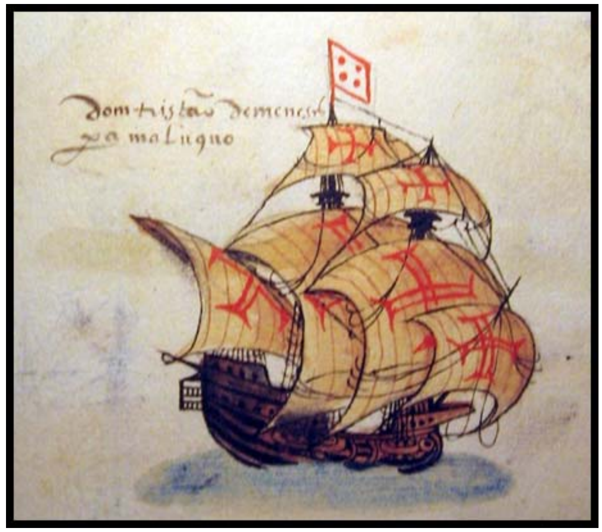


Figure 26: Three-masted nau under sail (3N-63). From *Livro Lisuarte D'Abreu*, 1558-1561.

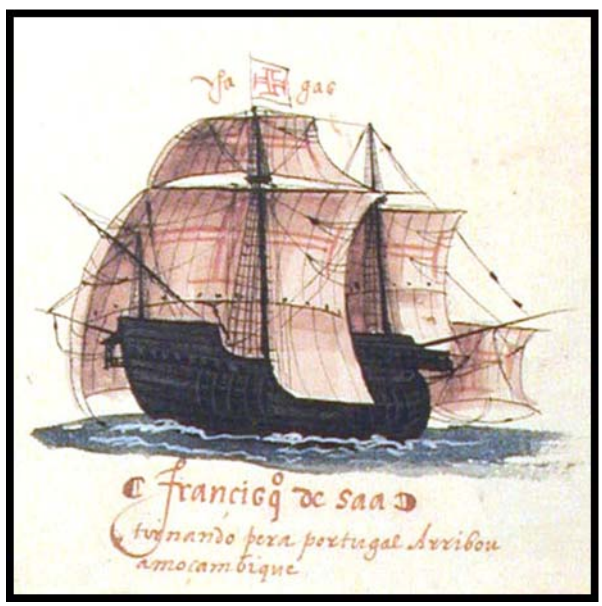


Figure 27: Three-masted nau under sail (3N-40). From *Memória das Armadas*, 1558-1561.

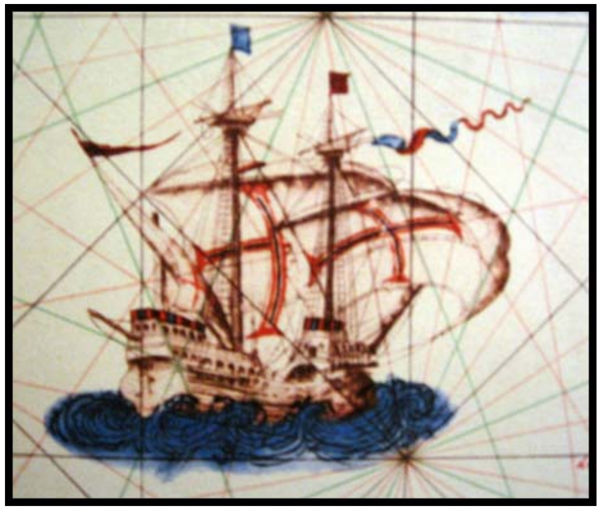


Figure 28: Three-masted nau under sail (3N-49). From Lopo Homem-Reneis' Atlas Miller, 1519.

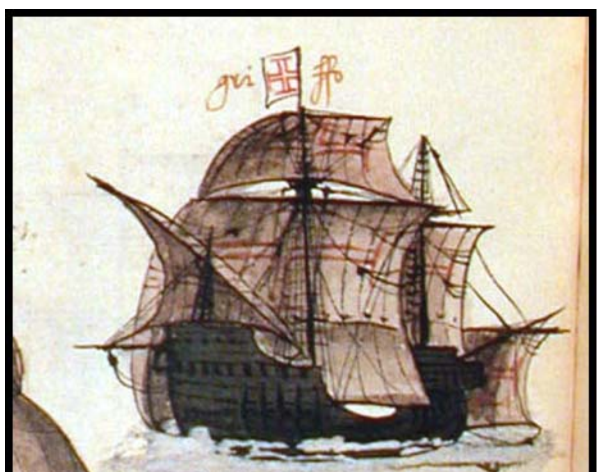


Figure 29: Three-masted nau under sail (3N-57). From *Memória das Armadas*, 1558-1561.

exception of the fore topsail (Figure 29). The last group (3N-34) of eight naus is sailing under the main and fore courses while the spritsail and the mizzen course are furled with raised yards and the topsails are furled on lowered yards. The remaining five rigging configurations of the three-masted naus consist of 10 vessels each with a different sail and yard setting; the groups are defined by the variable presence of mizzen topmasts and main and fore topgallants (Appendix 13). Likewise, there are only seven naus with four masts all of which also have individualized settings and are also listed in Appendix 13.

Overall Trends in the Sail and Yard Settings

An interesting aspect of the sail and yard setting is that a large number of vessels have their yards raised roughly half way up the mast, but vary in the exact placement. Normally, raised yards are situated near the top of the mast just under the crowsnest or the mast head; however, it is common for raised yards to be shown slightly below this level. Based on a visual estimate, the placement of the raised yards ranges between 30% and 70% of the length of the mast. In particular, the fore topyards are the most difficult to analyze due to the fact that they appear to be depicted in a generally lower position than the bottom yards. One of the most problematic aspects is that, at times, it is not possible to determine the manner of a yard’s setting.

There are a total of 10 groups accounting for 40% of naus at anchor (22 out of 55), which collectively have one or more masts with half-raised yards indicating that this was a standard practice. Of the three-masted and four-masted naus at anchor with half-raised yards, one group (3N-10) has all the yards half-raised, one group (3N-16) has all but the mizzen yard half-raised, one group (3N-69) has the main and fore yards and topyards half-raised, three groups (3N-14,15,29) have the main and fore yards half-raised, two (3N-12,13) have only the main yard half-raised, another two (3N-20, 21) have only the fore yard half-raised, and one group (3N-19) has both topyards half-raised. Likewise, a half-raised fore yard is present in three caravel groups (4C-2,8,9), while a fourth group also has a half-raised fore topyard (4C-10), which together account for 22% (7 out of 32) of caravels at anchorage. Among galleons with half-raised yards, there are seven groups accounting for 50% (8 out of 16) of those at anchorage. Two groups (3G-1,2) have the main yard half-raised, while the remaining five groups (3G-6, 4G-2,4,5,10) have the main and fore yards half-raised. The half raised yards could suggest a longer term anchorage; which may, in turn, answer why some of those ships have sails and yards missing.

The absence of one or more yard and sail from a mast is a significantly less common, but it is an evident trend amongst anchored vessels. For the naus there are three different groups each with one vessel without a sail and yard: the first group (3N-2) is missing the main, main top, and fore sails and yards; while the second group (3N-3) does not have the main top and fore sails and yards. The last group (3N-68) only has the foremast rigged with a yard and sail. There is one two-masted caravel (2C-1) at anchorage which is completely unrigged, a galleon (3G-3) that is missing the fore sail and yard, and another (4G-14) that does not have bonaventure and mizzen topsails and topyards. Although there is a possibility that these sails may have been taken down for repair or to be changed, it does not adequately explain the absence of yards. Another possibility and perhaps a more cautious explanation, is that these yards were in reality lowered and the artist failed to depict them as such. The difficulty in analyzing sail settings is that it is ultimately a reflection of human behavior and the preference of ship captains. For this time period, it is not possible to substantiate most of these practices with evidence from written accounts.

One area in which it is possible to at least corroborate the represented sail setting with modern examples is the practice of leaving one sail unfurled in order to point the anchored vessel into the wind. There were five groups representing six naus (15% of the nau dataset), which have one sail unfurled while anchored suggesting that while it was not a ubiquitous practice, it was relatively common; there are two groups (3N-10, 29) which have the main sail unfurled and three groups (3N-12,16,25) with the fore sail unfurled. There are no caravels at anchor with unfurled sails, but there is one galleon (4G-1) with an unfurled and raised main course and another (3G-1) with a half-furled and half-raised main course.

The depiction of vessels in battle is relatively rare throughout the dataset. Collectively, there are only two naus, one (3N-31) which is fighting with the main course half-furled and half-raised and the spritsail set, and the other (3N-36) which has both the main and fore courses unfurled and raised. There are three galleons in battle, the first (3G-7) has the main and fore courses and the main and fore topsails set; while the second (4G-6) has the main and fore course set, but only the main topsail unfurled. Battling under full sails, the least commonly depicted of all naval warfare tactics in the dataset, is seen only on one galleon and one caravel. The third galleon (4G-9) is fighting under full sail excluding the missing spritsail as is one of the five caravels in battle (4C-24), which has the spritsail set. The second caravel (4C-13) only has the main course set and the fore course is half-furled and the fore yard is half-raised. As mentioned previously, there are three caravels depicted with the sails being furled, the first (4C-7) has all sails furled except the main course which is in the process of being furled by men atop the yards, whereas the second caravel (4C-6) has the mizzen and main course being furled and a fore yard half-raised with an unfurled sail. The last caravel (4C-13) has an unfurled main course as well as a half-furled fore course on a half-raised fore yard. The half-furled brailed sails are hanging from half-raised yards and only the fore course is resting on the forecastle, while the main course is suspended off the deck. This vessel is part of the 1524 fleet of the *Livro de Lisuarte de Abreu* (MA15) and its sail setting is repeated throughout all the ships in battle on the two folios representing that year.

Bonnets, additional sections of sails lashed to the lower edge of the main and fore courses are present on the square sails in the *Livro de Lisuarte de Abreu* manuscript. However, the way the sails are depicted could not have allowed shortening them by removing the bonnets, especially considering that lateen sails of the same appearance do not have bonnets at all. Additionally, there is the presence of brails on the square sails which is useful for quickly dumping the wind from the sails. Likewise, it takes time and man power to remove bonnets, which would be a wasteful use of resources in battle. Brailing the sails and slightly lowering the yards allowed the captain to control the speed and maneuvering of the ship during battle. Additionally, the captain could maintain the capacity to quickly deploy the sails, top off the yard, and move the vessel, which is vital during battle.

The variety of sail settings raises many questions including if there was a difference in sail settings between open water and coastal sailing. The answer to this question, however, is limited by the nature of Iberian iconography which favors ships depicted near landmasses. There is a marked difference in later centuries, during which time ships sailing in open water, particularly those that are in distress from a storm, become ubiquitous in marine art. Portuguese exploration was primarily coastal-based and ships on maps are nearly always in the proximity of land. Furthermore, harbor scenes are one of the most common subjects in related manuscripts and engravings. From a practical perspective, blue water sailing is significantly easier than along the coast. Sailing near or between landmasses can direct or channel the wind or create a wind shadow. Likewise, there are more hazards in coastal sailing (rocks, reefs, sand bars, etc) which requires the ability to swiftly maneuver a vessel. It is in these instances that a range of sail combinations are needed to maximize propulsion. Therefore it is reasonable to expect large variation in sail and yard settings with smaller populations of the groups especially in the more complex rigs.

As illustrated in the Table 1, the caravels always used the main sail followed by the fore and mizzen sail, whereas galleons used the bonaventure sail and main, and fore courses as back sails. Naus had the main and fore courses set on nearly every example and the mizzen was set on two-thirds of the ships while the main and fore topsails were used roughly half of the time. Due to the variations in the number of masts, it is

TABLE 1: Individual Sail Counts for Caravels, Galleons, and Naus under Sail

Caravels			
Sail	**# Unfurled**	**Sample Size**	**Percentage**
Mizzen	40	69	58%
Bonaventure	17	51	33%
Main Course	69	69	100%
Fore Course	22	37	59%
Fore Topsail	5	34	15%
Spritsail	6	37	16%
Galleons			
Sail	**# Unfurled**	**Sample Size**	**Percentage**
Mizzen	7	11	64%
Mizzen Topsail	0	1	0%
Bonaventure	4	5	80%
Bonaventure Topsail	0	1	0%
Main Course	8	11	73%
Main Topsail	3	10	30%
Main Topgallant	0	3	0%
Fore Course	7	11	64%
Fore Topsail	3	11	27%
Fore Topgallant	0	2	0%
Spritsail	2	11	18%
Naus			
Sail	**# Unfurled**	**Sample Size**	**Percentage**
Mizzen	112	168	67%
Mizzen Topsail	2	3	67%
Bonaventure	3	5	60%
Main Course	161	168	96%
Main Topsail	117	165	71%
Main Topgallant	1	2	50%
Fore Course	163	168	97%
Fore Topsail	70	158	44%
Fore Topgallant	0	1	0%
Spritsail	110	168	65%

TABLE 2: Sail Counts for Vessels under Sail

Mizzen Course	# Unfurled	Sample Size	Percentage
Caravel	40	69	58%
Galleon	7	11	64%
Nau	112	168	67%
Bonaventure Course	**# Unfurled**	**Sample Size**	**Percentage**
Caravel	17	51	33%
Galleon	4	5	80%
Nau	3	5	60%
Main Course	**# Unfurled**	**Sample Size**	**Percentage**
Caravel	69	69	100%
Galleon	8	11	73%
Nau	161	168	96%
Fore Course	**# Unfurled**	**Sample Size**	**Percentage**
Caravel	22	37	59%
Galleon	7	11	64%
Nau	163	168	97%
Spritsail	**# Unfurled**	**Sample Size**	**Percentage**
Caravel	6	37	16%
Galleon	2	11	18%
Nau	110	168	65%

Mizzen Topsail	# Unfurled	Sample Size	Percentage
Galleon	0	1	0%
Nau	2	3	67%
Bonaventure Topsail	**# Unfurled**	**Sample Size**	**Percentage**
Galleon	0	1	0%
Main Topsail	**# Unfurled**	**Sample Size**	**Percentage**
Galleon	3	10	30%
Nau	117	165	71%
Fore Topsail	**# Unfurled**	**Sample Size**	**Percentage**
Caravel	5	34	15%
Galleon	3	11	27%
Nau	70	158	44%
Fore Topgallant	**# Unfurled**	**Sample Size**	**Percentage**
Galleon	0	2	0%
Nau	0	1	0%
Main Topgallant	**# Unfurled**	**Sample Size**	**Percentage**
Galleon	0	3	0%
Nau	1	2	50%

suspected that the counts for the caravels are slightly misleading. The one- and two-masted caravels used the main sail in every instance whereas the mizzen was used only half of the time. The three-masted caravels again had the main sail set on every ship, but the bonaventure was unfurled and raised on only 30% of the vessels and the mizzen 40%. The four-masted caravels, which are much more comparable to the galleons and the naus because of the presence of the four basic masts, has the main lateen sail unfurled and raised on 100% of the ships and the mizzen on 73%; however, the bonaventure appears to be set much more infrequently at 35%. The comparison of the sail counts of each mast by ship types is presented in Table 2. The use of the mizzen sail on caravels, naus, and galleons is surprisingly consistent with a range of 58-67%. However, the use of the mizzen topsail is rare. It is unfurled on two of the three naus and furled on the one galleon. The bonaventure sail is used more often on galleons (80%) than on naus (60%) or caravels (33%), which is most likely due to the fact that it is the third and smallest lateen sail on the caravel and the mizzen was consistently chosen over it. A bonaventure topsail is only present on one galleon; hence, it was excluded.

The main sail was set on every caravel and nearly all the naus, but was only used on 73% of the galleons. This division is even wider when comparing the main topsails which are set on only 30% of the galleons versus 71% of naus. The fore sail is unfurled relatively consistently for the caravels and galleons (59 and 64%), but is used nearly every time on the naus (97%). Fore topsails are hardly ever set on the caravels (15%) and galleons use this sail essentially as often as they do the main topsail. As evident by a decrease from 71% to 44%, the naus use it significantly less than the main topsail. Main and fore topgallant sails are extremely rare and only one nau has a topgallant set on the main mast (Figure 30). Similar to the fore course, the spritsail is unfurled on caravels and galleons far less (16 and 18%) than the naus (65%) which can logically be explained by vessel morphology.

Galleons are set apart from both caravels and naus by their frequent usage of the bonaventure sails and limited use of the main course, but they tend to be slightly closer to the caravel numbers than the naus. Naus as merchantmen had far larger and beamier shapes than either the caravel or the galleon and together with the presence of high castles and more tonnage, this vessel type must have required more sail area than ships used for exploration. Although the sail counts are simplified for the purposes of quick comparisons between the vessels, they do show clear trends within the dataset.

The representational trends analysis of the ship typologies, rigging configurations, and sail and yard settings in the iconography successfully established typological rigging and upper hull characteristics of caravels, galleons, and naus. The checklist of construction components produced in this analysis defined features encountered within the iconography, and showed when certain changes came into popular awareness thereby indicating the evolution of hull features and rigs. This analysis provided a more precise timeline for the introduction and primary use of the different caravel rigging types in particular, as well as for rigging changes in galleons and naus in general. The representational trends analysis of certain standing and running rigging elements are explored further in the next chapter in attempt to discern if it is possible to obtain reliable information about the rigging from the iconography.

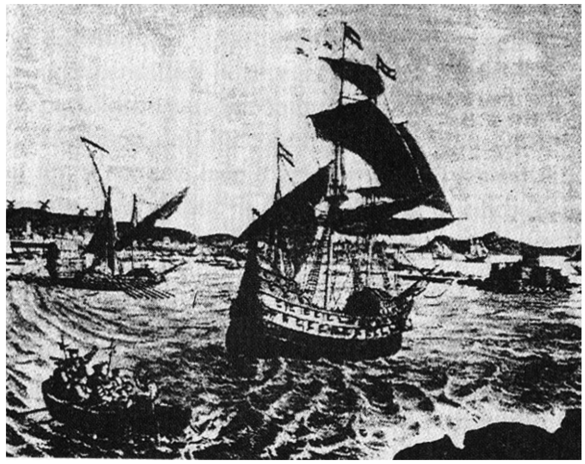


Figure 30: Three-masted nau with a main topgallant sail set (3N-67). From *La Armada*, 1525.

CHAPTER VI

REPRESENTATIONAL TRENDS ANALYSIS OF RIGGING ELEMENTS IN THE ICONOGRAPHY

The representational trends analysis of rigging features on 541 ships assessed the presence or absence of certain elements of the standing rigging (shrouds, ratlines, forestays, and backstays) as well as the running rigging (halyards and braces). Additionally, the number of shrouds and the exact position of the forestays and backstays were evaluated for each vessel. A comparative analysis of all rigging elements was conducted to discern which rigging elements were most represented in the iconography.

6.1 REPRESENTATIONAL TRENDS ANALYSIS OF SHROUDS

As the name implies, standing rigging functions to support the masts and after the ropes were made fast they required only minor adjustments. Shrouds are the heaviest component of the standing rigging and along with the backstays they provide lateral support to the mast (Harland, 1985: 22). The lower shrouds on all masts were usually set just abaft the mast in order to compensate for the forward pressure of the sails (Smith, 1993: 98). The lower shrouds on the main and fore masts extended symmetrically, on both the port and starboard sides from the top of the lower mast to shelf-like wooden chainwales located on the outside of the hull. The lower ends of the shrouds were attached to the hull at the chainwale by a pair of wooden deadeyes that altered adjustment of tension by several elongated wrought-iron chains the lowest link of which was bolted to the side of the hull. The shrouds for the mizzen mast were also lashed to the mast top like the main and fore mast shrouds, but were attached to tackles secured on deck or to the gunwale and not to a chainwale (Smith, 1993: 99). Topmast shrouds and topgallant mast shrouds were attached to the respective mast tops. Although futtock shrouds were common elements of the 16^{th}-century rig, they generally do not appear in the iconography as the rigging was commonly simplified by contemporary artists to its most characteristic elements.

The attachment of the shrouds to the outboard-protruding chainwales increased the lateral support for the mast (Harland, 1985: 22). As evidenced by the 15^{th}-century Mataró Model (dated to 1456-82), lower shrouds were originally attached inside the hull by means of iron ring bolts secured inside the bulwarks (Culver, 1929: 217; Akveld, 1983: 3-5; Smith 1993: 99). After chainwales were introduced to prevent chafing, the shrouds could be moved outboard, a move that lessened the strain on them. Palacio specifies that the chainwales must be upon the uppermost wale of the ship because the higher and wider they are, the less they strained the rig when sailing to windward. The connective chains had four to five links that were a *palm* (21cm) in width and somewhat elongated according to the thickness of the chain wale (Bankston, 1986: 124).

The iconography is largely inconclusive in regards to the placement of the bonaventure and mizzen shrouds. Their lower ends are obscured by the castle structure, castle railing, and railing decorations. There is also no obvious point of attachment outboard on the sterncastle, such as a bonaventure or mizzen chainwale, nor are there visible chains. The shrouds simply end at the beginning of the super structure, which on the surface appears to be evidence for an inboard placement. These masts supported smaller, less contemporary rigs and sails and may not have needed chainwales and chains. In the contemporary images artistic precedence is usually given to decorative elements and the sterncastle structure itself, however, and it is possible that little attention was paid to the lower details of the bonaventure and mizzen shrouds. In any case, the lack of evidence for an outboard placement suggests, but does not conclusively prove, inboard placement of bonaventure and mizzen shrouds.

The number of shrouds per mast varied according to the size of the rig and vessel. In this analysis of the iconography the number listed refers to one side of the vessel and not the entire complement. Palacio recommended that larger ships should have a total of 12 shrouds per side for the main mast, eight for the fore mast, and six for the mizzen mast, which are the same amounts recorded on the inventory of the Columbus's ship, the *Nina* (Smith, 1993: 99, 243; Bankston, 1986: 124). Palacio also recommends that the main topmast have six shrouds and the fore topmast shrouds five shrouds (Bankston, 1986: 124).

Another component of the standing rigging that is apparent in the iconography are the small lines called ratlines lashed between the shrouds effectively creating a ladder for access to the mast tops (Bankston, 1986: 125). Ratlines are mentioned in the inventory of the *Nina* and they were probably adopted for main mast first and then to the foremast as the height and complexity of ship rigs increased. The mizzen mast shrouds would also require ratlines later in the 16th century (Smith 1993: 100).

Bonaventure Mast Shrouds

There are 541 vessels in the representational trends database including 93 with bonaventure masts. Of these, 57 (61% of the sample) have the corresponding shrouds. The number of shrouds range from one to seven on each side of the bonaventure mast. As seen in Table 3, there are 13 vessels with one shroud (22% of the sample), 16 with two shrouds (28%), 10 with three shrouds (17%), nine with four shrouds (15%), six with five shrouds (10%), and 3 with seven shrouds (5%). The listing of the shrouds by the date ranges in Appendix 15 does not exhibit a temporal progression of the number of shrouds. As can be seen in Appendix 15, there is also no appreciable trend in number of shrouds associated with different periods throughout the 16th century. There is a slight division of the shrouds by ship type which is also listed in Appendix 15; however, 68% of the all-vessel sample distribution in Table 3 has one to three shrouds with two being the most common. Naus with bonaventure masts have an equal distribution of three and four shrouds whereas caravels and galleons have wider ranges, one to seven and one to five shrouds respectively (Table 4). The caravel distribution, however, indicates that one to two shrouds has the highest percentage accounting for 55.6% of the sample. The galleon distribution clearly shows that two shrouds is the most common (37.5% of the sample) followed by three shrouds (25% of the sample).

There are several different configurations of the shrouds forward and aft of the mast; the placement of the shrouds for all ship types can be viewed in Appendix 15, with

TABLE 3: Bonaventure Mast Shrouds Distribution – by Ship Type

ALL VESSELS (N=57)		
# of Shrouds	**# of Vessels**	**% of Sample**
1	13	22.81%
2	16	28.07%
3	10	17.54%
4	9	15.79%
5	6	10.53%
7	3	5.26%
CARAVELS (N=45)		
# of Shrouds	**# of Vessels**	**% of Sample**
1	12	26.67%
2	13	28.89%
3	6	13.33%
4	6	13.33%
5	5	11.11%
7	3	6.67%
GALLEONS (N=9)		
# of Shrouds	**# of Vessels**	**% of Sample**
1	1	12.50%
2	3	37.50%
3	2	25.00%
4	1	12.50%
5	1	12.50%
NAUS (N=4)		
# of Shrouds	**# of Vessels**	**% of Sample**
3	2	50.00%
4	2	50.00%

TABLE 4: Most Common Placement of the Bonaventure Mast Shrouds

BONAVENTURE			
# of Shrouds	**# of Vessels**	**Vessel Types**	**Shroud Position**
1	11	CARAVEL	1 FORE
1	1	GALLEON	1 AFT
2	8	CARAVEL	1 FORE / 1 AFT
2	1	GALLEON	1 FORE / 1 AFT
2	1	GALLEON	2 AFT
2	1	GALLEON	2 FORE
3	3	CARAVEL	2 FORE / 1 AFT
3	1	GALLEON	2 FORE / 1 AFT
3	1	NAU	3 AFT
3	1	GALLEON	3 AFT
3	1	NAU	3 FORE
4	1	NAU	1 FORE / 3 AFT
4	1	NAU	2 FORE / 2 AFT
4	1	GALLEON	2 FORE / 2 AFT
4	6	CARAVEL	2 FORE / 2 AFT
5	5	CARAVEL	2 FORE / 3 AFT
5	1	GALLEON	5 AFT
7	1	CARAVEL	2 FORE / 5 AFT
7	1	CARAVEL	3 FORE / 4 AFT
7	1	CARAVEL	4 FORE / 3 AFT

the most common placement of the shrouds listed in Table 4. The vast majority of caravels and galleons with one shroud (85% of the sample) have it set forward of the bonaventure while only two vessels have the shroud placed aft of the mast. The most common setting for caravels is the forward position while one galleon has it placed aft of the bonaventure mast. There are 13 caravels and three galleons with two shrouds divided into one shroud forward and one aft of the mast, two shrouds aft of the mast, and two shrouds forward of the mast. Although the galleons have one of each shroud configuration, the caravels have the shrouds predominantly in the centralized position of one fore and one aft (62% of the sample) making it the most common setting for caravels followed by the aft position of the shrouds (23% of the sample) and then the forward position of the shrouds (15% of the sample).

Of the vessels with three shrouds, the dominant overall placement is two forward of the bonaventure mast and one aft of it which is seen on three caravels and a galleon (40% of the sample) and is the most common setting for the caravels. There is also a single caravel with the reverse placement of the shrouds with one forward and two aft of the mast. The rest of the vessels have all three shrouds placed forward of the mast (30% of the sample) or aft of the mast (20% of the sample). There are six caravels, a galleon, and a nau which account for eight of the nine vessels in the sample with four shrouds divided into two placed forward of the bonaventure mast and two aft of it (and is thus the standard placement of the shrouds for all three vessel types). There is a single nau which has one shroud set forward and three shrouds aft of the mast.

The occurrence of five and seven shrouds is much less common than the previously mentioned amounts and the majority of the vessels (89% of the sample) are caravels from the *Livro de Lisuarte de Abreu* (MA15) painted in 1558-61; the ninth vessel is a galleon (MA02.01) from 1502 with five shrouds. The five caravels (MA15.1502.05, MA15.1505.05, MA15.1505.18, MA15.1533.14, MA15.1533.15) with five shrouds per side of the bonaventure mast have a configuration of two shrouds forward of the mast and three aft of it while the galleon has all the shrouds set aft making these the most common configurations for both vessel types. There are three caravels (MA1501.09, MA15.1502.02, MA15.1501.12) with a total of seven shrouds, each of which has a differing number of shrouds placed forward and after the mast; two fore/ five aft, three fore/ four aft, and four fore/ three aft respectively listed in the above ordering of the vessels. Although the presence of the galleon lends some credence to a five shroud variant, it is suspicious that the rest of the vessels come from a single source. In particular, the presence of five and seven shrouds is a relatively large number given the relatively short and narrow nature of the mast in comparison to the main and fore masts.

The data suggests that within the regional Iberian seafaring tradition the number of shrouds for the bonaventure mast was based on the preference of those responsible for rigging the ship whether the decision came from the shipyard or the captain. The *Memória das Armadas* (MA16) and the *Livro de Lisuarte de Abreu* (MA15) both portray the yearly fleets along the *Carreira da India* and have shrouds ranging from two to seven in the first manuscript and one to four in the second. Much like the overall bonaventure shroud sample in Appendix 15, there is no temporal division of the number of shrouds within these two manuscripts. Furthermore, the different configurations of the shrouds forward and aft of the mast in the iconographic record do not adhere to accepted principle that the shrouds should be placed aft of the mast to counter the forward pull from the sails. In fact, these shrouds may have served as both forestays and backstays due to the peculiarities of the lateen standing rigging and tacking arrangement. Another possible explanation is more variance within rigging standards than was recorded in the archival documents or artistic error; however, the temptation to automatically ascribe all abnormalities to the latter should be resisted.

Mizzen Mast and Mizzen Topmast Shrouds

The 541 vessels in the representational trends database include 515 with a mizzen mast. Of these, 283 (61% of the sample) show the corresponding shrouds. The number of shrouds ranges from one to 14 per each side of the mizzen mast. As seen in Table 5, there are seven vessels with one shroud (2.47% of the sample), 51 with two shrouds (18.02%), 61 with three shrouds (21.55%), 101 with four shrouds (35.69%), 27 with five shrouds (9.54%), 14 with six shrouds (4.95%), nine with seven and eight shrouds (3.18% each), two with nine shrouds (0.71%), and one with 12 and 14 shrouds (0.35% each). Much like the shrouds of the bonaventure mast, the date ranges of the mizzen mast listed in Appendix 16 do not demonstrate a temporal correlation. Likewise, there is no appreciable division of the shrouds by ship type (are also listed in Appendix 16). The galleons and naus have slightly wider ranges from one to 12 and one to 14 shrouds respectively, while the caravels have one to eight. The most common number of shrouds for all vessels, listed in Table 5, is two to four shrouds which together account for just over 75% of the sample. The distribution of the mizzen mast shrouds by ship types exhibits the same trend of two to four shrouds as the most common, which accounts for 78.69% of caravels, 63.16% of galleons, and 75.37% of naus (Table 5). While the caravels have a somewhat even distribution between two to four mizzen shrouds, the galleons and naus clearly demonstrate that four shrouds is the standard number.

There are several different configurations of the shrouds forward and aft of the mast, the exact placement of which for all vessels can be viewed in Appendix 16, while the most common placement of the shrouds is listed in Table 6. The naus, caravels, and the galleon with one shroud more commonly have it placed aft of the mizzen mast (71% of the sample) than forward of it (29% of the sample). The aft position is the standard setting for caravels and galleons; however, given the small sample size is not possible to determine which is more common for the nau sample. Of the vessels with two shrouds, the placement of the shrouds is fairly evenly divided between both shrouds forward of the mast (37% of the sample), both shrouds aft of the mast (33% of the sample), and one shroud forward and one shroud aft of the mast (29% of the sample). The most common setting for the caravels is one shroud forward and aft of the mast, for the galleons it is aft placement, and for the naus a forward placement.

Vessels with three shrouds have a more complex division of shroud placement. There are 19 naus out of the 61 vessels (31% of the sample) in the sample that have all three shrouds set forward of the mast making it the most common setting for the naus.

TABLE 5: Mizzen Mast Shrouds Distribution – All Vessels

ALL VESSELS (N=283)		
# of Shrouds	# of Vessels	% of Sample
1	7	2.47%
2	51	18.02%
3	61	21.55%
4	101	35.69%
5	27	9.54%
6	14	4.95%
7	9	3.18%
8	9	3.18%
9	2	0.71%
12	1	0.35%
14	1	0.35%

CARAVELS (N=61)		
# of Shrouds	# of Vessels	% of Sample
1	2	3.28%
2	18	29.51%
3	13	21.31%
4	17	27.87%
5	5	8.20%
6	1	1.64%
7	2	3.28%
8	3	4.92%

GALLEONS (N=19)		
# of Shrouds	# of Vessels	% of Sample
1	1	5.26%
2	3	15.79%
3	2	10.53%
4	7	36.84%
5	2	10.53%
6	1	5.26%
8	1	5.26%
9	1	5.26%
12	1	5.26%

NAUS (N= 203)		
# of Shrouds	# of Vessels	% of Sample
1	4	1.97%
2	30	14.78%
3	46	22.66%
4	77	37.93%
5	20	9.85%
6	12	5.91%
7	7	3.45%
8	5	2.46%
9	1	0.49%
14	1	0.49%

TABLE 6: Most Common Placement of the Mizzen Mast Shrouds

MIZZEN			
# of Shrouds	**# of Vessels**	**Vessel Type**	**Shroud Position**
1	2	CARAVEL	1 AFT
1	1	GALLEON	1 AFT
1	2	NAU	1 AFT
1	2	NAU	1 FORE
2	8	CARAVEL	1 FORE / 1 AFT
2	2	GALLEON	2 AFT
2	13	NAU	2 FORE
3	9	CARAVEL	2 FORE / 1 AFT
3	2	GALLEON	3 AFT
3	19	NAU	3 FORE
4	7	CARAVEL	2 FORE / 2 AFT
4	3	GALLEON	4 AFT
4	41	NAU	2 FORE / 2 AFT
5	3	CARAVEL	2 FORE / 3 AFT
5	1	GALLEON	3 FORE / 2 AFT
5	1	GALLEON	5 AFT
5	9	NAU	2 FORE / 3 AFT
6	1	CARAVEL	1 FORE / 5 AFT
6	1	GALLEON	6 AFT
6	8	NAU	3 FORE / 3 AFT
7	4	NAU	3 FORE / 4 AFT
7	2	CARAVEL	4 FORE / 3 AFT
8	2	CARAVEL	3 FORE / 5 AFT
8	1	GALLEON	4 FORE / 4 AFT
8	4	NAU	4 FORE / 4 AFT
9	1	GALLEON	2 FORE / 7 AFT
9	1	NAU	6 FORE / 3 AFT
12	1	GALLEON	7 AFT - 5 FORE
14	1	NAU	7 AFT - 7 FORE

There are 14 caravels, naus, and galleons (23% of the sample) with the three shrouds placed aft of the mizzen mast, but it is the dominant setting only for the galleons. An additional nine caravels and 11 naus (33% of the sample) have two shrouds forward of the mast and one aft, which is also the most common placement for the caravels. The remaining eight naus (13% of the sample) have the reverse configuration with one forward and two aft of the mizzen mast. Of the vessels with four shrouds, the predominant placement of the shrouds for caravels and naus (49.5% of the sample) is two forward and two aft of the mizzen mast. Whereas one shroud forward and three aft only accounts for 17 out of 101 vessels (16.8% of the sample) and three shrouds forward and one aft is represented by a single nau. Likewise, the placement of all four shrouds forward of the mast is more frequent than an aft position representing 20 out of 101 vessels as compared to only 13 out of 101 vessels of the latter, which is also the most common placement of shrouds in the galleon sample.

The occurrence of five through 14 shrouds is more atypical than the previously mentioned amounts. There are 27 caravels, galleons, and naus with five shrouds per side of the mizzen mast and interestingly there are five vessels (19% of the sample) with all five shrouds set aft of the mast, but there are none with all five shrouds forward of the mizzen mast. The majority of the remaining vessels (44% of the sample) have two shrouds forward and three aft of the mast configuration and it is the most common setting for the caravel and nau samples, while six naus and a galleon (26% of the sample) have the shrouds set with three forward and two aft of the mizzen mast. There are also two vessels with four shrouds forward and one aft of the mast (7% of the sample) and one with the reverse setting of one forward and four aft of the mizzen mast (4% of the sample). Like the five shroud sample, there are two vessels (14% of the sample) with six shrouds set aft of the mast and there no instances of all six shrouds forward of the mizzen mast. The most frequent configuration in the sample is three shrouds set forward and three aft of the mast, which accounts for eight out the 14 vessels (57% of the sample) and is the dominant placement for the naus. Of the remaining vessels with six shrouds, one (7% of the sample) has one shroud forward and five aft while another (7% of the sample) has two shrouds forward and four shrouds aft, and two (14% of the sample) have four shrouds forward and two shrouds aft.

Naus and caravels with seven shrouds are equally divided between four shrouds set forward of the mast and three aft and the reverse with three forward and four aft of the mast; both have four out of nine vessels (44% of the sample). The most common setting for the naus, however, is the former while the latter is the standard setting for the caravel sample. The ninth vessel is a nau with two shrouds placed forward of the mast and five aft, which only accounts for 11% of the sample. There are nine vessels which have eight shrouds per side of the mizzen mast and the most frequent placement of the shrouds is four forward and four aft of the mast (67% of the sample) which is the standard setting for the nau and galleons samples. While the other three vessels (33% of the sample) have three shrouds placed forward and five aft of the mizzen mast and is the most common placement for the caravel sample. Of the two vessels with nine shrouds, there is one with two shrouds forward and seven aft of the mast, while the second has six shrouds forward and three aft of the mizzen mast. The remaining two vessels represent the extreme end of the range with 12 and 14 shrouds, the first of which has seven shrouds forward and five aft while the last vessel has a split of seven shrouds on each side of the mizzen mast.

There are only three vessels with mizzen topmast shrouds suggesting that the presence of this mast was rare in the 16th century. Of the two naus with topmast shrouds, there is one with two shrouds that are set with one shroud forward and aft of the topmast and another with four shrouds that are all placed aft of the topmast. The third vessel is a galleon with one shroud set forward of the mizzen topmast.

Like the data from the bonaventure mast shrouds, it appears that the number of shrouds for the mizzen mast was based on preference and not rigid rules. Likewise, the iconographic record of the mizzen mast shrouds does not support the placement of all shrouds aft of the mast. It is possible to discern slightly different trends between caravels and galleons which average two to four shrouds and the naus with a tighter average range of three to four shrouds. There still remain, however, numerous variants as visible in the different configurations of the shrouds forward and aft of the mast.

Main Mast and Main Topmast Shrouds

The 541 vessels in the representational trends database all have main masts, yet, only 319 (59% of the sample) show the corresponding main mast shrouds and 174 (32%) have main topmast shrouds. The number of shrouds ranges from one to 24 per side of the main mast. As seen in Table 7, there is one vessel (0.31% of the sample) with one shroud, 12 (3.76%) with two shrouds, 20 (6.27%) with three shrouds, 55 (17.24%) with

TABLE 7: Main Mast Shrouds Distribution

ALL VESSELS	**(N=319)**	
# of Shrouds	**# of Vessels**	**% of Sample**
1	1	0.31%
2	12	3.76%
3	20	6.27%
4	55	17.24%
5	48	15.05%
6	58	18.18%
7	43	13.48%
8	40	12.54%
9	12	3.76%
10	15	4.70%
11	6	1.88%
12	7	2.19%
14	1	0.31%
24	1	0.31%

CARAVELS	**(N=81)**	
# of Shrouds	**# of Vessels**	**% of Sample**
1	1	1.23%
2	12	14.81%
3	17	20.99%
4	20	24.69%
5	13	16.05%
6	8	9.88%
7	2	2.47%
8	4	4.94%
9	1	1.23%
10	3	3.70%

GALLEONS	**(N= 23)**	
# of Shrouds	**# of Vessels**	**% of Sample**
4	3	13.04%
5	5	21.74%
6	5	21.74%
7	1	4.35%
8	2	8.70%
9	1	4.35%
10	2	8.70%
11	1	4.35%
12	2	8.70%
14	1	4.35%

NAUS	**(N= 215)**	
# of Shrouds	**# of Vessels**	**% of Sample**
3	3	1.40%
4	32	14.88%
5	30	13.95%
6	45	20.93%
7	40	18.60%
8	34	15.81%
9	10	4.65%
10	10	4.65%
11	5	2.33%
12	5	2.33%
24	1	0.47%
24	1	0.47%

TABLE 8: Main Topmast Shrouds Distribution

ALL VESSELS (N=174)		
# of Shrouds	**# of Vessels**	**% of Sample**
1	3	1.72%
2	31	17.82%
3	32	18.39%
4	59	33.91%
5	28	16.09%
6	17	9.77%
7	2	1.15%
8	1	0.57%
10	1	0.57%

CARAVELS (N=1)		
# of Shrouds	**# of Vessels**	**% of Sample**
2	1	100.00%

GALLEONS (N= 9)		
# of Shrouds	**# of Vessels**	**% of Sample**
2	2	22.22%
3	2	22.22%
4	2	22.22%
5	1	11.11%
6	2	22.22%

NAUS (N=164)		
# of Shrouds	**# of Vessels**	**% of Sample**
1	3	1.83%
2	28	17.07%
3	30	18.29%
4	57	34.76%
5	27	16.46%
6	15	9.15%
7	2	1.22%
8	1	0.61%
10	1	0.61%

four shrouds, 48 (15.05%) with five shrouds, 58 (18.18 %) with six shrouds, 43 (13.48%) with seven shrouds, 40 (12.54%) with eight shrouds, 12 (3.76%) with nine shrouds, 15 (4.70%) with 10 shrouds, six (1.88%) with 11 shrouds, seven (2.19%) with 12 shrouds, one (0.31%) with 14 shrouds, and one (0.31%) with 24 shrouds. The topmast shrouds, listed in Table 8, range from one to 10 with three vessels (1.72% of the sample) having one shroud, 31 (17.82%) have two shrouds, 32 (18.39%) have three shrouds, 59 (33.91%) have four shrouds, 28 (16.09%) have five shrouds, 17 (9.77%) have six shrouds, two (1.15%) have seven shrouds, one (0.57%) has eight shrouds, and another one (0.57%) has 11 shrouds.

The listing of both the main mast and main topmast shrouds by date ranges in Appendix 17 does not exhibit any temporal progression in the number of shrouds, and so like the bonaventure and mizzen mast shrouds, there is no appreciable trend in shroud number associated with the different decades of the 16th century. There is a noticeable division in the average number of shrouds by ship type (Appendix 17). In the all-vessel sample distribution (Table 7), four to six shrouds accounts for just over 50% of the sample. Naus have a wide distribution from three to 24 shrouds while caravels and galleons have smaller ranges from one to 10 and four to 14 shrouds respectively. The distribution for caravels, however, indicates that examples with three to four shrouds have the highest percentage, accounting for 45.68% of the sample. The galleon distribution clearly shows that five to six shrouds is the most common number accounting for 43.48%, whereas the nau distribution has the highest average at six to seven shrouds, which represents 39.43% of the sample. The distribution for all ship types for main topmast shrouds shows that just over 70% of the sample have two to four shrouds (Table 8). Naus with main topmasts have the largest distribution from one to 10 topmast shrouds, while the galleons and caravels have considerably smaller ranges from two to six and two shrouds respectively. As there is only one caravel with topmast shrouds, it is not a reliable indication of a normal range of the number of shrouds. The galleon and nau distributions indicate that two to four main topmast shrouds is the most common for both vessels types accounting for 66.66% of the sample for the first and 70.12% of the sample for the second.

Different configurations of shrouds forward and aft of the main mast for all the ship types can be viewed in Appendix 17, while the most common placement of the shrouds is listed in Table 9. There is only one caravel with one shroud and it is placed aft of the main mast. Of the 12 caravels with two shrouds, both shrouds are predominantly placed aft of the mast on eight vessels (66.66% of the sample) making it the most common setting. There are two vessels (16.66% of the sample) that have one shroud forward and one aft of the mast. Likewise, a further two vessels (16.66%) have both shrouds forward of the mast. The 18 vessels with three shrouds are fairly evenly split between those with all three shrouds forward of the mast (30% of the sample), those with one shroud forward and two aft (30%), and those with two shrouds forward and one aft (30%); the latter two are the most common shroud settings for the caravels. The remaining two vessels have all shrouds aft of the main mast (10% of the sample). There are 55 vessels with four shrouds on the main mast, and 28 vessels have all shrouds placed aft of the mast (51% of the sample). This arrangement is also the most common

TABLE 9: Most Common Placement of the Main Mast Shrouds

MAIN MAST			
# of Shrouds	**# of Vessels**	**Vessel Type**	**Shroud Position**
1	1	CARAVEL	1 AFT
2	8	CARAVEL	2 AFT
3	6	CARAVEL	1 FORE / 2 AFT
3	6	CARAVEL	2 FORE / 1 AFT
4	8	CARAVEL	2 FORE / 2 AFT
4	1	GALLEON	1 FORE / 3 AFT
4	1	GALLEON	4 AFT
4	1	GALLEON	4 FORE
4	21	NAU	4 AFT
5	4	CARAVEL	1 FORE / 4 AFT
5	4	GALLEON	5 AFT
5	13	NAU	5 AFT
6	4	CARAVEL	3 FORE / 3 AFT
6	3	GALLEON	6 AFT
6	17	NAU	6 AFT
7	1	CARAVEL	3 FORE / 4 AFT
7	1	CARAVEL	6 FORE / 1 AFT
7	1	GALLEON	3 FORE / 4 AFT
7	11	NAU	2 FORE / 5 AFT
8	2	CARAVEL	2 FORE / 6 AFT
8	1	GALLEON	2 FORE / 6 AFT
8	1	GALLEON	3 FORE / 5 AFT
8	12	NAU	3 FORE / 5 AFT
9	1	CARAVEL	3 FORE / 6 AFT
9	1	GALLEON	9 AFT
9	5	NAU	3 FORE / 6 AFT
10	2	CARAVEL	4 FORE / 6 AFT
10	1	GALLEON	4 FORE / 6 AFT
10	1	GALLEON	10 AFT
10	2	NAU	2 FORE / 8 AFT
10	2	NAU	3 FORE / 7 AFT
10	2	NAU	4 FORE / 6 AFT
11	1	GALLEON	4 FORE / 7 AFT
11	2	NAU	5 FORE / 6 AFT
12	2	NAU	4 FORE / 8 AFT
12	2	NAU	6 FORE / 6AFT
14	1	GALLEON	5 FORE / 9 AFT
24	1	NAU	12 FORE / 12 AFT

for the nau sample, followed by all four shrouds set forward of the mast (20% of the sample). There are six vessels with one shroud placed forward and three aft of the mast (11% of the sample). Furthermore, there are nine vessels with two shrouds forward and two aft (16% of the sample), eight of which are caravels making it the standard setting for that sample. Lastly, there is a single caravel with three shrouds forward and one aft of the main mast (02% of the sample). Of the 48 vessels with five shrouds, 19 (40% of the sample) have all five shrouds set aft of the mast; which is the most common setting for both the galleon and the nau samples. Whereas only four vessels (8% of the sample) have all the shrouds placed forward of the mast. There are 11 vessels with two shrouds forward and three aft of the main mast representing 23% of the sample. The remaining vessels are split between those with one shroud forward and four aft, which is the most common placement for the caravel sample. There are also those with three shrouds forward and two aft accounting for seven vessels or nearly 15% of the sample.

For the 58 vessels with six shrouds, the most frequent placement is all of them aft of the main mast (36% of the sample); this was the most common setting for both the galleon and nau samples. The six vessels with all shrouds situated forward account for 10% of the sample, 11 vessels with two shrouds forward and four aft represent 19% of the sample, the nine with one shroud forward and five aft are 15.5% of the sample, the seven with three shrouds on each side of the vessel are 12% of the sample (the most common placement for the caravel sample), and the four vessels with four shrouds forward and two aft are 7% of the sample. The most frequent configurations of seven shrouds are two shrouds forward and five aft of the mast with 11 out of 43 vessels (26%

of the sample) making it the most common nau setting. There are 10 vessels (23% of the sample) with three shrouds forward and four aft of the mast as well as nine vessels (21%) with all seven shrouds only aft. There are six vessels with one shroud forward and six aft of the mast (14% of the sample), five vessels with four shrouds forward and three aft (12%), the remaining two vessels have six shrouds forward and one aft (5%). Of the 40 vessels with eight shrouds, 13 have three shrouds forward and five aft of the mast accounting for almost 33% of the sample, while 12 vessels (30% of the sample) have two shrouds forward and six aft; these two configurations are the most common placement for the nau and caravel samples respectively. There are six vessels with four shrouds forward and aft of the mast (15% of the sample), five with one shroud forward and seven aft (12.5%), three with all eight shrouds aft (7.5%), and one vessel with five shrouds forward and three aft (2%).

The most frequent setting of shrouds on vessels with a total of nine shrouds per side of the main mast is three forward and six aft (50% of the sample), which is also the most common placement for the nau sample followed by all nine shrouds being placed aft (25% of the sample). The remaining three vessels are split between one shroud placed forward and eight aft, two shrouds forward and seven aft, and four shrouds forward and five aft; each representing around 8% of the sample. For the vessels with ten shrouds, the most common setting is four shrouds forward and six aft of the mast accounting for 33% of the sample. There are an addition eight vessels with the following configurations: two shrouds forward and eight aft of the mast (17% of the sample); three shrouds forward and seven aft of the mast (17%); six shrouds forward and four aft of the mast (17%); and all ten shrouds aft of the main mast (17%). All of these configurations represent the most common setting for the caravel and nau samples. There is also one vessel (7% of the sample) with five shrouds on either side of the mast and another one with seven shrouds forward and three aft of the main mast (7%).

The remaining categories of 11, 12, 14, and 24 shrouds most likely represent infrequent variants of the normal range of the amounts of shrouds and as such it is not possible to conclude which represent the most common setting for each of the ship types. Since these samples include only large galleons and naus, it is assumed that such a vast number of shrouds would only be used on ships requiring more robust rigging. Of the six vessels with 11 shrouds, there are five different configurations. Two vessels (33% of the sample) have five shrouds forward and six aft of the mast, while the remaining four vessels (17% of the sample each) are split between three shrouds forward and eight aft, four shrouds forward and seven aft, seven shrouds forward and four aft, and all 11 shrouds placed aft. There are seven vessels with 12 shrouds and the most frequent configurations are four shrouds forward and eight aft of the mast (43% of the sample) and six shrouds on either side of the main mast (29% of the sample). There is one vessel with two shrouds forward and ten aft of the mast and another one with five shrouds forward and eight aft (14% of the sample each). There is one vessel with 14 shrouds, nine of which are set forward and five aft of the mast; and one with 24 shrouds, which has 12 shrouds on either side of the main mast.

There are only three vessels with one main topmast shroud, two of which (67% of the sample) having the shroud placed aft of the mast representing the most common setting for the naus (Table 10). The last vessel (33% of the sample) has the shroud centered on the mast. For the 31 vessels with two topmast shrouds, the most repeated configuration is one shroud on either side of the mast (45% of the sample), which is the standard setting for the caravels and the naus (Table 10). This is followed in frequency by both shrouds set aft of the mast (32% of the sample), and then both shrouds forward of the mast (23%). There are 11 out of 32 vessels (34% of the sample) with three topmast shrouds which have all three shrouds placed aft of the mast and is the most common setting for galleons. There are only six vessels (19% of the sample), however, which have all three shrouds forward of the mast. The remaining vessels are separated into two groups, the first of which have one shroud forward and two aft; all 10 of which are naus (or 31% of the sample) making it the standard placement for this ship type. The second group has two shrouds forward and one aft of the mast (16% of the sample). Of the 59 vessels with four topmast shrouds, the predominant setting is two shrouds on either side of the mast accounting for 43 vessels (73% of the sample); it is also the most common placement for the nau sample. There are seven vessels with three shrouds forward and one aft of the mast (12% of the sample), five with one forward and three aft (8% of the sample), three with all four shrouds aft (5% of the sample), and a single vessels with all four shrouds forward (2% of the sample).

The standard configuration for those vessels with five shrouds is two forward and three aft of the mast (64% of the sample) and it is also the most common setting for the naus. This is followed in frequency by three forward and two aft of the mast (29% of the sample). The remaining two vessels are split between one shroud forward and four aft of

TABLE 10: Most Common Placement of the Main Topmast Shrouds

MAIN TOPMAST			
# of Shrouds	**# of Vessels**	**Vessel Type**	**Shroud Position**
1	2	NAU	1 AFT
2	1	CARAVEL	1 FORE / 1 AFT
2	13	NAU	1 FORE / 1 AFT
3	2	GALLEON	3 AFT
3	10	NAU	1 FORE / 2 AFT
4	1	GALLEON	1 FORE / 3 AFT
4	1	GALLEON	2 FORE / 2 AFT
4	42	NAU	2 FORE / 2 AFT
5	1	GALLEON	2 FORE / 3 AFT
5	17	NAU	2 FORE / 3 AFT
6	15	NAU	3 FORE / 3 AFT
6	1	GALLEON	1 FORE / 5 AFT
6	1	GALLEON	6 AFT
7	1	NAU	1 FORE / 6 AFT
7	1	NAU	4 FORE / 3 AFT
8	1	NAU	4 FORE / 4 AFT
10	1	NAU	4 FORE / 6AFT

the mast and all five forward of the mast (3% of the sample each). There are 17 vessels with six shrouds per side of the main topmast, the majority of which (88% of the sample) have three shrouds placed on either side of the mast making it the standard setting for naus. The remaining two vessels have one shroud forward and five aft of the mast and all six shrouds aft; each represents 6% of the sample. Of the two vessels with seven topmast shrouds, one has one shroud forward and six aft of the mast, while the other one has four shrouds forward and three aft. There is also one vessel with eight and one with 10 shrouds, the former having four shrouds set on either side of the mast and the latter four shrouds forward and six aft of the mast.

The data from the main and main topmast shrouds are similar to that of the bonaventure and mizzen mast shrouds, and indicate an absence of hard and fast rules for the number of shrouds or the placement of the shrouds around the mast. The differences among the caravels, galleons, and naus average three to four shrouds, five to six shrouds, and six to seven shrouds respectively; increasing in relation to the relative size of the ships. The averages for the topmast shrouds are more consistent between the galleons and naus, each of which has two to four shrouds; whereas the data for the caravel topmast shrouds is inconclusive.

Fore Mast, Fore Topmast, and Fore Topgallant Mast Shrouds

Out of 541 ships in the representational trends database, 318 have a fore mast; of which 159 (50%) have the corresponding shrouds. Out of 313 ships with a fore topmast, 123 (40%) have topmast shrouds; while out of 29 ships with a fore topgallant mast, 10

(34%) have shrouds. The number of shrouds range from one to 11 per each side of the fore mast, one to nine per each side of the fore topmast, and one to six per each side of the fore topgallant mast. As seen in Table 11, which lists fore mast shrouds, there are three vessels with one shroud (1.89% of the sample), 10 with two (6.29%), 21 with three (13.21%), 47 with four (29.56%), 32 with five (20.13%), 27 with six (16.98%), 14 with seven (8.81%) two with eight (1.26%); and one each with nine, 10, and 11 shrouds (0.63% each). Regarding the fore topmast which can be viewed in Table 12, there is one vessel with one topmast shroud (0.81% of the sample), 36 with two (29.27%), 32 with three (26.02%), 39 with four (31.71%), eight with five (6.50%), six with six (4.88%), one with nine (0.81%). Of the vessels with fore topgallant shrouds, which can be viewed in Table 13, there is one vessel each with one, five, and six shrouds respectively (10% each). Likewise there are two vessels each with two and three shrouds (20% each), and three vessels with four shrouds (30%).

The pattern of no demonstrable temporal progression of the number of shrouds has held for every mast. There is an appreciable division, however, of the shrouds by ship type; the list of fore mast, fore topmast, and fore topgallant mast shrouds can be found in Appendix 18. Although caravels, galleons, and naus have similar ranges of one to 11 fore mast shrouds, two to 12 fore mast shrouds, and one to nine fore mast shrouds respectively, the most frequent number of fore mast shrouds as well as the most common configuration of the shrouds differ by ship type. The most recurrent number of fore mast shrouds for all vessels is four to six shrouds, which together account for almost 67% of the sample. The distribution of the fore mast shrouds by ship types exhibits a

TABLE 11: Fore Mast Shrouds Distribution

ALL VESSELS (N=159)		
# of Shrouds	**# of Vessels**	**% of Sample**
1	3	1.89%
2	10	6.29%
3	21	13.21%
4	47	29.56%
5	32	20.13%
6	27	16.98%
7	14	8.81%
8	2	1.26%
9	1	0.63%
10	1	0.63%
11	1	0.63%

CARAVELS (N=38)		
# of Shrouds	**# of Vessels**	**% of Sample**
1	1	2.63%
2	2	5.26%
3	7	18.42%
4	14	36.84%
5	8	21.05%
6	4	10.53%
7	1	2.63%
10	1	2.63%

GALLEONS (N= 12)		
# of Shrouds	**# of Vessels**	**% of Sample**
2	1	8.33%
3	2	16.67%
4	4	33.33%
5	1	8.33%
6	1	8.33%
7	1	8.33%
8	1	8.33%
12	1	8.33%

NAUS (N= 109)		
# of Shrouds	**# of Vessels**	**% of Sample**
1	2	1.83%
2	7	6.42%
3	12	11.01%
4	29	26.61%
5	23	21.10%
6	22	20.18%
7	12	11.01%
8	1	0.92%
9	1	0.92%

TABLE 12: Fore Topmast Shrouds Distribution

ALL VESSELS (N=123)		
# of Shrouds	# of Vessels	% of Sample
1	1	0.81%
2	36	29.27%
3	32	26.02%
4	39	31.71%
5	8	6.50%
6	6	4.88%
9	1	0.81%

CARAVELS (N=29)		
# of Shrouds	# of Vessels	% of Sample
2	20	68.97%
3	4	13.79%
4	4	13.79%
5	1	3.45%

GALLEONS (N= 5)		
# of Shrouds	# of Vessels	% of Sample
2	2	40.00%
3	3	60.00%

NAUS (N= 89)		
# of Shrouds	# of Vessels	% of Sample
1	1	1.12%
2	14	15.73%
3	25	28.09%
4	35	39.33%
5	7	7.87%
6	6	6.74%
9	1	1.12%

TABLE 13: Fore Topgallant Mast Shrouds Distribution

ALL VESSELS (N=10)		
# of Shrouds	**# of Vessels**	**% of Sample**
1	1	10.00%
2	2	20.00%
3	2	20.00%
4	3	30.00%
5	1	10.00%
6	1	10.00%

NAUS (N= 9)		
# of Shrouds	**# of Vessels**	**% of Sample**
2	2	22.22%
3	2	22.22%
4	3	33.33%
5	1	11.11%
6	1	11.11%

GALLEONS (N= 1)		
# of Shrouds	**# of Vessels**	**% of Sample**
1	1	100%

similar yet slightly different trend for the caravels for which three to five shrouds is the most common number of shrouds accounting for just over 76% of the sample. Interestingly, three to four shrouds is the most frequent number (50% of the sample) for the galleons, while four to six shrouds represents 68% of the nau sample. The fore mast shrouds exhibit a reverse of the general trend in which the number of shrouds increases along with the relative size of the vessel.

The overall distribution of the fore topmast shrouds for all ship types shows that 87% of the sample has two to four shrouds. Unlike in the lower shroud samples, the naus with fore topmasts have the largest distribution ranging from one to nine shrouds, while the galleons and caravels have considerably smaller ranges from two to three and two to five shrouds respectively. The most common number of shrouds for the caravels is two shrouds, which account for almost 60% of the sample. The galleon and nau distributions demonstrate that two to three and three to four shrouds respectively is the most recurrent amount representing 100% of the sample for the former, and 67.42% of the sample for the latter. There are no caravels with fore topgallant masts and the overall distribution of one to six shrouds with two to four shrouds being the most frequent is comprised only of galleons and naus. Since there is only one galleon with a fore topgallant mast which has one shroud, the data is considered unreliable. The overall distribution is logically almost identical to that of the naus with two to four shrouds accounting for 77.77% of the sample.

There are several different configurations of the lower shrouds forward and aft of the mast. There are three vessels with one shroud of which two vessels (a caravel and a nau) have it placed aft of the fore mast, while the third (a nau) has is set forward. Of the ten vessels with two shrouds, there are three naus and a caravel with one shroud placed on either side of the mast (40% of the sample), five vessels with both shrouds placed aft (40%), and a single nau with both shrouds forward (10%). The most common placement of the shrouds for the naus and the caravels is split between one shroud forward and one aft or both shrouds aft of the mast, while the most common placement for the galleons is only the latter (Table 14). The majority of the vessels with three shrouds have all three placed aft of the fore mast (62% of the sample), which is the standard setting for the naus and galleons. The caravels are divided between this configuration and a placement of one shroud forward and two aft of the mast which accounts for five vessels or 24% of the sample. There is also a caravel with two shrouds forward and one aft of the mast (5% of the sample) and two naus with all three shrouds placed forward (9%).

There are 47 vessels with four shrouds and the dominant settings are all four aft of the mast (40% of the sample) or two forward and two aft (28%). The former is the most common placement for both the naus and galleons, while the latter is the standard for the caravels. These are followed in frequency by one shroud forward and three aft (15% of the sample), four shrouds forward (11%), and three shrouds forward and one aft (6%). The majority of the 32 vessels with five shrouds have two shrouds forward and three aft of the mast (34% of the sample) or five shrouds aft of the fore mast (25%); the former being the most common setting for the naus and caravels and the latter for the galleons. There are seven vessels with three shrouds forward and two aft of the mast (22% of the sample), four naus with all five shrouds forward (13%), and two naus with

TABLE 14: Most Common Placement of the Fore Mast Shrouds

FORE MAST				
# of Shrouds	**# of Vessels**	**Vessel Types**	**Date Range**	**Shroud Position**
1	1	NAU	1588-98	1 AFT
1	1	CARAVEL	1538-40	1 AFT
1	1	NAU	1517-1526	1 FORE
2	3	NAU	1568	1 FORE / 1 AFT
2	1	CARAVEL	1566	1 FORE / 1 AFT
2	3	NAU	1509-1540	2 AFT
2	1	GALLEON	1558-1561	2 AFT
2	1	CARAVEL	1588-98	2 AFT
3	3	CARAVEL	1566-1572	1 FORE / 2 AFT
3	8	NAU	1509-1572	3 AFT
3	2	GALLEON	1509-1540	3 AFT
3	3	CARAVEL	1485-1583	3 AFT
4	10	CARAVEL	1538-1566	2 FORE / 2 AFT
4	16	NAU	1500-1600	4 AFT
4	3	GALLEON	1538-1556	4 AFT
5	8	NAU	1513-1572	2 FORE / 3 AFT
5	3	CARAVEL	1558-1566	2 FORE / 3 AFT
5	1	GALLEON	1538-1540	5 AFT
6	1	CARAVEL	1566	2 FORE / 4 AFT
6	1	CARAVEL	1558-1561	3 FORE / 3 AFT
6	1	CARAVEL	1566	4 FORE / 2 AFT
6	7	NAU	1558-1579	6 AFT
6	1	GALLEON	1593	6 AFT
7	8	NAU	1515-1598	3 FORE / 4 AFT
7	1	CARAVEL	1558-1561	3 FORE / 4 AFT
7	1	GALLEON	1538-1550	3 FORE / 4 AFT
8	1	NAU	1538-1550	3 FORE / 5 AFT
8	1	GALLEON	1572	5 FORE / 3 AFT
9	1	NAU	1558-1561	9 AFT
10	1	CARAVEL	1558-1561	2 FORE / 8AFT
12	1	GALLEON	1502	8 AFT - 4 FORE

one shroud forward and four aft (6%). Of the 27 vessels with six shrouds, there are nine vessels with six shrouds aft of the fore mast (22% of the sample), which is the most common placement for the naus. Within this group, the galleons and caravels do not have a dominant shroud setting. There are five vessels each with two shrouds forward and four aft of the mast and four shrouds forward and two aft, each accounting for almost 19% of the sample. There are six vessels with three shrouds on either side of the mast (22% of the sample) and two vessels with all six shrouds forward (7% of the sample). The majority of vessels with seven shrouds per side of the fore mast have three shrouds forward and four aft of the mast (71% of the sample), which also the most common is setting for all three ship types. Three vessels have one shroud forward and six aft of the mast (21% of the sample) and the last vessel has all seven shrouds placed aft (8%). There are two vessels with nine shrouds split between three shrouds forward and five aft of the mast and the reverse setting of five forward and three aft. The last vessel with nine shrouds has all nine shrouds placed aft of the mast. Of the remaining two vessels with 10 and 12 shrouds respectively, the first has two shrouds forward and eight aft of the mast, and the second has eight shrouds forward and four aft.

The most common placement of the fore topmast and topgallant mast shrouds can be viewed in Tables 15 and 16. There is one vessel with a single topmast shroud which is placed forward of the mast. The majority of vessels with two topmast shrouds have one shroud set on either side of the mast (81% of the sample); the standard setting for caravels and naus. The most recurrent configuration for galleons is two shrouds aft of the mast which accounts for five of the remaining vessels (17% of the sample), while the

TABLE 15: Most Common Placement of the Fore Topmast Shrouds

FORE TOPMAST				
# of Shrouds	**# of Vessels**	**Vessel Types**	**Date Range**	**Shroud Position**
1	1	NAU	1566	1 FORE
2	12	NAU	1519-1598	1 FORE / 1 AFT
2	16	CARAVEL	1566-1572	1 FORE / 1 AFT
2	2	GALLEON	1538-1561	2 AFT
3	3	CARAVEL	1558-1566	1 FORE / 2 AFT
3	9	NAU	1538-1572	2 FORE / 1 AFT
3	2	GALLEON	1538-1593	3 AFT
4	3	CARAVEL	1558-1566	2 FORE / 2 AFT
4	26	NAU	1530-1566	2 FORE / 2 AFT
5	1	CARAVEL	1558-1561	2 FORE / 3 AFT
5	5	NAU	1558-1566	3 FORE / 2 AFT
6	4	NAU	1515-1566	3 FORE / 3 AFT
9	1	NAU	1558-1561	4 FORE / 5 AFT

TABLE 16: Most Common Placement of the Fore Topgallant Mast Shrouds

FORE TOPGALLANT				
# of Shrouds	**# of Vessels**	**Vessel Types**	**Date Range**	**Shroud Position**
1	1	GALLEON	1538-1540	1 AFT
2	2	NAU	1510-1526	2 AFT
3	2	NAU	1538-1550	2 FORE / 1 AFT
4	2	NAU	1530-1550	2 FORE / 2 AFT
5	1	NAU	1538-1550	2 FORE / 3 AFT
6	1	NAU	1515-1525	3 FORE / 3 AFT

last two vessels have both shrouds forward (3%). Of the 32 vessels with three topmast shrouds, there are 12 (38% of the sample) with one shroud forward and two aft of the mast and 10 with two shrouds forward and one aft (31%); the former and the latter settings are the most common placement for caravels and naus respectively. There are an additional seven vessels (22% of the sample) with all three shrouds set aft of the mast; the most dominant configuration for the galleons. The remaining three vessels (9% of the sample) have all three shrouds set forward of the topmast. There are 39 vessels with four shrouds 29 of which (74% of the sample) have two set on either side of the mast making it the most common placement for caravels and naus. There are eight vessels with one shroud forward and three aft of the mast (21% of the sample) and one vessels each with three shrouds forward and one aft as well as all four forward of the topmast (2.5 % each). Of the eight vessels with five shrouds, three have two shrouds forward and three aft of the mast and the remaining five have three shrouds forward and two aft of the topmast; the first is the most recurrent setting for caravels while the second is the standard for the naus. There are six vessels with six shrouds, within which the most prevailing setting for the naus is three shrouds on either side of the mast (4 out of 6 vessels or 67% of the sample). The remaining two vessels are split between one shroud forward and five aft of the mast and two shrouds forward and four aft, each accounting for nearly 17% of the sample. One nau with nine shrouds has four shrouds forward and five aft of the topmast.

One galleon has a single topgallant mast shroud placed aft of the mast and two vessels with two shrouds both of which are placed forward of the topmast. The two naus with three shrouds have two shrouds forward and one aft of the mast. Two of the three naus with four shrouds have two shrouds on either side of the mast while the third has all four shrouds forward of the topgallant mast. There is a single nau with five shrouds with two shrouds forward and three aft of the mast and another nau with six shrouds which are evenly divided forward and aft.

For the caravels, galleons, and naus the average range of shrouds is three to five, three to four, and four to six for the lower fore mast respectively; and two, two to three, and three to four shrouds for the fore topmast respectively. The average number of shrouds for the topgallant mast range from one shroud for galleons to two to four shrouds for the naus; there is no data available for the caravels. The general trend of the number of shrouds indicates an increase which corresponds with the relative size of the caravels, galleons, and naus; a continuous trend already seen for the previous masts with the overall averages for each vessel type presented in Table 17. The decision about the number of shrouds and the exact placement of shrouds on all ship types appears to be highly variable for each mast. Likewise, there is no temporal influence on the number or placement of shrouds and the 16th century seems to be fairly homogenous in regards to rigging Iberian ships in general and the shrouds in particular.

6.2 REPRESENTATIONAL TRENDS ANALYSIS OF RATLINES

The representational trends study of the ratlines is a presence or absence analysis that is further evaluated by the number of caravels, naus, and galleons as well as the individual masts with this rigging feature. The tabulation of ratlines by mast and vessel

TABLE 17: Average Shroud Counts in the Iconography

MAST	CARAVEL	GALLEON	NAUS
BONAVENTURE MAST	1-2	2-3	3-4
MIZZEN MAST	2-3	2-4	3-4
MAIN MAST	3-4	5-6	6-7
MAIN TOPMAST	0	2-4	2-4
FORE MAST	3-5	3-4	4-6
FORE TOPMAST	2	2-3	3-4
FORE TOPGALLANT MAST	0	1	2-4

TABLE 18: Presence of Ratlines by Mast and Vessel Type

BONAVENTURE MAST		
Vessel Types	**# of Vessels**	**Date Range**
CARAVEL	9	1558-1561
GALLEON	1	1538-1540
NAU	1	1558-1561

MAIN TOPMAST		
Vessel Types	**# of Vessels**	**Date Range**
CARAVEL	1	1566
GALLEON	3	1538-1593
NAU	144	1517-1603

MIZZEN MAST		
Vessel Types	**# of Vessels**	**Date Range**
CARAVEL	11	1558-1598
GALLEON	5	1538-1593
NAU	128	1510-1603

FORE MAST		
Vessel Types	**# of Vessels**	**Date Range**
CARAVEL	25	1485-1572
GALLEON	7	1538-1593
NAU	85	1513-1598

MIZZEN TOPMAST		
Vessel Types	**# of Vessels**	**Date Range**
NAU	1	1573-1603

FORE TOPMAST		
Vessel Types	**# of Vessels**	**Date Range**
CARAVEL	6	1558-1566
GALLEON	3	1538-1593
NAU	60	1529-1594

MAIN MAST		
Vessel Types	**# of Vessels**	**Date Range**
CARAVEL	18	1500-1598
GALLEON	14	1519-1616
NAU	226	1500-1596

FORE TOPGALLANT		
Vessel Types	**# of Vessels**	**Date Range**
NAU	1	1517-1526

can be viewed in Table 18. Out of the 93 ships, 11 (12% of the sample) with bonaventure masts have ratlines, the majority of which (9 caravels and 1 nau) comes from a single source (MA15: 1558-1561). The remaining galleon is from another source (MA13: 1538-1540), but also dates to the mid-sixteenth century. For the mizzen mast only 144 out of 515 vessels (28% of the sample) have ratlines. There are 128 naus from 1510-1603, 11 caravels from 1558-1598, and five galleons from 1538-1593. There is Of the 541 vessels with main masts, 258 (48%) have ratlines the majority of which are naus (226 vessels), whereas caravels and galleons have a significantly lower count of 18 and 14 respectively. All of the three vessels types have relatively similar date ranges; 1500-1598 for the caravels, 1519-1616 for the galleons, and 1500-1596 for the naus. There are 148 out 383 vessels with ratlines on the main topmast (39% of the sample). Of these 148 vessels, 144 are naus from 1517-1603, three are galleons from 1538-1593, and one is a caravel from 1566. Surprisingly, there are only 117 vessels out of 387 (30% of the sample) with ratlines on the fore mast. The total percentage of vessels with ratlines on the fore mast is considerably lower than what is found on the main mast. The majority of the sample is naus which date to 1513-1598. There are also 25 caravels dated to 1485-1572 and seven galleons dated to 1538-1593. For the fore topmast, there are 69 vessels out of 326 (21%) with ratlines 60 of which are naus, six are caravels, and three are galleons. The naus date to 1529-1594 while the caravels and galleons have narrower date ranges of 1558-1566 and 1538-1593 respectively. There is only one nau with ratlines on the fore topgallant mast which dates to 1517-1526. Based on this data, it is apparent that only a relatively small portion of the ships have bonaventure and mizzen mast ratlines while less than half of the sample have ratlines on the lower and upper main and fore masts. It is probable that these results reflect an artistic trend as opposed to an actual trend. Artists likely considered the ratlines as too insignificant to include or excluded them in an effort to minimize distracting details from the overall ship depiction.

This data can be further analyzed by a detailed approach to the individual ship types and by examining the associated date ranges. Excluding the bonaventure mast and mizzen topmast of which there is only a single example of each, the general presence of ratlines in the nau sample essentially spans the entire 16th century, whereas for the caravels this is only true for the main and fore mast. The bonaventure, mizzen, and fore topmast ratlines on caravels all date to the mid century and the mizzen is the only mast with a date range extending to the end of the century. The main topmast is a rare occurrence (N=1) and is dated to 1566. In almost direct contrast to the nau sample, the galleons only have one mast, the main mast, for which ratlines are seen roughly throughout the 16th century. The mizzen and fore masts on the galleons have an identical date range of 1538 to 1593 while the bonaventure mast has a tighter range of 1538 to 1540.

The bonaventure mast ratlines, in general, occur for a very short period of time in the middle of the century. As stated previously, 10 out of 11 of the vessels with bonaventure mast ratlines come from a single source (MA15) and appear on the yearly fleets from 1501-1533 while the last vessel, a galleon, is from 1538-1540 (MA13.09). The presence of bonaventure ratlines on more than one source could suggest that this was an early and rare rigging experiment. There are very few vessels that have a bonaventure topmast and none with an associated top. There is no reason to have ratlines on the lower bonaventure shrouds when there is no topmast or top as it would essentially create a ladder to nowhere; refer to Table 19 for a list of mast tops. The galleon (MA13.09), however, is the one and only vessel to have a bonaventure topmast and one of three to have a bonaventure top thus it is logical for this vessel to have ratlines. Given the fact that all the vessels from MA15 have neither a topmast nor a top, it is likely the ratlines in this case are the result of artistic error, copied from the earlier source MA13, or used to assist in moving and setting the long lateen yards on the bonaventure mast.

The mizzen ratlines which were common for the naus throughout the 16th century appeared only on the caravels and galleons around the second quarter of the century but lasted until the 17th century. Given the similarity of the rigging, it is unusual that there is almost a three-decade time difference between the presence of mizzen ratlines on the naus and when they appear on the galleons. Interestingly, there are only 11 naus and eight galleons with mizzen tops and only two from each ship type have associated ratlines on the shrouds; there are no caravels with tops. Like the bonaventure mast, one of the possible explanations is that the ratlines were used on some of the caravels and galleons (18% and 26% respectively) and the majority of the naus (63%) to facilitate the movement or setting of the long lateen yards of the mizzen mast. Although there was no Iberian archival evidence referring to this specific use of ratlines, it is a practical solution to enable access to the top of the mizzen mast. This does not explain, however, the lack of mizzen ratlines on so many caravels and galleons and some of the naus. One potential

TABLE 19: Mast Tops Listed by Mast

BONAVENTURE MAST			
# of Vessels	**Vessel Type**	**Date**	**Top Structure**
3	GALLEON	1538-1600	PLATFORM
MIZZEN MAST			
# of Vessels	**Vessel Type**	**Date Range**	**Top Structure**
5	GALLEON	1538-1600	PLATFORM
3	GALLEON	1538-1600	BASKET
6	NAU	1556-1603	PLATFORM
5	NAU	1527-1600	BASKET
MAIN MAST			
# of Vessels	**Vessel Type**	**Date Range**	**Top Structure**
5	CARAVEL	1500-1584	PLATFORM
16	GALLEON	1502-1593	PLATFORM
358	NAU	1485-1600	PLATFORM
MAIN TOPMAST			
# of Vessels	**Vessel Type**	**Date Range**	**Top Structure**
4	GALLEON	1502-1589	PLATFORM
43	NAU	1500-1603	PLATFORM
FORE MAST			
# of Vessels	**Vessel Type**	**Date Range**	**Top Structure**
26	CARAVEL	1500-1566	PLATFORM
7	GALLEON	1538-1561	PLATFORM
105	NAU	1500-1600	PLATFORM
FORE TOPMAST			
# of Vessels	**Vessel Type**	**Date Range**	**Top Structure**
21	CARAVEL	1541-1593	PLATFORM
19	GALLEON	1502-1600	PLATFORM
174	NAU	1500-1603	PLATFORM

reason is that the mizzen masts were shorter and less robust on the caravels and the galleons which often had a fourth lateen bonaventure mast and thus required fewer or no shrouds for reaching the top of the mast. For more details, refer to the section on mast dimensions in Chapter X.

The data suggest that ratlines on the main and fore mast shrouds were common to all three ship types throughout the 16th century. Main and fore ratlines appear on 100% of naus with main shrouds, almost 78% of the naus with fore shrouds, roughly 60% of all galleons with main and fore shrouds, and nearly 66% of caravels with fore shrouds. Only 22% of the caravels with shrouds have corresponding ratlines and this low percentage is due to the fact that a significant number of them had lateen main masts and only one vessel also had an associated main top. In contrast, 10 out of 16 galleons (63%), and 218 out of 358 naus (61%) with main tops have ratlines. The question is therefore not why there are main mast ratlines on so many galleons and naus; it is why there are not ratlines on all these vessels with mast tops. It seems apparent that it is a matter of the incomplete representations of vessels which are lacking these features. Only 17 naus and one galleon have the shrouds and ratlines obscured by the placement of the sails or the view in which the ship was portrayed. This does not account for the almost 34% of naus and 31% of galleons with mast tops and no apparent way to reach them. There are 14 out of 26 caravels (54%), four out of seven galleons (57%), and 40 out of 105 naus (38%) with fore mast tops that have ratlines. The percentages for the caravels and galleons are fairly consistent with what was observed for the main mast. It is, however, quite contrary to the naus with main mast tops. The fore mast and associated shrouds and ratlines are obscured by sails far more often than the main mast; which accounts for an additional 13 caravels, two galleons, and 98 naus. While it is not possible to say that all these vessels have either fore mast tops or ratlines or both, it does provide a reasonable explanation as to why there are so few naus with these features in comparison to the main mast.

Main and fore topmast ratlines appear on almost 88% of naus with main topmast shrouds, 67% of the naus with fore mast shrouds, on roughly 33% of all galleons with main topmast shrouds, 60% of galleons with fore topmast shrouds, 100% of the caravels with main topmast shrouds and nearly 21% of with fore topmast shrouds. The caravel with main topmast ratlines does not have a mast top and only three of the eight galleons with mast tops have ratlines (38%). There is a very interesting pattern to the main topmast nau sample; there are 143 naus with main topmast ratlines, 38 with main topmast tops, and only four with both. This clearly shows that ratlines were not solely used to reach mast tops especially in the case of the main mast, but there is another purpose for their placement on the main topmast shrouds. It is not possible to conclusively determine what their function may have been other than to say that access to the top of the mast or the masthead was considered desirable based on the evidence that 88% of the naus with topmast shrouds have ratlines. The pattern for the fore topmast ratlines and tops is similar to that of the lower fore mast and different from the main topmast for which the number of ratlines far outweighs that of the tops. There are five out of 22 caravels (23%), three out of 19 galleons (16%), and only 32 out of 174 naus (18%) with fore mast tops that have ratlines and like the lower fore mast the low percentages suggest that the topmast shrouds and ratlines have been obscured in some manner. There are an additional 13 caravels, 2 galleons, and 78 naus for which the ratlines are not visible and these have the potential for increasing the percentages to a comparable range for the main mast.

6.3 REPRESENTATIONAL TRENDS ANALYSIS OF FORE AND BACK STAYS

The second component to the standing rigging is the fore and back stays. Fore stays are situated on the center line of the ship (fore-and-aft axis) and as the name suggests they run forward of the mast they support (Longridge and Bowness, 1989: 219). In addition to the shrouds, the back stays provide backward and lateral support, as well as counter act the forward pull of the sails on the top mast heads (Harland, 1985: 22). Palacio confirms the function of the forestay stating that the ship must be braced at the middle from bow to stern, which is done with a stay and a preventer stay; the main stay and preventer stay must reach from the mast top to the stem where a chain with its bull's eye is lashed below the beakhead's principle timber and the knee of the head, to which the main stay is strongly bound (Bankston, 1986: 125). According to Smith (1993: 100) the main stay was moved to the base of the foremast with the development of the full ship rig. The fore mast stay and preventer stay are made fast by their lanyards to two dead eyes which are customarily placed 2/3 of the way out on the bowsprit (Bankston, 1986: 125). Mizzen stays did not appear until the late 16th century as they prevented the mizzen yard from swinging when the ship tacked (Smith, 1993: 100). The only mention of stays for the bowsprit comes from Palacio who states that two stout ropes called backstays were rigged to both sides of the hull (Bankston, 1986: 127).

Bonaventure and Mizzen Mast Fore and Back Stays

There are 93 vessels with bonaventure masts and 515 with mizzen masts in the representational trends database. Out of these, there are only two vessels with bonaventure forestays (2%), 24 with bonaventure backstays (26%), nine with mizzen forestays (less than 1%), 148 with mizzen backstays (29%), and one nau with a mizzen topmast backstay. The lateen-rigged bonaventure and mizzen masts have different rigging requirements than the square-rigged main and fore masts. The primary difference in regards to the stays is that the lateen masts need either a fore or a back stay, but not both. Lateen yards are awkward to handle when tacking as it is necessary to haul the yard vertically around the mast (Bojakowski, 2007: 197). The stay, whether fore or back, would automatically impede a vertical alignment of the yard. It would not be possible to maneuver the long lateen yards around both stays; hence, all the fore and aft rigging elements are placed on one side of the mast only. In the iconography, the stays are most commonly placed aft of the bonaventure and mizzen masts and any changes to the positioning of the yards occur forward of the respective mast.

The two caravels with bonaventure forestays are from the same source, *Lendas da India de Gaspar Correa* date to 1538-1550, and run from the masthead to the base of the mizzen mast. The only other rigging elements present are shrouds indicating that the rigging was not fully or accurately depicted and as such it seems more plausible that the vessels had bonaventure backstays as opposed to forestays. The mizzen forestays, like the bonaventure forestays, only represent a very small portion of the sample; in this case just one percent. The forestay is located at the base of the mizzen mast for a majority of the vessels (e.g. four caravels and one galleon) and at mid-deck in front of the mizzen mast for the remaining two caravels. The bonaventure and mizzen fore and backstays can be viewed in Table 20. The negligible presence of forestays in the iconographic record could indicate that this is either a rare variant of the standing rigging or that it is an artistic error rather than a viable rigging alternative. For the first quarter of the 16th century, there are no caravels with stays; thus, the shrouds are the only standing rigging present. The appearance of forestays in 1538 and backstays in 1558 may suggest that for the few caravels with forestays, this might be an early attempt at incorporating stays into the rigging. It seems likely, however, that the idea of adding stays to the rigging would have stemmed from the ubiquitous naus, which already had backstays on the mizzen mast. As such, there is no practical explanation as to why some vessels were rigged with forestays without contemporary examples.

In every instance, the bonaventure backstays are placed at the end of the boomkin. The most common placement of the mizzen backstay (99% of the sample) for the naus is also the end of the boomkin. The caravels which have both a bonaventure and mizzen mast have the mizzen backstay running to the middle of the poop deck on 10 out of 16 vessels (62% of the sample), the top of the bonaventure on three vessels (19%), and to the base of the bonaventure on three vessels (19%). The one four-masted nau and one of the four-masted galleons also have the mizzen backstay running to the base of the bonaventure. There is only one nau with a mizzen topmast backstay which is also

TABLE 20: Bonaventure and Mizzen Mast Fore and Backstays

BONVENTURE	**FORESTAYS**		
# of Vessels	Vessel Types	Date Range	Forestay Position
2	CARAVEL	1538-1550	BASE MIZZEN MAST
BONVENTURE	**BACKSTAYS**		
# of Vessels	Vessel Types	Date Range	Backstay Position
24	CARAVEL	1558-1584	END BOOMKIN
MIZZEN	**FORESTAYS**		
# of Vessels	Vessel Types	Date Range	Forestay Position
4	CARAVEL	1538-1593	BASE MIZZEN MAST
1	GALLEON	1552	BASE MIZZEN MAST
2	CARAVEL	1538-1572	MID DECK
2	NAU	1572-1598	MID DECK
MIZZEN	**BACKSTAYS**		
# of Vessels	Vessel Types	Date Range	Forestay Position
3	CARAVEL	1566	BASE BONAVENTURE
1	GALLEON	1593	BASE BONAVENTURE
1	NAU	1510	BASE BONAVENTURE
3	CARAVEL	1558-1584	TOP BONAVENTURE
130	NAU	1509-1603	END BOOMKIN
10	CARAVEL	1566	MID POOP
MIZZEN	**TOPMAST**	**BACKSTAYS**	
# of Vessels	Vessel Types	Date Range	Backstay Position
1	NAU	1573-1603	END BOOMKIN

located at the end of the boomkin. That the backstays are always placed at the end of the boomkin is a significant distinction from the bonaventure or mizzen sail sheets, which are often located near the middle of the spar. Distinguishing between the stays and sheets for the bonaventure mast on caravels and galleons and the mizzen mast for naus can often be difficult. The best way to differentiate between the two is that backstays always run from the masthead in a taut line to the end of the boomkin. Even though at first glance sheets that appear on a yard on which the sail is furled can look nearly identical, they will run from the middle of the boomkin to the middle of the yard. Furthermore, the sheets are sometimes depicted with a slack line. Although there is only one vessel (MA15.1502.05) with both a bonaventure backstay and sheets, there are many mizzen masts with both of these rigging elements (31% of the sample). The mizzen fore and backstays in the iconographic record clearly contradict Smith's statement that mizzen stays did not occur until the end of the 16th century. For the nau sample, there is representation of the mizzen stay from 1509 to 1603. The galleons and caravels have a similar date range from mid to late 16th century with caravel forestays appearing as early as 1538 and backstays in 1558.

Main Mast, Main Topmast, Main Topgallant Mast Fore and Back Stays

There are 541 vessels with lower main masts, 383 with main topmasts, and 32 with main topgallant masts in the representational trends database. There are 136 vessels with main mast forestays (25%), 147 with main topmast forestays (42%), 18 with main topgallant forestays (56%). There are also 71 vessels with main mast backstays (13%), 16 with main topmast backstays (4%), and one galleon with a main topgallant backstay (3%). The placement of the main mast forestays can be view in Table 21 and the back stays in Table 22. The most common placement of the main mast forestays is the base of the foremast which accounts for 106 vessels, while three naus have the forestays attached midway on the foremast and an additional six vessels have the forestays running to the start of the forecastle. There is also one galleon and seven naus which have the forestays set at the top of the fore mast or the base of the fore topmast which is the standard placement for the main topmast forestays, accounting for 92 vessels (63% of the sample). The remaining 53 naus and two galleons (47%) have the main topmast forestay running to the fore topmast masthead. The main topgallant mast forestays are set in the same positions as the topmast forestays: the base of the fore topmast (61% of the sample) and the fore topmast masthead (49%). There are 13 caravels without a foremast, six of which have the main forestay secured forward of the mast on the deck, another six have it further forward in the middle of the waist, and one has the stay attached to the stem.

Bowsprits only occur on vessels with foremasts just as boomkins are only present when there is a bonaventure or mizzen mast as these spars function to anchor the rigging associated with these masts. Hence, the main forestays for the three-masted caravels can only run somewhere forward of the mast. These lateen-rigged caravels do not have topmasts as they would be rendered excessive given the extensive length of the lower yards and the corresponding amount of sail area. Although the lack of a fore mast automatically separates the caravels into main forestay subcategories, there is no

TABLE 21: Main Mast Forestays

MAIN MAST			
# of Vessels	**Vessel Types**	**Date Range**	**Forestay Position**
83	NAU	1485-1603	BASE FORE MAST
10	CARAVEL	1538-1593	BASE FORE MAST
13	GALLEON	1509-1616	BASE FORE MAST
3	CARAVEL	1517-1566	START FORECASTLE
2	NAU	1566	START FORECASTLE
1	GALLEON	1574	START FORECASTLE
3	NAU	1568	FOREMAST - MID WAY
6	CARAVEL	1509-1572	FORWARD OF MAST
6	CARAVEL	1519-1598	MID WAIST
1	CARAVEL	1519	STEM POST
1	GALLEON	1589	TOP FORE MAST
7	NAU	1565-1595	TOP FORE MAST
MAIN	**TOPMAST**		
# of Vessels	**Vessel Types**	**Date Range**	**Forestay Position**
2	GALLEON	1558-1589	ATOP FORE TOPMAST
53	NAU	1565-1600	ATOP FORE TOPMAST
1	CARAVEL	1584	BASE FORE TOPMAST
7	GALLEON	1538-1593	BASE FORE TOPMAST
84	NAU	1500-1600	BASE FORE TOPMAST
MAIN	**TOPGALLANT**	**MAST**	
# of Vessels	**Vessel Types**	**Date Range**	**Forestay Position**
1	GALLEON	1538-1540	ATOP FORE TOPMAST
6	NAU	1500-1550	ATOP FORE TOPMAST
1	GALLEON	1572	BASE FORE TOPMAST
10	NAU	1530-1603	BASE FORE TOPMAST

TABLE 22: Main Mast Backstays

MAIN	**MAST**		
# of Vessels	**Vessel Types**	**Date Range**	**Backstay Position**
5	CARAVEL	1558-1593	ATOP MIZZEN MAST
5	GALLEON	1509-1593	ATOP MIZZEN MAST
18	NAU	1510-1593	ATOP MIZZEN MAST
9	CARAVEL	1515-1589	BASE MIZZEN MAST
1	GALLEON	1589	BASE MIZZEN MAST
7	NAU	1500-1600	BASE MIZZEN MAST
1	GALLEON	1572	MID MIZZEN MAST
1	NAU	1500-1600	MID MIZZEN MAST
2	GALLEON	1519-1574	END POOP DECK
2	CARAVEL	1517-1572	END POOP DECK
2	NAU	1531-1570	END POOP DECK
2	CARAVEL	1520-1572	MID POOP DECK
2	NAU	1566	MID POOP DECK
1	CARAVEL	1566	END HALF DECK
1	NAU	1573-1603	END HALF DECK
9	CARAVEL	1566	MID HALF DECK
2	CARAVEL	1572	END QUARTER DECK
1	NAU	1572	END QUARTER DECK
MAIN	**TOPMAST**		
# of Vessels	Vessel Types	Date Range	Backstay Position
1	CARAVEL	1584	TOP MIZZEN MAST
3	GALLEON	1572-1593	TOP MIZZEN MAST
11	NAU	1514-1603	TOP MIZZEN MAST
1	NAU	1582	BASE MIZZEN TOPMAST
MAIN	**TOPGALLANT**	**MAST**	
# of Vessels	Vessel Types	Date Range	Backstay Position
1	GALLEON	1572	TOP MIZZEN MAST

difference in the positioning of the main backstays.

There are 28 vessels (40% of the sample) with the main mast backstays attached to the mizzen masthead and only 17 vessels (24%) running to the base of the mast. A further two vessels (3% of the sample) have the backstay secured in the middle of the mizzen mast; however, this is more likely an artistic error as it is not a logical place to attach the backstay given the amount of pressure from the weight and pull of the main mast. This strain would likely snap the mast at the point of attachment. The remaining vessels have the backstay secured along the sterncastle with the forward end of the poop deck as the attachment point for six vessels (8% of the sample), mid-poop deck for four (6%), forward end of the quarter deck for three (4%), forward end of the half deck for two (3%), and mid-half deck for the last nine (12%). For the main topmast backstay the predominant position is the mizzen masthead, which account for 15 out 16 vessels; while on the last nau it is located nearby at the base of the mizzen topmast. There is only one vessel with a main topgallant mast backstay and the placement is at the mizzen masthead.

Fore Mast and Fore Topmast Fore and Back Stays

There are 388 vessels with lower fore masts, 316 with fore topmasts, and 29 with fore topgallant masts in the representational trends database. There are 240 vessels with fore mast forestays (62% of the sample), 198 with fore topmast forestays (63%), nine with fore topgallant forestays (31%). There are also 10 with fore mast backstays (3%), and three with fore topmast backstays (1%). There are significantly more fore mast forestays with 447 instances than backstays for which there are only 13 vessels. This is predominantly caused by the presence of the main course and the main topsail as well as the exaggerated nature of the depiction of the sails which either obscure the backstays or the artist eliminates them in order to simplify the portrayal of the vessel. The placement of the fore mast forestays can be viewed in Table 23 and the back stays in Table 24. The most common placement of the fore mast forestay is midway on the bowsprit (63% of the sample) followed by the end of the bowsprit with 64 (29%) vessels and three-quarters the length of the bowsprit with 20 vessels (8%). There is one nau with the forestay placed at the base of the bowsprit but as this accounts for less than half a percent of the sample it should be discounted. There are two main positions for the fore topmast forestay with the end of the bowsprit accounting for 166 out of 198 vessels (84% of the sample) while the remaining 32 vessels (26%) have the stay attached at three-quarters of the length of the bowsprit. Of the nine vessels with fore topgallant mast forestays, seven have the stay running straight down to the base of the fore topmast and only two have it secured at the end of the bowsprit.

There are 10 vessels with fore mast backstays of which five naus have the stay secured at the base of the main mast and one nau at the middle of the main mast; both are highly unlikely positions as it would interfere with the movement of the main course. The two other naus have the backstay attached to aft end of the forecastle. The galleon has the backstay secured to the main mast forestay, while the caravel has it positioned in the middle of the forecastle. There is one galleon with a fore topmast backstay which is also attached to the main mast forestay and two naus with it secured to the base of the

TABLE 23: Fore Mast Forestays

FORE	MAST		
# of Vessels	**Vessel Types**	**Date Range**	**Forestay Position**
1	NAU	1500-1600	BASE BOWSPRIT
3	CARAVEL	1538-1593	1/2 BOWSPRIT
3	GALLEON	1538-1593	1/2 BOWSPRIT
14	NAU	1500-1589	1/2 BOWSPRIT
24	CARAVEL	1538-1583	3/4 BOWSPRIT
7	GALLEON	1519-1589	3/4 BOWSPRIT
124	NAU	1485-1598	3/4 BOWSPRIT
17	CARAVEL	1485-1584	END BOWSPRIT
9	GALLEON	1509-1556	END BOWSPRIT
38	NAU	1509-1600	END BOWSPRIT
FORE	**TOPMAST**		
# of Vessels	**Vessel Types**	**Date Range**	**Forestay Position**
2	CARAVEL	1558-1561	3/4 BOWSPRIT
2	GALLEON	1538-1561	3/4 BOWSPRIT
28	NAU	1500-1589	3/4 BOWSPRIT
36	CARAVEL	1538-1593	END BOWSPRIT
11	GALLEON	1519-1589	END BOWSPRIT
119	NAU	1519-1598	END BOWSPRIT
FORE	**TOPGALLANT**	**MAST**	
# of Vessels	**Vessel Types**	**Date Range**	**Forestay Position**
7	NAU	1530-1550	BASE FORE TOPMAST
1	NAU	1535-1570	END BOWSPRIT
1	GALLEON	1538-1540	END BOWSPRIT

TABLE 24: Fore Mast Backstays

FORE	**MAST**		
# of Vessels	**Vessel Types**	**Date Range**	**Backstay Position**
5	NAU	1500-1600	BASE MAIN MAST
1	NAU	1500-1600	MID MAIN MAST
1	GALLEON	1593	MAIN FORESTAY
1	NAU	1565	START FORE CASTLE
1	CARAVEL	1538-1540	MID FORECASTLE
1	NAU	1572	END FORECASTLE
FORE	**TOPMAST**		
# of Vessels	**Vessel Types**	**Date Range**	**Backstay Position**
1	GALLEON	1593	MAIN FORESTAY
2	NAU	1509-1519	BASE MAIN MAST

main mast.

6.4 REPRESENTATIONAL TRENDS ANALYSIS OF HALYARDS AND BRACES

Halyards were attached to the yardarms to raise and support the main and fore yards as well as to hold them properly square (Bankston, 1986: 126). A rope was rove through a block that was hung on a strop from the masthead and into another block and strop at the tip of the yard; the rope was then rove back through the first block down to the deck where it was secured (Bankston, 1986: 126; Smith, 1993: 113). On heavy yards, several blocks were spread across the yard for more purchase (Smith, 1993: 113). Braces adjusted the yard in a horizontal plane and were attached to the yardarms; they were also utilized to swing the yard and sail around the mast to meet the wind at the proper angle. Square sail yards had a pair of braces that ran from the hull up to the blocks and strops fastened to the tops of the yardarms and back to the deck (Smith, 1993: 113).

Palacio gives a fairly detailed description of the running rigging of the mizzen's lateen yard which entails the tye and halyard configuration; however there is no information given regarding lifts or braces. According to Palacio, one end of the main or fore yard's halyard is made fast to the head of the top mast and the other returns through the block at the yardarm to reeve through a block that will be at the same masthead and from there the rope-point will come back as far as the top (Bankston, 1986: 128). Likewise, there is a brace pendant on each yardarm that is a third of the yard in length with a common block at the end through which is rove a rope. One point of each rope is made fast at the cheeks of the mizzen mast and reaches to the shrouds on each side and reeve through a single block until the rope reaches the quarter deck (Bankston, 1986: 128). The foremast yard braces have the same configuration and were handled from the waist (Bankston, 1986: 126; Smith, 1993: 113). The tackles for the main and fore topsail yards lifts are the same as the main and fore yards; however, they were 1/5 smaller. Braces are affixed to the main topmast stay and the other two ends were rove through their blocks as far aft as the quarter deck (Bankston, 128).

Bonaventure and Mizzen Yards and Topyards

In the representational trends database, there are 93 vessels with bonaventure masts and one vessel with a bonaventure topmast, 37 of which show bonaventure yard halyards (40% of the sample), 14 vessels have bonaventure yard braces (15%), and one vessel has bonaventure topyard halyards. The majority of the vessels with bonaventure halyards and braces are caravels which account for a total of 76% of both samples, while galleons represent only 18% and naus only 6%. There are 515 vessels with mizzen masts, 105 of which have mizzen yard halyards (20% of the sample) and 108 have mizzen yard braces (21%). There are 11 vessels with mizzen topmasts four of which have mizzen topyard halyards (36%) and one vessel has mizzen topyard braces (9%). The presence of halyards and braces for the bonaventure and mizzen mast can be viewed in Table 25. Overall, there are relatively few vessels depicted with braces on the bonaventure yard in comparison to those with halyards, while only seven caravels and

TABLE 25: Bonaventure and Mizzen Yard Halyards and Braces

BONAVENTURE

HALYARDS		
# of Vessels	**Vessel Type**	**Date**
29	CARAVEL	1539-1566
6	GALLEON	1502-1589
2	NAU	1510

TOPYARD HALYARDS		
# of Vessels	**Vessel Type**	**Date**
1	GALLEON	1538-1540

BRACES		
# of Vessels	**Vessel Type**	**Date**
10	CARAVEL	1558-1566
3	GALLEON	1589
1	NAU	1558-1561

MIZZEN

HALYARDS		
# of Vessels	**Vessel Type**	**Date**
14	CARAVEL	1500-1598
1	GALLEON	1500-1593
90	NAU	1485-1600

BRACES		
# of Vessels	**Vessel Type**	**Date**
6	CARAVEL	1558-1572
1	GALLEON	1552
101	NAU	1510-1595

TOPYARD HALYARDS		
# of Vessels	**Vessel Type**	**Date**
2	GALLEON	1538-1552
2	NAU	1535-1595

TOPYARD	BRACES	
# of Vessels	**Vessel Type**	**Date**
1	GALLEON	1552

TABLE 26: Main and Fore Yard Halyards and Braces

MAIN MAST

HALYARDS		
# of Vessels	**Vessel Type**	**Date**
18	CARAVEL	1500-1598
23	GALLEON	1500-1593
240	NAU	1485-1600
BRACES		
# of Vessels	**Vessel Type**	**Date**
23	CARAVEL	1500-1566
21	GALLEON	1502-1593
275	NAU	1485-1603
TOPYARD HALYARDS		
# of Vessels	**Vessel Type**	**Date**
3	CARAVEL	1500-1566
15	GALLEON	1519-1593
245	NAU	1485-1603
TOPYARD BRACES		
# of Vessels	**Vessel Type**	**Date**
3	CARAVEL	1500-1566
12	GALLEON	1519-1593
231	NAU	1485-1603
TOPGALLANT YARD HALYARDS		
# of Vessels	**Vessel Type**	**Date**
6	GALLEON	1538-1593
20	NAU	1500-1570
TOPGALLANT YARD BRACES		
# of Vessels	**Vessel Type**	**Date**
3	GALLEON	1538-1593
16	NAU	1500-1603

FORE MAST

HALYARDS		
# of Vessels	**Vessel Type**	**Date**
30	CARAVEL	1485-1593
18	GALLEON	1502-1593
123	NAU	1485-1600
BRACES		
# of Vessels	**Vessel Type**	**Date**
41	CARAVEL	1538-1593
19	GALLEON	1500-1593
175	NAU	1485-1600
TOPYARD HALYARDS		
# of Vessels	**Vessel Type**	**Date**
44	CARAVEL	1485-1593
15	GALLEON	1519-1593
157	NAU	1485-1600
TOPYARD BRACES		
# of Vessels	**Vessel Type**	**Date**
22	CARAVEL	1485-1593
11	GALLEON	1538-1593
115	NAU	1485-1600
TOPGALLANT YARD HALYARDS		
# of Vessels	**Vessel Type**	**Date**
3	GALLEON	1538-1550
17	NAU	1500-1550
TOPGALLANT YARD BRACES		
# of Vessels	**Vessel Type**	**Date**
1	GALLEON	1538-1540
15	NAU	1500-1603

one galleon have both of these running rigging elements. Unlike the bonaventure mast, there are far more naus in the mizzen mast sample than either caravel and galleons accounting for 81% as opposed to 16% and 3% respectively. Unlike the bonaventure sample, there is a consistent number of ships with halyards and with braces.

Main and Fore Yards, Topyards, and Topgallant Yards

The representational trends database has 541 vessels with lower main masts, 383 with main topmasts, and 32 with main topgallant masts. There are 281 vessels with main yard halyards (52% of the sample), 319 with main yard braces (59%), 263 with main topyard halyards (69%), 246 with main topyard braces (64%), 26 with main topgallant yard halyards (81%), and 19 vessels with main topgallant yard braces (59%). There are 388 vessels with lower fore masts, 316 of which with fore topmasts, and 29 with fore topgallant masts. There are 171 vessels with fore yard halyards (44%), 235 with fore yard braces (61%), 216 with fore topyard halyards (68%), 148 with fore topyard braces (47%), 20 with fore topgallant yard halyards (69%), and 16 vessels with fore topgallant yard braces (55%). The different rigging combinations were tabulated for both the main and fore mast and can be viewed in Table 26. There is little variation in the representation of the running rigging for the main and fore masts with the square sails. Although there is a relatively consistent number of vessels with halyards and braces in the sample, the latter tend to have lower overall percentages. The exception to this is the lower main and fore yards which have more braces visible than halyards. Likewise, the running rigging for the lower yards is less represented than the higher topmast and topgallant masts for which there is a very simple explanation. It appears that the lower main and fore courses are usually unfurled and tend to be billowed in a slightly exaggerated manner thereby obscuring many of the rigging elements.

6.5 COMPARATIVE ANALYSIS OF THE STANDING AND RUNNING RIGGING

Bonaventure and Mizzen Yards

The rigging of the lateen bonaventure and mizzen masts involves a complicated arrangement of different standing and running rigging elements which were tabulated for in Appendices 19 and 20 respectively. Although the bonaventure mast has less variation than the mizzen, only those which account for 10% or more of the sample will be discussed here. The most common standing and running rigging combination for bonaventure mast is shrouds only (34.72% of the sample) followed by the presence of shrouds, a backstay, and halyards together (23.61%) and then shrouds and halyards (9.72%); only 5.56% of the sample has all four rigging elements. The braces account for very little of the sample which is reflected in the lower overall percentage in the representational trends (15% of the sample). This is unusual given the vital role braces played in stabilizing the long lateen yards. These yards usually have two stabilizing ropes, the peak and foot braces, which assist in controlling the yard and setting it at the appropriate angle (Bojakowski, 2007: 202). Due to the lack of braces, the three most common rigging settings for the bonaventure mast are in reality unachievable. Shrouds alone and even the combination of shrouds with backstays and halyards provide the necessary support to the mast itself, but not the yard. Halyards raise and stabilize the yard in the center but without the braces on the yardarms, the sail would never be trimmed properly as the force of the wind on the long arms would subject the yard to excessive vertical and horizontal movement. The lack of braces in the iconography is most likely due to the tendency of the artists to simplify rigging elements within the depiction of the ship.

The most common running and standing rigging combination for the mizzen mast is the presence of shrouds, a backstay, halyards, and braces (20% of the sample) followed by shrouds only (15%) and a combination of shrouds, backstay, and braces (15%). The remaining two combinations are backstays and halyards (11%) and shrouds, backstays, and halyards (11%). Like the previous discussion for the bonaventure mast, these variations arise from simplified depictions and from the sails obscuring a portion of the rigging; hence, these are not necessarily realistic variants of the standing and running rigging.

One aspect of the running rigging of the bonaventure and mizzen masts which is currently poorly understood is whether or not the backstay is truly a permanent fixture of the standing rigging or if it is an adjustable line more comparable to the running rigging. The presence of permanent "classic" stays would be an awkward addition to these masts given the complicated maneuvering of the yard, which is evidenced by the stay's relatively small presence in the iconography. It may be possible, that these stays acted more like a brace that could be adjusted and then secured after the tacking was completed. The yard is brought to a vertical position during tacking and then moved to the opposite side of the mast. In some instances the ability to loosen the line could facilitate the tacking process. As mentioned previously, the backstays were identified as such because they originated at the masthead and terminated on the boomkin.

Main and Fore Yards, Topyards, and Topgallant Yards

The different rigging combinations were tabulated for the lower mast, topmast, and top gallant mast for both the main and fore masts, both of which can be viewed in Appendices 21 and 22 respectively. The main and fore masts exhibit a wide range of variation in the rigging configurations; however, only those which account for 10% or more of the sample will be discussed here. The most common standing and running rigging combination for the lower main mast is halyards, braces, and shrouds which accounts for almost 20% of the sample. The depiction of only the halyards and braces is the second most frequent arrangement representing 16% of the sample followed by halyards, braces, shrouds, and forestays as well as shrouds alone (10% each). The halyards and braces predominate for the main topmast (18% of the sample) while halyards, braces, shrouds, and forestays represent 17%; and halyards, braces, and shrouds account for 16%. There are two equal primary settings for the main topgallant mast each totaling 13% of the sample and a third setting representing 11%. The first one consists of halyards, braces, and shrouds, while the second is comprised of halyards and braces. The third setting is halyards and forestays.

The most common standing and running rigging combination for the lower fore mast is halyards, braces, shrouds, and forestays representing 21% of the sample; while halyards, braces, and forestays account for 14%. The next two most frequent rigging settings are braces, shrouds, and forestays (13% of the sample), and braces and forestays (13%). The fore top mast has the halyards, shrouds, and forestays, or halyards, braces, and forestays, as the most commonly depicted rigging combinations, with each of these representing 15% of the sample. The next most frequent setting shown in roughly 13% of the depictions is the presence of halyards, braces, shrouds, and forestays. The dominant rigging for the fore topgallant mast is halyards and braces which account for 17% of the sample followed by four different combinations, each representing 10%. These are shrouds only; halyards, braces, shrouds, and forestays; halyards, braces, and forestays; and braces and forestays.

The main mast rigging combinations largely center on the halyards, braces, and shrouds while forestays and backstays are present in only one out of four settings for the lower mast and one out of three for the topmast and topgallant mast. Although stays are necessary elements for any square-rigged mast, they often are partially or completely obscured by the large sails. In comparison, the forestays in the fore mast sample are depicted in every one of the most common rigging combinations for the lower and upper fore masts, and in three out of five of the fore topgallant mast settings. Like the bonaventure and mizzen mast samples, the rigging elements of the main and fore masts indicate that the standing and running rigging was overly simplified in the depictions of the ships and reduced down to the most basic elements. None of these settings are inferences of variation of rigging configurations, however, as no square-rigged vessel could operate without halyards, shrouds, braces, forestays or backstays.

The overall analysis of the standing and running rigging indicates a remarkable consistency considering the fact that the iconography was produced by numerous artists, none of whom was a shipwright, and over the course of a century. With the exception of the mizzen stays, there is no major revelation as to the temporal development of the rigging throughout the 16th century. This was expected, however, as these ships belong to a transitional period of maritime technology dating from the 15th to the 18th centuries (Bradley, 2007b: IV-23). The rigging, and to some extent the hull design, was fixed by the 16th century and remained relatively static through the 18th century. Regardless, the analysis of the iconography provides more insight into the actual nuances of the standing and running rigging. The exact placement of the backstays and sheets on the boomkin is better understood as is the running of the sheets forward to an accessible point on the deck. The number and placement of the shrouds at first seem highly variable, but the averages reflect standards within the variation for the caravels, galleons, and naus, as well as between these three ship types.

Although the iconography does not illuminate some previously-undiscovered aspects of rigging, it does provide nuances and perhaps a greater understanding of the crucial roles of the captains in the rigging of ships. The flexibility of the rigging was important in order to take maximum advantage of the local winds, currents, and specific climatic conditions while allowing the vessel to travel through many regions of the world and increase the range of the vessel (Bradley, 2007a: IV-1). This was vital for Iberian voyages to the Indian Ocean and the Caribbean and the regional exploration and trade that occurred within and around these bodies of water.

CHAPTER VII

REPRESENTATIONAL TRENDS ANALYSIS OF HULL CONSTRUCTION AND DECORATIVE ELEMENTS IN THE ICONOGRAPHY

The representational trends analysis of the hull analyzes the presence of absence of sterncastles comprised of the poop deck, quarter deck, and half deck and forecastles as well as stern galleries and gun decks in the iconography. The analysis presented in this chapter also moved beyond the construction features of a ship which were the primary focus of the previous chapters to explore the decorative elements represented on the ship. In particular pendants, flags, castle shields, and sail decorations were assessed by the number of each element depicted on the ship as well as their position and color scheme or nationality markers.

7.1 REPRESENTATIONAL TRENDS ANALYSIS OF THE STERNCASTLE AND FORECASTLE

Sterncastles in the Iconography

The representational trends analysis of sterncastles and forecastles examines the presence and absence of the both of these superstructures for each ship type. The analysis also investigates the number of decks and the combination of decks; which includes the half deck, the quarter deck, and the poop deck on the sterncastle, as well as an upper deck on the forecastle (refer to Figure 3). The sterncastle data has been tabulated for all subsections in Table 27. In the representational trends database there are 514 vessels with sterncastles, which accounts for 95% of all vessels analyzed. There are 114 out of 116 caravels (98% of the sample), 35 out of 35 galleons (100%), and 365 out of 390 naus (94%) with sterncastles present and/or visible. The caravels have seven different combinations of the sterncastle decks while the galleons and naus have only five. The most common deck arrangement is a poop and half deck representing 49 out of 114 caravels (44% of the sample) followed by a single half deck accounting for 31 caravels (27%), and a quarter and a half deck with 23 caravels (20%). The remaining four combinations of the different decks are less conventional variants and include: a poop and a quarter deck (4% of the caravel sample), a single quarter deck (3%), a single poop deck (1%), and a half, quarter and poop deck (1%). The two most common galleon deck combinations are a half and quarter deck and a half, quarter, and poop deck both of which are represented by 10 out of 35 vessels (29% of the sample). There are eight galleons with a single half deck (23%), five with a poop and a half deck (14%), and one with a poop and a quarter deck (5%). Nearly half of the naus have a poop and a half deck (48% of the sample) while an additional 30% has a quarter and a half deck. The remaining three combinations include 46 naus with a half, quarter, and poop deck (13% of the sample), 23 with a single half deck (6%), and nine with a poop and a quarter deck (3%).

There are 74 (14% of the overall sample) vessels with open railings along the upper most deck of the sterncastle structure (see Table 28). Of these, there are 20

TABLE 27: Sterncastles in the Representational Trends Database

STERNCASTLE		N=514	
# of Vessels	**Vessel Type**	**Date**	**% of Sample**
114	CARAVEL	1485-1616	22.18%
35	GALLEON	1500-1616	6.81%
365	NAU	1500-1603	71.01%
POOP, QUARTER DECKS		N=16	
# of Vessels	**Vessel Type**	**Date**	**% of Sample**
5	CARAVEL	1500-1598	31.25%
2	GALLEON	1500-1540	12.50%
9	NAU	1500-1600	56.25%
POOP, QUARTER, HALF DECKS		N=57	
# of Vessels	**Vessel Type**	**Date**	**% of Sample**
1	CARAVEL	1550	1.75%
10	GALLEON	1519-1616	17.54%
46	NAU	1510-1600	80.70%
QUARTER DECKS		N=3	
# of Vessels	**Vessel Type**	**Date**	**% of Sample**
3	CARAVEL	1509-1616	100.00%
HALF DECKS		N=62	
# of Vessels	**Vessel Type**	**Date**	**% of Sample**
31	CARAVEL	1500-1588	50.00%
8	GALLEON	1509-1593	12.90%
23	NAU	1500-1600	37.10%
QUARTER, HALF DECKS		N=140	
# of Vessels	**Vessel Type**	**Date**	**% of Sample**
23	CARAVEL	1485-1598	16.43%
10	GALLEON	1519-1616	7.14%
107	NAU	1485-1596	76.43%
50	CARAVEL	1500-1593	21.83%
5	GALLEON	1519-1589	2.18%
174	NAU	1500-1600	75.98%

caravels (18% of the caravel sample), nine galleons (26% of the galleon sample), and 45 naus (12% of the nau sample). Although there is a clear association between the presence of the railing and the poop deck, no correlation to a specific combination of decks can be identified. The tabulation of the sterncastle railing by the different deck combinations shows that the percentages relate only to the general frequency of the deck combination (see Table 28). The railing is predominantly on the poop deck due to the fact that this is the uppermost deck in the superstructure for the majority of the deck combinations. The most common deck combination with open railings is actually a quarter and a half deck (35% of the railing sample) while an additional 16% of the sample is represented by vessels with a single half deck. As such, it is clear that there is a relatively low frequency of vessels with sterncastle railing and there is no preferential appearance of it on any deck combination.

Forecastles in the Iconography

In the representational trends database there are 385 vessels with forecastles (71% of all vessels) of which 63 are caravels (54% of all caravels), 31 are galleons (89% of all galleons), and 291 are naus (75% of all naus). Of these, 230 (60% of the sample) have an upper deck on the forecastle; a number which includes 26 out of the 63 caravels (41%), 12 out of the 31 galleons (39%), and 192 out of the 291 naus (66%); refer to Table 29. There are 47 vessels with an open railing on the forecastle which accounts for 12% of the sample and is comparable to the 14% of the vessels with railing on the sterncastle. Like the sterncastles, there is no correlation between deck configurations of

TABLE 28: Sterncastle Railing by Vessel and Deck Combination

STERNCASTLE RAILING		N=74	
# of Vessels	**Vessel Type**	**Date**	**% of Sample**
20	CARAVEL	1500-1572	27.03%
9	GALLEON	1500-1600	12.16%
45	NAU	1500-1603	60.81%
QUARTER, HALF DECK		N=26	
# of Vessels	**Vessel Type**	**Date**	**% of Sample**
5	CARAVELS	1513-1572	19.23%
2	GALLEON	1552-1593	7.69%
19	NAUS	1519-1594	73.08%
POOP, HALF DECKS		N=21	
# of Vessels	**Vessel Type**	**Date**	**% of Sample**
8	CARAVELS	1515-1572	38.10%
2	GALLEON	1519-1540	9.52%
11	NAUS	1500-1603	52.38%
HALF DECK		N=12	
# of Vessels	**Vessel Type**	**Date**	**% of Sample**
4	CARAVELS	1556-1572	33.33%
1	GALLEON	1556	8.33%
7	NAUS	1513-1589	58.33%
POOP, QUARTER, HALF DECKS		N=10	
# of Vessels	**Vessel Type**	**Date**	**% of Sample**
3	GALLEON	1519-1600	30.00%
7	NAUS	1519-1594	70.00%
POOP, QUARTER DECKS		N=5	
# of Vessels	**Vessel Type**	**Date**	**% of Sample**
3	CARAVELS	1500-1534	60.00%
1	GALLEON	1500-1525	20.00%
1	NAUS	1573-1603	20.00%

TABLE 29: Forecastles in the Representational Trends Database

FORECASTLE		**N=385**	
# of Vessels	**Vessel Type**	**Date**	**% of Sample**
63	CARAVEL	1485-1616	16.36%
31	GALLEON	1500-1600	8.05%
291	NAU	1485-1603	75.58%
FORECASTLE WITH UPPER DECK		**N=230**	
# of Vessels	**Vessel Type**	**Date**	**% of Sample**
26	CARAVEL	1558-1566	11.30%
12	GALLEON	1519-1600	5.22%
192	NAU	1500-1598	83.48%

TABLE 30: Vessels with Forecastle Railings

VESSELS WITH FORECASTLE RAILING		**N=47**	
# of Vessels	**Vessel Type**	**Date**	**% of Sample**
6	CARAVEL	1515-1534	12.77%
8	GALLEON	1519-1593	17.02%
33	NAU	1500-1603	70.21%
RAILING ON LOWER DECK		**N=19**	
# of Vessels	**Vessel Type**	**Date**	**% of Sample**
6	CARAVELS	1515-1534	31.58%
4	GALLEONS	1538-1593	21.05%
9	NAUS	1500-1603	47.37%
RAILING ON UPPER DECK		**N=28**	
# of Vessels	**Vessel Type**	**Date**	**% of Sample**
4	GALLEONS	1519-1552	14.29%
24	NAUS	1519-1592	85.71%

the superstructure and the presence of the railing for the galleons and the naus. The sample is divided between those ships with both a lower and an upper deck and railing (60% of the sample) and those with a lower deck only and railing (40%) (see Table 30). There are no caravels, however, with an upper deck and railing.

Caravel Forecastle Discussion

As discussed previously, all three ship types have sterncastles. In addition to the sterncastles, the vast majority of galleons and naus also have forecastles but only half of the caravels have a forecastle structure. In order to explore the relationship between the caravel and the presence or absence of the forecastle, it is necessary to understand the correlation between foremasts and forecastles. Although the topic is missing from any discussion on the rigging of the caravels in modern literature, this research establishes that caravels only had forecastles when a fore mast is present. A possible explanation is that the forecastle would interfere with the movement of a lateen main or fore sail.
The statistical and representational trends analyses overwhelmingly support this trend with the exception of five caravels which have some sort of a superstructure present on the bow and no foremast including: three two-masted caravels (MA08.01, MA10.09, MA11.09) and two three-masted caravels (CA04.31, MA08.02). The interpretation of these five bow superstructures is problematic, however, since it is not possible to call them true forecastles. Three of the six vessels (CA04.31, MA10.09, MA11.09) retain the characteristic curvature of the bow and upturned stem of two- and three-masted caravels and all have short and low sterncastles. Likewise, on the others (CA04.31, MA11.09)

there is strong evidence that these structures are simply railings (Figures 31 and 32). The presence of shields on the bow structures on three of the caravels (MA08.01, MA08.02, MA10.09) and the nature of the depiction make it difficult to discern if the structures are, in fact, railings (Figures 33 and 34); however, it is a completely plausible explanation for almost every vessel. The two caravels (MA08.01, MA08.02) could be an exception to the railing theory as they have more robust sterncastle and bow structures and are proportionally similar to the four-masted caravels. Collectively, it seems likely that the bow structures on caravels without foremasts are simply railings indicating added safety features. It is also equally possible that they represent partial superstructures or a covered area in the bow in addition to the sterncastle. The idea of a covered area in the bow is supported by Parry (1966: 23) who states that the caravels did not have raised forecastles; rather, there was a fore-peak used to store cables and gear. A partial deck in the bow could also have been used a defensive or offensive structure or as a useful area to handle anchors.

There are scholars who provide general descriptions of the caravel with a low forecastle. For instance, Barata claims that the typical two-masted *caravela latina* used for explorations in the 15th century had a low forecastle to accommodate the long main yard passing over the stem (Barata, 1989: 120). Edwards (1992: 426) also emphasizes a low forecastle in caravels based on the premise that the lateen yards would be impeded by large superstructures. Likewise, they contend that a low forecastle was no longer necessary when square sails were rigged on the foremast later in the century. The analysis of the iconography in this dissertation refutes both Barata's and Edward's

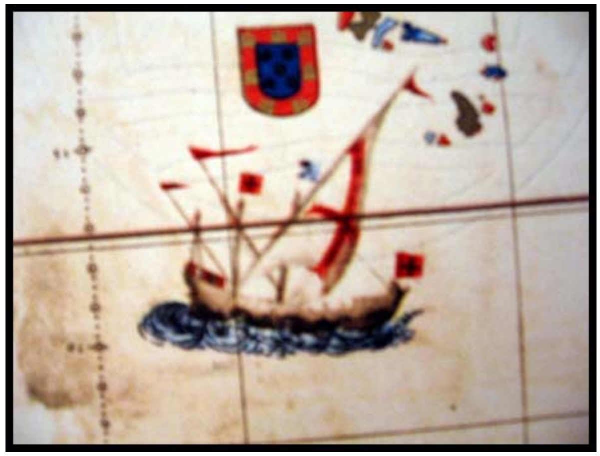


Figure 31: CA04.31. From Lopo Homem-Reneis' Atlas Miller, 1519.

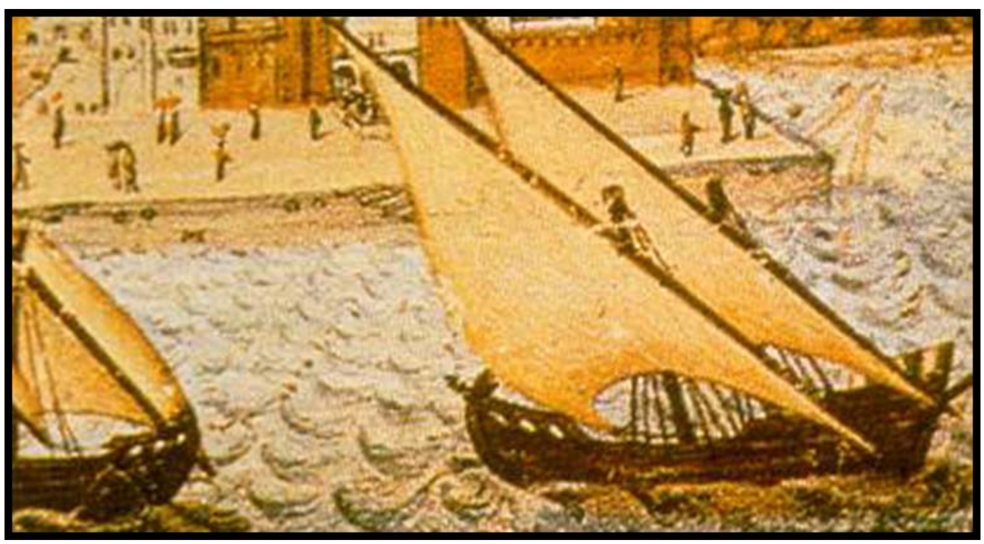


Figure 32: MA11.09. From Holland's *Genealogia de Dom Afonso I*, 1530-1534.

Figure 33: MA08.01 and MA08.02. From *Chronica de Dom Afonso Henriques*, 1515-1525.

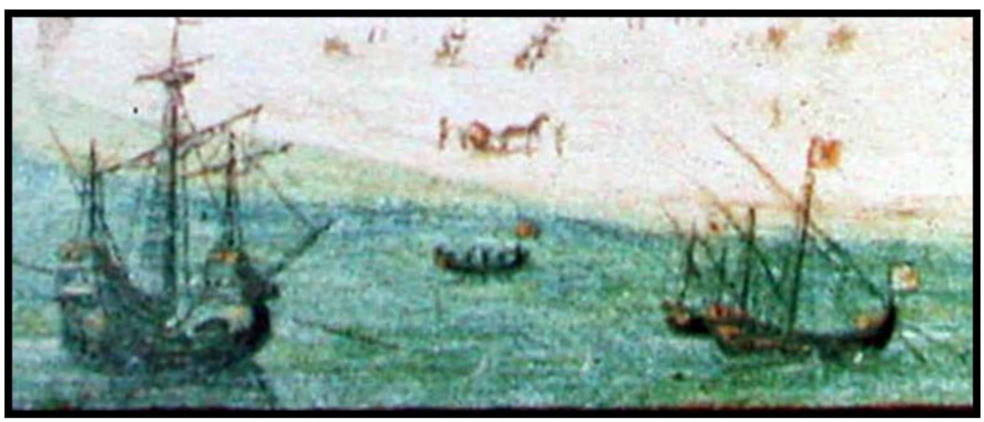


Figure 34: MA10.08 on left and MA10.09 on right. From *Livro de Horas de Dom Manuel*, 1517-1526.

claims of forecastles on caravels without foremasts. As evidenced by the iconography, castles were installed over the bows with the addition of the square-rigged foremast. As previously mentioned, there are only two caravels representing less than 2% of the entire sample (MA08.01, MA08.02) which do not have foremasts and do have possible superstructures. Furthermore, both caravels are from the same manuscript (MA08), which cannot be used as legitimate variation. Furthermore, Edwards seem to be incorrect in stating that the foremast was a late 16th-century addition to the caravel rig since the representational trends data clearly indicates the existence of 53 caravels with a foremast dated from 1485 to 1593. Such a large number provides strong evidence that the rig started in the late 15th century and not in the 16th century. As the iconography or archival evidence upon which Barata and Edwards based their claims is not known, it can only be described as their overgeneralization of the caravel as a ship type.

Stern Galleries and Quarter Galleries

Among the 541 vessels in the representational trends database there are 141 with a stern gallery which is a balcony projecting from the stern (stern gallery) or quarter (quarter gallery) of a ship. Of these, six are caravels, nine are galleons, and 126 are naus. The vast majority of the stern galleries are covered structures (89% of the sample) while the remaining 10% are uncovered (Table 31). The uncovered galleries resemble a veranda as they do not have a roof, or stanchions to support a roof. The caravels and galleons with stern galleries date from 1538 to 1561 and from 1538 to 1603 respectively, while the naus date from 1500 to 1603. There are five galleons (1552-1616) and three

TABLE 31: Vessels with Stern Galleries in the Iconography

ALL STERN GALLERIES		N=141	
# of Vessels	**Vessel Type**	**Date**	**% of Sample**
6	CARAVEL	1538-1561	4.26%
9	GALLEON	1538-1616	6.38%
126	NAU	1500-1603	89.36%
COVERED GALLERIES		N=126	
# of Vessels	**Vessel Type**	**Date**	**% of Sample**
5	CARAVEL	1538-1561	3.55%
6	GALLEON	1538-1600	4.26%
115	NAU	1519-1603	81.56%
UNCOVERED GALLERIES		N=15	
# of Vessels	**Vessel Type**	**Date**	**% of Sample**
1	CARAVEL	1550	0.71%
3	GALLEON	1600-1616	2.13%
11	NAU	1500-1603	7.80%

TABLE 32: Vessels with Quarter Galleries in the Iconography

ALL QUARTER GALLERIES		N=8	
# of Vessels	**Vessel Type**	**Date**	**% of Sample**
5	GALLEON	1552-1616	62.50%
3	NAU	1500-1603	37.50%
COVERED GALLERIES		**N=3**	
# of Vessels	**Vessel Type**	**Date**	**% of Sample**
2	GALLEON	1552-1600	66.67%
1	NAU	1573-1603	33.33%
UNCOVERED GALLERIES		**N=5**	
# of Vessels	**Vessel Type**	**Date**	**% of Sample**
3	GALLEON	1593-1616	60.00%
2	NAU	1500-1603	40.00%

naus (1500-1603) with quarter galleries, three of which are covered and the other five uncovered (Table 32). Of the eight vessels with quarter galleries, six also have visible stern galleries. It is assumed that the remaining two also have stern galleries; however, it is not possible to discern this because of the perspective. Stern and quarter galleries were typically connected structures, as seen on a galleon depicted by Hendrick Cornelisz Vroom in 1593 (PA08.01; Figure 35), as well as on the archaeological remains of the Swedish Royal warship *Vasa*, which sank in 1629 (Cederlund and Hocker, 2006).

According to Richard Barker (2003), stern galleries only occur in dated iconography from about 1546 and are first mentioned in historic records in 1510. However, the iconographic evidence has clearly refuted these dates of origin. All three ship types predate 1546 and the naus extend the presence of stern galleries nearly half century earlier to the begining of the 16th century (refer to Table 33). There are six naus from the *Livro de Lisuarte de Abreu* (MA15; Figure 36), dated to 1558-1561 and representing fleets from 1509 to 1529 with two covered stern galleries. There is also another nau (MA10.08) dated to 1517-1526 with two uncovered stern galleries. The stern galleries from the iconography are considered as separate, because it is not possible to discern whether or not these were integrated structures with access between each gallery. It is more probable that access to each of the stern galleries was from the individual decks as opposed to stairs between the galleries.

Gun Decks and Guns

That the caravels, galleons, and naus were armed has never been questioned.

TABLE 33: Ships with Stern Galleries Before 1546

SHIPS WITH STERN GALLERIES		
VESSEL #	**SHIP TYPE**	**DATE**
MA14.03	CARAVEL	1538-1550
MA13.15	GALLEON	1538-1540
MA13.01	GALLEON	1538-40
MA07.03	NAU	1500-25
MA09.01	NAU	1515-30
MA10.08	NAU	1517-1526
CA04.05	NAU	1519
CA04.19	NAU	1519
CA04.20	NAU	1519
CA05.01	NAU	1519
EN01.01	NAU	1525
MA12.06	NAU	1535-1570
MA13.14	NAU	1538-1540
MA14.01	NAU	1538-1550
MA14.02	NAU	1538-1550
MA14.04	NAU	1538-1550
MA14.06	NAU	1538-1550
MA14.07	NAU	1538-1550
MA14.08	NAU	1538-1550

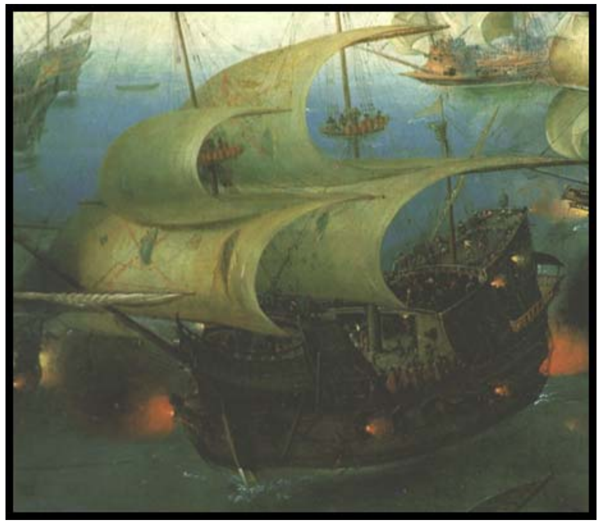


Figure 35: PA08.01; detail of a stern and quarter gallery. From Hendrick Cornelisz Vroom's painting of a Portuguese galleon.

Figure 36: MA15.1517. From *Livro de Lisuarte de Abreu*, 1558-1561.

There are numerous accounts of naus along the *Carreia da India* engaging in direct battle with other ships as well as the stories of ships jettisoning heavy armament during a wrecking or sinking of a ship. Although galleons are little mentioned in archival accounts, this ship type functioned as a man-of-war and was used primarily for defensive purposes. Likewise, the *caravela da armada* is largely considered an armed caravel. As the early domination of the trade routes progressed into monopolies, the Portuguese found it necessary to defend themselves from other nations that would readily encroach upon their territories. Individual ships were outfitted with guns or heavily armed vessels accompanied fleet. Thus, it seems likely that guns and gun ports should not only be visible in the iconography, but displayed prominently. This has proved not to be the case as only 50 of 541 vessels (roughly 9% of the sample) show visible guns or gun ports.

Although naus account for 52% of the vessels with armament while caravels and galleons represent 16% and 32% respectively, when compared to their respective ship type sample the percentages change drastically. The armed naus account for only 2% of all naus and the caravels only 7% of all caravels, while the galleons have a higher percentage at 42% of the galleon sample. Overall, these are extremely low values for the caravels and naus. Although higher, the value for the galleons is also surprising as a much more widespread representation of armament might be expected.

The evidence for armament is either the depiction of cannon projecting out of ports, which accounts for 82% of the sample, or the presence of gun ports without guns, which accounts for the remaining 18%. All of the galleons with gun ports have visible guns, while the overall division of caravels and naus into those with and without guns visible in the ports can be seen in Table 34.

The presence of the upper gun deck ports account for 74% of the overall gun port sample; the calculated values generally reflect the overall sample listed in Table 35. Out of 541 vessels, there are only 37 (7% of the sample) exhibiting evidence of armament on the upper gun deck. Of these, almost 51% are naus, 19% are caravels, and 30% are galleons; which is illustrated in the Table 36. The naus with guns or upper gun deck ports represent only 5% of the nau sample, while the caravels and galleons account for 6% and 31% respectively. The depiction of cannon is seen on 78% of the vessels, while the remaining 22% have gun ports but no visible guns.

The number of guns and their placement along the profile of the upper gun deck vary (see Table 37). To facilitate analysis the profile of the gun deck was divided into the following sections: the stern or after section under the sterncastle, the bow or forward section under the forecastle, the waist or midship section under the waist, and the entire length of the deck. The two most common placements of guns on the upper gun deck are in the stern (27% of the sample), followed by the placement of guns along the entire deck (24%). Four caravels, two galleons, and four naus show guns placed in the stern; their number varies between two and six, with the average being three. Likewise, there are five galleons and four naus showing a full gun deck. The number of guns in this case, logically much larger than those shown in just the stern, ranges from two to ten with an average around five to six guns. Of the 37 vessels with guns, seven have them in the stern and the bow (19%), while another five have them placed only in the waist (14%). One caravel, one galleon, and five naus have guns in the stern and the bow, with an

TABLE 34: Upper and Lower Gun Decks in the Representational Trends Database

SHIPS WITH GUN DECKS		**N=50**	
# of Vessels	**Vessel Type**	**Date**	**% of Sample**
8	CARAVEL	1535-1570	16.00%
16	GALLEON	1538-1616	32.00%
26	NAU	1515-1600	52.00%
GUN DECKS SHOWING GUNS		**N=41**	
# of Vessels	**Vessel Type**	**Date**	**% of Sample**
6	CARAVEL	1535-1570	14.63%
16	GALLEON	1538-1616	39.02%
19	NAU	1515-1600	46.34%
GUN DECKS SHOWING PORTS		**N=9**	
# of Vessels	**Vessel Type**	**Date**	**% of Sample**
2	CARAVEL	1566	22.22%
7	NAU	1519-1566	77.78%

TABLE 35: Upper Gun Decks in the Representational Trends Database

SHIPS WITH UPPER GUN DECKS		**N=37**	
# of Vessels	**Vessel Type**	**Date**	**% of Sample**
7	CARAVEL	1535-1570	18.92%
11	GALLEON	1538-1616	29.73%
19	NAU	1515-1600	51.35%
GUN DECKS SHOWING GUNS		**N=30**	
# of Vessels	**Vessel Type**	**Date**	**% of Sample**
5	CARAVEL	1535-1570	16.67%
11	GALLEON	1538-1616	36.67%
14	NAU	1515-1600	46.67%
GUN DECKS SHOWING PORTS		**N=7**	
# of Vessels	**Vessel Type**	**Date**	**% of Sample**
2	CARAVEL	1566	28.57%
5	NAU	1519-1566	71.43%

TABLE 36: Presence and Position of Guns on the Upper Gun Deck in the Representational Trends Database

POSITION AND NUMBER OF GUNS		N=37			
Position of Guns	**# of Vessels**	**Vessel Type***	**Date**	**# of Guns**	**% of Sample**
FULL DECK	9	G, N	1519-1616	3-10	24.32%
STERN	10	C, G, N	1556-1593	2-6	27.03%
STERN, BOW	7	C, G, N	1515-1594	2-5	18.92%
STERN, WAIST	4	C, G, N	1535-1572	1-8	10.81%
WAIST	5	C, G, N	1538-1603	2-3	13.51%
WAIST, BOW	2	N	1535-1566	2-3	5.41%

* C = CARAVELS, G = GALLEONS, N = NAUS

TABLE 37: Lower Gun Decks in the Representational Trends Database

SHIPS WITH LOWER GUN DECKS		N=13	
# of Vessels	**Vessel Type**	**Date**	**% of Sample**
1	CARAVEL	1556	7.69%
5	GALLEON	1552-1616	38.46%
7	NAU	1525-1600	53.85%
GUN DECKS SHOWING GUNS		**N=11**	
# of Vessels	**Vessel Type**	**Date**	**% of Sample**
1	CARAVEL	1535-1570	9.09%
5	GALLEON	1538-1616	45.45%
5	NAU	1515-1600	45.45%
GUN DECKS SHOWING PORTS		**N=2**	
# of Vessels	**Vessel Type**	**Date**	**% of Sample**
2	NAU	1566	100.00%

average of three to four guns in both locations. One caravel, one galleon, and three naus show guns (an average of three guns) in the waist. Another four vessels have guns placed in the stern and the waist accounting for 11% of the sample. These vessels are one caravel, one nau, and two galleons with an average of five guns between these two areas. The final category is represented by two naus which have two to three guns in the waist and the bow of the ship.

Of the 37 vessels with an upper gun deck, 13 (35% of the sample) also show the parts of a lower gun deck. There is only caravel with a lower gun deck (CA14.02), but roughly 37% of the armed galleons and 45% of the armed naus have two levels of guns (see Table 38). The galleons all have guns present on the upper and lower gun decks, but there are only five naus with and two without guns on both levels. The different placement of the guns along the lower gun deck can be seen in Table 38. There are four galleons and four naus with a lower gun deck that runs the entire length of the hull accounting for 62% of the sample with an average of eight guns spread along the deck. There are two naus with one to two guns placed in the stern and the waist, and one galleon and one nau with six and four guns respectively in the stern only (15% of the sample each). There is a single caravel with one gun in the waist (8% of the sample). There is a higher degree of division of the guns along upper gun deck, predominantly centered in the stern and the waist, and to a lesser degree in the bow of the vessel as the number of gun ports is inhibited by rigging elements such as the shrouds and chainwale. The lower gun deck, however, appears to be more fully developed along the entire length of the ship or from the stern castle to the waist (see the nau in PA06.01, Figure

TABLE 38: Presence and Position of Guns on the Lower Gun Deck in the Representational Trends Database

POSITION AND NUMBER OF GUNS			**N=13**		
Position of Guns	**# of Vessels**	**Vessel Type***	**Date**	**# of Guns**	**% of Sample**
FULL DECK	8	G,N	1525-1616	5-13	61.54%
STERN	2	G,N	1572-1600	1-2	15.38%
STERN, WAIST	2	N	1566-1592	4-6	15.38%
WAIST	1	C	1556	1	7.69%

* C = CARAVELS, G = GALLEONS, N = NAUS

Figure 37: PA06.01. From a painting depicting the life of São Francisco Xavier in the *Museu Casa Pia de Evora*, 1552.

Figure 38: PA07.01. From *Biombos Namban*, 1573-1603.

TABLE 39: Guns in the Castles in the Representational Trends Database

GUNS ON STERNCASTLE		**N=13**	
# of Vessels	**Vessel Type**	**Date**	**% of Sample**
3	CARAVEL	1556	23.08%
4	GALLEON	1552-1616	30.77%
6	NAU	1525-1600	46.15%
GUNS ON FORECASTLE		**N=8**	
# of Vessels	**Vessel Type**	**Date**	**% of Sample**
5	CARAVEL	1556	62.50%
1	GALLEON	1552-1616	12.50%
2	NAU	1525-1600	25.00%

37). There are only two depictions with distinguishable gun port lids, the first of which is a galleon (PA08.01, Figure 35) with lids on the upper gun deck. The second example is a nau (PA07.01, Figure 38) with lids on the ports of the upper and lower gun decks. In addition to upper and lower gun decks, three caravels, four galleons, and six naus also have visible guns on the stern castle. An additional eight vessels show guns in the forecastle, five of which are caravels, two naus, and the last a galleon (Table 39).

Armament aboard ships not only symbolizes power and military might, but also wealth. In the 16th century, the amount of state money invested in cannons, particularly bronze cannons, was considerable. Their cast decorations often included powerful national symbols such as the armillary sphere and royal crest for Portugal, the Tudor Rose for England, or the Fleur de Lys for France and they were often cast with ornate decorative flourishes. Yet curiously in the Iberian iconography the presence of guns and gun ports are minimal. The symbolism on the ships in the iconography is expressed, instead, in the decorative sails which often portray the cross of the Order of Christ. From the iconographic evidence, it would appear that the Portuguese did not associate armament with national power at least not in their maritime art. The wealth the state procured through the Order of Christ, which sponsored the initial voyages of discovery, allowed the creation of a Portuguese maritime empire. Although limited, the archaeological evidence attests to the presence of gun aboard ships. This is supported by the 30 bronze cannon found on the Boudeuse Cay wreck in the Seychelles (Mid-16th century) which represent a significant financial and symbolic investment in armament (Blake and Green, 1986: 1). It seems that for the Portuguese the cross of the Order of

Christ became the dominant national or heraldic symbol within the iconography as well as contemporary architecture. The actual use of the cross of the Order of Christ on ships cannot be determined whereas the presence of cannon on 16th-century Portuguese ships is proven by finds on shipwrecks and by archival evidence.

7.2 REPRESENTATIONAL TRENDS ANALYSIS OF DECORATIVE ELEMENTS

European Vessels: Specialization, Function, and Decoration

> "Nothing is more impressive nor so befits the majesty of the King than that his ships bear the finest ornamentation yet seen on the high seas."
> Jean-Baptiste Colbert (1619-1683)

In early medieval Europe, there were two common ship types: the galley (an oared vessel) was the standard fighting vessel while the sailing ship was used to carry cargo (Unger, 1981: 234). Specialization in Northern Europe began to decline in the 11th and 12th centuries with the development and widespread use of cog-type vessels. These vessels were replaced by hulks at the start of the 15th century and then by the carracks, which were equivalent to the naus of the Iberian Peninsula (Greenhill, 1976: 283-285). In these last vessels, the carracks, functions of war and trade overlapped as they were suitable for both roles. During the late medieval centuries, a lightly armed cargo ship was sufficient for trade throughout Atlantic Europe; however, in the 16th century the vastly expanded trade routes and overseas colonial territories necessitated both the maximization of vessel size to provide large armed cargo carriers, as well as the introduction of separate vessels to protect fleets from pirates and rivals thus beginning the trend once again towards specialized vessel types. Likewise, starting in the 16th century, European monarchs consolidated greater power and had the ability to 'contain and direct violence' for which task specific warships were needed (Unger, 1981: 235). This renewed differentiation of vessels used for war and for trade truly culminated in the 17th century. The question under consideration here is how the transitional 16th century correlates to ship decoration.

The process of specialization begun in the 16th century and fully realized by the 17th century is reflected in the amount and types of decorative elements on ships. Ship decorations of the 16th century were primarily limited to painted sails and scattered hull decorations. It was only in the 17th century with different classes of merchant and war vessels that lavish carvings and ornamentation flourished. The amount and types of decorative elements varied by nationality and thus only generalities are discussed in this section. In the first half of the 17th century, decorative sculpture and carvings on the prow and stern were common on European naval ships (Petrejus, 1967: 99). The prows of naval vessels were covered with ornate carvings and figureheads became standard; for example, English ships had the heraldic English lion, the French had figureheads relating to the name of the vessel or a Greek Olympic deity, and Danish ships had either swans or a lion (Petrejus, 1967: 100). The stern received the most embellishment; in the social partitioning of vessels, the stern is where the captain and officers resided. During the 17th century the stern came to be decorated with sculptures, gilded emblems, ornamental friezes, and a shield bearing national symbols and the name of the ship. The Dutch preferred statues and large, heavily-decorated stern rails while the French, who kept teams of sculptors in their naval yards, had galleries and balustrades with a level of decorations comparable to the palace at Versailles built at the end of the 17th century (Petrejus, 1967: 100). The decoration became so excessive on man-of-war ships that they often impeded the handling of the ship at sea and in the harbor, and captains were known to cut off decorations that interfered with the rigging or anchor lines (Petrejus, 1967: 100). Towards the end of the 17th century a trend towards simplification lead to the decreasing use of decorative elements until they generally disappeared in the 19th century.

The 1,400 ton flagship *Vasa* commissioned by King Gustave Adolf of Sweden in 1628 is one of the best existing examples of 17th-century ship embellishment and a natural benchmark for comparison to the relative simplicity of 16th century vessels. Franzén (1967: 65) describes *Vasa* as "vividly painted and sumptuously decorated, here was a ship to inflame national pride and instill fear into the hearts of all enemies of Sweden." War with Sweden's enemy, the Hapsburgs Emperor Ferdinand II in 1630-1635 initiated initiated the development of the Swedish navy. King Gustave took a personal interest, stating "…After God, it is the navy which will determine the future prosperity of our Kingdom…" (Franzén, 1967: 65). *Vasa* was the pride of the Swedish Navy and of the king; however, on her maiden voyage she capsized and sank about 1,600 meters out of port. *Vasa* was excavated in 1956 and in total nearly 500 figure sculptures and several hundred ornaments were found on the wreck (Soop, 1992: 19).

There are traces of paint and gilding on these elements and the hull itself was certainly painted, but overall the paint and gild did not survive three hundred years in the water (Soop, 1992: 20).

The general themes of *Vasa's* decorations were Greek and Roman mythology; Roman literature, history and philosophy; the Old Testament; and the ancient Gothic-Scandinavian mythical tradition. Knowing these themes allowed the researchers to identify the armored or naked male figures as Greek or Roman mythical heroes (Hercules and Peleus), sea-gods (Proteus and Thetis), Israeli kings or leaders (David and Gideon), several named Roman emperors, and tall knights in Gothic armor (mythic Scandinavian kings) (Soop, 1992: 20). It is believed that the decorative elements symbolized courage, wisdom, power, patience, and strength, characteristics often attributed to kings. *Vasa's* entire stern was adorned as a monument to the king and a statue of Gustave was placed on top of the stern panel in which he is represented as a young boy with long hair surrounded by two griffins holding a royal crown over his head. The ornamentation of the stern was meant to illustrate the fact that Gustave was equal to Hercules, David, Gideon, and his predecessors on the Swedish throne. This concept of ships reflecting the power of the monarch is also present in contemporary French iconography of the flagship of the Louis XIV (Soop, 1992: 20).

Decorative elements on 16th-century ships reflect the widespread use of armed merchantmen along with the nascent specialization of warships. As power coalesced in many nations there was a growing need for specialized warships in addition to the multi-purpose vessels along the trade routes. Nonetheless, warships and merchant ships were for the most part indistinguishable throughout the 16th century. Iberian galleons can be viewed as a trend towards a specialization, as they are generally recognized as more effective warships than naus; however, the definition and distinction of a ship as a galleon is not well-understood. Iberian galleons in the 16th century were known to function in a naval capacity on one voyage and in a commercial capacity on the next (Adams, 2003: 147). Likewise, flagships of Portuguese or Spanish fleets were often carracks or naus adapted to war by heavy armament. The Spanish relied heavily upon naus to transport troops in their 1588 Armada against England. This lack of differentiation is also a reflection of warfare theory in the 16th century. The strategic potential of battles at sea was slowly being recognized during this century, but there was still a heavy reliance placed upon land troops conquering cities and nations. The Spanish had only two squadrons in the Armada (Squadron of Portugal and of Castille) comprised predominantly of galleons while each English squadron had royal ships (true naval vessels) along with conscripted armed merchant vessels (Konstam, 2005: 89-94). As sea battles techniques began to change so did the design and armament requirements of warships. The Iberians placed too much confidence in their large naus which were essentially wooden fortresses at sea which relied on size to intimidate their enemies. Throughout the century the English and the Dutch began to use more specialized vessels that were faster and carried more guns to attack Iberian naus. Their adoption of purpose-built warships and new sea battle techniques soon outdistanced the Spanish and Portuguese.

This general lack of vessel differentiation throughout the 16th century was reflected in the minimal decorations on ships. One example of this trend is the 600-ton carrack *Mary Rose* which sank in 1545 during a battle with the French**.** Although *Mary Rose* was the flagship of Henry VIII's bourgeoning navy, the shipwrights did not add carved decorative elements to the hull; rather, she was decorated with numerous flags, banners, streamers, and some painting on the hull as is evidenced by a contemporary illustration drawn by Thomas Pettyt in the Anthony Roll of 1546. The flags, banners, and streamer were portable badges of office that denoted rank and the importance of the principal officer on board and these decorative items are still used today by navies for celebratory or ceremonial purposes (Howard, 1979: 61). The *Mary Rose* is also shown in the Anthony Roll with painted borders or edging along the castles and heraldic shields along the main deck (Soop, 1992: 8). In a depiction of Henry VIII leaving Dover in May 1520, the flagship and the other ships have shields on the sides of their castles decorated with the Cross of St. George and the French Lily (similar to the traditional French Fleur-de-Lis and a common heraldic symbol) (Soop, 1992: 8). The heraldic shields were hung along the rails as protection for the crew but this changed to decorated cloth by the end of the century (Howard, 1979: 61). Other English vessels on the Anthony Roll such as the *Henry Grace á Dieu* built in 1514 have red diagonal stripes painted on the hull but little else. *Ark Royal*, an English flagship in the battle against the Spanish Armada of 1588, was drawn in Matthew Baker's manuscript "Fragments of Ancient English Shipwrightery" with painted geometric designs along the sides of the castles and the beak head (Soop, 1992: 8). English ships of the 16th century, like those of most European countries, had figureheads and the most important vessels had decorated sails that were used mainly on important occasions (Howard, 1979: 61). The money spent on these decorative elements was fairly significant, however, as was the investment in bronze cannon which were often ornately decorated in and of themselves.

The ships of the Continental European nations were also characterized by a modest amount of hull painting (Howard, 1979: 59). Portuguese vessels of the 16th century were similar to their European counterparts in that Iberian shipwrights employed very few decorative elements. There was little ship specialization and Portugal did not truly develop a purpose-built royal navy. Furthermore, the Portuguese trade system was a royal affair and the crown was concerned with exploration, trade, and obtaining territories to advance their goals. There was greater emphasis on arming their vessels along the trade routes as a protective measure than on initiating large naval campaigns. The lack of decorative elements on Portuguese vessels was not due to a lack of resources, as the capital gained from the monopoly on the India Route was significant. Interestingly, royal carriages, used for transportation on land, were lavishly decorated on the level of the 17th century flagships, and 16th-century Portuguese buildings were crafted with maritime symbols that celebrated Portugal's ships and the voyages of discovery.

Pendants and Flags

Out of 541 vessels in the representational trends database, 98 (18%) have pendants (a colored triangular flag or banner sometimes bearing symbols) on one or more of the masts. By ship type, these are 12 caravels, 17 galleons, and 69 naus with pendants, which represent 10%, 49%, and 18% of total sample respectively. The number of pendants by ship type, shown in Table 40, demonstrates that overall a single pendant accounts for 50% of the caravels, 47% of the galleons, and 58% of the naus. A further 38% of the naus have two pendants and only 4% have three; while among caravels there are 17% with two pendants, 25% with three, and 8% with four. The galleons have the largest percentage of four pendants (35%) while only 18% of galleons have two. In general, it is apparent that the galleons, followed by the caravels, have the most decorative pendants as compared to the naus. Collectively, this is consistent with the theory of decorative elements increasing with ship differentiation.

The tabulation of all pendants and flags can be viewed in Appendix 23. There are seven caravels, nine galleons, and one nau with pendants on the bonaventure mast the majority of which (88% of the sample) are white, while there are only two red pendants. The bonaventure mast has little variation in the pendants but the mizzen, main, and fore masts exhibit a wider range of colors and emblems. There are 46 vessels with pendants on the mizzen mast of which four are caravels, 12 are galleons, and 30 are naus. Although white pendants still account for the vast majority of the sample (85%), there are five vessels with red pendants (11%), one blue pendant, and one striped pendant (2% each). Pendants on the main mast occur on 10 caravels, 12 galleons, and 42 naus and there are 53 vessels with white pendants (82% of the sample), seven vessels with a pendant bearing the cross of the Order of Christ (11%), and five vessels with red pendants (7%). There are foremast pendants on two caravels, seven galleons, and 27 naus of which 33 vessels have white pendants (92% of the sample), two have red

TABLE 40: Number of Pendants by Ship Type

ONE PENDANT		N=54	
# of Vessels	**Vessel Type**	**Date**	**% of Sample**
6	CARAVEL	1519-1560	11.11%
8	GALLEON	1502-1589	14.81%
40	NAU	1500-1603	74.07%
TWO PENDANTS		N=31	
# of Vessels	**Vessel Type**	**Date**	**% of Sample**
2	CARAVEL	1500-1525	6.45%
3	GALLEON	1558-1600	9.68%
26	NAU	1485-1600	83.87%
THREE PENDANTS		N=6	
# of Vessels	**Vessel Type**	**Date**	**% of Sample**
3	CARAVEL	1519-1593	50.00%
3	NAU	1525-1603	50.00%
FOUR PENDANTS		N=7	
# of Vessels	**Vessel Type**	**Date**	**% of Sample**
1	CARAVEL	1541	14.29%
6	GALLEON	1500-1600	85.71%

pendants (6%), and one has a red and blue pendant (2%).

Out of 541 vessels in the representational trends database, 243 (45%) have flags on one or more of the masts. By ship type, these are 57 caravels (49% of the caravel sample), 23 galleons (66% of the galleon sample), and 163 naus (42% of the nau sample) with flags (Appendix 23). As shown in Table 41, the number of flags by ship type indicates that a flag on one mast dominates the sample accounting for 40% of the caravels, 43% of the galleons, and 27% of the naus. The presence of two flags is the next most common amounting for 8% of the caravels, 14% of the galleons, and 11% of the naus. There are relatively few vessels with three flags (1% of caravels, 9% of galleons, and 4% of naus) and only one nau (less than 1%) with four. There are only seven vessels with flags on the bonaventure mast of which three are caravels, three are galleons, and only one is a nau. Collectively, all three ship types predominantly have one or two flags, while the galleons have the highest percentage of three flags; which could have suggest a correlation between the number of decorative elements and level of ship specialization. There is an increase in the use of colored flags and those with emblems flown from the different masts compared to the mostly white pendants. White is the most common color for the flags accounting for 57% of the entire sample followed by two caravels (29%) with the cross of the Order of Christ on the flag (Figure 39) and one galleon (14%) with yellow and red striped flag of the Crown of Aragon, Catalonia (Figure 40). There are three caravels, six galleons, and 22 naus with flags on the mizzen mast the majority of which have white flags (71% of the sample), while there are three vessels with red flags (10%), three with the cross of the Order of Christ (10%), and three vessels with red flags

TABLE 41: Number of Flags by Ship Type

ONE FLAG		N=167	
# of Vessels	**Vessel Type**	**Date**	**% of Sample**
46	CARAVEL	1519-1560	27.54%
15	GALLEON	1502-1589	8.98%
106	NAU	1500-1603	63.47%
TWO FLAGS		N=57	
# of Vessels	**Vessel Type**	**Date**	**% of Sample**
9	CARAVEL	1500-1525	15.79%
5	GALLEON	1558-1600	8.77%
43	NAU	1485-1600	75.44%
THREE FLAGS		N=18	
# of Vessels	**Vessel Type**	**Date**	**% of Sample**
1	CARAVEL	1519-1593	5.56%
3	GALLEON	1520	16.67%
14	NAU	1525-1603	77.78%
FOUR FLAGS		N=1	
# of Vessels	**Vessel Type**	**Date**	**% of Sample**
1	NAU	1520	100.00%

Figure 39: MA09.01; showing a flag on the main mast with the cross of the Order of Christ. From *Livro De Horas Da Condessa De Bertiandos*, 1515-1530.

Figure 40: PA09; the ship on left showing an example of a flag on the main mast bearing the Papal crest and the ship on the right with the Catalonian flag on the mizzen mast. From a painting of the Spanish Armada in the National Maritime Museum, London.

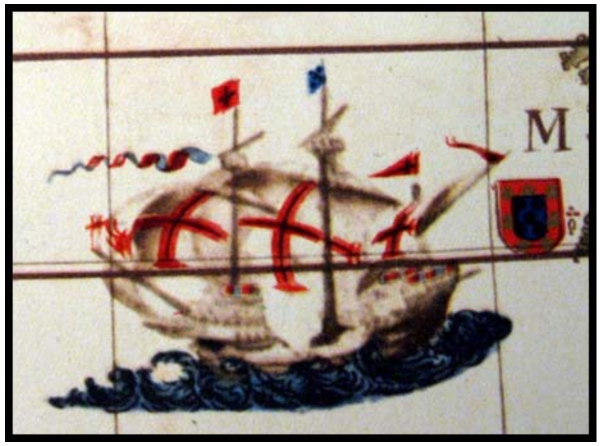


Figure 41: CA04.30; a ship showing a red flag with a black cross on the mizzen and fore masts, a blue Portuguese *quina* on the main mast with the associated crest off the stern of the vessel, and the cross of the Order of Christ on the sails. From *Lopo Homem-Reneis'* Atlas Miller (1519).

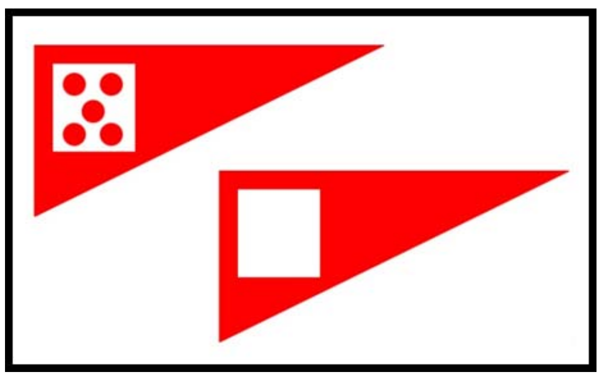


Figure 42: Examples of the red Portuguese *quina* variants found on the *Carta de la Juan de Cosa.*

with a black cross (9%) from CA04. Since there is no historical parallel for this flag, it is believed to be a derivation of the cross of the Order of Christ, which is also present on the main and fore courses of all three ships, each of which is also flying the typical blue Portuguese *quina* flag on the fore mast (Figure 41). Furthermore, the caravel, galleon, and nau are from the same source (CA04) which supports the notion that this is may be an artistic deviation.

The number of vessels with flags on the main mast increases greatly from that of the bonaventure and mizzen masts with 55 caravels, 14 galleons, and 147 naus. Collectively, there are 155 vessels with white flags (72% of the sample) and 35 vessels (16%) with flags bearing the cross of the Order of Christ. The remaining flag color variations represent only a small portion of the sample: there are four vessels each (2% each) with blue flags and the blue Portuguese *quina* flag; three vessels each (1.5% each) with red flags, red triangular flags with a white square containing five red circles which may be a variant of the Portuguese *quina*, and red flags with white squares the details of which are not discernable (Figure 42). There are also two vessels each (1% each) with red flags with a blue cross (Figure 43) and white flags with five red circles which is essentially the same as the variant of the Portuguese *quina* seen in Figure 39. There is also one vessel each (.05% each) with a white flag with a red "X" symbol, which likely represents the cross of Burgundy Flag and was used for the Spanish overseas territories (Figure 44); a two tone blue striped flag, a blue flag with a red cross, a yellow and red Catalonian flag, and one flag with a papal crest with the characteristic crossed keys and tiara designating the Vatican city, which was included as a special case of English

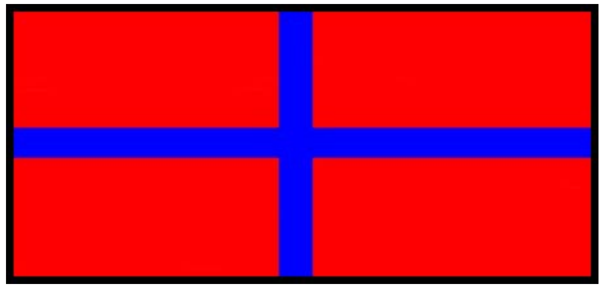


Figure 43: Example of a red flag with a blue cross found in the Linschoten print entitled "*Vista de Angra*."

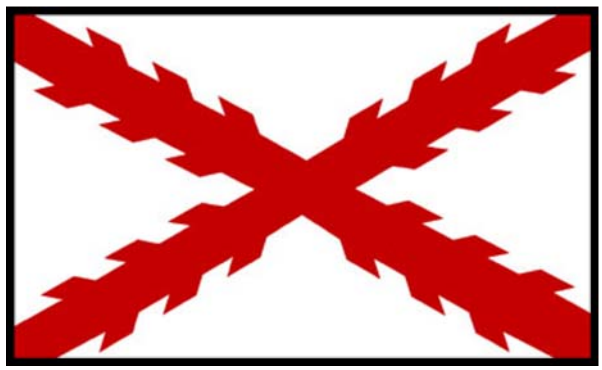


Figure 44: Spanish cross of Burgundy.

propaganda showing a "ship of fools" (Figure 40). Of the six caravels, 10 galleons, and 68 naus with flags on the fore mast, 66 vessels (79% of the sample) have white flags while five vessels each (6% each) have the Order of Christ and red flags. An additional two vessels each (2% each) have the following flags: blue flags with red crosses, which is possibly a deviation of the English St. George's cross (Figure 40); the blue Portuguese *quina* flags; and a red flag with a black cross, which is the cross of the Order of Christ variant discussed for the mizzen mast and is from the same source (CA04). There is also one nau with a red flag with a blue cross which accounts for 1% of the sample.

Altogether there are 12 caravels (10% of the caravel sample), 18 galleons (51% of the galleon sample), and 70 naus (18% of the nau sample) with pendants on one or more masts. Likewise, there are 57 caravels (49% of the caravel sample), 22 galleons (63% of the galleon sample), and 164 naus (43% of the nau sample) with flags on one or more of the masts. As previously stated, the galleons have far more pendants and significantly more flags than the caravels and naus supporting the theory of a higher degree of decoration on specialized war vessels. Furthermore, the vast majorities of pendants and flags are white or have the cross of the Order of Christ which signifies it was a more important symbol for these ships than the Portuguese national flags.

Castle Shields and Flags

There are relatively few sterncastle or forecastle shields in the representational trends database compared to the high number of flags. There are only eight caravels (7% of the caravel sample), three galleons (9% of the galleon sample), and 22 naus (6% of the nau sample) with shields on the sterncastle (Appendix 24). Since the shields depicted in the iconography usually lack details, only the general color patterns can be discerned. There are seven vessels each with the following shield types, collectively accounting for 64% of the sample: red shields, red and blue shields, and red and yellow shields. Shields bearing the cross of the Order of Christ represent only 9% of the sample and are only present on three naus. There are two galleons with red and green shields and two naus with shields with an undetermined color scheme or pattern (6% each). The remaining vessels each have different a shield type that accounts for 3% of the sample: red and white shields; red shields with a blue cross alternated with green shields with a yellow cross; green and white shields; yellow and brown shields; and yellow and green shields.

Although there are even fewer vessels with shields along the forecastle railing, the sample include three caravels (3% of the caravel sample), three naus (9% of the galleon sample), and 25 naus (7% of the nau sample) (Appendix 25). There are eight vessels with red and blue shields (26% of the entire sample), six vessels with red and yellow shields (19%), four vessels with red shields (13%), and three naus with the cross of the Order of Christ (10%). There are two vessels each (6% each) with red and green shields, yellow shields, and indistinguishable shields. There is one vessel each (3%) with red shields with a blue cross alternated with green shields with a yellow cross, red and white shields, green and white shields, and yellow and brown shields. The shields were used primarily for defensive purposes and secondarily as ceremonial or festive decorations. As the Portuguese vessels were participating in the royal trade network it is likely that shields bearing personal insignias and emblems were not encouraged or generally not used on the scale of other European nations such as the English.

The sterncastle flags generally resemble the color schemes and patterns of the shields. Although the flags occur at roughly the same percentage as the shields, there is a significantly higher number of galleons with shields than either the caravels or naus. There are four caravels (3% of the caravel sample), 13 naus (3% of the nau sample), and five galleons (14% of the galleon sample) with shields (Appendix 23). Of the 22 vessels with sterncastle flags, six (27% of the entire sample) bear the cross of the Order of Christ, three (14%) have red flags with a blue cross (Figure 40), and two naus (9%) have orange flags. The remaining vessels each represent one of the following color schemes (5% each): red and yellow, orange and white, white, green, and a white flag with the Portuguese crest with the crown and *quina* emblem. There are six caravels (5% of the caravel sample), two galleons (6% of the galleon sample), and nine naus (2% of the nau sample) with flags on the forecastle the majority of which (three caravels and five naus or 47% of the sample) bear the cross of the Order of Christ. There are two caravels (12% of the sample) with red flags on the bow near the stem, which were included in this analysis only because these ships do not have forecastles. In addition, there is one nau with a red flag (6%), a caravel with a red flag with a white cross (6%), and five vessels with unidentifiable flags (29%).

Sail Decorations

Out of 541 vessels in the representational trends database, 254 (47%) have decorative elements on one or more of the following sails: bonaventure, mizzen, main course, main topsail, fore course, fore topsail, and the spritsail. Overall, these are 44 caravels, 5 galleons, and 205 naus with pendants which account for 38%, 14%, and 53% of the individual ship type samples respectively. As illustrated in Table 42, the number of decorated sails by ship type demonstrates that decorations on a single sail accounts for 27% of the caravels, 40% of the galleons, and 8% of the naus. There are 83 vessels (33% of the entire sample) with two decorated sails, which represent 41% of caravels and 32% of naus. The presence of three decorated sails is the accounts for 21% of the sample and 14% of the caravels, 40% of the galleons, and 22% of the galleons. Of the 35 vessels with four decorated sails, there are only two caravels (5% of the caravel sample) and 33 naus (16% of the nau sample); while for those with five decorated sails, there are three caravels (7% of the caravel sample) and 19 naus (9% of the nau sample). Six decorated sails is the highest number in the entire sample and is represented by 29 vessels which account for 7% of the caravel sample, 20% of the galleon sample, and 12% of the nau sample.

Overall, the naus and caravels have a far greater percentage of decorated sails than the galleons, which is reverse of the general trend. The high percentage of decorated sails on caravels and naus, however, results from two different manuscripts (*Memória das Armadas* and the *Livro de Lisuarte d'Abreu*) in which nearly every sail has the cross of the Order of Christ upon it. The cross of the Order of Christ within the iconography is used to designate all Portuguese ships. As such, sail decorations are not a good indicator of the relationship between vessel ornamentation and specialization. Furthermore, the immense amount of iconographic evidence of sail ornamentation most

TABLE 42: Number of Decorated Sails by Ship Type

ALL		N=254	
# of Vessels	**Vessel Type**	**Date**	**% of Sample**
19	CARAVEL	1500-1566	17.32%
5	GALLEON	1519-1593	1.97%
58	NAU	1513-1594	80.71%
SIX SAILS		N=29	
# of Vessels	**Vessel Type**	**Date**	**% of Sample**
3	CARAVEL	1500-1566	10.34%
1	GALLEON	1558-1561	3.45%
25	NAU	1558-1566	86.21%
FIVE SAILS		N=22	
# of Vessels	**Vessel Type**	**Date**	**% of Sample**
3	CARAVEL	1558-1561	13.64%
19	NAU	1558-1568	86.36%
FOUR SAILS		N=35	
# of Vessels	**Vessel Type**	**Date**	**% of Sample**
2	CARAVEL	1558-1561	5.71%
33	NAU	1519-1566	94.29%
THREE SAILS		N=54	
# of Vessels	**Vessel Type**	**Date**	**% of Sample**
6	CARAVEL	1558-1566	11.11%
2	GALLEON	1519-1593	3.70%
46	NAU	1519-1574	85.19%
TWO SAILS		N=83	
# of Vessels	**Vessel Type**	**Date**	**% of Sample**
18	CARAVEL	1519-1566	21.69%
65	NAU	1513-1568	78.31%
ONE SAIL		N=31	
# of Vessels	**Vessel Type**	**Date**	**% of Sample**
12	CARAVEL	1500-1566	38.71%
2	GALLEON	1519-1589	6.45%
17	NAU	1513-1594	54.84%

likely represents symbolic use within the artwork rather than its actual use on the ships. The tabulation of the different types of sail decorations by mast can be viewed in Appendix 26. There are five caravels with decorated bonaventure sails all of which have the cross of the Order of Christ; while at the same time, there are 24 caravels, two galleons, and 80 naus with decorated mizzen sails. Additionally, there are 43 caravels, five galleons, and 205 naus with decorated main sails of which 41 caravels, four galleons, and 201 naus have the cross of the Order of Christ accounting for 97% of the sample (246 out of 253 vessels). One of the galleons (CA04.28; Figure 45) has the cross of the Order of Christ on the main course as well as the main course bonnet. There are also two caravels and two naus (2% of the sample) from one source (CA03) with small red crosses on each half of the main course and the main course bonnets. Two naus (1% of the sample) from the Portuguese map by Fernao Vaz Dourado of 1568 (CA21) have a suspected Portuguese crest on the main course. Although the details are not visible, it was depicted by a known Portuguese mapmaker and the main topsail on one of the vessels (CA21.07; Figure 46) has the cross of the Order of Christ. The Portuguese galleon painted by Vroom has the Madonna and child depicted on the main course, which is a unique sail decoration accounting for less than 1% of the sample (Figure 35). The main topsail of this galleon also has the Madonna and child shown next to a large red crest presumed to be Portuguese underscored by a red “X” symbol. The remaining 145 vessels with main topsail decorations have the cross of the Order of Christ of which two are caravels, one is a galleon, and 142 are naus. Nearly all of the fore course sails also have the cross of the Order of Christ (148 out of 150 vessels or 99% of the sample).

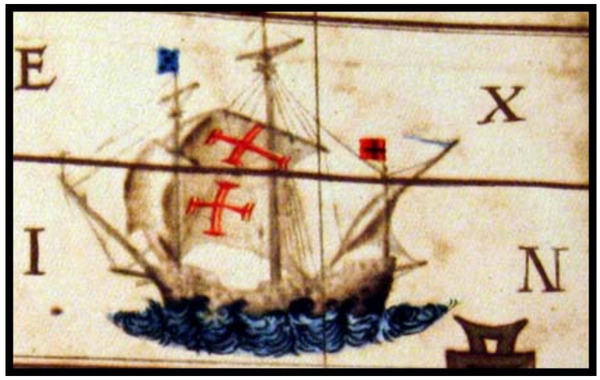


Figure 45: CA04.28; a ship bearing the cross of the Order of Christ on the main course and main course bonnet. From *Lopo Homem-Reneis'* Atlas Miller (1519).

Figure 46: CA21.07; a ship showing a suspected Portuguese crest along with a cross of the Order of Christ. From a 1568 map by Fernao Vaz Dourado.

There is a nau (CA03.05) with a small red cross on each half of the fore course and the Vroom galleon again has the Madonna and Child next to a large red crest underscored by the red "X" symbol, each accounting for .05% of the sample. There are 50 vessels with fore topsail decorations which include six caravels, one galleon, and 43 naus as well as two caravels, one galleon, and 76 naus with decorated spritsails; all have the cross of the Order of Christ.

From the iconographic sources currently under study in this dissertation, it is evident that decorative elements are dominated by the cross of the Order of Christ on the sails and flags. The cross originates from Prince Henry the Navigator who was the principle force behind the voyages of exploration. Henry was also in command of the Order of Christ, an extension of the Templar Knights, which funded the voyages. According to Barker (2003:22) the cross of the Order of Christ "should only have been borne by Royal ships or ships with members of the Order on board," but they are nevertheless frequently displayed on the depicted sails. As the vessels were painted as an expression of a growing sense of national identity and maritime power, it would be more logical that the majority of the decorative elements were monarchical in nature such as the Portuguese flag as opposed to the cross. The number of vessels depicted with the cross strongly suggests that it was used as an indentifying symbol for Portuguese ships and was not limited to royal vessels. Out of 251 different vessels with the cross of the Order of Christ on one or more of the sails, 44 are caravels (38% of the caravel sample), four are galleons (11% of the galleon sample), and 203 are naus (53% of the nau sample). In the *Memória das Armadas* and the *Livro de Lisuarte d'Abreu*, every unfurled sail has the cross of the Order of Christ; however, due to uniformity only a select portion of the vessels from these manuscripts are included in the representational trends database. It is likely that the cross was used to symbolize royal fleets as it was used much more sparingly throughout the rest of the iconography.

Conclusion

The archaeological evidence of *Mary Rose* and the iconographical evidence of the Portuguese vessels are examples of the limited nature of 16th-century ship decorations, whereas the archaeological remains of *Vasa* are indicative of the lavish ornamentation of the following century. Portuguese vessels of the 16th century employed very few decorative elements and it was not from a lack of resources as the capital gained in this era was substantial. There was little ship specialization beyond the beginning of the galleon function as a warship, which is reflected in the iconography with a higher percentage of decorative elements on this ship type when compared to the caravel and the nau.

Specialization began to occur in Atlantic Europe in the 16th century because of the factors of trade, war, and power. The European monarchies were on the verge of becoming absolute and modern states. Ship decorations reflect not only specialization but also consolidation of power. The armed trading vessels of the 16th century had little to no decorative elements beyond general indicators of nationality and although the trading vessels of the 17th century retained a level of ornamentation, warships were lavishly decorated. There is a simple correlation between warships and decoration that began in the 16th century and culminated in the 17th century. The level of decoration on warships is indicative of status, as it was flagships that received the highest amount of, and most complex, embellishment (i.e, the *Vasa*).

As the monarchs consolidated power, they built standing royal navies; the English started in the 16th century under Henry VII and Henry VIII (with ships like *Mary Rose*) and the Swedish followed the suit in the 17th century (with ships like *Vasa*); whereas prior to this, most naval squadrons were composed of private vessels (merchantmen) impressed into service and armed for battle. Portuguese-built warships are a product of standing navies, which is not to say that kings did not have vessels associated with them before. What it does imply is that the specialization of vessels and the increased construction of naval vessels was a reflection of the power and might of the nation and of the king himself, which by and large is the ideological implications of the decorative elements. In a way, specialization was a necessary precursor to a standing navy as we can see when considering the 16th-century Portuguese whose vessels were not specialized and who did not develop a true royal navy. Their primary emphasis was on royal fleets of large armed trading vessels.

On a broader level, it is speculated that ship decorations became more prevalent as sociopolitical organization of the state becomes more complex. It is reasonable to infer this correlation because with higher levels of sociopolitical structuring there are likely to be more resources and advanced technologies, centralization of power, growing national-regional identity, and more complex ideologies. Under the consolidated rule of a regional political leader (the king) the society becomes more stratified and the resources are unequally redistributed. Artisan classes emerge and wealth accumulates, all of which are necessary for adopting a style that included largely unessential decorations on ships. Although the resources and talent for carved ship decorations existed in the 16th-century, this style was not adopted until the 17th century which coincides with widespread ship specialization. A further supposition is that as sociopolitical organization becomes more complex the symbolic decorative elements will reflect more complicated ideologies. The European ideology of the 17th century reflected an institution, the power and might of a nation, and the projected personal qualities of the king as the head of the monarchy. All of which included religious elements, historical figures, and mythology such as was seen on *Vasa* (Soop, 1992: 20).

CHAPTER VIII

DESCRIPTIVE STATISTICS OF MAST RAKE AND PLACEMENT IN THE ICONOGRAPHY

In the statistical analysis dataset for this dissertation there are 492 vessels and 148 measurements of various hull and rigging features per each ship (see Appendix 4). These measurements were transformed into 210 ratios for each ship (see Appendix 5). In addition to the standard representational trends analysis of presence, absence, and date of representation of rigging features, the rakes and placements of masts are analyzed in this chapter with simple statistical descriptive and frequencies programs (see Figure 47). Descriptive statistics was used because it is the simplest statistical method of analyzing and interpreting the data that is accessible to all scholars with a moderate understanding of statistical methods.

8.1 MAST RAKE ANALYSIS

The mast rakes samples of caravels, galleons, and naus were limited to profile views while those depicted in three-quarter profile or stern views were eliminated. It was determined that there were enough ships shown in a profile view in the dataset to avoid complicated calibrations to compensate for an angled view. Even though measuring the rake of the masts is fast and reasonably accurate within Adobe Photoshop. For the majority of images, measuring the rake is not a problem as the bottom and top of the

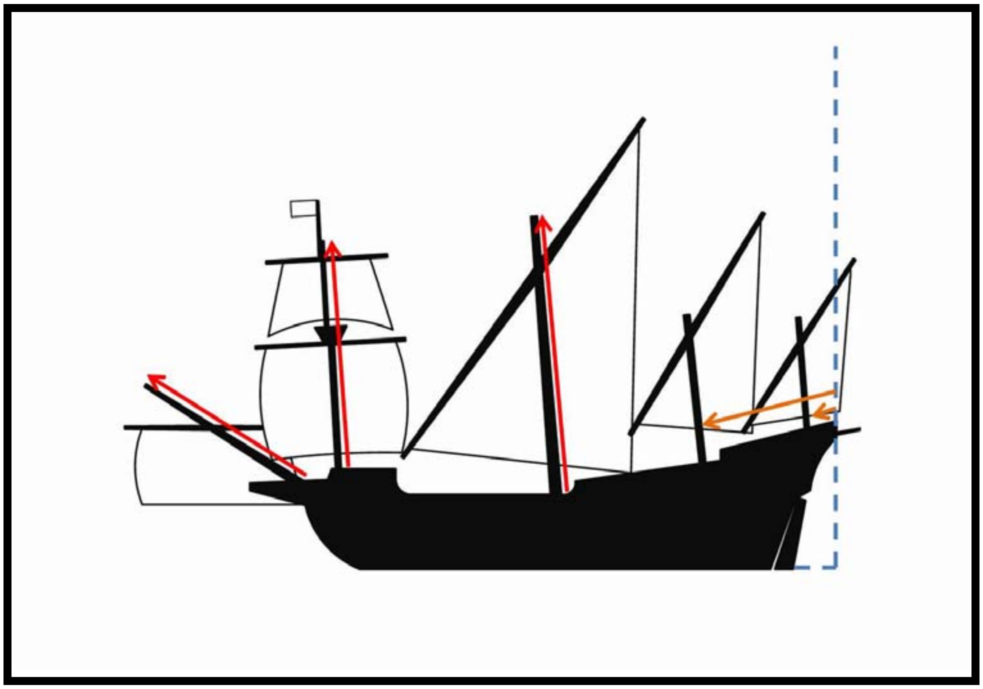


Figure 47: Illustration of the mast rake (main and fore masts and bowsprit) and mast placement (bonaventure and mizzen masts) measurements. Please note that rakes were taken at the centerline of each mast.

masts are easily seen and the rake is always taken at the center of the mast. In some images getting the correct angle was made more difficult because the mast is partially or fully obscured at the bottom by a sail or by the ratlines. It is also necessary to calibrate the angle of rake based on the port or starboard view which is depicted. In this dissertation the angles taken for ships depicted in the starboard and port views are corrected to indicate the degrees forward or aft from 90 degrees (i.e., 3° forward rake or 3° aft rake). Additionally, the rakes of the bowsprit and boomkin are each taken from a horizon of zero to 90 degrees and are stated in the absolute angle and not the relative rake from a set point as is the case with the masts.

The scarcity of information regarding the rake of the masts in the archival records makes it necessary to conduct a more informative statistical analysis of the distribution of the data in order to determine whether it is a viable sample. This additional statistical test, however, will only be conducted on the mast rakes and the placement of the mast because there are vital pieces of information when reconstructing the hull and rigging. The only archival sources mentioning the mast rakes are for the main mast. In the *Livro Náutico* a rake of 3.5° is dictated but Fernandez gives a slightly more pronounced rake of 6.1° and Sousa a rake of 10° (Castro, 2005b: 113). However, these rakes are for naus and it is not understood if the rakes differed between ship types or lateen- versus square-rigged masts.

Caravel Mast Rakes

The rakes of mast were analyzed with statistical descriptive and frequencies programs (see Appendix 27). The histogram graphs produced from the statistics allows a more comprehensive approach to the range of values and the standard deviation with easy to comprehend graphs. The N values for each mast are divided into valid and missing, which in this case reflect the fact that each ship has a different rig. For obvious reasons, only the valid numbers are processed here. It is important to know whether or not rake values produced from the iconography form a normal distribution, which in turn can be determined using the relationship between the mean and the median as well as viewing the skewness and kurtosis numbers. If the mean is very different from the median it suggests an asymmetric distribution and a large skewness would verify this find; both of these would affect the standard error of deviation. The mean and median are both measures of central tendency; however, the mean is the sum divided by the number of cases while the median is the 50^{th} percentile or the value above and below which half the cases fall. The skewness is a measure of the asymmetry of a distribution; a normal distribution is symmetric and has a skewness value of zero. A distribution with a significant positive skewness has a long right tail while one with a considerable negative skewness has a long left tail. If the skewness value is more than twice its standard error (less than -2 or greater than +2), it is asymmetrical.

In order to illustrate how these different values affect the interpretation of the mast rakes, the frequencies statistical test for the entire caravel data set will be used as an example. The results for the individual caravel samples as well as the galleons and naus, however, will only be used as a comparative means of establishing a normal range of variation. It is clear from the frequencies analysis that for every caravel mast the mean is close to the median and the skewness numbers are low indicating a fairly symmetrical distribution with short tails to the right with (positively skewed or forward rake) for all masts except the main and fore, which have short tails to the left (negatively skewed or aft rake). The skewness value is within twice the standard error of skewness for the boomkin, mizzen, main, and fore mast but is slightly outside of this margin for the bowsprit (2.41) and more so for the bonaventure mast (3.4) which means these two spars have an asymmetrical distribution.

Kurtosis measures the extent to which numbers cluster around a central point. In a normal distribution the kurtosis is zero and a positive kurtosis indicates that the observations cluster more and have longer tails than those in the normal distribution, while a negative kurtosis signifies the observations cluster less and have shorter tails. If the kurtosis value is more than twice its standard error (less than -2 or greater than +2), it is asymmetrical. For the kurtosis values, the boomkin and bowsprit have a negative kurtosis with less clustering and longer tails but values less than twice the standard error of kurtosis; while the bonaventure, mizzen, main, and fore masts have a positive kurtosis with more clustering and shorter tails and values far greater than twice the standard error of kurtosis. The kurtosis, like the skewness, indicates that although this is close to being a normal distribution as determined by the mean and median, it is still relatively asymmetrical and there are some problems with this distribution which is illustrated in the histogram graphs. The histogram graph of the boomkin and bowsprit with negative kurtosis, shown in Figures 48 and 49, shows little clustering in the first and a bi-modal clustering in the second which is verified by the statistical mode. Conversely, the bonaventure, mizzen, main, and fore masts all of which have a positive kurtosis display a normal curve in the histogram graphs (Figures 50-53) with modes at zero degrees indicating the point at which the peak curves. The mode is useful as a general indicator of a distribution and is usually very close to the median; however, it does not mean that the mode is the normal rake of a mast. The rake of a mast will never be one number as it simply was not possible for the shipwrights and workers of the era to step a mast with such accuracy so there will naturally be a range of degrees for the rake. Moreover, the ships were not depicted by shipwrights and they reflect what the artist saw or imagined.

There are two ways of determining a normal range from the iconography, the first is by using one standard deviation and the second the center of distribution statistics (see Appendix 28). The standard deviation is a measure of dispersion around the mean; in a normal distribution, 68% of cases fall within one standard deviation of the mean and 95% of cases fall within two standard deviations (the mean and standard deviation for each mast are shown in Appendix 28). For each mast, the center of distribution is approximated by the median, or second quartile, and from this we find that half of the values fall between the first and third quartiles. For the mast rakes a positive number indicates a forward rake, while a negative number is an aft rake. Calculating one standard deviation for each of the masts provides a range accounting for the majority of the mast rakes; one standard deviation of the boomkin rake is 5.82 to 26.10 degrees, of the bowsprit rake is 9.12 to 38.64 degrees; of the bonaventure mast rake is -4.68 to 4.79

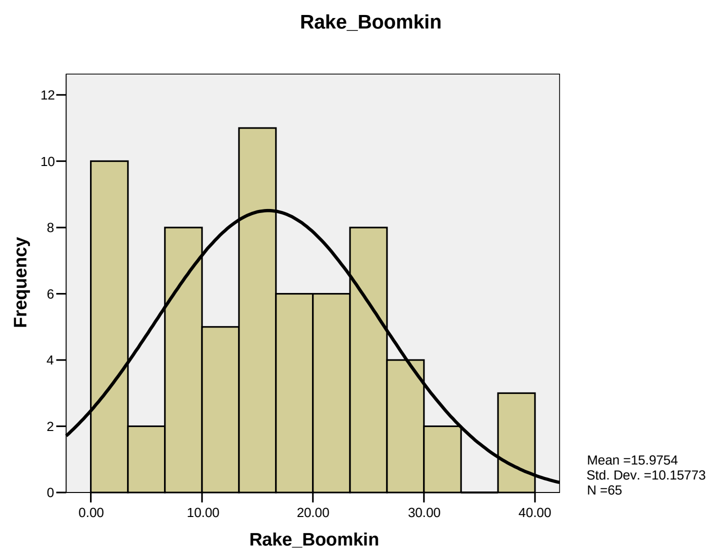


Figure 48: Histogram of the rake of the boomkin in caravels. Refer to Appendix 27 for data.

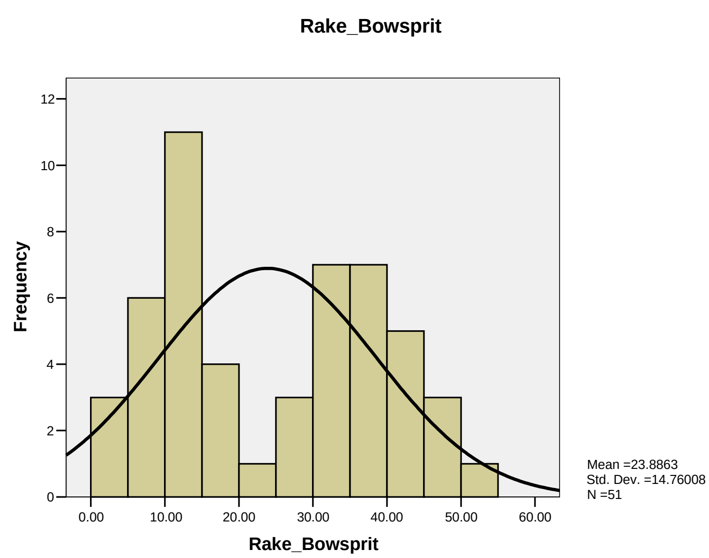


Figure 49: Histogram of the rake of the bowsprit in caravels. Refer to Appendix 27 for data.

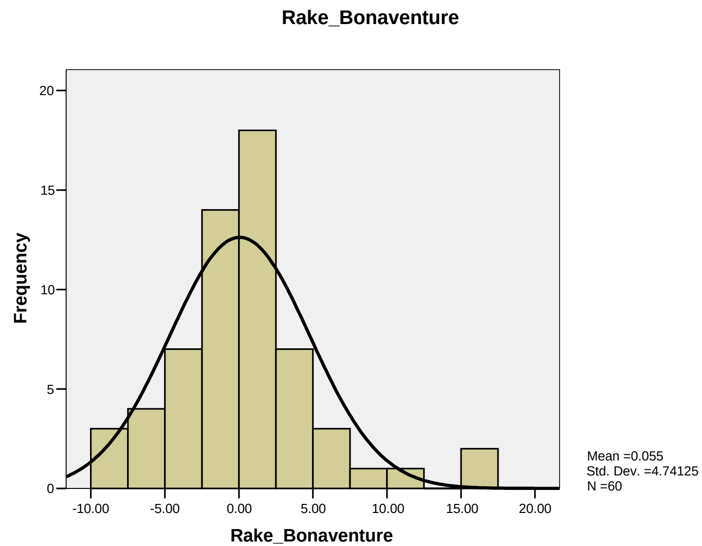


Figure 50: Histogram of the rake of the bonaventure mast in caravels. Refer to Appendix 27 for data.

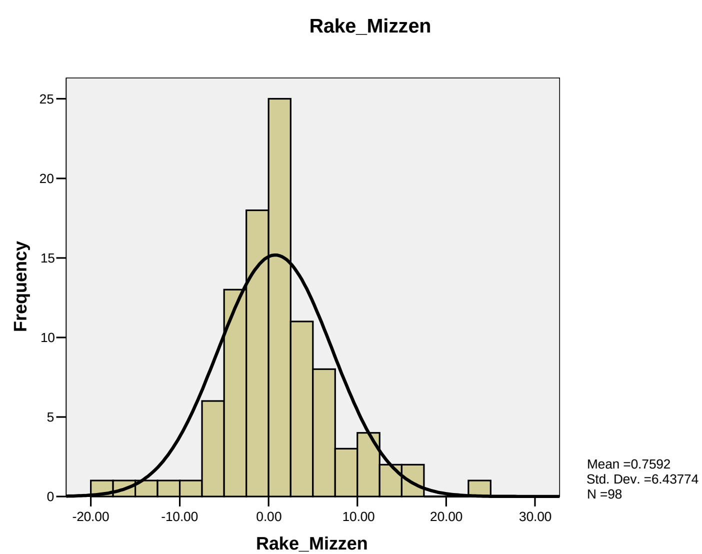


Figure 51: Histogram of the rake of the mizzen mast in caravels. Refer to Appendix 27 for data.

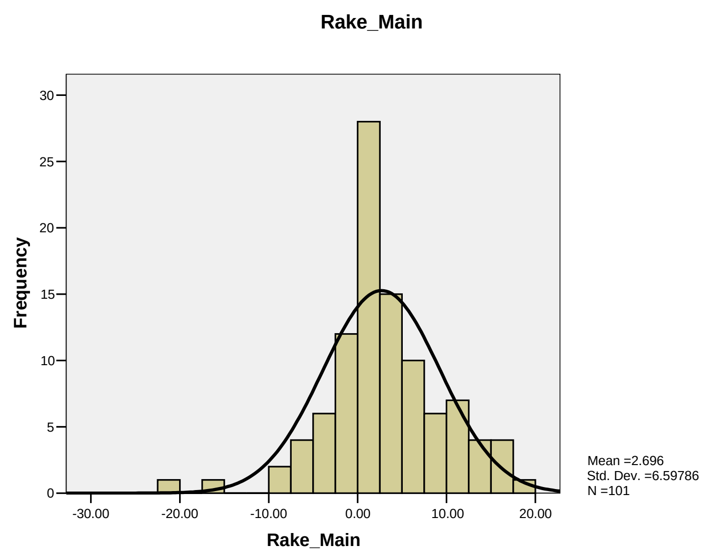


Figure 52: Histogram of the rake of the main mast in caravels. Refer to Appendix 27 for data.

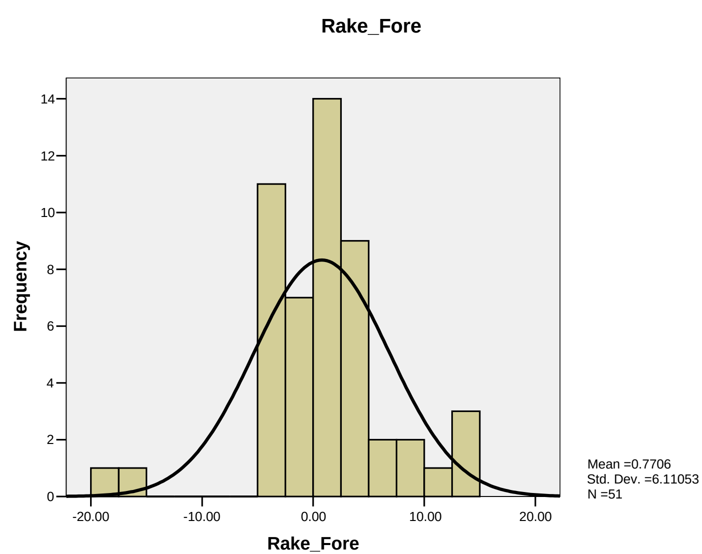


Figure 53: Histogram of the rake of the fore mast in caravels. Refer to Appendix 27 for data.

degrees, of the mizzen mast rake is -5.67 to 7.19 degrees, of the main mast rake is -3.90 to 9.28 degrees, and of the fore mast rake is -5.33 to 6.88 degrees. The center of distribution for the boomkin is 9 to 24 degrees, for the bowsprit is 10 to 37 degrees, for the bonaventure mast is -2.4 to 1.9 degrees, for the mizzen mast is -2.5 to 4 degrees, for the main mast is -.95 to 5.9 degrees, and for the fore mast is -2.6 to 3.7 degrees.

Determining the normal range of variation through the center of distribution provides a more conservative range (50% versus 68%), which may be too limited for such a generalized study with little to no comparative material. Thus, using one standard deviation is arguably the best approach given the newness of using iconography to determine the rake of masts. Before determining if this is a reasonable range to use when reconstructing a vessel, however, it first needs to be further analyzed by rig type. Likewise, the kurtosis and skewness values indicate that although these samples are close to being a normal distribution as determined by the mean and median, it is still relatively asymmetrical and there are some problems with this distribution. It is highly probable that the wide range of variation in the data set due to the differing rigging configurations of each ship type is causing the asymmetrical distributions. To fully understand the rakes of caravels, galleons, and naus, it is necessary to examine the individual mast rakes of all the rig configurations separately to determine the extent of variance between the ship types.

<u>Two-Masted Caravels Distribution Analysis</u>

Although there are 38 main mast rakes for the two-masted caravel dataset, there are only 14 boomkin rakes, and 37 mizzen rakes because of the different rigging configurations. The mean is close to the median for the mizzen and main mast and the skewness numbers are low indicating a fairly symmetrical distribution with short tails to the right (positively skewed or forward rake for the masts). There is a relatively large discrepancy between the mean and the median for the boomkin, however, suggesting an asymmetrical distribution which is clearly visible in the histogram graph (Figure 54). Nonetheless, taken in perspective, it is still a good sample. The boomkin rake demonstrates that there is a wider range of variation than found for the mizzen and main masts. The skewness value is within twice the standard error of skewness for the boomkin and the main mast but is outside of this margin for the mizzen mast (3.7) meaning this spar has an asymmetrical distribution. The kurtosis value is negative for the boomkin with less clustering and longer tails and a value slightly more than twice the standard error of kurtosis (-2.17). The mizzen and main masts have positive kurtosis values with more clustering and shorter tails; the kurtosis values for the mizzen mast are far greater than twice the standard error of kurtosis (3.97), while the kurtosis value of the main mast is less than the standard error of kurtosis. The main mast has good clustering around a mode of zero while the mizzen is less clustered and has a longer right tail. The kurtosis like the skewness signifies that although the distribution has some asymmetrical elements, they are both close to being a normal distribution for the mizzen and main mast, which is evident in the histogram graph (Figures 55 and 56) and thus a viable

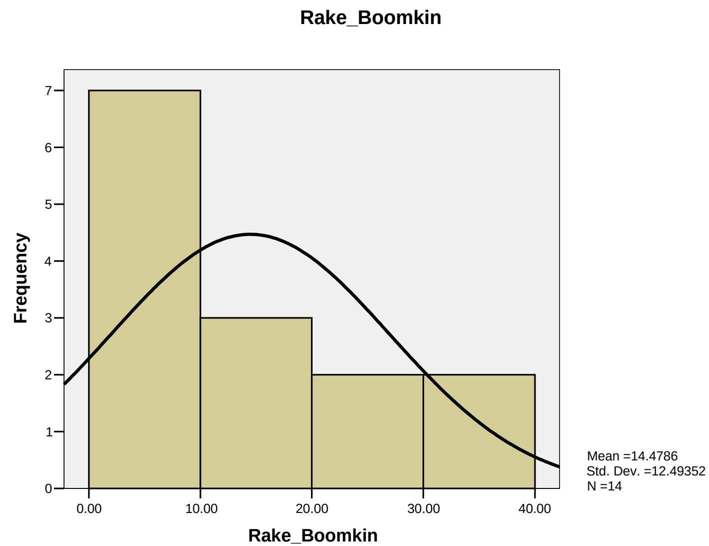


Figure 54: Histogram of the rake of the boomkin in two-masted caravels. Refer to Appendix 27 for data.

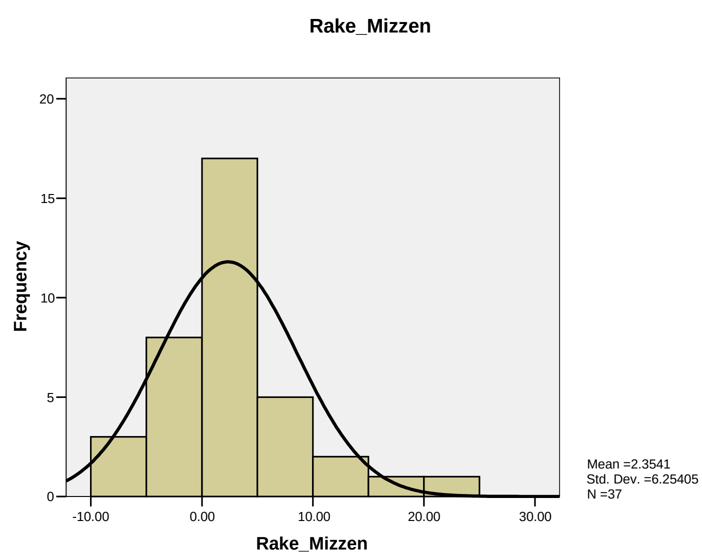


Figure 55: Histogram of the rake of the mizzen mast in two-masted caravels. Refer to Appendix 27 for data.

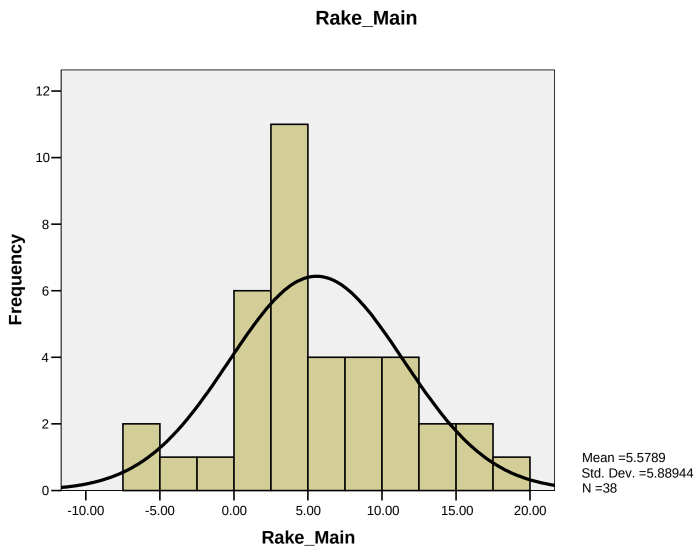


Figure 56: Histogram of the rake of the main mast in two-masted caravels. Refer to Appendix 27 for data.

sample. The standard deviation for the boomkin rake is 1.98 to 26.96 degrees while the mizzen mast rake is -3.72 to 3.37 degrees and the main mast rake is -0.31 to 11.45 degrees. The center of distribution for the boomkin is 3.5 to 26.15 degrees, for the mizzen mast is -1.8 to 5.1 degrees, and for the main mast is 1.8 to 9 degrees.

Three-Masted Caravels Distribution Analysis

In the three-masted caravel dataset there are 12 mizzen and main mast rakes, 11 bonaventure rakes, four boomkin rakes, and two bowsprit rakes due to differing rigging configurations. The mean is close to the median for the boomkin, bowsprit, and all of the masts; however, the sample size of the bowsprit (N=2) is too small for a meaningful histogram graph and is excluded from the statistical tests. The skewness numbers for the boomkin and masts are low indicating a fairly symmetrical distribution. The bonaventure is the only positively skewed mast with a short tail to the right (forward rake) while the boomkin, mizzen, and main have a negatively skewed distribution with short tails to the left (aft rake). The skewness value is within twice the standard error of skewness for the boomkin and the masts confirming a fairly symmetrical distribution. The kurtosis values are positive for the boomkin and all the masts with more clustering and shorter tails and values within twice the standard error of kurtosis. The kurtosis and skewness both indicate that boomkin, bonaventure, mizzen, and main mast have normal distributions which is evident in the corresponding histogram graphs (Figures 57 - 60) and are good samples.

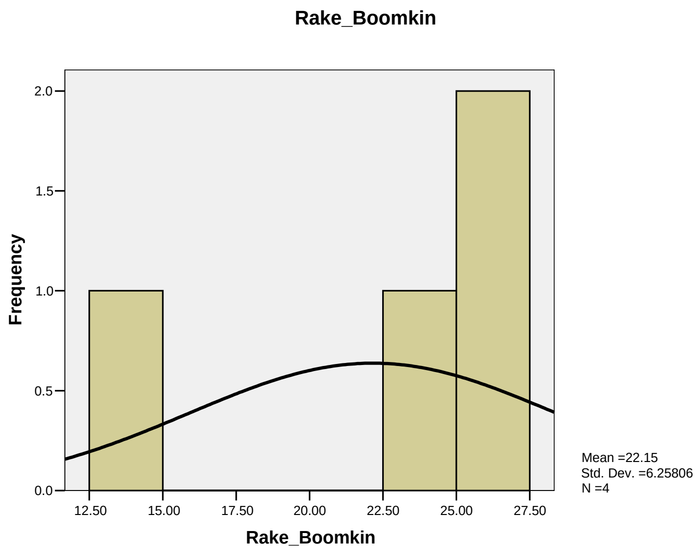


Figure 57: Histogram of the rake of the boomkin in three-masted caravels. Refer to Appendix 27 for data.

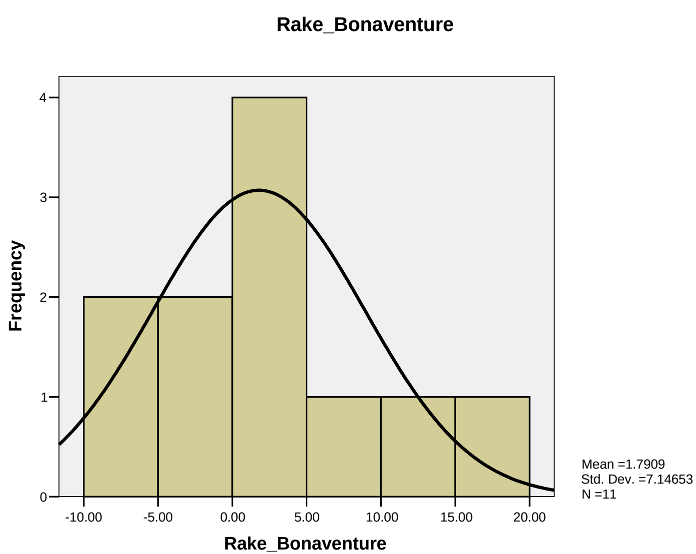


Figure 58: Histogram of the rake of the bonaventure mast in three-masted caravels. Refer to Appendix 27 for data.

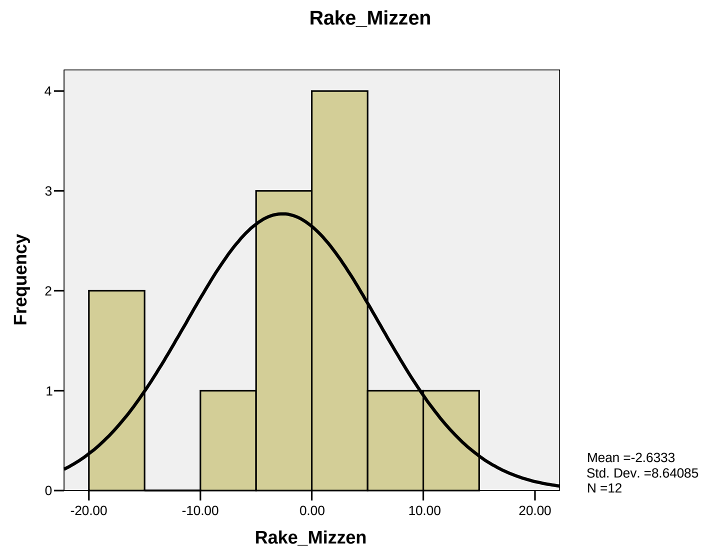


Figure 59: Histogram of the rake of the mizzen mast in three-masted caravels. Refer to Appendix 27 for data.

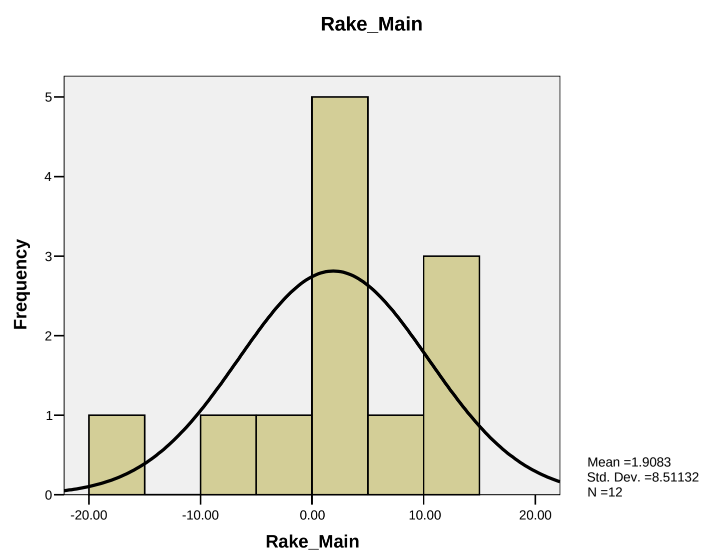


Figure 60: Histogram of the rake of the main mast in three-masted caravels. Refer to Appendix 27 for data.

The boomkin has a bimodal distribution with the main mode designated as 12.9 degrees. Given that there are only four ships in this sample, it is prudent to assume that the boomkin has a larger range of variation rather then automatically discarding the rake with a lower value. Additionally, the mode is assigned to the lower value and without more samples the findings for the boomkin are inconclusive. The mizzen also has a bimodal distribution and again the mode was set at the lower value which in this case is -7.7 degrees. After viewing the histogram graph, it is apparent that the larger mode of zero degrees would have been more applicable for this distribution. The standard deviation for the boomkin rake is 15.9 to 28.4 degrees while the bonaventure mast rake is -5.35 to 8.93 degrees, the mizzen mast rake is -11.27 to 6 degrees and the main mast rake is -6.6 to 10.41 degrees. The center of distribution for the boomkin is 15.67 to 26.22 degrees, for the bonaventure mast it is -3.9 to 6.7 degrees, for the mizzen mast it is -6.32 to 1.55 degrees, and for the main mast it is -1.72 to 8.97 degrees.

Four-Masted Caravels Distribution Analysis

In the four-masted caravel dataset, there are 49 bowsprit, bonaventure, mizzen, main, and fore mast rakes and 47 boomkin rakes. The mean is close to the median for the boomkin, bowsprit, and all of the masts and the skewness numbers are low indicating a fairly symmetrical distribution. The main mast is the only negatively skewed mast with short tails to the left or an aft rake while the boomkin, bowsprit, bonaventure, and mizzen are positively skewed with a short tail to the right and forward rakes. The skewness value is within twice the standard error of skewness for the boomkin, bowsprit, mizzen, and fore masts confirming a fairly symmetrical distribution (Figures 61 – 64), but is outside of the limits for the bonaventure and main masts (Figures 65 and 66). The kurtosis values are positive for the four masts with more clustering and shorter tails but are negative for the boomkin and bowsprit. The values are within twice the standard error of kurtosis for the bowsprit and mizzen; however, the boomkin, bonaventure, main, and fore masts numbers are well outside of the margin. The kurtosis like the skewness signifies that although the distribution has some asymmetrical elements, they are both close to being a normal distribution for the mizzen and main mast and thus a viable sample.

The bowsprit has a bimodal distribution with the main mode designated as 10 degrees; however, it could just as easily be in the 30-40 degree range. The boomkin has a mode of 15 while the bonaventure, main, and fore masts have a mode of 0 and the mizzen -1 degrees. The standard deviation for the boomkin rake is 6.23 to 25.5 degrees and 14.26 to 38.44 degrees for the bowsprit while the bonaventure mast rake is -4.35 to3.68 degrees, the mizzen mast rake is -5.29 to 6.06 degrees, the main mast rake is -5.35 to 6.42 degrees, and the fore masts is -4.41 to 6.72 degrees. The center of distribution for the boomkin is 9 to 22.8 degrees, for the bowsprit it is 10.5 to 37 degrees, for the bonaventure mast it is -2.25 to .5 degrees, for the mizzen mast it is -2.7 to 3.1 degrees, for the main mast it is -2 to 3.15 degrees, and for the fore mast it is -2.3 to 3.85 degrees.

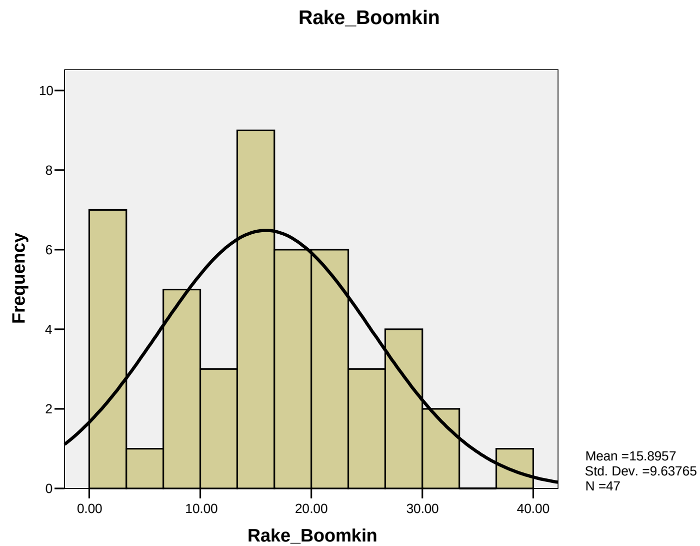


Figure 61: Histogram of the rake of the boomkin in four-masted caravels. Refer to Appendix 27 for data.

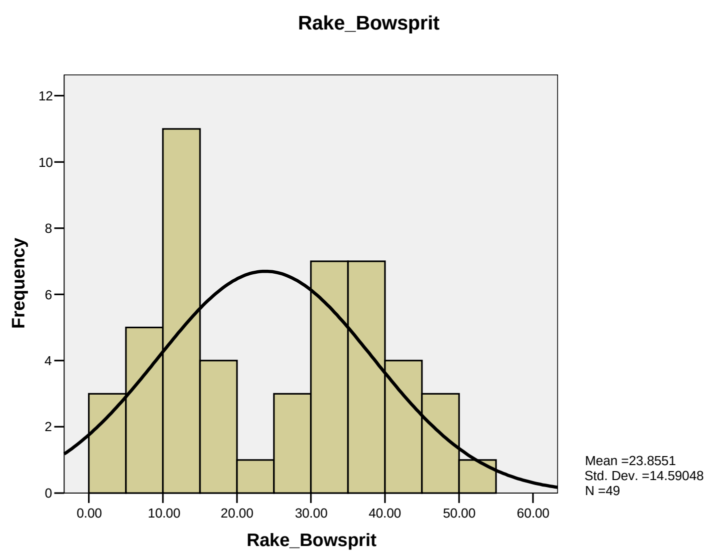


Figure 62: Histogram of the rake of the bowsprit in four-masted caravels. Refer to Appendix 27 for data.

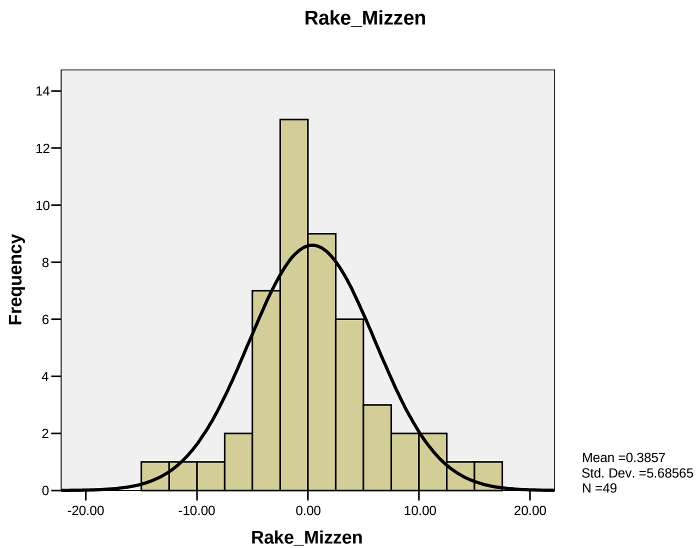


Figure 63: Histogram of the rake of the mizzen mast in four-masted caravels. Refer to Appendix 27 for data.

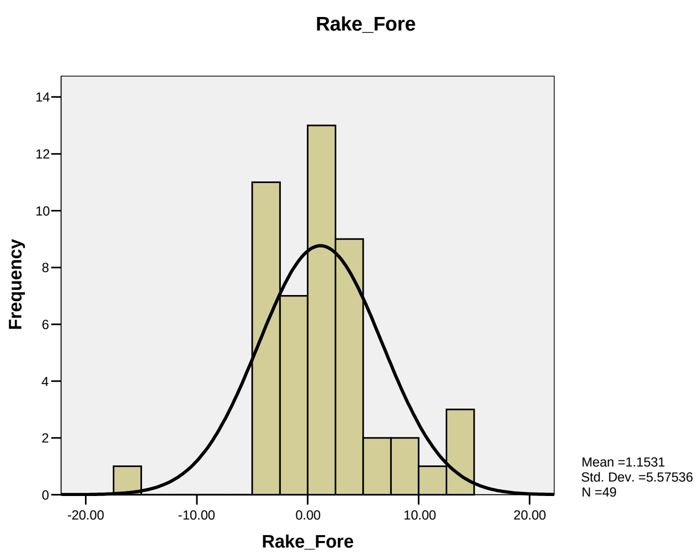


Figure 64: Histogram of the rake of the fore mast in four-masted caravels. Refer to Appendix 27 for data.

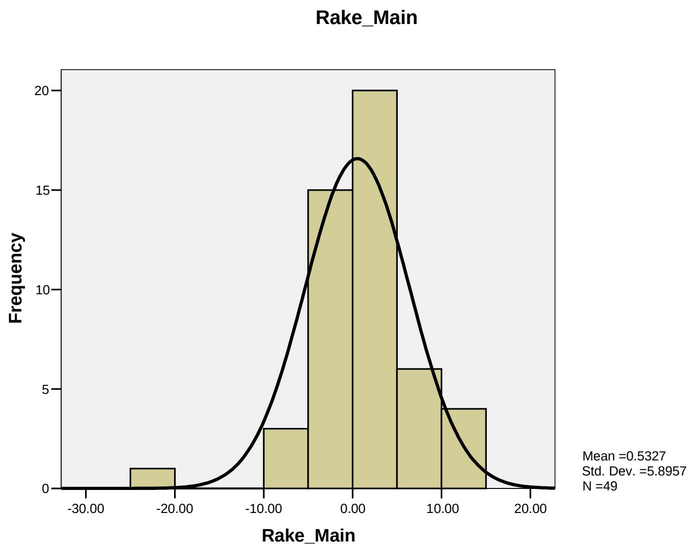


Figure 65: Histogram of the rake of the main mast in four-masted caravels. Refer to Appendix 27 for data.

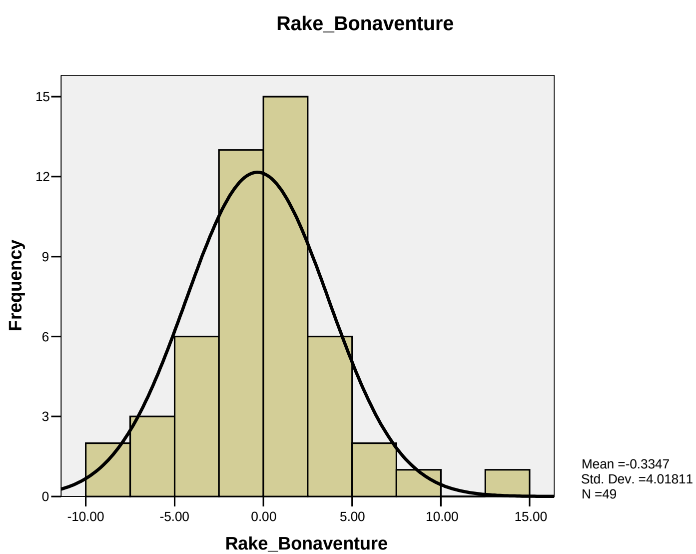


Figure 66: Histogram of the rake of the bonaventure mast in four-masted caravels. Refer to Appendix 27 for data.

Comparison of Caravel Mast Rakes

Given that there is no archival documentation of the mast rakes specifically for caravels, the data is thus compared to itself resulting in a range of potential mast rakes. Although the center of distribution provides a more conservative range of variation (50%), the more liberal range of one standard deviation is used for comparative purposes of the caravel subtypes; refer to Appendix 28 for the tabulation of all mast rakes. The rake of the boomkin has a consistent upper end of (25.5° to 28.4°) between the two-, three-, and four-masted caravels and the data taken as a whole. The two-masted and four-masted caravel range are closest to the values for boomkin rakes of the entire caravel sample which is to be expected as the two subtypes accounts for a majority of the sample size (61 out of 65 caravels with boomkin). The two-masted caravels have a lower end of two degrees and three-masted caravels are significantly higher at nearly sixteen degrees while the four-masted caravels are in between with six degrees. The differences in the rakes of the boomkin between the caravel subtypes are also seen in the histograms (Figures 54, 58, and 61) with a widespread distribution for the four-masted caravels, two clearly separated modes for the three-masted caravels, and a long right tail for the two-masted caravels. As such, it is logical to use the range produced by one standard deviation for the entire caravel dataset which results in a range of roughly six to 26 degrees. Given the difference between the caravel subtypes, strict attention should be paid to the individual results for each subtype when reconstructing the rake of the boomkin. When the mast rakes exhibit such a divergence, the overall average will be used to provide a generalized idea of a normal range of variation and to facilitate the comparison between caravels, galleons, and naus which would be unnecessarily complicated by the addition of subtype ranges.

The bowsprit is easily analyzed as it is only present on two of the three-masted caravels and all of the four-masted caravels. The standard deviation between the entire sample and the four-masted caravels differs only by three degrees (9 to 14) on the lower end and is otherwise identical; however, the three-masted vessels with the bowsprits are significantly different with a roughly 10 degree difference on the lower end and 12 degrees on the higher end of the range. Therefore the normal range for the bowsprit is set at nine to 39 degrees using the one standard deviation for the entire caravel dataset which reflects the two modes exhibited in the histogram of the four-masted caravels (Figure 62).

Similar to the bowsprit, there is a detectable difference between the rake of the bonaventure mast for the three-masted and four-masted caravels. The rake of the bonaventure mast varies between the three-masted caravel sample which has a one standard deviation range extending almost to nine degrees forward and the four-masted caravel sample which has a forward rake of only four degrees. The two caravel subtypes have similar lower end of the range, however, with only one degree deviation. The normal range of bonaventure rakes is set as -5 to 5 degrees based on the one standard deviation for the entire sample which reflects the modes in both histograms (Figures 58 and 66). The mizzen mast rake is fairly consistent on the higher end of the one standard deviation range between the three-masted and four-masted caravels, which is also reflected in the overall sample range; however, the three-masted caravels have a lower end that is skewed much more aft (-11.27) compared to the more centralized two- and four-masted caravels. Like the bonaventure mast, there is a moderate discrepancy between the rig configurations and the entire sample range of six degrees aft to seven degrees forward is the overall average and is supported by the modes displayed in the histograms (Figures 55, 59, and 63).

The rake of the main mast diverges between the different rig configurations. The three-masted and four-masted caravels have a similar aft rake of around six degrees that extends to roughly 10 degrees forward for the three-masted caravels and six degrees forward for the four-masted caravels. The range for the two-masted caravels is more positively skewed with forward rakes from essentially zero to 11 degrees. It appears that the main mast has a more pronounced forward rake in the two- and three-masted caravels when there is not a fore mast that could potentially interfere with the movement of a main yard. The overall range produced by one standard deviation for the main mast rake is set at roughly four degrees aft to just past nine degrees forward. Therefore it is the most reliable estimate of normal variation what is consistent with the modes shown in each histogram (Figures 58, 60, and 65). The fore mast only exists on the 49 four-masted caravels (Figure 64) and a single two-masted caravel. The predominance of the previous is clearly reflected in the overall range of five degrees aft to nearly seven degrees forward produced by one standard deviation.

In general, although there are moderate differences between the rakes of masts of the caravel rig configurations there is actually relatively little variation within the entire dataset. The ranges are essentially a few degrees forward and aft of a vertical position for each mast. In the reconstruction of different types of caravels the more specific ranges can be extremely useful; however, until more information is obtained from archaeological or archival evidence the overall averages should be considered sufficient indicators of mast rakes.

Galleon Mast Rakes

Three-Masted Galleon Mast Rakes Distribution Analysis

In the three-masted galleon dataset, there are 12 boomkin, bowsprit, mizzen, main, and fore mast rakes. The mean is close to the median for all the masts but is moderately different for the boomkin and bowsprit which, at first, could suggest an asymmetric distribution. The skewness values do not support this, however, as all are low and within twice their standard deviations indicating a fairly symmetrical distribution. The bowsprit is the only negatively skewed mast (Figure 67) with a short tail to the left (aft rake) while the boomkin, mizzen, main, and fore masts are positively skewed with a short tail to the right (forward rakes) (Figures 68 – 71). The kurtosis values are positive for the mizzen and main masts with more clustering and shorter tails but are negative for the boomkin, bowsprit, and fore with less clustering. The values are within twice the standard error of kurtosis for all the masts and spars and the kurtosis and skewness together signifies that all have a normal distribution and the data set is a viable sample.

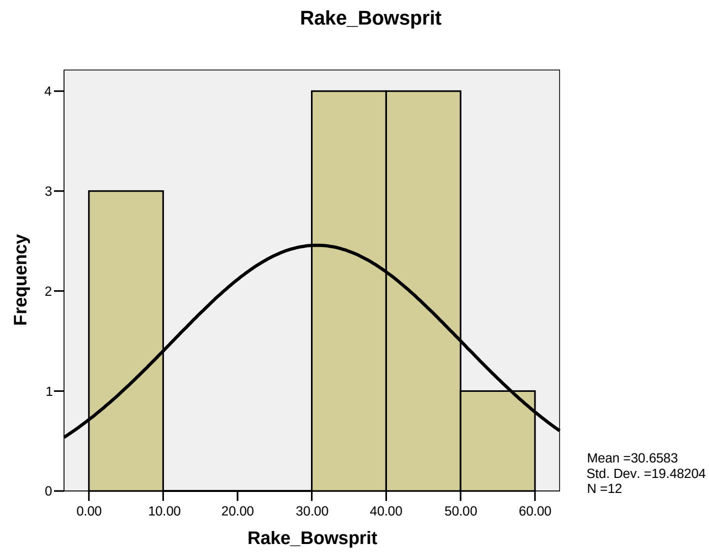


Figure 67: Histogram of the rake of the bowsprit in three-masted galleons. Refer to Appendix 27 for data.

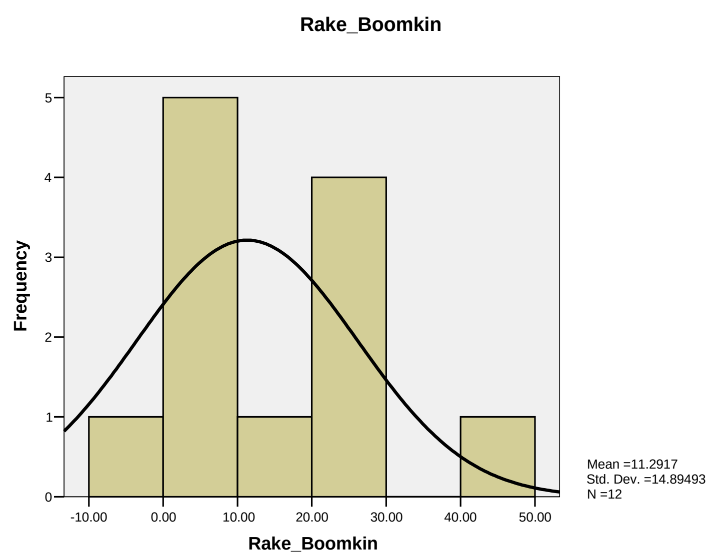


Figure 68: Histogram of the rake of the boomkin in three-masted galleons. Refer to Appendix 27 for data.

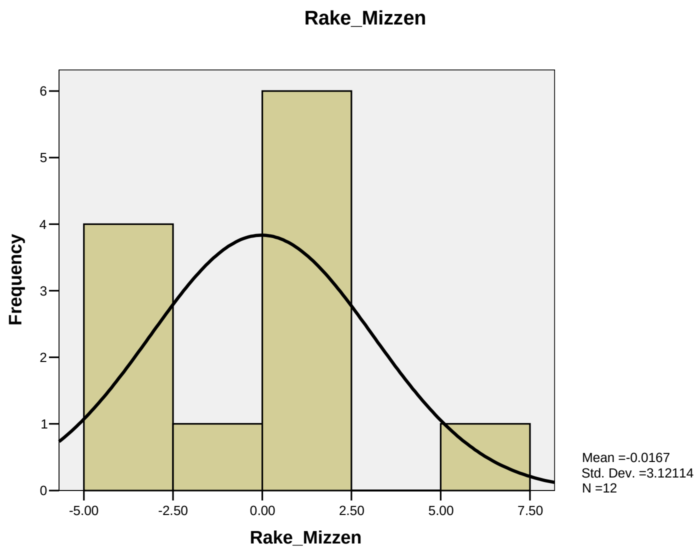


Figure 69: Histogram of the rake of the mizzen mast in three-masted galleons. Refer to Appendix 27 for data.

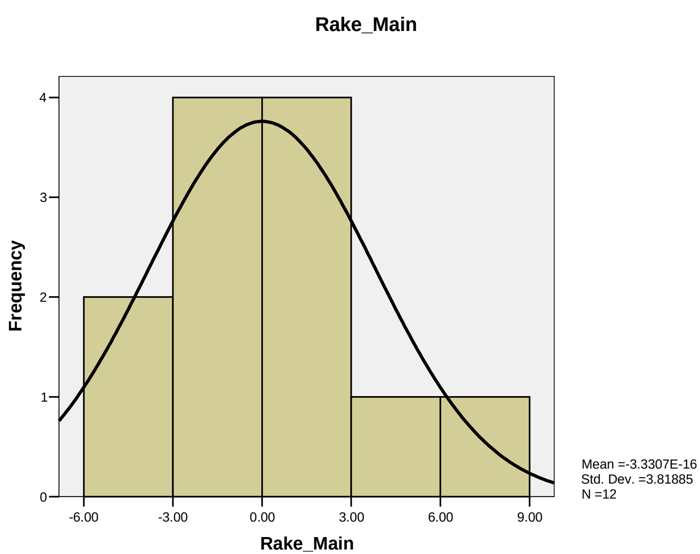


Figure 70: Histogram of the rake of the main mast in three-masted galleons. Refer to Appendix 27 for data.

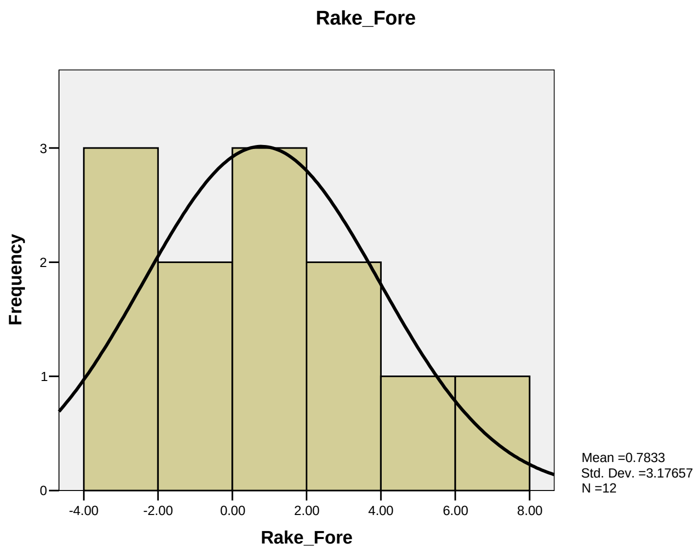


Figure 71: Histogram of the rake of the fore mast in three-masted galleons. Refer to Appendix 27 for data.

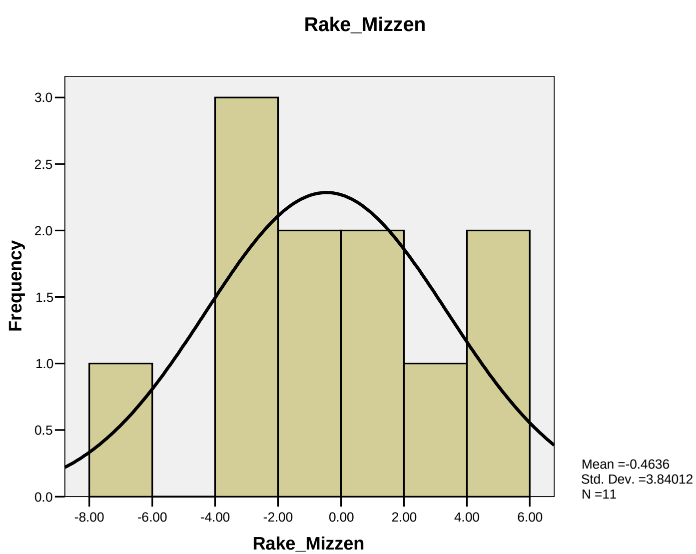


Figure 72: Histogram of the rake of the mizzen mast in four-masted galleons. Refer to Appendix 27 for data.

The main and fore are the only masts designated as being bimodal with the primary modes of -5.4 and -4 respectively, and the secondary modes with more probable peaks from -3 to 3 degrees for the main and 0 to 2 degrees for the fore mast. The boomkin and bowsprit, which have less consistent samples, are not considered bimodal distributions. The boomkin and bowsprit both have modes at 0 degrees but the boomkin has a secondary peak at 20 to 30 degrees and the bowsprit has a broad peak ranging from 30 to 50 degrees. The standard deviation for the boomkin rake is -3.6 to 26.2 degrees and 11.2 to 50.1 degrees for the bowsprit both of which reflect the secondary peaks. The standard deviation for mizzen mast rake is -3.1 to 3.1 degrees, the main mast rake is -3.8 to 3.8 degrees, and the fore masts is -2.4 to 4 degrees. The center of distribution for the boomkin is 0 to 22.7 degrees, for the bowsprit it is 7.6 to 45.5 degrees, for the mizzen mast it is -2.7 to 1.8 degrees, for the main mast it is -2.2 to 2.1 degrees, and for the fore mast it is -1.9 to 3.6 degrees.

Four-Masted Galleon Mast Rakes Distribution Analysis

In the four-masted galleon dataset, there are 11 boomkin, bowsprit, bonaventure, mizzen, main, and fore mast rakes. The mean is close to the median for all the masts and the skewness values are low and within twice their standard deviations indicating a symmetrical distribution. The bowsprit, mizzen, and fore masts are negatively skewed with a short tail to the left or an aft rake for the mizzen and fore (Figures 72 and 73) and a downward raking bowsprit (Figure 74). While the boomkin, the bonaventure mast, and

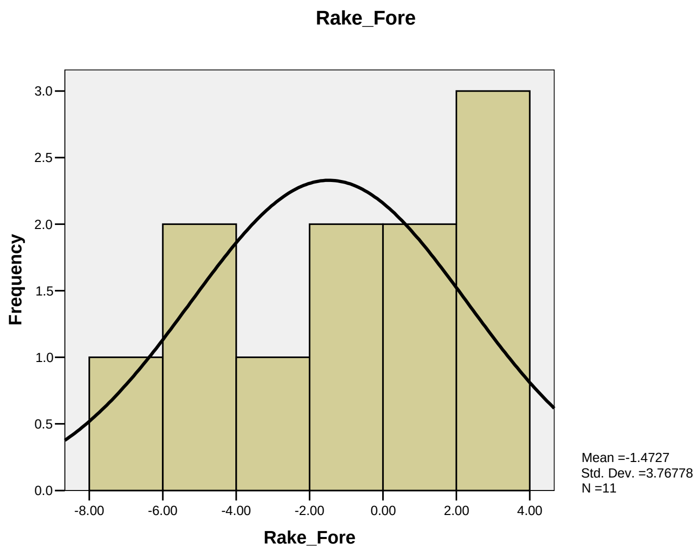


Figure 73: Histogram of the rake of the fore mast in four-masted galleons. Refer to Appendix 27 for data.

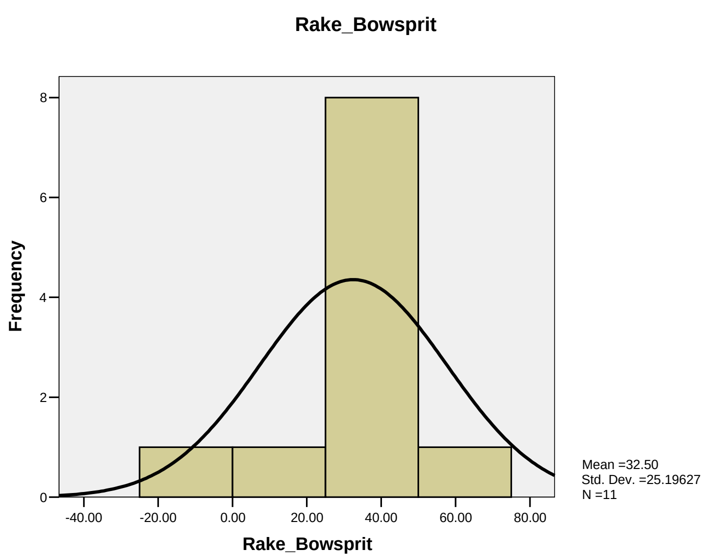


Figure 74: Histogram of the rake of the bowsprit in four-masted galleons. Refer to Appendix 27 for data.

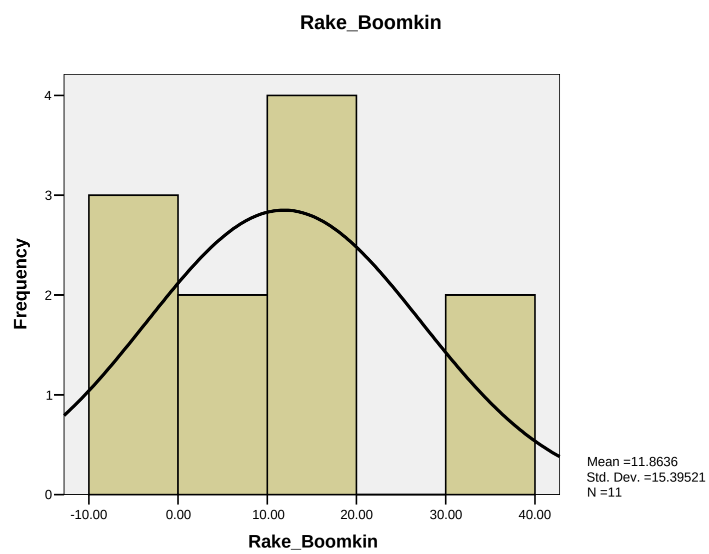


Figure 75: Histogram of the rake of the boomkin in four-masted galleons. Refer to Appendix 27 for data.

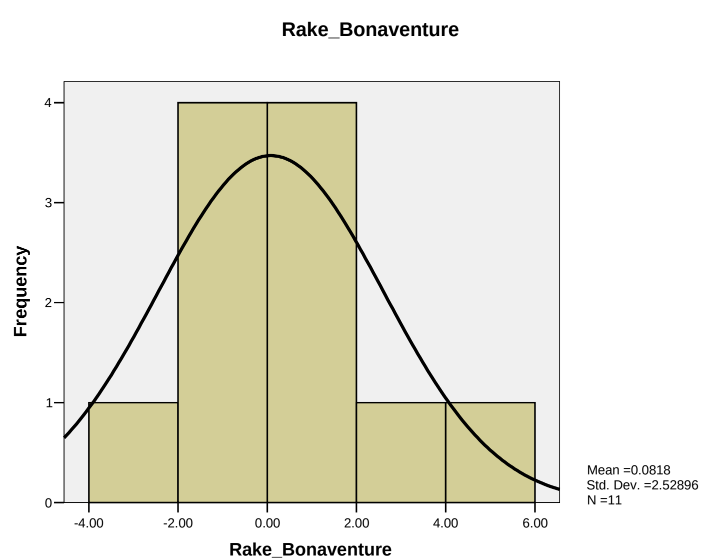


Figure 76: Histogram of the rake of the bonaventure mast in four-masted galleons. Refer to Appendix 27 for data.

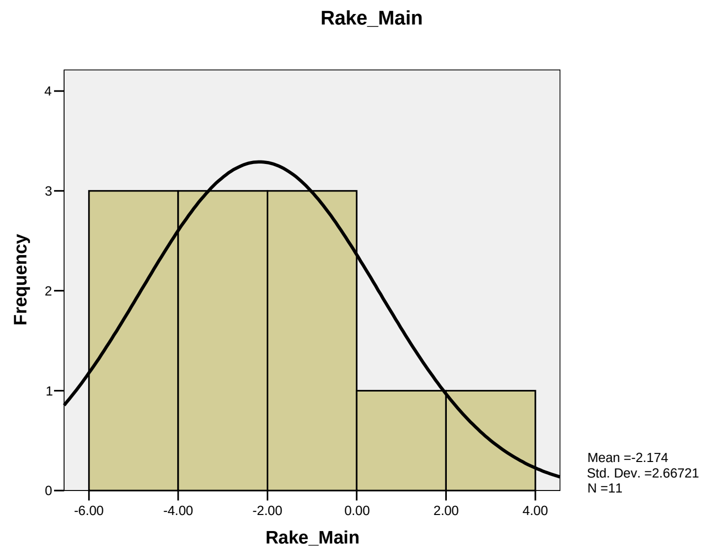


Figure 77: Histogram of the rake of the main mast in four-masted galleons. Refer to Appendix 27 for data.

the main mast are all positively skewed with a short tail to the right and forward rakes (Figures 75 – 77). The kurtosis values are positive for the bowsprit, bonaventure, and main masts with more clustering and shorter tails but are negative for the boomkin, mizzen, and fore with less clustering. The kurtosis values are within twice the standard error of kurtosis for all the masts and spars except for the bonaventure which is slightly outside the margin indicating an asymmetrical distribution. The histogram of the bonaventure clearly shows a normal curve and the asymmetric elements is the strong peak ranging from -2 to 2 degrees. The kurtosis and skewness together signifies that all masts and spars have a normal distribution and the four-masted galleon data set is a viable sample.

All masts except for the bonaventure are bimodal; however the more probable peaks are from 10 to 20 degrees for the boomkin, roughly 22 to 43 for the bowsprit, -4 to -2 degrees for the mizzen, -6 to 0 degrees for the main mast, and 2 to 4 degrees for the fore mast. The standard deviations for the boomkin rake is -3.5 to 27.3 degrees, 7.3 to 57.7 degrees for the bowsprit, -2.4 to 2.6 for the bonaventure, -4.3 to 3.4 for the mizzen, -4.8 to 0.5 for the main, and -5.2 to 2.3 for the fore mast rake is all of which reflect the main peaks visible in the histogram. The center of distribution for the boomkin is -1 to 18 degrees, for the bowsprit it is 30.3 to 48 degrees, for the bonaventure mast it is -1.1 to .9, for the mizzen mast it is -2.8 to 3.6 degrees, for the main mast it is -4.4 to -.4 degrees, and for the fore mast it is -5.1 to 2.4 degrees.

Comparison of Galleon Mast Rakes

Like the caravels, there is no archival documentation of the rakes of masts specifically for galleons. As such, the data cannot be compared to other lines of evidence providing substantiation for the validity of the results or refuting them. Although the center of distribution for each mast is listed in Appendix 28 the more liberal one standard deviation (68%) is preferred for determining a normal range of variation for the galleon mast rakes. The rake of the boomkin is exceptionally consistent between the three- and four-masted galleons with virtually no difference on the lower end and less than one degree divergence on the higher end of the range (Figures 68 and 75). The one standard deviation for the all galleon sample of three degrees aft to 26 degrees forward is the suggested normal range of variation. The bowsprit has a somewhat similar range between the three- and four-masted galleons with a six degree difference on the lower end and seven degrees on the higher end. Interestingly, the center of distribution for the four-masted galleons drastically narrows the range from roughly seven to 58 degrees to 30 to 48 degrees. Likewise, the three-masted galleons exhibit an unusual center of distribution range which is skewed lower than the standard deviation whereas most center of distributions are more centralized than the standard deviation. The histogram of the three-masted galleons (Figure 67) and the four-masted galleons (Figure 74) both display viable peaks on the higher end of the range indicating that a more reliable range for the bowsprit rake is 30 to 47 degrees instead of the 15 to 52 degrees produced by one standard deviation.

The bonaventure mast is only present on the four-masted galleons (Figure 76) and has a range of roughly two degrees aft to nearly three degrees forward. The mizzen mast has a highly consistent range between the three-masted and four-masted galleons (Figures 69 and 72) which are reflected in the overall sample range of four degrees aft to three degrees forward. The rake of the main mast on four-masted galleons is negatively skewed with a range from four degrees aft to essentially a vertical position and diverges from that of the three-masted galleons which has a higher end that reaches nearly four degrees forward. The histograms of the main mast for both the three- and four-masted galleons (Figures 70 and 77) show that the majority of main masts are raked aft but the three-masted galleons have a wider range extending into the positive values. Therefore, the overall range of four and a half degrees aft to nearly two and a half degrees forward produced by one standard deviation is considered suitable for this dataset. The foremast has the most divergence between the rakes of three- and four-masted galleons and both histograms display a wide range of values indicating there is far more variation of this mast compared to the others (Figures 71 and 73). These results clearly indicate that the overall center of distribution is too limited for the fore mast and support the general decision to use the ranges from the more liberal one standard deviation which in this case is roughly four degrees aft to three degrees forward. Like the caravels, there is relatively little variation between the rakes of masts of the two different galleon rigging configurations and the ranges are all a few degrees forward and aft of a vertical position.

Nau Mast Rakes

Nau Mast Rakes Distribution Analysis

The nau mast rakes were limited to only those ships for which it was possible to measure the rake of every mast as well as the boomkin or bowsprit. These parameters eliminated all of the four-masted naus with a bonaventure mast and as such only the results for the three-masted naus are described. The three-masted naus are then compared to the overall ranges of each mast for the caravels and galleons. The nau sample size for the mizzen, main, and fore mast is 152; while the bowsprit rake was only measured on 150 naus and the boomkin on 131 naus.

The mean is close to the median for all the masts and the skewness values are low and within twice their standard deviations indicating a symmetrical distribution. The bowsprit, mizzen, and main masts are negatively skewed with a short tail to the left (aft rake) for the mizzen and main (Figures 78 and 79) and down raking bowsprit (Figure 80). The boomkin and the fore mast are positively skewed with a short tail to the right (forward rakes) (Figures 81 and 82). The only skewness value that is more than twice the standard error of skewness is the boomkin suggesting that it is an asymmetrical distribution which is apparent in the histogram with the peaks far to the left and a long right tail. The kurtosis values are positive for the all masts and spars with more clustering and shorter tails except the bowsprits which has a negative value with less clustering. The kurtosis values are not within twice the standard error of kurtosis for all

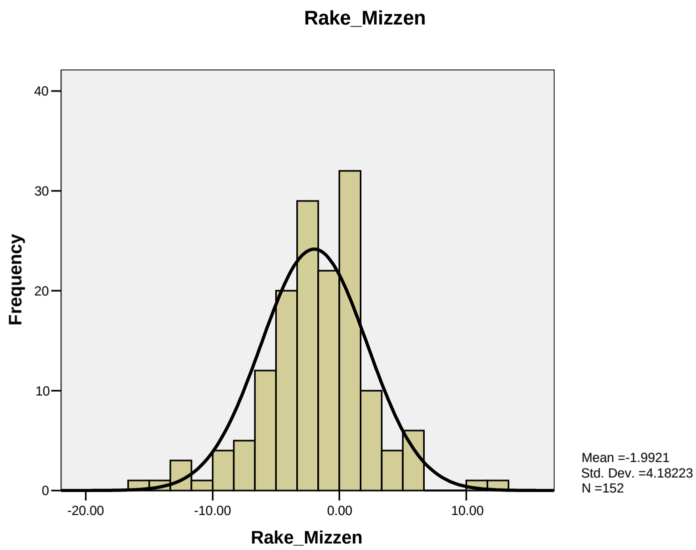


Figure 78: Histogram of the rake of the mizzen mast in naus. Refer to Appendix 27 for data.

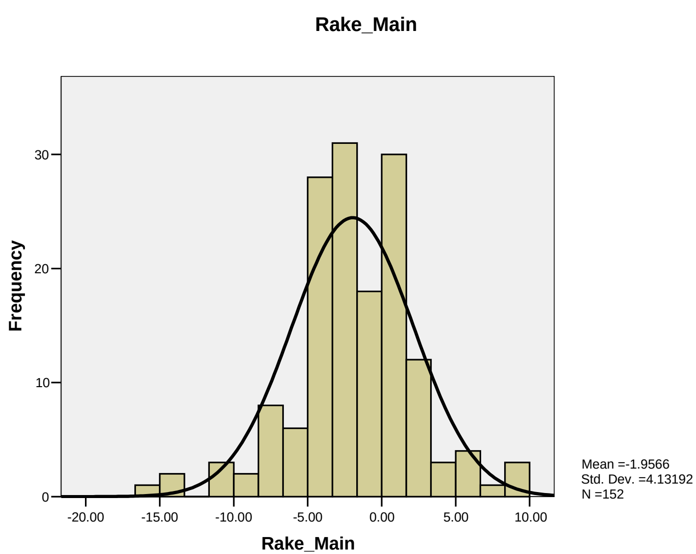


Figure 79: Histogram of the rake of the main mast in naus. Refer to Appendix 27 for data.

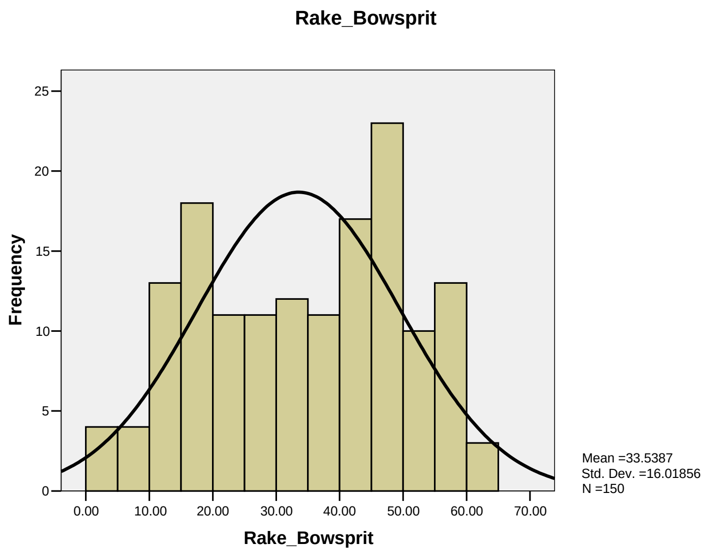


Figure 80: Histogram of the rake of the bowsprit in naus. Refer to Appendix 27 for data.

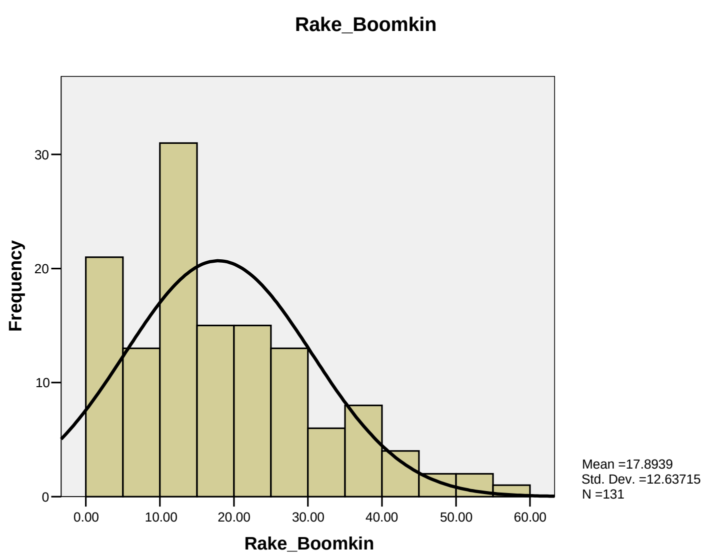


Figure 81: Histogram of the rake of the boomkin in naus. Refer to Appendix 27 for data.

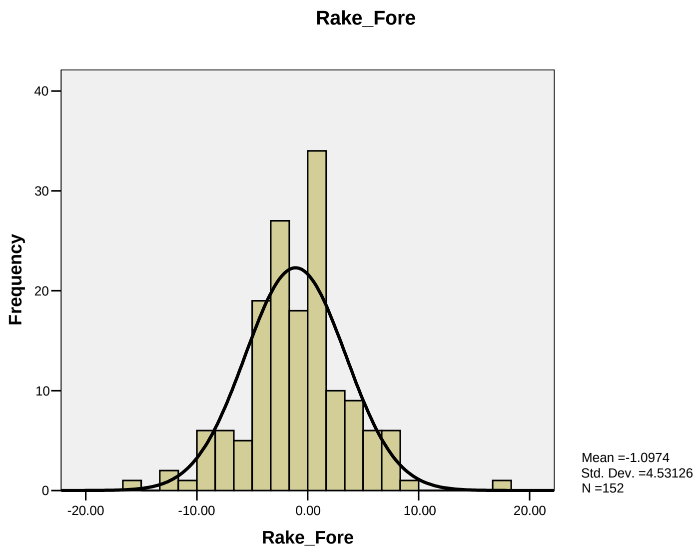


Figure 82: Histogram of the rake of the fore mast in naus. Refer to Appendix 27 for data.

the masts and spars except for the boomkin also demonstrating an asymmetrical distribution. The kurtosis like the skewness signifies that although the distributions of the mast rakes have some asymmetrical elements, which are to be expected with such a large number of naus, they are close to being a normal distribution as evident in the histogram graph and thus a viable sample. All masts except for the boomkin are unimodal; however the more probable peak for the boomkin is from 10 to 15. The standard deviations for the boomkin rake is 5.3 to 30.5 degrees, 17.5 to 49.5 degrees for the bowsprit, -6.1 to 2.2 for the mizzen, -6 to 2.2 for the main, and -5.6 to 3.4 for the fore mast rake. The center of distribution for the boomkin is 9 to 25 degrees, for the bowsprit it is 18 to 47 degrees, for the mizzen mast it is -4 to 0 degrees, for the main mast it is -4.3 to 0 degrees, and for the fore mast it is -4 to 1 degrees. The ranges produced by the standard deviation and the center of distribution all reflect the main peaks visible in the histograms; however, the previous will be used as a normal range of variation for each mast and compared to caravels and galleons.

As stated previously the only archival mentions of rakes are for the main mast. In the *Livro Náutico* an aft rake of 3.5° is dictated but Fernandez gives a slightly more pronounced rake of 6.1° and Sousa a rake of 10° (Castro, 2005b: 113). The aft rakes listed in the archival documents correspond to the negative rakes in this study. The range of rakes for naus produced by one standard deviation is consistent with the rakes mentioned in the *Livro Náutico* and by Fernandez. The 10 degree aft main mast rake described by Sousa is only supported by four vessels in the iconographic data: CA06.02 from 1529 with a -11.3° rake; CA07.01 from 1529 with a -10.6° rake, CA16.05 from

1559 with -10.01° rake, and MA10.03 from 1517-26 with -14.6° rake. Based on this very limited archival evidence, it appears that the mast rake data generated from the iconography is generally reliable.

Comparison of Caravel, Galleon, and Nau Mast Rakes

There are a total of 98 caravels, 23 galleons, and 152 naus in the mast rake dataset; however, the number for each mast differs by ship type due to the differing rigging configurations. The tabulation of the center of distribution and the one standard deviations are listed in Table 43. Although the center of distribution provides a more concise range, the more liberal range of one standard deviation is used for comparative purposes for the caravels, galleons, and naus. The range of normal variation for the boomkin rakes is fairly consistent between the three ship types. The caravel and naus have a nearly identical lower end of around five degrees, while the galleons extend down to three degrees. There is more uniformity between the higher ends of the range; the caravels and galleons both have higher end rakes of 26 degrees with the naus reaching just past 30 degrees. Overall, the boomkin rakes are essentially the same for the caravels and naus with slightly more variation in the galleon, which is further emphasized when looking at the center of distribution range. There is more divergence between the range of bowsprit rakes for the galleons and naus and for the caravels. The bowsprit rakes for the galleons and naus are within two degrees of each other on either end of the range while the rake for the caravels is skewed several degrees lower from the other two ship types. The center of distribution for the galleons is far different from both the caravels

TABLE 43: One Standard Deviation and Center of Distribution Figures for all Mast Rakes

ALL MAST RAKES			
BOOMKIN	N Values	One Standard Deviation (68%)	Center of Distribution (50%)
Caravel	N=65	5.82° to 26.10°	9° to 24°
Galleon	N=23	-3.2° to 26.4°	0° to 21.8°
Nau	N=131	5.3° to 30.5°	9° to 25°
BOWSPRIT	N Values	One Standard Deviation (68%)	Center of Distribution (50%)
Caravel	N=51	9.12° to 38.64°	10° to 37°
Galleon	N=23	15.4° to 51.9°	30.3° to 46.9°
Nau	N=150	17.5° to 49.5°	18° to 47°
BONAVENTURE	N Values	One Standard Deviation (68%)	Center of Distribution (50%)
Caravel	N=60	-4.68° to 4.79°	-2.4° to 1.9°
Galleon	N=11	-1.7° to 1.7°	0° to 0°
MIZZEN	N Values	One Standard Deviation (68%)	Center of Distribution (50%)
Caravel	N=98	-5.67° to 7.19°	-2.5° to 4°
Galleon	N=23	-3.6° to 3.2 °	-2.7° to 2°
Nau	N=152	-6.1° to 2.2°	-4° to 0°
MAIN	N Values	One Standard Deviation (68%)	Center of Distribution (50%)
Caravel	N=99	-3.90° to 9.28°	-.95° to 5.9°
Galleon	N=23	-4.5° to 2.4°	-4° to 1°
Nau	N=152	-6° to 2.2°	-4.3° to 0°
FORE	N Values	One Standard Deviation (68%)	Center of Distribution (50%)
Caravel	N=61	-5.33° to 6.88°	-2.6° to 3.7°
Galleon	N=23	-3.9° to 3.3°	-3.1° to 2.6°
Nau	N=152	-5.6° to 3.4°	-4° to 1°

and naus suggesting that there is much more variability in the caravels and naus than the galleons.

The bonaventure mast rake was only analyzed for the caravels and galleons as the four-masted naus were few in number and had incomplete mast rake measurements. The caravels have a much more pronounced bonaventure rake extending from nearly five degrees aft to five degrees forward, while the galleons do not even reach two degrees aft or forward. This limited galleon range is further emphasized by the center of distribution which is a vertical placement (0°) with no rake forward or aft. The mizzen mast rakes differ slightly between the caravels, galleons, and naus but are within a few degrees of each other. The caravels have the widest range of variation extending from nearly six degrees aft to seven degrees forward. Although the naus have a similar lower end of six degrees aft, they have a more limited forward rake of only two degrees. The galleons have an intermediary place between the caravels and naus with a forward and an aft rake just over three degrees each.

The main mast rakes for the caravels and galleons have a similar lower end of the range of around four degrees aft while the nau rakes extend to six degrees. The galleons and naus have an almost identical higher end of two degrees forward whereas the caravels have a range reaching past nine degrees forward. The galleons and naus are more similar to each other than either is to the caravel, which is clearly exhibited in their very close center of distributions. The fore mast range for the caravel is much wider than both the galleons and naus. The lower end of the caravels range is essentially the same as the naus and there is less than two degrees difference with the galleon. The caravels reach almost seven degrees forward while the other two ship types are only at three degrees. In the ranges produced by the center of distribution it is apparent that the galleons and naus each shift to an increasingly aft rake from the caravel range.

It was originally thought that the mast rakes would follow a general pattern throughout the caravels, galleons, and naus (i.e., all masts on any given ship type would essentially have the similar range). Although there are no observable trends within the rakes of all the masts for each ship type, there is surprising consistency in the ranges of the individual masts between the caravels, galleons, and naus. It appears that within the Iberian shipbuilding tradition, the masts were raked according to some general standard and this essentially did not differ much between the caravels, galleons, and naus. It can also be concluded that the individual mast rakes varied by only a few degrees from each other no matter the ship type. The mast rakes were measured using comparatively sophisticated measuring devices within Photoshop software and one should always keep in mind that the contemporary shipwrights had simple geometrical means to determine the rake and human introduced errors in the calculations were inevitable. Modern measuring devices are standardized while those from antiquity were not resulting in slight errors that could accumulate. Likewise, the source material is also full of artistic errors and misperceptions. Due to the fact that the average mast rakes correspond perfectly to the rare archival documentation of mast rakes, the measurements seem to produce sound and logical ranges. Although the dates are not listed for each ship in the mast rake section, there is no evident temporal trend in the data set suggesting homogenous mast rakes throughout the sixteenth century.

8.2 MAST PLACEMENT ANALYSIS

The mast placements for the caravels, galleons, and naus were easily measured using the ruler tool within Adobe Photoshop. The ratios for mast placement were calculated using the overall length of the ship at the deck level to the length from the stern to each mast. Although the measurements were taken from the stern to each mast and from the bow to each mast, only the former was used to maintain consistency (refer to Figure 47). The length to the mast was calculated from the stern to the aft most end of the mast. The lengths to the mast were not measured to the centerline of the mast in order to prevent miscalculations. Likewise, only the ships depicted in starboard and port profiles were utilized in the analysis in order to avoid complications from a skewed perspective (three-quarter profiles or stern views) that may introduce errors in the analysis. Similar to the mast rakes, it was determined that with a large dataset such as this there were enough ships shown in profile view to provide an adequate sample.

Unfortunately, there is little information regarding the placement of the masts in the archival records which again makes it necessary to do a more sophisticated statistical analysis of the distribution of the data in order to determine whether it is a viable sample. Like the previous mast rakes section, the placements of the masts were analyzed using simple statistical descriptive and frequencies programs. The histogram produced from the statistics test allows for an easy approach to examining the distribution of the sample. It is important to know whether or not the mast placement ratios produced from the iconography form a normal distribution and are a statistically valid sample. A challenging aspect of studying the placement of the masts in the iconography is that the archival documents often describe the stepping of a mast in relation to a specific deck and not as a percentage of the overall length of the ship. For instance, Fernandez indicates the mizzen mast should be stepped at the level of the main deck or slightly above on the transom structure and the fore mast should be stepped forward on the forecastle near the stem at the level of the lower deck (Castro, 2005b: 117). According to Castro, the treatises generally agree that the mainmast was stepped on the center of the keel, abaft the midship frame, and raked a few degrees to the stern; however, he does not explicitly state the treatises from which this information comes (Castro, 2005b: 113).

Caravel Mast Placements

Two-Masted Caravels Mast Placement Distribution Analysis

There are 35 main mast placement ratios and 34 mizzen mast placement ratios for the two-masted caravel dataset due to the different rigging configurations. The mean is very close to the median for both the mizzen and main masts which suggests good clustering; refer to Appendix 29 for the frequency tables of all ship types. The skewness numbers, however, are high indicating a fairly asymmetrical distribution with longer tails to the right representing more forward mast placements. The skewness value is more than twice the standard error of skewness for the mizzen and main masts meaning they have an asymmetrical distribution. When the high skewness numbers are compared to the histogram graphs, it is clear that the mizzen and main mast placements still represent a viable distribution. However, they clearly have a wider range of variation than found for the three- and four-masted caravels. The kurtosis values are positive for the mizzen and main masts with more clustering and the values are just within or at twice the standard error of kurtosis. The mizzen is less clustered and has a long right tail that extends to 0.40 in the histogram graph shown in Figure 83. Although the statistically designated mode is 0.04, the largest peak on the histogram is roughly 0.08-0.10 followed by a second mode at 0.18-0.20. The main mast has much better clustering around a primary mode of 0.48-0.50 and a secondary mode of 0.53-0.55 and a shorter right tail that reaches to 0.70 which can be viewed in Figure 84. The standard deviation for the mizzen mast placement is six to 22% while the main mast placement is 46 to 57%. The center of distribution for the mizzen mast is eight to 18%, and for the main mast it is 48 to 54%; refer to Appendix 30 for the standard deviations and center of distribution values for each ship type.

Three-Masted Caravels Mast Placement Distribution Analysis

In the three-masted caravel dataset there are 12 bonaventure mast, 14 mizzen mast, and 14 main mast placement ratios. The mean is close to the median for all three

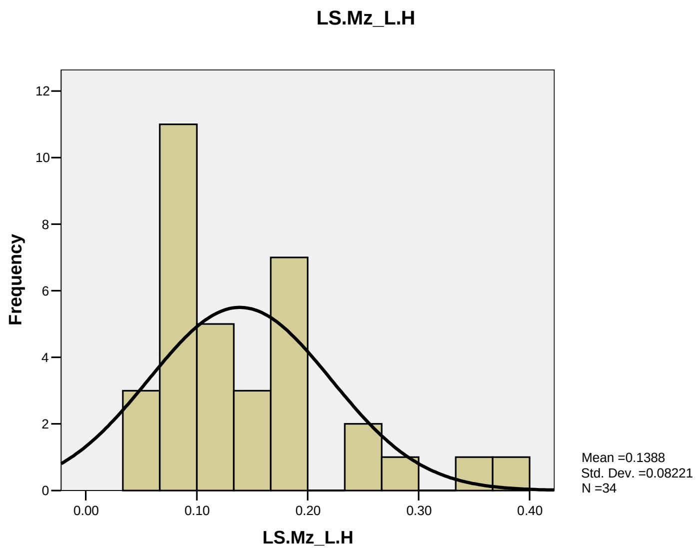


Figure 83: Histogram of the placement of the mizzen mast in two-masted caravels. Refer to Appendix 29 for data.

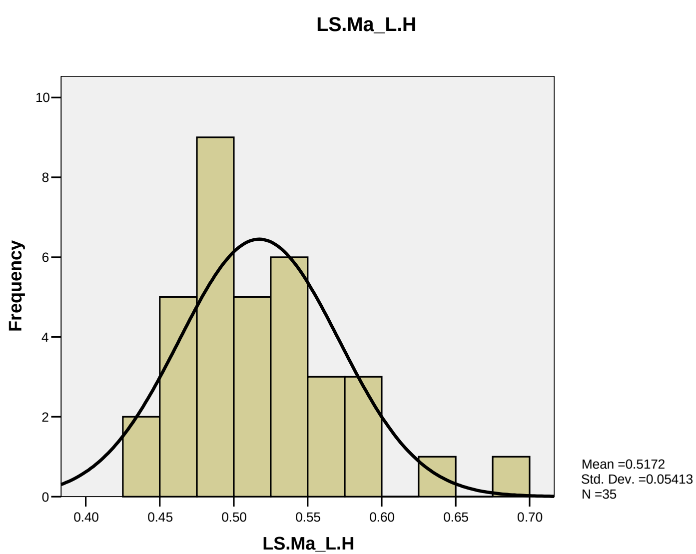


Figure 84: Histogram of the placement of the main mast in two-masted caravels. Refer to Appendix 29 for data.

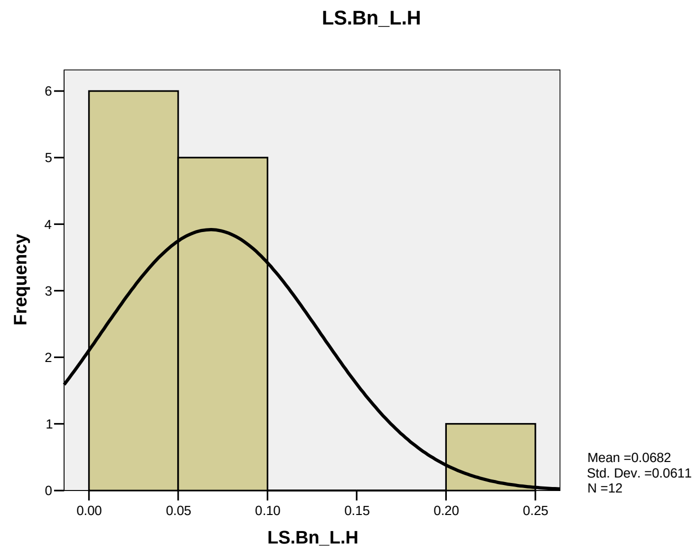


Figure 85: Histogram of the placement of the bonaventure mast in three-masted caravels. Refer to Appendix 29 for data.

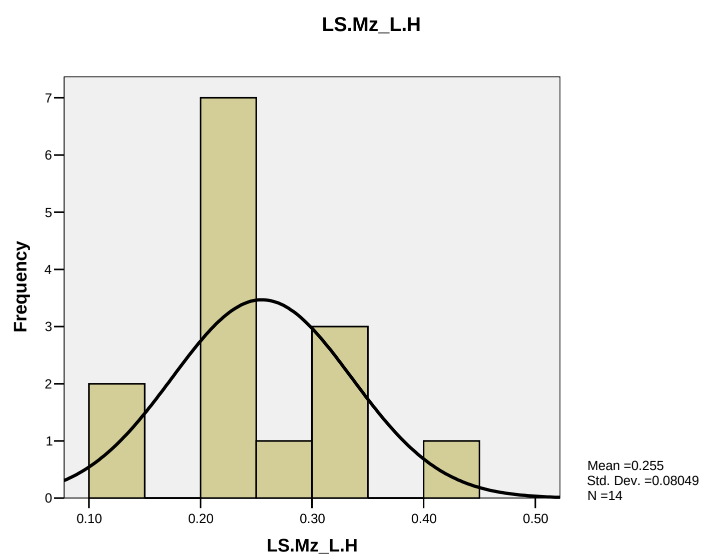


Figure 86: Histogram of the placement of the mizzen mast in three-masted caravels. Refer to Appendix 29 for data.

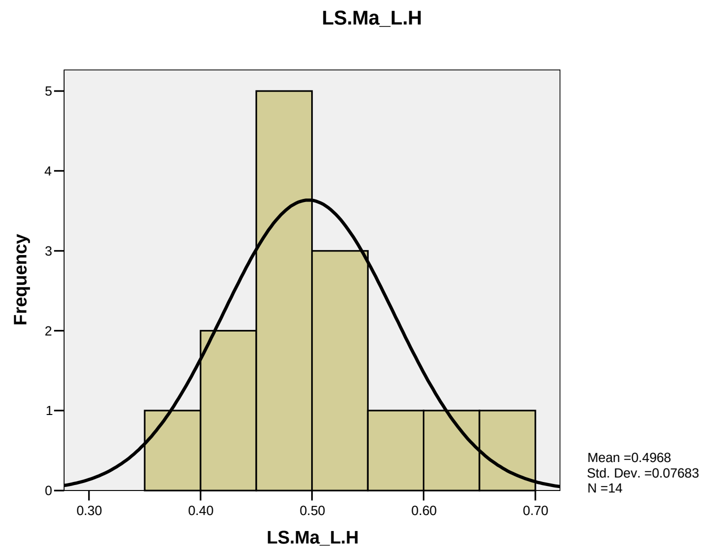


Figure 87: Histogram of the placement of the main mast in three-masted caravels. Refer to Appendix 29 for data.

masts and the skewness values are low and within twice their standard deviations for the mizzen and main mast indicating a symmetrical distribution. The bonaventure mast, however, has a significantly higher skewness value which is more than four times the standard deviation of skewness signifying an asymmetrical distribution with a very long tail to the right which can be seen in the histogram in Figure 85. The kurtosis values are positive for the mizzen and main masts with more clustering and shorter tails (Figures 86 - 87) and are within twice the standard error of kurtosis. The bonaventure mast has a positive kurtosis value that is ten times the standard deviation of kurtosis. The skewness and kurtosis values indicate that the bonaventure mast placement has an asymmetrical distribution. By viewing the histogram of the bonaventure mast, however, it is evident that the distribution is disrupted by the presence of one ship that has a ratio of 0.20-0.25. The sample is otherwise, closely clustered with little variation. This ship should be excluded from a normal distribution and the sample can then be considered viable along with the mizzen and main masts.

All the masts have a bi-modal distribution, the more probable peak for the mizzen mast is, however, 0.20 to 0.24 and 0.45 to 0.50 for the main mast. The bonaventure is the only mast that has the highest peak from 0.00 to 0.05 coinciding with the statistically determined mode of .02%. The standard deviations for the bonaventure mast placement is one to 13%, 17 to 34% for the mizzen, and 42 to 57% for the main mast. The center of distribution for the bonaventure mast placement is three to seven percent and is considered far more accurate than the standard deviation of the sample which is greatly skewed because of the presence of the outlier. The center of distribution for the mizzen mast it is 21 to 31% while it is 44 to 54% for the main mast. The ranges produced by the standard deviation and the center of distribution all reflect the main peaks visible in the histograms.

Four-Masted Caravels Mast Placement Distribution Analysis

In the four-masted caravel dataset, there are 47 bonaventure, mizzen, main, and fore mast placement ratios. The mean is close to the median for all the masts and the skewness values is low for the foremast and within twice the standard deviations indicating a symmetrical distribution, but higher for the bonaventure, mizzen, and main mast and more than twice their standard deviations suggesting an asymmetrical distribution. The kurtosis values are positive for the mizzen, main, and fore masts with more clustering and shorter tails which can be viewed in the respective histogram graphs in Figures 88 - 90. The kurtosis is negative for the bonaventure mast, however, with less clustering and a longer tail (Figure 91). The kurtosis values are within twice the standard error of kurtosis for bonaventure and fore masts, but are slightly outside the margin for the mizzen and main masts indicating an asymmetrical distribution. The histogram of the mizzen and main clearly shows a relatively normal curve and the asymmetric elements are single vessels with mast placements outside of the main group. The kurtosis and skewness together signify that all masts and spars essentially have a normal distribution and the four-masted caravel data set is a viable sample.

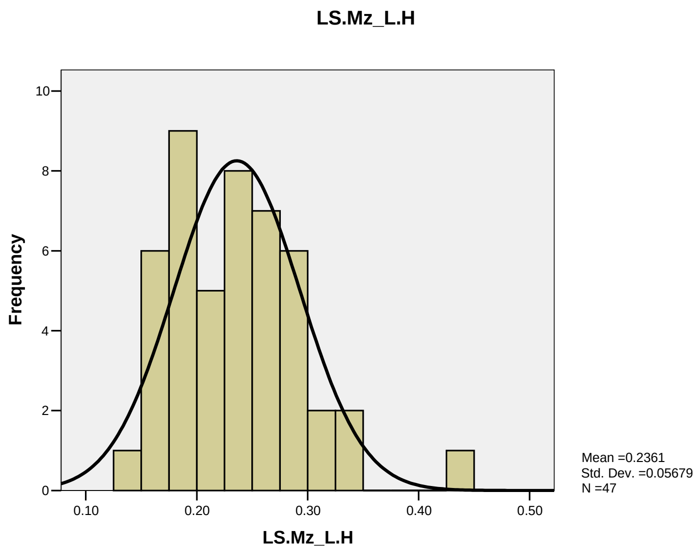


Figure 88: Histogram of the placement of the mizzen mast in four-masted caravels. Refer to Appendix 29 for data.

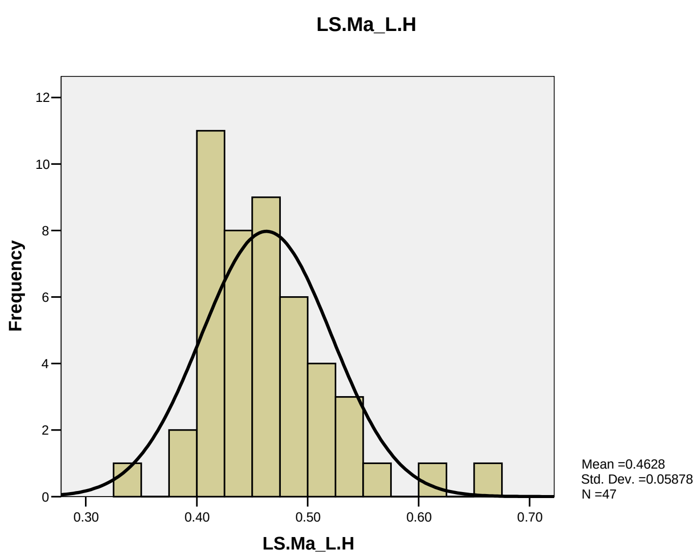


Figure 89: Histogram of the placement of the main mast in four-masted caravels. Refer to Appendix 29 for data.

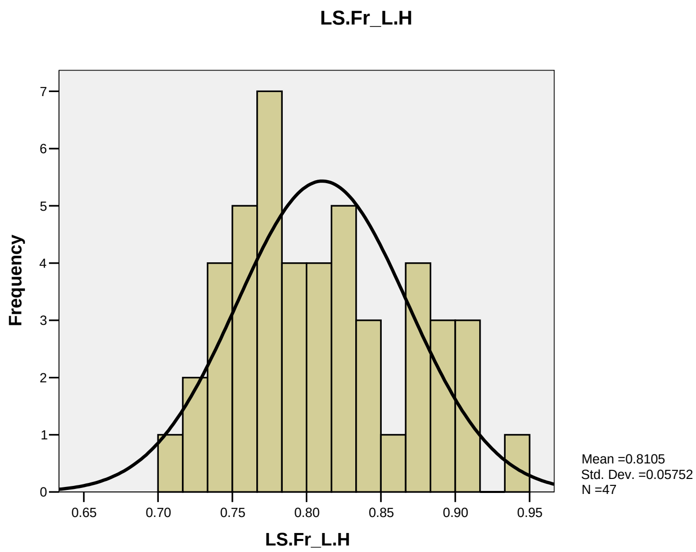


Figure 90: Histogram of the placement of the fore mast in four-masted caravels. Refer to Appendix 29 for data.

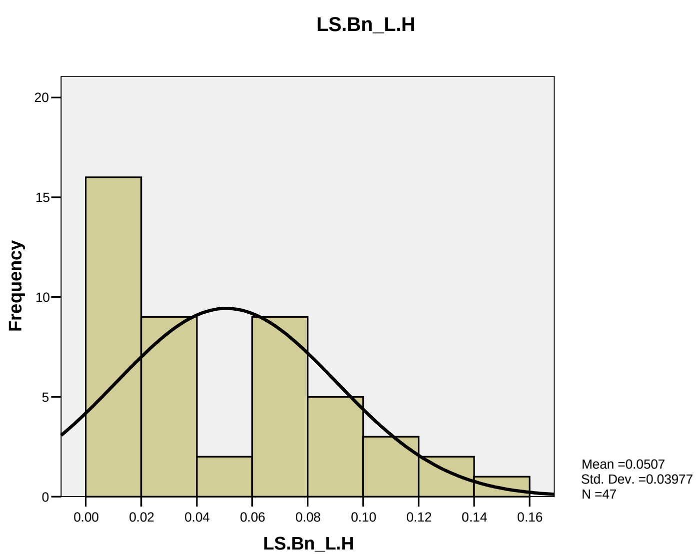


Figure 91: Histogram of the placement of the bonaventure mast in four-masted caravels. Refer to Appendix 29 for data.

All masts except for the bonaventure have a bi-modal distribution, but the more probable peaks are from 0.18 to 0.20 for the mizzen, 0.40 to 0.42 for the main mast, and 0.77 to 0.78 for the fore mast. The standard deviation is 1 to 9 percent for the bonaventure, 18 to 29% for the mizzen, 40 to 52% for the main, and 75 to 87% for the fore mast rake all of which reflect the main peaks visible in the histogram. The center of distribution for the bonaventure mast is 1 to 8 percent and it is 20 to 27% for the mizzen mast, 42 to 49% for the main mast, and 76 to 86% for the fore mast.

Comparison of Caravel Mast Placements

Given that there is no archival documentation of the placement of masts specifically for caravels, the data is therefore compared to itself and will later be compared to the galleons and naus. Although the center of distribution provides a more concise range of variation (50%), the more liberal range of one standard deviation is used for comparative purposes on the caravel subtypes. There is essentially no difference between the placement of the bonaventure mast for the three-masted and four-masted caravels. The placement of the bonaventure mast varies only four percent between the three-masted caravels, which have one standard deviation extending to nine percent and the four-masted caravels reaching 13%. The normal range of placement of the bonaventure mast is set as one to nine degrees based on the one standard deviation for the entire sample which reflects the modes in both histograms (Figures 85 and 91). The placement of the mizzen mast is fairly consistent between the three-masted and four-masted caravels. The three-masted caravels have a slightly wider one standard deviation range than the four-masted caravels with a one percent difference on the lower end (17% vs. 18%) and a five percent difference on the higher end (29% vs. 35%). There is a moderate discrepancy between the three- and four-masted and the two-masted caravels which have a similar higher end, but a lower end with a significant 10% difference. From this, it is apparent that the mizzen mast was sometimes stepped further aft on two-masted caravels compared to the other caravel subtypes. The overall average for the entire sample is 12 to 29% and is considered the normal range of variation for the placement of the mizzen mast (Figures 83, 86, and 88).

The placement of the main mast is exceptionally consistent between the different caravel rig configurations. The two-masted and three-masted caravels have the same higher end of one standard deviation (57%) and a similar lower end that only varies four percent. The range for the four-masted caravels (40-52%) is skewed slight aft which is probably due to the presence of a fore mast. The two-masted and three-masted caravels do not have foremasts which allow the main mast to be stepped in a more forward position and allowing more space for the movement of the mizzen lateen yard. The overall range produced by one standard deviation for the placement main mast set at 42-56% is therefore the most reliable estimate of normal variation and is consistent with the modes shown in each histogram. The fore mast only exists on the four-masted caravels and the overall range of 75 to 87% produced by one standard deviation is set as the normal range of variation. Although there are moderate differences between the placements of the individual masts of the caravel rig configurations, there is actually relatively little variation within the entire dataset. In the reconstruction of different types of caravels the more specific ranges can be extremely useful; however, until more information is obtained from archaeological or archival evidence the overall averages should be considered sufficient indicators of the placement of the masts.

Galleon Mast Placements

Three-Masted Galleons Mast Placement Distribution Analysis

In the three-masted galleon dataset there are nine mizzen, main, and fore mast placement ratios and the mean is close to the median for all of the masts. The skewness numbers for the main and fore masts are low indicating a fairly symmetrical distribution. The mizzen is the only mast with a high skewness value that is more than twice the standard error of skewness while the main and fore masts are within twice the standard error of skewness confirming a fairly symmetrical distribution. The kurtosis values for the main and fore are also within twice the standard error of kurtosis with more clustering and shorter tails; however, the kurtosis value for the mizzen mast is well outside the limits of the standard error of kurtosis. The kurtosis and skewness both indicate that main and fore masts have a normal distribution which is evident in the histogram graph (Figures 92 - 93). The histogram of the mizzen mast indicates that it is also a viable sample, but has been distorted by the presence of one vessel with a mast placement outside of the normal range (Figure 94). All three masts have a bimodal

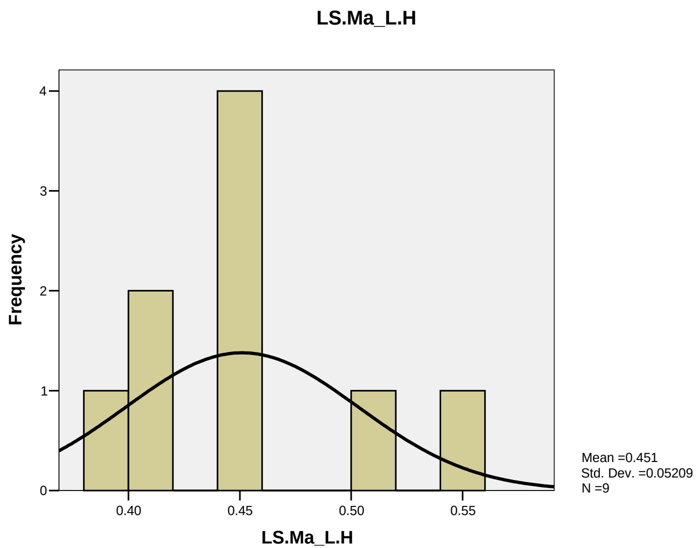


Figure 92: Histogram of the placement of the main mast in three-masted galleons. Refer to Appendix 29 for data.

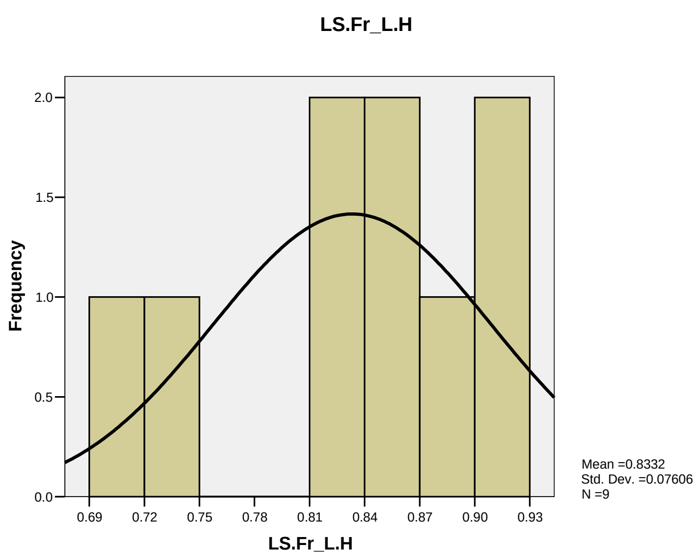


Figure 93: Histogram of the placement of the fore mast in three-masted galleons. Refer to Appendix 29 for data.

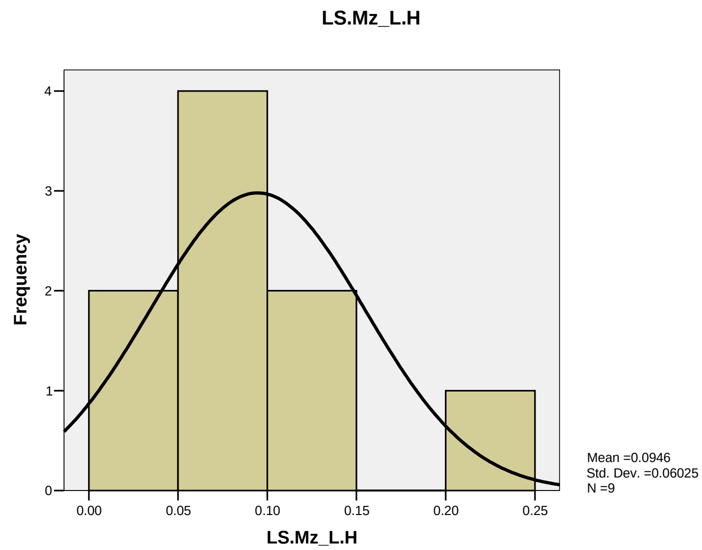


Figure 94: Histogram of the placement of the mizzen mast in three-masted galleons. Refer to Appendix 29 for data.

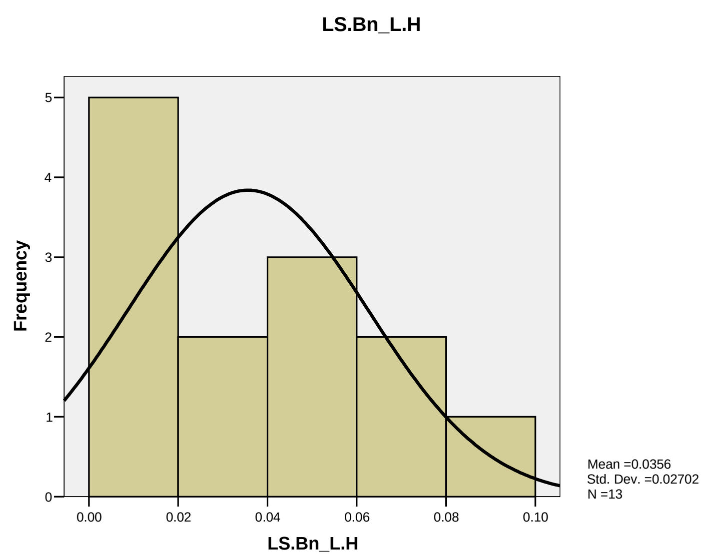


Figure 95: Histogram of the placement of the bonaventure mast in four-masted galleons. Refer to Appendix 29 for data.

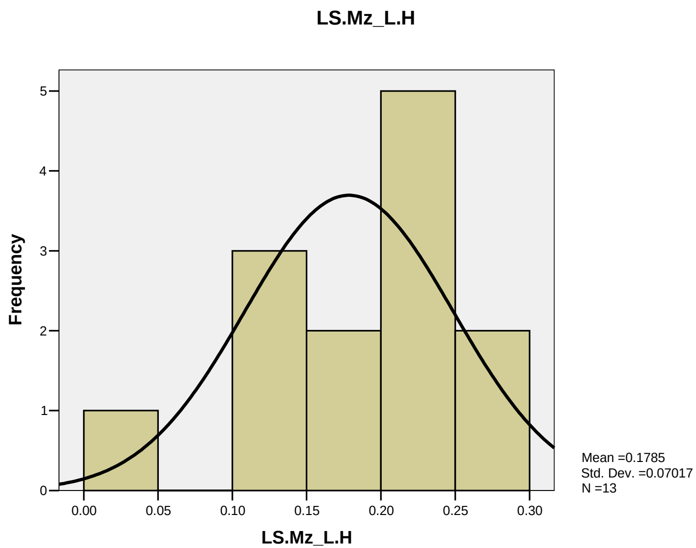


Figure 96: Histogram of the placement of the mizzen mast in four-masted galleons. Refer to Appendix 29 for data.

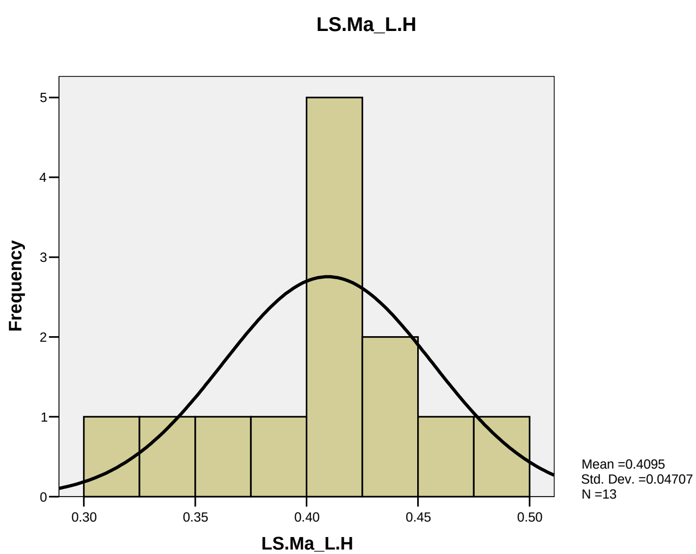


Figure 97: Histogram of the placement of the main mast in four-masted galleons. Refer to Appendix 29 for data.

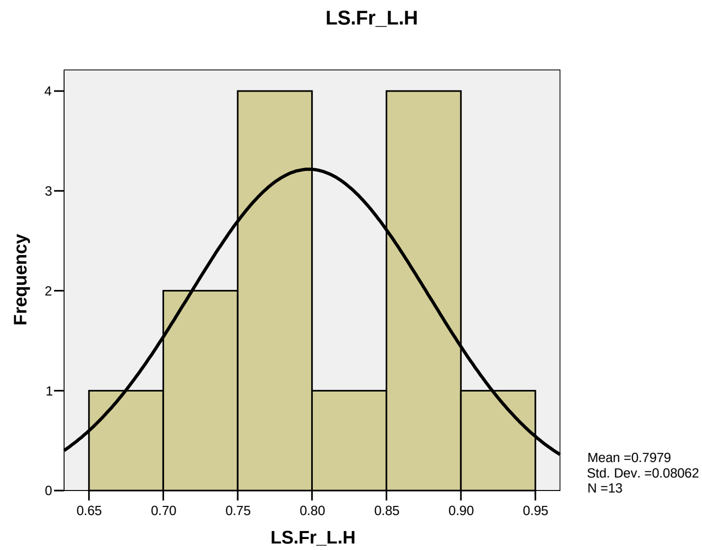


Figure 98: Histogram of the placement of the fore mast in four-masted galleons. Refer to Appendix 29 for data.

distribution, but the main peak for the mizzen is 0.05 to 0.10, 0.44 to 0.46 for the main mast, and 0.81 to 0.87 for the fore mast with an equal secondary peak at 0.90 to 0.93.

The standard deviation for the placement of the mizzen mast is three to 15%, for the placement of the main mast it is 40 to 50%, and it is 78 to 91% for the placement of the fore mast. The center of distribution for the mizzen mast is five to 11%, for the placement of the main mast it is 41 to 48%, and for the placement of the fore mast it is 77 to 90% of the overall length of the vessel on deck.

Four-Masted Galleons Mast Placement Distribution Analysis

The four masted galleon sample size for the bonaventure, mizzen, main, and fore mast is 13 mast placement ratios. The mean is close to the median for all the masts and the skewness values are low and within twice their standard deviations indicating symmetrical distributions for each mast. The kurtosis values are positive for all masts with more clustering and shorter tails except for the fore mast which has a negative value with less clustering. The kurtosis values are within twice the standard error of kurtosis for all the masts confirming that the mast placement distributions are symmetrical and the sample is viable which is evident in the histogram graphs (Figures 95 - 98). All masts except for the bonaventure are bimodal; however, the more probable peak for the mizzen is from 0.20 to 0.24 with a secondary peak at 0.10 to 0.15 and 0.40 to 0.45 as the primary peak for the main mast while the fore mast has two equal peaks at 0.75 to 0.80 and 0.85 to 0.90. The standard deviations for the placement of the bonaventure mast are one to six percent, 11 to 25% for the placement of the mizzen mast, 36 to 46% for the placement of the main, and 72 to 88% for the placement of the fore mast. The center of distribution for the placement of the bonaventure is also one to six degrees, for the placement of the mizzen mast it is 14 to 23%, for the placement of the main mast it is 37 to 44%, and for the placement of the fore mast it is 74 to 88%. The ranges produced by the standard deviation and the center of distribution all reflect the main peaks visible in the histograms.

Comparison of Galleon Mast Placements

Like the caravels, there is no archival documentation of the placement of masts specifically for galleons. As such, the data is therefore compared to itself and will later be compared to the caravels and naus as a group of Iberian ship types. Although the center of distribution provides a more conservative range of variation (50%), the more liberal range of one standard deviation is used for comparative purposes of the galleon subtypes. The bonaventure mast only exists on the four-masted galleons and the overall range of one to six percent produced by one standard deviation is set as the normal range of variation. There is a relatively significant difference between the placement of the mizzen mast on the three-masted galleons and those on the four-masted galleons. The three-masted galleons have a one standard deviation range from three to 15% while the same range for the four-masted galleons is from 11 to 25%. From this, it is apparent that the mizzen mast was generally stepped further forward on the four-masted galleons to accommodate the bonaventure mast. The overall average for the entire sample is seven to 22% and is considered the normal range of variation for the placement of the mizzen mast.

The placement of the main mast is reasonably consistent between the three- and four-masted galleons with only a four percent difference on both the higher and lower end of one standard deviation range. The main mast on three-masted galleons is stepped further forward (40 to 50%) than the average placement of the four-masted galleons which is at 36 to 46% of the overall length of the vessel at the deck. The range for the four-masted galleons is skewed slight aft due to the presence of a fourth mast which necessitates less space between each mast. The overall range produced by one standard deviation for the placement of the main mast is set at 36 to 46%. It is the most reliable estimate of normal variation and is consistent with the modes shown in each histogram. The placement of the fore mast varies only six percent on the lower end of the range between the three-masted galleons which have a one standard deviation starting at 78% and the four-masted galleons which is further aft at 72%. Likewise, there is only a three percent difference at the higher end of the range with 91 versus 88% respectively. The normal range of fore mast placement is set as 73 to 89% based on one standard deviation for the entire sample which reflects the modes in both histograms.

Although there are generally more differences between the placements of the masts of the three- and four-masted galleons in comparison to the caravels, there is still a high level of consistency within the entire dataset. The three-masted galleons tend to have the mizzen mast set further aft with more space between it and the main mast. The main and fore mast appear to be evenly spread through the remaining forward length of the vessel. Like the caravels, reconstructions of three-masted and four-masted galleons should use the more specific ranges; however, until more information is obtained from archaeological or archival evidence the overall averages should be considered sufficient indicators of placement of the individual masts.

Nau Mast Placements

Three-Masted Nau Mast Placement Distribution Analysis

The nau mast rakes were limited to only those ships for which it was possible to measure the placement of every mast, which eliminated all of the four-masted naus with a bonaventure mast and thus only the results for three-masted naus are described. The three-masted naus are then compared to the overall ranges of each mast for the caravels and galleons. The nau sample size for the mizzen, main, and fore mast consists of 166 vessels.

The mean is close to the median for all the masts and the skewness values are low and within twice their standard deviations for the main and fore masts indicating a symmetrical distribution. The mizzen mast has a high skewness value that is six times the standard deviation of skewness. The kurtosis values are positive for all three masts suggesting more clustering, but are not within twice the standard error of kurtosis indicating an asymmetrical distribution. The histograms of the mizzen, main, and fore masts clearly shows normal curves and the asymmetric elements are individual vessels with values outside the main group (Figures 99 – 101). The kurtosis and skewness together signify that all masts have a normal distribution and the nau data set is a viable sample.

The mizzen, main, and fore masts are all bimodal. As previously stated, the statistical test automatically lists the smallest mode or peak as the main mode. The more probable peaks, however, are from 0.10 to 0.12 for the mizzen with a secondary peak at roughly 0.07 to 0.10. Likewise, there are three main peaks from 0.40 to 0.45 for the main mast and the fore mast has a primary peak at 0.80 to 0.82 and a secondary peak at roughly 0.75. The standard deviations are five to 14% for the placement of the mizzen mast, 39 to 49% for the placement of the main mast, and 74 to 84% for the placement of the fore mast all of which reflect the main peaks or modes visible in the histograms. The center of distribution for the placement of the mizzen mast is seven to 11%, 41 to 47% for the placement of the main mast, and 76 to 83% for the placement of the fore mast.

Comparison of Caravel, Galleon, and Nau Mast Placement

There is a total of 104 caravels, 22 galleons, 166 naus in the mast rake dataset; however, the number for each mast differs by ship type due to the differing rigging configurations and the individual N values are listed in Table 44. Although the center of distribution is listed in the same table (55), the more liberal range of one standard deviation is used for comparative purposes for the caravels, galleons, and naus.

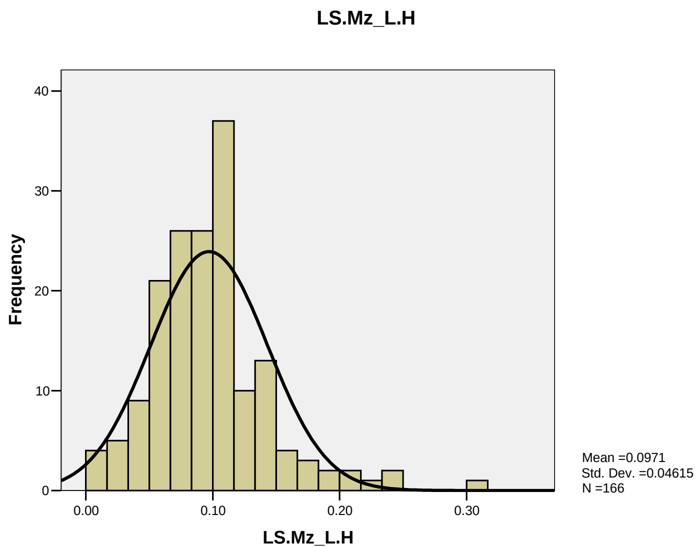


Figure 99: Histogram of the placement of the mizzen mast in naus. Refer to Appendix 29 for data.

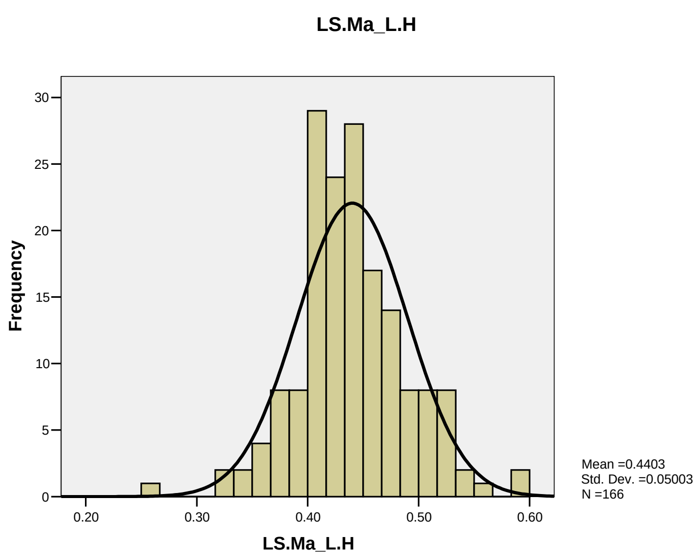


Figure 100: Histogram of the placement of the main mast in naus. Refer to Appendix 29 for data.

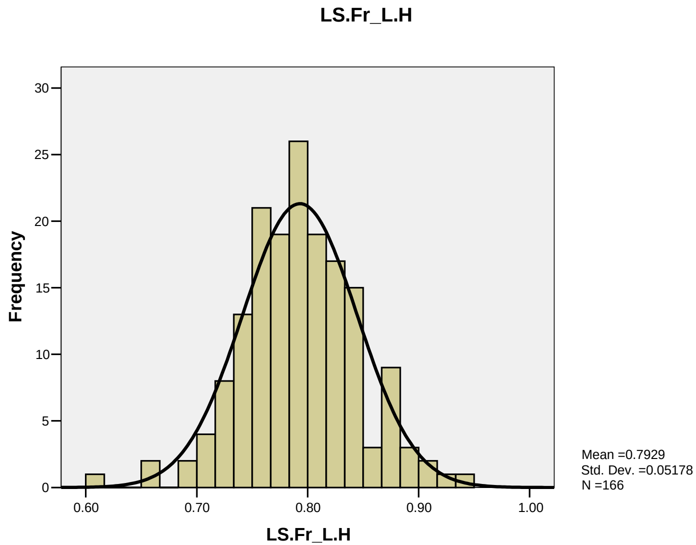


Figure 101: Histogram of the placement of the fore mast in naus. Refer to Appendix 29 for data.

TABLE 44: One Standard Deviation and Center of Distribution Figures for all Mast Placements by Ship Type

ALL MAST PLACEMENT			
BONAVENTURE	N Values	One Standard Deviation (68%)	Center of Distribution (50%)
Caravel	N=59	0.01 to 0.09	0.02 to 0.08
Galleon	N=13	0.01 to 0.06	0.01 to 0.06
MIZZEN	N Values	One Standard Deviation (68%)	Center of Distribution (50%)
Caravel	N=95	0.12 to 0.29	0.14 to 0.25
Galleon	N=22	0.07 to 0.22	0.09 to 0.22
Nau	N=166	0.05 to 0.14	0.07 to 0.11
MAIN	N Values	One Standard Deviation (68%)	Center of Distribution (50%)
Caravel	N=94	0.42 to 0.56	0.44 to 0.52
Galleon	N=22	0.37 to 0.48	0.40 to 0.45
Nau	N=166	0.39 to 0.49	0.41 to 0.47
FORE	N Values	One Standard Deviation (68%)	Center of Distribution (50%)
Caravel	N=47	0.75 to 0.87	0.76 to 0.86
Galleon	N=22	0.73 to 0.89	0.75 to 0.88
Nau	N=166	0.74 to 0.84	0.76 to 0.83

The bonaventure mast placement was only analyzed for the caravels and galleons and the results were remarkably similar. The only difference is that the caravels have a range that is skewed slightly more forward by three percent which is very little considering that bonaventure masts were found on three-masted and four-masted caravels. This somewhat forward skewing of the caravel data is further emphasized by the center of distribution which is from two to eight percent of the total length of the vessel on deck.

The placement of the mizzen mast has the most diverse range between the caravels, galleons, and naus but they are more or less within a few percentage points of each other. The caravels have the forward-most range of variation extending from 12 to 30%. Although the galleons have a somewhat similar higher end of 22%, they have a more limited lower end of only seven percent. The mizzen mast on naus is stepped further aft than the caravels and galleons with a significantly different higher end of 14%. The most logical explanation for this divergence is the variable presence of the bonaventure on some of the caravels and galleons which would demand a more forward placement of the mizzen. This supposition is further evidenced by examining the percentages for the caravels and galleons without a bonaventure mast. The two-masted caravels are the only subtype without a bonaventure mast and although the higher end still extends to 22%, the lower end is much closer to the naus at six percent. Likewise, there is a high correlation between the placement of the mizzen mast on three-masted galleons with a range of three to 15% and the naus.

The placement of the main mast is again strikingly consistent for the galleons and naus with less than two percent difference on either end of the one standard deviation range. The three-masted galleons are even more similar to the naus with only a one degree difference on either end of the range. The caravels have a range that is skewed moderately forward from the galleons and naus reaching from 42% to just past 56%. Although the galleons and naus are far more similar to each other than either is to the caravel, the center of distribution ranges indicated that the caravel is not significantly different from the other two ship types.

The placement of the fore mast, which is square-rigged on all three ship types, is essentially the same on caravels, galleons, and naus. The galleons have the widest range from 73 to 89%; however, the caravels have only a two percent difference on either end of this range. The lower end of the range for the naus is an intermediary between the caravels and galleons, but the higher end is slightly more aft at 84%. The placement of the fore mast on the three-masted galleons (78-91%) does not parallel the naus as was seen in the placement of the mizzen and main masts. Rather it deviates modestly from the overall averages of both the caravels and naus and is stepped much further forward.

The only noticeable trend of similarity between the ship types is that of the three-masted galleons and the three-masted naus both of which have the standard ship rig. It is interesting to note, however, that this connection only holds true for the placements of the mizzen and main masts while the placement of the fore mast is different. Additionally, there is surprising consistency in the overall placements of bonaventure, main, and fore masts between the caravels, galleons, and naus, but there is significant variation in the placement of the mizzen mast between the ship types. Like the mast rakes, it appears that within the Iberian shipbuilding tradition, the masts were placed according to some general standard and did not significantly differ between the caravels, galleons, and naus. Again, it should be noted that the placement of the masts was calculated using comparatively sophisticated measuring devices within Photoshop software whereas contemporary shipwrights had simple geometrical means to determine where masts were to be stepped.

A serious limitation of using iconography is that it is necessary to utilize ratios to express the proportional relationships of constructional features on the ships. The only value available to measure the placement of the individual masts is the overall length of the vessel on deck which does not necessarily correspond to the lengths used by shipwrights when stepping all of the masts. Referring again to the limited archival evidence, the authors often describe the stepping of a mast in relation to a deck and not as a percentage of the overall length of the ship. For instance, Fernandez indicates the mizzen mast should be stepped at the level of the main deck or slightly above on the transom structure and the fore mast should be stepped forward on the forecastle near the stem at the level of the lower deck (Castro, 2005b: 117). While these descriptions can be roughly equated to the percentages acquired through the iconography, it is not possible to confirm the validity of these results. The placement of the main mast is easier to correlate, as it is described as being stepped on the center of the keel, abaft the midship frame. This corresponds perfectly to the placement of the main mast calculated from the iconography. This is, of course, working on the assumption that the midship frames aligned roughly with the center of the deck length.

It appears that within the Iberian shipbuilding tradition, masts were raked and placed according to some general standard and did not significantly differ between the caravels, galleons, and naus. The ranges of the mast rakes are essentially a few degrees forward and aft of a vertical position for each mast. Based on the limited archival evidence available, the mast rake data generated from the iconography is exceptionally reliable. In the reconstruction of different types of caravels, galleons, and naus the more specific ranges of the mast rakes and placement can be extremely useful. However, more archaeological evidence is needed before the overall averages can be considered true indicators of mast rakes. Although the dates are not listed for each ship in the mast placement section, there is no evident temporal trend in the data set suggesting homogenous mast placements throughout the sixteenth 16th century.

CHAPTER IX

DESCRIPTIVE STATISTICS OF MAST AND YARD DIMENSIONS IN THE ICONOGRAPHY: BONAVENTURE AND MIZZEN MASTS

In the next three chapters the height and width of the lower and upper masts as well as the length and width of the yards are analyzed using the frequencies tool within SPSS program in order to establish a normal range based on one standard deviation and the center of distribution. Unlike the previous chapter in which the mast rakes and mast placement were calculated, an in-depth examination of the sample distribution was not conducted for the mast dimensions. Every frequencies table and histogram was examined to ascertain any sample that is not valid. Collectively, the samples were all viable distributions that were close to normal. Although most distributions were skewed, this reflects those ships with mast and yard dimensions well outside the normal trend. Likewise, the results were analyzed to determine if there was a temporal influence on the mast dimensions; though, none was found. Fortunately, there is slightly more information about mast dimensions than mast rakes and placements in the archival manuscripts. When possible, measurements were taken to reflect constructional relationships detailed within the manuscripts (see Figure 102). Otherwise, the measurements express what was considered the most logical relationships for reconstructing a vessel's rig.

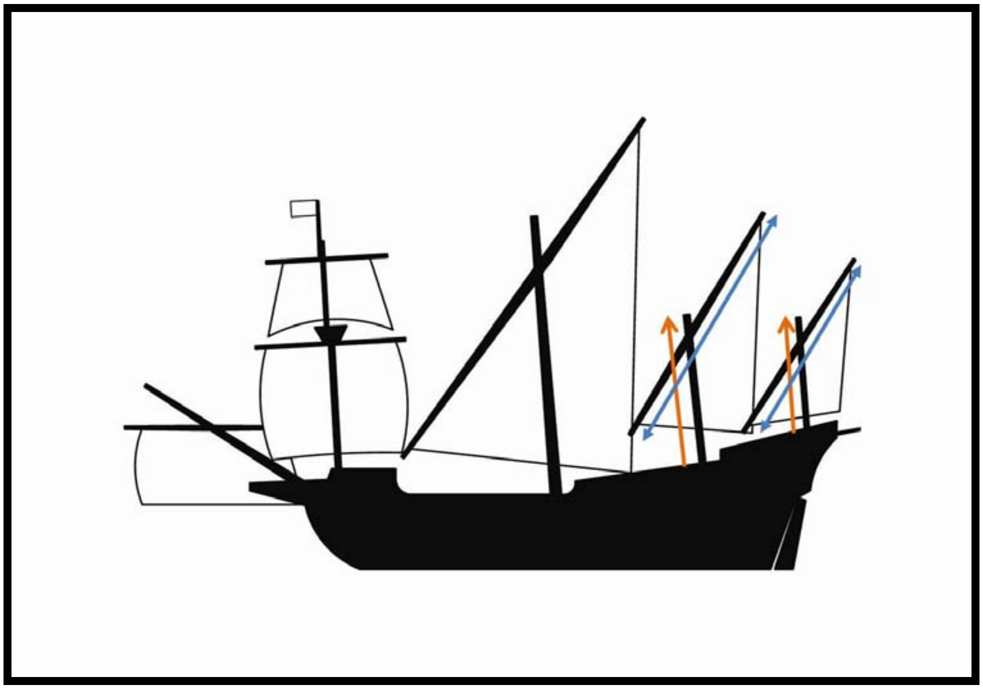


Figure 102: Illustration of the bonaventure and mizzen mast height and yard length measurements.

9.1 BONAVENTURE MAST AND YARD DIMENSIONS

Bonaventure Mast Dimensions

In the representational trends analysis there are 53 caravels and 12 galleons with sufficient measurements to conduct a statistical analysis of the bonaventure mast dimensions. The sample was divided into three-masted caravels (12), four-masted caravels (41), and four-masted galleons (12). There is only one galleon (MA13.09) from 1538-40 with an upper bonaventure mast and as such it has not been analyzed. Furthermore, there were no four-masted naus included because of inadequate measurement data. As the bonaventure mast is rarely described in the manuscripts, the ratios used in this analysis are predominantly based on logical constructional relationships. Palacio states that the bonaventure is one third of the length of both the mizzen mast and the bowsprit, which have the same dimensions (Bankston, 1986: 120). This relationship will be further explored in the mizzen mast and bowsprit sections. The frequency tables for the bonaventure mast and yards for the three-masted caravels, four-masted caravels, and the three-masted galleons can be viewed in Appendix 31.

Bonaventure Mast Height Ratios

Height of the Bonaventure Mast to the Length of the Hull: (H.Bn_L.H)

The height of the bonaventure was compared to the overall length of hull on deck and to the heights of the mizzen mast and the bowsprit. The height of the bonaventure mast to the length of the hull on deck ratio for the three-masted caravels sample (N=12) has a one standard deviation from 0.22 to 0.38. This is consistent with the histogram graph (Figure 103) which shows the primary mode at 0.25 to 0.30 and the main distribution ranging from 0.15 to 0.45. One standard deviation of the height of the bonaventure mast to the length of the hull on deck for the four-masted caravel sample is from 0.18 to 0.32. The corresponding histogram graph (Figure 104) shows a primary mode of roughly 0.18 to 0.20 with the main distribution ranging from 0.15 to 0.30. The secondary distribution is from 0.33 to 0.43 and includes eight four-masted caravels, which equals 20% of the sample. These eight caravels are from five different sources (CA27, CA28, MA06, MA13, and MA15) that date from 1500 to 1588; it is more likely that the bonaventure mast was depicted as proportionally too tall as there is no temporal explanation. Additionally, one source (MA15) has other ships with bonaventure masts that fall within the normal distribution. The height of the bonaventure mast to the length of the hull on deck ratio for the four-masted galleon (N=12) sample has a one standard deviation from 0.21 to 0.39. The histogram graph (Figure 105) exhibits a primary mode from 0.25 to 0.35 with the main distribution extending to 0.40. There are two galleons (CA10.01 and CA22.22) with a ratio of 0.15 to 0.20 and a third (MA02.01) at 0.52 which are probably relatively smaller and larger than the normal range due to artistic error.

The comparison of the bonaventure height ratios for the three-masted caravels, four-masted caravels, and four-masted galleons is listed in Table 45. The height of the bonaventure to the length of the hull at deck has marked similarity between the three

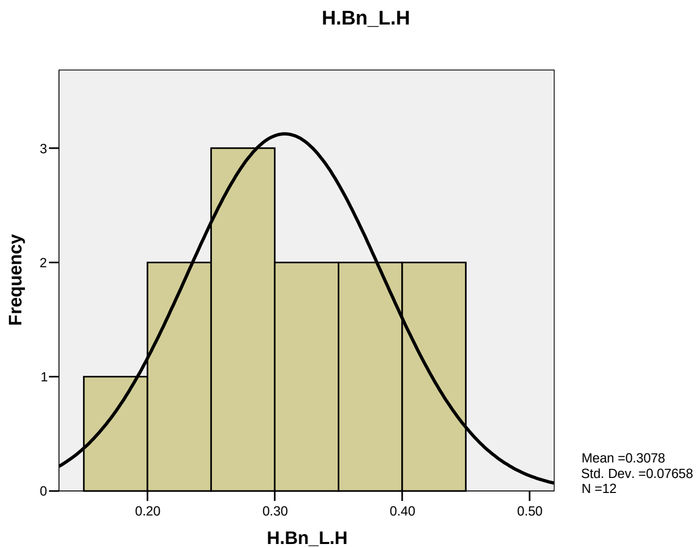


Figure 103: Histogram of the height of the bonaventure to the length of the hull in three-masted caravels. Refer to Appendix 31 for data.

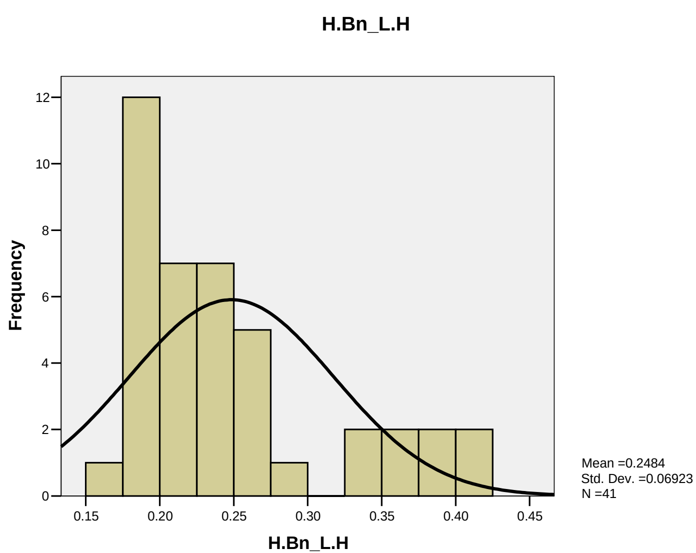


Figure 104: Histogram of the height of the bonaventure to the length of the hull in four-masted caravels. Refer to Appendix 31 for data.

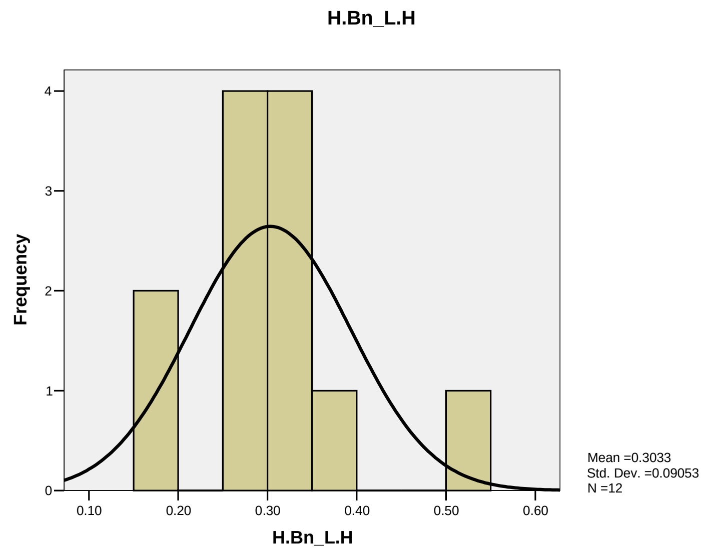


Figure 105: Histogram of the height of the bonaventure to the length of the hull in four-masted galleons. Refer to Appendix 31 for data.

TABLE 45: Comparison of the One Standard Deviation and Center of Distribution of the Bonaventure Height Ratios by Ship Type

H.Bn_L.H	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Three-masted Caravels	0.22 to 0.38	0.24 to 0.37
Four-masted Caravels	0.18 to 0.32	0.20 to 0.27
Four-masted Galleons	0.21 to 0.39	0.26 to 0.34
H.Bn_H.Mz	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Three-masted Caravels	0.58 to 1.03	0.69 to 0.95
Four-masted Caravels	0.59 to 0.90	0.66 to 0.83
Four-masted Galleons	0.58 to 0.85	0.65 to 0.80
H.Bn_L.Bw	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Four-masted Caravels	0.47 to 1.02	0.56 to 0.78
Four-masted Galleons	0.56 to 0.98	0.63 to 0.88

ship sub-types. Interestingly, the four-masted galleons have nearly identical mast heights to the three-masted caravels while the four-masted caravels appear to have slightly shorter bonaventure masts.

Height of the Bonaventure Mast to the Height of the Mizzen Mast and the Length of the Bowsprit: (H.Bn_H.Mz); (H.Bn._L.Bw)

According to Palacio, the height of the bonaventure to the height of the mizzen as well as the length of the bowsprit should have a 1:3 (.33) relationship; however, this is clearly not the case. The height of the bonaventure compared to the height of the mizzen mast for the three-masted caravel sample has a one-standard deviation of 0.58 to 1.03. The reason for this extensive range is clear in the histogram graph (Figure 106), which shows that the overall distribution is from 0.40 to 1.40. The main mode, however, is from 0.60 to 0.80 indicating that the bonaventure masts were depicted much taller than prescribed by Palacio. The three-masted caravels, which have a lateen bonaventure, mizzen, and main mast do not have a bowsprit; therefore, the height of the bonaventure to the length of the bowsprit was not calculated for this ship sub-type. The four-masted caravel sample has a one standard deviation of 0.55 to 0.92 for the height of the bonaventure to the height of the mizzen mast ratio. Like the three-masted caravels sample, the four-masted caravels have a main mode of 0.60 to 0.80 in the histogram graph while the main distribution is from 0.40 to 1.20 (Figure 107). The height of the bonaventure to the length of the bowsprit ratio for the four-masted caravels also has an extensive one standard deviation that ranges from 0.47 to 1.02 with a primary mode at

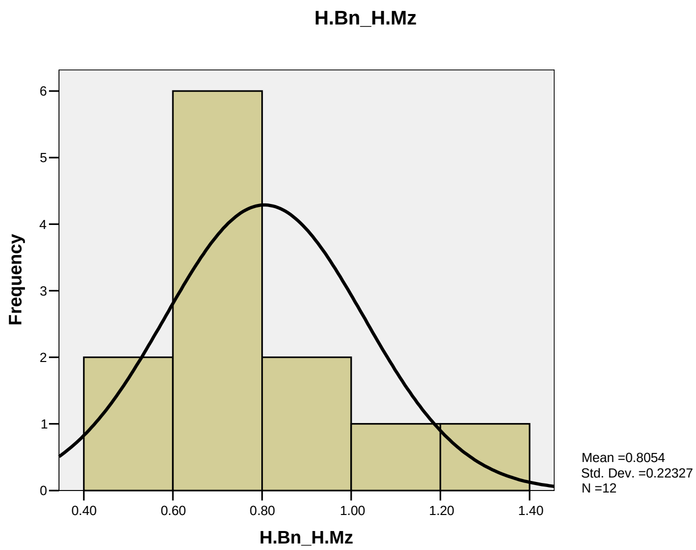


Figure 106: Histogram of the height of the bonaventure to the height of the mizzen in three-masted caravels. Refer to Appendix 31 for data.

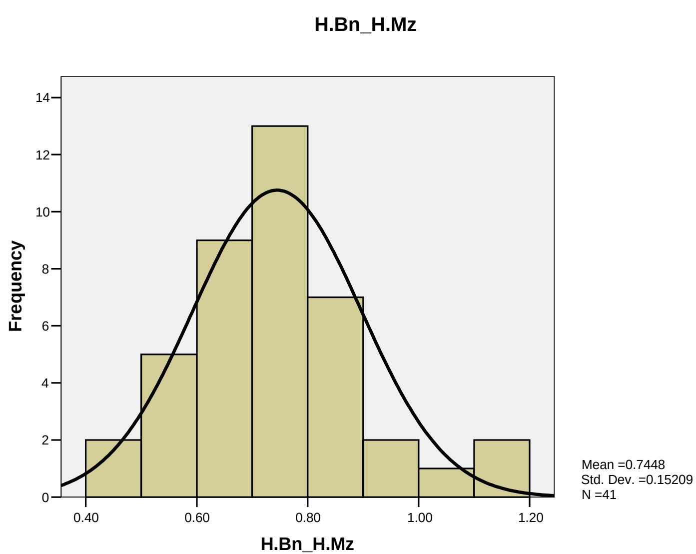


Figure 107: Histogram of the height of the bonaventure to the height of the mizzen in four-masted caravels; refer to Appendix 31 for data.

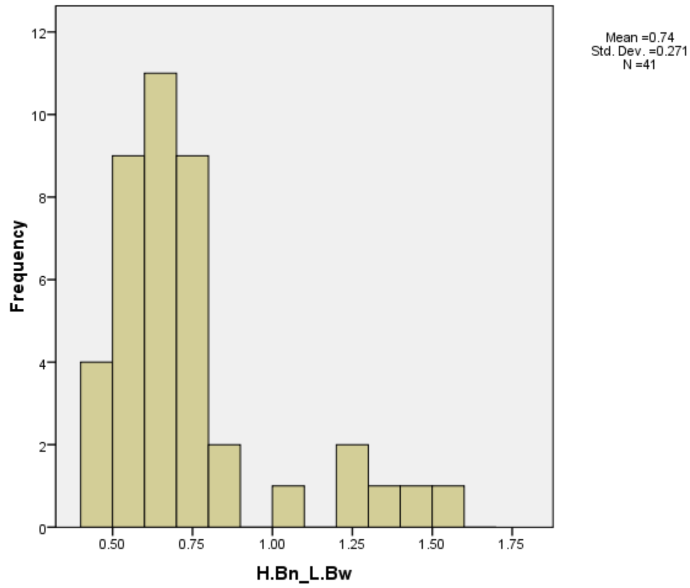


Figure 108: Histogram of the height of the bonaventure to the length of the bowsprit in four-masted caravels. Refer to Appendix 31 for data.

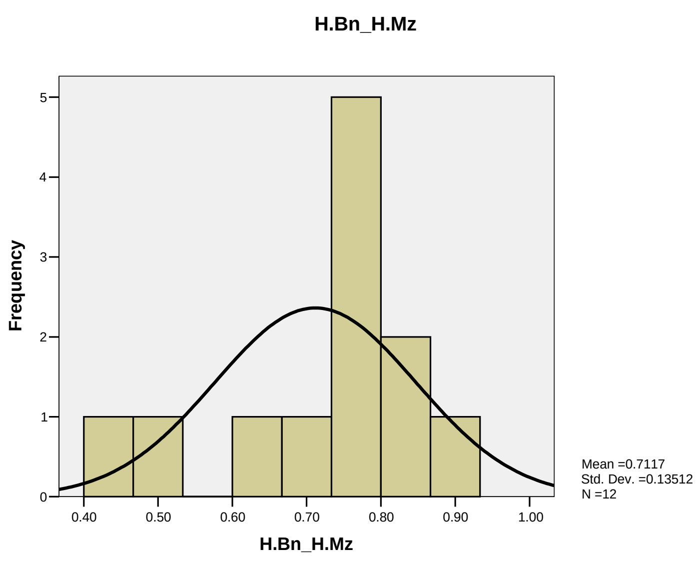


Figure 109: Histogram of the height of the bonaventure to the height of the mizzen in four-masted galleons. Refer to Appendix 31 for data.

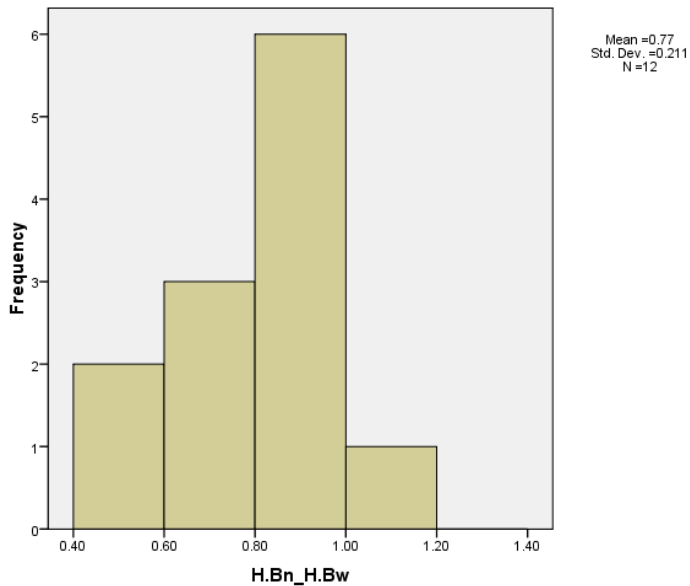


Figure 110: Histogram of the height of the bonaventure to the length of the bowsprit in four-masted galleons. Refer to Appendix 31 for data.

roughly 0.60 to 0.70 (Figure 108). The distribution of the four-masted caravels ranges broadly from 0.40 to 1.60. However, there are six vessels with ratios from 1.00 to 1.60 from four different sources (MA06, MA15, MA16, and CA22) which date from 1500 to 1572. Again, it is more likely that the bonaventure mast was depicted as proportionally too tall as there is no temporal explanation and all but one source (MA06) have other ships with bonaventure masts that fall within the normal distribution.

One standard deviation of the height of the bonaventure mast to the height of the mizzen mast for the four-masted galleon sample is from 0.58 to 0.85 and the primary mode in the histogram graph is from 0.75 to 0.80 (Figure 109). The main distribution is from 0.60 to 0.92, but there are two vessels (MA13.15 and MA15.1550.00) that are from 0.40 to 0.53 and are most likely proportional errors introduced by the artist. The height of the bonaventure to the length of the bowsprit for the four-masted galleons has a one standard deviation of 0.56 to 0.98. The primary mode is from 0.80 to 0.90 and similar to the previous mizzen mast ratio the main distribution is from 0.60 to 1.00 (Figure 110). Again, the two vessels mentioned previously stand out with a range of 0.40 to 0.45, but there is also a third galleon (PA04.03) that has a range of 1.10 to 1.20. Given that this last galleon was within the normal range of the height of the mizzen mast, it is apparent that it has a short bowsprit.

The comparison of the bonaventure height ratios for the three-masted caravels, four-masted caravels, and four-masted galleons is listed in Table 45. The height of the bonaventure to both the height of the mizzen mast and the length of the bowsprit do not correspond to Palacio's ratio of one to three (.33); rather, they appear to have a roughly two to three (.66) relationship. Although all the ship sub-types have a nearly identical lower end of the range produced by one standard deviation of the height of the bonaventure to the height of the mizzen mast, the three-masted caravels have the largest ending point (1.03). It is possible that when there are only three masts, the bonaventure is slightly larger than their four-masted counterparts or even the same height as the mizzen mast. The three-masted caravels with all lateen-rigged masts, in particular, could require greater heights in order to maximize the sail area and thereby increase propulsion power. The four-masted caravels and galleons have a similar lower end of the range at 0.90 and 0.85 respectively and a nearly identical center of distribution, which suggests that the addition of the fore mast could necessitate a slightly smaller bonaventure mast. The height of the bonaventure to the length of the bowsprit ratio differs by only a few percentage points between the four-masted caravels (0.47-1.02) and the four-masted galleons (0.56-0.98). Given the striking similarity between the height of the bonaventure to the mizzen mast, this minimal variation is most likely due to differences in the lengths of the bowsprit between the two ship types.

<u>Bonaventure Mast Width Ratios</u>

Bottom Width of the Bonaventure Mast to the Height of the Bonaventure Mast: (W.Bt.LBn_H.Bn)

The bottom width of the bonaventure was compared to the top width of the mast and then each to the height of the mast. The bottom width of the bonaventure mast to height of the bonaventure ratio for the three-masted caravels has a one standard deviation from 0.05 to 0.13, which is exactly the main distribution shown in the histogram graph (Figure 111) with a primary mode at 0.05 to 0.07. There is one vessel (CA27.02) at 0.20 to 0.22 on the histogram graph which should be considered an outlier in the sample given the general consistency for the widths of the bonaventure and the fact that this same ship was also outside the normal distribution for the height of the bonaventure to the length of the hull. The four-masted caravels also have a one standard deviation range from 0.05 to 0.13 while the four-masted galleons has a slightly smaller range from 0.06 to 0.12. The four-masted caravels have a main distribution in the histogram graph (Figure 112) from 0.03 to 0.21 and a primary mode from 0.06 to 0.08. There is a single four-masted caravel (CA27.05) from the same source as the outlier from the three-masted caravels, which is also outside the normal distribution. The fact that caravels from this source (CA27) are repeatedly abnormal could indicate that there is significant artist introduced errors. The four-masted galleons have a primary mode of 0.08 to 0.10 in the histogram graph (Figure 113) and a main distribution from 0.02 to 0.16.

The comparison of the bonaventure width ratios for the three-masted caravels, four-masted caravels, and four-masted galleons is listed in Table 46. The one standard deviations and center of distribution of the bottom width of the bonaventure to the height of the bonaventure mast ratio is nearly identical for all three ship types (0.05 to 0.13 and 0.07 to 0.10 respectively). The only exception is the one standard deviation of the four-masted galleons which is slightly smaller with a range from 0.06 to 0.12. As such, the

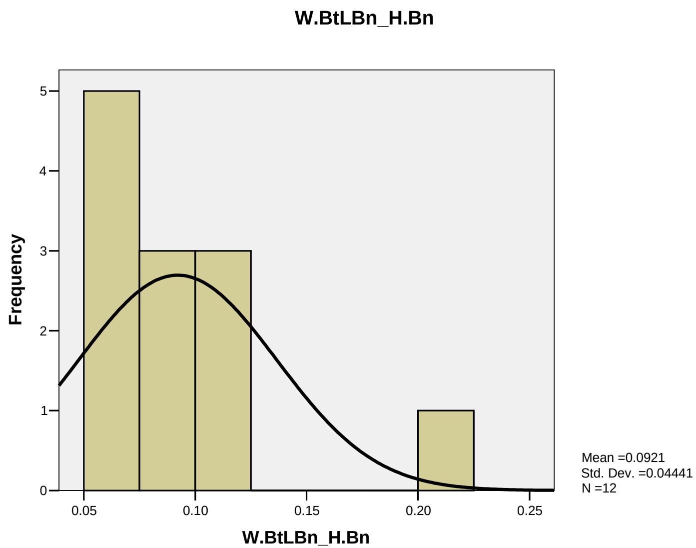


Figure 111: Histogram of the bottom width of the bonaventure to the height of the bonaventure in three-masted caravels. Refer to Appendix 31 for data.

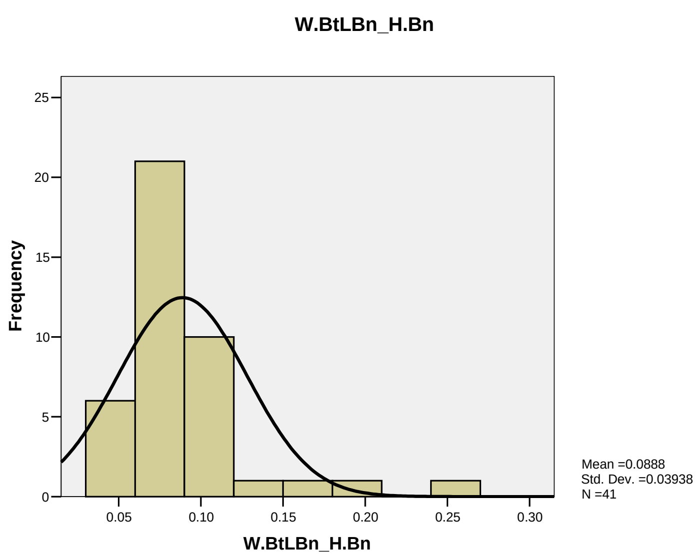


Figure 112: Histogram of the bottom width of the bonaventure to the height of the bonaventure in four-masted caravels. Refer to Appendix 31 for data.

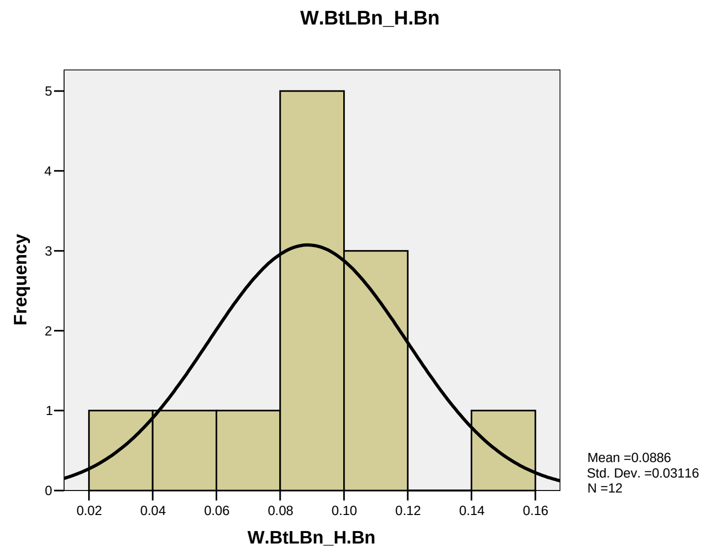


Figure 113: Histogram of the bottom width of the bonaventure to the height of the bonaventure in four-masted galleons. Refer to Appendix 31 for data.

TABLE 46: Comparison of the One Standard Deviation and Center of Distribution of the Bonaventure Width Ratios by Ship Type

W.BtLBn_H.Bn	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Three-masted Caravels	0.05 to 0.13	0.07 to 0.10
Four-masted Caravels	0.05 to 0.13	0.07 to 0.10
Four-masted Galleons	0.06 to 0.12	0.07 to 0.10
W.TpLBn_W.BtLBn	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Three-masted Caravels	0.43 to 0.93	0.52 to 0.80
Four-masted Caravels	0.43 to 0.93	0.52 to 0.80
Four-masted Galleons	0.48 to 0.85	0.50 to 0.82

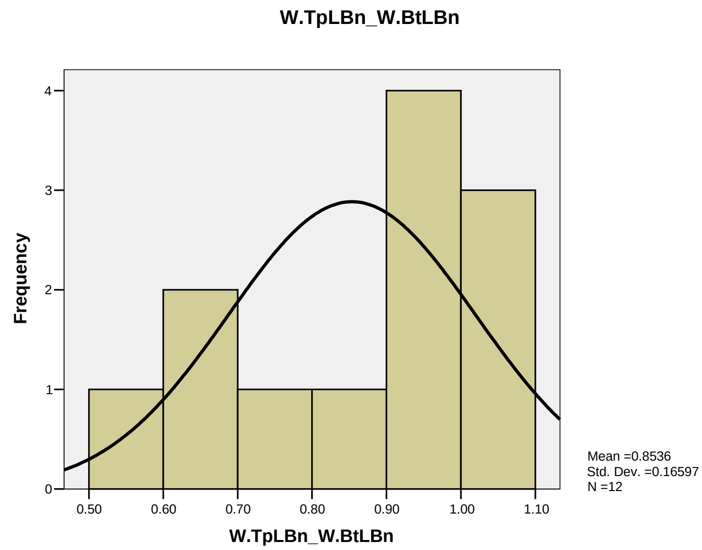


Figure 114: Histogram of the top width of the bonaventure to the bottom width of the bonaventure in three-masted caravels. Refer to Appendix 31 for data.

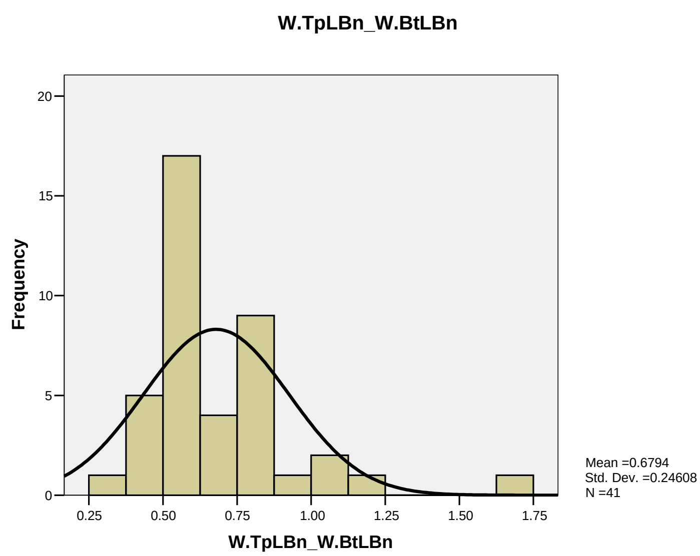


Figure 115: Histogram of the top width of the bonaventure to the bottom width of the bonaventure in four-masted caravels. Refer to Appendix 31 for data.

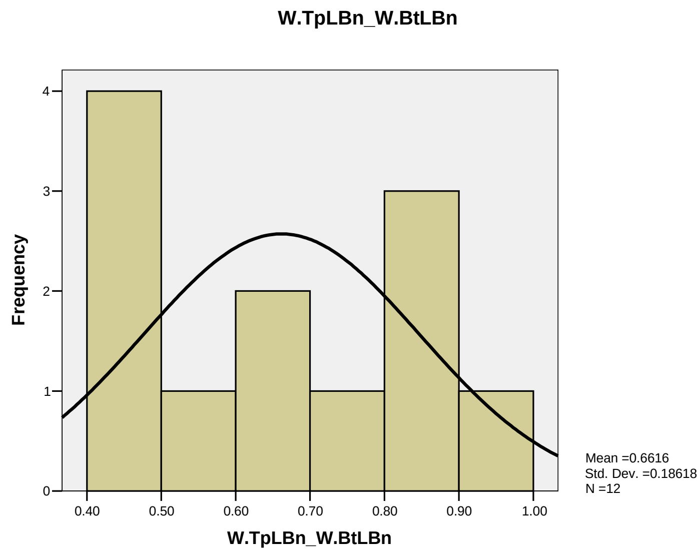


Figure 116: Histogram of the top width of the bonaventure to the bottom width of the bonaventure in four-masted galleons. Refer to Appendix 31 for data.

bottom width is roughly 5% to 13% of the height of the bonaventure mast.

Top Width of the Bonaventure Mast to the Bottom Width of the Bonaventure Mast:(W.Tp.LBn_ W.Bt.LBn)

The one standard deviations for the top width of the bonaventure mast to the bottom width ratio is the same for the three-masted caravels and the four-masted caravels (0.43 to 0.93) while the four-masted galleons have a similar range of (0.48 to 0.85). Although the main distribution for the three-masted caravels in the histogram graph (Figure 114) extends from 0.50 to 1.00, the primary mode is from 0.90 to 1.00 with a secondary mode at 1.00 to 1.10 suggesting little to no tapering of the bonaventure mast for the majority of the sample. The four-masted caravels also have an extensive main distribution in the histogram graph (Figure 115) from 0.25 to 1.25 with an outlier (MA16.1533.19) at 1.60 to 1.75. The primary mode, however, is from 0.50 to 0.63 while the secondary mode is from 0.75 to 0.90. This bi-modal pattern is repeated for the four-masted galleons, which have a main distribution in the histogram graph (Figure 116) from 0.40 to 1.00, but a primary mode at 0.40 to 0.50 and a secondary mode at 0.80 to 0.90.

Although there is remarkable consistency between the one standard deviation of the bonaventure top width to bottom width ratio for the three-masted caravels, four-masted caravels, and four-masted galleons (refer to Table 46), the distribution is very broad suggesting extensive variation in the vertical tapering of the bonaventure mast. The primary and secondary modes for the three-masted caravels are considerably different than those of the four-masted vessels. The four-masted galleons have modes similar to the four-masted caravels centering around 0.50 and 0.85 while the three-masted caravels have modes at significantly higher percentages of 0.90 to 1.10. This marked difference between the three-masted caravels and the four-masted vessels may, again, be related to the all lateen-rigged masts which would logically necessitate a more stout mast to carry the weight of the long lateen yards. There is no temporal explanation for the split in the primary and secondary modes of the four-masted caravels and galleons as the date ranges are randomly dispersed throughout the sample. Additionally, it is common for a single source to have vessels in both the primary and secondary mode, suggesting that this variation is more likely due to artistic error. The top width of the bonaventure mast is taken just under the mast head at which point many of the rigging elements such as shroud lines originate. These particular details are very small in nature and it is sometimes difficult to accurately discern the top mast width as well as where the mast head itself begins and ends.

Bonaventure Yard Dimensions

Bonaventure Yard Length Ratios

In the statistical analysis of the bonaventure yard there are nine three-masted caravels, 11 four-masted caravels, and 16 four-masted galleons with sufficient measurements. The length of the yard was measured from yardarm to yardarm, the middle width was taken as close as possible to its intersection with the mast, and the end width was taken at the yardarm. Unfortunately, there is no information regarding the dimensions of the bonaventure yard in the treatises. Therefore, the length of the yard was compared to the length of the hull and the height of the bonaventure mast as well as the length of the mizzen yard as a control measure. The end and middle widths were both compared to the length of the yard as well as to each other.

Length of the Bonaventure Yard to the Length of the Hull: (L.BnY_L.H)

The length of the bonaventure yard to the length of the hull ratio for the three-masted caravels sample has a one standard deviation from 0.41 to 0.84, which is consistent with the histogram graph (Figure 117) showing the primary mode at 0.40 to 0.50. The main distribution for the three-masted caravels is split into a primary and secondary grouping the first of which is from .10 to .60 and includes six vessels while the second accounts for three vessels with a much higher range of 0.80 to 1.00. These three vessels (CA01.03, CA22.35, and CA01.06) have extremely long bonaventure yards that are nearly the same length as the ship, which is highly suspect given that there are two other longer lateen yards that must be accommodated on these caravels. The one standard deviation of .40 to .61 for the four-masted caravel sample is smaller than the three-masted caravels. The corresponding histogram graph (Figure 118) has a very concise primary mode from 0.50 to 0.55 with a split distribution ranging from 0.30 to 0.45 in the secondary group of four vessels and 0.50 to 0.70 in the main group of seven vessels. The secondary group of four vessels (MA15.1502.05, CA22.18, CA13.02, CA22.20) has proportionally smaller yards than the other seven vessels; however, these

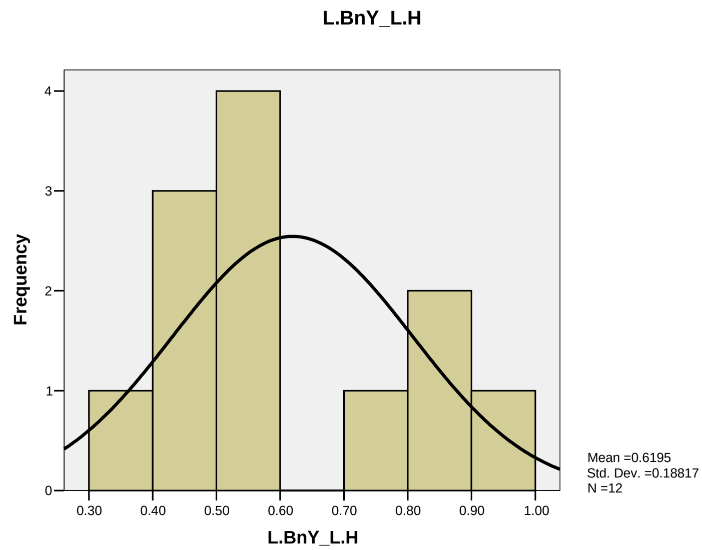


Figure 117: Histogram of the length of the bonaventure yard to the length of the hull in three-masted caravels. Refer to Appendix 31 for data.

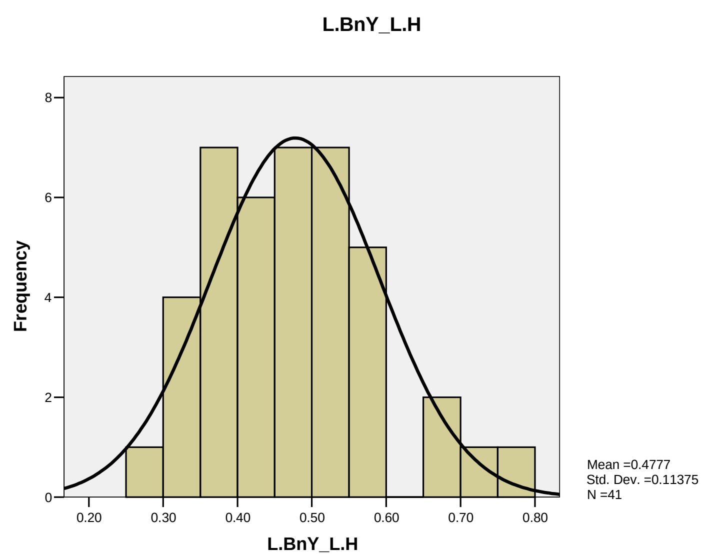


Figure 118: Histogram of the length of the bonaventure yard to the length of the hull in four-masted caravels. Refer to Appendix 31 for data.

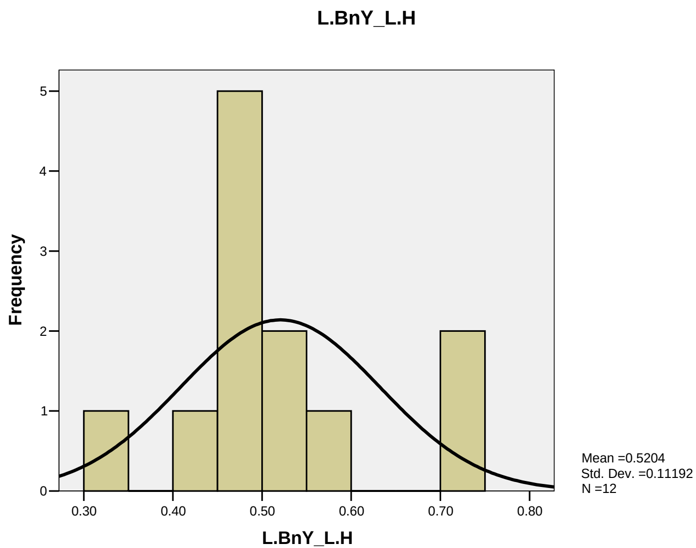


Figure 119: Histogram of the length of the bonaventure yard to the length of the hull in four-masted galleons. Refer to Appendix 31 for data.

TABLE 47: Comparison of the One Standard Deviation and Center of Distribution of the Bonaventure Yard Length Ratios by Ship Type

L.BnY_L.H	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Three-masted Caravels	0.41 to 0.84	0.49 to 0.88
Four-masted Caravels	0.40 to 0.61	0.37 to 0.61
Four-masted Galleons	0.33 to 0.77	0.36 to 0.67
L.BnY_H.Bn	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Three-masted Caravels	0.40 to 0.60	0.42 to 0.55
Four-masted Caravels	0.39 to 0.65	0.45 to 0.59
Four-masted Galleons	0.41 to 0.78	0.46 to 0.67
L.BnY_L.MzY	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Three-masted Caravels	0.63 to 0.83	0.65 to 0.81
Four-masted Caravels	0.57 to 0.83	0.57 to 0.83
Four-masted Galleons	0.64 to 0.84	0.68 to 0.84

ratios are consistent with the three-masted caravel sample and are considered valid lengths. The four-masted galleons have a one standard deviation of 0.33 to 0.77 due to the extensive main distribution 0.20 to 1.20. These values are skewed lower than the caravels which are also reflected in the primary mode of 0.40 to 0.60 and the secondary mode of 0.20 to 0.40 in the histogram graph (Figure 119).

The one standard deviation of the length of the bonaventure yard in relation to the overall length of the hull, listed in Table 47, is relatively consistent for each of the caravel subtypes and the galleons. The three-masted caravels and the four-masted galleons have the most variation of all the samples with respective ranges of 0.41 to 0.84 and 0.33 to 0.77 while the four-masted caravels have much more concise one standard deviation of 0.40 to 0.61. The center of distribution figures (Table 47) indicate that the four-masted caravels and galleons (0.37 to 0.61 and 0.36 to 0.67 respectively) are more closely associated than the three-masted caravels with a range of 0.49 to 0.88 which is suggestive of proportionally larger yards. The primary modes verify the regularity of peak proportions between the three samples; however, the four-masted galleons have the most variability with a range of 0.20 to 0.60. The three-masted caravels actually have slightly smaller yards (0.40 to 0.50) than the four-masted caravels (0.50 to 0.55), which may be a reflection of the overall length of the vessel and relative lengths rather than the tangible lengths of the yards. On average, for the three samples, the length of the bonaventure mast seems to be within 40% to 60% of the length of the hull with slight variations between the individual subtypes.

Length of the Bonaventure Yard to the Height of the Bonaventure Mast: (L.BnY_L.MzY)

The length of the bonaventure yard to the height of the bonaventure mast ratio for the three-masted caravels sample has a one standard deviation from 0.40 to 0.60. The primary mode in the histogram graph (Figure 120) is from 0.50 to 0.55 and the main distribution is from 0.35 to 0.60; there is also one outlier (CA27.02) at 0.75. The one standard deviation of 0.39 to 0.65 for the four-masted caravel sample is similar to the three-masted caravels. The corresponding histogram graph (Figure 121) shows a primary mode from .40 to .50 with a broad main distribution ranging from 0.20 to 0.90. The four-masted galleons have a larger one standard deviation of 0.41 to 0.78 due to the presence of two outliers at 0.86 (PA04.03) and 1.00 (MA02.01). The main distribution in the histogram graph (Figure 122) is more concise from 0.30 to 0.70 and there are two equal primary modes from 0.40 to 0.50 and from 0.60 to 0.70.

The one standard deviation of the lengths of the bonaventure yard in relation to the height of the bonaventure mast is relatively consistent for the three-masted and four-masted caravels, whereas the galleons, at first, exhibit more variation. The primary modes indicate, however, that the galleons are comparable to the caravels but with slightly more variability within the sample. Overall the length of the yard appears to be roughly 40% to 50% of the height of the mast with minor differences between the individual subtypes.

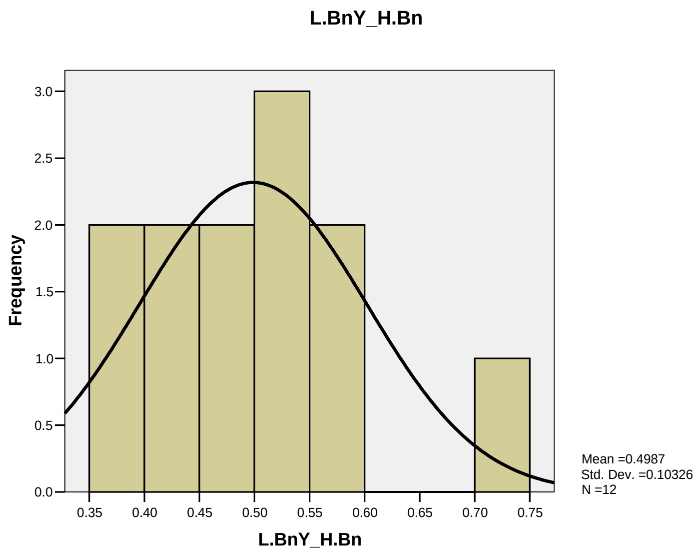


Figure 120: Histogram of the length of the bonaventure yard to the height of the bonaventure mast in three-masted caravels. Refer to Appendix 31 for data.

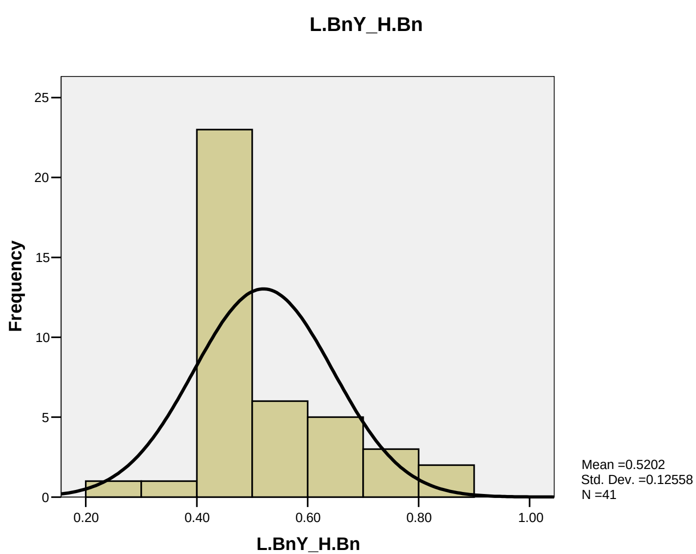


Figure 121: Histogram of the length of the bonaventure yard to the height of the bonaventure mast in four-masted caravels. Refer to Appendix 31 for data.

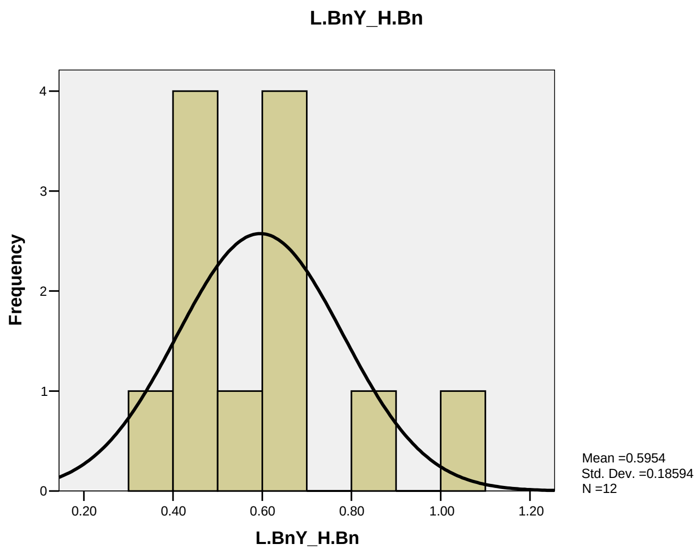


Figure 122: Histogram of the length of the bonaventure yard to the height of the bonaventure mast in four-masted galleons. Refer to Appendix 31 for data.

Length of the Bonaventure Yard to the Length of the Mizzen Yard

The length of the bonaventure yard to the length of the mizzen yard ratio for the three-masted caravel sample has a one standard deviation from 0.63 to 0.83 which is consistent with the histogram graph (Figure 123), which shows the primary mode at 0.70 to 0.75 and a secondary mode at 0.80 to 0.85. The main distribution ranges from 0.70 to 0.85 and there are two outliers from 0.55 to 0.65 (CA04.10 and CA04.13). One standard deviation for the four-masted caravel sample is from 0.57 to 0.83. The corresponding histogram graph (Figure 124) has a primary mode of roughly 0.50 to 0.60 with the main distribution ranging from 0.50 to 1.00. The four-masted galleon sample has a one standard deviation from 0.64 to 0.84 with a main distribution in the histogram graph (Figure 125) from 0.55 to 0.95. The primary mode is from 0.70 to 0.75 while the secondary mode is from 0.65 to 0.70.

The comparison of the length of the bonaventure yard to the length of the mizzen yard exhibits marked similarity between the three ship sub-types. The one standard deviations ranges are highly consistent between the three samples with only a few percentage points difference for the three-masted caravels (0.63 to 0.83), the four-masted caravels (0.57 to 0.83), and the four-masted galleons (0.64 to 0.84). The center of distribution figures show nearly identical ranges to the one standard deviations. It is in the modal ranges, however, that the minimal differences between the samples are highlighted. The three-masted caravels and the four-masted galleons, which have the closest one standard deviations also have identical primary modes of 0.70 to 0.75. The secondary modes demonstrate that the sample is skewed higher for the three-masted

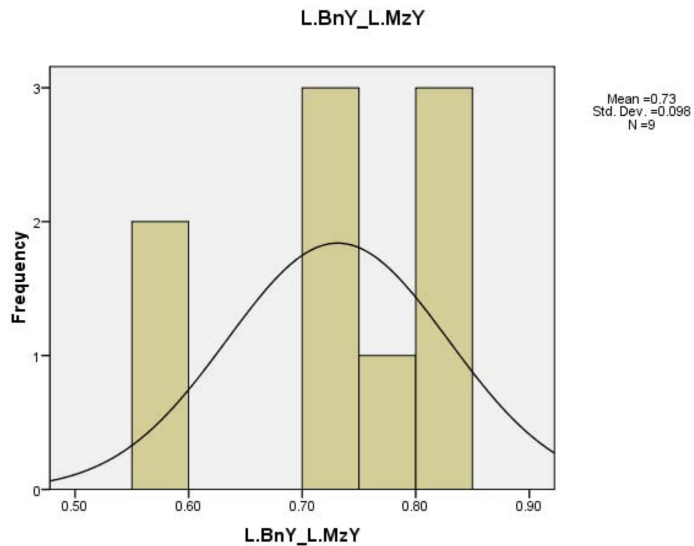


Figure 123: Histogram of the length of the bonaventure yard to the length of the mizzen yard in three-masted caravels. Refer to Appendix 31 for data.

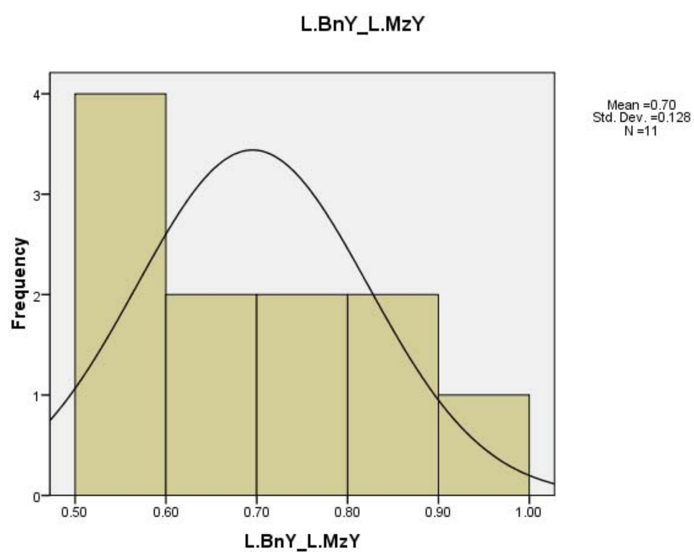


Figure 124: Histogram of the length of the bonaventure yard to the length of the mizzen yard in four-masted caravels. Refer to Appendix 31 for data.

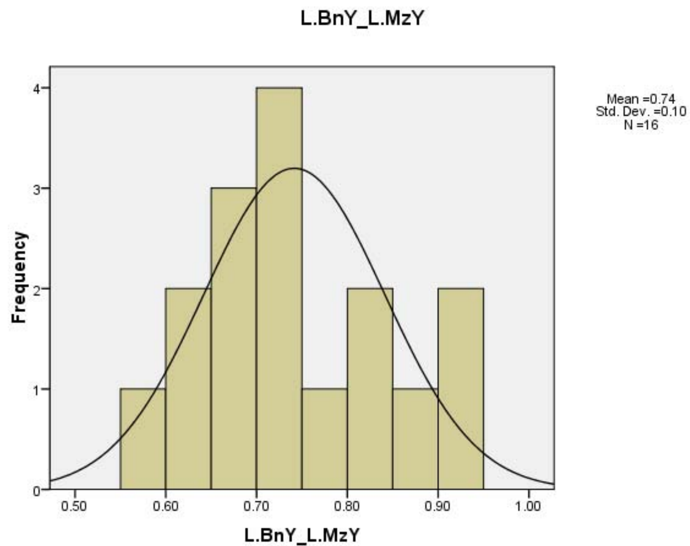


Figure 125: Histogram of the length of the bonaventure yard to the length of the mizzen yard in four-masted galleons. Refer to Appendix 31 for data.

caravels (0.80 to 0.85) and lower for the four-masted galleons (0.65 to 0.70). The four-masted caravels have the lowest range of 0.50 to 0.60, which suggests proportionally smaller bonaventure yards than mizzen yards compared to the other samples. Based on the primary modes it appears that the bonaventure yard was 70% to 75% of the length ofthe mizzen yard for the three-masted caravels and the four-masted galleons, and 50% to 60% for the four-masted caravels.

Bonaventure Yard Width Ratios

Middle Width of the Bonaventure Yard to the Length of the Bonaventure Yard: (W.MBnY_L.BnY)

The middle width of the bonaventure yard to the length of the bonaventure yard for the three-masted caravel, four-masted caravel, and the galleon sample all have a one standard deviation from 0.02 to 0.05. The main distribution of the three-masted caravels in the histogram graph (Figure 126) is from 0.01 to 0.06 and there are four equal primary modes 0.01 to 0.02, 0.02 to 0.03, 0.03 to 0.04, and 0.04 to 0.05. The main distribution in the histogram graph (Figure 127) for the four-masted caravels is from 0.01 to 0.07 and the primary mode is from 0.03 to 0.04 and the secondary mode is from 0.02 to 0.03. The galleons have a main distribution from 0.01 to 0.06 with an outlier at 0.07 to 0.08 (EN04.03). The primary mode in the histogram graph (Figure 128) is from 0.02 to 0.03 which is more consistent with the four-masted caravels.

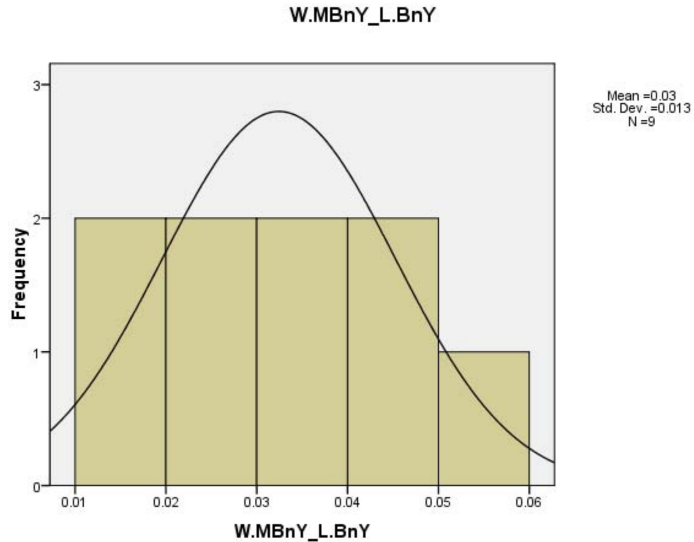


Figure 126: Histogram of the middle width of the bonaventure yard to the length of the bonaventure yard in three-masted caravels. Refer to Appendix 31 for data.

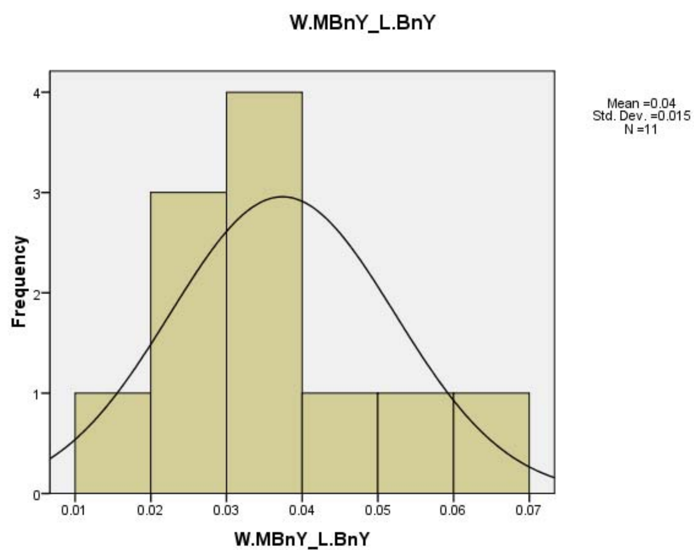


Figure 127: Histogram of the middle width of the bonaventure yard to the length of the bonaventure yard in four-masted caravels. Refer to Appendix 31 for data.

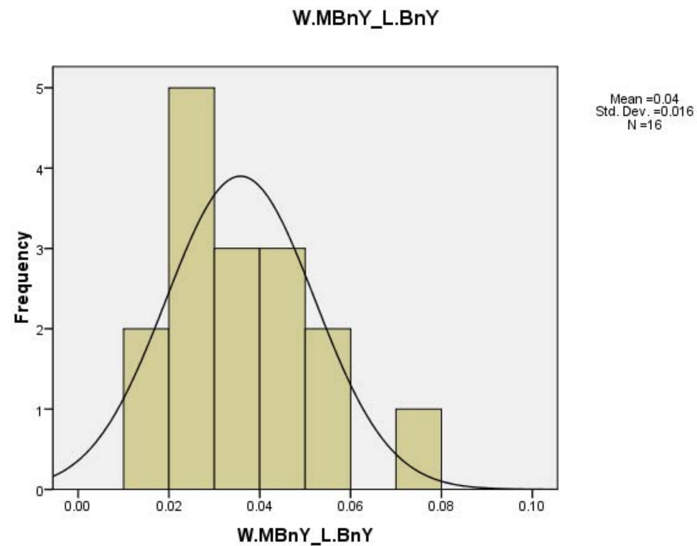


Figure 128: Histogram of the middle width of the bonaventure yard to the length of the bonaventure yard in four-masted galleons. Refer to Appendix 31 for data.

TABLE 48: Comparison of the One Standard Deviation and Center of Distribution of the Bonaventure Yard Width Ratios by Ship Type

W.MBnY_L.BnY	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Three-masted Caravels	0.02 to 0.05	0.02 to 0.04
Four-masted Caravels	0.02 to 0.05	0.03 to 0.04
Four-masted Galleons	0.02 to 0.05	0.03 to 0.04
W.MBnY_W.EBnY	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Three-masted Caravels	0.76 to 1.11	0.77 to 1.00
Four-masted Caravels	0.61 to 1.03	0.72 to 1.00
Four-masted Galleons	0.78 to 1.01	0.56 to 1.00

The one standard deviation of the middle width of the bonaventure yard to the length of the bonaventure yard shown in Table 48 is identical for all three samples. Likewise, the center of distribution figures only differ by one percentage point between the three-masted caravels (0.02 to 0.04) and the four-masted caravels and the four-masted galleons both of which have a range of 0.03 to 0.04. The modal ranges verify the strong association of the caravels and the galleons, but demonstrate that there is some variation between the three samples. The three-masted caravels have a broad modal range that spans almost the entire distribution of the sample. Although the four-masted caravels and the four-masted galleons have a similar modal range, the primary peak is larger for the caravels (0.03 to 0.04) and smaller for the galleons (0.02 to 0.03). Overall the one standard deviation generally indicate that the middle width of the bonaventure yard is 2% to 5% of the length of the yard, but that the modal ranges should be adhered to for specific ship types.

Middle Width of the Bonaventure Yard to the End Width of the Bonaventure Yard: (W.MBnY_E.WBnY)

The one standard deviation of the middle width to the end width of the bonaventure yard for the three-masted caravels is from 0.76 to 1.11 and the main distribution in the histogram graph (Figure 129) is from 0.70 to 1.00 with one outlier (CA01.06) at 1.20 to 1.30. The primary mode is from 0.90 to 1.00 and the secondary mode is from 0.70 to 0.80. The one standard deviation for the four-masted caravels is from 0.61 to 1.03, which is consistent with the primary mode from 0.90 to 1.00 in the

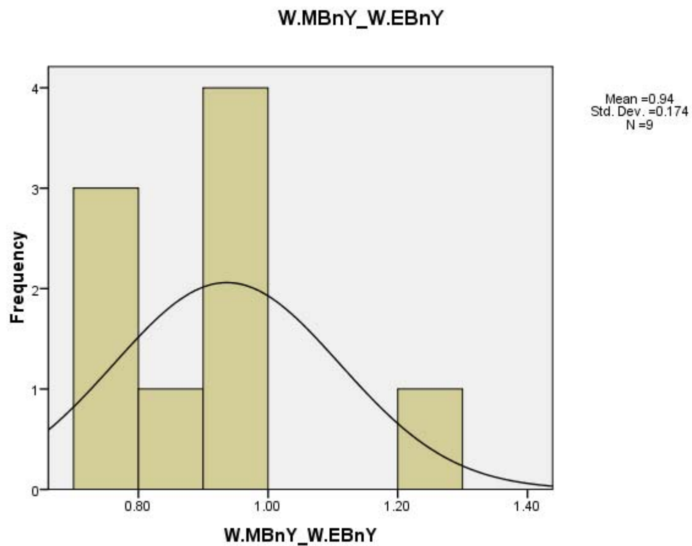


Figure 129: Histogram of the middle width of the bonaventure yard to the end width of the bonaventure yard in three-masted caravels. Refer to Appendix 31 for data.

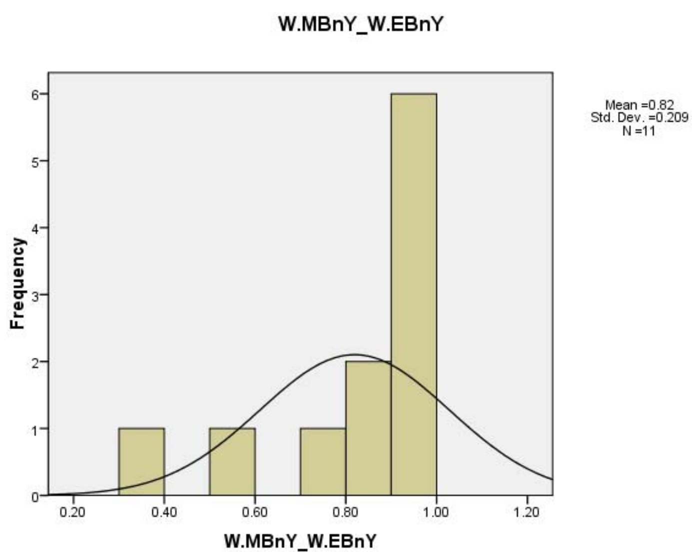


Figure 130: Histogram of the middle width of the bonaventure yard to the end width of the bonaventure yard in four-masted caravels. Refer to Appendix 31 for data.

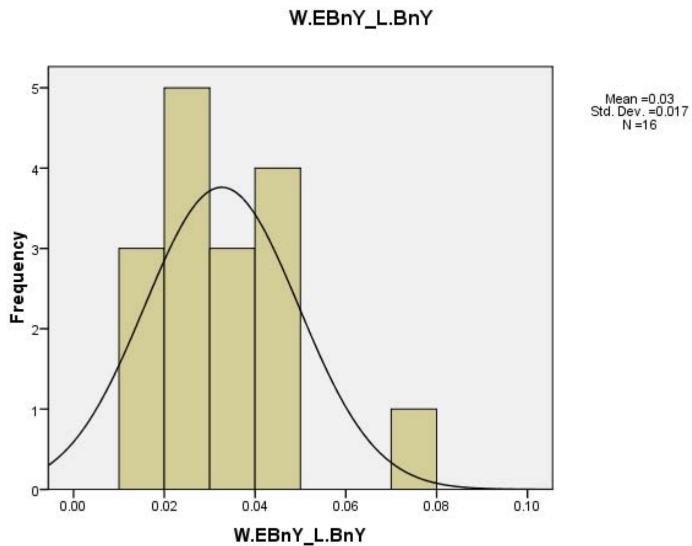


Figure 131: Histogram of the middle width of the bonaventure yard to the end width of the bonaventure yard in four-masted galleons. Refer to Appendix 31 for data.

histogram graph shown in Figure 130. The main distribution of the four-masted caravel sample is the same as the three-masted caravels, 0.70 to 1.00, and there are two outliers from 0.30 to 0.40 (MA15.1501.12) and from 0.50 to 0.60 (MA15.1502.05). The four-masted galleons have a one standard deviation of 0.78 to 1.01 and the primary mode is from 1.00 to 1.05. The main distribution in the histogram graph (Figure 131) is from 0.75 to 1.05 with one outlier (MA02.01) at 0.55 to 0.65.

Although the one standard deviation for the middle to end width ratios are consistent between the ship sub-types; they all have significantly large ranges suggesting high variability in the amount of tapering of the yard. The one standard deviations clearly show that ratios range from roughly the 70^{th} percentile to the 100^{th} for the three-masted caravels and the four-masted galleons while the four-masted caravels have a lower range down to the 60^{th} percentile. The center of distribution, however, show that the caravels have almost identical ranges of 0.72 to 1.00 and 0.77 to 1.00 while the galleons have a much broader range starting at 0.56. The modes for the caravels and galleons considerably narrow the range of variation within the sample. The three-masted and four-masted caravels have the same primary mode of 0.90 to 1.00 while the four-masted galleons have a similar primary mode of 1.00 to 1.05 indicating that there is little to no tapering of the bonaventure yard despite the broad distributions.

9.2 MIZZEN MAST AND YARD DIMENSIONS

Mizzen Mast Dimensions

In the statistical analysis of the lower mizzen mast there are 86 caravels, 33 galleons, and 195 naus which had sufficient measurements to conduct a statistical analysis of the mizzen mast dimensions (refer to Figure 102). The sample was divided into two-masted caravels (34), three-masted caravels (12), four-masted caravels (40), three-masted galleons (10), four-masted galleons (23), and naus (195); refer to Appendix 32 for the frequency tables of all ship types. There are only eight vessels with a mizzen topmast including one caravel (MA13.10), two galleons (MA13.05, PA09.03), and five naus (CA14.01, MA13.02, PA07.01-3). The one standard deviation, center of distribution, and the primary modes for the mizzen topmast ratios can be viewed in Table 49. The statistical analysis of the mizzen topmast was limited because the presence of the mast is rare in the iconography and there was no observable sorting of the data by ship type, date, or source. Likewise, there is no information about the mizzen topmast in the archival sources. As such, the ranges of normal variation tabulated in this table cannot be meaningfully compared to other sources nor properly analyzed.

According to Palacio, the mizzen mast and the bowsprit are the same length and thickness (Bankston, 1986: 120). Although the height of the mizzen mast is the same in both the *Livro Náutico* and Fernandez (10 *braças* or 17.6m) it is not possible to correlate this absolute number to the ratios produced within this analysis. Additionally the dimensional relationship between the mizzen mast and the main mast is expounded upon

TABLE 49: Tabulation of the One Standard Deviation, Center of Distribution, and Primary Modes of the Mizzen Topmast Ratios

MIZZEN TOPMAST			
	One Standard Deviation (68%)	**Center of Distribution (50%)**	**Primary Modes**
H.UMz_L.H	0.12 to 0.34	0.15 to 0.35	0.15 to 0.20; 0.25 to 0.30; 0.35 to 0.40
H.UMz_H.Mz	0.33 to 1.00	0.34 to 0.46	0.325 to 0.35; 0.45 to 0.475
W.BtUMz_ H.UMz	0.01 to 0.12	0.03 to 0.12	0.60 to 0.80; 0.80 to 1.00
W.BtUMz_ W.TpUMz	0.36 to 0.94	0.59 to 0.79	0.00 to 0.05; 0.05 to 0.10

TABLE 50: Comparison of the One Standard Deviation and Center of Distribution of the Mizzen Mast Height Ratios by Ship Type

H.LMz_L.H	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Two-masted Caravels	0.30 to 0.52	0.32 to 0.48
Three-masted Caravels	0.31 to 0.48	0.33 to 0.48
Four-masted Caravels	0.25 to 0.45	0.27 to 0.41
Three-masted Galleons	0.28 to 0.46	0.33 to 0.41
Four-masted Galleons	0.29 to 0.60	0.36 to 0.53
Naus	0.26 to 0.51	0.31 to 0.44
H.LMz_H.LMa	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Two-masted Caravels	0.44 to 0.66	0.48 to 0.64
Three-masted Caravels	0.52 to 0.85	0.57 to 0.82
Four-masted Caravels	0.45 to 0.74	0.48 to 0.68
Three-masted Galleons	0.34 to 0.73	0.44 to 0.57
Four-masted Galleons	0.53 to 0.90	0.57 to 0.86
Naus	0.41 to 0.75	0.46 to 0.67
H.LMz_L.Bw	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Four-masted Caravels	0.74 to 1.47	0.89 to 1.40
Three-masted Galleons	0.80 to 1.25	0.83 to 1.15
Four-masted Galleons	0.73 to 1.22	0.84 to 1.10
Naus	0.71 to 1.46	0.80 to 1.33

in the *Livro Náutico*, which states that the mizzen mast cap should stand 2 *braças* lower than the level of the mast cap of the lower mainmast. From this it is possible to calculate that lower main mast would have a height of 12 *braças* and the corresponding proportional relationship between the mizzen mast and the main mast is 83.33%.

Mizzen Mast Height Ratios

Height of the Mizzen Mast to the Length of the Hull: (H.Mz_L.H)

The height of the mizzen mast to the length of the hull ratio for the two-masted caravels sample has a one standard deviation from 0.30 to 0.52; the tabulation of all the mizzen mast height ratios can be viewed in Table 50. The primary mode in the histogram graph (Figure 132) is from 0.40 to 0.45 while the secondary mode is from 0.30 to 0.35 and the tertiary mode is from 0.25 to 0.30. The main distribution, which ranges from 0.25 to 0.75, at first, suggests high variability within the iconography and is too broad to be practical in a reconstruction. These three modes support the normal variation determined by one standard deviation, however, and prove there is regularity in the height of the mizzen mast on two-masted caravels. One standard deviation of the height of the mizzen mast to the length of the hull on deck for the three-masted caravel sample is from 0.31 to 0.48. The corresponding histogram graph (Figure 133) has three equal modes at 0.30-0.35, 0.40-0.45, and 0.45-0.50 with the main distribution ranging from 0.20 to 0.55. The four-masted caravels have a one standard deviation of 0.25 to 0.45, but are similar to the three-masted caravels with three equal modes at 0.20-0.25,

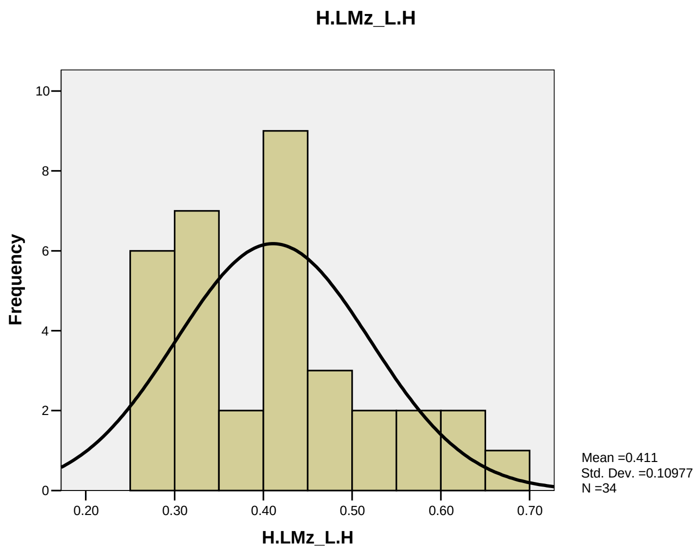


Figure 132: Histogram of the height of the mizzen mast to the length of the hull in two-masted caravels. Refer to Appendix 32 for data.

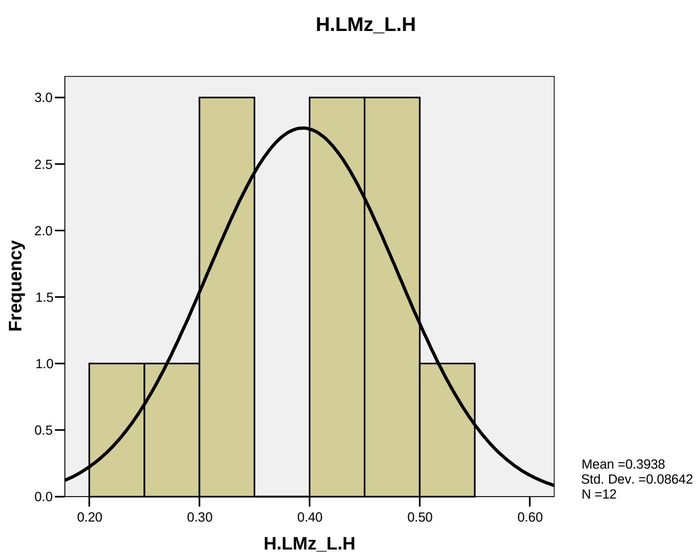


Figure 133: Histogram of the height of the mizzen mast to the length of the hull in three-masted caravels. Refer to Appendix 32 for data.

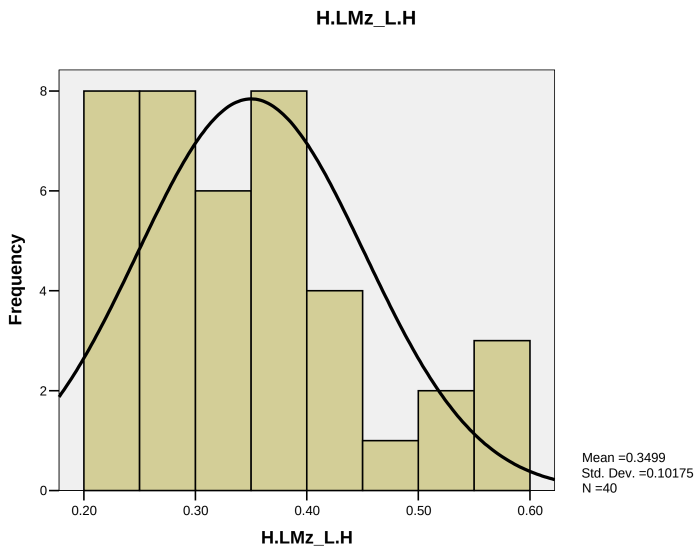


Figure 134: Histogram of the height of the mizzen mast to the length of the hull in four-masted caravels. Refer to Appendix 32 for data.

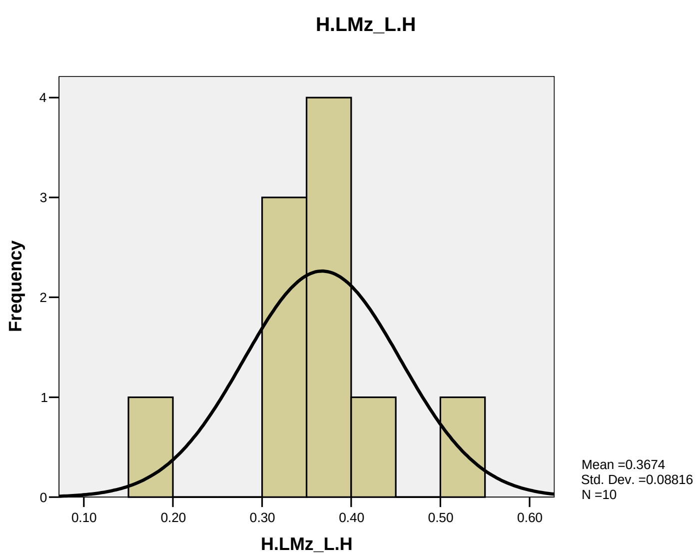


Figure 135: Histogram of the height of the mizzen mast to the length of the hull in three-masted galleons. Refer to Appendix 32 for data.

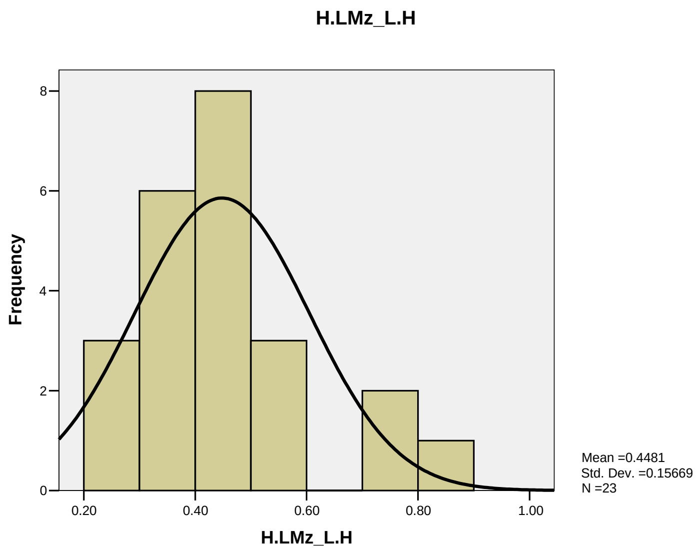


Figure 136: Histogram of the height of the mizzen mast to the length of the hull in four-masted galleons. Refer to Appendix 32 for data.

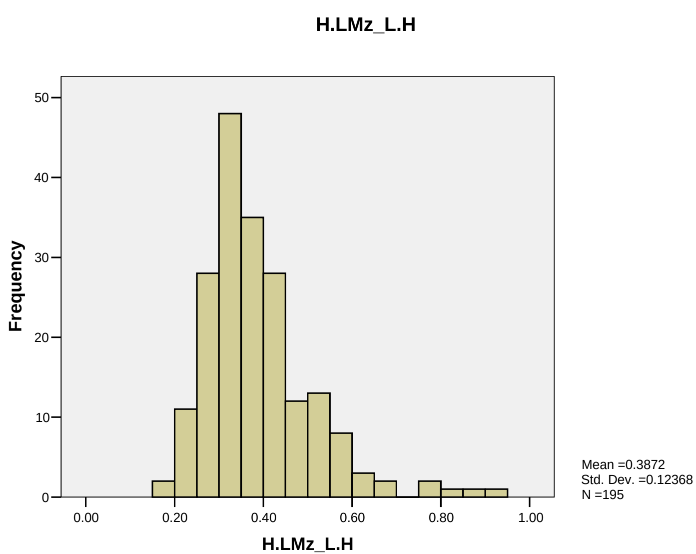


Figure 137: Histogram of the height of the mizzen mast to the length of the hull in naus. Refer to Appendix 32 for data.

0.25-0.30, and 0.35-0.40. The main distribution in the histogram graph (Figure 134) is from 0.20 to 0.60. The three-masted galleons have a one standard deviation of the height of the mizzen mast to the length of the hull from 0.28 to 0.46, which is consistent with the primary mode of 0.35 to 0.40 and the secondary mode of 0.30 to 0.35 in the histogram graph (Figure 135). The main distribution is from 0.30 to 0.45 and there are two outliers at 0.15-0.20 (CA14.04) and 0.50-0.55 (CA04.29). The one standard deviation of the four-masted galleons is 0.29 to 0.60 and nearly the same as the main distribution (0.20 to 0.60), but the main mode of 0.40 to 0.45 and the secondary mode of 0.35 to 0.40 in the histogram graph (Figure 136) provide a more precise range of normal variation. There are three outliers in the four-masted galleon sample: two (EN04.01, MA02.01) at 0.75 to 0.80 and one (MA13.09) at 0.80 to 0.85.

One standard deviation of the height of the mizzen mast to the length of the hull on deck for the nau sample is from 0.26 to 0.51. The corresponding histogram graph (Figure 137) has a primary mode at 0.30 to 0.35 and a secondary mode at 0.35 to 0.40. The main distribution range is highly variable from 0.15 to 0.70 and is further extended by four outliers from 0.75 to 0.95 listed here in order of increasing size (MA16.1497-04, CA33.02, CA33.04, and PA03.05). These outliers are irrelevant to determining normal variation given the large sample size of the naus (195) and are only important for the analysis of those particular images. A total of 93 naus (47%) are within the primary mode (56) and secondary mode (37) and an additional 58 naus are within the 0.25 to 0.30 and 0.40 to 0.45 ranges.

The one standard deviation of the height of the mizzen mast in relation to the overall length of the hull is relatively consistent for each of the caravel and galleon subtypes and the naus. The four-masted caravels and the four-masted galleons have the most variation of all the samples with respective ranges of 0.25 to 0.45 and 0.29 to 0.60. Furthermore, there are three equal primary modes for the four-masted caravels from 0.20 to 0.40. The four-masted galleons, however, have much more concise primary and secondary modes ranging from 0.35 to 0.45. As such, the modes of the four-masted galleon are more akin to the three-masted vessels but skewed slightly larger, which is surprisingly similar to the two-masted caravels. The one standard deviation and the center of distribution of the two-masted and three-masted caravels indicate that these two caravel subtypes, on average, have slightly larger mizzen masts than the three-masted galleons and naus. The respective modes show that they are actually very similar to the three-masted galleons and naus on the lower end of the range, but are more comparable to the four-masted galleons on the higher end. The naus appear to have mizzen masts that are skewed slightly smaller with a one-standard deviation range starting at 0.26, which is only matched by the lower end of the four-masted caravels with a 0.25. On average, for all of the ship types, the height of the mizzen mast seems to be within 30% to 40% of the length of the hull with slight variations between the individual subtypes.

Height of the Mizzen Mast to the Height of the Lower Main Mast: (H.Mz_H.L.Ma)

The height of the mizzen mast to the height of the lower main mast ratio for the two-masted caravels sample has a one standard deviation from 0.44 to 0.66. There is a broad main distribution in the histogram graph (Figure 138) from 0.30 to 0.90 as well as two equal primary modes from 0.55 to 0.66 and a secondary mode at 0.45 to 0.50. The three-masted caravels sample has an extensive one standard deviation range from 0.52 to 0.85 and a main distribution from 0.30 to 1.00. There are two equal primary modes of 0.60 to 0.70 and the secondary mode of 0.80 to 0.90 in the histogram graph (Figure 139), which provides a more precise range of normal variation. The four-masted caravels have a one-standard deviation of 0.45 to 0.74; however, the histogram graph (Figure 140) indicates that there is a high degree of variability within the sample. The main distribution, similar to the other two-masted and three-masted caravel samples, is from 0.30 to 0.90 and the two equal primary modes are 0.45 to 0.50 and 0.60 to 0.65 with a secondary modal peak at 0.65 to 0.70.

One standard deviation of the height of the mizzen mast to the height of the lower main mast for the three-masted galleon sample is from 0.34 to 0.73. The main distribution is from 0.35 to 0.65 and there is one outlier (PA08.01) that has a mizzen mast equal to the lower main mast. The primary mode in the histogram graph (Figure 141) for the three-masted galleons is 0.40 to 0.50. The four-masted galleons have a one standard deviation from 0.53 to 0.90 and a much larger main distribution from 0.40 to 1.10. The primary mode in the histogram graph (Figure 142) is from 0.60 to 0.70 and the

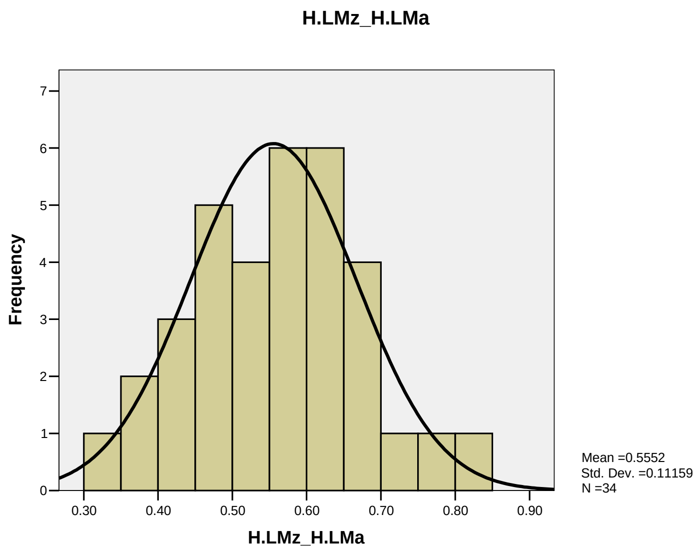


Figure 138: Histogram of the height of the mizzen mast to the height of the lower main mast in two-masted caravels. Refer to Appendix 32 for data.

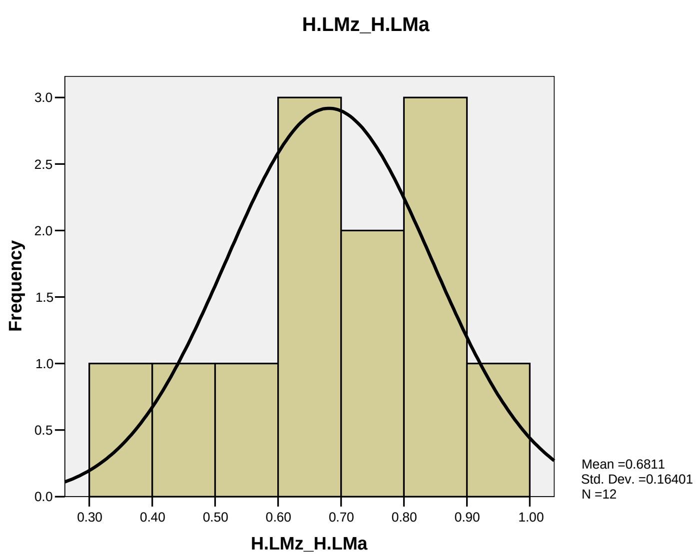


Figure 139: Histogram of the height of the mizzen mast to the height of the lower main mast in three-masted caravels. Refer to Appendix 32 for data.

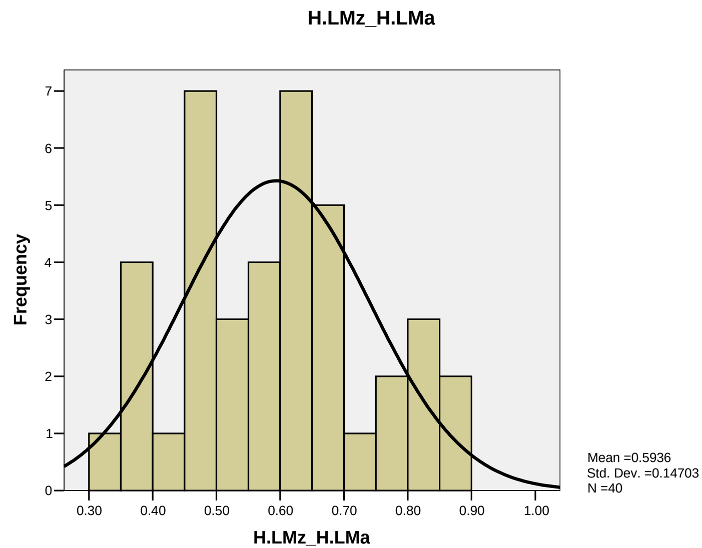


Figure 140: Histogram of the height of the mizzen mast to the height of the lower main mast in four-masted caravels. Refer to Appendix 32 for data.

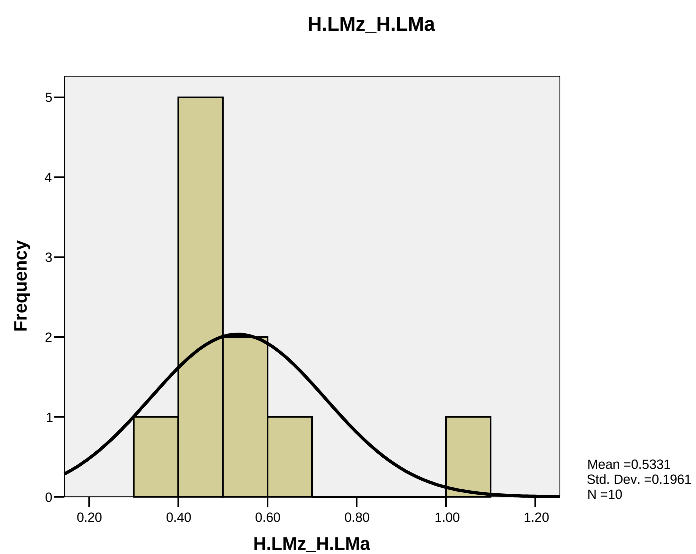


Figure 141: Histogram of the height of the mizzen mast to the height of the lower main mast in three-masted galleons. Refer to Appendix 32 for data.

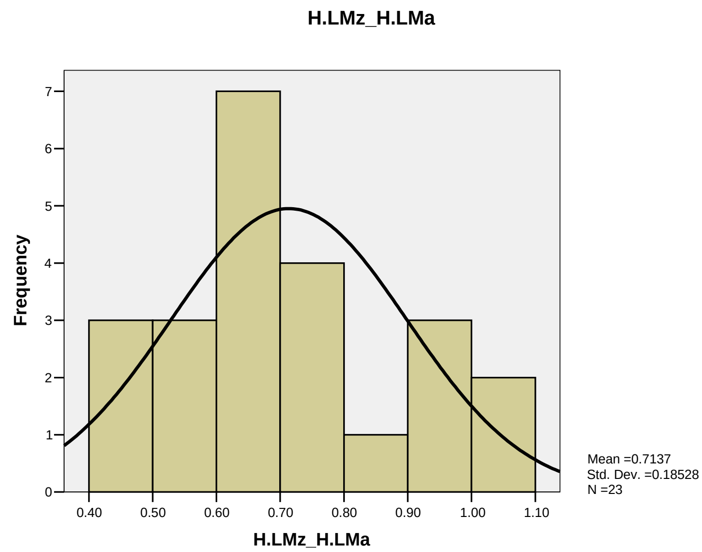


Figure 142: Histogram of the height of the mizzen mast to the height of the lower main mast in four-masted galleons. Refer to Appendix 32 for data.

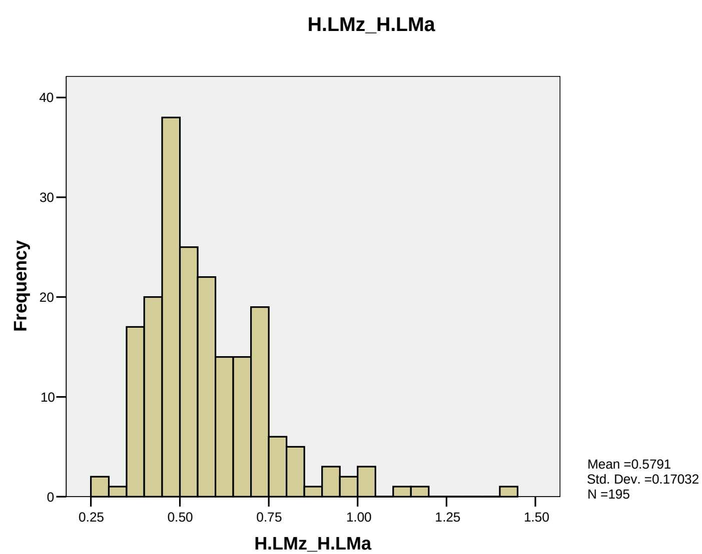


Figure 143: Histogram of the height of the mizzen mast to the height of the lower main mast in naus. Refer to Appendix 32 for data.

secondary is from 0.70 to 0.80. The one standard deviation for the nau sample is 0.41 to 0.75. The primary mode in the histogram graph (Figure 143) is from 0.45 to 0.50 while the secondary mode is from 0.50 to 0.55. Like the caravels and galleons, the nau sample also has a large main distribution, which ranges from 0.25 to 1.05. There are three outliers with the height of the mizzen mast exceeding the normal range of variation in relation to the lower main mast: EN05.01 at 1.11, CA27.05 at 1.18, and PA07.01 at 1.40.

The height of the mizzen mast in relation to the height of the main mast should be around 80% according to the *Livro Náutico*. A limiting factor in this study is that the height of the lower main mast can only be taken at the base of the mast top or crow's nest, which skews the resulting ratio lower. Although it is not possible to accurately predict the exact percentage of the mast that resides within the mast top structure, it is logical to suggest that it would be no more than 5% to 10% of the overall height of the lower main mast thereby lowering the expected proportion to 70% to 75%. Using the dimensions of the lower main mast from the *Livro Náutico*, 12 *braças*, the proposed portion of the mast not seen in the iconography would equate to a length of .06 to 1.2 *braças* which equals 1.1 to 2.1 meters or 3.6 to 6.9 feet. It is a reasonable assumption that the crow's nest would not exceed the height of a man; even the presence of interior planking within its structure would only reduce the height by inches and not feet. Unfortunately, none of the archival sources cite information on the heights of the mast tops or crow's nest and their circumferences are proportionally linked to the breadth of the ship both of which are very difficult to accurately measure in the iconography.

Although the resulting one-standard deviations for the height of the mizzen mast to the height of the lower main mast are reasonably within this proposed range, all of the samples are skewed much lower. The one-standard deviations for the caravel samples show that the two-masted caravels have comparatively the smallest mizzen masts in relation to the main mast while the three-masted caravels have the greatest proportional height with the four-masted caravels situated in between. It is curious that the two-masted vessels with only a mizzen and a main mast would have a greater disparity between the heights of the two masts given that it would reduce the amount of sail area and therefore the propulsion and power of the vessel. Likewise, it would be more logical that the four-masted vessel would have the smallest mizzen mast because of the addition of a square fore mast to the three lateen rigged masts. A smaller mast equals a shorter yard, which could be vital to a vessel with three long lateen yards and a fourth square-rigged mast. The three-masted caravel has a similar range to the four-masted galleon while the three-masted galleons and the naus have one-standard deviations aligned more with the four-masted caravels.

Examining the modes allows for a more concise look at highest concentrations within the sample. The primary and secondary modes show that the three-masted galleons and the naus are the only vessels that do not come near the proposed 70-75% relationship of the mizzen mast to the lower main mast. The three-masted galleons have the smallest modal range from 0.40 to 0.50 whereas the nau ratios exhibit a slightly larger mizzen mast at 0.45 to 0.55. The two-masted caravels have a somewhat similar range from 0.45 to 0.66, but the primary mode is on the higher end and is close to the

70% mark and is similar to the four-masted caravels with 0.45 to 0.70. Again, the three-masted caravels and the four-masted galleons are very similar and have the highest modal ranges with proportions well within the expected 70-75%. It appears that the depicted heights of the mizzen mast are somewhat accurate, yet too small on average, in relation to the main mast according to the dimensions found in the *Livro Náutico*. Although there is much room for debate on how the comparative dimensions were reached and the applicability of one source to the entire sample of ships, this test provides scholars with a general sense of the reliability of the iconography and practical ranges of variation for the height of the mizzen mast.

Height of the Mizzen Mast to the Length of the Bowsprit: (H.Mz_L.Bw)

The height of the mizzen mast to the length of the bowsprit ratio was void for the two-masted and three-masted caravels, which do not have bowsprits. The four-masted caravels have a one standard deviation from 0.74 to 1.47 and a main distribution from 0.45 to 2.00. The histogram graph (Figure 144) shows a primary mode on the higher end of this range from roughly 1.00 to 1.25 with the secondary mode at 1.45 to 1.55. The three-masted galleons have a one standard deviation of 0.80 to 1.25, which is consistent with the primary mode of 0.80 to 0.90 and the secondary mode of 1.00 to 1.10 in the histogram graph (Figure 145). The main distribution is from 0.70 to 1.20 and the one standard deviation is affected by two outliers from 1.30 to 1.50 (CA04.26 and CA04.27). The four-masted galleons sample is similar to the three-masted galleons with a one

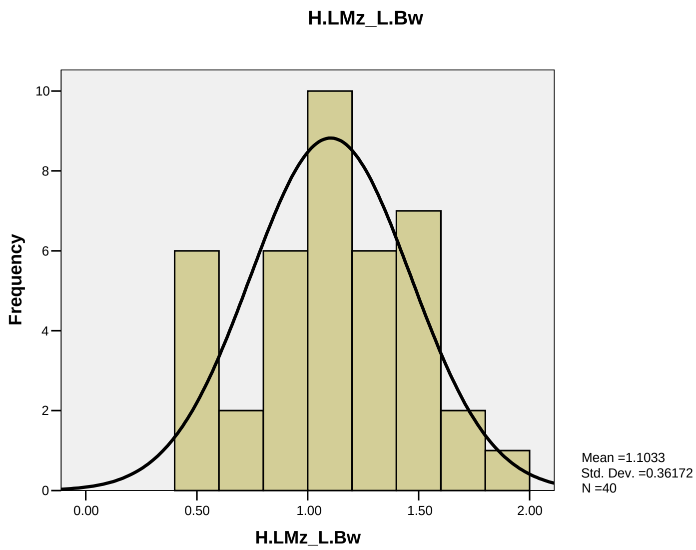


Figure 144: Histogram of the height of the mizzen mast to the length of the bowsprit in four-masted caravels. Refer to Appendix 32 for data.

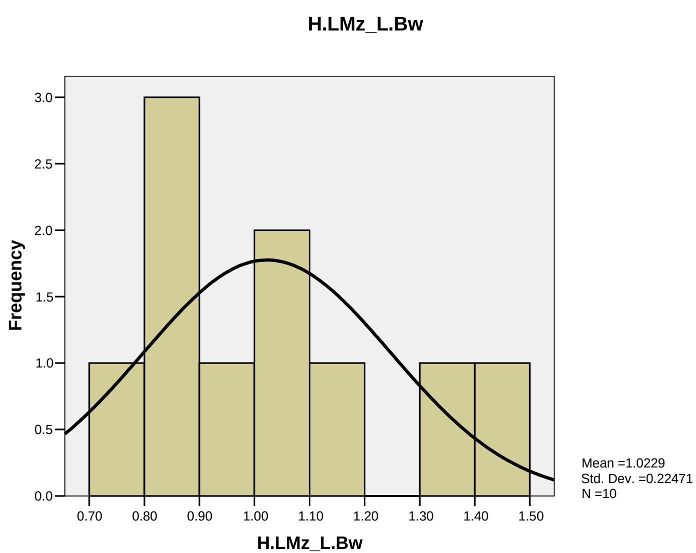


Figure 145: Histogram of the height of the mizzen mast to the length of the bowsprit in three-masted galleons. Refer to Appendix 32 for data.

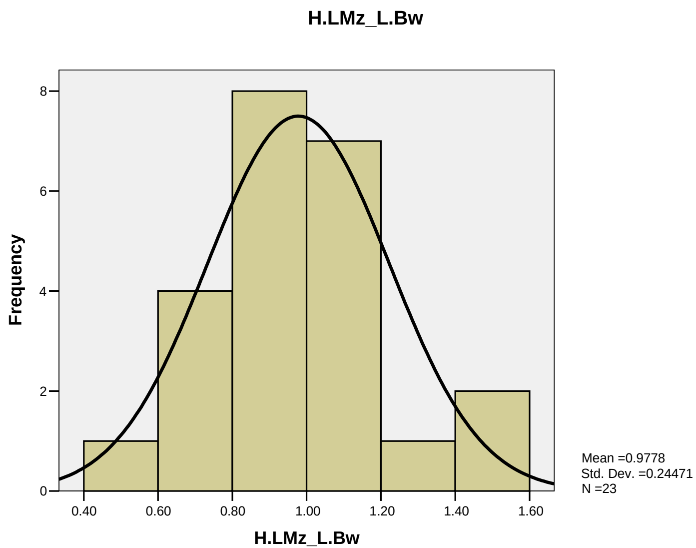


Figure 146: Histogram of the height of the mizzen mast to the length of the bowsprit in four-masted galleons. Refer to Appendix 32 for data.

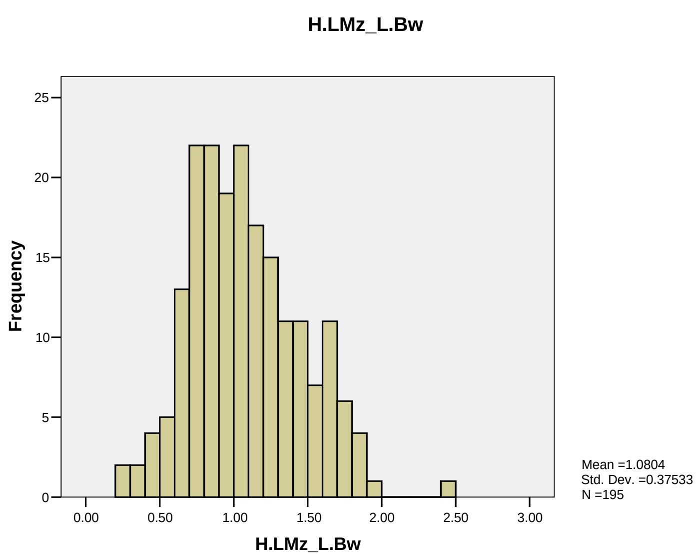


Figure 147: Histogram of the height of the mizzen mast to the length of the bowsprit in naus. Refer to Appendix 32 for data.

standard deviation range of 0.73 to 1.22. The main distribution in the histogram graph (Figure 146) is from 0.40 to 1.60 while the primary mode is from 0.80 to 1.00 and the secondary mode is from 1.00 to 1.20. One standard deviation of the height of the mizzen mast to the length of the bowsprit for the nau sample is from 0.71 to 1.46. The corresponding histogram graph (Figure 147) reveals that there are three equal primary modes from 0.70 to 0.80, 0.80 to 0.90, and 1.00 to 1.10 with the secondary mode filling in the gap at 0.90 to 1.00. Although the nau sample has an extreme main distribution, which ranges from 0.20 to 2.00 and an outlier (CA04.25) at 2.50, roughly half of the naus fall within the primary or secondary modes proving there is relative consistency.

The one standard deviation of the height of the mizzen mast in relation to the length of the bowsprit is consistent between the caravels, galleons, and naus. In particular, the lower end of the one standard deviation range for all vessels is within a range of 0.71 to 0.80 with the naus having the lowest percentage and the three-masted galleons the highest. The higher end of the range, which equates to the maximum height in a normal variation, shows a marked similarity between the caravels and the naus with a mizzen mast that can reach almost 150% of the length of the bowsprit. The higher end of the range for the three-masted and four-masted galleons is only at 125%. The primary and secondary modes confirm that the two galleon subtypes are the most closely associated. The four-masted galleons have a slightly larger modal range of 0.80 to 1.20 while the three-masted galleons have separated modes from 0.80 to 0.90 and 1.00 to 1.10 and less variation in the height of the mizzen mast to the bowsprit. Interestingly, the modal ranges of the caravels and naus appear less correlated than the one standard deviation ranges. There is a high degree of variability within the nau sample and the three equal primary modes and the secondary mode constitute a continuous spread from 0.70 to 1.00.

According to the modal ranges, the naus are more aligned with the galleons than the caravels. Additionally, the four-masted caravels are significantly set apart from the other three vessels with a primary mode of 1.00 to 1.25 and a secondary mode of 1.45 to 1.55, which suggests that caravels had appreciably shorter bowsprits. Further evidence for a shorter bowsprit is provided in the previous two tests on the height of the mizzen mast to the length of the hull and to the height of the lower main mast. It would have been readily apparent if the four-masted caravels had proportionally taller mizzen masts compared to the other vessel types. Although this needs to be confirmed during the analysis of the dimensions of the bowsprit, it seems clear that the caravels did have shorter bowsprits than the galleons and naus. Likewise, it is clear that the galleons and naus had relatively similar relationships between the height of the mizzen mast and the length of the bowsprit. The iconography also corroborates Palacio's statement that the mizzen mast and the bowsprit have the same height and thickness (Bankston, 1986: 120). All the vessels have a primary mode around 1.00 except the three-masted galleons, which is slightly less at 0.90.

Mizzen Mast Width Ratios

Bottom Width of the Mizzen Mast to the Height of the Mizzen Mast: (W.Bt.LMz_H.Mz)

The bottom width of the mizzen mast to the height of the mizzen mast has a one standard deviation of 0.06 to 0.13 for the two-masted caravels with a main distribution from 0.04 to 0.16. Refer to Table 51 for the tabulation of all one standard deviations and center of distribution figures for the mizzen mast width ratios. The primary mode in the histogram graph (Figure 148) is from 0.06 to 0.08 and the secondary mode from .08 to .10; there are two outliers (MA11.05 and MA10.06) at 0.18 to 0.20. The three-masted caravels have a one standard deviation from 0.05 to 0.12. The main distribution in the histogram graph (Figure 149) is from 0.05 to 0.10 and there is one outlier (MA03.16) at 0.175 to 0.20. The primary mode is from 0.075 to 0.10 and the secondary mode is from 0.05 to 0.075. The four-masted caravels have a similar one standard deviation range from 0.05 to 0.10 but a much wider main distribution from 0.025 to 0.125 and a more concise primary mode at 0.0625 to 0.075 in the histogram graph (Figure 150). Like the other two caravel samples, there is one outlier (CA27.05) at a higher percentage from 0.14 to 0.15.

The one standard deviation for the bottom width of the mizzen mast to the height of the mizzen mast for the three-masted galleons is 0.04 to 0.11. The main distribution in the histogram graph (Figure 151) is from 0.01 to 0.14 with a primary mode at 0.06 to 0.08 and the secondary mode at 0.04 to 0.06. The four-masted galleons have the same one standard deviation as the three-masted galleons, 0.04 to 0.11; however, the main

TABLE 51: Comparison of the One Standard Deviation and Center of Distribution of the Mizzen Mast Width Ratios by Ship Type

W.BtLMz_H.Mz	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Two-masted Caravels	0.06 to 0.13	0.07 to 0.11
Three-masted Caravels	0.05 to 0.12	0.06 to 0.08
Four-masted Caravels	0.05 to 0.10	0.05 to 0.09
Three-masted Galleons	0.04 to 0.11	0.05 to 0.10
Four-masted Galleons	0.04 to 0.11	0.06 to 0.09
Naus	0.05 to 0.10	0.06 to 0.09
W.BtLMz_W.TpLMz	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Two-masted Caravels	0.47 to 0.89	0.55 to 0.77
Three-masted Caravels	0.48 to 0.91	0.53 to 0.89
Four-masted Caravels	0.47 to 0.84	0.50 to 0.80
Three-masted Galleons	0.45 to 0.95	0.56 to 0.83
Four-masted Galleons	0.41 to 0.81	0.45 to 0.72
Naus	0.44 to 0.89	0.50 to 0.80

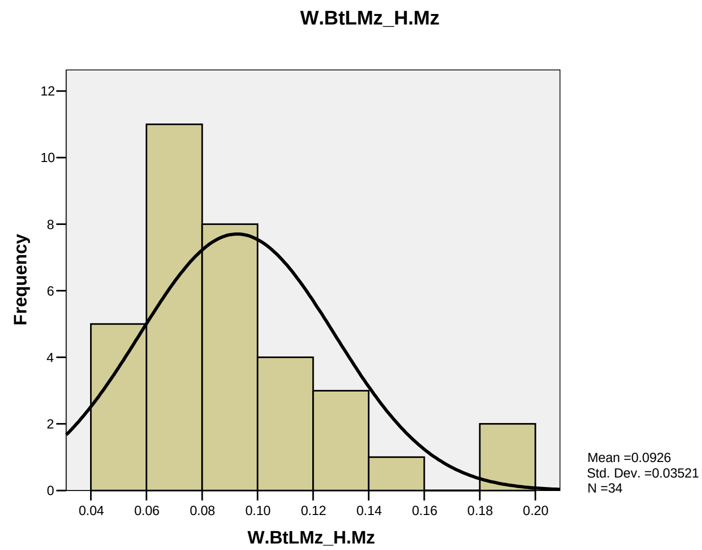


Figure 148: Histogram of the bottom width of the mizzen mast to the height of the mizzen mast in two-masted caravels. Refer to Appendix 32 for data.

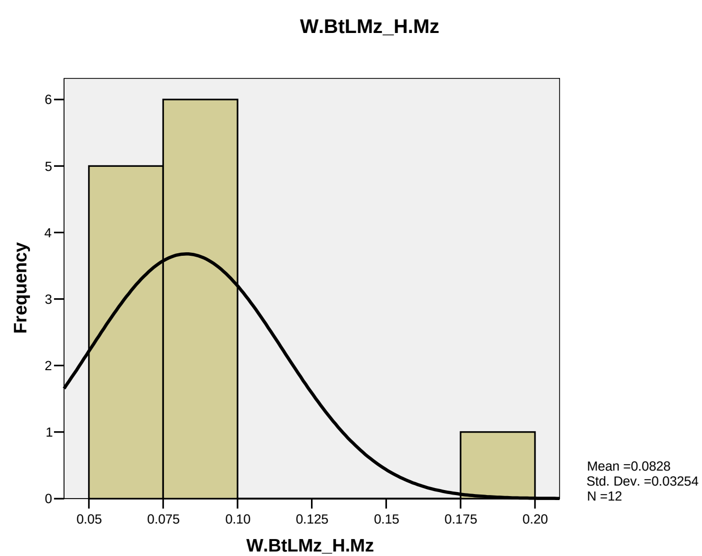


Figure 149: Histogram of the bottom width of the mizzen mast to the height of the mizzen mast in three-masted caravels. Refer to Appendix 32 for data.

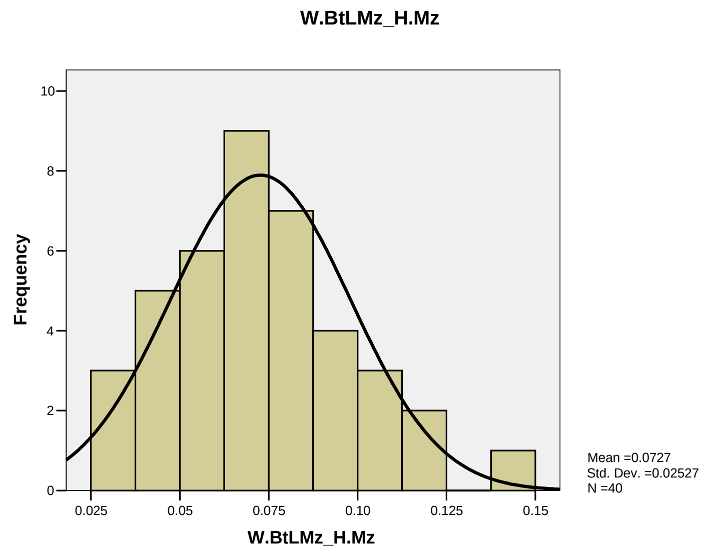


Figure 150: Histogram of the bottom width of the mizzen mast to the height of the mizzen mast in four-masted caravels. Refer to Appendix 32 for data.

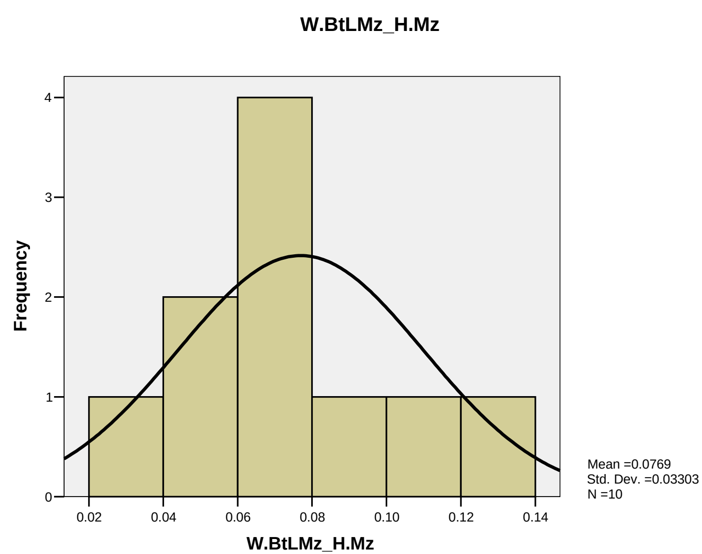


Figure 151: Histogram of the bottom width of the mizzen mast to the height of the mizzen mast in three-masted galleons. Refer to Appendix 32 for data.

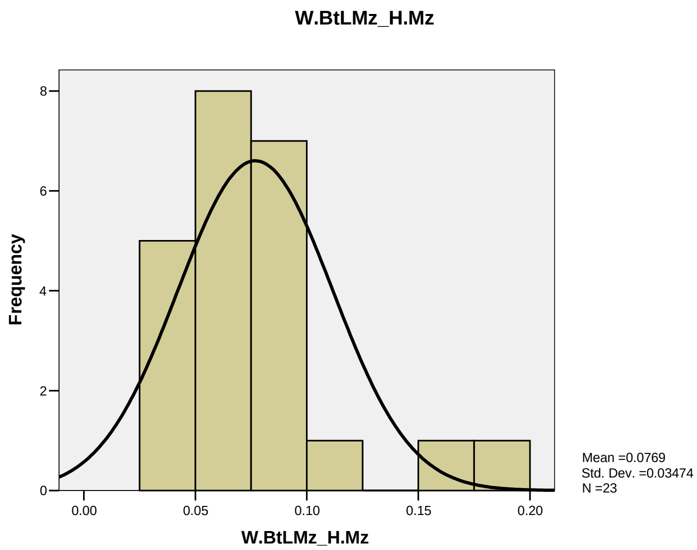


Figure 152: Histogram of the bottom width of the mizzen mast to the height of the mizzen mast in four-masted galleons. Refer to Appendix 32 for data.

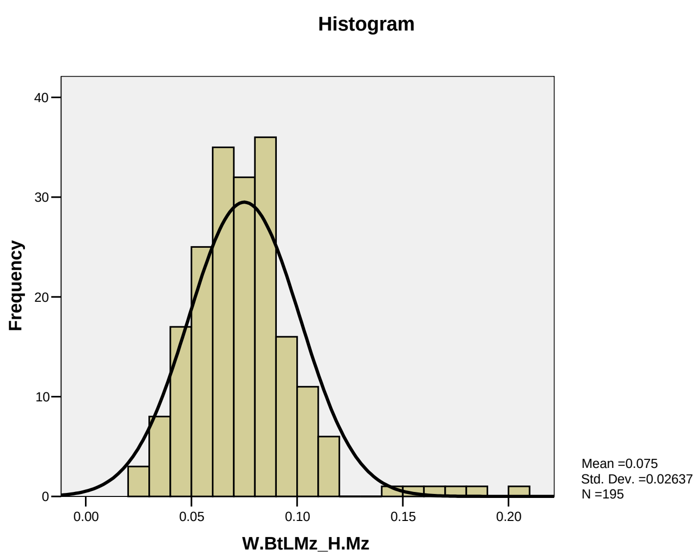


Figure 153: Histogram of the bottom width of the mizzen mast to the height of the mizzen mast in naus. Refer to Appendix 32 for data.

distribution is a more concise 0.03 to 0.12 with two outliers (CA10.01, MA13.12) from 0.15 to 0.20. The primary mode in the histogram graph (Figure 152) is 0.05 to 0.075 and the secondary mode is from 0.075 to 0.10. The nau sample has a one standard deviation of 0.05 to 0.10 and a main distribution of 0.03 to 0.12 in the histogram graph (Figure 153). The nau sample also has six outliers (CA03.05, CA27.03, CA27.04, EN05.01, MA03.14, and MA03.15) ranging from 0.15 to 0.21. The primary mode is from 0.08 to 0.09 with a secondary mode of 0.06 to 0.07 and a tertiary mode of 0.07 to 0.08.

The one standard deviation of the bottom width of the mizzen mast to the height of the mizzen mast is consistent throughout the caravels, galleons, and naus with only a few percentage points difference between the ship types. The three-masted and four-masted galleons have the same deviation (0.04-0.11) with a slightly larger range than the four-masted caravels and the naus both of which have a deviation of 0.05 to 0.10. While the three-masted caravels have a similar range from 0.05 to 0.12. The two-masted caravels have bottom widths that are somewhat thicker in comparison to the height of the mast (0.06 to 0.13) than the other ship sub-types, but the discrepancy is small.

The modal ranges indicate a slightly more nuanced relationship between the vessels with even less variability within the dataset. The three-masted caravels and the four-masted galleons both have a range from 0.05 to 0.10. While the two-masted caravels, four-masted caravels, and the naus have a similar range from 0.06 to 0.09-0.10. It is the three-masted galleons as opposed to the two-masted caravels from the one standard deviation that are set slightly apart from the group with a smaller bottom width ranging from 0.04 to 0.08. The two-masted caravels at first appear have relatively larger widths as discussed in the previous paragraph; however, the difference is even smaller than originally shown in the one standard deviation. Likewise, the primary mode for the two-masted caravels is from 0.06 to 0.08 which is smaller than that of the naus at 0.08 to 0.09 virtually negating prior evidence for larger bottom widths. Overall there is very little variation in the bottom widths of the mizzen mast to the height of the mizzen masts between the ship types and the ranges are relatively concise which is remarkable given the extent of the sample size and date ranges. On average, the bottom width of the mizzen mast is about 5% to 10% of the height.

Bottom Width of the Mizzen Mast to Top Width of the Mizzen Mast: (W.Bt.Mz_ W.Tp.Mz)

The one standard deviation of the bottom width to the top width of the mizzen mast for the two-masted caravels is from 0.47 to 0.89 while the main distribution in the histogram graph (Figure 154) is from 0.20 to 1.20 with one outlier (CA22.04) at 1.54. There are two equal primary modes from 0.40 to 0.80, which account for 26 of the 34 vessels or 76% of the sample. The three-masted caravels have a one standard deviation from 0.48 to 0.91. The distribution in the histogram graph (Figure 155) is separated into two groups from 0.30 to 0.60 and 0.70 to 1.00 both of which have equal modes from 0.50 to 0.60 and 0.70 to 0.80. The one standard deviation for the four-masted caravels is

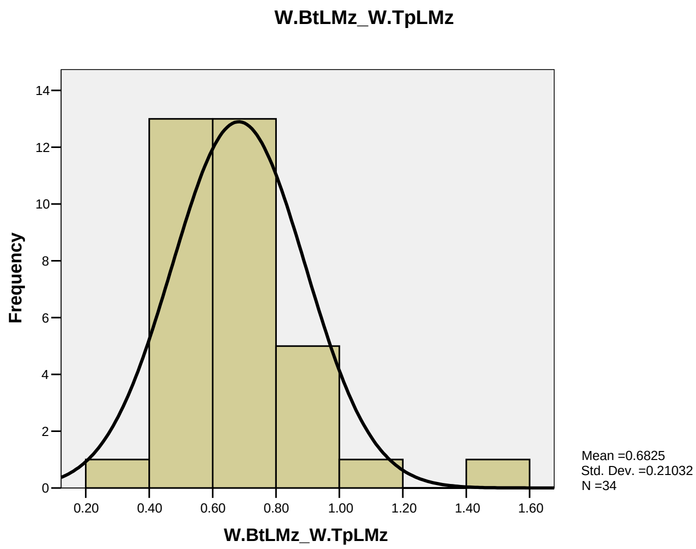


Figure 154: Histogram of the bottom width to the top width of the mizzen mast in two-masted caravels. Refer to Appendix 32 for data.

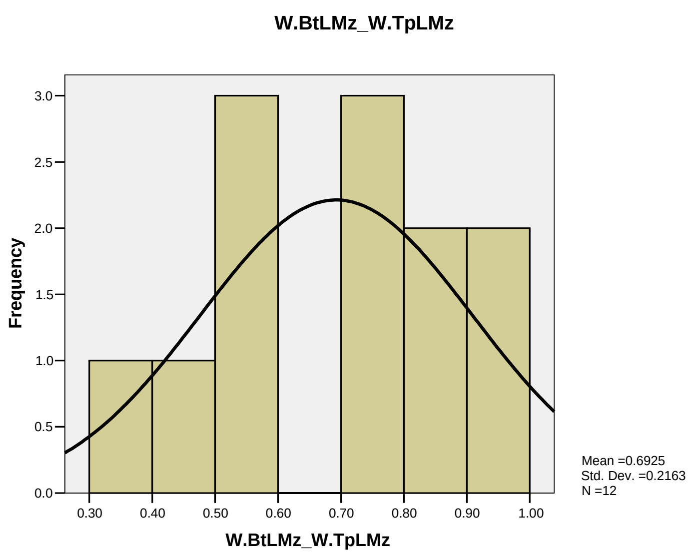


Figure 155: Histogram of the bottom width to the top width of the mizzen mast in three-masted caravels. Refer to Appendix 32 for data.

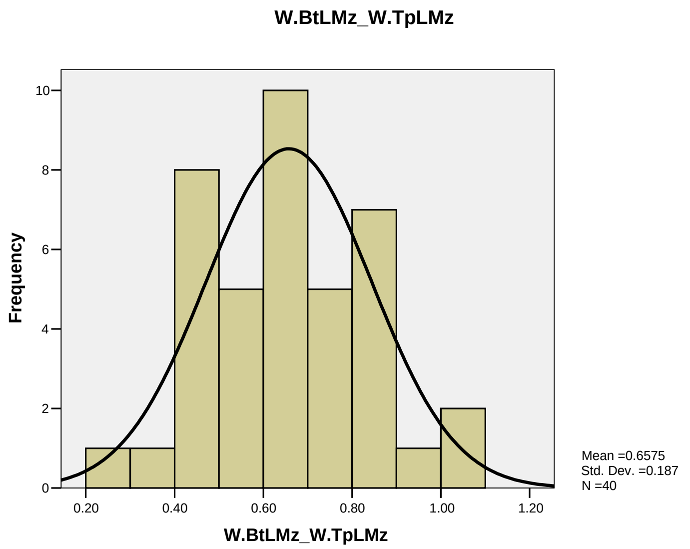


Figure 156: Histogram of the bottom width to the top width of the mizzen mast in four-masted caravels. Refer to Appendix 32 for data.

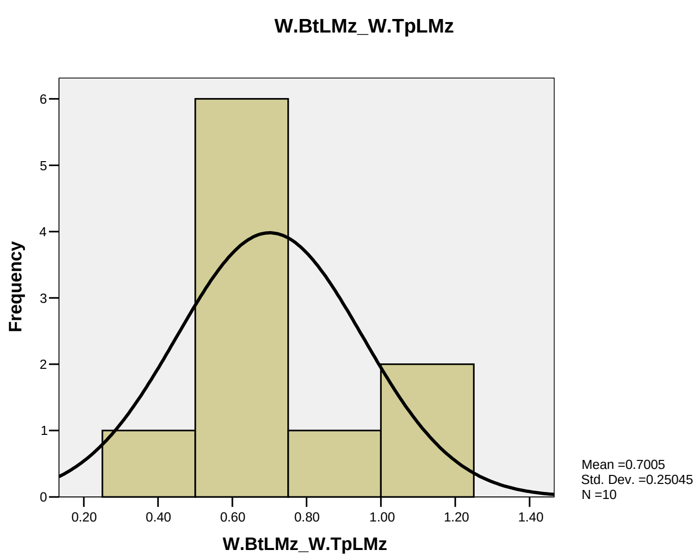


Figure 157: Histogram of the bottom width to the top width of the mizzen mast in three-masted galleons. Refer to Appendix 32 for data.

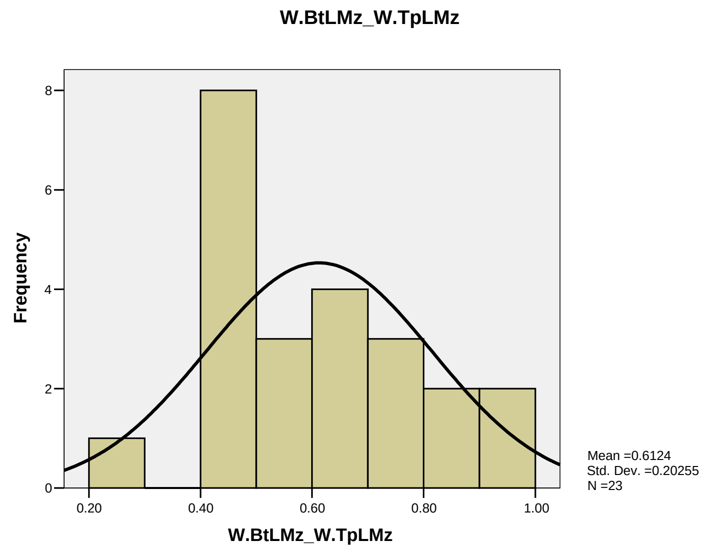


Figure 158: Histogram of the bottom width to the top width of the mizzen mast in four-masted galleons. Refer to Appendix 32 for data.

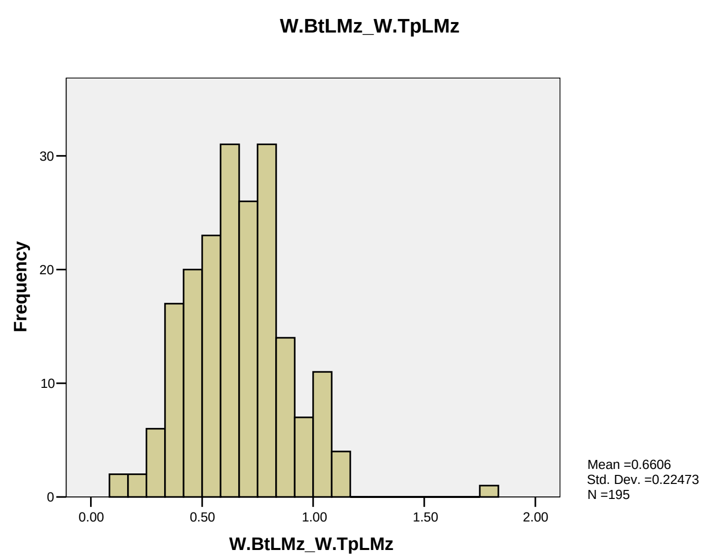


Figure 159: Histogram of the bottom width to the top width of the mizzen mast in naus. Refer to Appendix 32 for data.

from 0.47 to 0.84 which is consistent with the primary mode from 0.60 to 0.70, the secondary mode 0.40 to 0.50, and the tertiary mode from 0.80 to 0.90 in the histogram graph (Figure 156). The main distribution of the four-masted caravel sample is quite extensive from 0.20 to 1.10.

The one standard deviation for the bottom to top widths of the mizzen mast for the three-masted galleons is 0.45 to 0.95 and the main distribution in the histogram graph (Figure 157) is from 0.25 to 1.25 while the primary mode is from 0.50 to 0.75. The four-masted galleons have a one standard deviation of 0.41 to 0.81. The main distribution in the histogram graph (Figure 158) is from 0.40 to 1.00 with one outlier (MA13.12) at 0.25. The primary mode is from 0.40 to 0.50. The one standard deviation for the nau sample is 0.44 to 0.89. The main distribution in the histogram graph (Figure 159) is also large ranging from 0.10 to 1.15 with one outlier (CA04.19) at 1.80. There are two equal primary modes from roughly 0.60 to 0.70 and 0.80 to 0.85 with a secondary mode from 0.70 to 0.80.

Although the one standard deviation for the bottom to top widths is consistent between the ship types, they all have significantly large ranges suggesting high variability. It is interesting that the bottom width in relation to the height of the mast are highly uniform and produce small ranges, whereas there is significant variation of the mast tapering between the samples. It would be more logical if all three ratios for the widths of the mizzen mast had large ranges, which would indicate uniform variability and therefore less reliable data with more artistic error. Likewise, the resulting ratios do not sort by date and there is conclusively no temporal influence to the ranges. Neither is there a sorting of the vessels by artist; vessels from the same source are spread throughout the spectrum. The one standard deviations clearly show that ratios range roughly from the 40th percentile to the 80th for all ship types. The four-masted galleons appear to have comparatively more tapering of the mizzen mast with a range of 0.41 to 0.81 closely followed by the three-masted galleons and the naus with 0.45 to 0.95 and 0.44 to 0.89 respectively. The caravels seem to have somewhat less tapering with ranges that fall within a parameter of 0.47 to 0.91.

The modes for the caravels, galleons, and naus are extremely helpful in instances such as this when there is a wide range of variation within the sample. Only the four-masted caravels and naus have secondary or tertiary modes while the other ship subtypes only have one dominant primary mode. The two- and three-masted caravels both have two equal modes that hardly decrease the size of the range. Likewise, the four-masted caravels have secondary and tertiary modes that actually increase the range of variation to 0.40 to 0.90. The three-masted galleons have the most concise range of 0.40 to 0.50 but this may be due to the small sample size (N=10). The four-masted galleons appear to have less tapering than the three-masted galleons with a range of 0.50 to 0.75. The nau sample has the least amount of tapering of the mizzen mast with two modes at 0.60 to 0.70 and 0.80 to 0.85. Overall, there is less consistency within the caravel sample compared to the other ship types and galleons appear to have the most tapering of the mizzen mast.

Mizzen Yard Dimensions

Mizzen Yard Length Ratios

In the statistical analysis of the mizzen yard there are 33 two-masted caravels, 14 three-masted caravels, 42 four-masted caravels, nine three-masted galleons, 23 four-masted galleons, and 205 naus. The length of the yard was measured from yardarm to yardarm while the middle width was taken as close to possible at its intersection with the mast and the end width is at the yardarm.

According to Cano the mizzen yard was equal to the length of the mizzen mast as well as to the fore yard and typically had a smaller center diameter than the yards carrying square sails with less pronounced tapering at the yardarms (Smith, 1993: 103). The comparison of the yard to the length of the mast is confirmed by Palacio who indicates that the mizzen yard was the same length as the mizzen mast plus a third (Bankston, 1986: 124), which corresponds well to a ratio of around 0.66 for the height of the mizzen mast to the length of the mizzen yard. The width to the length of the yard ratio can be calculated with information provided in the *Livro Náutico* and by Fernandez. The length of the mizzen yard in the *Livro Náutico* is 13 *braças* (22.88 m) and the diameter is 1 *palma de vara*, which corresponds to a maximum diameter of 22cm and a minimum of 11cm. According to Fernandez, however, this yard should be 16 *braças* (28.16 m) in length, nine of which are abaft the mast and seven before, with a diameter of 1 *palma de goa* and 2 *dedos* (29 cm) tapering to 15 cm (Castro, 2005b: 119). The resulting ratios for both sets of measurements are 0.01 for the middle width to the length of the yard and 0.005 for the end width. According to Fernandez's measurements, there is a 52% tapering from the mid section of the yard to the spar and 50% for the yard in the *Livro Náutico*.

Length of the Mizzen Yard to the Length of the Hull: (L.MzY_L.H)

The length of the mizzen yard to the length of the hull ratio for the two-masted caravels sample has a one standard deviation from 0.71 to 1.06, which is consistent with the primary mode of 0.80 to 0.90 and the secondary mode of 0.90 to .100 in the histogram graph (Figure 160). The tabulation of the mizzen yard one standard deviation and center of distribution figures for all vessels can be viewed in Table 52. The main distribution ranges from 0.50 to 1.10 and there are two outliers from 1.20 to 1.30 (CA01.05) and 1.30 to 1.40 (CA01.04). One standard deviation for the three-masted caravel sample is from 0.63 to 1.12. The corresponding histogram graph (Figure 161) has a primary mode at 0.60 to 0.80 and a secondary mode at 0.80 to 1.00 with the main distribution ranging from 0.20 to 1.20 and an outlier at 1.40 to 1.60 (MA08.02). The four-masted caravels have a smaller one standard deviation than the two-masted and three-masted caravels from 0.54 to 0.80 with a primary mode from 0.60 to 0.70 and a secondary mode from 0.50 to 0.60. The main distribution in the histogram graph (Figure 162) ranges from 0.10 to 1.00.

The three-masted galleons have a one standard deviation of the length of the mizzen yard to the length of the hull from 0.65 to 0.95, which is consistent with the primary mode of 0.35 to 0.40 and the secondary mode of 0.70 to 0.80 in the histogram

TABLE 52: Comparison of the One Standard Deviation and Center of Distribution of the Mizzen Yard Length Ratios by Ship Type

L.MzY_L.H	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Two-masted Caravels	0.71 to 1.06	0.78 to 0.98
Three-masted Caravels	0.63 to 1.12	0.66 to 1.05
Four-masted Caravels	0.54 to 0.80	0.57 to 0.79
Three-masted Galleons	0.65 to 0.95	0.72 to 0.88
Four-masted Galleons	0.41 to 1.13	0.51 to 0.94
Naus	0.53 to 0.95	0.60 to 0.84
H.Mz_L.MzY	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Two-masted Caravels	0.34 to 0.60	0.37 to 0.54
Three-masted Caravels	0.35 to 0.58	0.38 to 0.51
Four-masted Caravels	0.39 to 0.70	0.42 to 0.65
Three-masted Galleons	0.48 to 0.82	0.51 to 0.77
Four-masted Galleons	0.37 to 0.88	0.48 to 0.70
Naus	0.36 to 0.79	0.44 to 0.67
L.FrY_L.MzY	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Four-masted Caravels	0.48 to 0.98	0.53 to 0.87
Three-masted Galleons	0.26 to 0.81	0.32 to 0.73
Four-masted Galleons	0.30 to 1.02	0.42 to 0.82
Naus	0.39 to 1.13	0.54 to 0.89

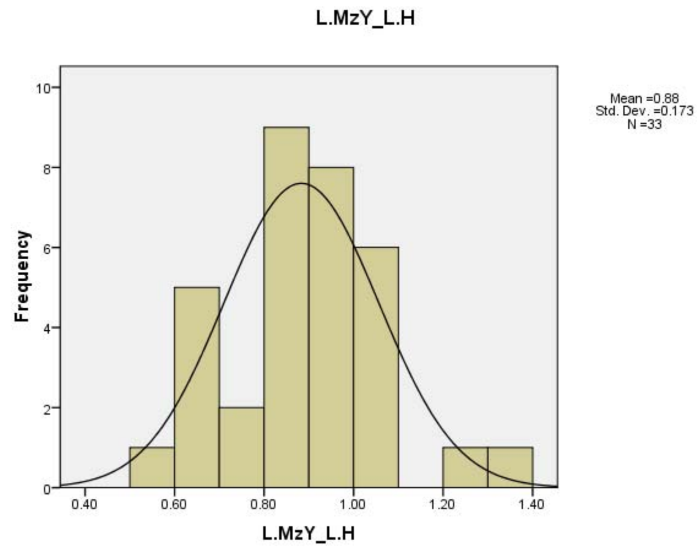


Figure 160: Histogram of the length of the mizzen yard to the length of the hull in two-masted caravels. Refer to Appendix 32 for data.

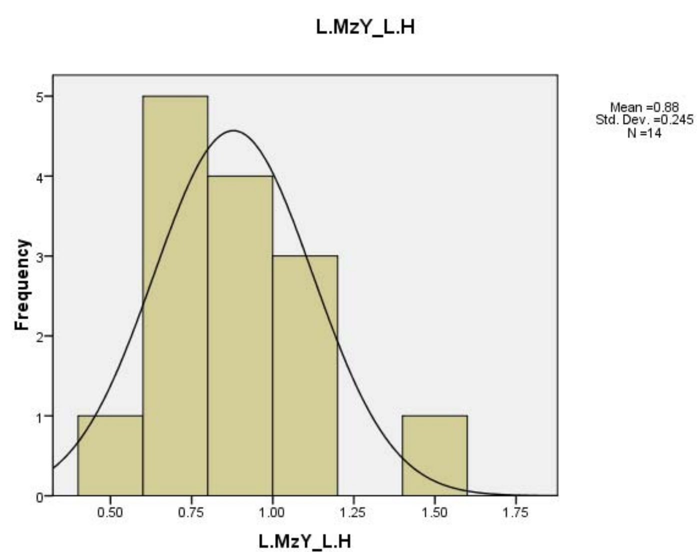


Figure 161: Histogram of the length of the mizzen yard to the length of the hull in three-masted caravels. Refer to Appendix 32 for data.

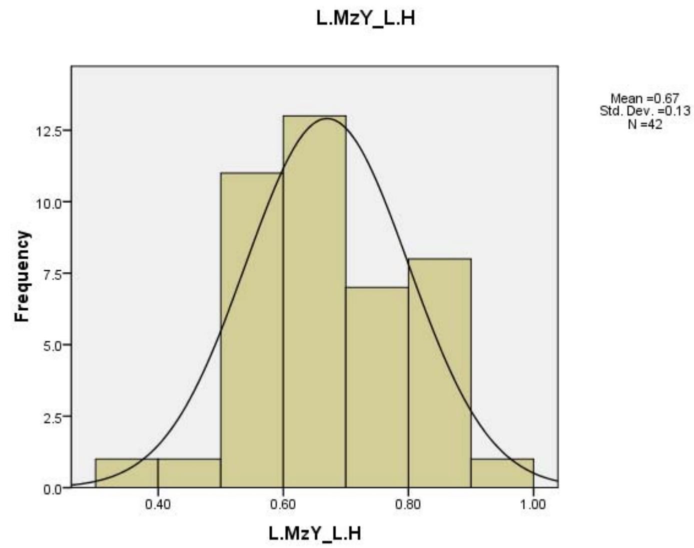


Figure 162: Histogram of the length of the mizzen yard to the length of the hull in four-masted caravels. Refer to Appendix 32 for data.

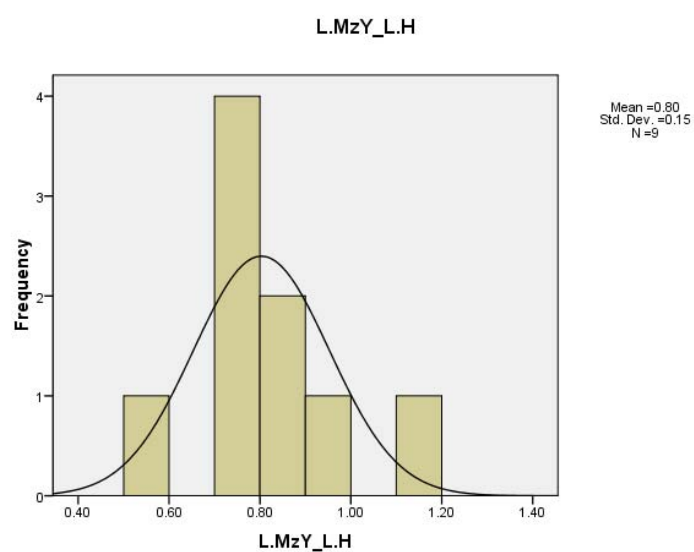


Figure 163: Histogram of the length of the mizzen yard to the length of the hull in three-masted galleons. Refer to Appendix 32 for data.

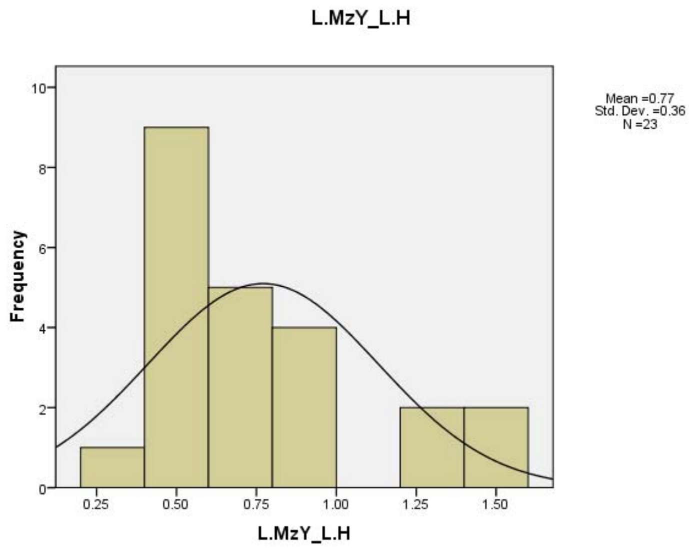


Figure 164: Histogram of the length of the mizzen yard to the length of the hull in four-masted galleons. Refer to Appendix 32 for data.

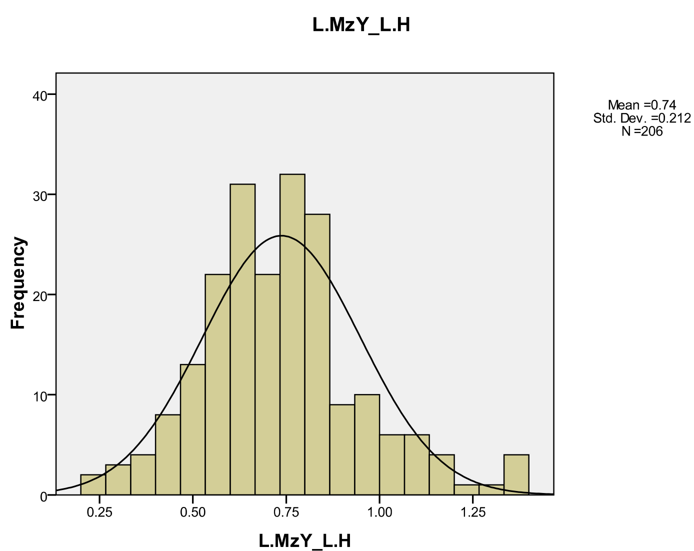


Figure 165: Histogram of the length of the mizzen yard to the length of the hull in naus. Refer to Appendix 32 for data.

graph (Figure 163). The main distribution is from 0.70 to 1.00 and there are two outliers at 0.50 to 0.60 (MA13.01) and 1.10 to 1.20 (CA04.29). The one standard deviation of the four-masted galleons ranges broadly from 0.41 to 1.13 and has a main distribution from 0.20 to 1.00 and two outliers from 1.20 to 1.40 (MA02.01 and EN04.01) and 1.40to 1.60 (PA06.01 and MA13.09). The primary mode in the histogram graph (Figure 164) is from 0.40 to 0.60 and the secondary mode of 0.20 to 0.40. For the nau sample, the one standard deviation is from 0.53 to 0.95. The corresponding histogram graph (Figure 165) shows a primary mode at 0.74 to 0.82 and a secondary mode at 0.60 to 0.68. The main distribution range is highly variable from 0.10 to 1.40.

The one standard deviation of the length of the mizzen yard in relation to the overall length of the hull exhibits moderate variation between each of the caravel and galleon subtypes and the naus. The two-masted and three-masted caravels have proportionally longer yards with ranges from 0.71 to 1.06 and 0.63 to 1.12 respectively as does the four-masted galleon sample with a wide range from 0.41 to 1.16. The four-masted caravels (0.54 to 0.80), three-masted galleons (0.65 to 0.95), and the naus (0.53 to 0.95) have relatively similar one standard deviation ranges; however, the caravels are skewed to the lower end and the galleons and naus to the higher end. Although the center of distribution figures narrows the differences between the vessel types, it is through the primary modes that typical variation can be determined.

The modal ranges retain a high degree of variance within the samples, but there are some discernable general trends. The two-masted caravels have the longest yards that are 80% to 100% of the length of the hull. The three-masted caravels have a very high secondary mode of 0.80 to 1.00 matching the two-masted caravels but a more moderate primary mode of 0.60 to 0.80 that is similar to the other vessels. Although these two caravels appear to have extremely long yards, it is not unusual given the fact that they only have two to three masts with relatively shorter hull lengths. Likewise, the only way to ensure the appropriate amount of sail area to propel the vessel is through increased yard lengths. The three-masted galleons have a very concise peak at 0.70 to 0.80 while the naus have a similar primary mode of 0.74 to 0.82 and a lower secondary mode of 0.60 to 0.68. The three-masted galleons and the naus have the same rigging configuration and as such the close association of the mizzen yard lengths between the two is logical. The four-masted caravel modal range is skewed slightly lower at 0.50 to 0.70, although it is the four-masted galleons that have the shortest yards at only 20% to 60% of the length of the hull. The four-masted vessels have the least amount of space to accommodate lateen yards due to the presence of a fourth mast and its associated rigging arrangements. The four-masted galleons, in particular, have complex rigging elements for two square masts and the main mast standing rigging would impede the length of the mizzen yard.

Height of the Mizzen Mast to the Length of the Mizzen Yard: (H.Mz_L.MzY)

The height of the mizzen mast to the length of the mizzen yard ratio for the two-masted caravels has a one standard deviation of 0.34 to 0.60 and a primary mode in the histogram graph (Figure 166) of 0.35 to 0.40 both of which are consistent with the main distribution of 0.25 to 0.80. The three-masted caravels have a one standard deviation

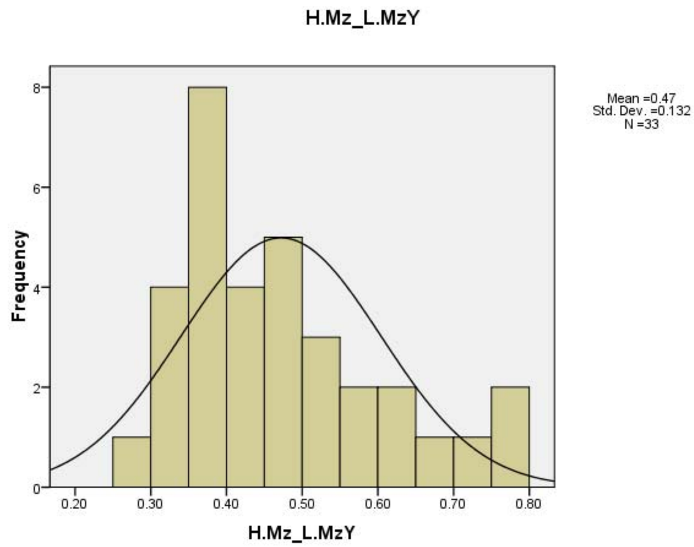


Figure 166: Histogram of the height of the mizzen mast to the length of the mizzen yard in two-masted caravels. Refer to Appendix 32 for data.

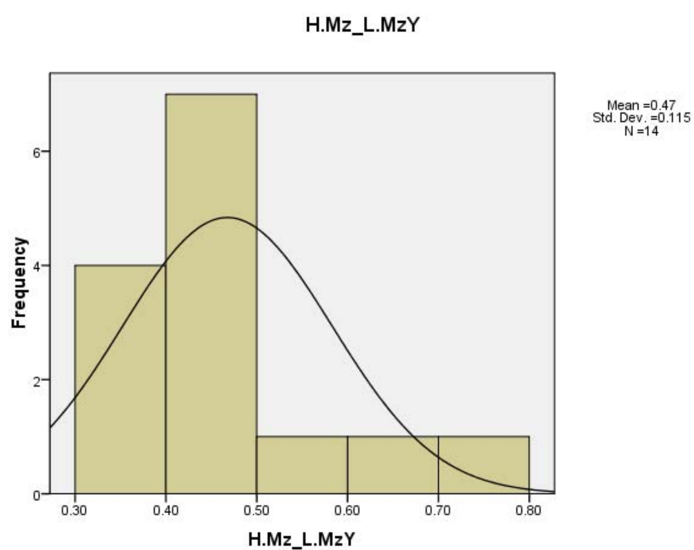


Figure 167: Histogram of the height of the mizzen mast to the length of the mizzen yard in three-masted caravels. Refer to Appendix 32 for data.

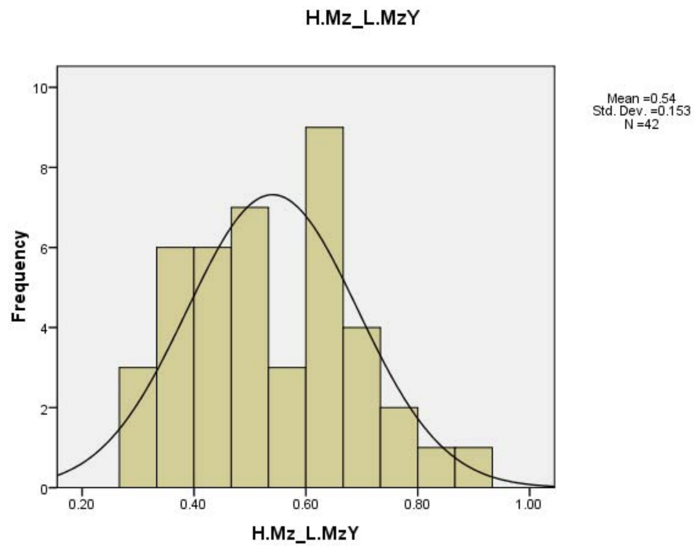


Figure 168: Histogram of the height of the mizzen mast to the length of the mizzen yard in four-masted caravels. Refer to Appendix 32 for data.

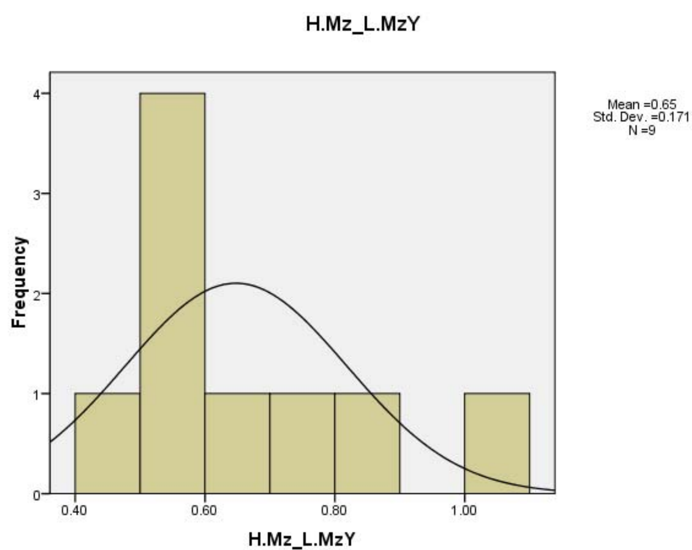


Figure 169: Histogram of the height of the mizzen mast to the length of the mizzen yard in three-masted galleons. Refer to Appendix 32 for data.

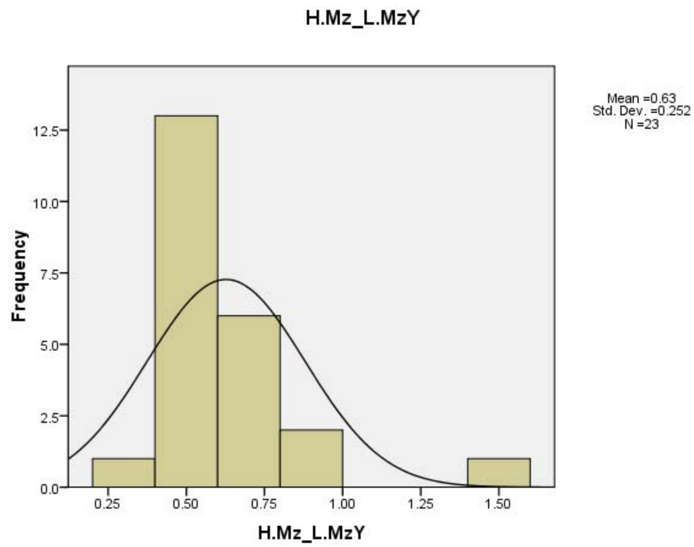


Figure 170: Histogram of the height of the mizzen mast to the length of the mizzen yard in four-masted galleons. Refer to Appendix 32 for data.

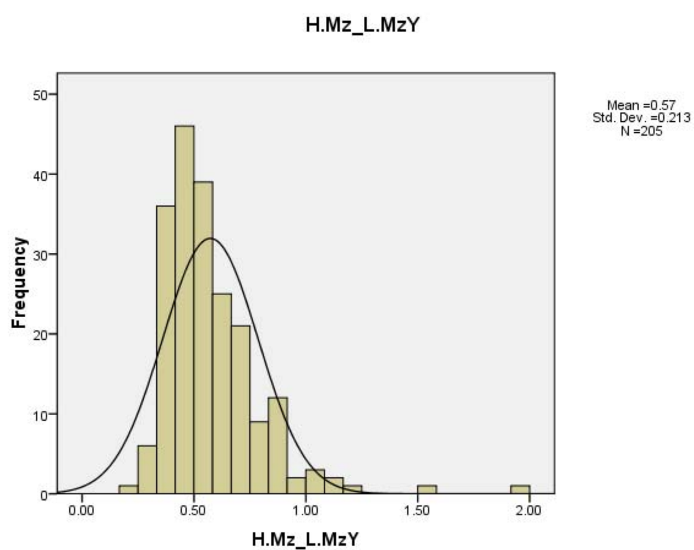


Figure 171: Histogram of the height of the mizzen mast to the length of the mizzen yard in naus. Refer to Appendix 32 for data.

from 0.35 to 0.58 and a distribution in the histogram graph (Figure 167) from 0.30 to 0.80; the primary mode from 0.40 to 0.50. One standard deviation for the four-masted caravels is 0.39 to 0.70. The main distribution in the histogram graph (Figure 168) is from 0.30 to 0.90 and the primary mode is from 0.60 to 0.72 while the secondary mode is from 0.46 to 0.52.

The height of the mizzen mast to the length of the mizzen yard ratio for the three-masted galleon sample has a one standard deviation from 0.48 to 0.82 and a primary mode in the histogram graph (Figure 169) of 0.50 to 0.60. While the main distribution is from 0.40 to 0.90 and there is an outlier at 1.00 (PA09.03). The four-masted galleons have a one standard deviation of 0.37 to 0.88 and a main distribution in the histogram graph (Figure 170) of 0.20 to 1.00 with an outlier at 1.60 (PA08.01). The primary mode of the four-masted galleon sample is from 0.40 to 0.60 and the secondary mode is from 0.20 to 0.40. The one standard deviation for the nau sample is from 0.36 to 0.79 and the primary mode in the histogram graph (Figure 171) is from 0.50 to 0.58 with a secondary mode at 0.58 to 0.66. The main distribution is from roughly 0.20 to 1.25 and there is an outlier from 1.50 to 1.60 (PA03.05) and another at 1.90 to 2.00 (PA07.03).

The one standard deviations of the height of the main mast to the length of the hull is very similar for the caravels, galleons, and naus extending from around the 30th percentile through the 80th percentile. The two-masted and three-masted caravels have almost identical ranges that differ by only a few percentage points while the four-masted caravels have a slightly higher range reaching 70%. The three-masted galleons, the four-masted galleons, and the naus all extend into the 80th percentile, which indicates that the mizzen yard is relatively smaller than the mizzen mast compared to the caravel because of the inverse relationship of the ratio. The higher ratios demonstrate that the length of the yard is longer than the height of the mizzen mast.

The primary modes narrow the gap between the ship sub-types and suggest that there is even less variation between the samples. On average, the primary modes are around the 40th to the 60th percentiles but the secondary modes lower the overall ranges of the samples. The two- and three-masted caravels have modal ranges of 0.35 to 0.40 and 0.40 to 0.50 which again indicate that these two caravel sub-types have proportionally longer mizzen yards than their counterparts. The four-masted caravels actually have the highest range from 0.46 to 0.72 with the shortest mizzen yards which is nearly matched by the three-masted galleons (0.50 to 0.60) and the naus (0.50 to 0.66). The four-masted galleons have the broadest range from 0.20 to 0.60; the reason for such high variability is unknown.

As stated previously, the comparison of the length of the mizzen yard to the height of the mast by Palacio resulted in a ratio of around 0.66 while Cano has a 1:1 relationship (1.00). The three-masted galleon, four-masted galleon, four-masted galleons, and the nau samples all reach 0.66 on the higher end of the respective one standard deviation ranges; however, the two- and three-masted caravel sub-types fall short of the mark by 6% and 8%. Furthermore, the only modal range that reaches 0.66 is the four-masted caravel sample and there is not a single figure that comes close to a 1.00 relationship between the yard and mast. All the vessel samples suggest that the yards were actually more than a third longer than the mizzen mast possibly reaching one and a half times the height. The question as to whether this indicates that the lengths of the yards, in general, were exaggerated by contemporary artists cannot be answered until all the yards are analyzed. The mizzen yard lengths, however, suggest that all other ratios described in the treatises fit perfectly with the iconography.

Length of the Fore Mast Yard to the Length of the Mizzen Yard: (L.FrY_L.MzY)

The length of the fore mast yard to the length of the mizzen yard ratio was only calculated for the four-masted caravels, the galleons, and the naus due to the fact that the two-masted and three-masted caravels do not have fore masts. The four-masted caravels have a one-standard deviation of 0.48 to 0.98. The main distribution in the histogram graph (Figure 172) is from roughly 0.40 to 1.25 and there is an outlier (MA15.1524.07) from 1.40 to 1.50. The primary mode is from 0.50 to 0.60 with a secondary peak at 0.70 to 0.80. One standard deviation for the three-masted galleon sample is from 0.39 to 1.13. The main distribution in the histogram graph (Figure 173) is quite extensive from 0.00 to 1.00 and the primary mode is from 0.40 to 0.60. The four-masted galleons have a one standard deviation from 0.30 to 1.02 a main distribution from 0.25 to 1.00 with two outliers at 1.31 (PA08.01) and 1.64 (PA09.01). The primary mode in the histogram graph (Figure 174) is from 0.25 to 0.50 and the secondary is from 0.50 to 0.75. The one standard deviation for the nau sample is 0.39 to 1.13 and the main mode in the histogram graph (Figure 175) is from 0.50 to 0.62. Like the caravels and galleons, the nau sample also has a large main distribution which ranges from 0.00 to 1.37. There are two outliers from 1.50 to 1.62 (MA15.1510.05 and CA31.02), two from 1.62 to 1.74 (MA15.1515.03

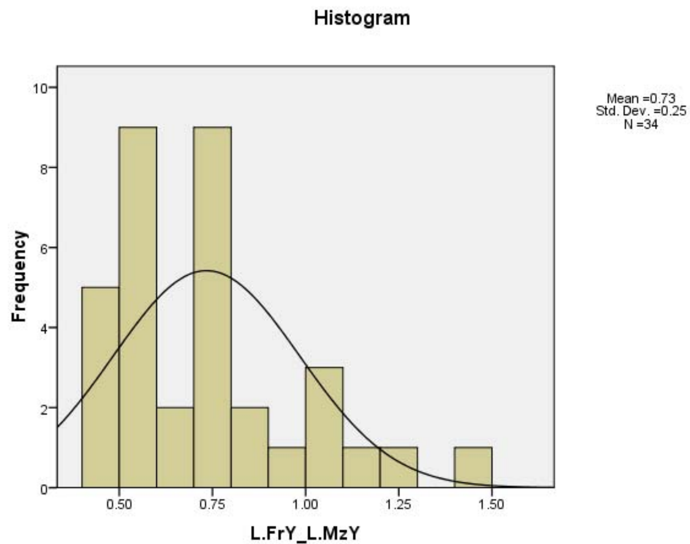


Figure 172: Histogram of the length of the fore yard to the length of the mizzen yard in four-masted caravels. Refer to Appendix 32 for data.

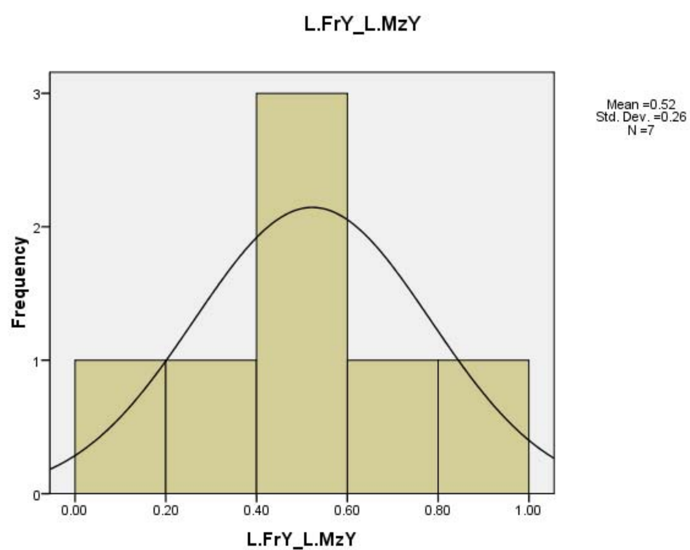


Figure 173: Histogram of the length of the fore yard to the length of the mizzen yard in three-masted galleons. Refer to Appendix 32 for data.

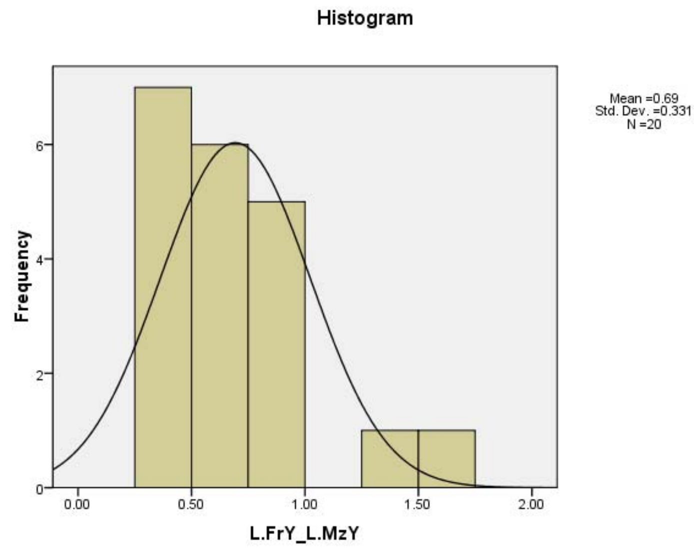


Figure 174: Histogram of the length of the fore yard to the length of the mizzen yard in four-masted galleons. Refer to Appendix 32 for data.

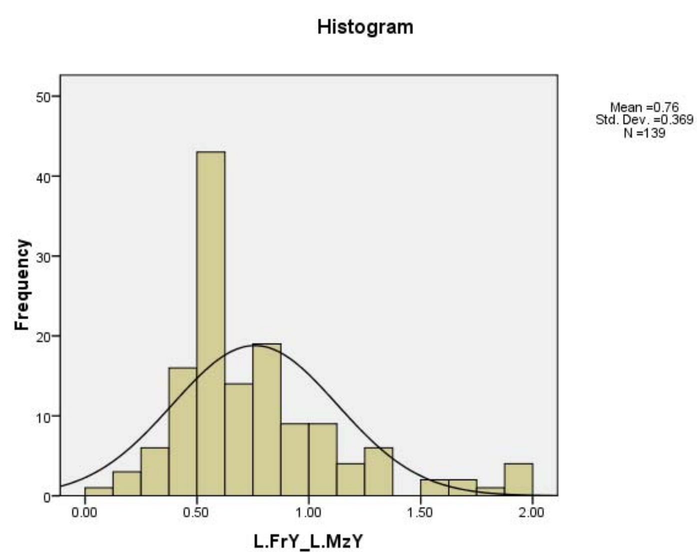


Figure 175: Histogram of the length of the fore yard to the length of the mizzen yard in naus. Refer to Appendix 32 for data.

and CA32.01) one from 1.74 to 1.86 (MA15.1509.11) and four from 1.87 to 2.00 (MA15.1509.16, MA15.1523.06, PA07.03, PA03.05).

The four-masted caravels have the smallest one standard deviation range of 0.48 to 0.98 followed by the three-masted galleons with 0.26 to 0.81; however, the four-masted galleons and the naus have quite extensive ranges from the 30th percentile through to the 110th percentile. The center of distribution figures tighten these ranges considerably and show that the four-masted caravels and naus have near identical numbers, which is further justified by the primary modes. The modal ranges suggest that three-masted galleons have relatively long mizzen yards compared to the fore yard while there is much less discrepancy between the two spars in the four-masted caravels (0.50 to 0.80) and the naus (0.50 to 0.62). Four-masted galleons have a broad range from 0.25 to 0.75 indicating extreme variation within the sample. In no instance does the length of the fore yard equal that of the mizzen mast as was suggested by Cano (Smith, 1993: 103). Furthermore, it appears there is a very weak correlation between the two spars as evidenced by the expansive distributions and ranges.

Mizzen Yard Width Ratios

Middle Width of the Mizzen Yard to the Length of the Mizzen Yard: (M.MMzY_L.MzY)

The middle width of the mizzen yard to the length of the mizzen yard has a one standard deviation of 0.02 to 0.05 for the two-masted caravels; refer to Table 53 for the tabulation of all mizzen yard width ratios one standard deviation and center of

TABLE 53: Comparison of the One Standard Deviation and Center of Distribution of the Mizzen Yard Width Ratios by Ship Type

W.MMzY_L. MzY	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Two-masted Caravels	0.02 to 0.05	0.02 to 0.05
Three-masted Caravels	0.01 to 0.03	0.01 to 0.03
Four-masted Caravels	0.01 to 0.04	0.01 to 0.03
Three-masted Galleons	0.01 to 0.03	0.01 to 0.03
Four-masted Galleons	0.02 to 0.04	0.02 to 0.04
Naus	0.01 to 0.05	0.02 to 0.03
W.MMzY _ W.EMzY	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Two-masted Caravels	0.56 to 1.03	0.64 to 1.00
Three-masted Caravels	0.52 to 1.08	0.67 to 1.00
Four-masted Caravels	0.52 to 1.00	0.59 to 0.96
Three-masted Galleons	0.16 to 0.95	0.21 to 0.97
Four-masted Galleons	0.61 to 0.95	0.60 to 0.97
Naus	0.55 to 1.05	0.67 to 1.00

distribution figures. The main distribution in the histogram graph (Figure 176) is from 0.00 to 0.08 and there is one outlier from 0.10 to 0.12 (CA22.08). The primary mode is from 0.02 to 0.03. The three-masted caravels have a one standard deviation from 0.01 to 0.03. The main distribution in the histogram graph (Figure 177) is from .00 to .05 with a primary mode from 0.02 to 0.03 and a secondary mode from 0.01 to 0.02. The four-masted caravels have a similar one standard deviation range from 0.01 to 0.04 and a main distribution from 0.01 to 0.05 with an outlier from 0.06 to 0.07 (MA03.05) and another from 0.10 to 0.11 (CA27.05). The primary mode in the histogram graph (Figure 178) is from 0.01 to 0.02 while the secondary mode is from 0.02 to 0.03.

The one standard deviation for the middle width of the mizzen yard to the length of the mizzen yard for the three-masted galleons is 0.01 to 0.03. The distribution in the histogram graph (Figure 179) is split between a secondary distribution from 0.0175 to 0.0225 with a modal peak from 0.02 to 0.0225 and the main distribution from 0.025 to 0.0325 with a modal peak from 0.03 to 0.0325. The four-masted galleons have a one standard deviation of 0.02 to 0.04 and a main distribution from 0.01 to 0.07. The primary mode in the histogram graph (Figure 180) is 0.01 to 0.02 and there are two equal secondary modes from 0.02 to 0.03 and 0.03 to 0.04. The nau sample has a one standard deviation of .01 to .05 and a broad main distribution of 0.00 to 0.10 in the histogram graph (Figure 181) with one outlier at .14 (CA27.03). The primary mode is from 0.015 to 0.025 with a secondary mode of 0.025 to 0.035.

The one standard deviation of the bottom width of the mizzen mast to the height of the mizzen mast is consistent throughout the caravels, galleons, and naus with

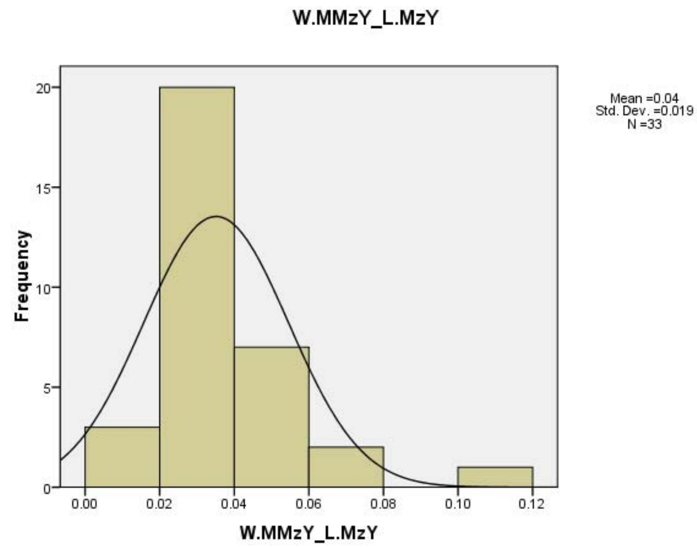


Figure 176: Histogram of the middle width of the mizzen yard to the length of the mizzen yard in two-masted caravels. Refer to Appendix 32 for data.

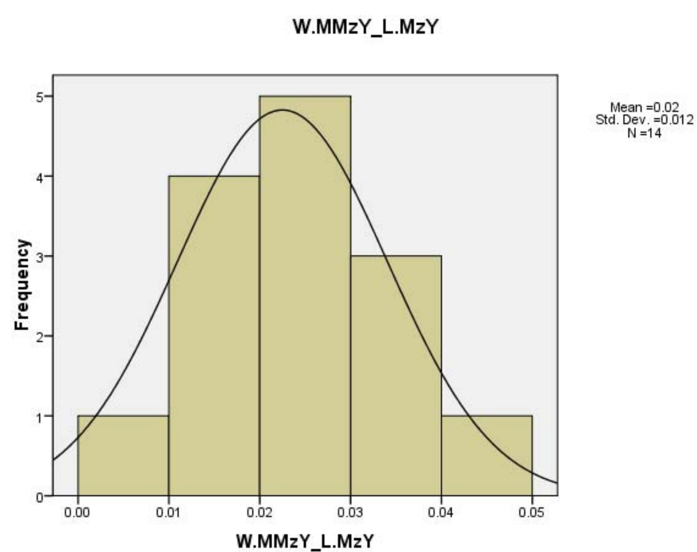


Figure 177: Histogram of the middle width of the mizzen yard to the length of the mizzen yard in three-masted caravels. Refer to Appendix 32 for data.

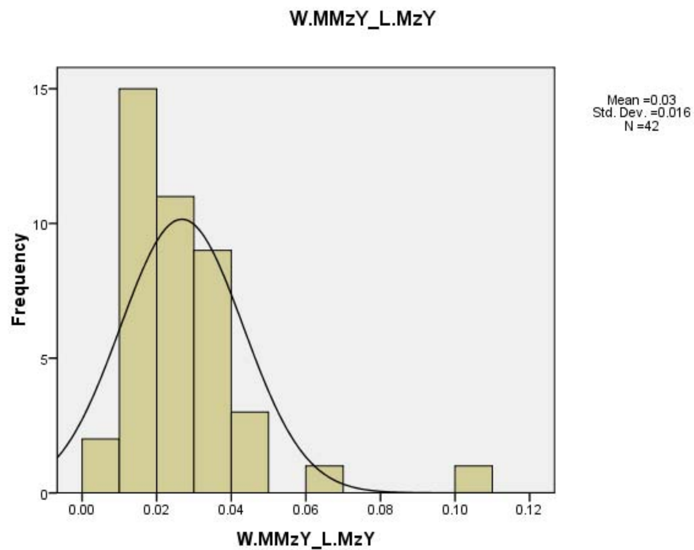


Figure 178: Histogram of the middle width of the mizzen yard to the length of the mizzen yard in four-masted caravels. Refer to Appendix 32 for data.

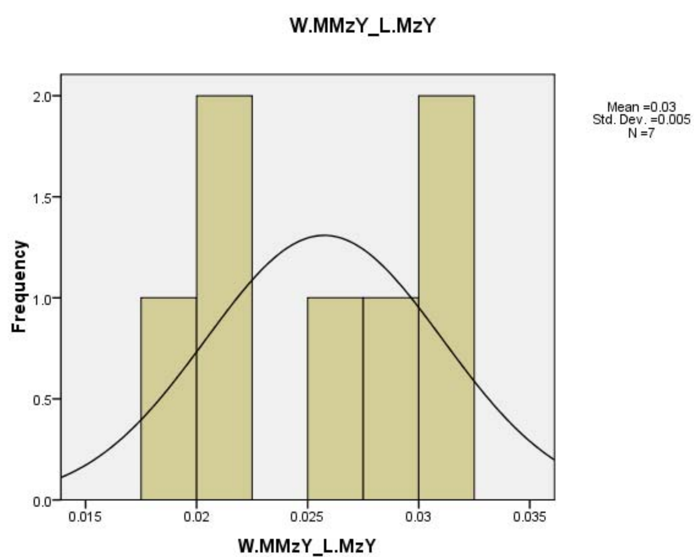


Figure 179: Histogram of the middle width of the mizzen yard to the length of the mizzen yard in three-masted galleons. Refer to Appendix 32 for data.

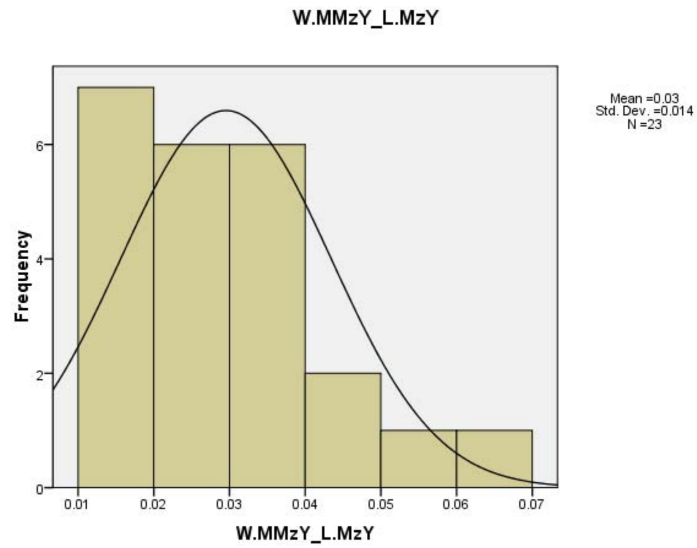


Figure 180: Histogram of the middle width of the mizzen yard to the length of the mizzen yard in four-masted galleons. Refer to Appendix 32 for data.

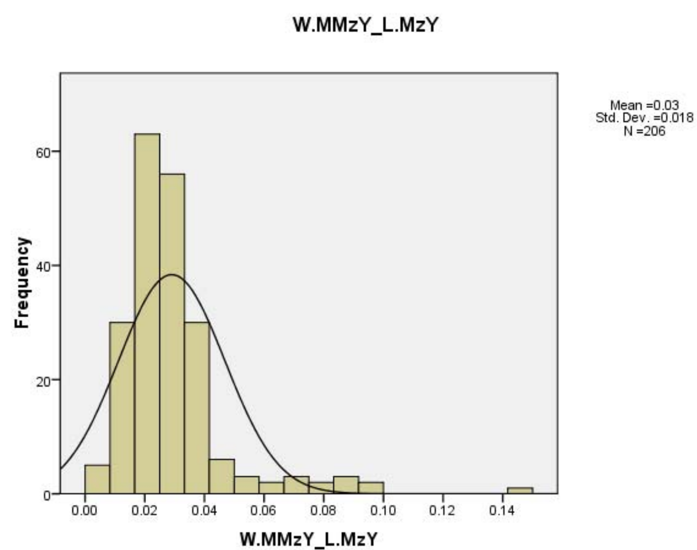


Figure 181: Histogram of the middle width of the mizzen yard to the length of the mizzen yard in naus. Refer to Appendix 32 for data.

very minimal differences between the ship types. Likewise, the modal ranges exhibit little variation in the middle width of the yard to the length of the yard. The three-masted caravels and four-masted caravels have the lowest range of 0.01 to 0.03 followed by the four-masted galleons and the naus with roughly 0.01 to 0.04 and the two-masted caravels and the three-masted galleons with about 0.02 to 0.03. On average, the middle width of the mizzen yard is 2% to 3% of the height of the spar which is larger than the 1% calculation based on the measurements in the *Livro Náutico* and by Fernandez.

Middle Width of the Mizzen Yard to the End Width of the Mizzen Yard: (M.MMzY_ M.EMzY)

The one standard deviation of the middle width to the end width of the mizzen yard for the two-masted caravels is 0.56 to 1.03 and the main distribution in the histogram graph (Figure 182) is from 0.40 to 1.10 with one outlier (CA29.03) at 0.00 to 0.10. The primary mode is from 1.00 to 1.10. The three-masted caravels have a one standard deviation from 0.52 to 1.08. The main distribution in the histogram graph (Figure 183) is from 0.40 to 1.20 and there is an outlier from 0.00 to .20 (CA27.02); the primary mode 1.00 to 1.20 and the secondary mode is from 0.80 to 1.00. The one standard deviation for the four-masted caravels is from 0.52 to 1.00 and there is an outlier from .00 to .10 (MA13.03), which is consistent with the main distribution of the four-masted caravel sample is quite extensive from 0.20 to 1.10. The primary mode in the histogram graph (Figure 184) is from 1.00 to 1.10 and the secondary mode 0.80 to .90.

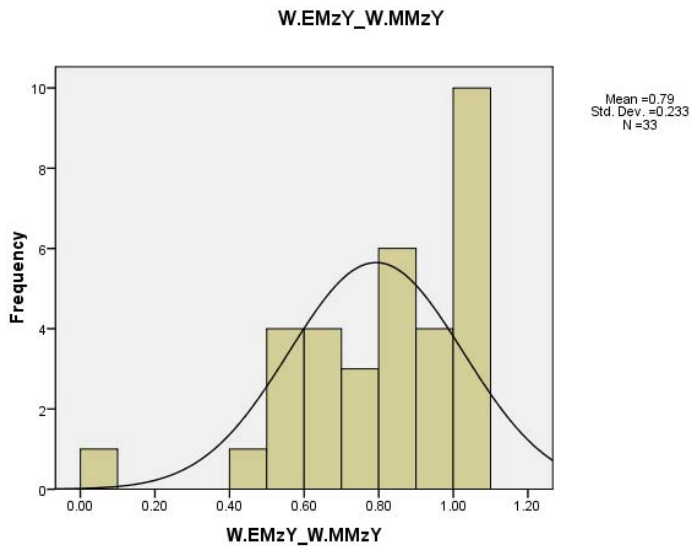


Figure 182: Histogram of the middle width to the end width of the mizzen yard in two-masted caravels. Refer to Appendix 32 for data.

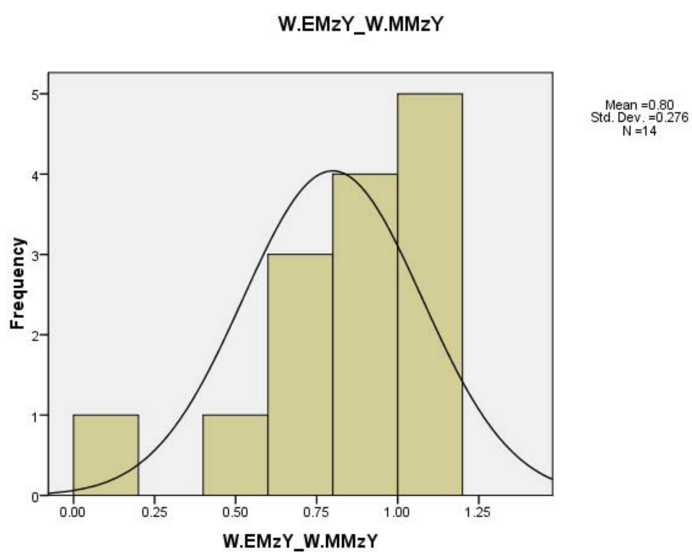


Figure 183: Histogram of the middle width to the end width of the mizzen yard in three-masted caravels. Refer to Appendix 32 for data.

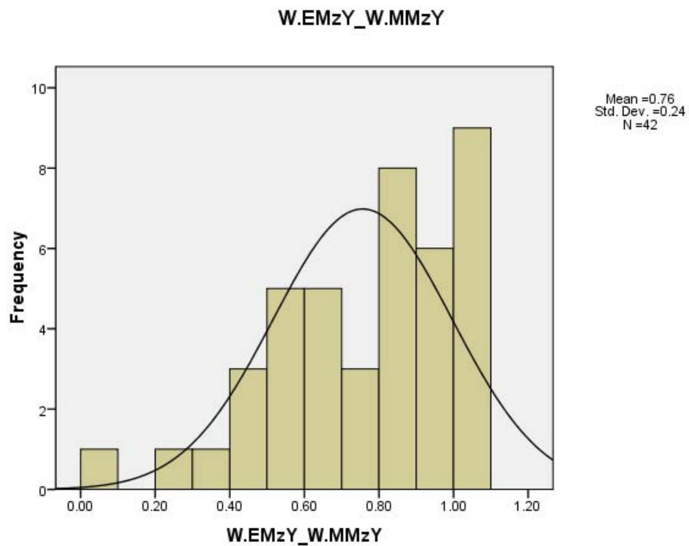


Figure 184: Histogram of the middle width to the end width of the mizzen yard in four-masted caravels. Refer to Appendix 32 for data.

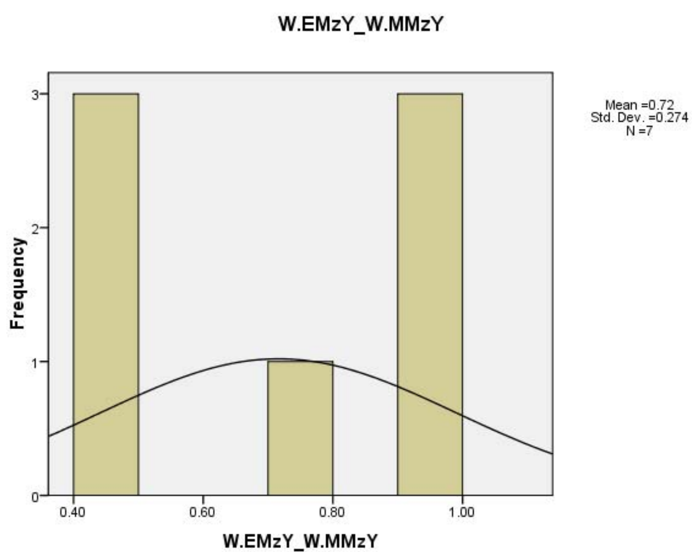


Figure 185: Histogram of the middle width to the end width of the mizzen yard in three-masted galleons. Refer to Appendix 32 for data.

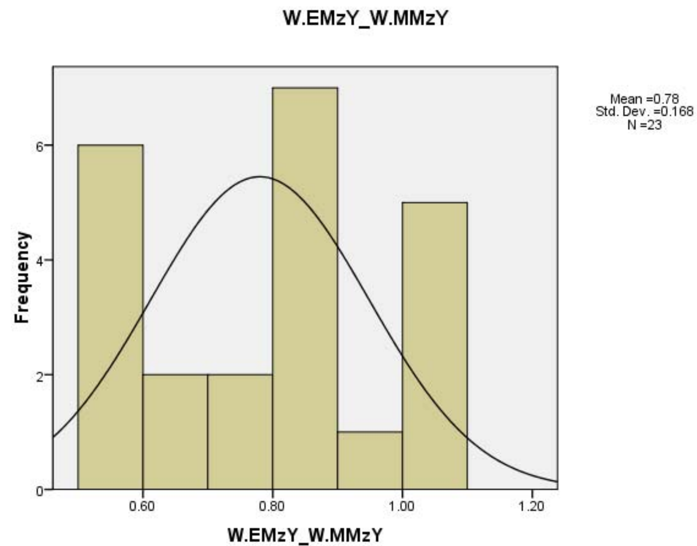


Figure 186: Histogram of the middle width to the end width of the mizzen yard in four-masted galleons. Refer to Appendix 32 for data.

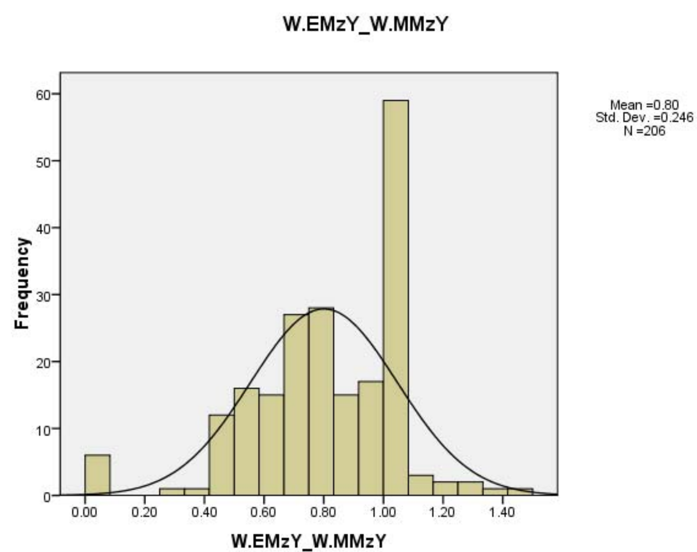


Figure 187: Histogram of the middle width to the end width of the mizzen yard in naus. Refer to Appendix 32 for data.

The one standard deviation for the middle to end widths of the mizzen yard for the three-masted galleons is 0.16 to 0.95 and the distribution in the histogram graph (Figure 185) is from 0.40 to 1.00 while there are two equal primary modes from 0.40 to 0.50 and 0.90 to 1.00. The four-masted galleons have a one standard deviation of 0.61 to 0.95. The main distribution in the histogram graph (Figure 186) is from 0.50 to 1.10 and the primary mode is from 0.80 to 0.90 while the secondary mode is from 0.50 to 0.60. The one standard deviation for the nau sample is 0.55 to 1.05 and the main distribution is also large ranging from 0.25 to 1.45 with six outliers (MA13.06, CA12.01, PA03.04, MA16.1538-07, MA16.1512-03, MA16.1524-01) from 0.00 to 0.10. The primary mode in the histogram graph (Figure 187) is from 1.00 to 1.08.

The one standard deviation ranges are consistently from around the 50th percentile to the 110th percentile with the exception of the three-masted galleons, which begins at 0.16. The primary modes of the caravels and the naus all indicate that there is no tapering and in most cases the end width is slightly greater than the middle width. The secondary modes of the three-masted (0.80 to 1.00) and four-masted caravels (0.80 to 0.90) suggest some tapering within the sample. The three-masted and four-masted galleons, however, have a much broader range from 0.40 to 1.00 and 0.50 to 0.90 respectively, which may be a result of the smaller sample sizes that emphasizes the extreme variants rather than weeding them out as do the larger sample sizes. According to Fernandez's measurements, there is a 52% tapering from the mid section of the yard to the spar and 50% for the yard in the *Livro Náutico*. On average, the end width of the yard is 90% to 100% of the middle width and only the galleon samples come close to the tapering described in the treatises. It appears that the widths of the yards were largely exaggerated by the artists within the artwork.

In this chapter the dimensions of the bonaventure and mizzen masts and yards were statistically analyzed and compared to the archival records when possible. The results of the mizzen mast and yards analysis indicate the iconography correlates well to the archival evidence. The only written documentation of the bonaventure mast compares its height to that of the bowsprit and the mizzen mast. One of the most interesting findings, however, was that the height of the bonaventure mast in the iconography far exceeded the proportions dictated in the archival records. The height of the bonaventure mast in the iconography was on average twice what the contemporary manuscripts dictated. Although the dates are not listed for each ship in the analysis of the bonaventure and mizzen masts and yards, there is no evident temporal trend in the data set suggesting homogenous mast and yard dimensions throughout the 16th century.

CHAPTER X

DESCRIPTIVE STATISTICS OF MAST AND YARD DIMENSIONS IN THE ICONOGRAPHY: MAIN MAST

Similar to Chapter IX, which focused on the dimensions of the bonaventure and mizzen masts and yards, the height and width of the lower and upper main masts as well as the length and width of the main yards are analyzed using the frequencies tool within SPSS program in order to establish a normal range based on one standard deviation and the center of distribution. Although an in-depth examination of the sample distribution was not conducted for the main mast dimensions, each frequencies table and histogram was examined to ascertain any sample that is not valid. When possible, measurements were taken to reflect constructional relationships detailed within the manuscripts (see Figure 188). Otherwise, the measurements express what was considered the most logical relationships for reconstructing a vessel's rig.

10.1 MAIN MAST AND YARD DIMENSIONS

In the statistical analysis of the lower main mast there are 98 caravels, 33 galleons, and 237 naus, which had sufficient measurements to conduct a statistical analysis of the main mast dimensions. The sample was divided into two-masted caravels (36), three-masted caravels (12), four-masted caravels (41), three-masted galleons (08), four-masted galleons (23), and three-masted naus (192); refer to Appendix 32 for the

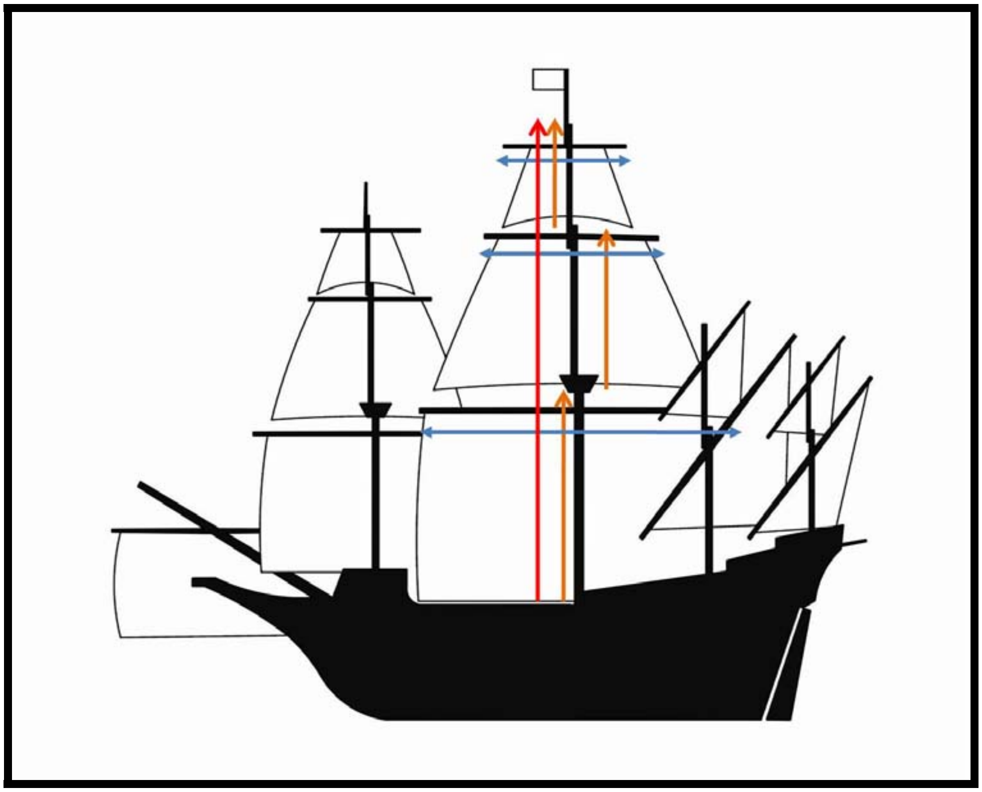


Figure 188: Illustration of main mast height and main yard length measurements.

frequency tables of all ship types. There are 11 vessels with a main topgallant mast, which includes five naus and six four-masted galleons. Although the sample was not analyzed, the resulting one standard deviation, center of distribution, and modal peaks can be viewed in Table 54. The measurements of the lower and upper masts were taken from the bottom of the main mast at deck level to the base of the main top and started again at the upper rim of the main top to the main topmast head. It is not possible to tell how much overlap there is because the portion is covered by the top and there is no available information regarding the doubling that is readily accessible.

Lower Main Mast Dimensions

<u>Lower Main Mast Height Ratios</u>

Palacio indicates the main mast of any ship is to have the length of the keel plus the rake. Although he mentions that using a measurement slightly less than this would make the ship more seaworthy and the rigging and masts more secure (Bankston, 1986: 120). Additionally, the subtracted amount from the length of the main mast prescribed by Palacio should be added to the topmast (Bankston, 1986: 120). This same proportion is repeated in the *Livro Náutico* in which it is stated that the mainmast, in this instance for a nau, should have as many *braças* of length as the number of *rumos* (length) of the keel (Castro, 2005b: 115). Fernandez includes the doubling within this measurement, whereas the author of the *Livro Náutico* mentions that it does not include the doubling (Castro, 2005b: 115). Although it is not possible to calculate the length of the keel from

TABLE 54: Comparison of the One Standard Deviation, Center of Distribution, and Modal Peaks of the Royal Main Mast Ratios

ROYAL MAIN MAST				
	One Standard Deviation (68%)	**Center of Distribution (50%)**	**Primary Mode(s)**	**Secondary Mode**
H.RMa_H.Ma	0.16 to 0.24	0.15 to 0.24	0.015 to 0.0175	NA
H.RMa_L.H	0.13 to 0.33	0.16 to 0.28	0.10 to 0.20	0.20 to 0.30
H.RMa_H.LMa	0.28 to 0.48	0.28 to 0.44	0.35 to 0.40	0.25 to 0.30
H.RMa_H.UMa	0.53 to 0.98	0.62 to 0.94	0.60 to 0.80	NA
W.TpRMa_H.RMa	0.05 to 0.09	0.06 to 0.09	0.05 to 0.07; 0.08 to 0.09	NA
W.BtRMa_H.RMa	0.06 to 0.09	0.07 to 0.09	0.08 to 0.09	0.07 to 0.08
W.BtRMa_W.TpRMa	0.66 to 1.24	0.75 to 1.06	0.80 to 1.00	NA

the iconography, this missing measurement does not render the information useless in the statistical analysis of the main mast dimensions. According to the constructional rule of *ah*, *dos*, *tres* (one, two, three) the length of the keel should be roughly two-thirds the length on deck. Therefore, it would be expected that the height of the main mast would be somewhere in the vicinity of 0.66 of the length of the hull measurement.

The *Livro Náutico* also has two different maximum diameters for the nau; the first mentions 4.5 *palmas de vara* or 99 cm at the main deck level tapering to 53 cm at the level of the cheeks (Castro, 2005b: 115). The second listing, however, specifies the maximum diameter should be 1/10 of the beam, which is also the rule for the galleon in the treatise. Fernandez states that the maximum diameter of the main mast should be 4.5 *palmas de goa* or 1.16 m tapering to 5/7 of this diameter (83 cm) at the top (Castro, 2005b: 115). Accordingly, the top width of the main mast to the bottom width results in a ratio of 0.54 for the *Livro Náutico* and 0.72 in Fernandez's manuscript.

Height of the Main Mast to the Length of the Hull: (H.Ma _L.H)

The overall height of the main mast to the length of the hull was only calculated for the galleons and naus due to the fact that the caravels do not have a main topmast. The three-masted galleons have a one standard deviation from 0.87 to 1.36 and a distribution in the histogram graph (Figure 189) that is separated into two groups from 0.70 to 0.80 and 1.00 to 1.40. The tabulation of the one standard deviation and center of distribution figures for all the lower main mast height ratios can be viewed in Table 55. There are three equal primary modes from 0.70 to 0.80 in the first group and 1.20 to 1.30

TABLE 55: Comparison of the One Standard Deviation and Center of Distribution of the Lower Main Mast Height Ratios

H.Ma _L.H	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Three-masted Galleons	0.87 to 1.36	0.87 to 1.3
Four-masted Galleons	0.62 to 1.20	0.61 to 1.12
Naus	0.77 to 1.39	0.88 to 1.21
H.LMa_L.H	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Two-masted Caravels	0.58 to 0.92	0.63 to 0.80
Three-masted Caravels	0.50 to 0.75	0.51 to 0.71
Four-masted Caravels	0.44 to 0.78	0.50 to 0.74
Three-masted Galleons	0.62 to 1.03	0.68 to 0.98
Four-masted Galleons	0.41 to 0.81	0.50 to 0.78
Naus	0.51 to 0.93	0.58 to 0.81
H.LMa_H.Ma	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Three-masted Galleons	0.57 to 0.93	0.60 to 0.96
Four-masted Galleons	0.51 to 0.89	0.56 to 1.00
Naus	0.60 to 0.73	0.62 to 0.72

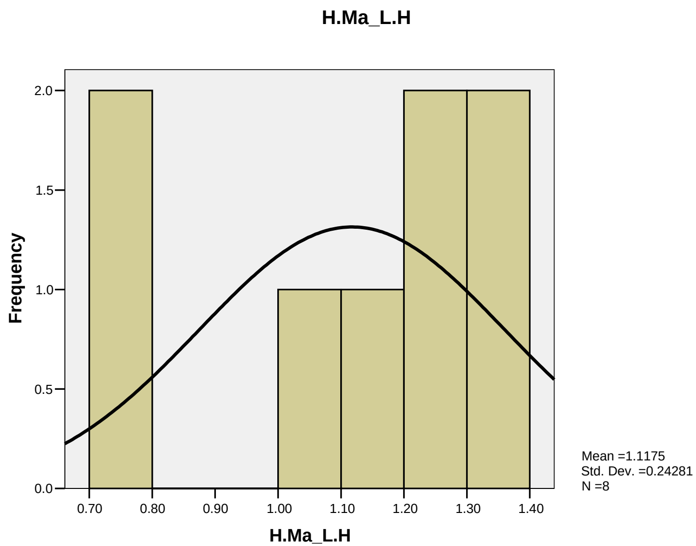


Figure 189: Histogram of the height of the main mast to the length of the hull in three-masted galleons. Refer to Appendix 33 for data.

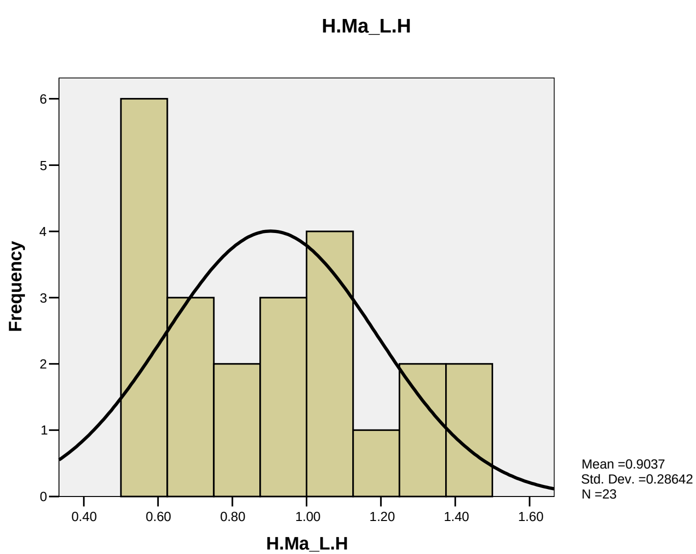


Figure 190: Histogram of the height of the main mast to the length of the hull in four-masted galleons. Refer to Appendix 33 for data.

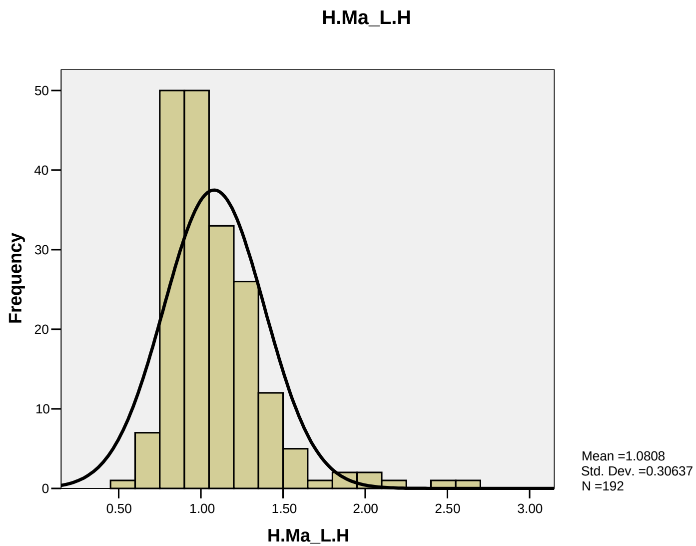


Figure 191: Histogram of the height of the main mast to the length of the hull in naus. Refer to Appendix 33 for data.

and 1.30 to 1.40 in the main distribution. The height of the mast to the length of the hull ratio for the four-masted galleon sample has a one standard deviation from 0.62 to 1.20, which is consistent with the main distribution in the histogram graph (Figure 190) from 0.45 to 1.45. The primary mode, however, is on the lower end from 0.50 to 0.62 while the secondary mode is more centralized from 1.00 to 1.10. The one standard deviation for the nau sample is from 0.77 to 1.39 and there are two equal primary modes in the histogram graph (Figure 191) from around 0.75 to 0.95 and 0.95 to 1.10. The main distribution is from roughly 0.48 to 2.25 and there are two outliers from 2.40 to 2.60: PA03.05 and CA33.04. The one standard deviations of the height of the main mast to the length of the hull is very similar for the three-masted galleons and the naus. Whereas, the four-masted galleons have a range that is skewed to the lower end indicating that either the main mast, on average, is slightly shorter than its three-masted counterpart or that it has a proportionally longer hull to accommodate a fourth mast. The primary modes further justify the relationship between the three-masted galleons and naus and while the latter has a continuous range from 0.75 to 1.10, the previous is split between the modes in the main distribution from 1.20 to 1.40 and the secondary group from 0.70 to 0.80. The small sample size of the three-masted galleons makes the analysis hard to qualify; nonetheless, there is enough data to show a general trend. There is a similar split in the four-masted galleons with a low primary mode from 0.50 to 0.62 and a secondary mode from 1.00 to 1.10. Overall it appears that although all three vessel samples reach the expected .66 relationship between the main mast and the length of the hull, there are many vessels that have proportionally taller main masts.

The question remains of whether the 1:1 ratio between the overall length of the main mast to the length of the keel was a hard fast rule of construction or if there was more variation than realized. The descriptions of the height of the main mast in the treatises vary by the addition or exclusion of the doubling and the inclusion of the rake of the mast in the measurement all of which would result in a higher ratio. However, there is the element of artistic error with which to contend and the commonly held belief that artists exaggerated the rigging in order to create a ship with a more imposing presence within the artwork. There are also several instances in which vessels from the same source have a high degree of variability; for example three naus from PA03 have ratios ranging from 1.5 to 2.5 and the vessels from MA15 and MA16 are spread throughout the entire nau sample.

There is no evidence of a temporal division in the sample; however, there is some sorting according to the view in which it was depicted. Although there are naus portrayed in ¾ port or starboard profile views throughout the entire sample, the majority of them are concentrated in the higher end of the range from roughly 1.25 to 2.56. The same holds true for the galleons as the vessels in a ¾ view tend to sort on the higher end of the ratios. The essential problem with using the ships that have a ¾ view is the length of the hull. Some vessels retain appropriate proportions no matter the angle in which it is portrayed while others are significantly distorted. This is the main argument for using large sample sizes and the resulting averages to determine normal ranges of variability and weeding out the extreme cases.

Height of the Lower Main Mast to the Length of the Hull: (H.LMa_L.H)

The height of the lower mast to the length of the hull ratio for the two-masted caravels sample has a one standard deviation from 0.58 to 0.92, which is consistent with the main distribution in the histogram graph (Figure 192) from 0.50 to 1.30 and the primary mode at 0.70 to 0.80. The one standard deviation for the three-masted caravels is from 0.50 to 0.75 and the main distribution in the histogram graph (Figure 193) is from 0.45 to 0.75 with a two outliers (CA22.34 and MA03.16) at 0.80 to 0.90. There are four equal primary modes which range from 0.45 to 0.65 which are comprised of two vessels each indicating a wide range of variability within the small sample size. The four-masted caravels have a broader one-standard deviation (0.44 to 0.78) and main distribution (0.33 to 1.00) than the other caravels, but the primary mode in the histogram graph (Figure 194) is from 0.50 and 0.60, which is more consistent with the two- and three-masted caravels.

The height of the lower mast to the length of the hull ratio for the three-masted galleons sample has a one standard deviation from 0.62 to 1.03 and a primary mode of.80 to 0.90 in the histogram graph (Figure 195). The main distribution is from 0.60 to 0.90 and there is one outlier (CA29.04) from 0.40 to 0.50 and two others (CA04.27 and CA04.29) from 1.00 to 1.20. The four-masted galleons have a one standard deviation from 0.41 to 0.81 and a primary mode in the histogram graph (Figure 196) from 0.50 to 0.60. The main distribution is from 0.30 to 0.90 and there are two outliers (EN04.01 and MA02.01) from 1.00 to 1.20. The one standard deviation of the nau sample is from 0.51 to 0.93 and the main distribution broadly ranges from 0.25 to 1.30 with three outliers

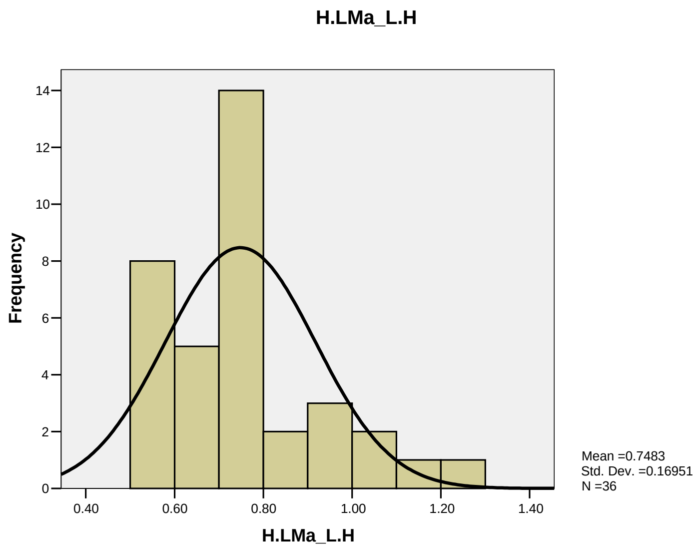


Figure 192: Histogram of the height of the lower main mast to the length of the hull in two-masted caravels. Refer to Appendix 33 for data.

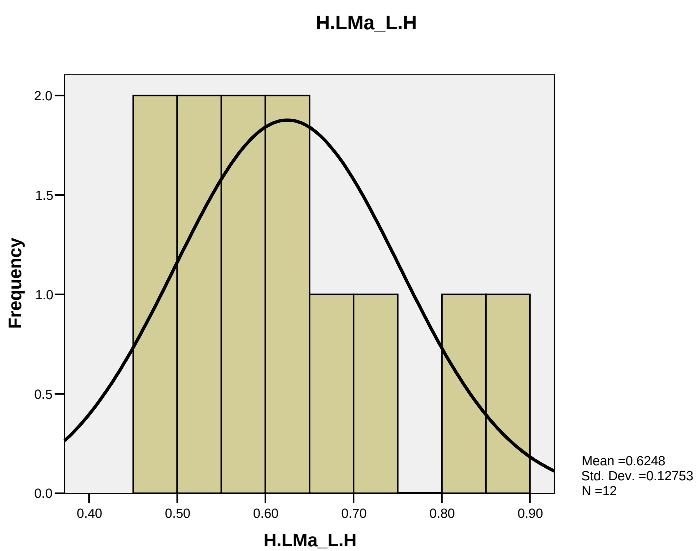


Figure 193: Histogram of the height of the lower main mast to the length of the hull in three-masted caravels. Refer to Appendix 33 for data.

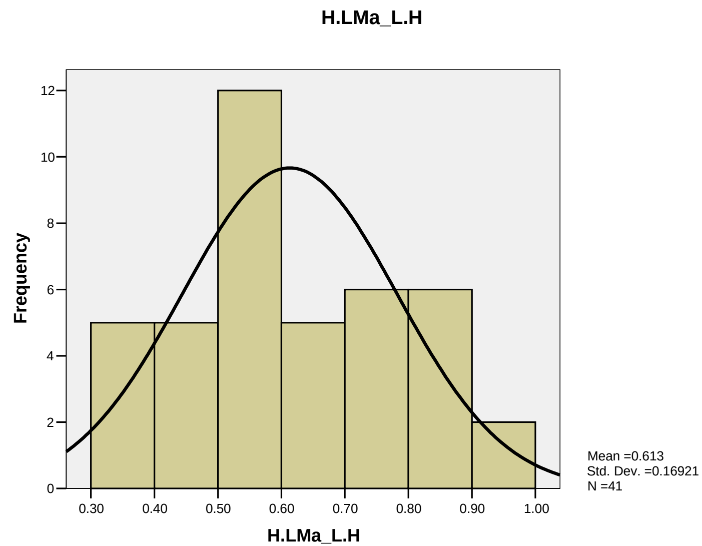


Figure 194: Histogram of the height of the lower main mast to the length of the hull in four-masted caravels. Refer to Appendix 33 for data.

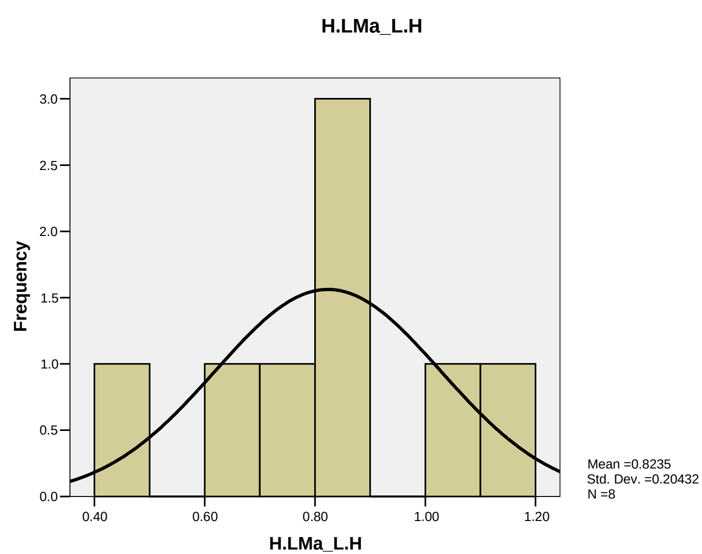


Figure 195: Histogram of the height of the lower main mast to the length of the hull in three-masted galleons. Refer to Appendix 33 for data.

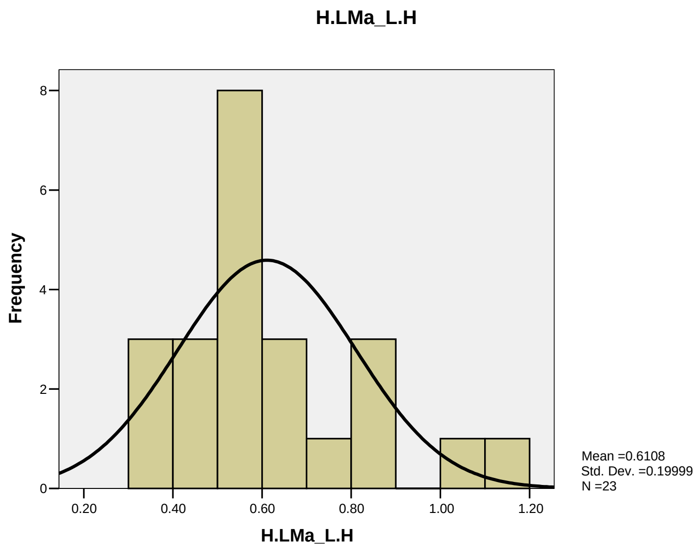


Figure 196: Histogram of the height of the lower main mast to the length of the hull in four-masted galleons. Refer to Appendix 33 for data.

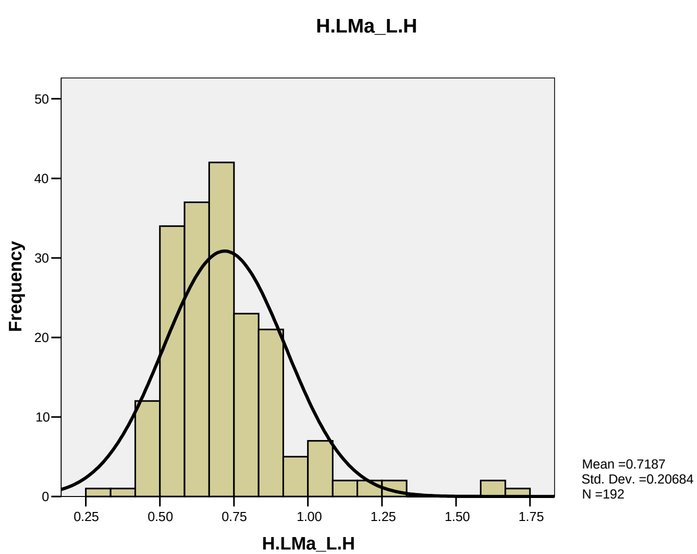


Figure 197: Histogram of the height of the lower main mast to the length of the hull in naus. Refer to Appendix 33 for data.

(PA03.04, PA03.05 and CA33.04) from 1.60 to 1.75. The primary mode in the histogram graph (Figure 197) is from 0.67 to 0.75 while the secondary is from 0.59 to 0.67 and the tertiary is from 0.50 to 0.59. The center of distribution figures show that all but two vessel sub-types (two-masted naus and three-masted galleons) are within the 50th percentile to the 70th and 80th percentile with the naus reaching the highest at 0.81. In both the one standard deviation and the center of distribution the four-masted caravels and the four-masted galleons have similar ranges that are on the lower end indicating proportionally shorter lower main masts than the other vessel subtypes. Whereas, the naus followed by the two-masted caravels and the three-masted galleons have taller lower main masts.

Height of the Lower Main Mast to the Height of the Main Mast: (H.LMa_H.Ma)

The height of the lower main mast to the overall height of the main mast was only calculated for the galleons and naus due to the fact that the caravels do not have a main topmast. The three-masted galleons have a one standard deviation of 0.57 to 0.93 and a center of distribution of 0.60 to 0.96, which is consistent with the three primary modes in the histogram graph (Figure 198) from 0.50 to 0.60, 0.60 to 0.70, and 0.90 to 1.00. The four-masted galleons have a one standard deviation from 0.53 to 0.90. The main distribution is much larger from 0.51 to 0.89 and the center of distribution is similar at 0.56 to 1.00. The primary mode in the histogram graph (Figure 199) from 0.60 to 0.70 narrows this broad range, which was caused by six galleons that have ratios between 0.90 and 1.00. Unlike the three- and four-masted galleons, the nau sample does

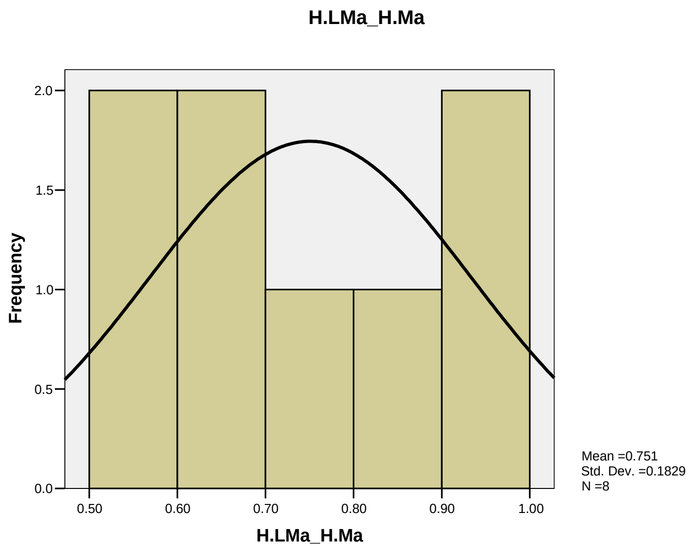


Figure 198: Histogram of the height of the lower main mast to the height of the main mast in three-masted galleons. Refer to Appendix 33 for data.

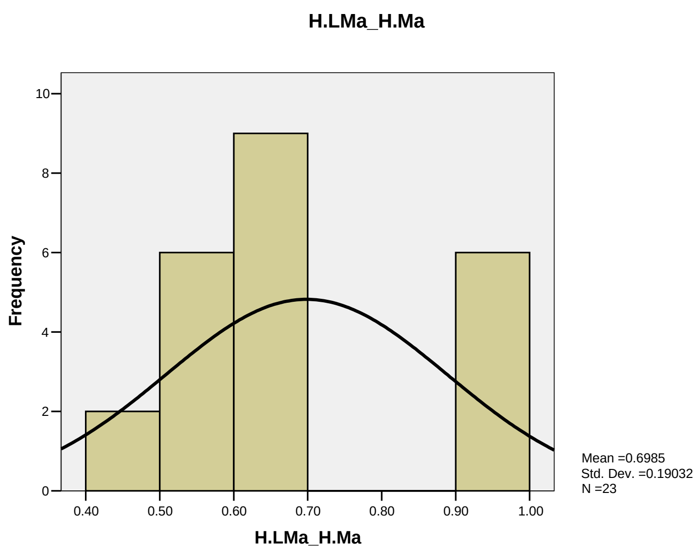


Figure 199: Histogram of the height of the lower main mast to the height of the main mast in four-masted galleons. Refer to Appendix 33 for data.

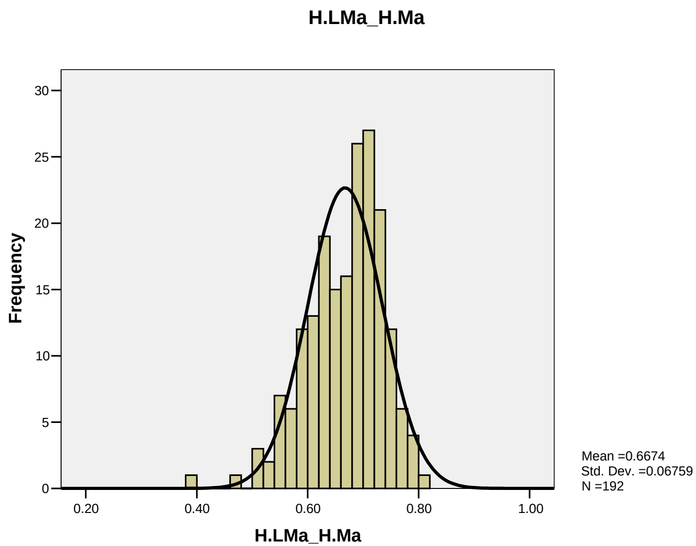


Figure 200: Histogram of the height of the lower main mast to the height of the main mast in naus. Refer to Appendix 33 for data.

TABLE 56: Comparison of the One Standard Deviation and Center of Distribution of the Lower Main Mast Width Ratios

W.BtLMa_H.LMa	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Two-masted Caravels	0.05 to 0.08	0.05 to 0.08
Three-masted Caravels	0.05 to 0.08	0.06 to 0.08
Four-masted Caravels	0.04 to 0.07	0.04 to 0.07
Three-masted Galleons	0.03 to 0.06	0.03 to 0.05
Four-masted Galleons	0.05 to 0.09	0.05 to 0.09
Naus	0.04 to 0.08	0.04 to 0.07
W.TpLMa_W.BtLMa	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Two-masted Caravels	0.46 to 0.74	0.50 to 0.69
Three-masted Caravels	0.44 to 0.84	0.47 to 0.82
Four-masted Caravels	0.47 to 0.89	0.52 to 0.86
Three-masted Galleons	0.56 to 0.84	0.59 to 0.87
Four-masted Galleons	0.48 to 0.72	0.50 to 0.68
Naus	0.48 to 0.83	0.53 to 0.79

not have a large main distribution; rather, it is more concise from 0.50 to 0.82. There are two outliers with the height of the lower main mast below the normal range of variation in relation to the overall height of the main mast: EN02.01 at 0.39 and MA13.08 at 0.47. The one standard deviation and center of distribution are essentially the same: 0.60 to 0.73 for the prior compared to 0.62 to 0.72 for the latter. The primary mode in the histogram graph (Figure 200) is from 0.70 to 0.72 while the secondary mode is from 0.68 to 0.70. Using the primary modes as a guide to normal variation, it appears that the lower main mast is around 60% to 70% of the overall height of the mast with small differences between the three samples.

Lower Main Mast Width Ratios

Bottom Width of the Lower Main Mast to the Height of the Lower Main Mast: (W.BtLMa_H.LMa)

The bottom width of the lower main mast to the height of the lower main mast has a one standard deviation of 0.05 to 0.08 for the two-masted caravels with a main distribution from 0.03 to 0.12 in the histogram graph (Figure 201). The primary mode is from 0.05 to 0.06 and there are two equal secondary modes from 0.04 to 0.05 and 0.06 to 0.07. The tabulation of the one standard deviation and center of distribution figures for all the lower main mast width ratios can be viewed in Table 56. The three-masted caravels have a one standard deviation from 0.05 to 0.08 and a main distribution in the histogram graph (Figure 202) from 0.055 to 0.085 and two outliers from 0.04 to 0.045

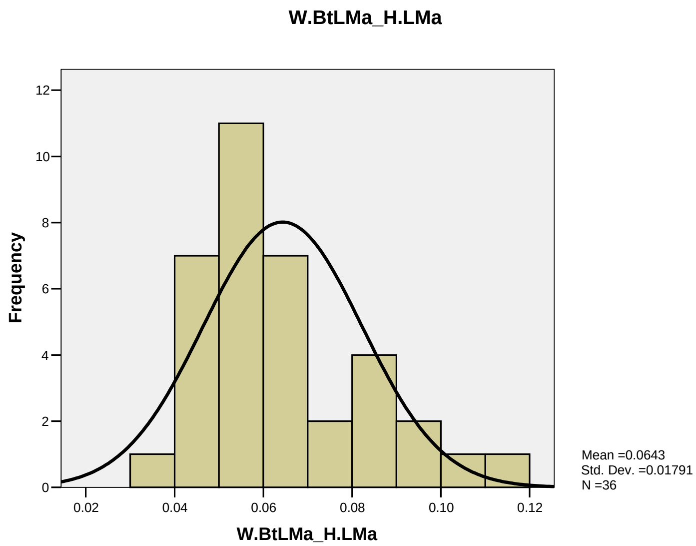


Figure 201: Histogram of the bottom width of the lower main mast to the height of the lower main mast in two-masted caravels. Refer to Appendix 33 for data.

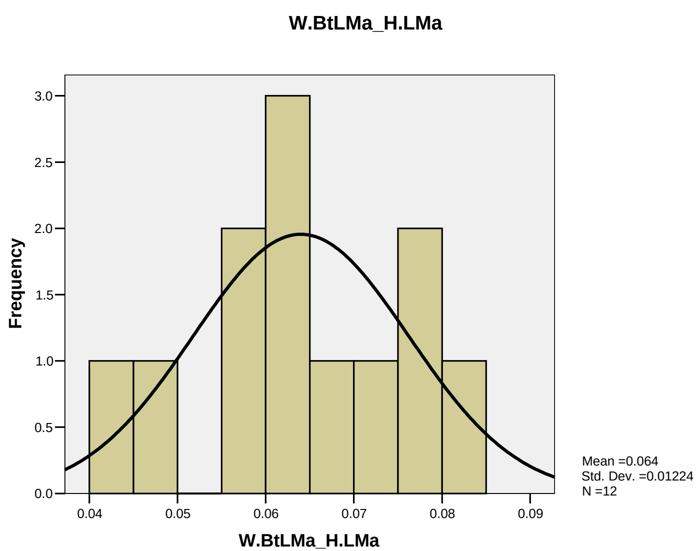


Figure 202: Histogram of the bottom width of the lower main mast to the height of the lower main mast in three-masted caravels. Refer to Appendix 33 for data.

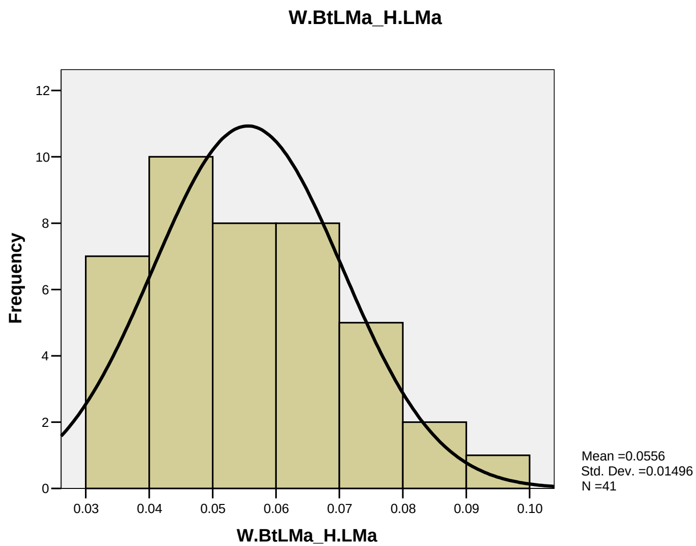


Figure 203: Histogram of the bottom width of the lower main mast to the height of the lower main mast in four-masted caravels. Refer to Appendix 33 for data.

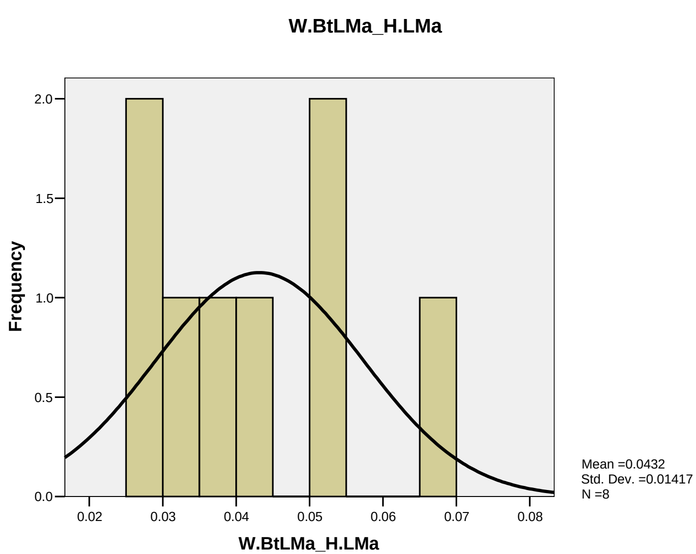


Figure 204: Histogram of the bottom width of the lower main mast to the height of the lower main mast in three-masted galleons. Refer to Appendix 33 for data.

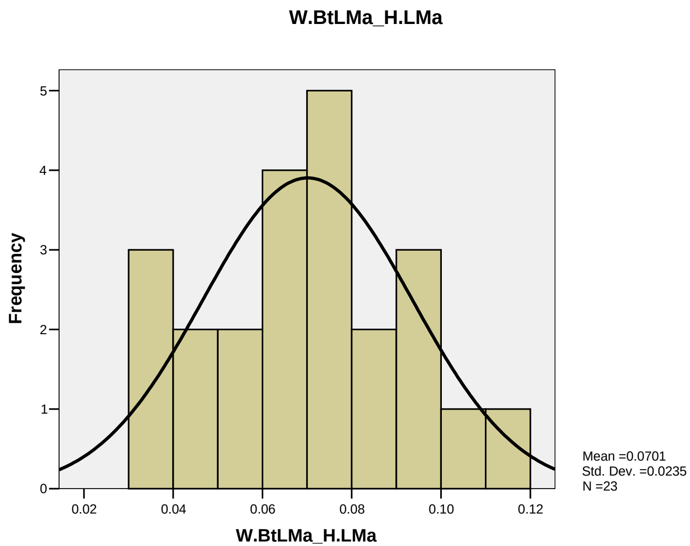


Figure 205: Histogram of the bottom width of the lower main mast to the height of the lower main mast in four-masted galleons. Refer to Appendix 33 for data.

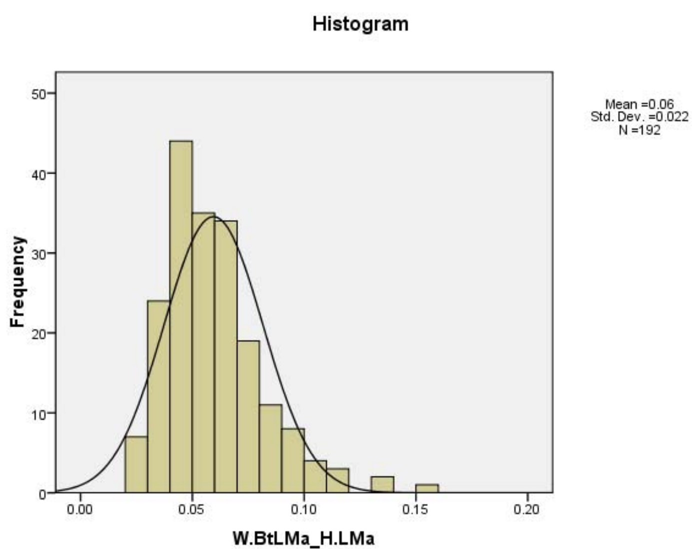


Figure 206: Histogram of the bottom width of the lower main mast to the height of the lower main mast in naus. Refer to Appendix 33 for data.

(CA04.31) and 0.045 to 0.05 (MA03.16). The primary mode is from 0.06 to 0.065 and the two secondary modes are from 0.055 to 0.06 and 0.075 to 0.08. The four-masted caravels have a similar one standard deviation range from 0.04 to 0.07 to the other caravel sub-types, but like the two-masted caravels they have a much wider main distribution than the three-masted caravels from 0.03 to 0.10. The primary mode in the histogram graph (Figure 203) is from 0.04 to 0.05, while the secondary mode is from 0.05 to 0.07 and the tertiary mode is from 0.03 to 0.04. The one standard deviation for the bottom width of the lower main mast to the height of the lower main mast for the three-masted galleons is 0.03 to 0.06. The main distribution in the histogram graph (Figure 204) is from 0.025 to 0.045 with two outliers at 0.05 to 0.055 (CA04.28) and another at 0.065 to 0.07 (CA29.04). There are two equal primary modes from 0.025 to 0.03 and 0.05 to 0.055 the latter of which is actually separated from the main distribution. The four-masted galleons have a one standard deviation that is skewed slightly higher than the three-masted galleons, 0.05 to 0.09 and a much broader main distribution from 0.03 to 0.12. The primary mode in the histogram graph (Figure 205) is 0.07 to 0.08 while the secondary mode is from 0.06 to 0.07. The nau sample has a standard deviation of 0.04 to 0.08 and a main distribution of 0.02 to 0.12 in the histogram graph (Figure 206). The nau sample also has three outliers (EN05.01, CA27.03, and MA13.20) ranging from 0.13 to 0.16. The primary mode is from 0.04 to 0.05 with a secondary mode of 0.05 to 0.06 and a tertiary mode of 0.06 to 0.07.

The one standard deviation of the bottom width of the lower main mast to the height of the lower main mast is fairly consistent throughout the caravels, galleons, and naus with a difference of only a few percentages between the ship types. The two- and three-masted galleons have the same deviation (0.05-0.08) with a slightly larger range than the four-masted caravels (0.04-0.07). The naus (0.04-0.08) and the four-masted galleons (0.05-0.09) both have deviations similar to the caravels while the three-masted galleons have the lowest range from 0.03 to 0.06 suggesting a thinner mast width than the other ships. There is little to no discrepancy between the thickness of the lateen main masts (caravels) and the square-rigged main masts (galleons and naus).

The modal ranges indicate a slightly more nuanced relationship between the vessels with more variability within the dataset. The two-masted caravels (0.04-0.07), four-masted caravels (0.03-0.07), and the naus (0.04-0.07) have very similar overall modal ranges while the three-masted caravels and four-masted galleons have a range from 0.06 to 0.08. Again, the three-masted galleons that is set slightly apart from the group with a smaller bottom width to the height of the mizzen mast ranging from 0.025 to 0.055. Overall there is very little variation in the bottom widths of the lower main mast to the height of the masts between the ship types and like the top widths of the lower main mast, the ranges are relatively concise which is remarkable given the extent of the sample size and date ranges. On average, the bottom width of the main mast is 4% to 7% of the height of the mast.

Top Width of the Lower Main Mast to the Bottom Width of the Lower Main Mast: (W.TpLMa_ W.BtLMa)

The one standard deviation for the top width to the bottom width of the lower main mast ratio for the two-masted caravels is 0.46 to 0.74 while the three-masted caravels (0.44 to 0.84) and the four-masted caravels (0.47 to 0.89) have slightly larger deviations. The main distribution for the two-masted caravels in the histogram graph (Figure 207) extends from 0.30 to 1.00 the primary mode is from 0.60 to 0.70 with a secondary mode at 0.40 to 0.50. The three- and four-masted caravels also have an extensive main distribution in the histogram graphs (Figure 208 and 209) from 0.30 to. 1.00 and 0.20 to 1.20 respectively. The primary mode of both, however, is from 0.50 to 0.60 while the secondary mode for the three-masted caravels is from 0.40 to 0.50 and the tertiary mode is from 0.70 to 0.90 and the secondary mode for the four-masted caravels is from 0.75 to 0.85.

The three-masted galleons have the smallest one standard deviation range of 0.56 to 0.84 while the four-masted galleons and naus have similar ranges to those of the caravels with 0.48 to 0.72 for the first and 0.48 to 0.83 for the latter. The main distribution of the three-masted galleons is from 0.50 to 0.70 with three outliers from 0.75 to 0.95 (MA06.02, CA29.04, CA04.29). The primary mode in the histogram graph (Figure 210) is from 0.65 to 0.70. The four-masted galleons have a large main distribution from 0.35 to 0.75 with two outliers from 0.80 to 0.85 (MA15.1555.00, MA02.01). The primary mode in the histogram graph (Figure 211) is from 0.55 to 0.60 and there are two equal secondary modes from 0.45 to 0.50 and 0.65 to 0.70. The main

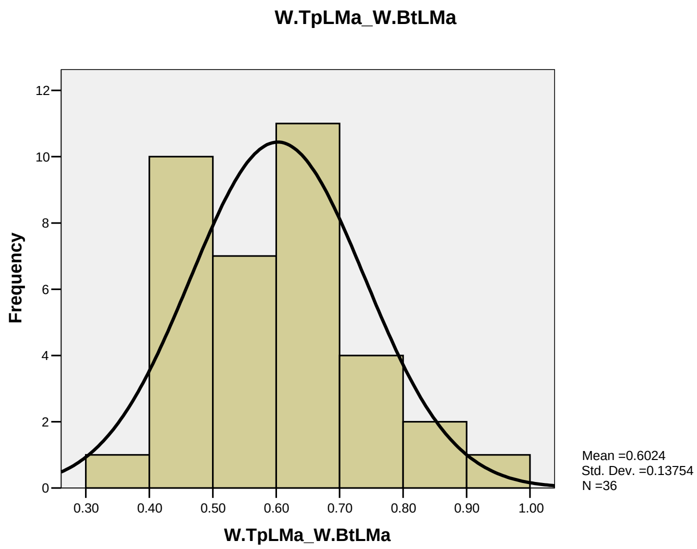


Figure 207: Histogram of the top width to the bottom width of the lower main mast in two-masted caravels. Refer to Appendix 33 for data.

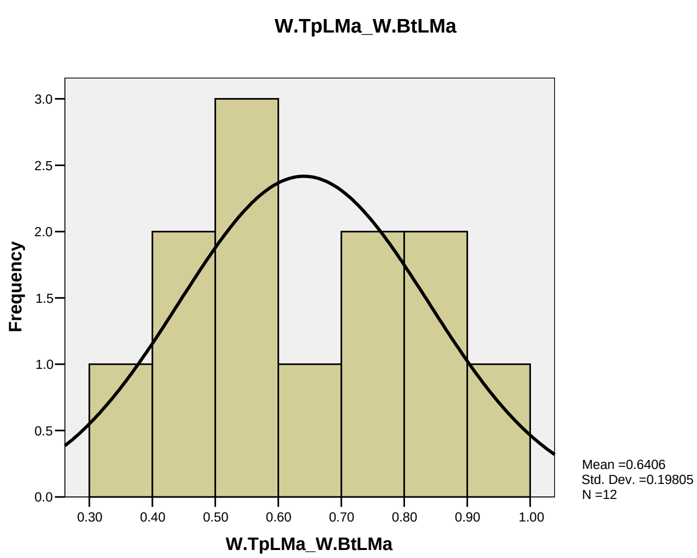


Figure 208: Histogram of the top width to the bottom width of the lower main mast in three-masted caravels. Refer to Appendix 33 for data.

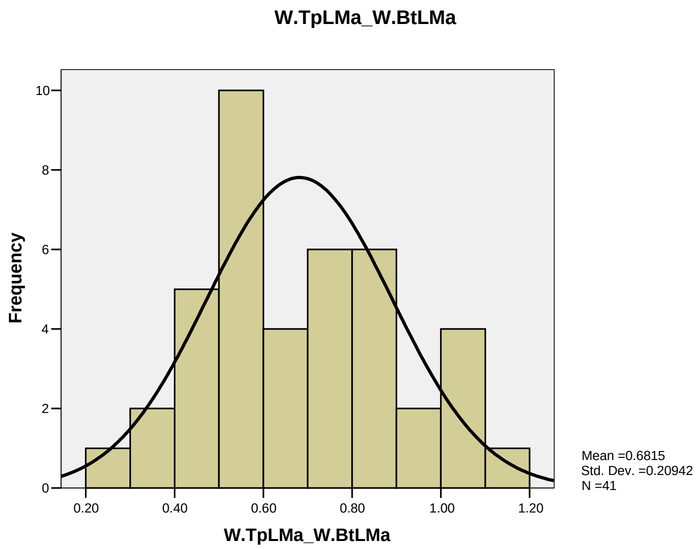


Figure 209: Histogram of the top width to the bottom width of the lower main mast in four-masted caravels. Refer to Appendix 33 for data.

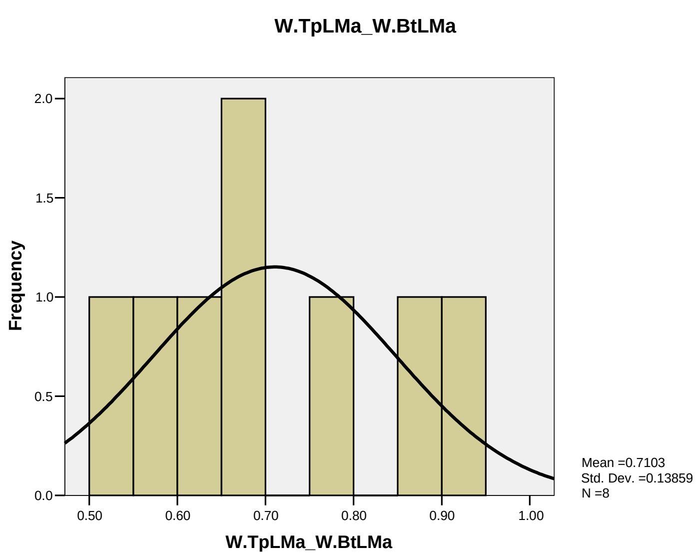


Figure 210: Histogram of the top width to the bottom width of the lower main mast in three-masted galleons. Refer to Appendix 33 for data.

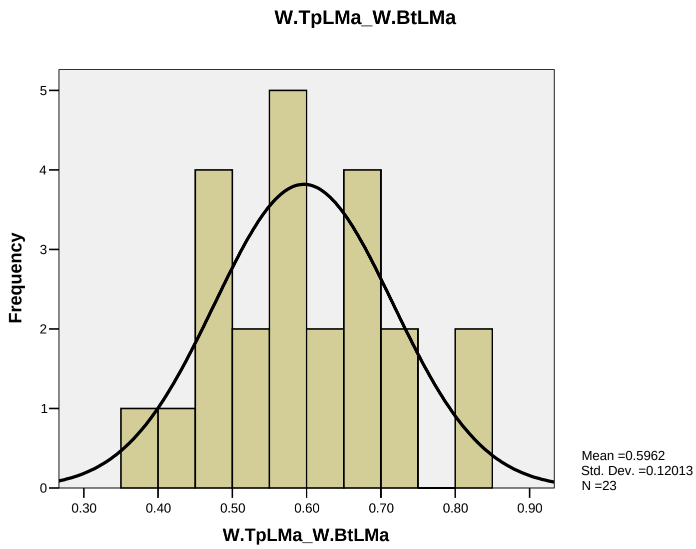


Figure 211: Histogram of the top width to the bottom width of the lower main mast in four-masted galleons. Refer to Appendix 33 for data.

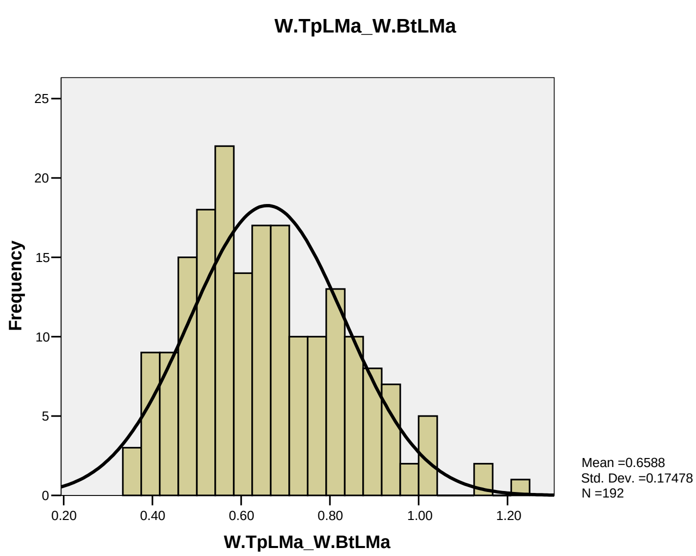


Figure 212: Histogram of the top width to the bottom width of the lower main mast in naus. Refer to Appendix 33 for data.

distribution of the naus is very broad extending from 0.35 to 1.05 and with three outliers from roughly 1.10 to 1.25 (MA16.1518-02, MA16.1561-05, CA07.06). The primary mode in the histogram graph (Figure 212) is from 0.54 to 0.59 while the secondary mode is 0.50 to 0.54.

The one standard deviations of the top width to the bottom width of the lower main mast for the caravels, galleons, and naus all fall within a similar range; the three-masted galleons have the least amount of tapering while the three-masted caravels have the most. The strong primary modes for this ratio suggest that there is relative consistency throughout the samples. The three- and four-masted caravels both have a primary mode of 0.50 to 0.60 while the four-masted galleons and the naus both essentially have primary modes of 0.55 to 0.60. The two-masted caravels with a primary mode of 0.60 to 0.70 and the three-masted galleons with a primary mode of 0.65 to 0.70 have the least amount of tapering in the lower main mast. There a reasonable amount of variation in the top to bottom widths of the lower main mast and both the one standard deviation and primary modes suggesting there was about an average of 40% tapering between the top and bottom of the lower main mast.

According to the *Livro Náutico* and Fernandez's manuscript the top width of the main mast to the bottom width should be a ratio of 0.72 and 0.54 respectively. The three-masted, four-masted caravels, four-masted galleons, and the naus all have primary modes that are within range of the ratio prescribed by Fernandez whereas the two-masted caravel and the three-masted galleon samples are slightly short of the ratio mentioned in the *Livro Náutico*. In both cases the iconography is exceptionally consistent with the measurements provided in these manuscripts.

Main Topmast Dimensions

Main Topmast Height Ratios

The topmasts are smaller and lighter in the sixteenth and seventeenth centuries than the following centuries and are made using straight timbers that have a good grain and no knots (Bankston, 1986: 120). The *Livro Náutico* states that the length of the main upper mast is 13.2 m with a diameter of 1.5 *palmas de goa* or 39 cm and Fernandez gives a length of 18.48 m with a diameter of 2 *palmas de vara* or 44 cm; in both manuscripts the height of the lower main mast as 31.68 m (Castro, 2005b: 115-117). These numbers indicate that the ratio of the height of the main topmast to the lower main mast is 0.42 for the *Livro Náutico* and 0.58 for Fernandez; based on this evidence a range of roughly 0.40 to 0.60 should be considered normal.

According to Palacio, the main topmast should be as long as the ship's beam and half again (1.5 x beam) and the fore topmast should be one-fifth of this (Bankston, 1986: 120). Although it is not possible to calculate the beam in the iconography, using the *ah, dos, tres* rule it would be one-third of the length on deck; therefore the length of the upper mast should be one-third (2/6) this measurement and half again (1/6) or roughly 50% (3/6). In this data set the length on deck is labeled the length of the hull and the relationship between it and the main topmast is explored further in this section. As the caravels generally do not have main topmasts they were excluded from this analysis.

Height of the Main Topmast to the Height of the Lower Main Mast: (H.UMa_H.LMa)

The height of the main topmast to the height of the lower main mast ratio for the three-masted galleons sample has an expansive one standard deviation from 0.26 to 0.81. The tabulation of the one standard deviation and center of distribution figures for all the main topmast height ratios can be viewed in Table 57. There is essentially no main distribution in the histogram graph (Figure 213), which shows a primary mode from 0.20 to 0.25 and three other groupings from 0.40 to 0.60, 0.70 to 0.80, and 0.90 to 1.00. The one standard deviation for the four-masted caravels is from 0.44 to 0.72 and the main distribution in the histogram graph (Figure 214) is from 0.30 to 0.72 with a primary mode from 0.50 to 0.60 and a secondary mode from 0.60 to 0.70. The one standard deviation of the nau sample is from 0.38 to 0.66 and the main distribution broadly ranges from 0.25 to 1.05. The primary mode in the histogram graph (Figure 215) is from 0.40 to 0.45 while the secondary is from 0.45 to 0.50.

The three-galleon sample is difficult to analyze given the sporadic nature of the distribution, which is most likely due to the small sample size. The one standard deviation for the four-masted galleons and the nau samples, however, correspond nicely to 0.40 to 0.60 calculated from the *Livro Náutico* and from Fernandez. The nau modal ranges (0.40 to 0.50) and the four-masted galleon range (0.50 to 0.70) are also consistent with the manuscripts. From this data, it appears that the four-masted galleons have larger

TABLE 57: Comparison of the One Standard Deviation and Center of Distribution of the Main Topmast Width Ratios

H.UMa_H.LMa	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Three-masted Galleons	0.26 to 0.81	0.27 to 0.77
Four-masted Galleons	0.44 to 0.72	0.52 to 0.66
Naus	0.38 to 0.66	0.42 to 0.60
H.UMa_L.H	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Three-masted Galleons	0.23 to 0.56	0.23 to 0.54
Four-masted Galleons	0.18 to 0.48	0.23 to 0.44
Naus	0.25 to 0.48	0.29 to 0.42

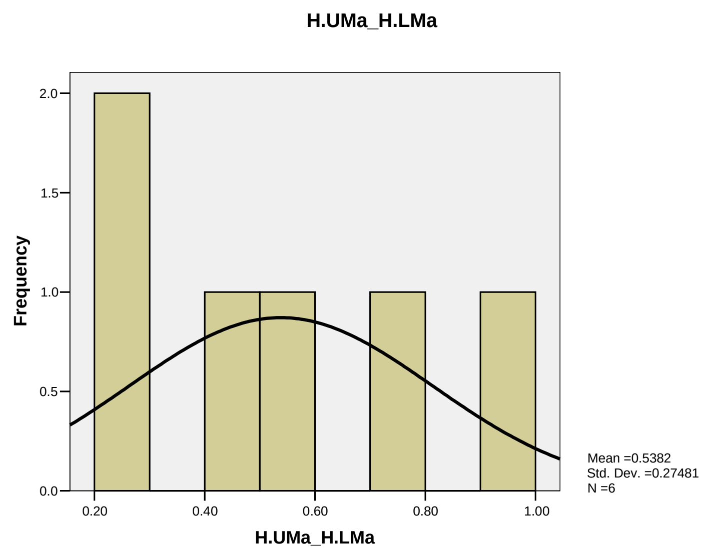


Figure 213: Histogram of the height of the main topmast to the height of the lower main mast in three-masted galleons. Refer to Appendix 33 for data.

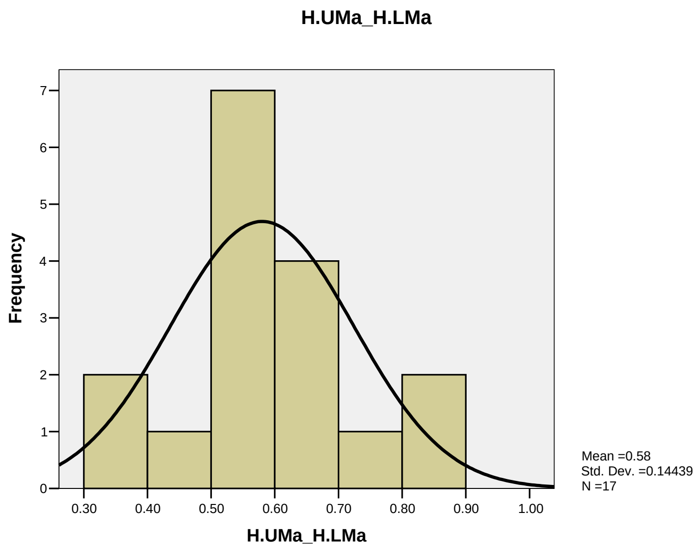


Figure 214: Histogram of the height of the main topmast to the height of the lower main mast in four-masted galleons. Refer to Appendix 33 for data.

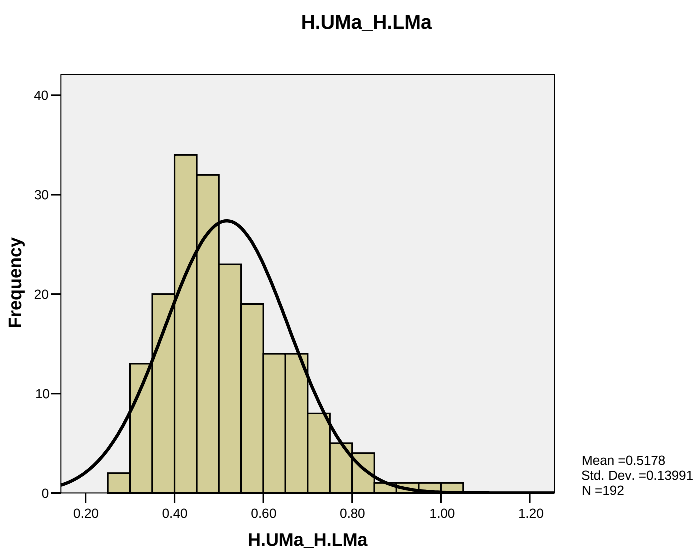


Figure 215: Histogram of the height of the main topmast to the height of the lower main mast in naus. Refer to Appendix 33 for data.

main topmast in comparison to the lower main mast than the naus, but that for both the upper mast is roughly half the size of the lower mast.

Height of the Main Topmast to the Length of the Hull: (H.UMa_L.H)

The height of the main topmast to the length of the hull ratio for the three-masted galleons sample has a one standard deviation from 0.23 to 0.56, which is consistent with the main distribution in the histogram graph (Figure 216) from 0.20 to 0.70; the primary mode is 0.20 to 0.30. One standard deviation for the four-masted galleon sample is from 0.18 to 0.48. The corresponding histogram graph (Figure 217) has a similar distribution to the three-masted galleons from 0.10 to 0.70 and a primary mode from 0.20 to 0.30. The nau sample has a one standard deviation from 0.25 to 0.48. The primary mode in the histogram graph (Figure 218) is from 0.28 to 0.32 and the secondary mode is from 0.32 to 0.36. The main distribution ranges from 0.15 to 0.65 and is further extended by four outliers from 0.75 to 1.00 (MA16.1497-04, PA03.05, CA33.02, CA33.04).

The one standard deviation of the height of the main topmast in relation to the overall length of the hull is relatively consistent for each of the galleon subtypes and the naus. The one standard deviation and the center of distribution of three-masted galleons indicate that the upper masts are skewed slightly larger than the four-masted galleons and the naus. The respective modes show that the three- and four-masted galleons are identical; although the naus are similar, they are on the higher end of the range. On average, for all of the ship types, the height of the main topmast seems to be within 20% and 30% for the length of the hull for the galleons and 30% to 40% for the naus.

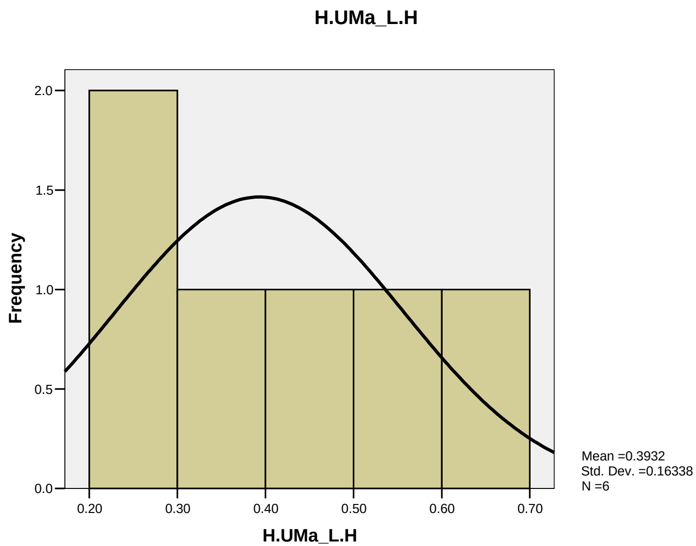


Figure 216: Histogram of the height of the main topmast to the length of the hull in three-masted galleons. Refer to Appendix 33 for data.

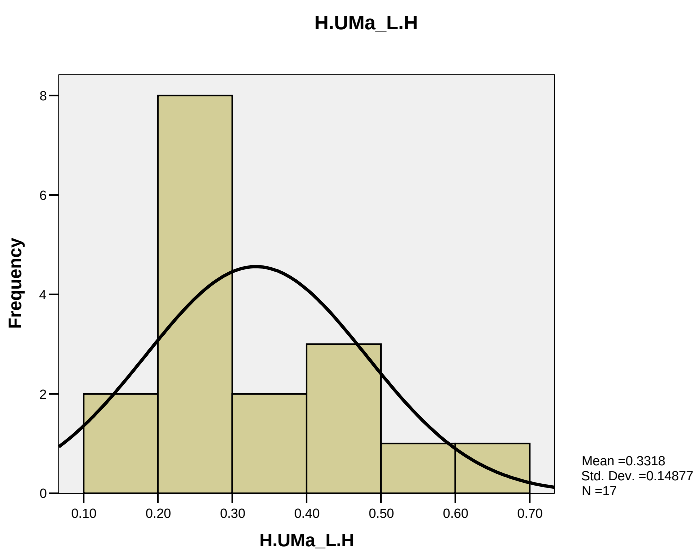


Figure 217: Histogram of the height of the main topmast to the length of the hull in four-masted galleons. Refer to Appendix 33 for data.

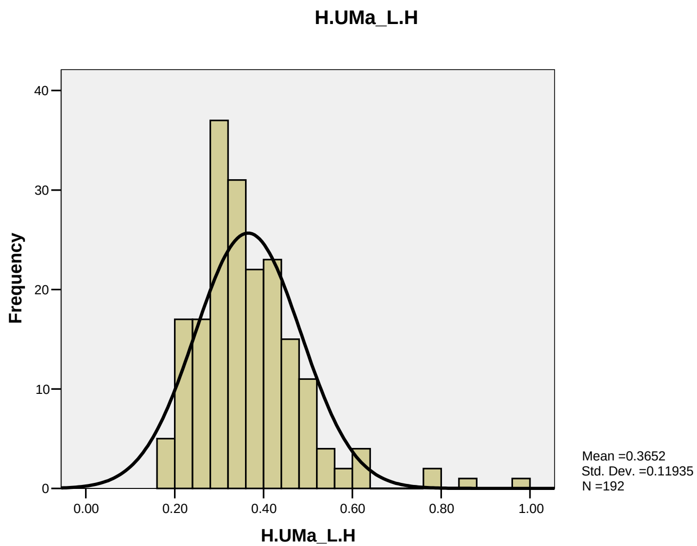


Figure 218: Histogram of the height of the main topmast to the length of the hull in naus. Refer to Appendix 33 for data.

Although the modal ranges are less than the expected 50%, all three ship subtypes reach this percentage in one standard deviation. The modal ranges of the galleons and the naus, however, suggest that a more accurate calculation would be somewhere between the ship's beam and one and a half times the ship's beam.

Main Topmast Width Ratios

Bottom Width of the Main Topmast to the Height of the Main Topmast: (W.BtUMa_H.UMa)

The one standard deviation for the bottom width of the main topmast to the height of the main topmast for the three-masted galleons is 0.03 to 0.09. The tabulation of the one standard deviation and center of distribution figures for all the main topmast width ratios can be viewed in Table 58. The main distribution in the histogram graph (Figure 219) is from 0.00 to 0.125 and the primary mode is from 0.025 to 0.05. The four-masted galleons have a smaller one standard deviation than the three-masted galleons of 0.05 to 0.08 and main distribution from 0.05 to 0.10. The primary mode in the histogram graph (Figure 220) is 0.07 to 0.08 and there is one outlier at 0.03 to 0.04 (MA15.1555.00). The nau sample has a standard deviation of 0.04 to 0.09 and a main distribution of 0.02 to 0.125 in the histogram graph (Figure 221). The nau sample also has four outliers; PA03.02 and MA13.14 at 0.01 and 0.02 and CA27.04 and CA06.03 at 0.13 and 0.14. The primary mode is from 0.054 to 0.058 with a secondary mode from 0.058 to 0.062.

TABLE 58: Comparison of the One Standard Deviation and Center of Distribution of the Main Topmast Width Ratios

W.BtUMa_H.UMa	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Three-masted Galleons	0.03 to 0.09	0.03 to 0.09
Four-masted Galleons	0.05 to 0.08	0.06 to 0.08
Naus	0.04 to 0.09	0.05 to 0.08
W.TpUMa_W.BtUMa	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Three-masted Galleons	0.82 to 0.98	0.84 to 1.00
Four-masted Galleons	0.65 to 0.97	0.64 to 1.00
Naus	0.30 to 1.37	0.65 to 0.95

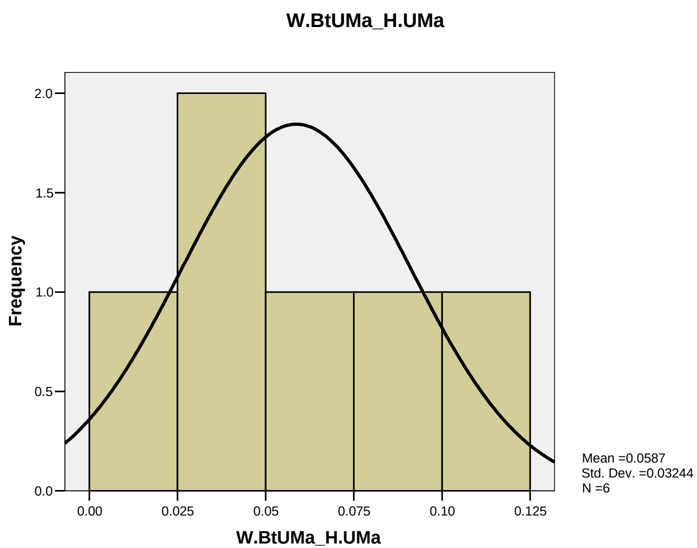


Figure 219: Histogram of the bottom width of the main topmast to the height of the main topmast in three-masted galleons. Refer to Appendix 33 for data.

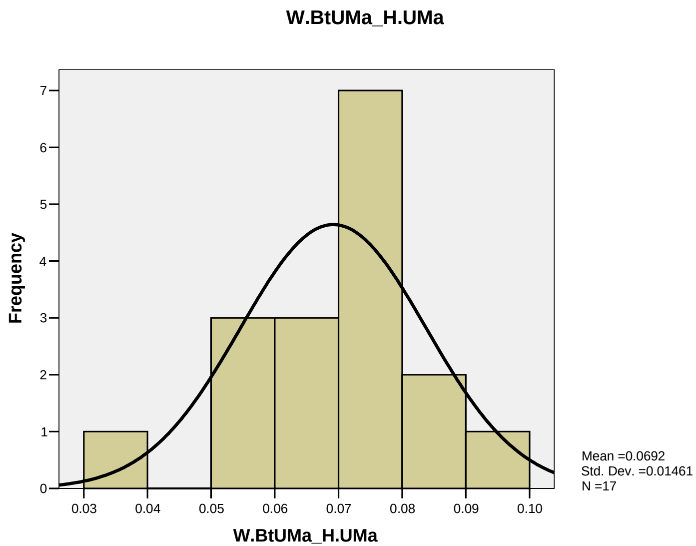


Figure 220: Histogram of the bottom width of the main topmast to the height of the main topmast in four-masted galleons. Refer to Appendix 33 for data.

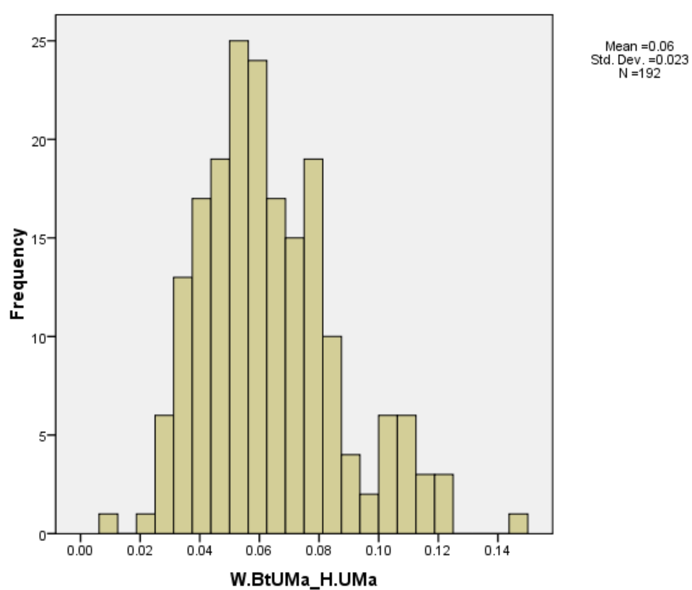


Figure 221: Histogram of the bottom width of the main topmast to the height of the main topmast in naus. Refer to Appendix 33 for data.

The one standard deviation of the bottom width of the main topmast to the height of the main topmast is constant throughout the galleons and nau samples with only slight differences between the ship types. The three-masted galleons and naus have similar deviations (0.03-0.09 and 0.04-0.09) while the four-masted galleons have a smaller range (0.05-0.08). The modal ranges indicate more variability within the three datasets. The three-masted galleons have the smallest range from 0.025 to 0.05 followed by the naus with 0.05 to 0.062 and then the four-masted galleons with 0.07 to 0.08 suggesting that this progression also reflects the increasing relative thickness of the main topmasts of the three ship samples.

Overall, there is remarkable uniformity between the bottom widths of the main topmast to the height of the main topmasts. Likewise, there is a correlation between the main topmast bottom widths and the bottom widths of the lower main mast for all three ship types. The three-masted galleons have a one standard deviation of 0.03 to 0.06 for the lower mast and a range of 0.03 to 0.09 for the upper mast. The ranges for the four-masted galleons are 0.05 to 0.09 for the lower mast and 0.05 to 0.08 for the upper mast. Likewise, for the naus the one standard deviation for the lower mast is 0.04 to 0.08 and 0.04 to 0.09 for the upper mast. The same consistency is seen in the modal ranges for the three ship samples; the lower and upper ranges are respectively 0.025-0.055 and 0.025-0.05 for the three-masted galleons, 0.06 to 0.08 and 0.07 and 0.08 for the four-masted galleons, and 0.04 to 0.07 and 0.05 to 0.062 for the naus.

Top Width of the Main Topmast to the Bottom Width of the Main Topmast: (W.TpUMa_W.BtUMa)

The one standard deviation for the bottom to top widths of the main topmast for the three-masted galleons is 0.82 to 0.98 and there are two distributions in the histogram graph (Figure 222) from 0.80 to 0.85, which is also the primary mode and from 0.90 to 1.00. The four-masted galleons have a one standard deviation of 0.65 to 0.97 and have three distributions in the histogram graph (Figure 223) from 0.55 to 0.75, from 0.80 to 0.90 and from 0.95 to 1.00, which is also the primary mode. The one standard deviation for the nau sample is much broader than that of the galleons from 0.30 to 1.37. The main distribution in the histogram graph (Figure 224) is also large ranging from 0.35 to 1.15 with two outliers at 0.25 to 0.30 (MA15.1523.06 and PA07.02) and another at 1.35 (EN02.01). The primary mode is from 1.00 to 1.05.

There is significant inconsistency between the one standard deviation ranges for the bottom to top widths between the three samples. It is interesting that the ratios of the bottom and top widths in relation to the height of the mast are highly uniform and produced small ranges whereas, the same measurements compared to each other results in discrepancies within the samples. The primary modes for the galleons and the naus are extremely helpful in instances such as this when there is a wide range of variation within the sample. The three-masted galleons have the most concise range of 0.80 to 0.85 but this may be due to the small sample size (N=10). The four-masted galleons appear to have less tapering than the three-masted galleons with a range of 0.95 to 1.00 while the nau sample has the no tapering of the main topmast with a mode at 1.00 to 1.05.

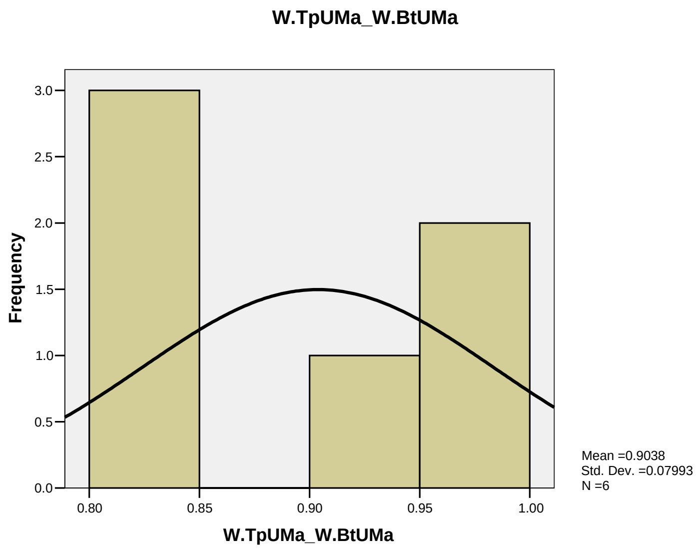


Figure 222: Histogram of the top width to the bottom width of the main topmast in three-masted galleons. Refer to Appendix 33 for data.

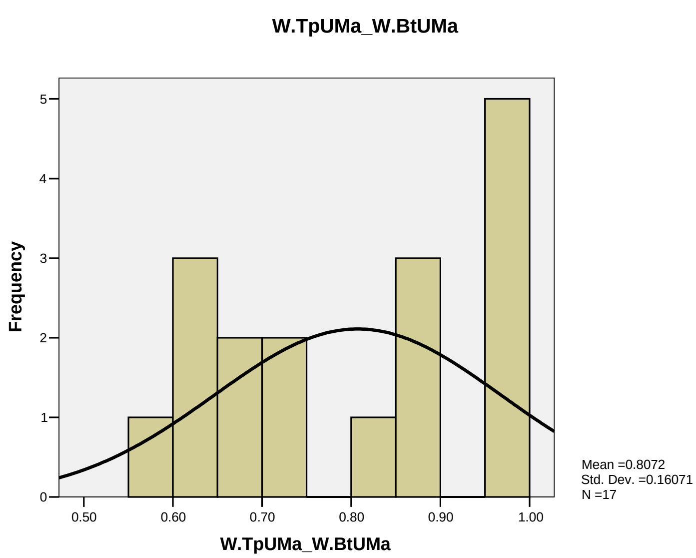


Figure 223: Histogram of the top width to the bottom width of the main topmast in four-masted galleons. Refer to Appendix 33 for data.

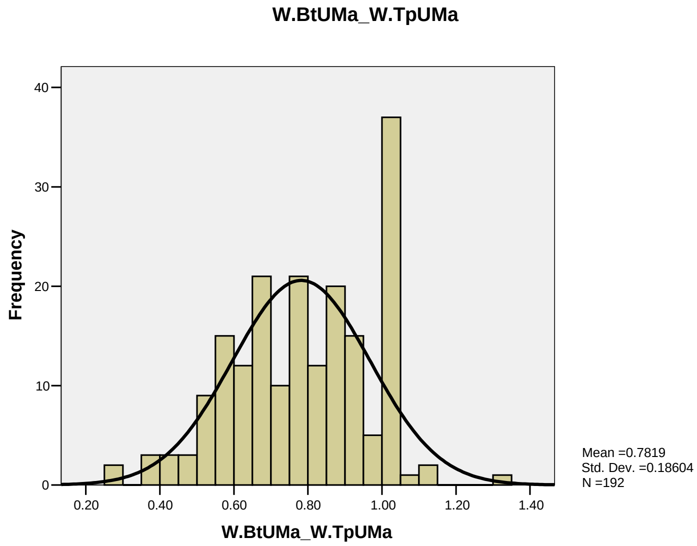


Figure 224: Histogram of the top width to the bottom width of the main topmast in naus. Refer to Appendix 33 for data.

There are noteworthy differences between the bottom to top widths of the main topmast and the bottom to top widths of the lower main masts between the three ship samples. The three-masted galleons have a lower mast one standard deviation of 0.56 to 0.84 and an upper range of 0.82 to 0.98 and the lower mast range for the four-masted galleons is 0.48 to 0.72 and the upper range is 0.65 to 0.97. Likewise, for the naus the lower mast one standard deviation range is 0.48 to 0.83 and an upper mast range of 0.30 to 1.37. The same level of variance is seen in the modal ranges for the three ship samples; the lower and upper mast ranges are respectively 0.65-0.70 and 0.80-0.85 for the three-masted galleons, 0.45-0.70 and 0.95-1.00 for the four-masted galleons, and 0.50-0.59 and 1.00-1.05 for the naus. This comparison clearly shows that there is a trend of significantly less tapering on the main topmast than the lower main mast, which was not as visible when evaluating the widths to the height of the mast.

Main Yard Dimensions

Main Yard Length Ratios

In the statistical analysis of the main yard there are 32 two-masted caravels, 13 three-masted caravels, 41 four-masted caravels, nine three-masted galleons, 23 four-masted galleons, and 181 naus. The length of the yard was measured from yardarm to yardarm while the middle width was taken as close to possible at its intersection with the mast and the end width is at the yardarm.

The main yard was the heaviest and the longest and often more than twice the breadth of the ship (Smith, 1993: 102). The *Livro Náutico* and Palacio both use the beam for calculating the length of the main sail yard. According to Palacio, the main yard should be slightly larger at 2 ⅓ what the ship's beam is in length (Bankston, 1986: 124). The length of the main yard in the *Livro Náutico*, however, is reported as being three times the beam. Although the beam generally cannot be directly measured in the iconography, it can be deduced using the *ah*, *dos*, *tres* rule. The calculated beam from this rule is one third the length of the hull on deck. As such, the ratio between the length of the main sail yard and the length of the hull in this analysis would be 0.33. Therefore, 2 ⅓ the beam (Palacio) would equal 0.75 and three times the beam (*Livro Náutico*) would equal 1.00 or exactly the length of the hull at deck; the expected range in the iconography is thus 0.75 to 1.00. Fernandez takes a different approach and states that the length of the main sail yard should equal the height of the main mast; Although it is not specified if this refers to the lower main mast or the entire spar, the iconographic analysis uses the latter.

The center of the main yard, which is the thickest portion of the spar, had the same diameter as the main mast. This proportion continued through the first part of the 17th century; however, in some cases the thickness decreased to roughly half of the diameter of the main masts (Smith, 1993: 102). Fernandez states that the diameter of the main yard is no larger than 51cm tapering to half this value at the ends (Castro, 2005b: 116). Castro (2005b: 116) affirms that all the documents used in his analysis (Fernandez and *Livro Náutico*) indicate that the tapered ends are half the value of the maximum diameter which is measured on the halyard. According to Palacio, however, the diameter of the main yard should be as thick as the main mast is in the middle, tapering ⅓ less to the yardarms thereby negating Castro's generalized statement (Bankston, 1986: 124). The resulting ratios of the tapering of the main sail yard based on the treatises is expected to be from 0.33 (Palacio) to 0.50 (Fernandez and *Livro Náutico*).

Length of the Main Yard to the Length of the Hull: (L.MaY_L.H)

The length of the main yard to the length of the hull ratio has a one standard deviation from 0.95 to 1.56 for the two-masted caravels. The main distribution in the histogram graph (Figure 225) is from 0.40 to 1.80 while the primary mode is from 1.20 to 1.40 and the secondary mode is from 1.40 to 1.60. The tabulation of the one standard deviation and center of distribution figures for all the main yard length ratios can be viewed in Table 59. The three-masted caravels have a one standard deviation of 0.76 to 1.50 and there is a split distribution in the histogram graph (Figure 226) from 0.40 to 1.00 with five vessels and from 1.20 to 1.80 with eight vessels. The primary mode of 1.20 to 1.40 is in the second distribution group. The four-masted caravels sample has a lower one standard deviation than the other two caravel samples from 0.60 to 1.06. The main distribution in the histogram graph (Figure 227) is from 0.40 to 1.30 with an outlier from 0.20 to 0.30 (MA16.1528-03). There are two equal primary modes from 0.60 to 0.70 and 0.80 to 0.90.

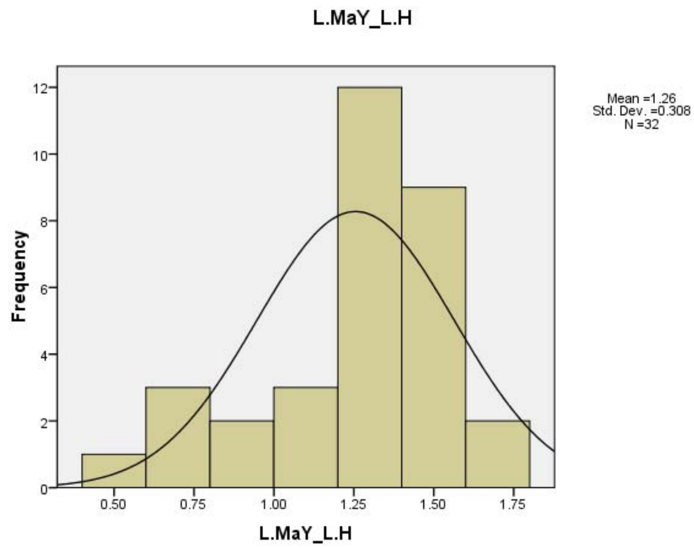


Figure 225: Histogram of the length of the main yard to the length of the hull in two-masted caravels. Refer to Appendix 33 for data.

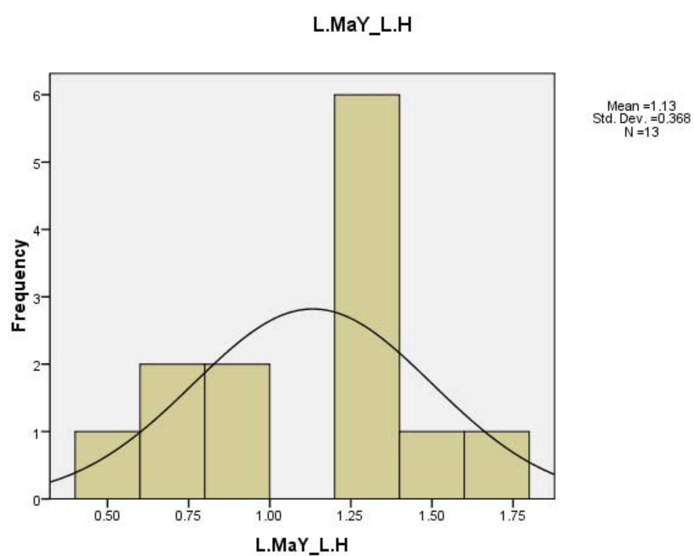


Figure 226: Histogram of the length of the main yard to the length of the hull in three-masted caravels. Refer to Appendix 33 for data.

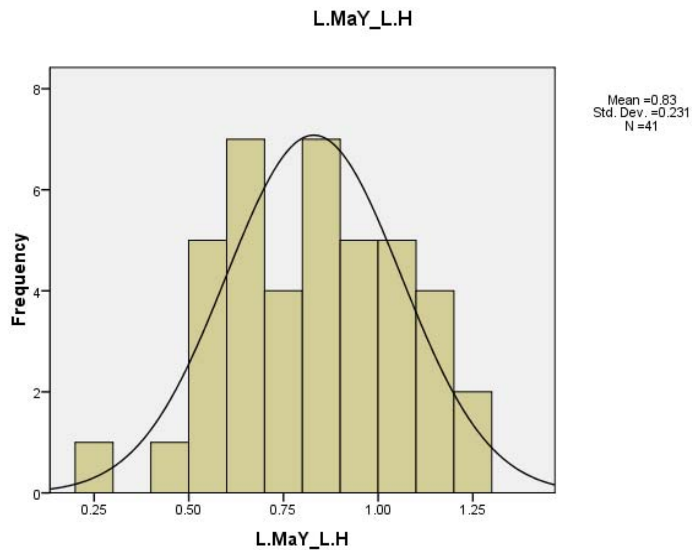


Figure 227: Histogram of the length of the main yard to the length of the hull in four-masted caravels. Refer to Appendix 33 for data.

TABLE 59: Comparison of the One Standard Deviation and Center of Distribution of the Main Yard Length Ratios

L.MaY_L.H	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Two-masted Caravels	0.95 to 1.56	1.10 to 1.46
Three-masted Caravels	0.76 to 1.50	0.82 to 1.35
Four-masted Caravels	0.60 to 1.06	0.64 to 1.02
Three-masted Galleons	0.24 to 1.08	0.34 to 0.87
Four-masted Galleons	0.48 to 1.24	0.47 to 1.09
Naus	0.53 to 1.14	0.61 to 0.96
L.MaY_H.Ma	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Two-masted Caravels	0.31 to 1.01	0.49 to 0.69
Three-masted Caravels	0.28 to .93	0.40 to 0.68
Four-masted Caravels	0.42 to 1.21	0.52 to 1.03
Three-masted Galleons	0.82 to 2.46	1.02 to 2.30
Four-masted Galleons	0.55 to 1.63	0.60 to 1.48
Naus	0.94 to 1.72	1.11 to 1.60

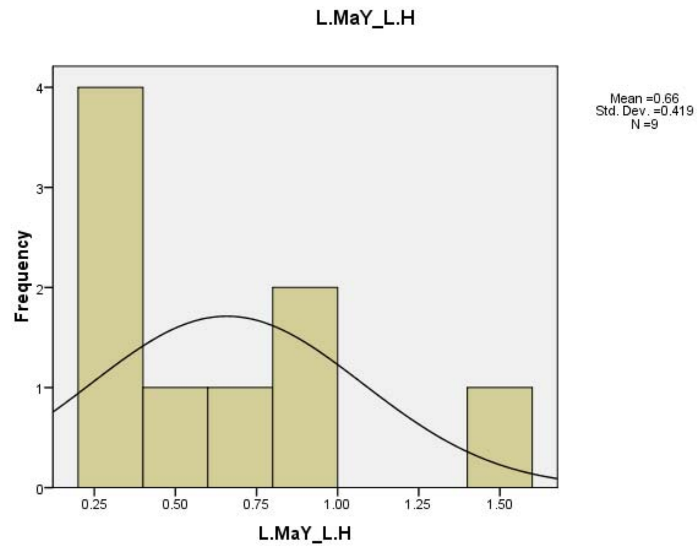


Figure 228: Histogram of the length of the main yard to the length of the hull in three-masted galleons. Refer to Appendix 33 for data.

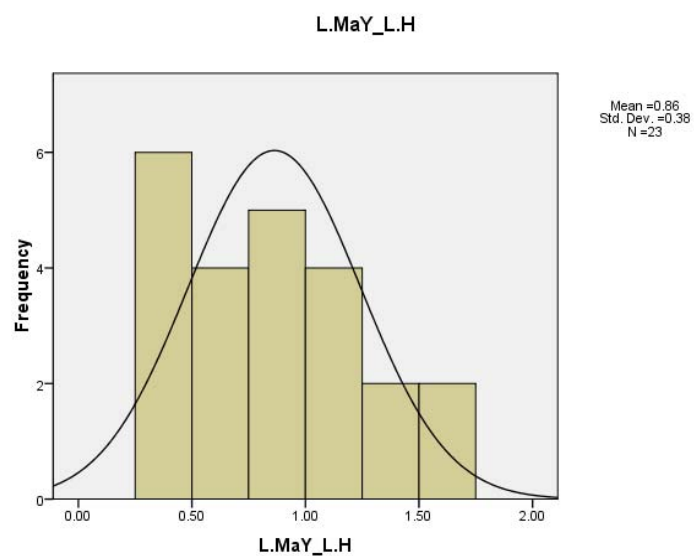


Figure 229: Histogram of the length of the main yard to the length of the hull in four-masted galleons. Refer to Appendix 33 for data.

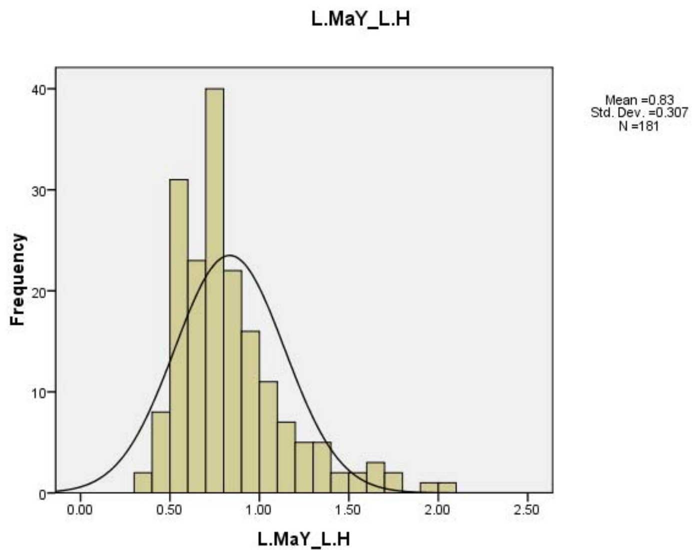


Figure 230: Histogram of the length of the main yard to the length of the hull in naus. Refer to Appendix 33 for data.

The length of the main yard to the length of the hull ratio for the three-masted galleons has a one standard deviation from 0.24 to 1.08 and a primary mode of 0.20 to 0.40 in the histogram graph (Figure 228). The main distribution of this sample is from 0.20 to 1.00 with an outlier from 1.40 to 1.60 (PA06.01). The four-masted galleons have a one standard deviation of 0.48 to 1.24 and a very broad primary mode of 0.25 to 0.50 and secondary mode of 0.75 to 1.00. The main distribution in the histogram graph (Figure 229) is from 0.25 to 1.75. The one standard deviation for the nau sample is from 0.53 to 1.14 and the main distribution is from roughly 1.30 to 1.80 and there are two outliers from 1.90 to 2.00 (MA16.1532-02) and 2.00 to 2.10 (PA03.05). The primary mode in the histogram graph (Figure 230) is from 0.70 to 0.80 while the secondary mode is from 0.50 to 0.60.

The one standard deviations of the length of the main yard to the length of the hull ratio all exhibit very broad ranges and there are modest discrepancies between the samples. The two- and three-masted caravel ranges are skewed the highest from 0.95 to 1.56 and 0.76 to 1.50 respectively while the three-masted galleons have the lowest range from 0.24 to 1.08. The four-masted caravels and galleons as well as the naus have relatively similar ranges from about the 50th percentile to roughly 110th percentile for the caravels and galleons all the way up to the 120th percentile for the naus. The center of distribution figures verifies these relative relationships between the samples.

The modal ranges show that the two- and three-masted caravels again have the longest yards compared to the length of the hull and have the same primary mode of 1.20 to 1.40; the range is extended to 1.60 with the secondary mode of the two-masted caravels. The four-masted caravels (0.60-0.90) and the naus (0.50-0.80) have modal ranges that are within 10% percent of each other suggesting moderate lengths of the main sail yard. The modal ranges of the galleons, however, are atypical with a very a low peak of 0.20 to 0.40 for the three-masted galleons and an extreme range of 0.25 to 1.00 for the four-masted galleons. Based on the one standard deviation ranges, it was expected that modal range for the four-masted galleons would be more similar to the four-masted caravels and the naus. The extremely low and abnormal modal range of the three-masted galleons can only be explained by the small sample number emphasizing errors rather than normal trends within the sample.

All of the samples reach the expected 0.75 to 1.00 relationship between the main sail yard and the beam by way of the length of the hull in the one standard deviation ranges. The modal ranges of the two- and three-masted caravels are well beyond the expected ratios while the four-masted caravels and naus appear to support Palacio's lower ratio of 0.75 or 2 ⅓ the beam. The secondary mode of the four-masted galleons is exactly the 0.75 to 1.00 ratio range, but the primary modes of both galleon samples are well below the proportions dictated by the treatises.

Length of the Main Yard to the Height of the Main Mast: (L.MaY_H.Ma)

The length of the main yard to the height of the main mast ratio for the two-masted caravel sample has a relatively large one standard deviation from 0.31 to 1.01. The main distribution in the histogram graph (Figure 231) is extensive from 0.30 to 1.50 with an outlier at 2.06 (MA10.06); the primary mode from 0.40 to 0.60. The three-

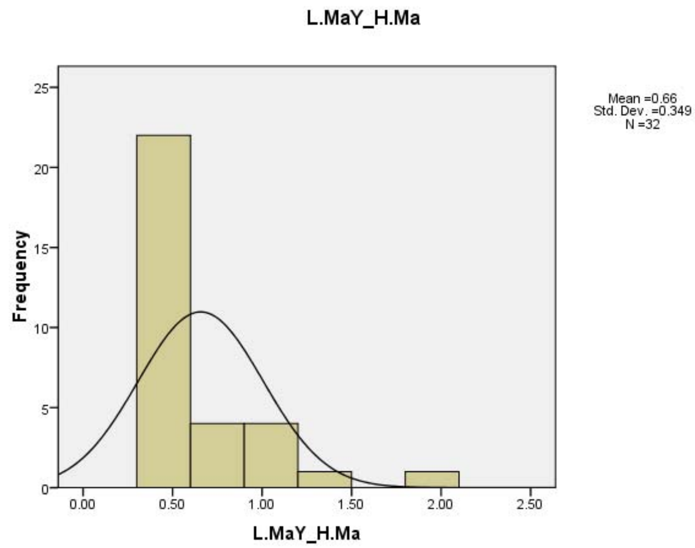


Figure 231: Histogram of the length of the main yard to the height of the main mast in two-masted caravels. Refer to Appendix 33 for data.

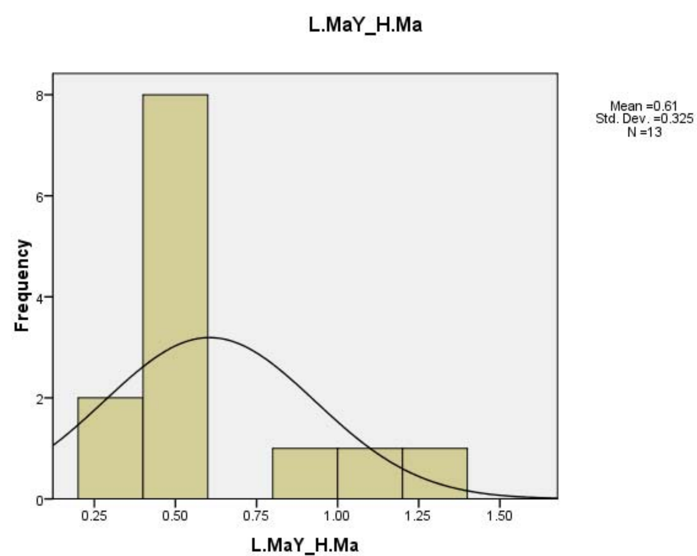


Figure 232: Histogram of the length of the main yard to the height of the main mast in three-masted caravels. Refer to Appendix 33 for data.

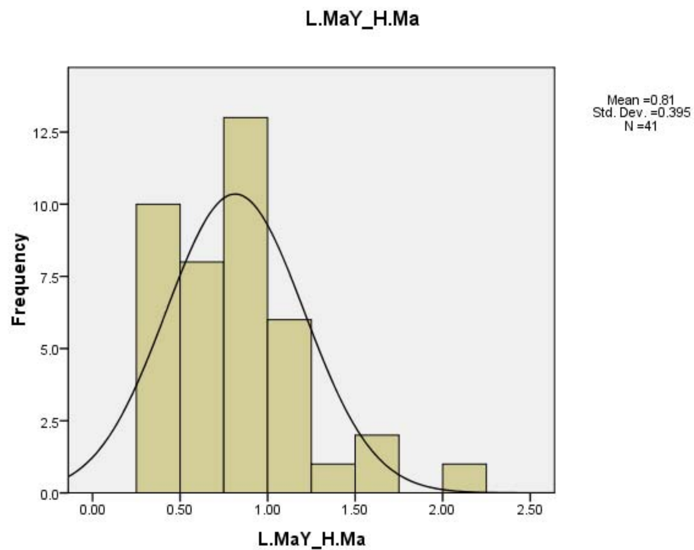


Figure 233: Histogram of the length of the main yard to the height of the main mast in four-masted caravels. Refer to Appendix 33 for data.

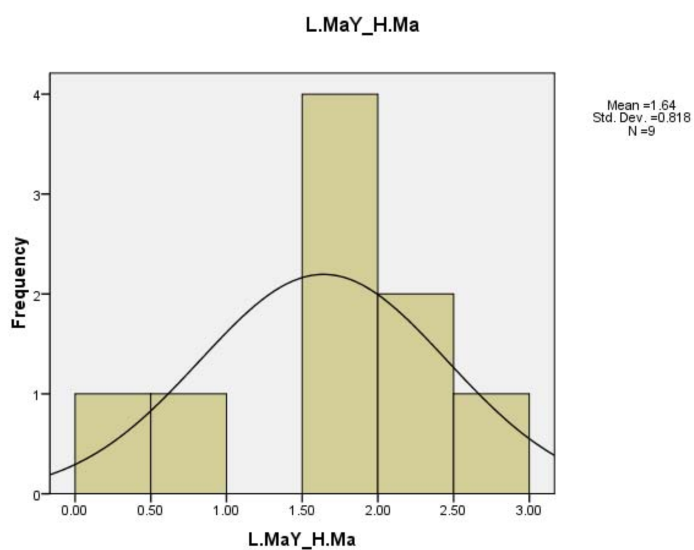


Figure 234: Histogram of the length of the main yard to the height of the main mast in three-masted galleons. Refer to Appendix 33 for data.

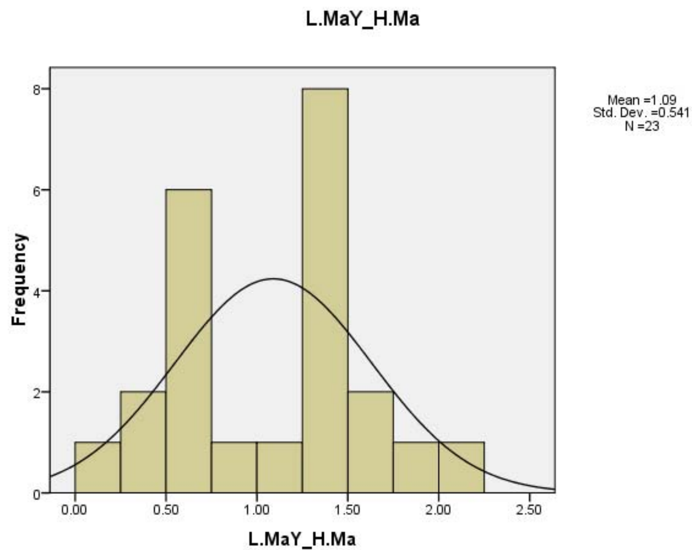


Figure 235: Histogram of the length of the main yard to the height of the main mast in four-masted galleons. Refer to Appendix 33 for data.

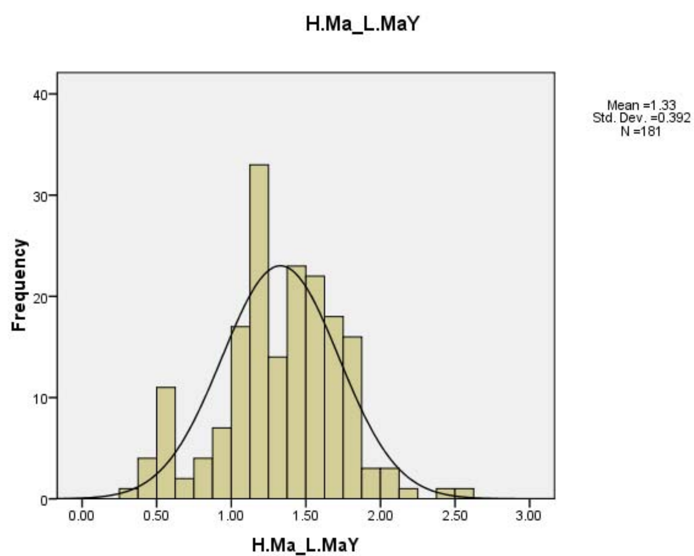


Figure 236: Histogram of the length of the main yard to the height of the main mast in naus. Refer to Appendix 33 for data.

masted caravels have a one standard deviation of 0.28 to 0.93 and a small main distribution in the histogram graph (Figure 232) from 0.20 to 0.60 with a primary mode 0.40 to 0.60. There are outliers at 0.84 (MA13.16), 1.16 (MA03.16), and 1.39 (CA27.02). The one standard deviation of the four-masted caravels is from 0.42 to 1.21 while the main distribution is from 0.25 to 1.75 with an outlier from 2.00 to 2.25 (MA16.1528-03). The primary mode in the histogram graph (Figure 233) is from 0.75 to 1.00.

The three-masted galleon sample has an extreme one standard deviation of the length of the main yard to the height of the main mast from 0.82 to 2.46 with the main distribution ranging from 1.50 to 3.00. There is an outlier at 0.25 to 0.50 (PA06.01) and another at 0.50 to 0.75 (MA15.1502.01). The corresponding histogram graph (Figure234) shows a primary mode from 1.50 to 2.00. The one standard deviation of the four-masted galleons is from 0.55 to 1.63 while the primary mode is from 1.25 to 1.50. The main distribution in the histogram graph (Figure 235) is from 0.00 to 2.25. The nau sample has a one standard deviation from 0.94 to 1.72. Although there is an extensive main distribution from 0.25 to 2.25, the primary mode of 1.12 to 1.24 in the histogram graph (Figure 236) is consistent with the one standard deviation.

The one standard deviation ranges for every sample are extensive; the caravel samples are skewed much lower from roughly the 30th to the 40th percentiles to the 100th to 120th percentiles. Whereas, the galleon and nau samples are much higher from the 50th to the 160th percentile in the case of the four-masted galleons to the 80th to the 240th and the 90th to the 170th percentiles for the three-masted galleons and the naus. However, it is logical that the caravels would have smaller yards in comparison to the height of the masts since these vessels only had a lower main mast. In contrast, the square-rigged galleon and nau main masts were comprised of a lower and an upper mast. This is also reflected in the small modal ranges of the two- and three-masted caravels from of 0.40 to 0.60; the four-masted caravels modes are higher at 0.75 to 1.00. The primary modes of the galleons and naus are nearly double that of the caravels and decrease in size from the three-masted galleons to the four-masted galleons to the naus, which is evident in the ranges suggesting high variability and thus less accuracy in the galleon samples.

Comparing Fernandez's statement that the length of the main yard should equal the height of the main mast to the iconography shows that all one standard deviation ranges meet a 1.00 ratio with the exception of the three-masted caravels which fall short at 0.93. The primary modes indicate, however, that there is much more variability within the iconography. The depicted caravels have shorter main yards to the height of the main mast while the galleons and naus have much larger yards. Again, given that the height of the main mast in the caravel samples is calculated only from the lower mast, this is not unexpected. The length of the main yard in the galleon and nau samples supports the generally accepted trend that the lengths of the yards in the iconography were exaggerated in order to produce a more powerfully depicted sail. Although it was not specified in the manuscript if the height of the main mast refers to the lower main mast or the entire spar, it is clear from these results that Fernandez is referring to the entire height of the main mast.

Main Yard Width Ratios

Middle Width of the Main Yard to the Length of the Main Yard: (W.MMaY_L.MaY)

The one standard deviation of the middle width of the main yard to the length of the main yard for the two-masted caravels is from 0.02 to 0.04. The main distribution in the histogram graph (Figure 237) is from 0.01 to 0.045 with one outlier (MA10.06) at 0.06 to 0.065. The primary mode is from 0.02 to 0.025 and the secondary mode in the graph is 0.025 to 0.02. The tabulation of the one standard deviation and center of distribution figures for all the main yard width ratios can be viewed in Table 60. The three-masted caravels have a one standard deviation from 0.01 to 0.04 and a main distribution from 0.00 to 0.025; there is an outlier at 0.04 to 0.05 (MA03.16) and another at 0.07 to 0.08 (CA27.02). The primary mode in the histogram graph (Figure 238) is from 0.01 to 0.02. The one standard deviation for the four-masted caravels is also from 0.01 to 0.04, which is consistent with the primary mode in the histogram graph (Figure 239) from 0.02 to 0.03. The main distribution is from 0.00 to 0.07 and there is an outlier from 0.09 to 0.10 (CA27.05).

The one standard deviation for the middle width to the length of the main yard for the three-masted galleons is 0.01 to 0.07 and the main distribution is from 0.00 to 0.10. The primary mode in the histogram graph (Figure 240) is from 0.03 to 0.04. The four-masted galleons have a one standard deviation of 0.02 to 0.05. The main distribution in the histogram graph (Figure 241) is from 0.01 to 0.06 with one outlier (EN04.03) from 0.08 to 0.09. The primary mode is from 0.02 to 0.03. The one standard

TABLE 60: Comparison of the One Standard Deviation and Center of Distribution of the Main Yard Width Ratios

W.MMaY_L. MaY	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Two-masted Caravels	0.02 to 0.04	0.02 to 0.03
Three-masted Caravels	0.01 to 0.04	0.02 to 0.03
Four-masted Caravels	0.01 to 0.04	0.02 to 0.03
Three-masted Galleons	0.01 to 0.07	0.02 to 0.07
Four-masted Galleons	0.02 to 0.05	0.02 to 0.04
Naus	0.01 to 0.05	0.02 to 0.04
W.MMaY _ W.EMaY	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Two-masted Caravels	0.64 to 0.98	0.67 to 1.00
Three-masted Caravels	0.66 to 1.00	0.71 to 0.99
Four-masted Caravels	0.52 to 0.99	0.56 to 1.00
Three-masted Galleons	0.65 to 1.04	0.69 to 1.00
Four-masted Galleons	0.59 to 0.95	0.62 to 0.95
Naus	0.61 to 0.98	0.66 to 1.00
W.MMaY _ W.BtLMa	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Two-masted Caravels	0.48 to 0.90	0.52 to 0.82
Three-masted Caravels	0.36 to 0.75	0.36 to 0.74
Four-masted Caravels	0.35 to 0.84	0.46 to 0.71
Three-masted Galleons	0.42 to 0.73	0.44 to 0.64
Four-masted Galleons	0.42 to 0.89	0.43 to 0.79
Naus	0.40 to 0.77	0.45 to 0.69

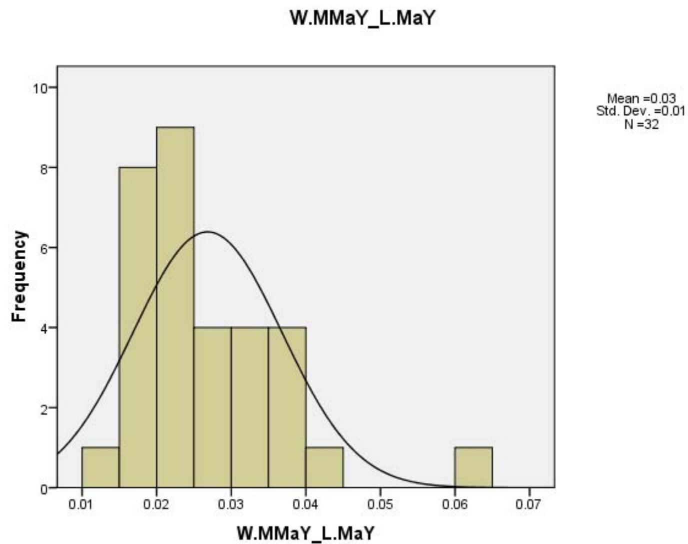


Figure 237: Histogram of the middle width of the main yard to the length of the main yard in two-masted caravels. Refer to Appendix 33 for data.

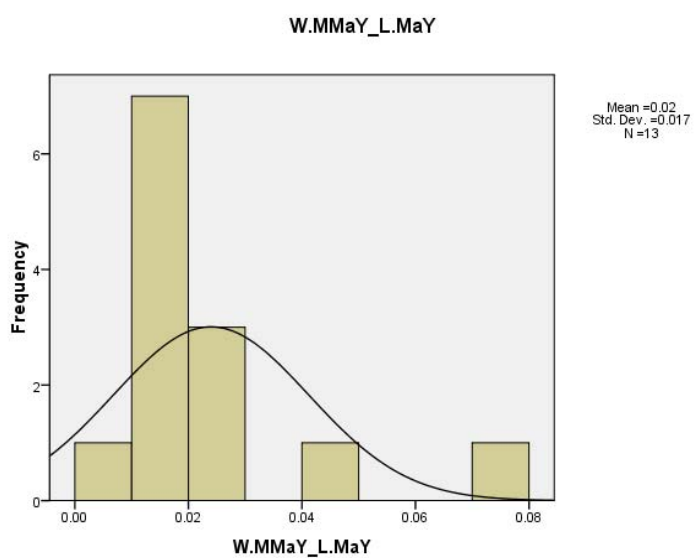


Figure 238: Histogram of the middle width of the main yard to the length of the main yard in three-masted caravels. Refer to Appendix 33 for data.

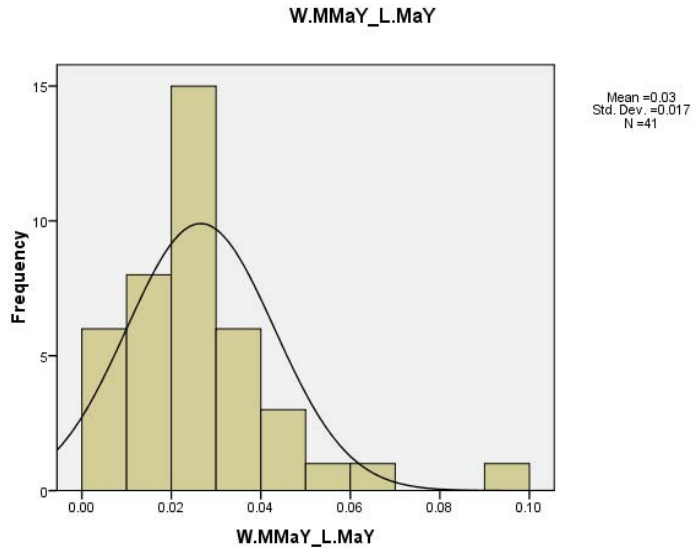


Figure 239: Histogram of the middle width of the main yard to the length of the main yard in four-masted caravels. Refer to Appendix 33 for data.

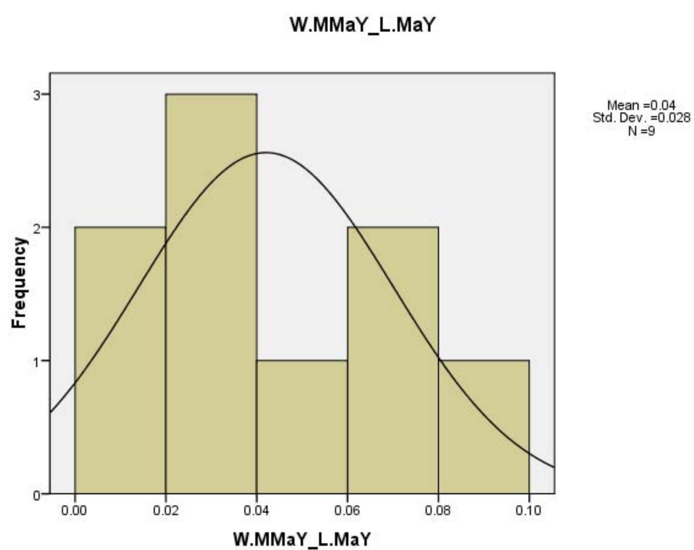


Figure 240: Histogram of the middle width of the main yard to the length of the main yard in three-masted galleons. Refer to Appendix 33 for data.

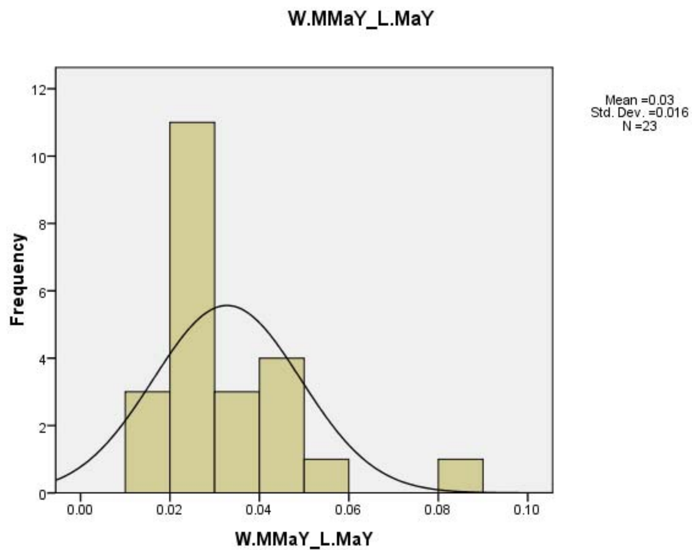


Figure 241: Histogram of the middle width of the main yard to the length of the main yard in four-masted galleons. Refer to Appendix 33 for data.

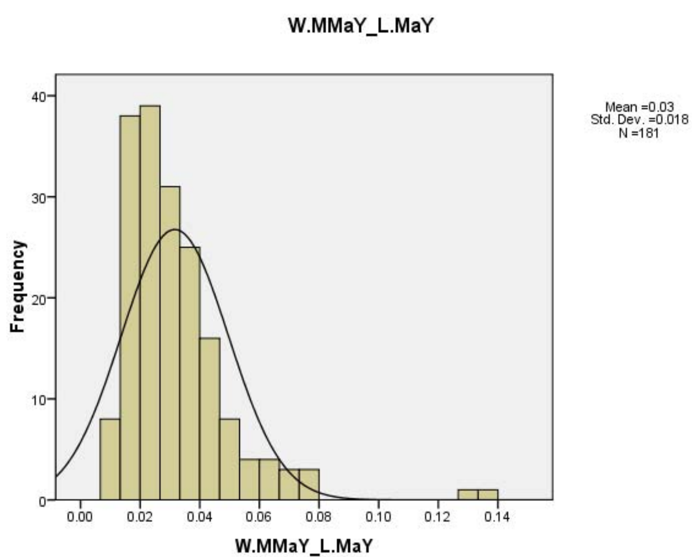


Figure 242: Histogram of the middle width of the main yard to the length of the main yard in naus. Refer to Appendix 33 for data.

deviation for the nau sample is 0.01 to 0.05 and the main distribution is from 0.01 to 0.08; there is one outlier (CA27.03) at 0.13 and another (CA27.06) at 0.14. There primary mode in the histogram graph (Figure 242) is from 0.02 to 0.03 with a secondary mode from 0.01 to 0.02.

The middle width of the main yard to the length of the main yard ratio has a consistent one standard deviation for the caravels, galleons, and naus with only a few percentage points difference between the ship types. The center of distribution figures narrows the distribution and shows that all three caravel samples have a range of 0.02 to 0.03 while the four-masted galleons and naus both have a range of 0.02 to 0.04. The three-masted galleon sample exhibits a broader variation with a range of 0.02 to 0.07. There is only nominal variance within the modal ranges of the middle width of the yard to the length of the yard. The three-masted caravels have peaks from 0.01 to 0.02, the naus have a range from 0.01 to 0.03, the two-masted caravels, four-masted caravels, and four-masted galleons all have a slightly higher range of 0.02 to 0.03, and the three-masted galleons have a range from 0.03 to 0.04. On average the middle width of the main yard is 1% to 3% of the length of the spar.

Middle Width of the Main Yard to the End Width of the Main Yard: (W.MMaY_ W.EMaY)

The one standard deviation of the middle width to the end width of the main yard for the two-masted caravels is 0.64 to 0.98. The main distribution in the histogram graph (Figure 243) is from 0.40 to 1.00 and there is a primary mode is from 0.90 to 1.00. The

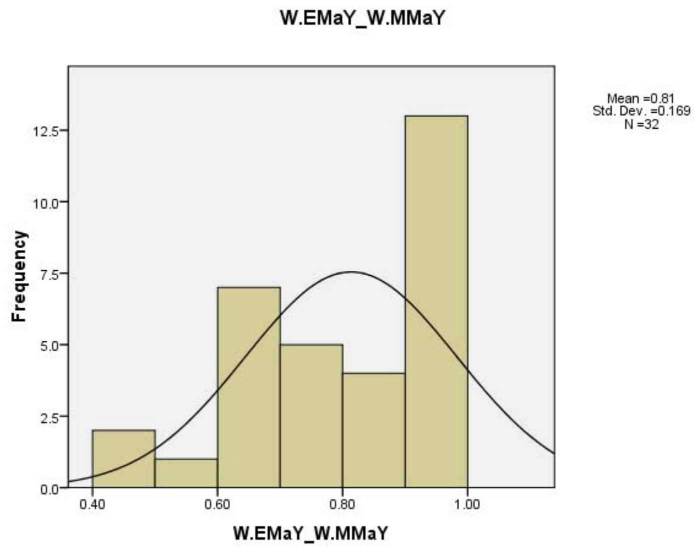


Figure 243: Histogram of the middle width to the end width of the main yard in two-masted caravels. Refer to Appendix 33 for data.

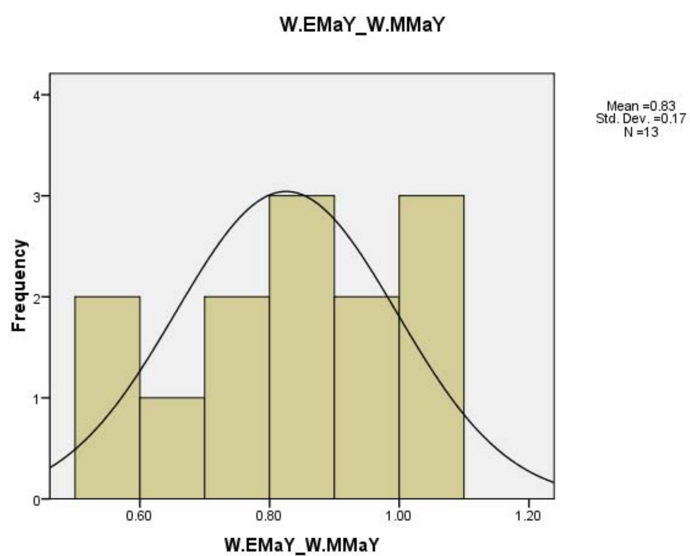


Figure 244: Histogram of the middle width to the end width of the main yard in three-masted caravels. Refer to Appendix 33 for data.

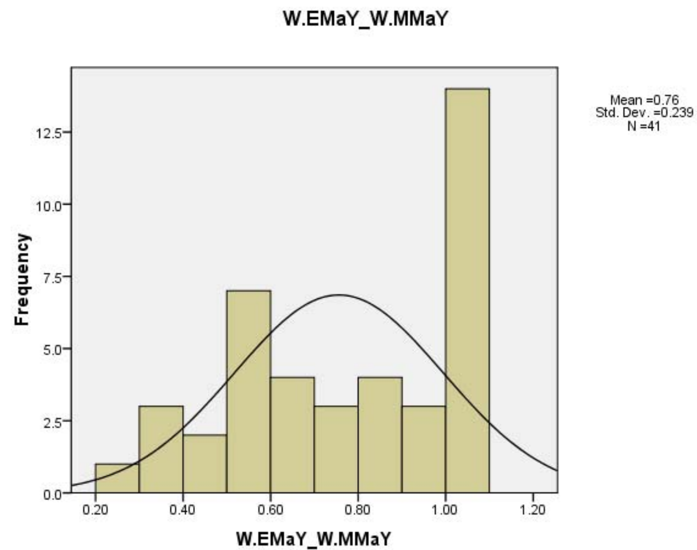


Figure 245: Histogram of the middle width to the end width of the main yard in four-masted caravels. Refer to Appendix 33 for data.

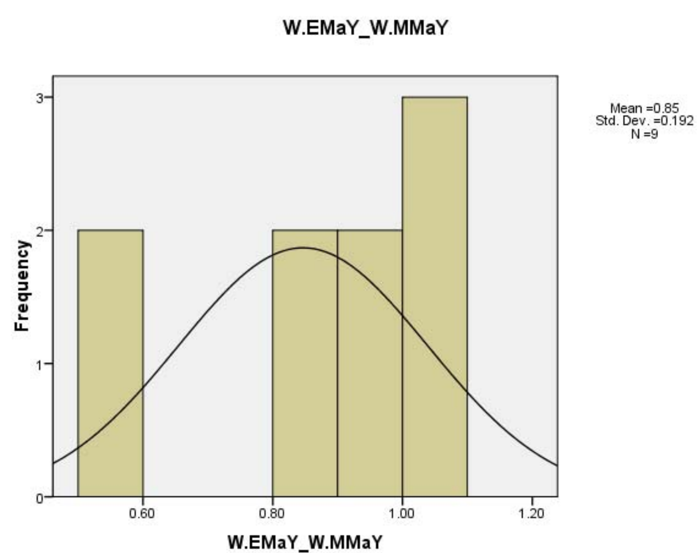


Figure 246: Histogram of the middle width to the end width of the main yard in three-masted galleons. Refer to Appendix 33 for data.

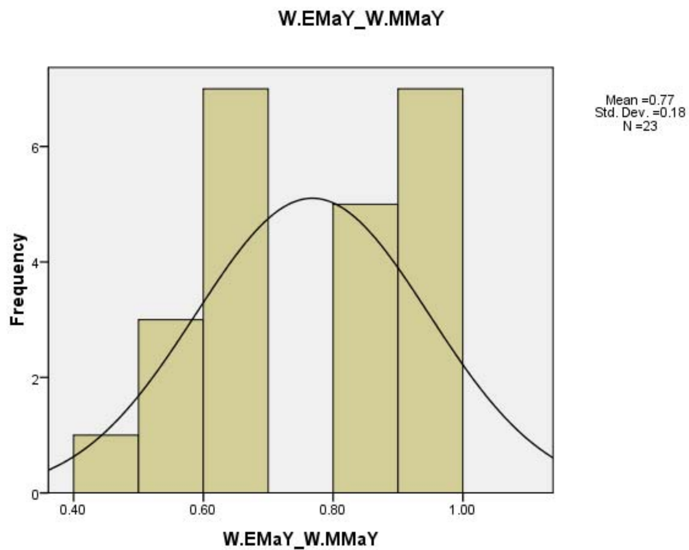


Figure 247: Histogram of the middle width to the end width of the main yard in four-masted galleons. Refer to Appendix 33 for data.

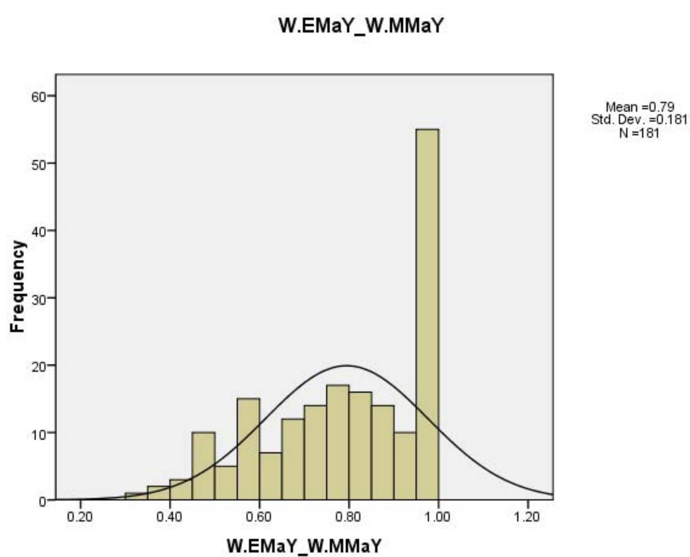


Figure 248: Histogram of the middle width to the end width of the main yard in naus. Refer to Appendix 33 for data.

three-masted caravels have a similar one standard deviation to the two-masted caravels from 0.66 to 1.00. The main distribution in the histogram graph (Figure 244) is from 0.50 to 1.10 and there are two equal primary modes from 0.80 to 0.90 and 1.00 to 1.10. The one standard deviation for the four-masted caravels is from 0.52 to 0.99, which is consistent with the main distribution of from 0.20 to 1.10. The primary mode in the histogram graph (Figure 245) is from 1.00 to 1.10.

The one standard deviation for the middle to end widths of the main yard for the three-masted galleons is 0.65 to 1.04. The main distribution in the histogram graph (Figure 246) is from 0.80 to 1.10 and there are two outliers from 0.50 to 0.60 (PA08.01); the primary mode is from 1.00 to 1.10. The four-masted galleons have a one standard deviation of 0.59 to 0.95. The distribution in the histogram graph (Figure 247) is split from 0.40 to 0.70 with a primary mode of 0.60 to 0.70 while the second distribution is from 0.80 to 1.00 with a primary mode is from 0.90 to 1.00. The one standard deviation for the nau sample is 0.61 to 0.98 and the main distribution is from 0.30 to 1.00; the primary mode in the histogram graph (Figure 248) is from 0.95 to 1.00.

The one standard deviation ranges are from roughly the 60th percentile to the 100th percentile with the exception of the four-masted caravels which start slightly lower at 0.52. The primary modes of the four-masted caravels and the three-masted galleons (1.00 to 1.10) show that there is no tapering of the yards for these samples and that the end width is minimally larger than the middle width. Likewise, the two-masted caravels and the nau samples range from 0.90 to 1.00 and 0.95 to 1.00 respectively, whereas the three-masted caravels are slightly lower at 0.80 to 1.10 all suggestive of little to no tapering of the main yard. The four-masted galleons have the largest modal range of 0.60 to 1.00 and given the other samples, it may be possible the secondary mode of 0.90 to 1.00 is a more reliable indicator of normal variation. The amount of tapering of the main yard based on the treatises was expected to be from 0.66 (Palacio) to 0.50 (Fernandez and *Livro Náutico*). Although the one standard deviations support Palacio's 0.66 ratio of middle to end tapering, none of the samples exhibit a 0.50 ratio. Likewise, the modal peaks are well beyond a 50% to 66% range for all samples except the four-masted galleons. It is probable that the artists did not show tapering of the yards because of the small nature of the spar within the painting and the emphasis on the sail as opposed to details of the yard. Furthermore, the widths of the masts and yards are prone to error because the diameter is a three-dimensional measurement that is portrayed as a flat two-dimensional measurement.

Middle Width of the Main Yard to the Bottom Width of the Lower Main Mast: (W.MMaY_W.BtLMa)

The one standard deviation for the middle width of the main yard to the bottom width of the lower main mast for the two-masted caravels is 0.48 to 0.90. The main distribution in the histogram graph (Figure 249) is from 0.30 to 1.20 and there are two equal primary modes from 0.40 to 0.50 and 0.50 to 0.60. The three-masted caravels have a one standard deviation of .36 to .75 and a main distribution from 0.40 to 0.90. There are two equal primary modes in the histogram graph (Figure 250) from 0.70 to 0.80 in the main distribution and from 0.20 to 0.30, which acts as a secondary distribution. The

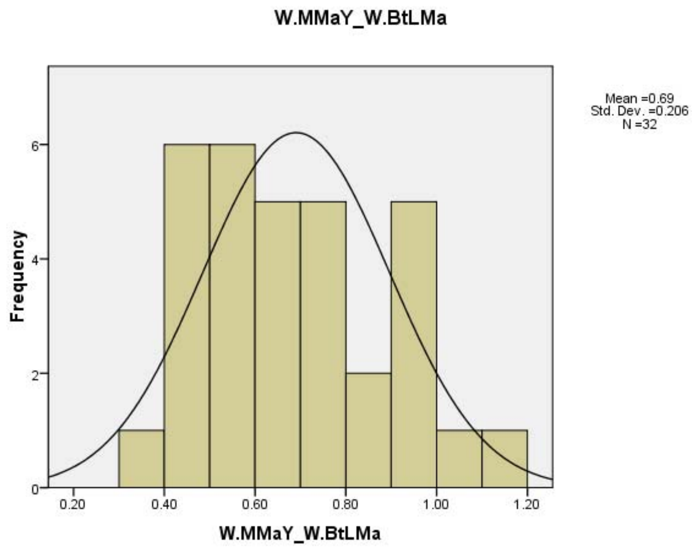


Figure 249: Histogram of the middle width of the main yard to the bottom width of the lower main mast in two-masted caravels. Refer to Appendix 33 for data.

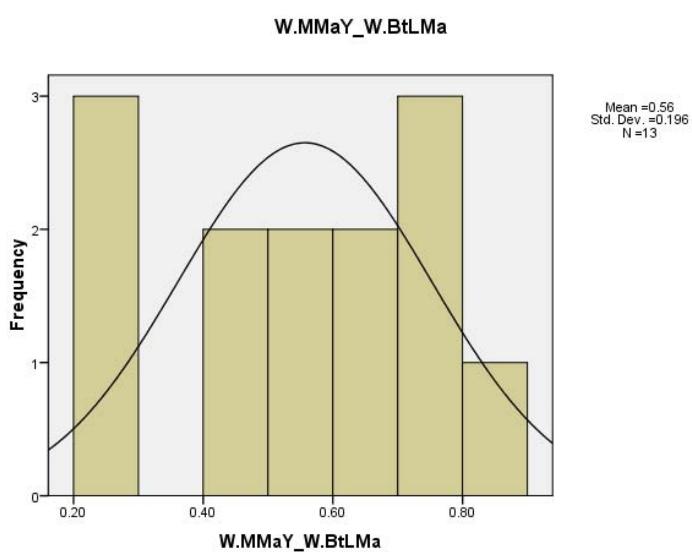


Figure 250: Histogram of the middle width of the main yard to the bottom width of the lower main mast in three-masted caravels. Refer to Appendix 33 for data.

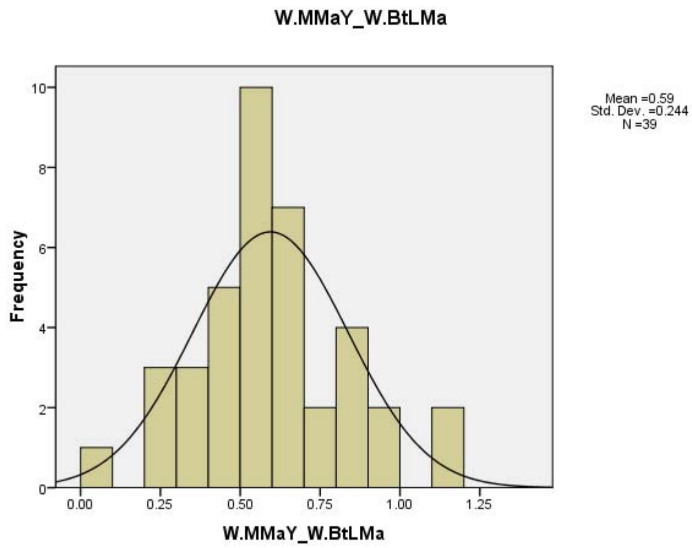


Figure 251: Histogram of the middle width of the main yard to the bottom width of the lower main mast in four-masted caravels. Refer to Appendix 33 for data.

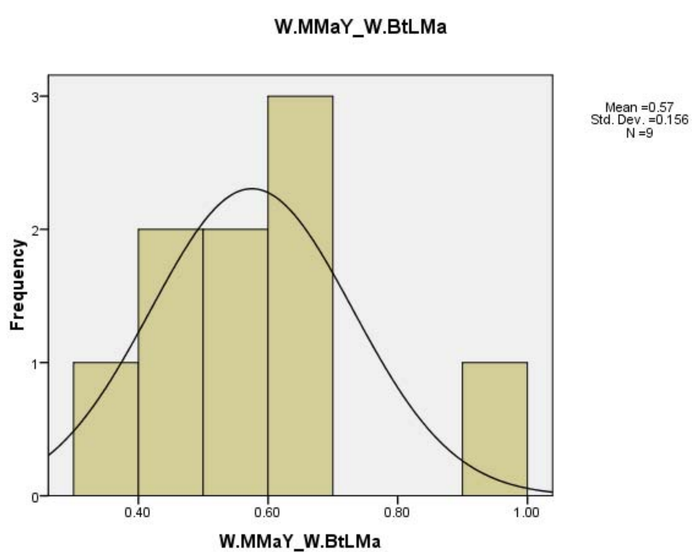


Figure 252: Histogram of the middle width of the main yard to the bottom width of the lower main mast in three-masted galleons. Refer to Appendix 33 for data.

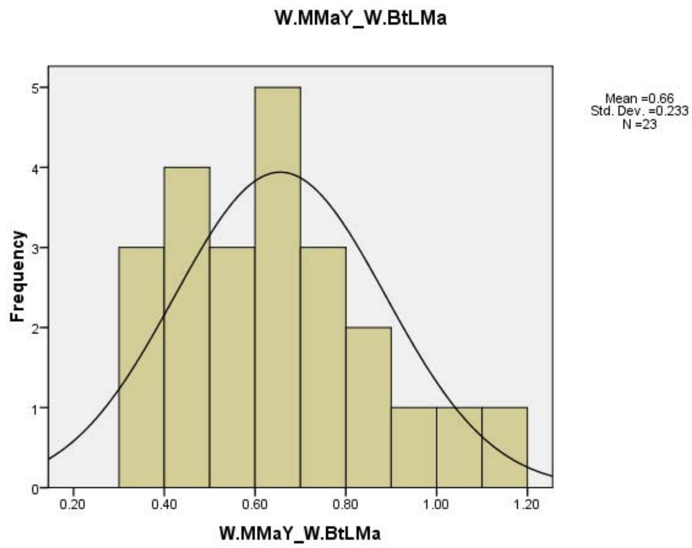


Figure 253: Histogram of the middle width of the main yard to the bottom width of the lower main mast in four-masted galleons. Refer to Appendix 33 for data.

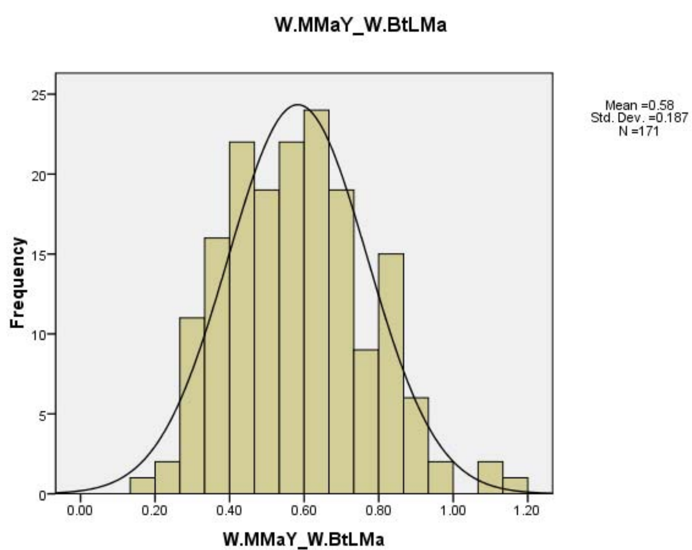


Figure 254: Histogram of the middle width of the main yard to the bottom width of the lower main mast in naus. Refer to Appendix 33 for data.

one standard deviation of the four-masted caravel sample is from 0.35 to 0.84 and the main distribution in the histogram graph (Figure 251) is from 0.20 to 1.00 with an outlier at 0.00 to 0.10 (MA01.02) and two at 1.10 to 1.20 (CA27.05 and CA13.02) while the primary mode is from 0.50 to 0.60.

The one standard deviation for the middle width of the main yard to the bottom width of the lower main mast for the three-masted galleons is from 0.42 to 0.73. The main distribution is from 0.30 to 0.70 and there is an outlier from 0.90 to 1.00 (CA04.29). The primary mode in the histogram graph (Figure 252) is from 0.60 to 0.70.

The four-masted galleons have a one standard deviation of 0.42 to 0.89 and an extensive main distribution from 0.30 to 1.20. Like the three-masted galleons, the primary mode in the histogram graph (Figure 253) is from 0.60 to 0.70. One standard deviation for the nau sample is from 0.40 to 0.77 and the main distribution is form 0.15 to 1.00 in the histogram graph (Figure 254) with two outliers at 1.10 to 1.15 (MA16.1558-02) and another from 1.15 to 1.20 (MA15.1529.02). The primary mode is from 0.60 to 0.65 and there are two equal secondary modes from 0.40 to 0.45 and from 0.55 to 0.60.

The one standard deviation figures indicate that the three- and four-masted caravels have the lowest skewed ranges from 0.36 to 0.75 and 0.35 to 0.84 respectively suggesting relatively small middle widths of the main yard to the width of the mast. The two-masted caravels, however, have the highest skewed sample from 0.48 to 0.90 with the opposite; thicker main yards to the mast width. The three-masted galleons, four-masted galleons, and the naus are fairly similar with the four-masted galleons having the broadest range of the three samples. The center of distribution figures demonstrate that all samples but the two- and three-masted caravels have ranges from roughly the 40th to the 70th percentile.

The modal ranges verify the correlations of the center of distribution figures but show that only the three-masted caravels (0.20 to 0.80) have modal peaks starting significantly lower than the rest of the samples. Whereas the two-masted caravels (0.40 to 0.60) are much more closely aligned with the four-masted galleons and the naus both of which have a range of 0.40 to 0.70. The four-masted caravels and the three-masted galleons are skewed higher at 0.50 to 0.60 and 0.60 to 0.70 respectively. Interestingly none of the figures match the 1:1 relationship between the middle width of the main yard and the maximum width of the main mast stated by Cano. Unlike the analysis of the length of the yard where the iconography exceeded the ratios from the treatises, these results cannot be explained by the exaggerated depiction of the yards. In this case, either the width of the main yard is too small or the width of the main mast is too large. Unfortunately, due to the fact that the widths of both the yards and mast are not given much attention in the treatises it is only possible to conclude that the iconography of the yards does not correspond to the archival evidence.

Main Topsail Yard Dimensions

Main Topsail Yard Length Ratios

In the statistical analysis of the main topsail yard there are 17 galleons and 155 naus; the caravels were excluded from the testing due to the absence of a main topmast for this ship type. The length of the yard was measured from yardarm to yardarm while the middle width was taken as close as possible at its intersection with the mast and the end width at the yardarm.

The *Livro Náutico* specifies that the main topsail yard is ⅓ less the length of the main yard (0.66) and that the maximum diameter is half a *penão, which* was one of the two halves of a square sail yard scarfed together in the center, of the main yard (Castro, 2005b: 117). In here, each *penão* for a main yard is 26 cm resulting in a maximum diameter of the main topsail yard of 13 cm and a ratio of 0.25. Palacio, however, calculates the main topsail yard as the length of the ship's beam or 11.3 m (Bankston, 1986: 124). The ship's beam using the *ah*, *dos*, *tres* rule is one-third the length of the hull which correlates to a ratio between the length of the main topsail yard and the length of the hull of 0.33.

Length of the Main Topsail Yard to the Length of the Hull: (L.MaTpY_L.H)

The length of the main topsail yard to the length of the hull ratio for the galleon sample has a one standard deviation from 0.18 to 0.53. The tabulation of the one standard deviation and center of distribution figures for all the main yard width ratios can be viewed in Table 61. The main distribution in the histogram graph (Figure 255) ranges from 0.10 to 0.60 and there is an outlier at 0.80 to 0.90 (PA09.02) and a primary mode at 0.20 to 0.30. The nau sample has a one standard deviation similar to the galleons from 0.23 to 0.52 with the main distribution ranging from 0.10 to 0.70 and outliers at 0.85 to 0.90 (MA16.1561-05), 0.90 to 0.95 (MA16.1543-02), and 0.95 to 1.00 (MA16.1532-02). The corresponding histogram graph (Figure 256) shows a primary mode at 0.35 to 0.40 and a secondary mode 0.30 to 0.35. The one standard deviation as well as the center of distribution figures are consistent between the galleons and naus and vary by only a few percentage points. Likewise, the modal ranges are similar but the galleons have a lower range from 0.20 to 0.30 while the naus have a higher range from 0.30 to 0.40 suggesting slightly longer yards. The comparison of the iconography to Palacio's statement that the main topsail yard should be the same dimension as the ship's beam (or 0.33 of the length of the hull) proves a strong association between the two sources of data. The one standard deviation ranges as well as the modal ranges both correlate highly with the 0.33 ratio between the length of the main topsail yard and the length of the hull.

Length of the Main Topsail Yard to the Length of the Main Yard: (L.MaTpY_L.MaY)

The length of the main topsail yard to the length of the main yard ratio for the galleon sample has a one standard deviation of 0.42 to 0.66 and two equal primary modes in the histogram graph (Figure 257) from 0.50 to 0.55 and 0.60 to 0.65 both of which are consistent with the main distribution of 0.30 to 0.75. One standard deviation

TABLE 61: Comparison of the One Standard Deviation and Center of Distribution of the Main Topsail Yard Length and Width Ratios

L.MaTpY_L.H	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Galleons	0.18 to 0.53	0.23 to 0.44
Naus	0.23 to 0.52	0.27 to 0.46
L.MaTpY_L.MaY	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Galleons	0.42 to 0.66	0.44 to 0.64
Naus	0.37 to 0.61	0.41 to 0.57
W.MMaTpY_L. MaTpY	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Galleons	0.03 to 0.08	0.04 to 0.07
Naus	0.03 to 0.08	0.03 to 0.07
W.MMaTpY _ W.EMaTpY	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Galleons	0.82 to 1.02	0.84 to 1.00
Naus	0.70 to 1.03	0.74 to 1.00
W.MMaTpY _ W.MMaY	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Galleons	0.59 to 0.95	0.63 to 0.94
Naus	0.57 to 1.07	0.63 to 1.00

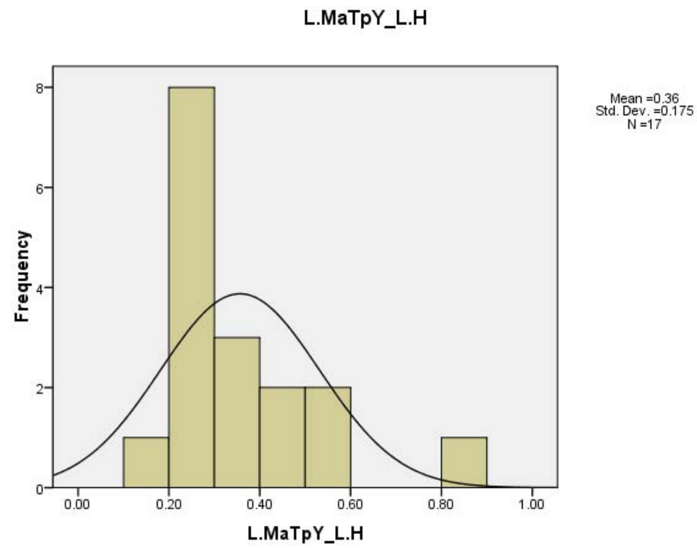


Figure 255: Histogram of the length of the main topsail yard to the length of the hull in galleons. Refer to Appendix 33 for data.

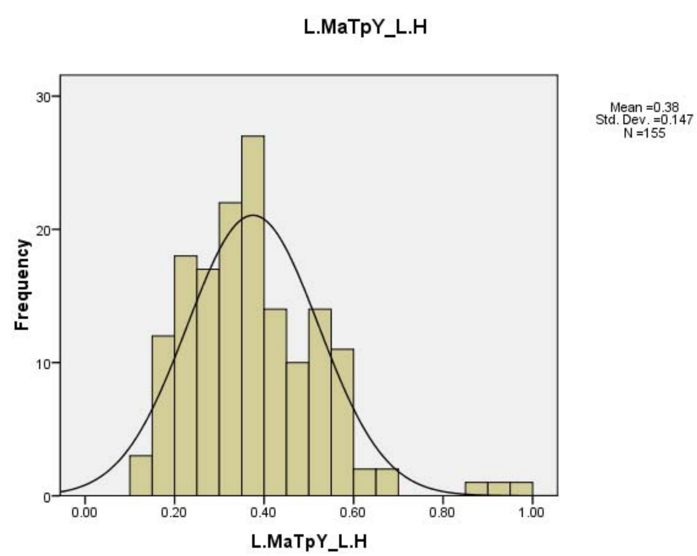


Figure 256: Histogram of the length of the main topsail yard to the length of the hull in naus. Refer to Appendix 33 for data.

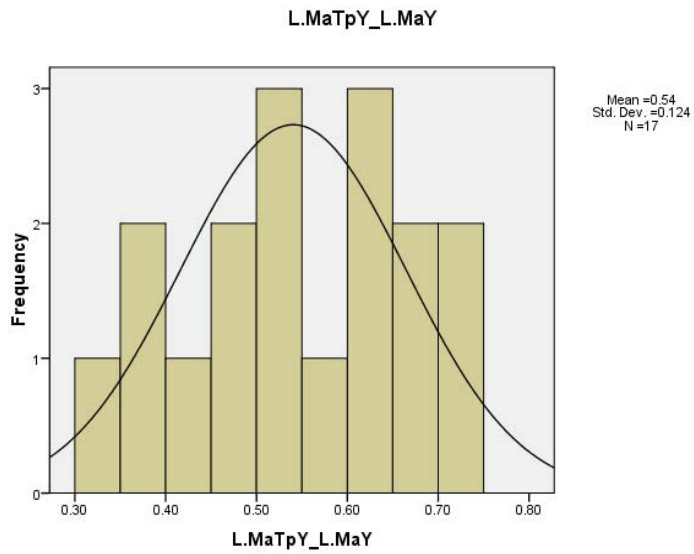


Figure 257: Histogram of the length of the main topsail yard to the length of the main yard in galleons. Refer to Appendix 33 for data.

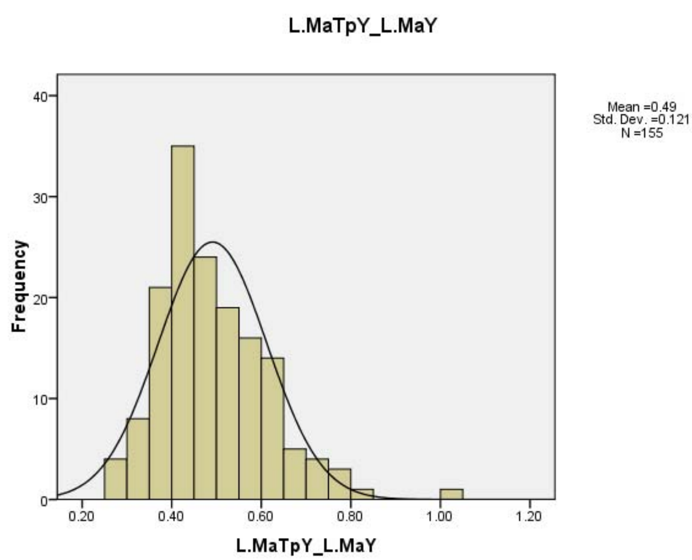


Figure 258: Histogram of the length of the main topsail yard to the length of the main yard in naus. Refer to Appendix 33 for data.

for the nau sample is 0.37 to 0.61. The main distribution in the histogram graph (Figure 258) is from 0.25 to 0.85with an outlier at 1.00 (MA16.1512-03) and a primary mode from 0.40 to 0.45.

The one standard deviation ranges for the galleons and naus are similar oscillating from 0.42 to 0.66 and 0.37 to 0.61. The center of distribution figures like the one standard deviation ranges indicate that the naus have minimally smaller main topsail yards in comparison to the main yards than the galleons. The modal ranges verify the smaller nature of the nau main topsail yards with peaks from 0.40 to 0.45 compared to the higher 0.50 to 0.65 peaks of the galleon sample. The *Livro Náutico* specifies that the main topsail yard is ⅓ less the length of the main yard which results in a ratio of 0.66. Although the one standard deviation and modal ranges of the galleons reach this ratio, the primary mode of the naus fall short by up to 20% and the one standard deviation by a 5%. In general, the main topsail yards of the naus appear to be too short. A logical explanation, however, is that either the main yards are depicted with an exaggerated length or the main topsail yards are too short both of which lower this ratio below what the treatise indicates it should be.

Main Topsail Yard Width Ratios

Middle Width of the Main Topsail Yard to the Length of the Main Topsail Yard:
(*W.MMaTpY_L. MaTpY)*

The one standard deviation of the middle width of the main topsail yard to the length of the main topsail yard for the galleons is 0.03 to 0.08. The main distribution in the histogram graph (Figure 259) is also from 0.03 to 0.08 and there is an outlier at 0.11 (PA09.02) and another at 0.12 (PA09.03). The primary mode is from 0.04 to 0.05 and the secondary mode is from 0.03 to 0.04. The naus have the same one standard deviation as the galleons from 0.03 to 0.08 but with a much broader main distribution from 0.015 to 0.12 with three outliers at 0.13 (CA07.01, EN05.01, and CA03.07). The primary mode in the histogram graph (Figure 260) is from 0.04 to 0.045. The one standard deviations and the center of distribution figures show virtually no difference between the middle widths to the lengths of the main topsail yard for the galleons and the naus. Likewise, the modal ranges show only slight variation, which suggest that the galleons (0.03 to 0.05) have a slightly smaller middle width than the naus (0.04 to 0.045). On average, the middle width is 4% to 5% of the length of the spar.

Middle Width of the Main Topsail Yard to the End Width of the Main Topsail Yard:
(*W.MMaTpY_ W.EMaTpY)*

The one standard deviation of the bottom width to the end width of the main topsail yard ratio for the galleons is from 0.82 to 1.02. The main distribution in the

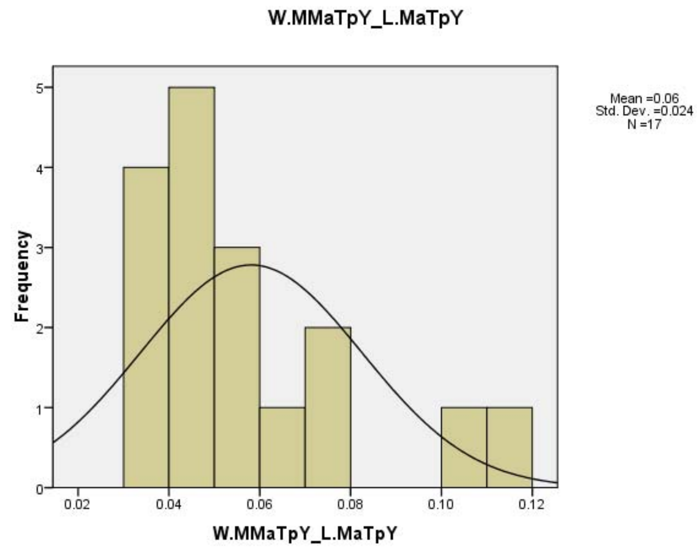


Figure 259: Histogram of the middle width of the main topsail yard to the length of the main topsail yard in galleons. Refer to Appendix 33 for data.

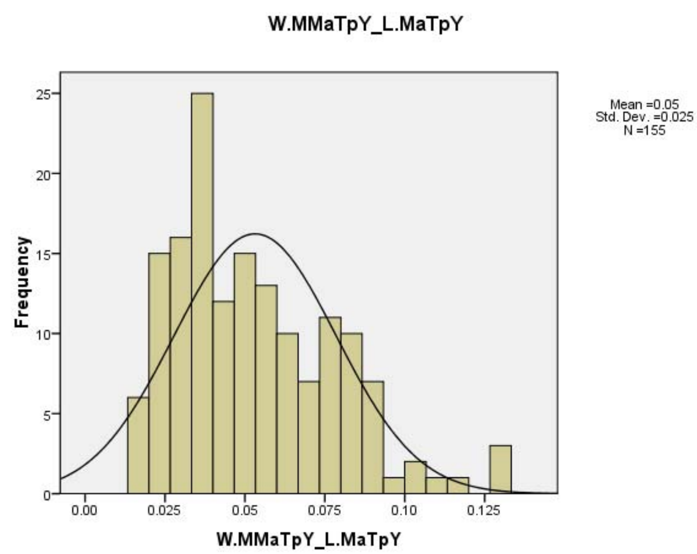


Figure 260: Histogram of the middle width of the main topsail yard to the length of the main topsail yard in naus. Refer to Appendix 33 for data.

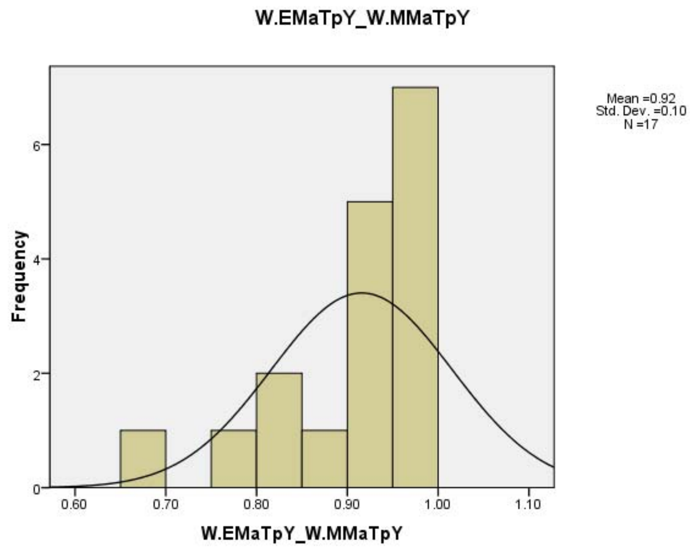


Figure 261: Histogram of the middle width to the end width of the main topsail yard in galleons. Refer to Appendix 33 for data.

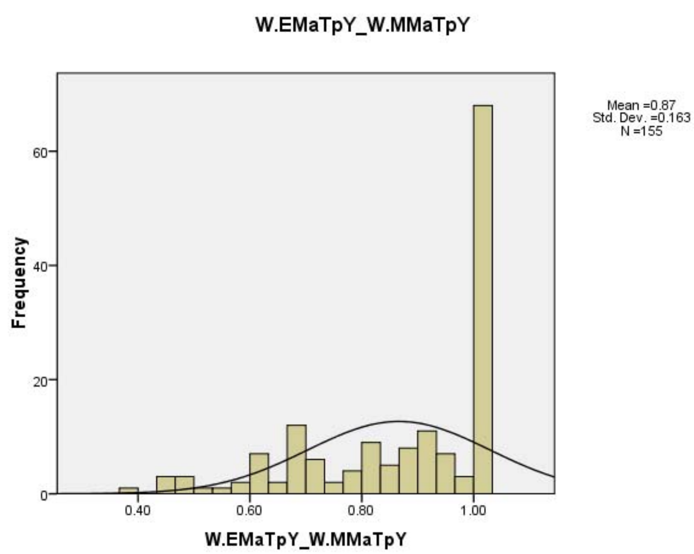


Figure 262: Histogram of the middle width to the end width of the main topsail yard in naus. Refer to Appendix 33 for data.

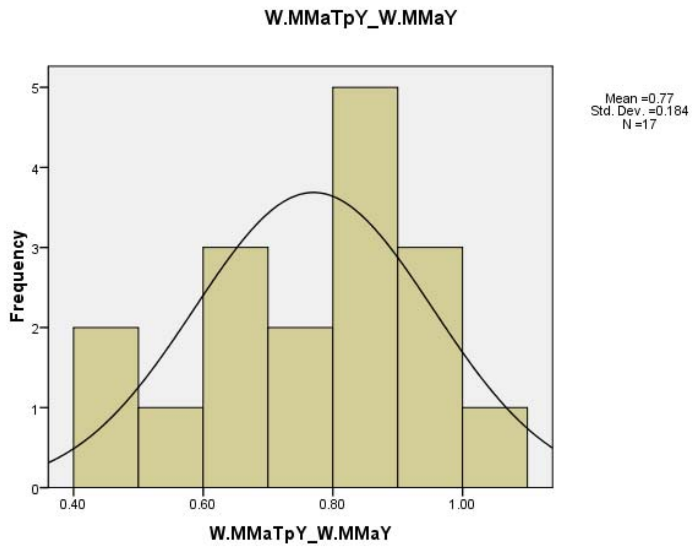


Figure 263: Histogram of the middle width of the main topsail yard to the middle width of the main yard in galleons. Refer to Appendix 33 for data.

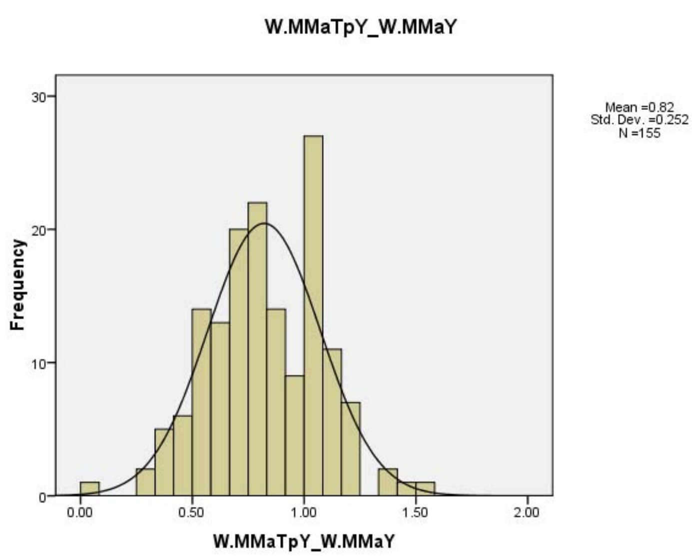


Figure 264: Histogram of the middle width of the main topsail yard to the middle width of the main yard in naus. Refer to Appendix 33 for data.

histogram graph (Figure 261) is from 0.75 to 1.00 with one outlier (PA08.01) at 0.67. The primary is from 0.95 to 1.00 and the secondary mode is from 0.90 to 0.95. The one standard deviation for the naus is from 0.70 to 1.03 which is consistent with the main distribution from 0.45 to 1.05; there is one outlier (MA16.1538-07) at 0.37. The primary mode in the histogram graph (Figure 262) is from 1.00 to 1.05. Although the one standard deviation figures for the bottom to top widths are fairly similar between the galleons and naus, they have relatively large ranges compared to the previous two sections suggesting a moderate amount of variability. The one standard deviation figures clearly show that ratios range roughly from the 70th percentile to the 100th for the naus and from the 70th percentile to the 100th for the galleons which is consistent with the center of distribution figures. The modal ranges narrow these ranges considerably and demonstrate that there is relatively little horizontal tapering of the yards for the both the galleons with peaks from 0.90 to 1.00 and the naus with a primary peak of 1.00 to 1.05.

Middle Width of the Main Topsail Yard to the Middle Width of the Main Yard: (*W.MMaTpY_ W.MMaY)*

The middle width of the main topsail yard to the middle width of the main yard ratio for the galleon sample has a one standard deviation of 0.59 to 0.95 and a primary mode in the histogram graph (Figure 263) from 0.80 to 0.90 both of which are consistent with the main distribution of 0.40 to 1.10. One standard deviation for the nau sample is 0.57 to 1.07. The main distribution in the histogram graph (Figure 264) is from 0.25 to 1.25 with an outlier at 0.08 (CA31.03), two outliers at 1.38 (CA04.21 and MA16.1503-

09), one at 1.43 (MA13.18) and another at 1.55 (CA26.02); the primary mode from 1.00 to 1.05. The one standard deviation and the center of distribution figures are similar for the two samples and show that there is only a few percentage points difference between the galleons and the naus. The modal ranges narrow these ranges and demonstrate that the middle widths of the main topsail yards for the galleons are 80% to 90% of the middle widths of the main yards while the nau main yards have essentially the same widths as the main yards. According to the *Livro Náutico*, however, the maximum diameter of the main topsail yard should only be 25% of that of the main yard which seems an exceptionally small ratio. There is no correlation between the ratios from the iconography and those from the treatise and the reason for this is not readily apparent. The answer lies somewhere between an exaggerated depiction of the width of the main topsail yards or an error in either the original calculation of the ratio in the *Livro Náutico* or in the translation of this work by Castro.

It has been suspected by many scholars that the main courses and topsails were greatly exaggerated in the iconography to create a more imposing vessel and to display the prominent Cross of the Order of Christ. In order to expand the sail area, it was thought that the lengths of the main yards and topyards were disproportionately increased. Although the length of the main yards and topyards appeared to be well proportioned, there were strong indications within the analysis suggesting otherwise. The one standard deviation ranges for several of the yard ratios are far broader than those found on the heights and widths of the masts providing evidence for the lengthening of the yards. Additionally, in almost every instance the widths to the length of the yards as well as the tapering of the yards did not correspond to the archival evidence. From the analysis of the yard width ratios, it became apparent that there was almost no horizontal tapering on the majority of the yards. The reason for this discrepancy in the tapering of the yards reported in the archival documents and the lack of tapering in the iconography is unknown; however, it is highly plausible to assume a level of artistic error. It is expected that the analysis of the fore mast and yards in the next chapter will result in the same conclusions.

CHAPTER XI

DESCRIPTIVE STATISTICS OF MAST AND YARD DIMENSIONS IN THE ICONOGRAPHY: FORE MAST, BOWSPRIT, AND BOOMKIN

Like the previous chapters, the height and width of the lower and upper fore masts, the length and width of the fore yards, as well as the dimensions of the boomkin and bowsprit are analyzed using the frequencies tool within SPSS program in order to establish a normal range based on one standard deviation and the center of distribution. Although an in-depth examination of the sample distribution was not conducted for the fore mast and yards and the boomkin and bowsprit dimensions, each frequencies table and histogram was examined to ascertain any sample that is not valid. When possible, measurements were taken to reflect constructional relationships detailed within the manuscripts (see Figure 265). Otherwise, the measurements express what was considered the most logical relationships for reconstructing a vessel's rig.

11.1 FORE MAST AND YARD DIMENSIONS

Lower Fore Mast Dimensions

In the statistical analysis of the lower fore mast there are 34 caravels, 23 galleons, and 131 naus which had sufficient measurements to conduct a statistical analysis of the fore mast dimensions. The sample was divided into four-masted caravels

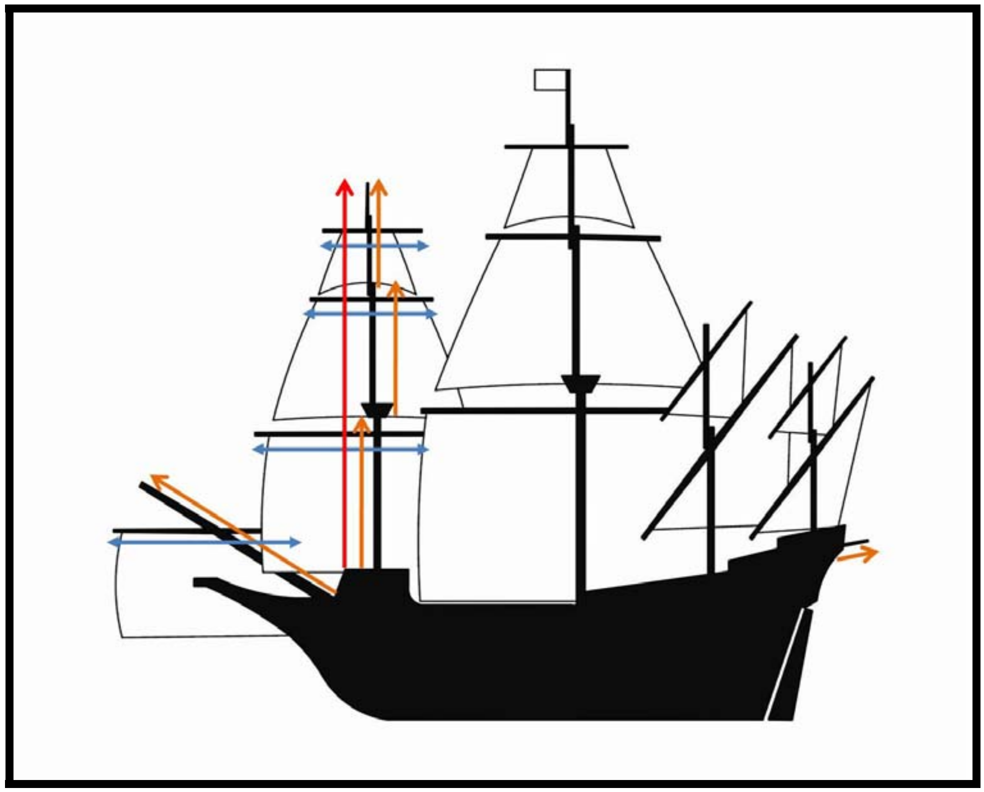


Figure 265: Illustration of fore mast height, fore yard length, bowsprit length, spritsail yard length, and boomkin length measurements.

(34), three-masted galleons (03), four-masted galleons (20), and naus (131); all of the vessels have fore topmasts (refer to Appendix 34 for the frequency tables of all ship types). Due to the small amount of three-masted galleons, the sample was analyzed along with the four-masted galleons in one sample. The number of vessels with complete fore mast dimensions is greatly reduced from that of the main mast due to the partial obscuring of different measurements by the sails. The measurements of the lower and upper mast were taken from the bottom of the fore mast at deck level to the base of the fore top and from that point to the fore topmast head. It is not possible to calculate the doubling because this portion of the mast is covered by the top.

The most practical measurement for the height of the fore mast is from Palacio who states that the height of the foremast is equal to the length of the keel (Bankston, 1986: 120). Although the keel cannot be measured in the iconography, it is possible to deduce this length using the *ah*, *dos*, *tres* rule, which indicates that the length of the keel is two-thirds the length of the ship on deck. A comparison of the height of the fore mast to the length of the hull as described here should result in a percentage of around 66%. Another comparative measurement comes from the *Livro Náutico* which gives a length of 15 *braças* (26.4 m) for the fore mast, not including the doubling, and indicates that the overall height of the mast should be one *braça* less than the main mast. This would suggest that the main mast is 16 *braças* and the height of the fore mast would therefore be about 94% of the height of the main mast.

Fernandez gives a measurement of 15.5 *braças* or 27.28 m for the height of the fore mast with a maximum diameter of 3 *palmas de goa* or 77 cm (Castro, 2005b: 118).

Using these measurements, a percentage point of 0.03% was calculated for the maximum diameter of the fore mast to the height of the fore mast ratio. Likewise, the maximum diameter of the fore mast in the *Livro Náutico* is 4 *palmas de vara* or 88 cm, which is also 0.03% of the height of the mast. Although the width at the top of the mast and the bottom of the mast was measured, the maximum width is often found at the base of the mast. As such, the percentage deduced from these two manuscripts provides comparative data for this analysis.

Lower Fore Mast Height Ratios

Height of the Fore Mast to the Length of the Hull: (H.Fr_L.H)

The height of the fore mast to the length of the hull ratio for the caravel sample has a relatively large one standard deviation from 0.59 to 0.91, which is consistent with the main distribution in the histogram graph (Figure 266) that ranges extensively from 0.40 to 1.20. The tabulation of the one standard deviation and center of distribution figures for all the fore mast and lower fore mast height ratios can be viewed in Table 62. Although there is a dominant primary mode at 0.70 to 0.80, the distribution and one standard deviation suggest high variability within the iconography. Like the caravels, the galleon sample has a very broad one standard deviation of the height of the fore mast to the length of the hull on deck from 0.53 to 1.01 with the main distribution ranging from 0.50 to 1.10 and an outlier at 1.20 to 1.30 (PA09.03 and MA13.09). The corresponding histogram graph (Figure 267) also exhibits great variation with three equal modes at 0.50

TABLE 62: Comparison of the One Standard Deviation and Center of Distribution of the Lower Fore Mast Height Ratios

H.Fr _L.H	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Caravels	0.59 to 0.91	0.65 to 0.85
Galleons	0.53 to 1.01	0.58 to 0.93
Naus	0.56 to 0.76	0.61 to 0.92
H.Fr _H.Ma	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Galleons	0.67 to 0.98	0.72 to 0.91
Naus	0.62 to 0.94	0.68 to 0.81
H.LFr_L.H	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Caravels	0.28 to 0.52	0.31 to 0.48
Galleons	0.31 to 0.61	0.35 to 0.61
Naus	0.32 to 0.44	0.35 to 0.51
H.LFr_H.Fr	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Caravels	0.42 to 0.65	0.41 to 0.63
Galleons	0.53 to 0.67	0.56 to 0.65
Naus	0.49 to 0.59	0.54 to 0.65

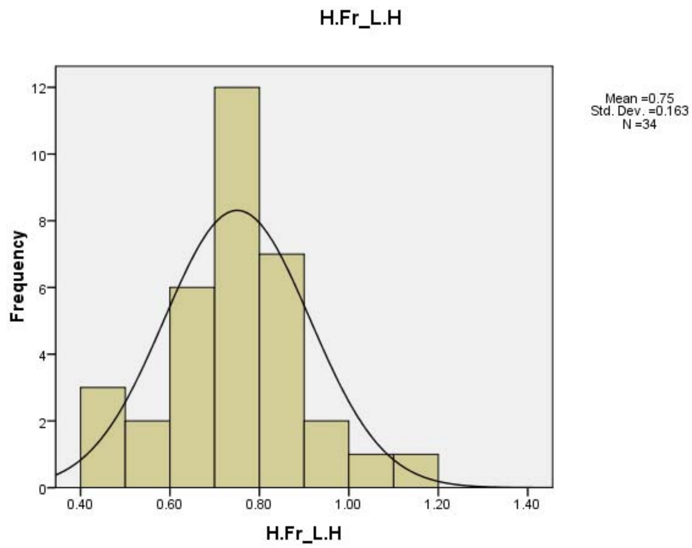


Figure 266: Histogram of the height of the fore mast to the length of the hull in caravels. Refer to Appendix 34 for data.

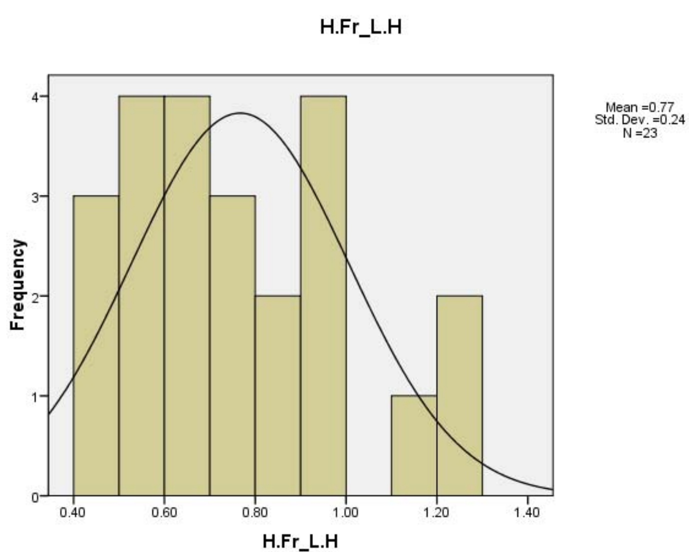


Figure 267: Histogram of the height of the fore mast to the length of the hull in galleons. Refer to Appendix 34 for data.

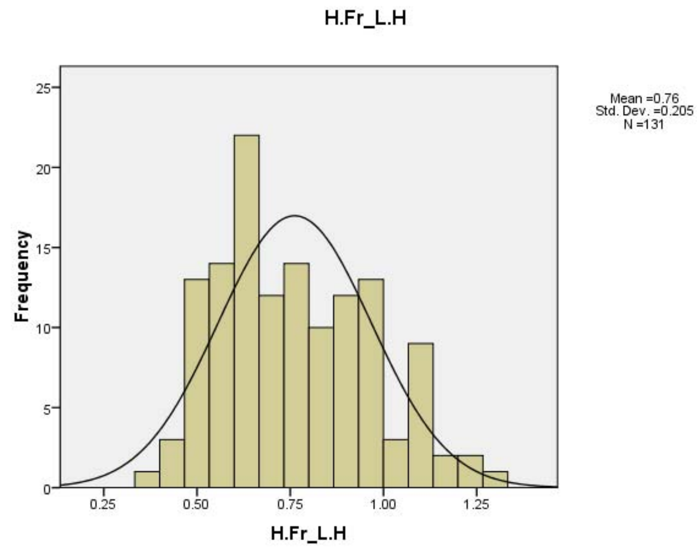


Figure 268: Histogram of the height of the fore mast to the length of the hull in naus.
Refer to Appendix 34 for data.

to 0.60, 0.60 to 0.70, and 0.90 to 1.00. The nau sample has a more concise one standard deviation of the height of the mizzen mast to the length of the hull from 0.56 to 0.76. Although there is a large main distribution (0.37 to 1.30), the primary mode (0.59 to 0.76) in the histogram graph (Figure 268) is exceptionally consistent with the one standard deviation.

The one standard figures ranges for the caravel and galleons extending roughly from the 50th to the 100th percentile is mirrored by the naus which have a slightly smaller range from 0.56 to 0.76. The one standard deviation ranges and the sample distributions are generally too broad to be practical in a reconstruction and reflect a high level of inconsistency within the iconography. Although the modal ranges prove that there is some level of standardization in the height of the fore mast to the length of the hull, there are differences between the ship types. The respective modes demonstrate the caravels and naus have somewhat similar primary modes from 0.70 to 0.80 for the previous and roughly 0.60 to 0.80 for the latter. The caravels and naus are within range of the 66% relationship of the height of the fore mast to length of the hull on deck which, in this case, is a reflection of the estimated length of the keel. The galleons, however, have a modal range of 0.50 to 1.00, which is too broad to be of use in any practical sense. The galleon sample (N=23) does seem not to have a sufficient number of vessels in the sample for dominate trends to appear or to establish a more concise normal variation. Interestingly, there are three caravels, 10 galleons, and 19 naus depicted in a ¾ starboard or a ¾ port side view all of which are spread throughout their respective samples. As such, it appears that the perspective of the drawing does not influence the height of the fore mast or increase the amount of variability within the sample.

Height of the Fore Mast to the Height of the Main Mast: (H.Fr_H.Ma)

The height of the fore mast to the height of the main mast could only be calculated for the galleon and nau samples as the caravels do not have an upper main mast. The height of the caravel's single lateen-rigged lower main mast differs so drastically from the overall height of the fore mast that it produces erratic results. The one standard deviation of the height of the fore mast to that of the main mast for the galleons is 0.67 to 0.98. The main distribution in the histogram graph (Figure 269) is 0.50 to 1.10 with an outlier at 1.20 to 1.30 (MA13.04). The primary mode is from 0.80 to 0.90 and the secondary mode is from 0.70 to 0.80. The nau sample has an exceptionally similar one standard deviation of 0.62 to 0.94. The primary mode in the histogram graph (Figure 270) is 0.73 to 0.80 and the secondary mode is 0.66 to 0.73 while the main distribution is from 0.40 to 0.90 and there is a secondary distribution from 1.00 to 1.40. The secondary distribution in the nau sample is comprised of 15 vessels all of which are from two sources: the *Memória das Armadas* (N=12) and the *Livro de Lisuarte d' Abreu* (N=3). An additional eight naus from the *Memória das Armadas* and 16 naus from the *Livro de Lisuarte d' Abreu* are found spread throughout the sample suggesting that roughly 60% of the first and 16% of the second manuscript have exaggerated fore masts. All of the vessels with fore masts exceeding 100% of the height of the main mast are depicted in starboard profile views and are from fleets

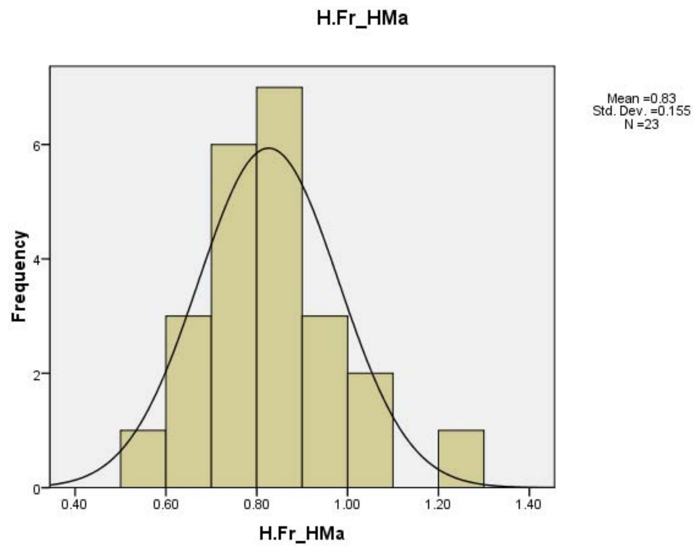


Figure 269: Histogram of the height of the fore mast to the height of the main mast in galleons. Refer to Appendix 34 for data.

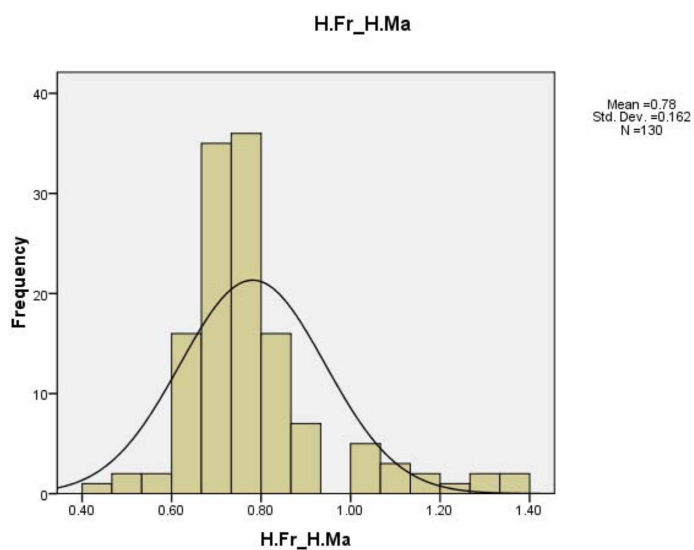


Figure 270: Histogram of the height of the fore mast to the height of the main mast in naus. Refer to Appendix 34 for data.

ranging in date from 1503 to 1538 indicating that perspective and temporality do not influence the height of the fore mast in the iconography. It is more likely this is an artistic exaggeration of the height of the fore mast, which often is shown with large fore courses and fore topsails bearing the cross from the Order of Christ. It is also suspected that the lengths of the yards were proportionally increased to expand the sail area and promote symbolism rather than technical accuracy.

The consistent one standard deviation of the galleon and nau samples, respectively 0.67 to 0.98 and 0.62 to 0.94, are indicative of a moderate degree of standardization between the two masts; both samples reach the 0.94 relationship prescribed in the *Livro Náutico*. The modal ranges of 0.70 to 0.90 for the galleons and 0.66 to 0.80 for the naus signify, however, that the normal variation is skewed towards a slightly smaller fore mast than is indicated in the manuscript.

Height of the Lower Fore Mast to the Length of the Hull: (H.LFr _L.H)

The height of the lower fore mast to the length of the hull ratio for the caravels sample has a one standard deviation from 0.28 to 0.52. The main distribution in the histogram graph (Figure 271) is from 0.20 to 0.65. The primary mode is from 0.25 to 0.30 and there is a secondary mode at 0.30 to 0.35. The galleon sample has the broadest one standard deviation from 0.31 to 0.61. The main distribution in the histogram graph (Figure 272) is from 0.20 to 0.80 and the primary mode is from 0.30 to 0.40. The one standard deviation of the nau sample is smaller than the previous two samples at 0.32 to 0.44 and the main distribution ranges from 0.20 to 0.85, which is almost identical to the

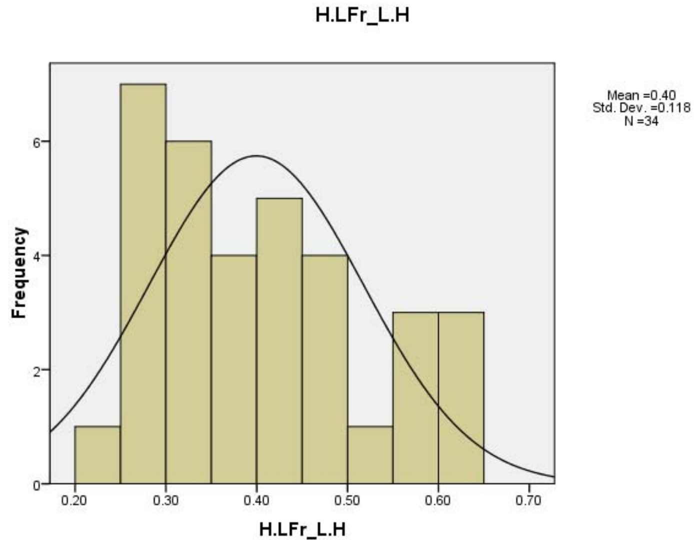


Figure 271: Histogram of the height of the lower fore mast to the length of the hull in caravels. Refer to Appendix 34 for data.

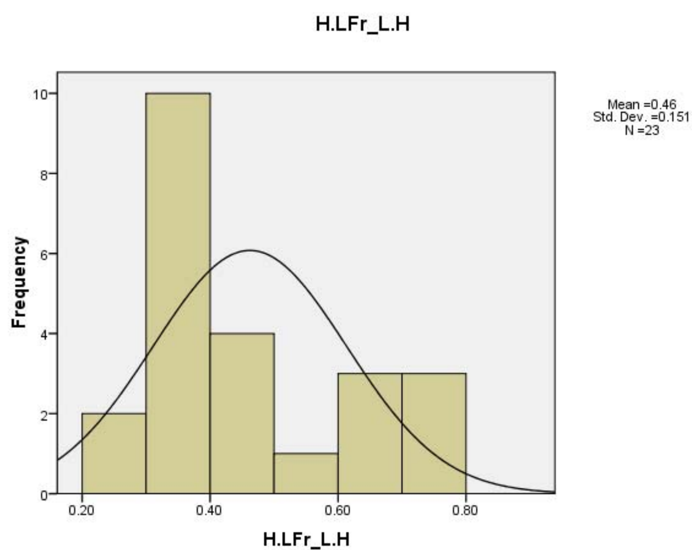


Figure 272: Histogram of the height of the lower fore mast to the length of the hull in galleons. Refer to Appendix 34 for data.

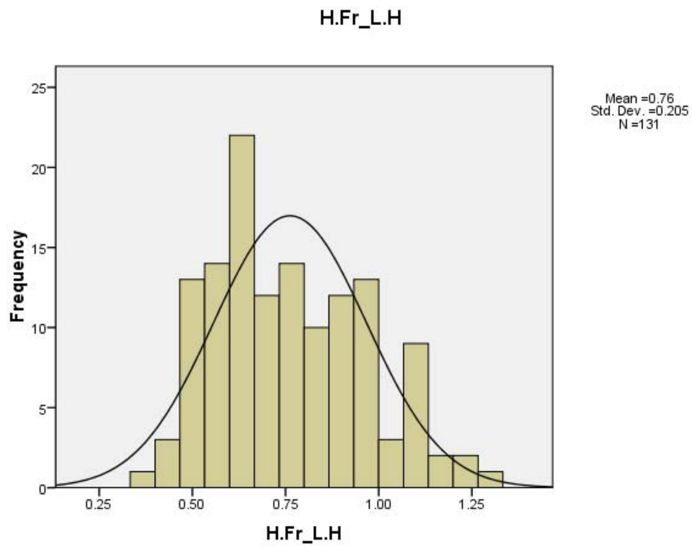


Figure 273: Histogram of the height of the lower fore mast to the length of the hull in naus. Refer to Appendix 34 for data.

galleon sample. The primary mode in the histogram graph (Figure 273) is from 0.40 to 0.45 while the secondary is from 0.35 to 0.40.

The one standard deviation of the three ship types show that although there is relative consistency between the samples, the galleons have the most variability with a range of 0.31 to 0.61, the naus the least amount with a deviation of 0.32 to 0.44, and the caravel sample is centered in between the two at 0.28 to 0.52. The center of distribution for these samples demonstrate that there is less variation between the caravels with a range of 0.31 to 0.48, the galleons with 0.35 to 0.61, and the naus with 0.35 to 0.51. The galleons still have the largest range; however, the caravels are now skewed slightly lower than the naus suggesting somewhat smaller fore masts in comparison to the galleons and naus. The modal ranges indicate an even more consistency between the caravels (0.25-0.35), galleons (0.30-0.40), and naus (0.35-0.45) and the height of the fore mast is roughly one- third the length of the hull on deck.

Height of the Lower Fore Mast to the Height of the Fore Mast: (H.LFr_H.Fr)

The height of the lower fore mast to the overall height of the fore mast ratio for the caravel sample has a one standard deviation from 0.42 to 0.65. The main distribution in the histogram graph (Figure 274) is from 0.35 to 0.70 and there is an outlier at 0.75 to 0.80 (CA29.01); the primary mode is from 0.60 to 0.65 and the secondary mode is from 0.55 to 0.60. The one standard deviation for the galleons is from 0.53 to 0.67 and the main distribution in the histogram graph (Figure 275) is from 0.45 to 0.70 with two outliers at 0.74 to 0.80 (CA04.29 and CA04.28). The primary mode is from 0.57 to 0.60.

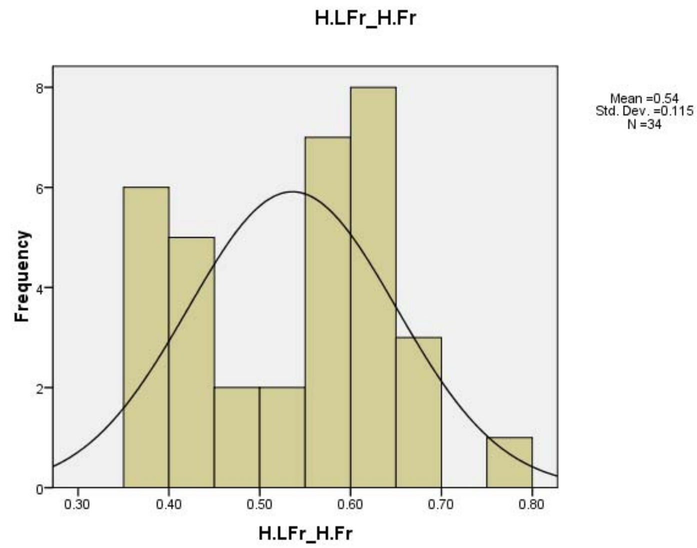


Figure 274: Histogram of the height of the lower fore mast to the height of the fore mast in caravels. Refer to Appendix 34 for data.

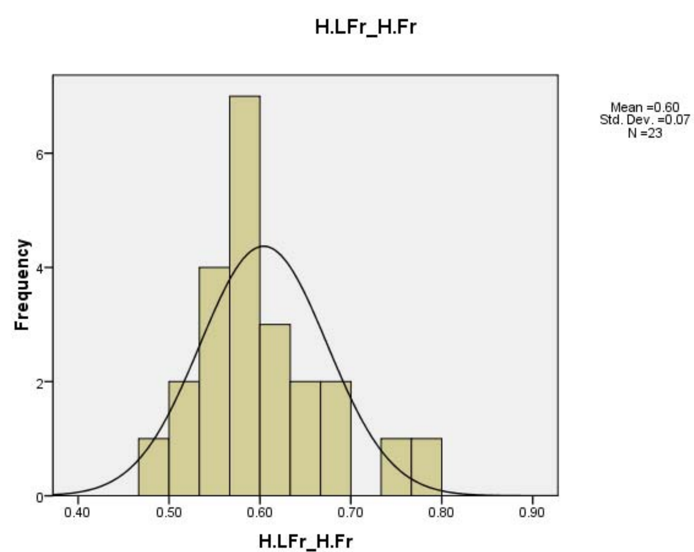


Figure 275: Histogram of the height of the lower fore mast to the height of the fore mast in galleons. Refer to Appendix 34 for data.

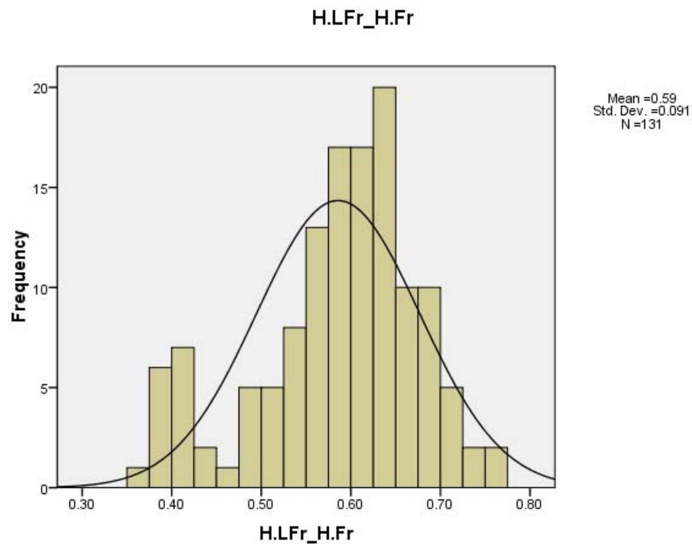


Figure 276: Histogram of the height of the lower fore mast to the height of the fore mast in naus. Refer to Appendix 34 for data.

The nau sample has a one standard deviation from 0.49 to 0.59 and the main distribution ranges from 0.37 to 0.77. The primary mode in the histogram graph (Figure 276) is from 0.65 to 0.675 while there are two equal secondary modes from 0.575 to 0.60, and 0.60 to 0.625. The caravels have the largest one standard deviation range (0.42 to 0.65) while the galleons (0.53 to 0.67) are skewed slightly to the higher end of the range and the naus to the lower end (0.49 to 0.59). The center of distribution confirms the more extensive range of the caravels with 0.41 to 0.63 and demonstrates that the galleons and naus are very similar with a difference of only two percentage points: 0.56 to 0.65 for the galleons, and 0.54 to 0.65 for the naus. The modal ranges indicate, however, that all three samples have a common peak within their normal variation at or around 0.60 with the following ranges: caravel (0.55 to 0.65), galleons (0.57 to 0.60), and naus (0.575 to 0.675). Overall, the height of the lower fore mast is 60% of the overall height of the mast for all three ship types.

Lower Fore Mast Width Ratios

Bottom Width of the Lower Fore Mast to the Height of the Lower Fore Mast: (W.BtLFr_H.LFr)

The bottom width of the lower fore mast to the height of the lower fore mast ratio has a one standard deviation of 0.04 to 0.09 for the caravels with a main distribution from 0.03 to 0.12 in the histogram graph (Figure 277). The tabulation of the one standard deviation and center of distribution figures for all the fore mast and lower fore

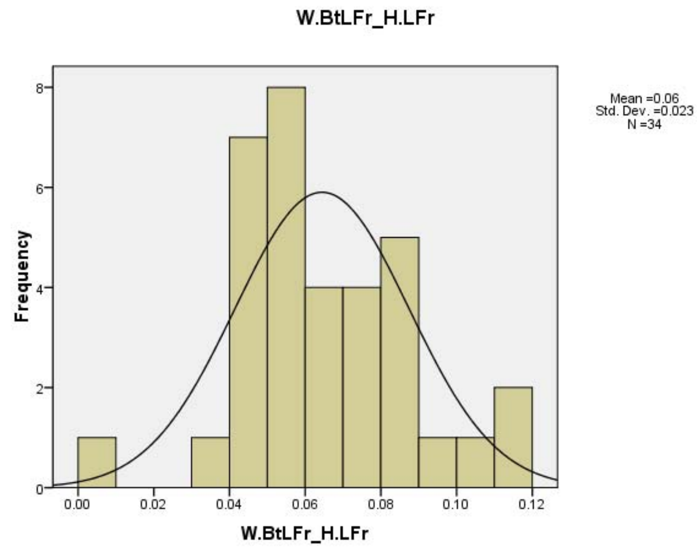


Figure 277: Histogram of the bottom width of the lower fore mast to the height of the lower fore mast in caravels. Refer to Appendix 34 for data.

TABLE 63: Comparison of the One Standard Deviation and Center of Distribution of the Lower Fore Mast Width Ratios

W.BtLFr_H.LFr	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Caravels	0.04 to 0.09	0.05 to 0.08
Galleons	0.04 to 0.11	0.06 to 0.08
Naus	0.05 to 0.08	0.06 to 0.10
W.TpLFr_W.BtLFr	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Caravels	0.54 to 0.98	0.57 to 0.95
Galleons	0.54 to 0.95	0.60 to 0.88
Naus	0.52 to 0.70	0.57 to 0.83

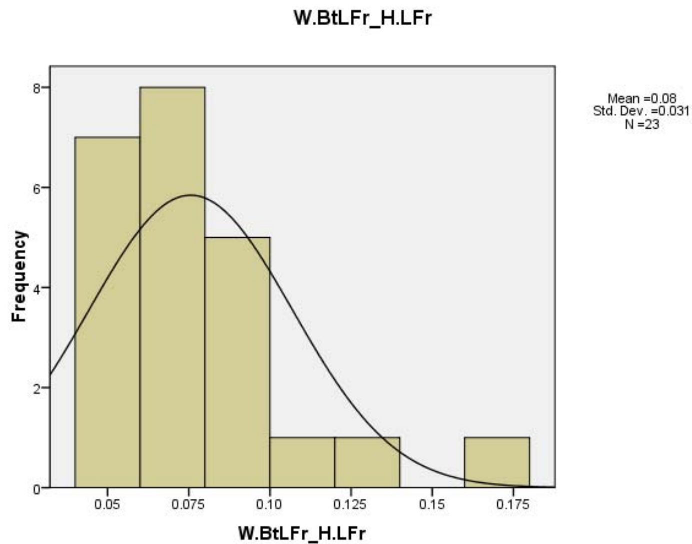


Figure 278: Histogram of the bottom width of the lower fore mast to the height of the lower fore mast in galleons. Refer to Appendix 34 for data.

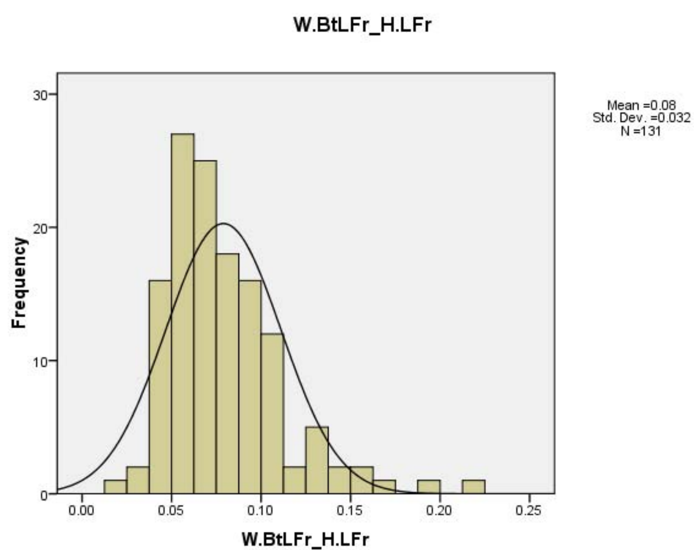


Figure 279: Histogram of the bottom width of the lower fore mast to the height of the lower fore mast in naus. Refer to Appendix 34 for data.

mast width ratios can be viewed in Table 63. The primary mode is from 0.05 to 0.06 while the secondary mode is from 0.04 to 0.05. The galleons have a larger one standard deviation from 0.04 to 0.11 and a main distribution in the histogram graph (Figure 278) from roughly 0.03 to 0.13; there is one outlier at 0.16 to 0.18 (MA02.01). The primary mode is from 0.06 to 0.08 and the secondary mode is from 0.04 to 0.06. The naus have a smaller one standard deviation range from 0.05 to 0.08, but like the galleons they have a much wider main distribution than the caravels from 0.02 to 0.17; there is an outlier at 0.19 to 0.20 (MA13.08) and another at 0.22 to 0.23 (MA13.02). The primary mode is from 0.05 to 0.065 with the secondary mode from 0.065 to 0.08 in the histogram graph (Figure 279).

The one standard deviation of the bottom width of the lower fore mast to the height of the lower fore mast is fairly consistent between the caravels, galleons, and naus with only a difference of only a few percentages between the ship types. The center of distribution figures also indicate a progression in the relative thickness of the mast at the top from the caravels with lowest from 0.05 to 0.08 to the galleons with 0.06 to 0.08 and the naus skewed to the higher end with a range from 0.06 to 0.10. This is confirmed in the modal ranges, which exhibit overall consistency between the vessels with the same progression from caravels (0.04 to 0.06) to galleons (0.04 to 0.08) to naus (0.05 to 0.08).

Top Width of the Lower Fore Mast to the Bottom Width of the Lower Fore Mast: (W.TpLFr_W.BtLFr)

The one standard deviation of the bottom width to the top width of the lower fore mast for the caravels is from 0.54 to 0.98. The main distribution in the histogram graph (Figure 280) is from 0.30 to 1.10 with one outlier (CA22.29) at 1.30. The primary mode is from 0.70 to 0.80 and the secondary mode is form 0.90 to 1.00. The galleons have a similar one standard deviation to the caravel sample from 0.54 to 0.95. The main distribution in the histogram graph (Figure 281) is from 0.30 to 1.00 and there is an outlier at 1.10 to .120 (MA13.05); the primary mode is from 0.80 to 0.90. The one standard deviation for the naus is from 0.52 to 0.70, which is consistent with the primary mode from 0.65 to 0.70; there is a secondary mode which his greatly distanced from the first at 1.05. The main distribution in the histogram graph (Figure 282) is quite extensive from 0.25 to 1.05.

Although the one standard deviation figures for the bottom to top widths are fairly similar between the ship types, they all have significantly large ranges suggesting high variability. Again, the bottom and top widths in relation to the height of the mast are highly uniform with small ranges whereas, the same measurements compared to each other results in significant variation within the samples. The one standard deviation figures clearly show that the ratio ranges roughly from the 50th percentile to the 70th for the naus and up to the 100th percentile for the galleons and naus. The center of distribution figures, however, indicates less variation between the ship types which have the following ranges: caravels (0.57 to 0.95), galleons (0.60 to 0.88), and nau (0.57 to

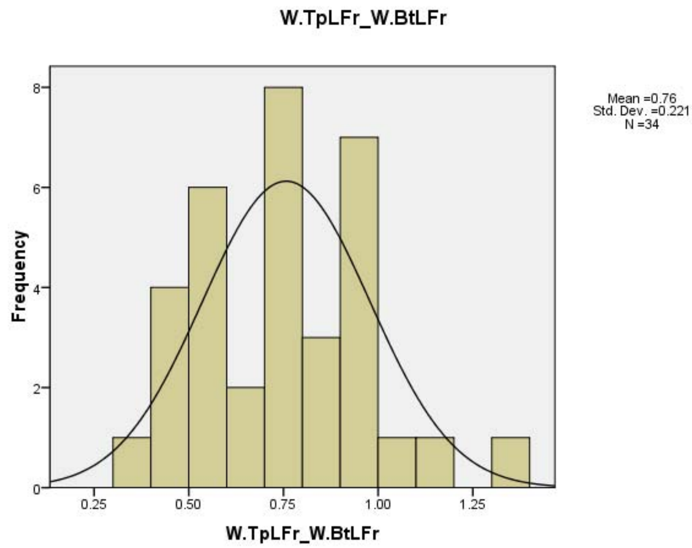


Figure 280: Histogram of the top width to the bottom width of the lower fore mast in caravels. Refer to Appendix 34 for data.

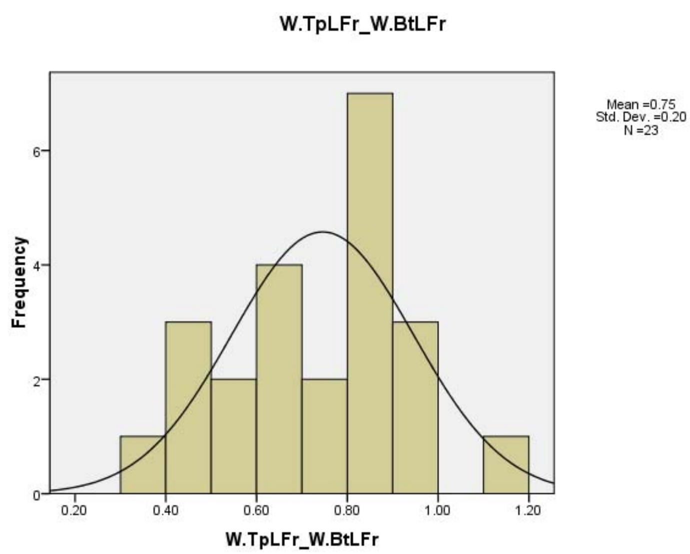


Figure 281: Histogram of the top width to the bottom width of the lower fore mast in galleons. Refer to Appendix 34 for data.

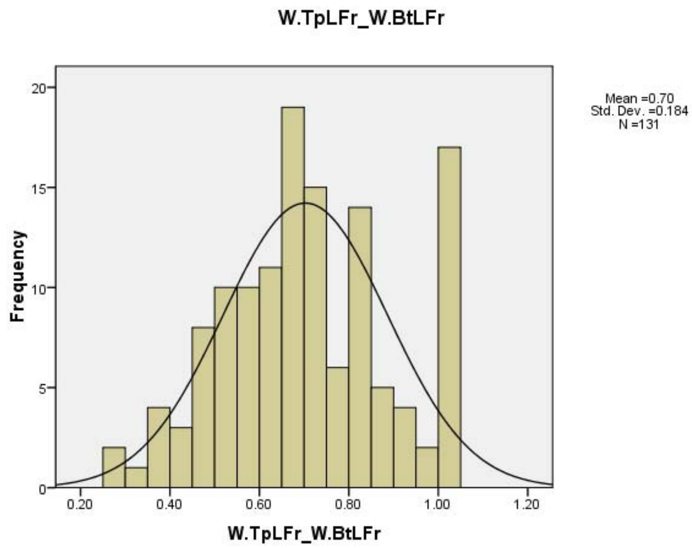


Figure 282: Histogram of the top width to the bottom width of the lower fore mast in naus. Refer to Appendix 34 for data.

0.83). The galleons and naus are more closely aligned in the center of distribution figures than in the one standard deviation numbers while the caravels have the broadest range. The modal peaks for the caravels (0.70 to 1.00), galleons (0.80 to 0.90), and naus (0.65 to 1.05) only narrow the ranges slightly; however, by viewing the primary modes alone a trend becomes visible. The primary modes of the caravels (0.70 to 0.80), galleons (0.80 to 0.90), and the naus (0.65 to 0.70) exhibit relative consistency between the ships and indicate that the naus had the most amount of vertical tapering whereas the galleons had the least.

Fore Topmast Dimensions

Fore Topmast Height Ratios

The ratio of the height of the fore topmast to the lower fore mast can be calculated using the measurements provided by Fernandez who writes the height of the fore topmast is 14.08 m or 52% of the height of the lower fore mast (27.28 m). According to Palacio, however, the fore topmast should be a one-fifth or 20% less than the height of the upper main mast (Bankston, 1986: 120). Fernandez also gives the maximum diameter as 1.5 *palmas de goa* or 39 cm on the base tapering to one-third of this at the top (13 cm). The maximum width to the height of the fore mast would be 3% while the top width ratio would only be 1%. The *Livro Náutico* gives a length of 10.44 m for the fore mast with a minimum diameter that is two-thirds of the maximum diameter

(33 cm) of the main topmast (Castro, 2005b: 118). The minimum diameter would then be 22 cm and this measurement is 2% of the height of the mast.

Height of the Fore Topmast to the Height of the Lower Fore Mast: (H.UFr_H.LFr)

The height of the fore topmast to the height of the lower fore mast ratio resulted in a very broad one standard deviation of 0.49 to 1.39 for the caravel sample. The tabulation of the one standard deviation and center of distribution figures for the fore topmast height ratios can be viewed in Table 64. The main distribution in the histogram graph (Figure 283) is from 0.15 to 1.15 with a secondary distribution of 11 vessels from 1.40 to 1.80, which is comprised of all the caravels from the *Memória das Armadas* (MA16); the primary mode is from 0.50 to 0.67. The galleons have a one standard deviation from 0.48 to 0.81 and a distribution in the histogram graph (Figure 284) from 0.20 to 1.10. The primary mode is from 0.70 to 0.80 and there are two equal secondary modes from 0.50 to 0.60 and 0.60 to 0.70. The one standard deviation for the nau sample is from 0.43 to 0.75. The primary mode in the histogram graph (Figure 285) is from 0.50 to 0.60 and the secondary mode is from 0.60 to 0.70. The main distribution is from roughly 0.30 to 1.10 and there is a secondary group of 15 vessels from 1.25 to 1.70 two of which are from CA31 (.04,.05), 12 are from MA16 (1520-02,1538-07, 1510-10, 1503-09, 1528-01, 1536-05, 1530-07, 1503-07, 1511-03, 1528-08, 1525-02, 1528-13), and one nau from EN02 (.01); there is also one outlier from 1.70 to 1.80 (MA16.1530-05). Although the 15 vessels comprising the secondary distribution account for 11% of the total nau sample and are from three different sources, it is highly unlikely that the fore

TABLE 64: Comparison of the One Standard Deviation and Center of Distribution of the Fore Topmast Height Ratios

H.UFr_H.LFr	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Caravels	0.49 to 1.39	0.57 to 1.45
Galleons	0.48 to 0.81	0.53 to 0.76
Naus	0.43 to 0.75	0.55 to 0.87
H.UFr_L.H	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Caravels	0.22 to 0.46	0.22 to 0.44
Galleons	0.17 to 0.42	0.20 to 0.36
Naus	0.19 to 0.32	0.23 to 0.39
H.UFr _H.UMa	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Galleons	0.70 to 1.14	0.73 to 1.10
Naus	0.69 to 0.97	0.74 to 0.91

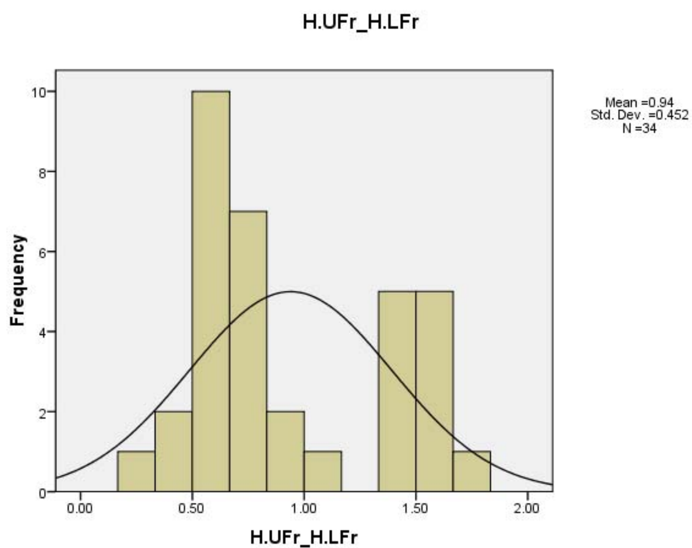


Figure 283: Histogram of the height of the fore topmast to the height of the lower fore mast in caravels. Refer to Appendix 34 for data.

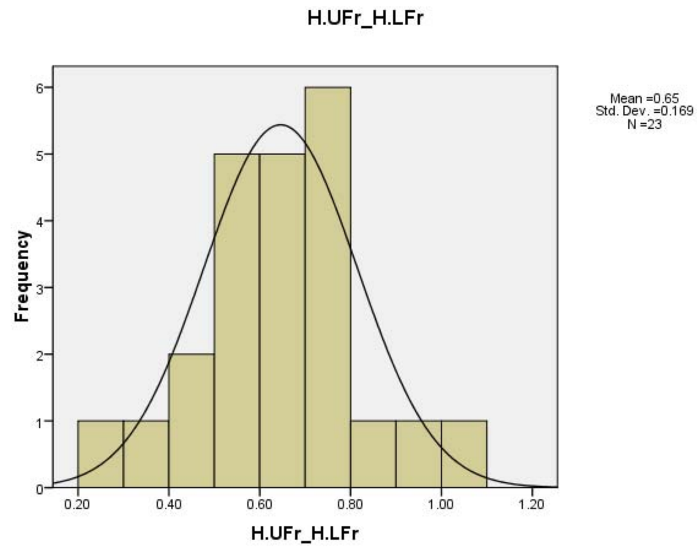


Figure 284: Histogram of the height of the fore topmast to the height of the lower fore mast in galleons. Refer to Appendix 34 for data.

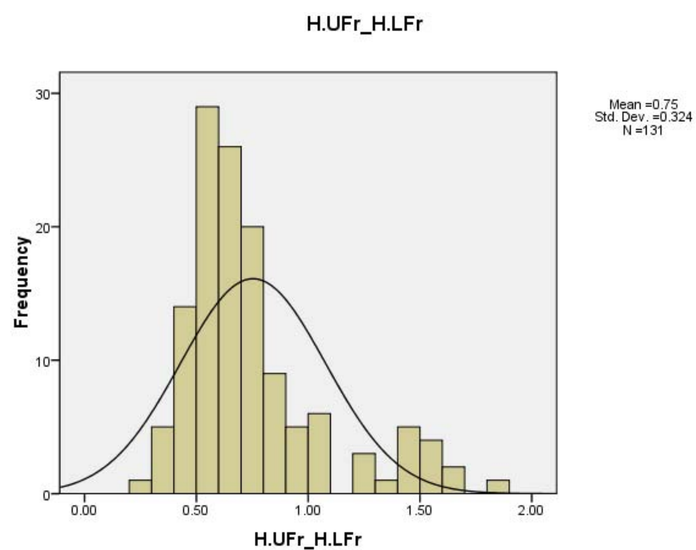


Figure 285: Histogram of the height of the fore topmast to the height of the lower fore mast in naus. Refer to Appendix 34 for data.

topmast would be 25% to 70% taller than the lower fore mast. As such, the depictions of the fore topmast in these vessels are the result of artistic error.

The one standard deviation figures of the height of the fore topmast to the height of the lower fore mast are comparable for the galleons and the naus. Whereas, the caravels have a range that begins in the 40th percentile like the galleons and naus but extends to 1.39 indicating a highly variable sample. The center of distribution figures confirms the findings in the one standard deviation ranges. The modal ranges justify a relationship between the caravels (0.50 to 0.67) and the naus (0.50 to 0.70), which was not evident in the one standard deviation of the samples due to the extremely broad range of the caravels. Although the galleons have a similar, yet larger, modal range (0.50 to 0.80), the primary mode for this sample is 0.70 to 0.80 demonstrating that peak is skewed towards taller fore topmasts than either the caravels or the naus. The calculated ratio of the height of the fore topmast to the lower fore mast using the measurements provided by Fernandez is 0.52, which is consistent with both the one standard deviations and the modal ranges of all three ship types. The ranges for both categories, however, are skewed higher than Fernandez's 52% suggesting that on average the fore topmasts were taller than what is indicated in the manuscript.

Height of the Fore Topmast to the Length of the Hull: (H.UFr_L.H)

The height of the fore topmast to the length of the hull ratio for the caravels sample has a one standard deviation from 0.22 to 0.46. The main distribution in the histogram graph (Figure 286) is from 0.10 to 0.60 and three equal primary modes from

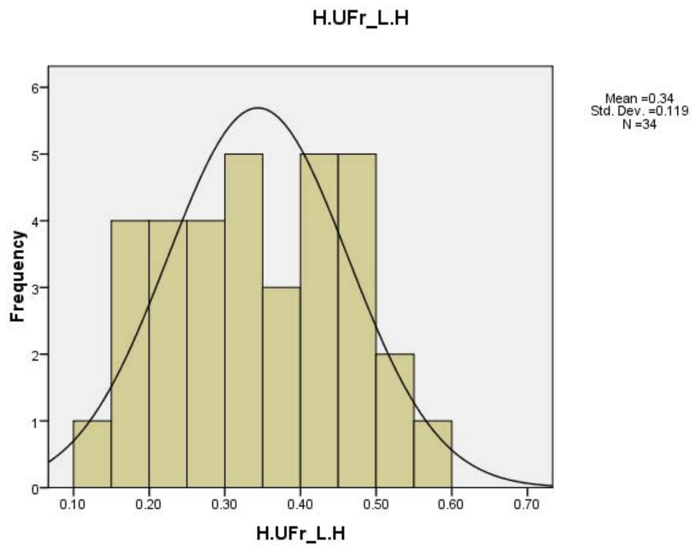


Figure 286: Histogram of the height of the fore topmast to the length of the hulls in caravels. Refer to Appendix 34 for data.

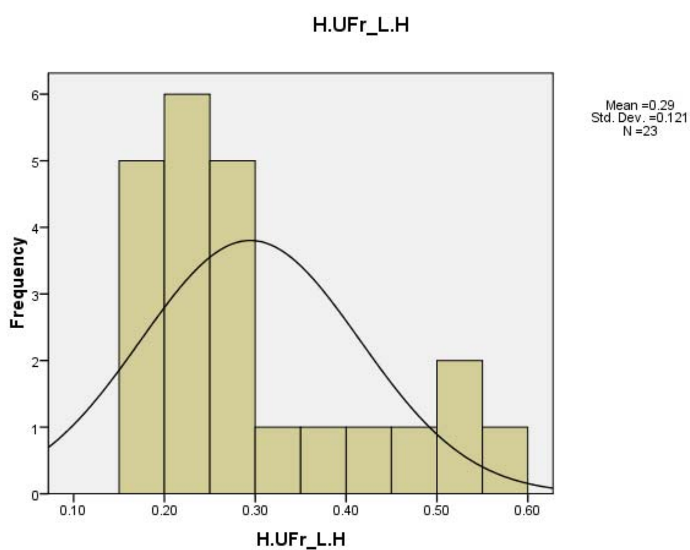


Figure 287: Histogram of the height of the fore topmast to the length of the hulls in galleons. Refer to Appendix 34 for data.

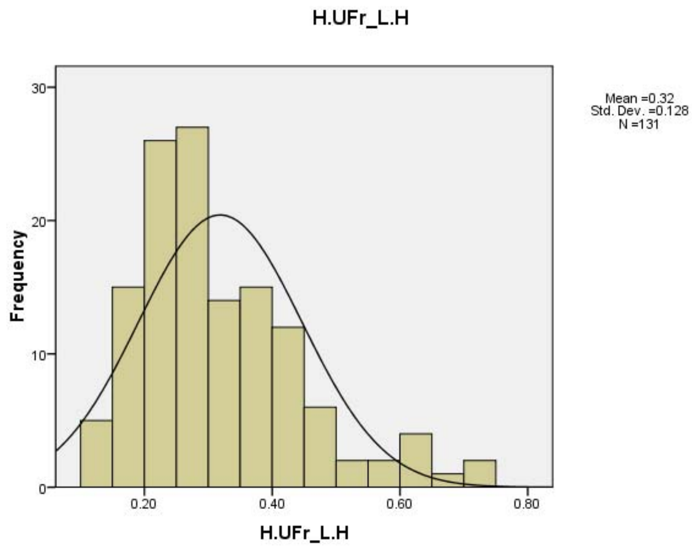


Figure 288: Histogram of the height of the fore topmast to the length of the hulls in naus. Refer to Appendix 34 for data.

0.30 to 0.35, 0.40 to 0.45, and 0.45 to 0.50. The galleon sample has a one standard deviation from 0.17 to 0.42 and a main distribution from 0.15 to 0.60. The primary mode in the histogram graph (Figure 287) is from 0.20 to 0.25 and there are two equal secondary modes from 0.15 to 0.20 and 0.25 to 0.30. The one standard deviation of the nau sample is smaller than the previous two samples at 0.19 to 0.32 and the main distribution in the histogram graph (Figure 288) ranges from 0.10 to 0.75; the primary mode is from 0.25 to 0.30 and the secondary mode is from 0.20 to 0.25.

The one standard deviation of the three ship types show that although there is relative consistency between the samples, the caravels and galleons have a similar ranges while the naus have the least amount of variability. The center of distribution for these samples demonstrate that there is less variation between the caravels with a range of 0.22 to 0.44, the galleons with 0.20 to 0.36, and the naus with 0.23 to 0.39. The naus still have the smallest range; however, the sample is now closer to the caravels and galleons. The modal ranges indicate a slightly different relationship between the three ship types with the galleons (0.15 to 0.30), and naus (0.20 to 0.30) more closely aligned. The caravels (0.30 to 0.50) have comparably larger fore topmasts than the galleons and the naus. The primary modes of the galleons and naus show the two samples are even more congruous with peaks at 0.20 to 0.25 for the first and 0.25 to 0.30 for the latter. The galleons have the proportionally smallest fore topmasts and the caravels the largest and on average the height of the fore topmast tends to be about one-fourth to one-third the length of the hull.

Height of the Fore Topmast to the Height of the Main Topmast: (H.UFr_H.UMa)

The height of the fore topmast to the height of the upper main mast ratio was not calculated for the caravels. The main mast consists only of the lower spar and is lateen-rigged whereas, the fore mast has both the upper and lower spars and is square-rigged; as such, any comparison between the two masts would be misleading. The galleons have a one standard deviation of 0.70 to 1.14, which is consistent with the primary mode of 0.80 to 0.90 and a main distribution of 0.60 to 1.40 in the histogram graph (Figure 289). One standard deviation for the nau sample is from 0.69 to 0.97. The corresponding histogram graph (Figure 290) reveals that the primary mode is from 0.75 to 0.80 and the secondary mode is from 0.80 to 0.85 while the main distribution which ranges from 0.45 to 1.20. The one standard deviation, center of distribution, and the modal ranges are fairly consistent between the galleons and the naus. From these figures it is evident that there is more variability within the galleon sample than the naus. The modal ranges narrow the broad one standard deviations and center of distribution figures for the two ship types and reveal that the height of the fore topmast on the galleons is 80% to 90 % of the upper main mast while it is only 75% to 85% for the naus. Palacio states that the fore topmast should only be one-fifth less than the height of the upper main mast and the resulting ratio of 0.80 fits perfectly with both the galleons and the naus.

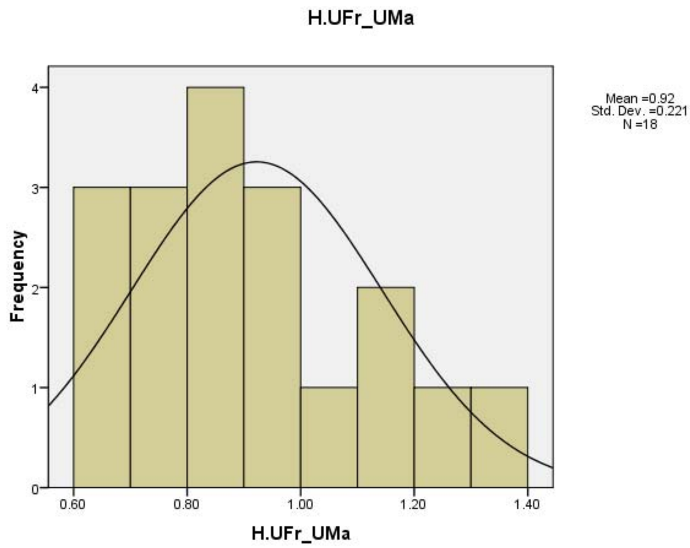


Figure 289: Histogram of the height of the fore topmast to the height of the upper main mast in galleons. Refer to Appendix 34 for data.

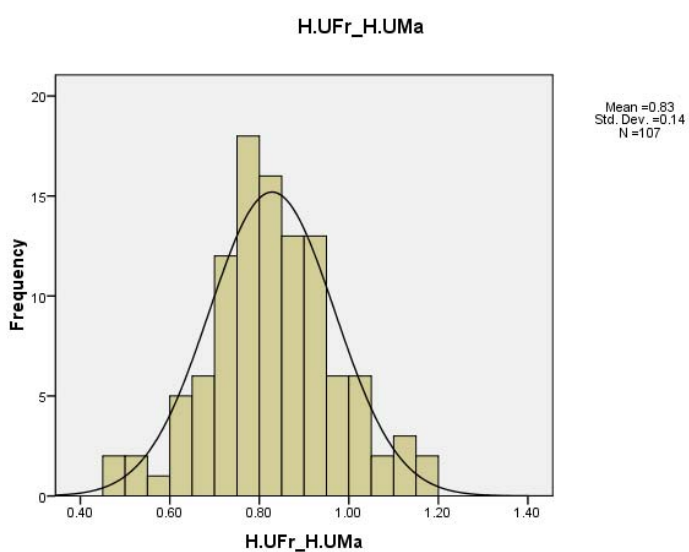


Figure 290: Histogram of the height of the fore topmast to the height of the upper main mast in naus. Refer to Appendix 34 for data.

Fore Topmast Width Ratios

Bottom Width of the Fore Topmast to the Height of the Fore Topmast: (W.BtUFr_H.UFr)

The one standard deviation for the bottom width of the fore topmast to the height of the fore topmast for the caravels is 0.03 to 0.10. The tabulation of the one standard deviation and center of distribution figures for fore topmast width ratios can be viewed in Table 65. The main distribution in the histogram graph (Figure 291) is from 0.00 to 0.15 and there are two equal primary modes from 0.015 to 0.025 and 0.05 to 0.065 and a secondary mode from 0.085 to 0.10. The galleons have a smaller one standard deviation than the caravels of 0.05 to 0.10 and main distribution from 0.03 to 0.13. The primary mode in the histogram graph (Figure 292) is from 0.065 to 0.08 and the secondary mode is from 0.10 to 0.115. The nau sample has the smallest one standard deviation of 0.04 to 0.07 and a main distribution of 0.02 to 0.12 in the histogram graph (Figure 293) with two outliers at 0.14 (CA07.04 and CA06.02), one outlier at 0.15 (CA03.01), and three outliers at 0.16 (EN05.01, CA07.01, CA27.04). The primary mode is from 0.07 to 0.08 with a secondary mode from 0.08 to 0.09.

The one standard deviation of the bottom width of the fore topmast to the height of the fore topmast is relatively constant throughout the three ship types with only slight differences between caravels, galleons, and naus. The galleons and naus have similar centers of distribution (0.05-0.10 and 0.05-0.09) while the caravels have a larger range (0.03 to 0.09). The modal ranges are highly variable within the three datasets and as such

TABLE 65: Comparison of the One Standard Deviation and Center of Distribution of the Fore Topmast Width Ratios

W.BtUFr_H.UFr	One Standard Deviation (68%)	Center of Distribution (50%)
Caravels	0.03 to 0.10	0.03 to 0.09
Galleons	0.05 to 0.10	0.05 to 0.10
Naus	0.04 to 0.07	0.05 to 0.09
W.TpUFr_W.BtUFr	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Caravels	0.62 to 0.96	0.67 to 0.94
Galleons	0.71 to 0.98	0.70 to 1.00
Naus	0.62 to 0.80	0.66 to 0.99

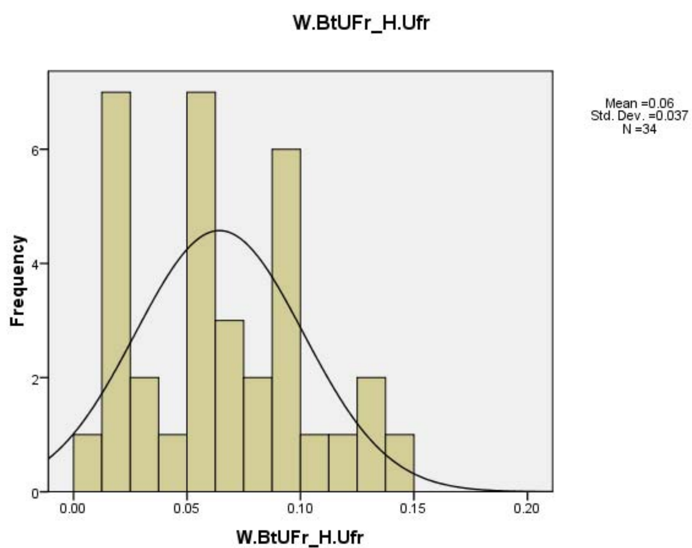


Figure 291: Histogram of the bottom width of the fore topmast to the height of the fore topmast in caravels. Refer to Appendix 34 for data.

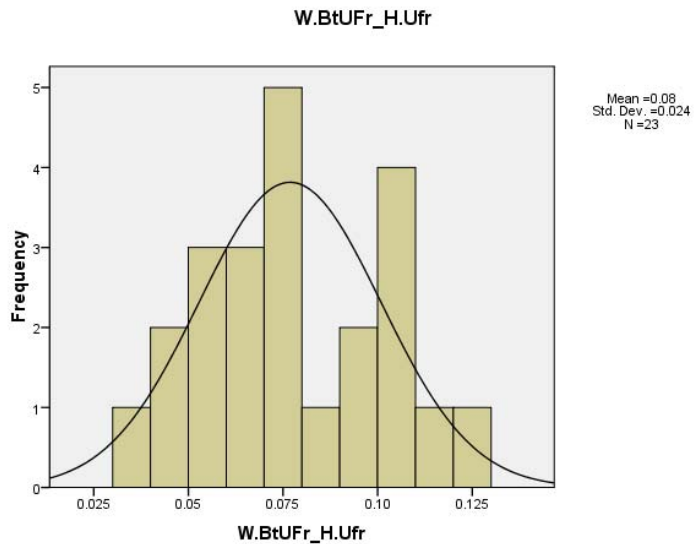


Figure 292: Histogram of the bottom width of the fore topmast to the height of the fore topmast in galleons. Refer to Appendix 34 for data.

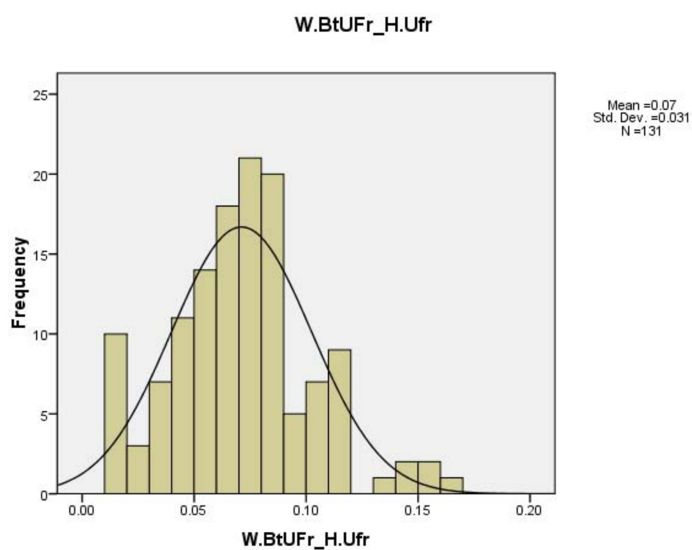


Figure 293: Histogram of the bottom width of the fore topmast to the height of the fore topmast in naus. Refer to Appendix 34 for data.

it is necessary to examine the primary modes alone. The galleons (0.065 to 0.08) and naus (0.07 to 0.08) have almost identical primary modes that are within half a percent from each other. The caravels have a split in the primary modes between a very low 0.015 to 0.025 and 0.05 to 0.065, which is closer to the modal peaks of the galleons and naus. On average the bottom width is 6% to 8% of the height of the topmast, which exceeds the maximum diameter ratio of 0.03 from Fernandez's manuscript. There is a strong correspondence between the bottom widths of the fore topmast to the height of the fore topmasts and the bottom widths of the lower fore mast to the height of the lower fore mast between the ship types. The caravels have a lower one standard deviation of 0.04 to 0.09 and an upper range of 0.03 to 0.10. For the galleons the lower range is 0.04 to 0.11 and the upper range is 0.05 to 0.10. Likewise, the naus have a lower one standard deviation of 0.05 to 0.08 and an upper range of 0.04 to 0.07. The same consistency is seen in the primary modes for the three ship samples; the lower and upper ranges are respectively 0.06 to 0.08 and 0.065 to 0.08 for the galleons, 0.05 to 0.065 and 0.07 and 0.08 for the naus, but the caravels diverge with a lower modal peak of 0.05 to 0.06 and upper peaks of 0.015 to 0.025 and 0.05 to 0.065, which is almost identical to the lower figures.

Bottom Width of the Fore Topmast to the Top Width of the Fore Topmast: (W.TpUFr_W.BtUFr)

The one standard deviation for the top to bottom widths of the upper main mast for the caravels is 0.62 to 0.96 and the main distributions in the histogram graph (Figure 294) is from 0.30 to 1.00. The primary mode in the caravel sample is from 0.90 to 1.00 and the secondary mode is from 0.80 to 0.90. The galleons have a smaller one standard deviation than the caravels from 0.71 to 0.98 and a main distribution in the histogram graph (Figure 295) from 0.60 to 1.00; the primary mode is from 0.95 to 1.00. The one standard deviation for the nau sample is from 0.62 to 0.80. The main distribution ranges from 0.50 to 1.05 with an outlier at 0.14 (CA06.05), two outliers at 0.35 to 0.40 (MA15.1524.10 and MA15.1532.02), and another two at 0.40 to 0.45 (MA15.1523.06 and MA15.1538.01). The primary mode in the histogram graph (Figure 296) is from 1.00 to 1.05.

There is relative consistency in the one standard deviation figures for the bottom to top widths between the ship types in comparison to the same ratio for the lower fore mast and the lower and upper main masts. All three samples have moderately large ranges given suggesting a relatively high level of variability. The caravels have the broadest range from the 60th through the 90th percentiles while the naus have the smallest which only reaches the 80th percentile. The one standard deviation range for the galleons begins with the 70th percentile but has a similar end point as the caravels. The center of distribution figures for the three ship types narrow the differences between the caravels, galleons, and naus and suggest more consistency with an average range of around .70 to

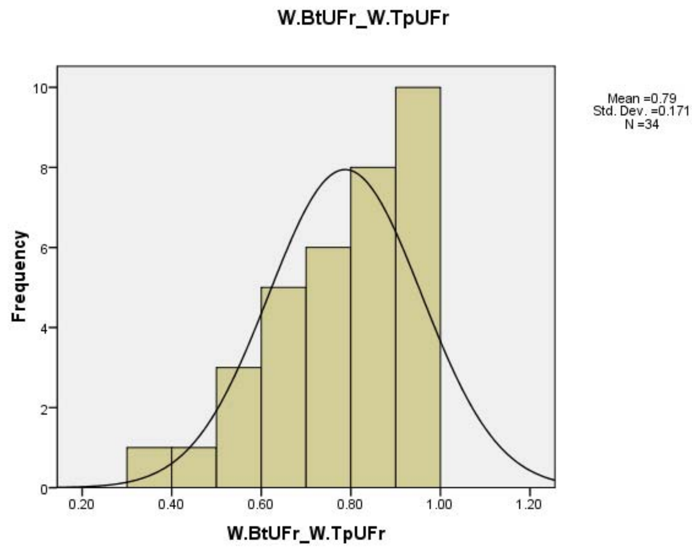


Figure 294: Histogram of the bottom width to the top width of the fore topmast in caravels. Refer to Appendix 34 for data.

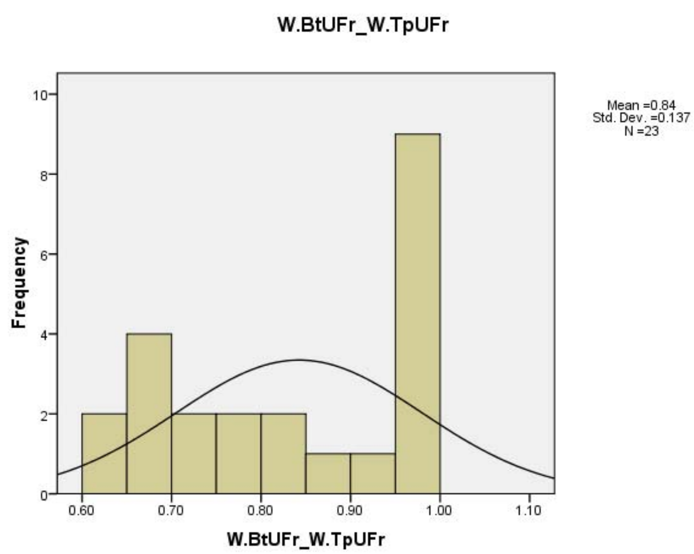


Figure 295: Histogram of the bottom width to the top width of the fore topmast in galleons. Refer to Appendix 34 for data.

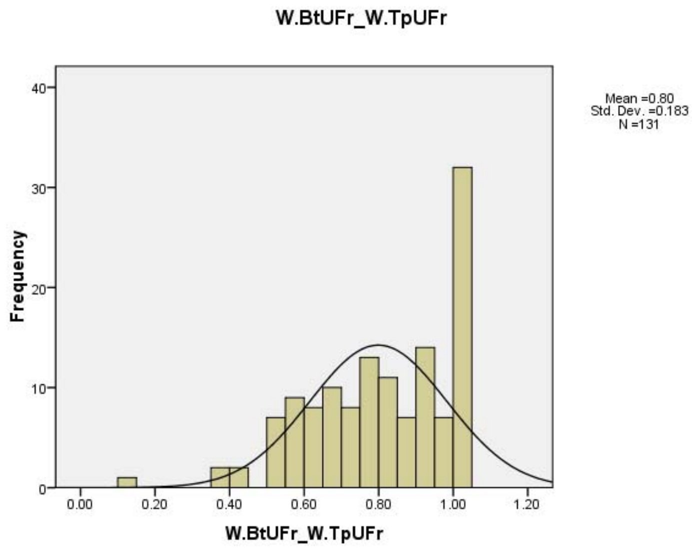


Figure 296: Histogram of the bottom width to the top width of the fore topmast in naus. Refer to Appendix 34 for data.

1.00. The primary modes for three ship types are helpful in this instance when there is a wide range of variation within the sample. The galleons and naus have the most concise ranges of 0.95 to 1.00 and 1.00 to 1.05 respectively while the caravels have a range from 0.90 to 0.95 all of which suggests there is almost no vertical tapering on the majority of the caravel, galleon, and nau fore masts.

There are differences between the bottom to top width ratio of the fore topmast and the bottom to top width ratio of the lower fore masts between the three ship samples, which indicate that there is more tapering on the lower spar than the upper one. The caravels have a lower mast one standard deviation of 0.54 to 0.98 and an upper range of 0.62 to 0.96 while the lower mast range for the four-masted galleons is 0.54 to 0.95 and the upper range is 0.71 to 0.98. Likewise, for the naus the lower mast one standard deviation range is 0.52 to 0.70 and an upper mast range of 0.62 to 0.80. The same level of variance is seen in the modal ranges for the three ship samples; the lower and upper mast ranges are respectively 0.70 to 1.00 and 0.80 to 1.00 for the caravels, 0.80 to 0.90 and 0.95 to 1.00 for the galleons, and 0.65 to 1.05 and 1.00-1.05 for the naus. This comparison clearly shows that there is a trend of significantly less tapering on the upper main mast than the lower main mast which was not as visible when evaluating the widths to the height of the mast. This same trend was also seen on the same main mast ratios. The relative widths to the heights of the upper and lower mast are exceedingly regular when compared to the calculated tapering of each mast. This also provides evidence for controlled proportionality throughout the masts in the iconography and is another indication of the reliability of pictures as a source of data.

Fore Yard Dimensions

Fore Yard Length Ratios

In the statistical analysis of the fore yard there are 35 four-masted caravels, seven three-masted galleons, 20 four-masted galleons, and 135 naus. The length of the yard was measured from yardarm to yardarm while the middle width was taken as close to possible at its intersection with the mast and the end width is at the yardarm.

The length of the fore yard is described in the *Livro Náutico* as being ¾ of the length of the main yard whereas Palacio specifies the fore yard should be one-third less the length of main yard (Bankston, 1986: 124), which would result in ratios ranging from 0.66 to 0.77. The length has also been compared to ship's beam by Cano who states that the length of the yard was equivalent to twice the ship's beam (Smith, 1993: 102); using the *ah*, *dos*, *tres* rule twice the beam is number is 0.66 of the length of the hull. The widths of the fore yard are determined as 1 *penão* in the *Livro Náutico* which equates to 51cm tapering to 19cm or 0.37. Fernandez gives a fore yard length of 14 *braças* (24.64 m) and a maximum diameter of 2 *palmas de vara*, or 51 cm, which tapers to 22 cm (Castro, 2005b: 118). This would provide a middle width to the length of the fore yard ratio of 0.01 and a horizontal tapering of 0.43.

Length of the Fore Yard to the Length of the Hull: (L.FrY_L.H)

The length of the fore yard to the length of the hull ratio for the four-masted caravel sample is from 0.30 to 0.61 and has a primary mode from 0.40 to 0.50 and a secondary mode from 0.30 to 0.40. The tabulation of the one standard deviation and center of distribution figures for the fore yard length and width ratios can be viewed in Table 66. The main distribution in the histogram graph (Figure 297) is from 0.20 to 0.90 with an outlier at 0.07 (CA22.31). The three-masted galleons have a one standard deviation of 0.15 to 0.49 which is consistent with the primary mode of 0.20 to 0.30 in the histogram graph (Figure 298). The main distribution is from 0.20 to 0.40 and there is an outlier from 0.60 to 0.70 (MA14.05). The one standard deviation of the four-masted galleons ranges is similar to the caravels at 0.31 to 0.60. The main distribution in the histogram graph (Figure 299) is from 0.20 to 0.90 and there is a primary mode of 0.40 to 0.50. For the nau sample, the one standard deviation is from 0.31 to 0.67, which is very close to the ranges of the caravels and the four-masted galleons. The corresponding histogram graph (Figure 296) shows a primary mode from 0.31 to 0.38 and a secondary mode from 0.45 to 0.52. The main distribution range is roughly from 0.15 to 0.85 with an outlier at 0.95 to 1.00 (MA15.1513.03), two from 1.00 to 1.05 (PA03.04 and MA15.1509.16), and another at 1.18 to 1.23 (PA03.05).

The one standard deviation figures of the length of the fore yard in relation to the overall length of the hull are exceptionally consistent between the four-masted caravels (0.30 to 0.61), the four-masted galleons (0.31 to 0.60) and the naus (0.31 to 0.67). The three-masted galleons, however, have a much lower range from 0.15 to 0.49. The center of distribution figures verifies the similarities of the three samples as well as the difference of the three-masted galleons. The modal ranges retain a high degree of regularity but exhibit more variance between the samples. The four-masted galleons and

TABLE 66: Comparison of the One Standard Deviation and Center of Distribution of the Fore Yard Length and Width Ratios

L.FrY_L.H	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Four-masted Caravels	0.30 to 0.61	0.37 to 0.58
Three-masted Galleons	0.15 to 0.49	0.23 to 0.32
Four-masted Galleons	0.31 to 0.60	0.36 to 0.50
Naus	0.31 to 0.67	0.36 to 0.57
L.FrY_L.MaY	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Four-masted Caravels	0.32 to 0.81	0.39 to 0.74
Three-masted Galleons	0.36 to 0.79	0.33 to 0.72
Four-masted Galleons	0.40 to 0.93	0.39 to 0.90
Naus	0.52 to 0.86	0.59 to 0.79
W.MFrY_L. FrY	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Four-masted Caravels	0.01 to 0.06	0.02 to 0.05
Three-masted Galleons	0.05 to 0.10	0.07 to 0.10
Four-masted Galleons	0.03 to 0.06	0.03 to 0.05
Naus	0.02 to 0.07	0.03 to 0.05
W.MFrY _ W.EFrY	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Four-masted Caravels	0.73 to 1.05	0.77 to 1.00
Three-masted Galleons	0.68 to 1.04	0.67 to 1.00
Four-masted Galleons	0.67 to 1.05	0.81 to 1.00
Naus	0.72 to 1.04	0.77 to 1.00

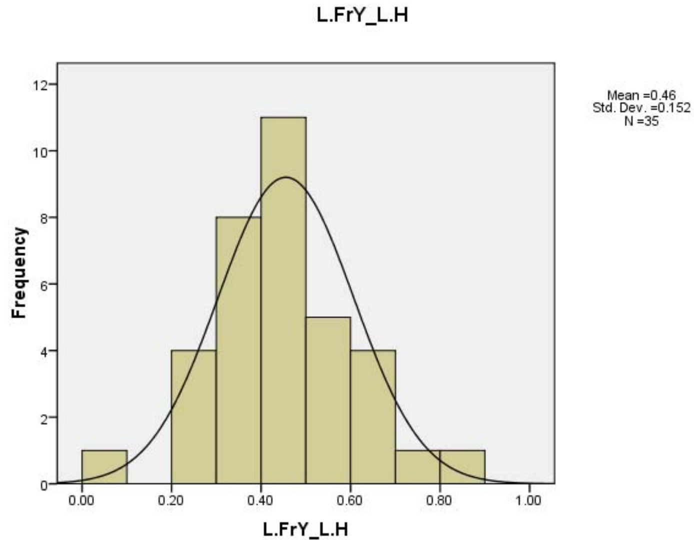


Figure 297: Histogram of the length of the fore yard to the length of the hull in four-masted caravels. Refer to Appendix 34 for data.

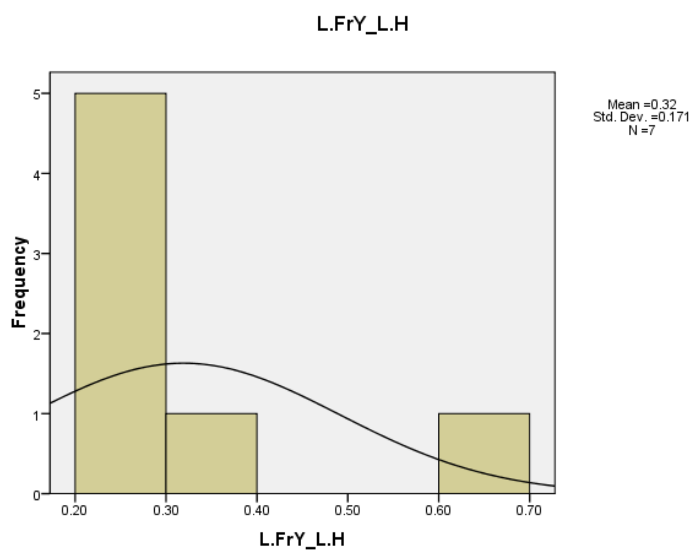


Figure 298: Histogram of the length of the fore yard to the length of the hull in three-masted galleons. Refer to Appendix 34 for data.

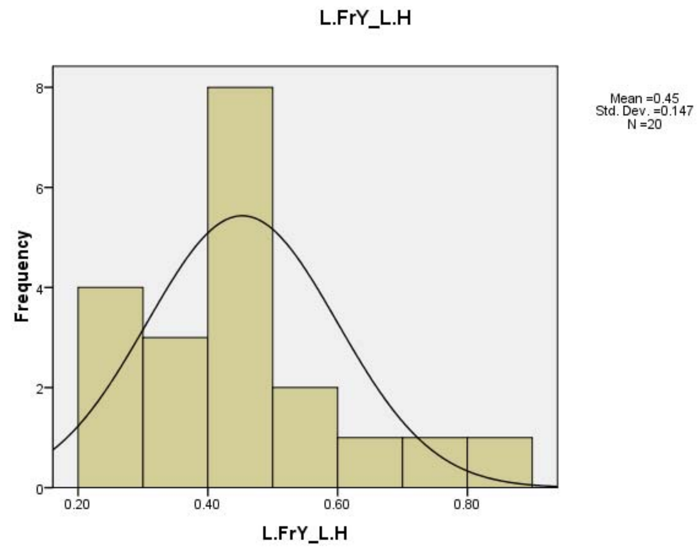


Figure 299: Histogram of the length of the fore yard to the length of the hull in four-masted galleons. Refer to Appendix 34 for data.

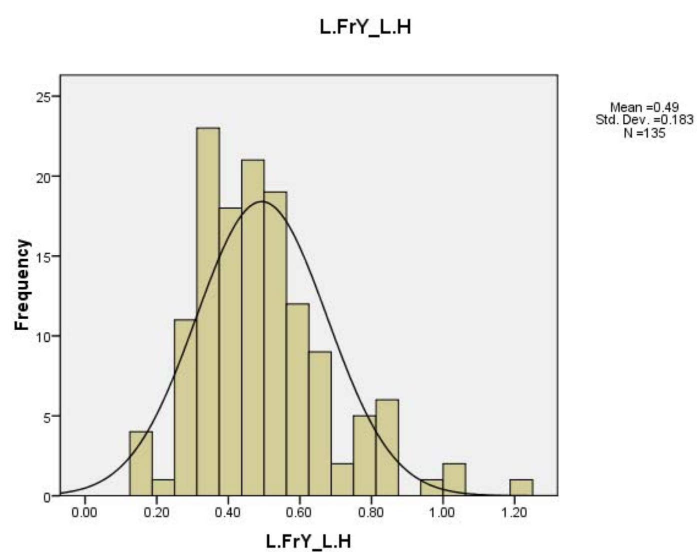


Figure 300: Histogram of the length of the fore yard to the length of the hull in naus. Refer to Appendix 34 for data.

the naus essentially have the same modal peaks from 0.30 to 0.50 with a slight discrepancy for the nau sample whereas the four-masted caravels have a broader range starting at 0.30 and reaching 0.50. The three-masted galleons are again separate from the other three samples with a lower modal range of 0.20 to 0.30 indicating that they have shorter fore yards.

Overall, it appears that the fore yards are roughly 40% to 50% of the length of the hull at deck. In the treatises, the length of the fore yard is purported to be twice the ship's beam which equates to 66% of the length of the hull. Although none of the samples reach this benchmark, the one standard deviation ranges of the caravels, four-masted galleons, and the naus are close; yet the ranges fall short of the 0.66 ratio.

Length of the Fore Yard to the Length of the Main Yard: (L.FrY_L.MaY)

The length of the fore yard to the length of the main yard ratio for the four-masted caravel sample has a one standard deviation from 0.32 to 0.81, which is consistent with the main distribution from 0.20 to 1.10; there is an outlier at 0.07(CA22.31). The primary mode in the histogram graph (Figure 301) is from 0.40 to 0.50 and there is a secondary mode of 0.30 to 0.40. For the three-masted galleons, the one standard deviation is from 0.36 to 0.79 while the main distribution is from 0.50 to 0.80 with an outlier from 0.20 to 0.30 (MA06.02) and another from 0.30 to 0.40 (CA04.28). The primary mode in the histogram graph (Figure 302) is from 0.70 to 0.80. The four-masted galleons have a one-standard deviation of 0.40 to 0.93. The main distribution is from 0.60 to 1.00 and there is a secondary distribution from 0.20 to 0.50

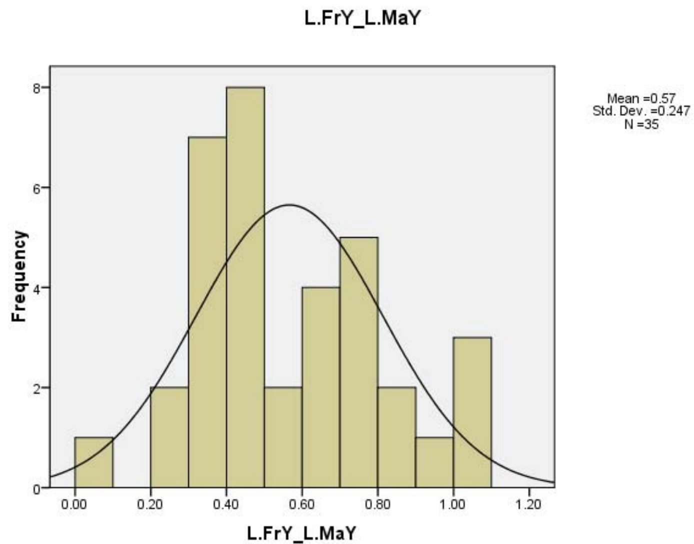


Figure 301: Histogram of the length of the fore yard to the length of the main yard in four-masted caravels. Refer to Appendix 34 for data.

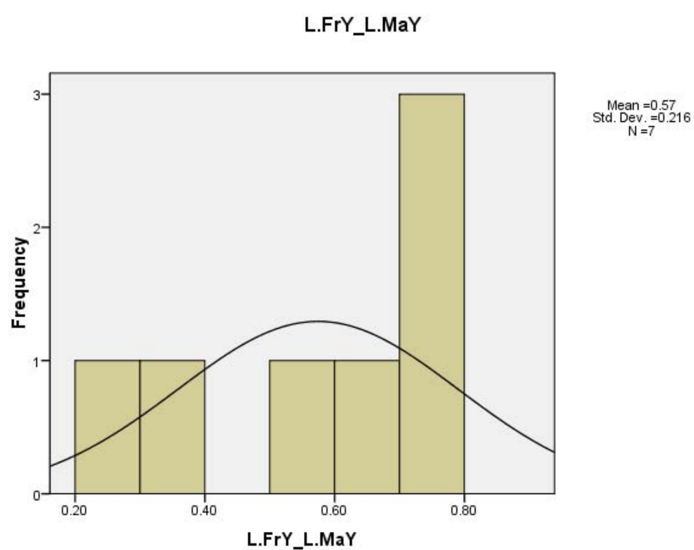


Figure 302: Histogram of the length of the fore yard to the length of the main yard in three-masted galleons. Refer to Appendix 34 for data.

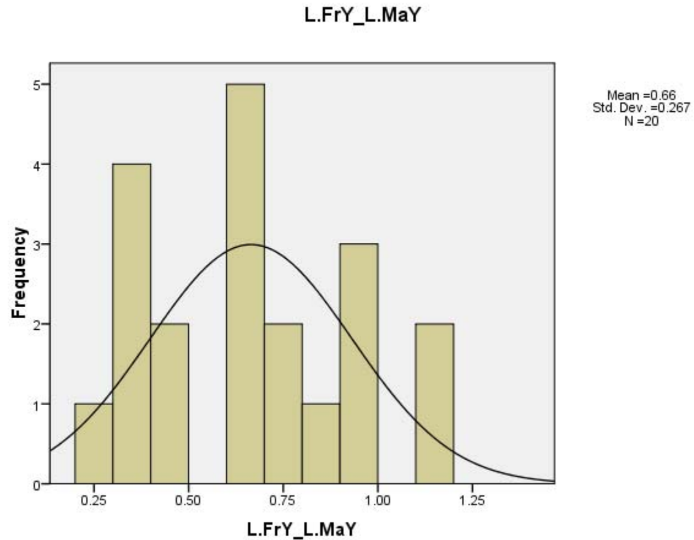


Figure 303: Histogram of the length of the fore yard to the length of the main yard in four-masted galleons. Refer to Appendix 34 for data.

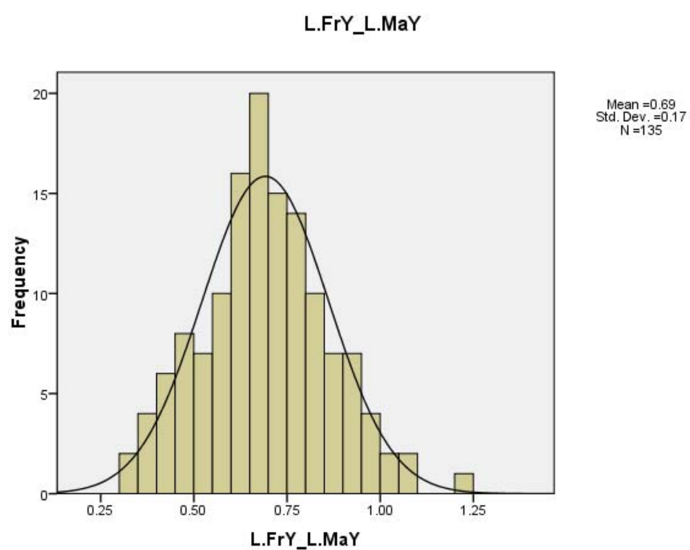


Figure 304: Histogram of the length of the fore yard to the length of the main yard in naus. Refer to Appendix 34 for data.

with two outliers from 1.10 to 1.20 (CA15.06 and PA09.01). The histogram graph (Figure 303) indicates that there is a primary mode from 0.60 to 0.70 and a secondary mode from 0.30 to 0.40. One standard deviation for the nau sample is from 0.52 to 0.86. The main distribution is from 0.30 to 1.10 and there is an outlier from 1.20 to 1.25 (CA04.24). The primary mode in the histogram graph (Figure 304) is from 0.65 to 0.70 and the secondary mode is from 0.60 to 0.65.

The one standard deviation figures are relatively consistent between the samples and the four-masted caravels and the three-masted galleons have the lowest range from the 30th to the 80th percentile while the four-masted galleons and the naus are skewed higher from respectively the 40th and the 50th to roughly the 90th percentile. Examining the modes allows for a more concise look at highest concentrations within the sample. The primary and secondary modes show that the four-masted caravels with a range of 0.30 to 0.50 have the smallest fore yards out of all the samples whereas the three-masted galleons actually have the highest peak from 0.70 to 0.80 contradicting the one standard deviation data. The nau sample has a similar modal range of 0.60 to 0.70 while the four-masted galleons have the same primary mode of 0.60 to 0.70 but a much lower secondary mode from 0.30 to 0.40. The length of the fore yard is described in the *Livro Náutico* as being three-quarters of the length of the main yard whereas Palacio specifies the fore yard should be one-third less the length of main yard, which would result in ratios ranging from 0.66 to 0.77. This expected range is congruous with both the one standard deviation ranges and all modal peaks which fall around the 60th to the 80th percentiles except for the four-masted caravels which only reach the 50th percentile.

<u>Fore Yard Width Ratios</u>

Middle Width of the Fore Yard to the Length of the Fore Yard: (W.MFrY_L.FrY)

The one standard deviation for the middle width of the fore yard to the length of the fore yard ratio for the four-masted caravels is 0.01 to 0.06. The main distribution in the histogram graph (Figure 305) is from 0.01 to 0.10 with an outlier at 0.12 (CA27.05) and a primary mode from 0.02 to 0.03. For the three-masted galleons, the one standard deviation is from 0.05 to 0.10 and the primary mode in the histogram graph (Figure 306) is from 0.06 to 0.08. The main distribution is from 0.06 to 0.12, however, and the one standard deviation is affected by the presence of an outlier from 0.02 to 0.04 (MA14.05). The four-masted galleons have a smaller one standard deviation than the three-masted galleons from 0.03 to 0.06 and a main distribution from 0.01 to 0.07. The primary mode in the histogram graph (Figure 307) is 0.03 to 0.04 and secondary mode is from 0.02 to 0.03. The nau sample has a standard deviation of 0.02 to 0.07 and a main distribution of 0.00 to 0.10 in the histogram graph (Figure 308). The nau sample also has an outlier at 0.12 (CA27.04) and another at 0.17 (CA27.06). The primary mode is from 0.024 to 0.032 with a secondary mode from 0.042 to 0.05.

There is a relatively high level of uniformity between the one standard deviation of the middle width of the fore yard to the length of the fore yard throughout the four-masted caravels, the four-masted galleons, and the naus with only slight differences between the ship types. The three-masted galleons, however, have a range that is skewed much higher than the other samples, which is probably due to the small sample size. The

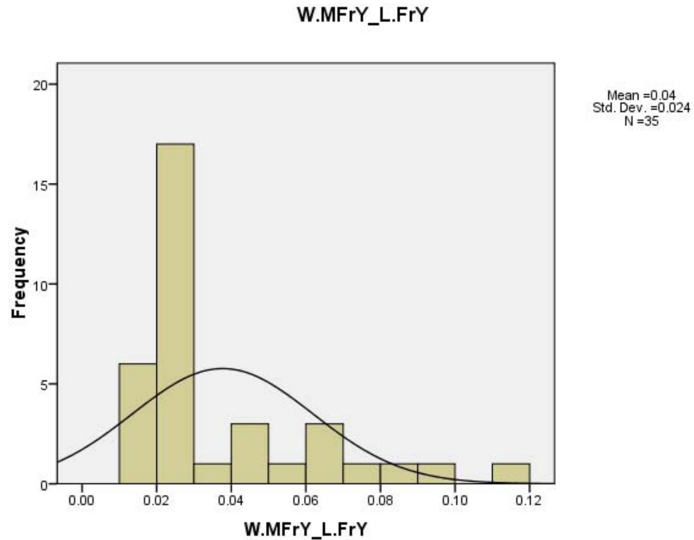


Figure 305: Histogram of the middle width of the fore yard to the length of the four yard in four-masted caravels. Refer to Appendix 34 for data.

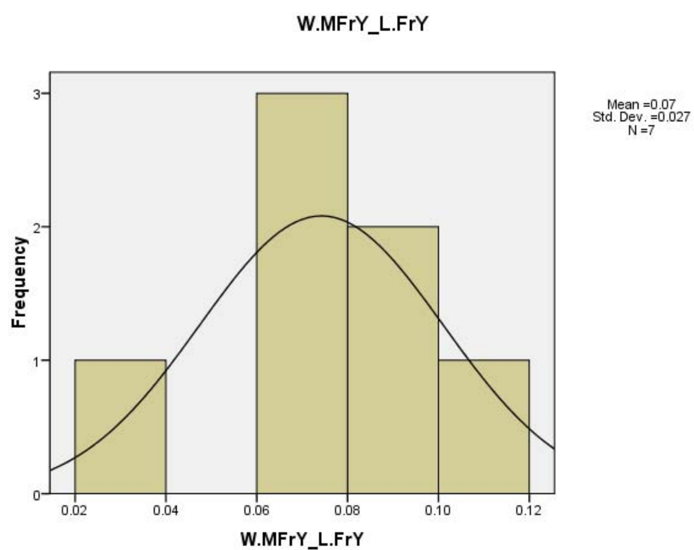


Figure 306: Histogram of the middle width of the fore yard to the length of the four yard in three-masted galleons. Refer to Appendix 34 for data.

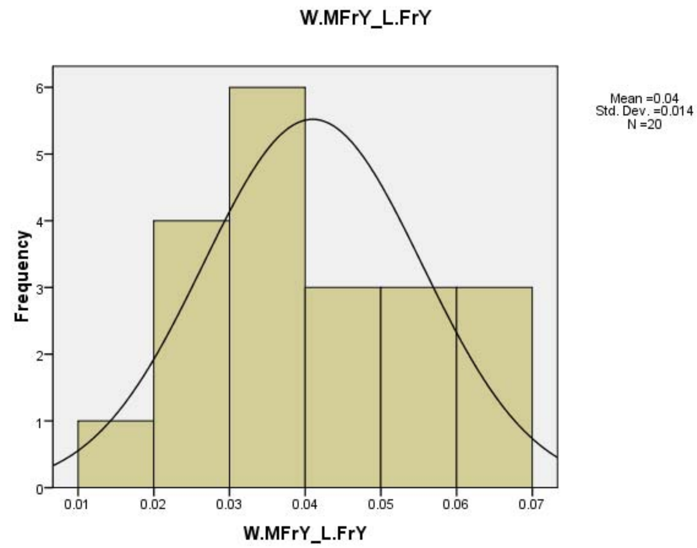


Figure 307: Histogram of the middle width of the fore yard to the length of the four yard in four-masted galleons. Refer to Appendix 34 for data.

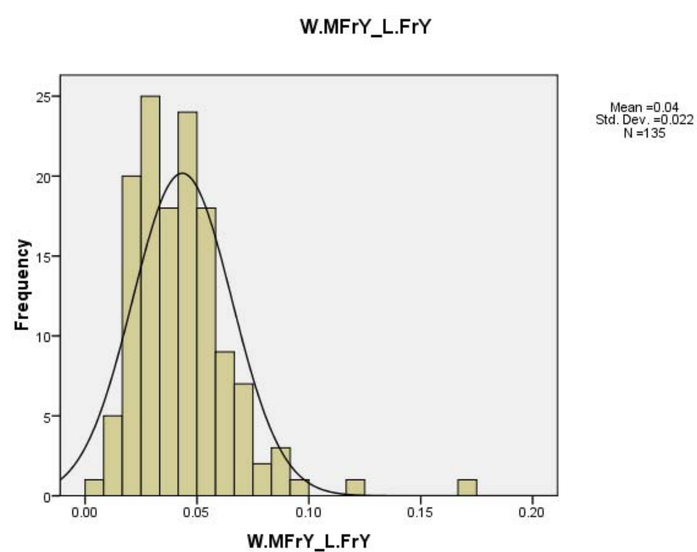


Figure 308: Histogram of the middle width of the fore yard to the length of the four yard in naus. Refer to Appendix 34 for data.

center of distribution data and the modal ranges also verify that the three-masted galleon sample is set apart from the other samples by higher figures. The modal ranges get progressively larger with thicker middle widths from the four-masted caravels (0.02 to 0.03) to the four-masted galleons (0.02 to 0.04) to the naus (0.02 to 0.05). According to the measurements provided by Fernandez, the middle width to the length of the fore yard results in a ratio of 0.01, which is similar to, but lower than the data gathered from the iconography. The one standard deviation of the end width of the fore yard to the length of the fore yard is consistent between four-masted caravels (0.01 to 0.06), the four-masted galleons (0.02 to 0.05), and the naus (0.02 to 0.06). Like the middle width analysis, the three-masted galleons have a range that is skewed much higher than the other samples from 0.04 to 0.10, which is reaffirmed in the center of distribution data and the modal ranges. The modal ranges for the other three samples are identical to those of the middle width analysis. The four-masted caravels and the naus have roughly the same modal peaks from 0.02 to 0.03 while the four-masted galleons are only slightly higher at 0.02 to 0.04.

Middle Width of the Fore Yard to the End Width of the Fore Yard: (W.MFrY_ W.EFrY)

The one standard deviation for the middle to the end widths of the fore yard for the four-masted caravels is 0.73 to 1.05 and the main distributions in the histogram graph (Figure 309) from 0.60 to 1.00 with an outlier from 0.04 to 0.50 (MA13.10) while the primary mode in the caravel sample is from 0.90 to 1.00. The three-masted galleons have a similar one standard deviation to the caravels from 0.68 to 1.04 and a main

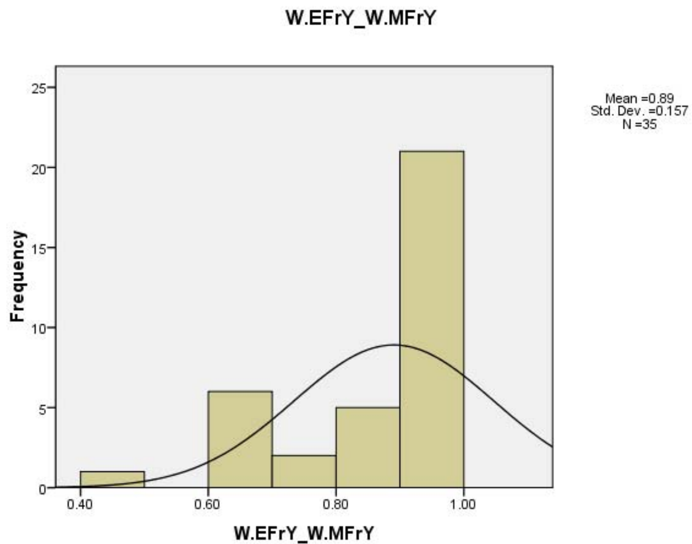


Figure 309: Histogram of the middle width to the end width of the fore yard in four-masted caravels. Refer to Appendix 34 for data.

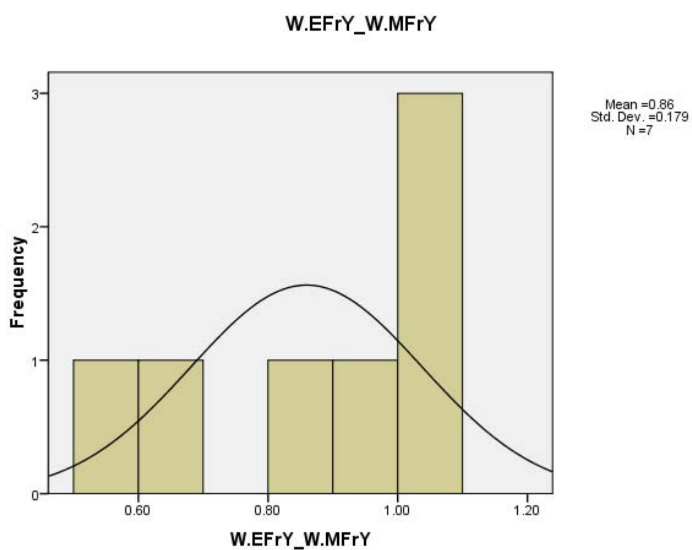


Figure 310: Histogram of the middle width to the end width of the fore yard in three-masted galleons. Refer to Appendix 34 for data.

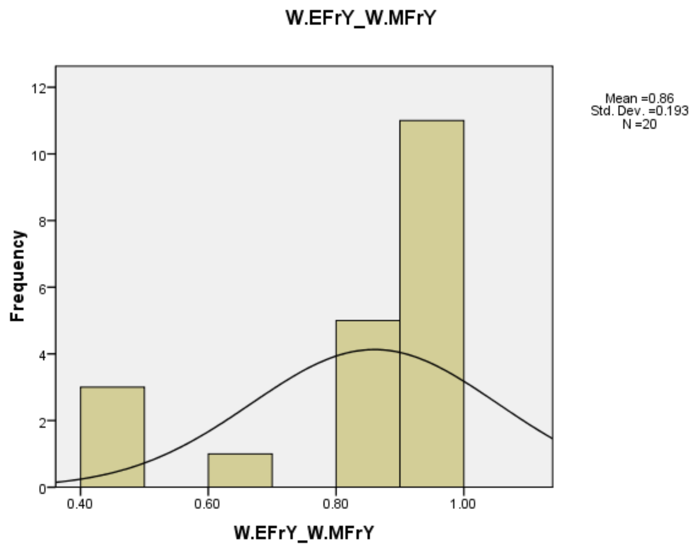


Figure 311: Histogram of the middle width to the end width of the fore yard in four-masted galleons. Refer to Appendix 34 for data.

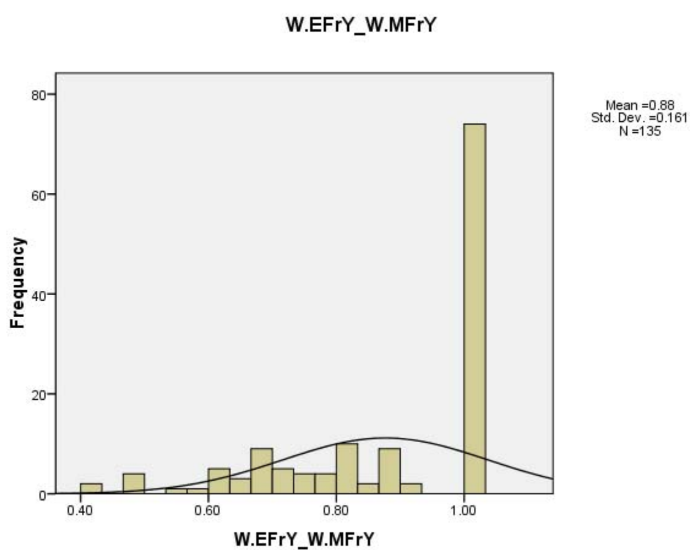


Figure 312: Histogram of the middle width to the end width of the fore yard in naus. Refer to Appendix 34 for data.

distribution from 0.80 to 1.10. The primary mode in the histogram graph (Figure 310) is from 1.00 to 1.10. For the four-masted galleons, the one standard deviation is almost identical to the three-masted galleons from 0.67 to 1.05 and the main distribution is from 0.40 to 1.20. The primary mode in the histogram graph (Figure 311) is from 0.90 to 1.00. The one standard deviation for the nau sample is slightly higher from 0.72 to 1.04. Although the main distribution in the histogram graph (Figure 312) is from roughly 0.55 to 0.95, the primary mode of 1.00 accounts for about 77 of the 135 vessels. There are two outliers from 0.40 to 0.45 (MA15.1501.08 and MA15.1528.01) and another three at 0.50 (EN02.01, MA15.1504.02, and MA16.1502-12).

There is a strong correlation between the one standard deviation figures for the middle to end widths between the caravel, galleon, and nau samples ranging from around the 70th to the 100th percentile, which is also supported by the center of distribution figures for the four samples. The modal ranges narrow the level of variability between the samples. The four-masted caravels and galleons have an identical peak of 0.90 to1.00 while the three-masted galleons and the naus both have peaks of 1.00 to 1.10 all of which suggests there is almost no horizontal tapering on the majority of the fore yards. The *Livro Náutico* and the manuscript by Fernandez, however, indicate significantly greater tapering from middle to end of 63% and 57% respectively. This same discrepancy has been seen in the tapering of other yards and the reason behind it is unknown. Again, it is most likely due to artistic error and the lack of detailed attention paid to these small spars.

Fore Topsail Yard Dimensions

<u>Fore Topsail Yard Length Ratios</u>

In the statistical analysis of the fore topsail yard there are 34 four-masted caravels, 20 three- and four-masted galleons, and 102 naus. The length of the yard was measured from yardarm to yardarm while the middle width was taken as close as possible at its intersection with the mast and the end width is at the yardarm.

The length of the fore topsail yard in the *Livro Náutico* is one-third of the fore yard length which results in a ratio of 0.33 (Castro, 2005b: 119). Additionally, the length of the fore topsail yard is stated as being 1 *braças* (2.04 m) shorter than the main topsail yard which is 13 m in length. Palacio, however, calculates the fore topsail yard as a fifth less the measurement of the main topsail yard (Bankston, 1986: 124). Following the *Livro Náutico* and Palacio, the length of the fore topsail yard would be 85% and 80% of the length of the main topsail yard. In regards to the width of the fore topsail yard, Fernandez writes that the spar should be 5 *braças* long (8.8 m) and have a center diameter of 1 *palmo de goas* or 26 cm (Castro, 2005b: 119); the resulting middle width to length ratio would be 0.03. The diameter of the fore topsail yard in the *Livro Náutico* is described as being 2 *dedos* less the mainsail diameter which is a difference of 26 cm versus 22 cm or ratio of 0.85 and there is a 50% horizontal tapering.

Length of the Fore Topsail Yard to the Length of the Hull: (L.FrTpY_L.H)

The length of the fore topsail yard to the length of the hull ratio for the four-masted caravel sample has a one standard deviation from 0.21 to 0.34, which is consistent with the main distribution in the histogram graph (Figure 313) from 0.15 to 0.38 and the two equal primary modes from 0.25 to 0.275 and 0.275 to 0.30. The tabulation of the one standard deviation and center of distribution figures for the fore yard length and width ratios can be viewed in Table 67. There are two outliers in the caravel sample at 0.40 (MA15.1519.17) and 0.44 (EN03.01). The one standard deviation of the galleon sample ranges from 0.18 to 0.31 and the main distribution is from 0.15 to 0.40. The primary mode in the histogram graph (Figure 314) is from 0.20 to 0.25. One standard deviation for the nau sample is from 0.17 to 0.41. The corresponding histogram graph (Figure 315) shows two equal primary modes from 0.27 to 0.30 and 0.37 to 0.33 and a main distribution from 0.05 to 0.57.

The one standard deviation and the center of distribution of the length of the fore topsail yard in relation to the overall length of the hull is relatively consistent for each of the caravel, galleon, and the naus with only a few percentage points difference between the samples. The respective modes exhibit even less variation with ranges progressing in relative size from the galleons with 0.20 to 0.25 to the four-masted caravels with 0.25 to 0.30 and the naus with 0.27 to 0.30. On average, for all of the ship types, the length of the fore topsail yard seems to be within 20% to 30% of the length of the hull with slight variations between the individual subtypes.

TABLE 67: Comparison of the One Standard Deviation and Center of Distribution of the Fore Topsail Yard Length and Width Ratios

L.FrTpY_L.H	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Four-masted Caravels	0.21 to 0.34	0.22 to 0.32
Galleons	0.18 to 0.31	0.20 to 0.27
Naus	0.17 to 0.41	0.20 to 0.39
L.FrTpY_L.FrY	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Four-masted Caravels	0.48 to 0.74	0.54 to 0.67
Galleons	0.39 to 0.78	0.45 to 0.67
Naus	0.41 to 0.73	0.46 to 0.66
L.FrTpY_L.MaTpY	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Galleons	0.68 to 0.91	0.72 to 0.90
Naus	0.65 to 1.05	0.72 to 0.95
W.MFrTpY _ L.FrTpY	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Four-masted Caravels	0.01 to 0.10	0.03 to 0.07
Galleons	0.04 to 0.10	0.05 to 0.10
Naus	0.03 to 0.10	0.04 to 0.09
W.EFrTpY_W.MFrTpY	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Four-masted Caravels	0.74 to 1.04	0.82 to 1.00
Galleons	0.77 to 1.03	0.78 to 1.00
Naus	0.80 to 1.04	0.86 to 1.00
W.MFrTpY _W.MMaTpY	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Galleons	.69 to 1.29	.75 to 1.24
Naus	.71 to 1.27	.80 to 1.18

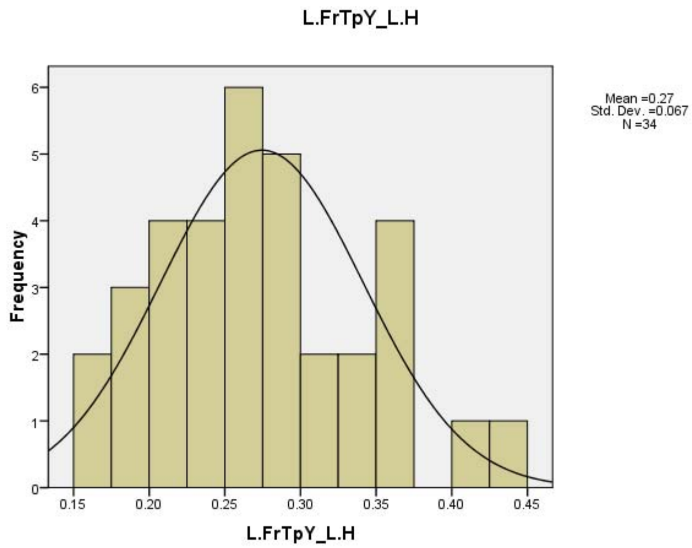


Figure 313: Histogram of the length of the fore topsail yard to the length of the hull in four-masted caravels. Refer to Appendix 34 for data.

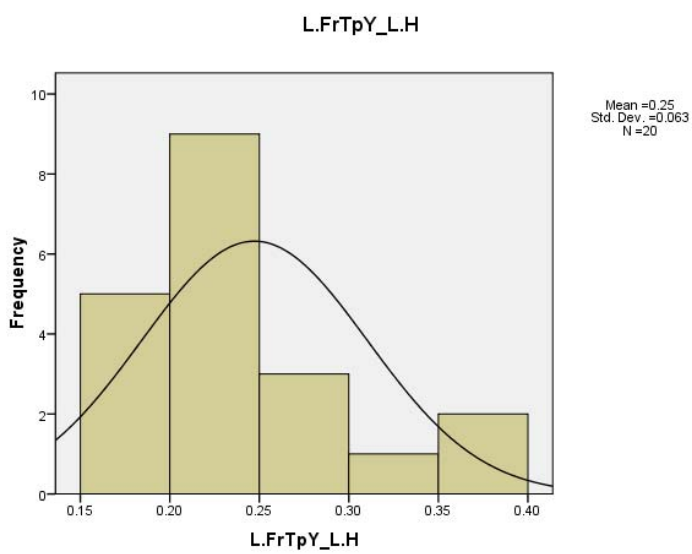


Figure 314: Histogram of the length of the fore topsail yard to the length of the hull in galleons. Refer to Appendix 34 for data.

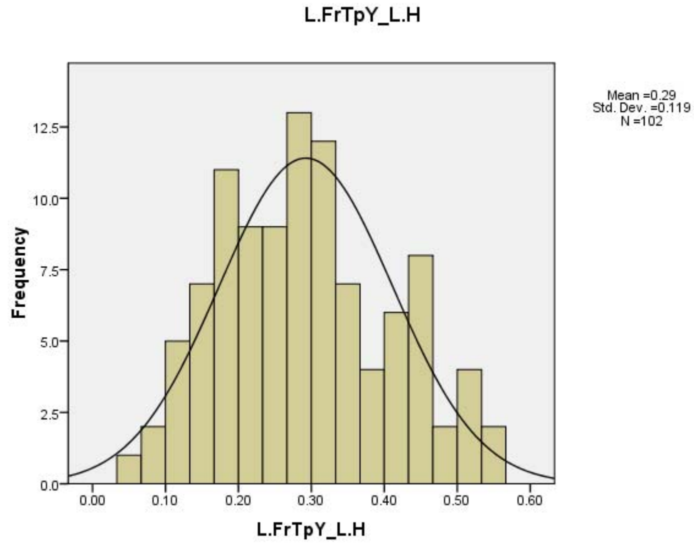


Figure 315: Histogram of the length of the fore topsail yard to the length of the hull in naus. Refer to Appendix 34 for data.

Length of the Fore Topsail Yard to the Length of the Fore Yard: (L.FrTpY_L.FrY)

The length of the fore topsail yard to the length of the fore yard ratio for the caravel sample has a one-standard deviation of 0.48 to 0.74. The main distribution in the histogram graph (Figure 316) is from .30 to .90 and there is an outlier (CA28.01) at 1.07. The primary mode is from 0.60 to 0.70 with a secondary peak at 0.50 to 0.60. One standard deviation for the galleon sample is from 0.39 to 0.78. The main distribution in the histogram graph (Figure 317) is from 0.30 to 0.70 and there is an outlier at 0.89 (MA15.1502.01), at 1.00 (EN04.02), and 1.02 (CA04.29); the primary mode is from 0.50 to 0.60. The one standard deviation for the nau sample is 0.41 to 0.73 and the main mode in the histogram graph (Figure 318) is from 0.50 to 0.55 and the secondary mode is from 0.45 to 0.50. The main distribution in the nau sample is from 0.30 to 0.85 and there are three outliers from 0.90 to 0.95 (MA16.1517-02, MA13.23, and MA16.1507-11), one from 1.00 to 0.105 (CA33.02), and another from 1.10 to 1.15(MA19.02).

The four-masted caravels have the highest one standard deviation range of 0.48 to 0.74 followed by the naus with 0.41 to 0.73 and the three-masted galleons with 0.39 to 0.78. The center of distribution figures narrows these ranges and shows that the galleons and naus have near identical ranges of 0.45 to 0.67 and 0.46 to 0.66 respectively while the four-masted caravels have a smaller range from 0.54 to 0.67. The modal ranges suggest that four-masted caravels (0.50 to 0.70) have relatively long fore topsail yards compared to the fore yards while the galleons (0.50 to 0.60) have slightly smaller yards followed by the naus with the shortest yards (0.45 to 0.55). The length of the fore topsail yard is purportedly one-third or a ratio of 0.33 of the fore yard length in the *Livro*

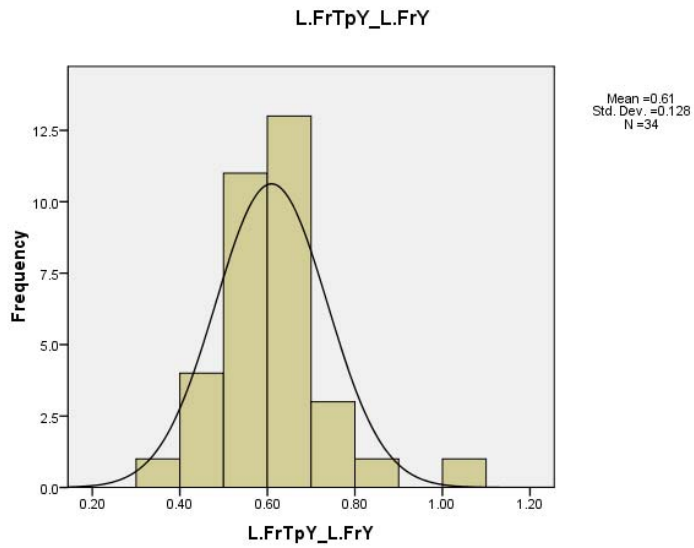


Figure 316: Histogram of the length of the fore topsail yard to the length of the fore yard in four-masted caravels. Refer to Appendix 34 for data.

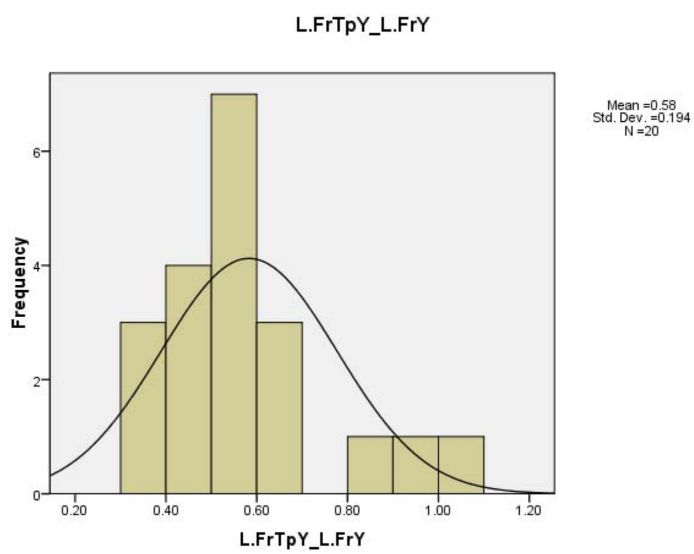


Figure 317: Histogram of the length of the fore topsail yard to the length of the fore yard in galleons. Refer to Appendix 34 for data.

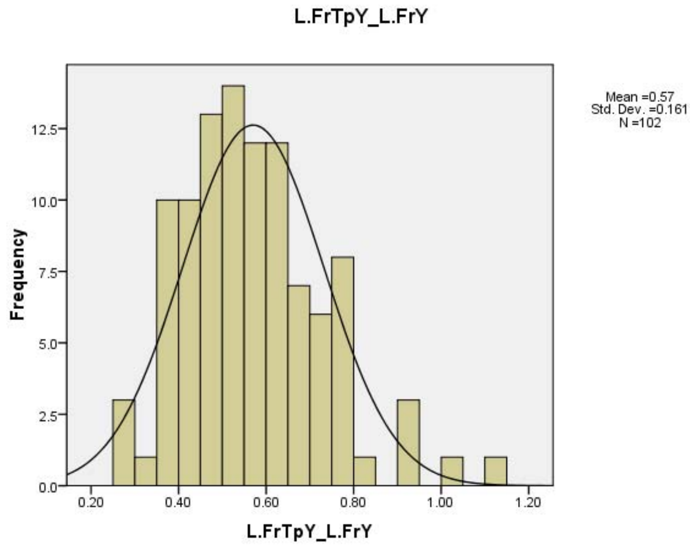


Figure 318: Histogram of the length of the fore topsail yard to the length of the fore yard in naus. Refer to Appendix 34 for data.

Náutico, which does not correlate to any of the samples. It would be more logical if the top yard was one-third less the length of the fore yard, which would result in a ratio of 0.66 and correspond well to the data gathered from the iconography.

Length of the Fore Topsail Yard to the Length of the Main Topsail Yard: (L.FrTpY_L.MaTpY)

The length of the fore topsail yard to the length of the main topsail yard ratio was not calculated for the caravel sample due to the lack of main topmasts. One standard deviation for the galleon sample is from 0.68 to 0.91. The main distribution in the histogram graph (Figure 319) is from 0.60 to 1.10 with a primary mode from 0.70 to 0.80. The nau sample has a one standard deviation from 0.65 to 1.05 and a main distribution from roughly 0.40 to 1.30 and an outlier at 1.52 (MA16.1507-11) and another at 1.71 (MA16.1508-14). The primary mode in the histogram graph (Figure 320) is from 0.92 to 1.00 and there are two equal secondary modes from 0.78 to 0.86 and from 0.86 to 0.92. The one standard deviation range of the galleons (0.69 to 0.91) is similar but slightly smaller than the naus (0.65 to 1.05). The center of distribution figures narrows these ranges considerably and shows that both samples are from the 70th to the 90th percentiles. The modal ranges, however, demonstrate that there is moderate variation between the samples. The naus have a broader modal range (0.78 to 1.00) indicating relatively longer fore topsail yards to the main topsail yards while the galleons (0.70 to 0.80) have a more concise range and shorter spars. According to calculations from Palacio and the *Livro Náutico* and, the length of the fore topsail yard would be 80%

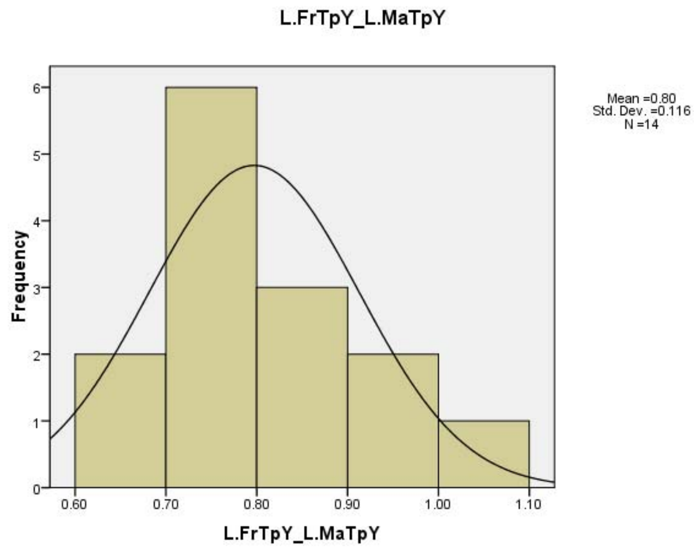


Figure 319: Histogram of the length of the fore topsail yard to the length of the main topsail yard in galleons. Refer to Appendix 34 for data.

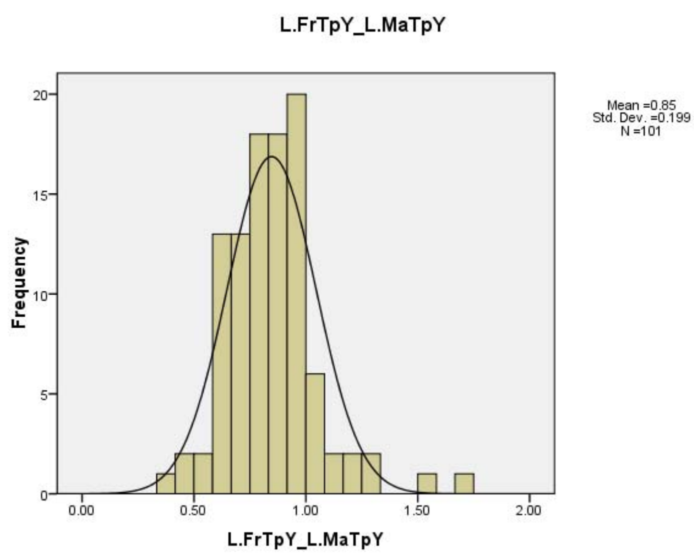


Figure 320: Histogram of the length of the fore topsail yard to the length of the main topsail yard in naus. Refer to Appendix 34 for data.

and 85% of the length of the main topsail yard which corresponds extremely well to the iconographic data.

Fore Topsail Yard Width Ratios

Middle Width of the Fore Topsail Yard to the Length of the Fore Topsail Yard: (W.MFrTpY_L.FrTpY)

The one standard deviation for the middle width of the fore topsail yard to the length of the fore topsail yard for the four-masted caravels is 0.01 to 0.10, which is consistent with the main distribution from 0.00 to 0.15; there is an outlier at 0.18 (CA29.01) and another at 0.21 (CA27.05). The primary mode in the histogram graph (Figure 321) is from 0.04 to 0.05. The one standard deviation of the galleon sample is from 0.04 to 0.10 and the main distribution in the histogram graph (Figure 322) is from 0.00 to 0.15. The primary mode is from 0.05 to 0.075 while the secondary mode is from 0.075 to 0.10. The nau sample has a one standard deviation of 0.03 to 0.10 and a primary 0.00 to 0.15. The primary mode is from 0.05 to 0.075 while the secondary mode is from 0.075 to 0.10. The nau sample has a one standard deviation of 0.03 to 0.10 and a primary mode of 0.08 to 0.09 with three equal secondary modes from 0.02 to 0.03, 0.03 to 0.04, and 0.05 to 0.06. The main distribution in the histogram graph (Figure 323) is from 0.01 to 0.18.

The one standard deviation of the middle width of the fore topsail yard to the length of the fore topsail yard ratio is consistent between the galleons (0.04 to 0.10), and

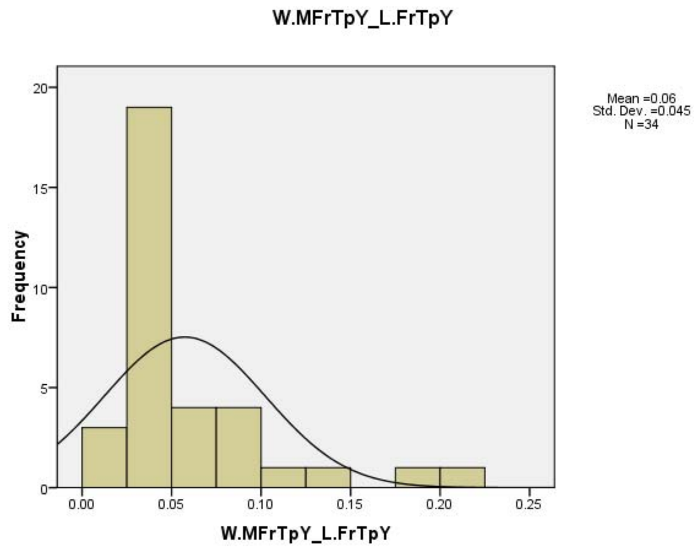


Figure 321: Histogram of the middle width of the fore topsail yard to the length of the fore topsail yard in four-masted caravels. Refer to Appendix 34 for data.

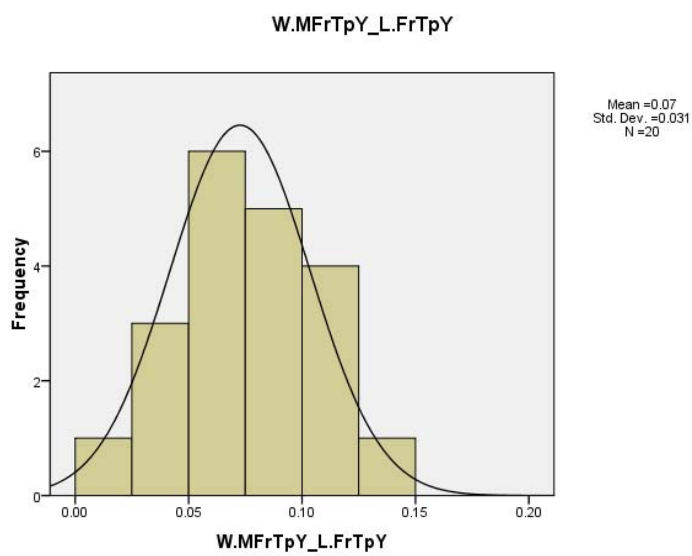


Figure 322: Histogram of the middle width of the fore topsail yard to the length of the fore topsail yard in galleons. Refer to Appendix 34 for data.

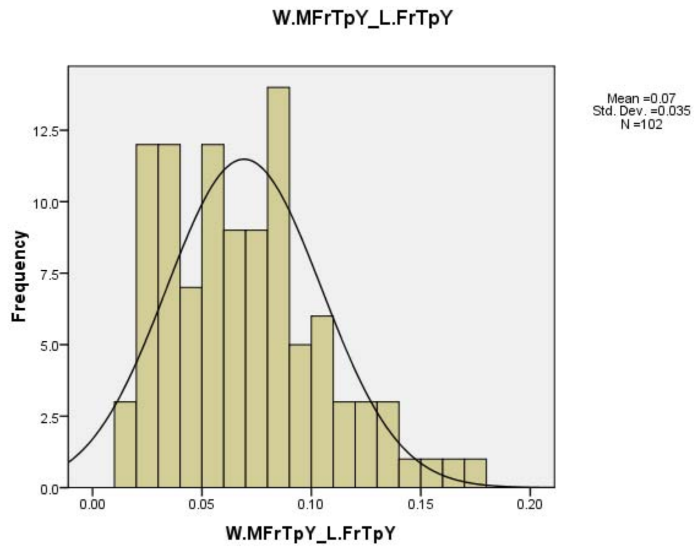


Figure 323: Histogram of the middle width of the fore topsail yard to the length of the fore topsail yard in naus. Refer to Appendix 34 for data.

the naus (0.03 to 0.10) while the caravels have a broader range from 0.01 to 0.10. The modal ranges show that the caravel sample has a concise and moderate peak of 0.04 to 0.05 while the galleons represent the higher end with peaks from 0.05 to 0.10. The naus have the broadest modal range of 0.02 to 0.09 indicating significant variability in the width of the spar. According to the measurements provided by Fernandez, the middle width to length ratio should be around 0.03. All three samples match this ratio but exhibit more variation.

End Width of the Fore Topsail Yard to the Middle Width of the Fore Topsail Yard: (W.EFrTpY_ W.MFrTpY)

The end width of the fore topsail yard to the middle width of the fore topsail yard for the caravel sample has a one standard deviation of 0.74 to 1.04 and a primary mode from 1.00 to 1.05. The main distribution in the histogram graph (Figure 324) is from 0.85 to 1.05 and there is a secondary distribution from 0.060 to 0.75 and an outlier at 0.51 (MA16.1502-02). The galleons have a similar one standard deviation from 0.77 to 1.03 and a main distribution in the histogram graph (Figure 325) from .75 to .100 with one outlier (CA23.01) from 0.60 to 0.65 and two more from 0.65 to 0.70 (CA15.04 and PA08.01); the primary mode is from 0.95 to 1.00. The one standard deviation for the nau sample is from 0.80 to 1.04 with a main distribution from 0.65 to 1.05 and a primary mode at 1.00 to 1.05 in the histogram graph (Figure 326). There is one outlier (MA15.1528.01) at 0.45, another (MA16.1517-02) at 0.50 and a third (MA15.1510.05) at 0.55.

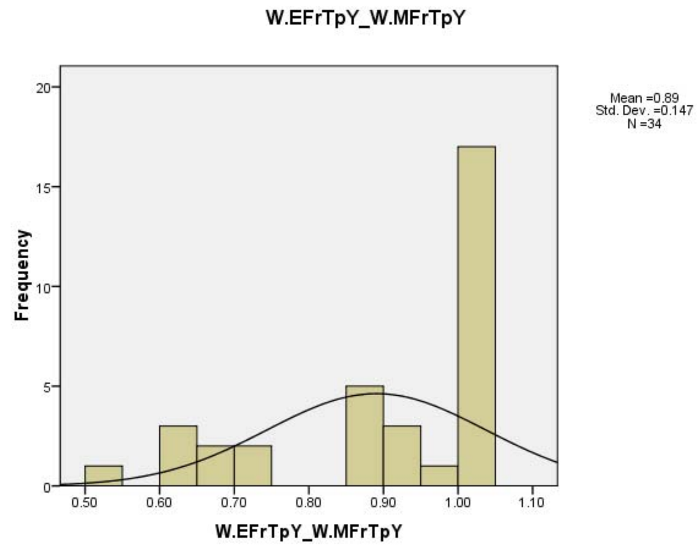


Figure 324: Histogram of the end width to the middle width of the fore topsail yard in four-masted caravels. Refer to Appendix 34 for data.

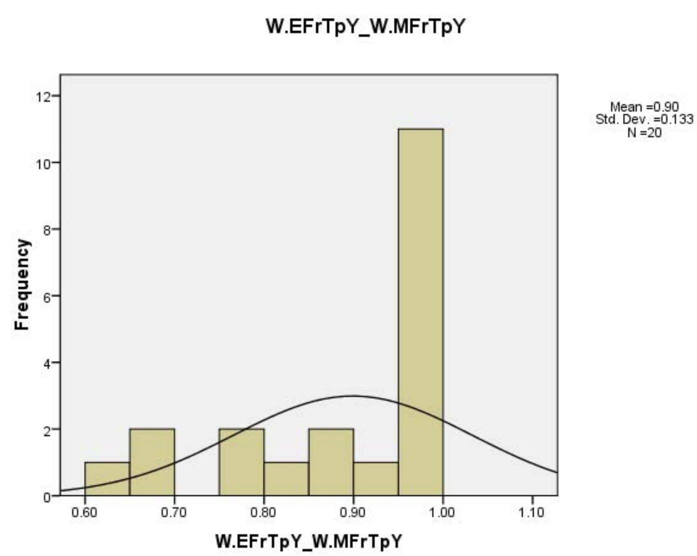


Figure 325: Histogram of the end width to the middle width of the fore topsail yard in galleons. Refer to Appendix 34 for data.

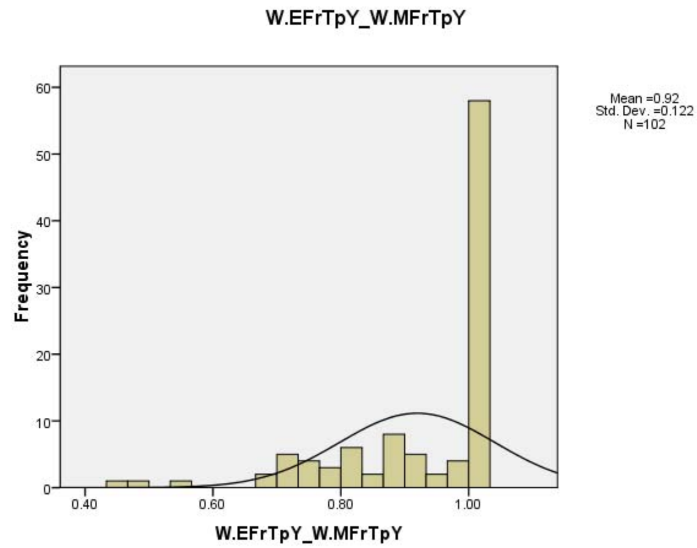


Figure 326: Histogram of the end width to the middle width of the fore topsail yard in naus. Refer to Appendix 34 for data.

The one standard deviation of the end width of the fore topsail yard to the middle width of the fore topsail yard is consistent throughout the caravels, galleons, and naus with only a few percentage points difference between the ship types. The caravels have the widest range from 0.74 to 1.03 while the galleons and naus are progressively smaller with ranges from 0.77 to 1.03 and 0.80 to 1.04. The modal ranges signify there is significantly less variability within the dataset than suggested by the one standard deviation figures. The caravels and naus have peaks at 1.00 to 1.05 with no tapering and the galleons exhibit a minimal amount of tapering with a range of 0.95 to 1.00. The fore topsail yard in the *Livro Náutico* is described as having a 50% horizontal tapering, which is not consistent with the iconographic data.

Middle Width of the Fore Topsail Yard to the Middle Width of the Main Topsail Yard: (W.MFrTpY_ W.MMaTpY)

The one standard deviation for the middle width of the fore topsail yard to the middle width of the main topsail yard ratio was not calculated for the caravels. The galleons have a one standard deviation range of 0.69 to 1.29 with a main distribution of 0.40 to 1.60. There are two equal primary modes in the histogram graph (Figure 327) from 0.60 to 0.80 and from 0.80 to 1.00. One standard deviation for the nau sample is from 0.71 to 1.27. The main distribution in the histogram graph (Figure 328) is from 0.40 to 1.70 with a primary mode from 1.00 to 1.20. The one standard deviations of the middle width of the fore topsail yard to the middle width of the main topsail yard ratio for the galleons and the naus both fall within a similar range from about the 70th to the

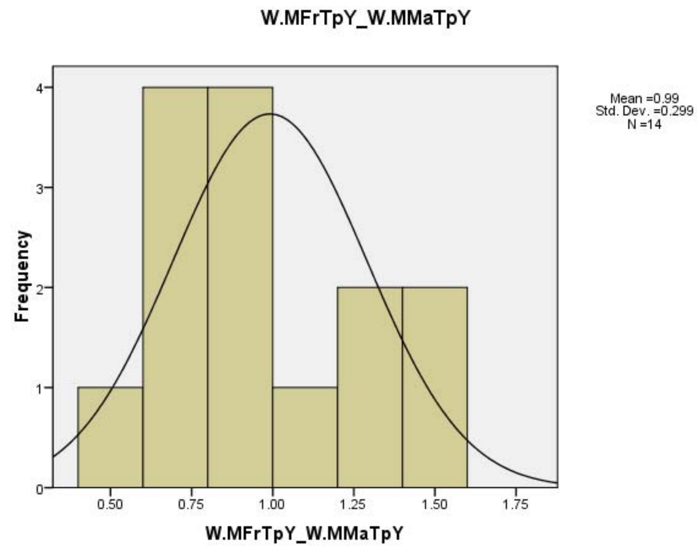


Figure 327: Histogram of the middle width of the fore topsail yard to the middle width of the main topsail yard in galleons. Refer to Appendix 34 for data.

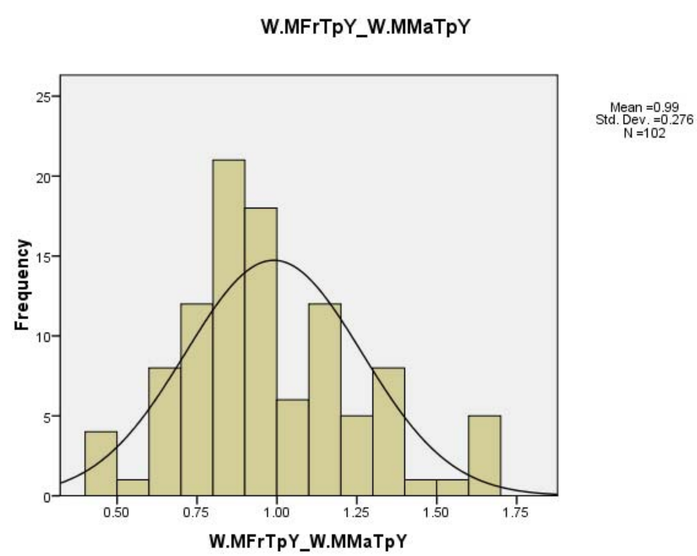


Figure 328: Histogram of the middle width of the fore topsail yard to the middle width of the main topsail yard in naus. Refer to Appendix 34 for data.

120th percentile. Although the modal ranges reflect the one standard deviation data, the strong primary modes for this ratio suggests that there is relative consistency throughout the two samples. The galleons have the lowest primary mode of 0.60 to 1.00, which is suggestive of proportionally thinner fore topsail yards compared to the main topsail yard while the naus have the highest modal peak from 1.00 to 1.20 indicating relatively thick spars. The middle width of the fore topsail yard to the middle width of the main topsail yard ratio in *Livro Náutico* was calculated as 0.85, which is consistent with the one standard deviation of both samples and the modal range of the galleons. The modal peak of the naus, however, is much higher demonstrating that the fore topsail yards were depicted in a disproportionate manner.

11.2 BOWSPRIT AND BOOMKIN DIMENSIONS

Boomkin Dimensions

In the statistical analysis of the boomkin there are 17 two-masted caravels, six three-masted caravels, 44 four-masted caravels, six three-masted galleons, 20 four-masted galleons, and 187 naus, which had a complete boomkin; refer to Appendix 35 for the frequency tables of all ship types. In the bowsprit sample there are 41 four-masted caravels, seven three-masted galleons, 24 four-masted galleons, and 191 naus with complete bowsprits; only caravels with a fore mast have a bowsprit which eliminated all two- and three-masted caravels from this analysis. Although there were no mentions of the boomkin in any of the treatises, Fernandez gives a length of 16 *braças* or 28.16 m for the bowsprit while the *Livro Náutico* states that the spar should be 15 *braças* or 26.40 m (Castro, 2005b: 119). Unfortunately, these measurements cannot be compared to the length of the hull which is not stated in the treatises. Additionally, these lengths are presumed to be for the entire bowsprit whereas the lengths of the bowsprits in the iconography are only for the part projecting out of the bow.

Boomkin Length Ratios

Length of the Boomkin to the Length of the Hull: (L.Bm_ L.H)

The length of the boomkin to the length of the hull ratio for the two-masted caravels sample has a one standard deviation from 0.11 to 0.25, which is consistent with the main distribution in the histogram graph (Figure 329) from 0.05 to 0.30; there is an outlier from 0.35 to 0.40 (MA10.09). The primary mode is form 0.10 to 0.15 and the secondary mode is from 0.20 to 0.25. The tabulation of the one standard deviation and center of distribution figures for the boomkin and bowsprit length ratios can be viewed in Table 68. The one standard deviation for the three-masted caravels is from 0.12 to 0.21 and there is no main distribution in the histogram graph (Figure 330); however, there are two primary modes from 0.14 to 0.16 and 0.18 to 0.20 with an outlier (CA09.01) at 0.8 to 0.10. The four-masted caravels have a one-standard deviation from 0.12 to 0.25 and the main distribution is from 0.07 to 0.26 with three outliers (CA28.01, MA16.1528-10, and CA34.01) from 0.30 to 0.40. The primary mode in the histogram graph (Figure 331) is from 0.20 to 0.23 and there are two equal secondary modes from

TABLE 68: Comparison of the One Standard Deviation and Center of Distribution of the Boomkin and Bowsprit Length Ratios

L.Bm_L.H	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Two-masted Caravels	0.11 to 0.25	0.13 to 0.21
Three-masted Caravels	0.12 to 0.21	0.13 to 0.20
Four-masted Caravels	0.12 to 0.25	0.14 to 0.23
Three-masted Galleons	0.13 to 0.22	0.14 to 0.22
Four-masted Galleons	0.11 to 0.23	0.12 to 0.23
Naus	0.12 to 0.30	0.15 to 0.26
L.Bw_ L.H	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Four-masted Caravels	0.25 to 0.49	0.28 to 0.45
Three-masted Galleons	0.31 to 0.49	0.33 to 0.51
Four-masted Galleons	0.28 to 0.55	0.33 to 0.49
Naus	0.27 to 0.53	0.31 to 0.48

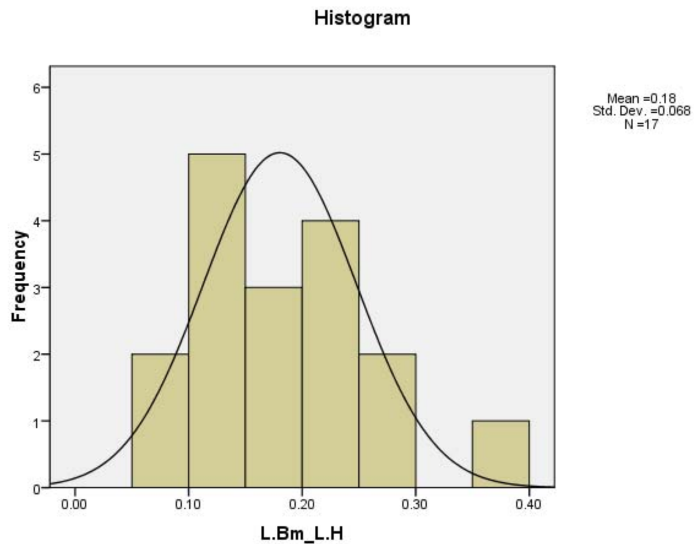


Figure 329: Histogram of the length of the boomkin to the length of the hull in two-masted caravels. Refer to Appendix 35 for data.

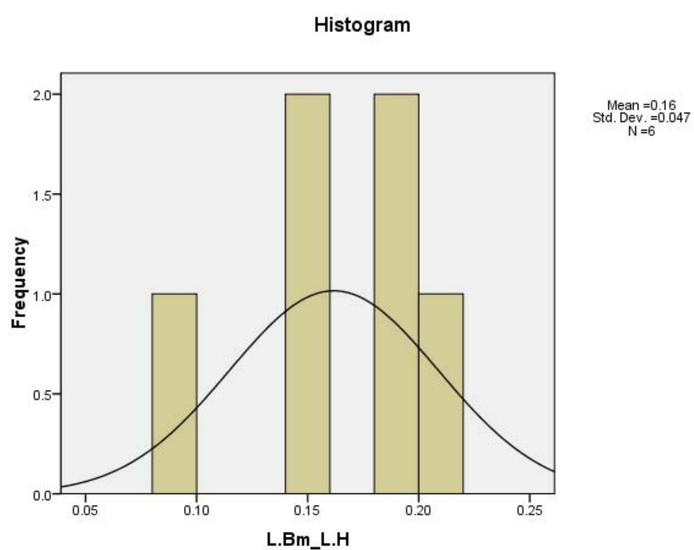


Figure 330: Histogram of the length of the boomkin to the length of the hull in three-masted caravels. Refer to Appendix 35 for data.

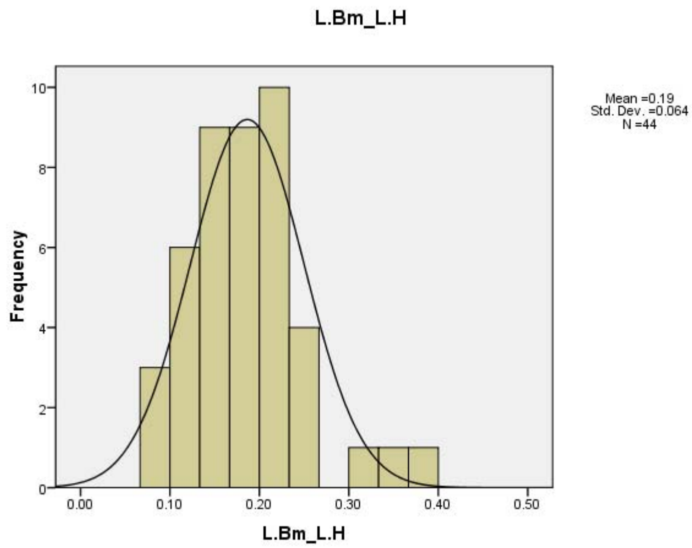


Figure 331: Histogram of the length of the boomkin to the length of the hull in four-masted caravels. Refer to Appendix 35 for data.

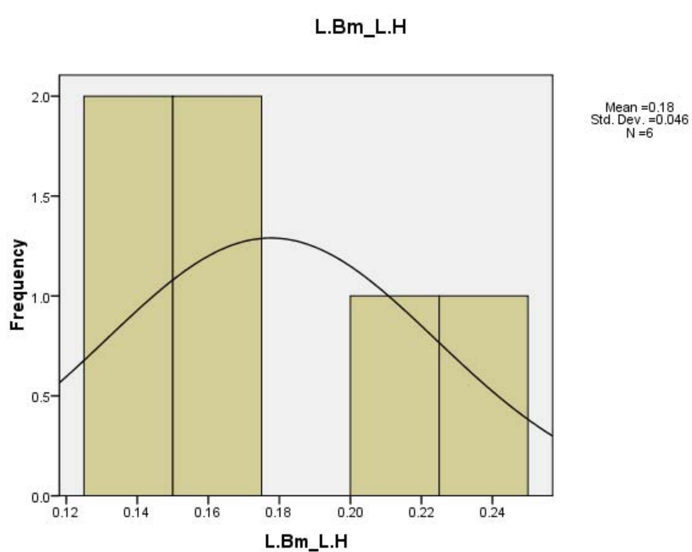


Figure 332: Histogram of the length of the boomkin to the length of the hull in three-masted galleons. Refer to Appendix 35 for data.

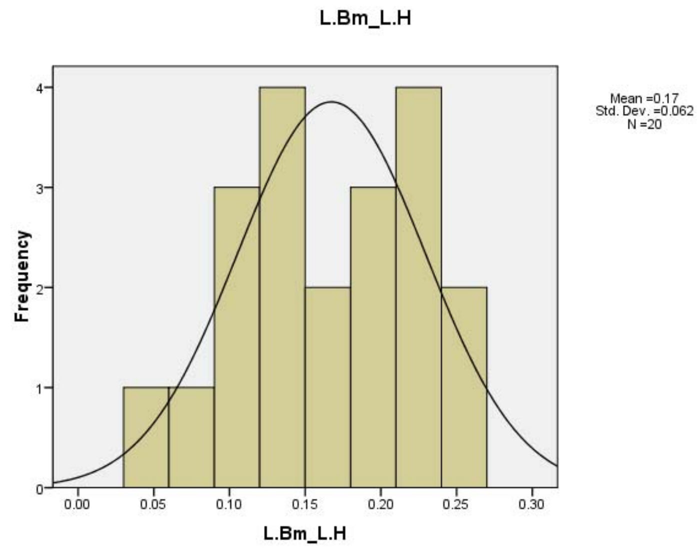


Figure 333: Histogram of the length of the boomkin to the length of the hull in four-masted galleons. Refer to Appendix 35 for data.

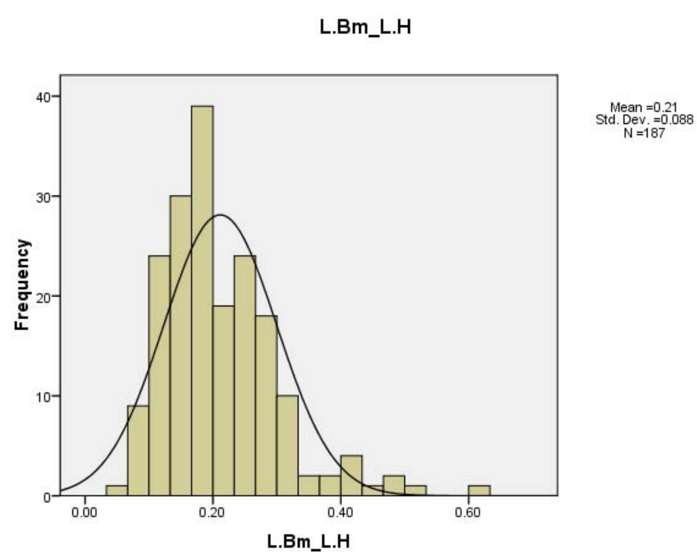


Figure 334: Histogram of the length of the boomkin to the length of the hull in naus. Refer to Appendix 35 for data.

0.14 to 0.17 and 0.17 to 0.20.

The length of the boomkin to the length of the hull ratio for the three-masted galleons sample has a one standard deviation from 0.13 to 0.22. There are two equal primary modes from 0.13 to 0.15 and from 0.15 to 0.17, which is also the main distribution in the histogram graph (Figure 332). There is one outlier (CA04.29) from 0.20 to 0.23 and another (MA03.09) from 0.23 to 0.26. The four-masted galleons have a one standard deviation from 0.11 to 0.23 and a primary mode from 0.12 to 0.15 and a secondary mode from 0.21 to 0.24. The main distribution in the histogram graph (Figure 333) is from 0.04 to 0.26. The one standard deviation of the nau sample is from 0.12 to 0.30 and the main distribution broadly ranges from 0.02 to 0.55 with an outlier (MA16.1532-02) from 0.60 to 0.62. The primary mode in the histogram graph (Figure 334) is from 0.17 to 0.20 while the secondary is from 0.14 to 0.17.

The one standard deviation figures are surprisingly consistent with only a few percentage points difference between all the caravels, galleons, and naus. The center of distribution figures show that all samples are around the 10^{th} to the 20^{th} percentile with the naus reaching the highest at 0.26. The modal ranges are also regular throughout the sample and the average length of the boomkin is 13% to 22% of the length of the hull at the deck with slight variations between each of the caravels, galleons, and naus.

Bowsprit Dimensions

Bowsprit Length Ratios

Length of the Bowsprit to the Length of the Hull: (L.Bw_ L.H)

The one standard deviation for the length of the bowsprit to the length of the hull for the four-masted caravels is 0.25 to 0.49, which is consistent with the main distribution in the histogram graph (Figure 335) from 0.05 to 0.60. There is one outlier (MA15.1554.03) from 0.65 to 0.68 and three equal primary modes from 0.25 to 0.30, 0.30 to 0.35, and 0.35 to 0.40. The one standard deviation of the three-masted galleon sample is from 0.31 to 0.49 and the primary mode is from 0.30 to 0.35. The main distribution, however, in the histogram graph (Figure 336) is from 0.30 to 0.40 and there are two outliers (CA04.27 and CA04.28) from 0.50 to 0.55 causing the large one standard deviation. The four-masted galleons have a one standard deviation of 0.28 to 0.55 and an extensive main distribution from 0.05 to 0.80. The primary mode in the histogram graph (Figure 337) is from 0.35 to 0.40 while the secondary mode is from 0.40 to 0.45. The nau sample has a one standard deviation of 0.27 to 0.53. The main distribution in the histogram graph (Figure 338) is from 0.08 to 0.72 with two outliers at 0.76 to 0.80 (MA15.1513.03 and MA15.1509.16) and another outlier from 0.80 to 0.84 (MA16.1543-02). The primary mode is from 0.28 to 0.32 with a secondary mode from 0.32 to 0.36.

The one standard deviations of the length of the bowsprit to the length of the hull

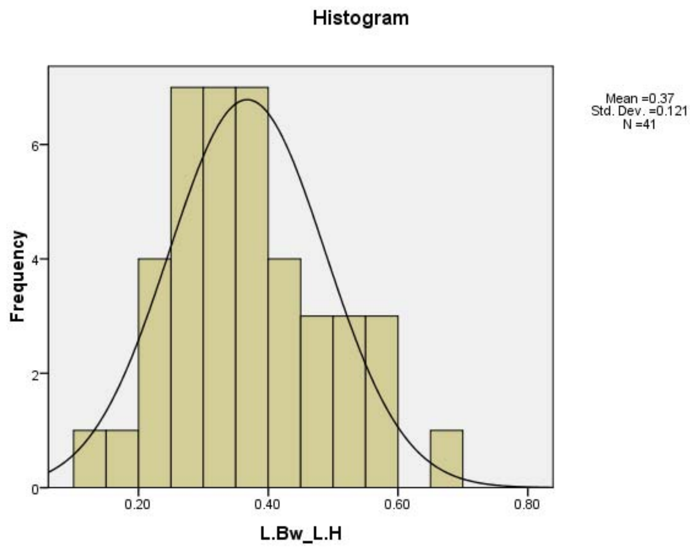


Figure 335: Histogram of the length of the bowsprit to the length of the hull in four-masted caravels. Refer to Appendix 35 for data.

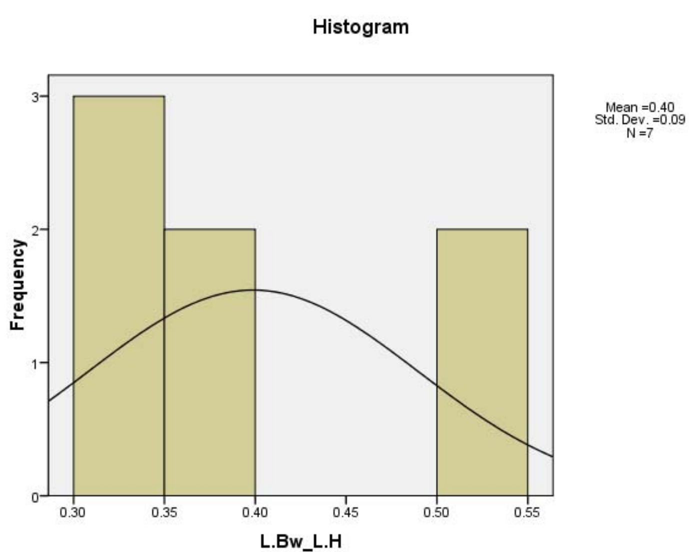


Figure 336: Histogram of the length of the bowsprit to the length of the hull in three-masted galleons. Refer to Appendix 35 for data.

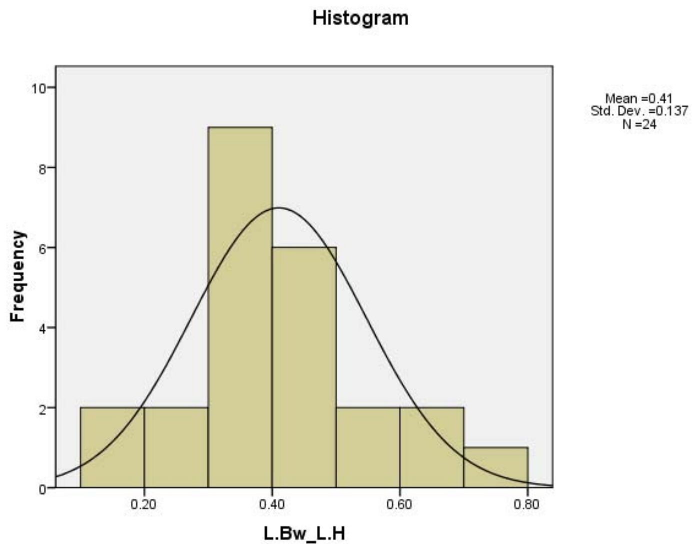


Figure 337: Histogram of the length of the bowsprit to the length of the hull in four-masted galleons. Refer to Appendix 35 for data.

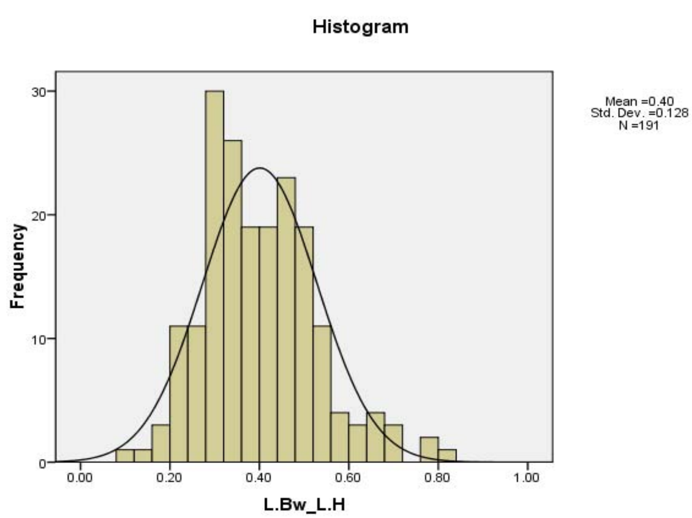


Figure 338: Histogram of the length of the bowsprit to the length of the hull in naus. Refer to Appendix 35 for data.

is fairly consistent between the caravels, the galleons, and the naus with only minimal differences between the ship types. The center of distribution figures also indicate a high degree of regularity and show even less variation than the one standard deviations. The modal ranges narrow the ranges considerably and show that the caravel sample has the widest range from 0.25 to 0.40 while the four-masted galleons have the largest bowsprits with modal peaks from 0.35 to 0.45. The three-masted galleons and the naus have similar ranges indicating that the bowsprit is roughly one-third the length of the hull on deck.

Spritsail Yard Ratios

In the statistical analysis of the spritsail yard there are 18 four-masted caravels, five galleons, and 57 naus. The length of the yard was measured from yardarm to yardarm while the middle width was taken as close to possible at its intersection with the bowsprit and the end width was taken at the yardarm.

In the *Livro Náutico*, the spritsail yard has a length of 9 *braças* or 15.84 m and a diameter of 1.5 *palmas de goa* or 33 cm tapering to 17 cm (Castro, 2005b: 119), which would result in a middle to end width ratio of 0.06. Cano states the spritsail yard was one-third less than the length of the bowsprit or a 0.66 ratio and one-fourth the diameter of the fore yard which would result in a ratio of 0.75 (Smith, 1993: 103). The length has also been reported as being four fifths ($4/5^{th}$) of the length and thickness of the fore yard and the expected ratio would be 0.80 for both the length and thickness (Smith, 1993:

103). Palacio indicates the spritsail was one-fourth less or 75% of the length of the main yard (Bankston, 1986: 124).

Length of the Spritsail Yard to the Length of the Bowsprit: (L.BwY_ L.Bw)

The length of the spritsail yard to the length of the bowsprit ratio for the four-masted caravel sample has a one standard deviation from 0.56 to 1.07. There is essentially no main distribution in the histogram graph (Figure 339), which shows a small grouping from 0.70 to 0.90 including the primary mode from 0.70 to 0.80 and three other groupings from 0.40 to 0.60, 1.00 to 1.10, and 1.20 to 1.40. The tabulation of the one standard deviation and center of distribution figures for the spritsail yard length and width ratios can be viewed in Table 69. The one standard deviation for the four-galleons is from 0.59 to 0.84. The main distribution in the histogram graph (Figure 340) is comprised of five different modal peaks from 0.30 to 0.40, 0.60 to 0.70, 0.70 to 0.80, 0.80 to 0.90, and 0.90 to 1.00. The one standard deviation of the nau sample is from 0.60 to 1.04 and the main distribution broadly ranges from 0.30 to 1.30 with outliers at 1.48 CA16.05) and at 1.51 (MA15.1504.08). There are two equal primary modes in the histogram graph (Figure 341) from 0.70 to 0.80 and 0.80 to 0.90.

The one standard deviation and modal ranges of the galleon sample is difficult to analyze and compare to the caravels and naus given the small sample size and the sporadic nature of the distribution. The one standard deviation for the four-masted caravels and the nau samples, however, are fairly consistent and correspond nicely to the 0.66 ratio calculated though the measurements provided by Cano. The modal ranges of

TABLE 69: Comparison of the One Standard Deviation and Center of Distribution of the Spritsail Yard Length and Width Ratios

L.BwY_L.FrY	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Four-masted Caravels	0.49 to 0.84	0.52 to 0.81
Galleons	0.58 to 0.65	0.56 to 0.67
Naus	0.51 to 0.84	0.55 to 0.77
W.MBwY_ L.BwY	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Four-masted Caravels	0.01 to 0.11	0.03 to 0.07
Galleons	0.03 to 0.10	0.03 to 0.09
Naus	0.02 to 0.09	0.03 to 0.07
W.MBwY _ W.EBwY	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Four-masted Caravels	1.00 to 1.00	1.00 to 1.00
Galleons	1.00 to 1.00	1.00 to 1.00
Naus	1.00 to 1.00	1.00 to 1.00
W.MBwY _W.MFrY	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Four-masted Caravels	0.69 to 1.08	0.69 to 1.06
Galleons	0.70 to 1.08	0.73 to 1.00
Naus	0.55 to 1.19	0.66 to 1.00

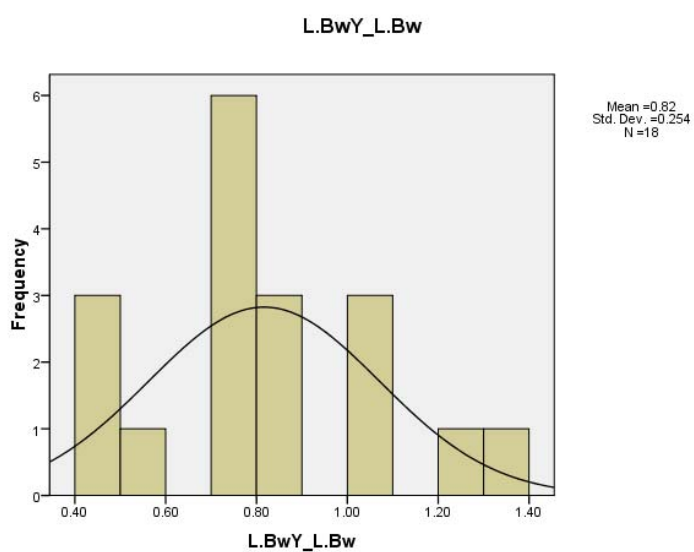


Figure 339: Histogram of the length of the spritsail yard to the length of the bowsprit in four-masted caravels. Refer to Appendix 35 for data.

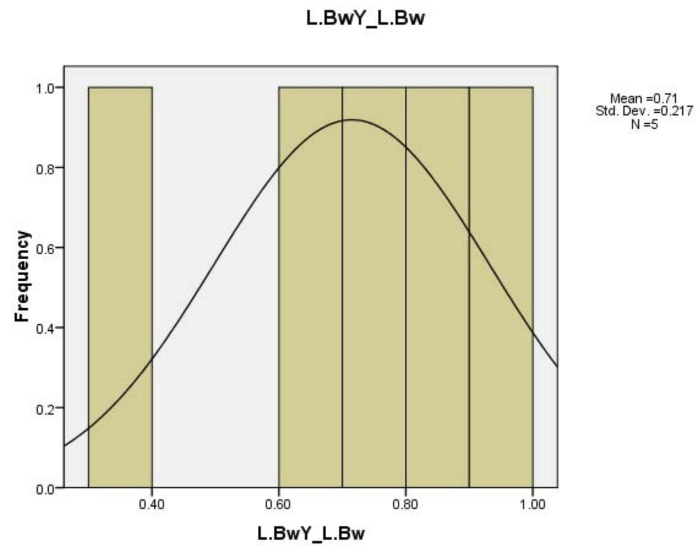


Figure 340: Histogram of the length of the spritsail yard to the length of the bowsprit in galleons. Refer to Appendix 35 for data.

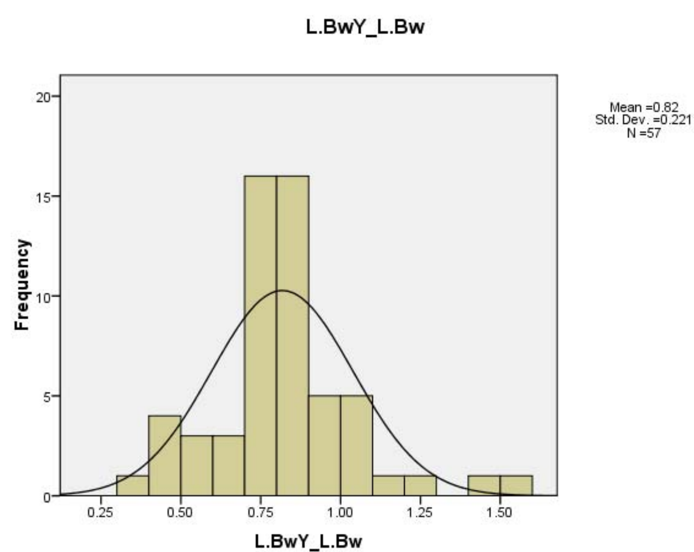


Figure 341: Histogram of the length of the spritsail yard to the length of the bowsprit in naus. Refer to Appendix 35 for data.

0.70 to 0.80 for the caravels and 0.70 to 0.90 for naus indicate that there is a high level of uniformity in the length of the spritsail yard to the bowsprit. The length of the spritsail yard may be slightly exaggerated, similar to other yards, in order to emphasize the sail area which would explain why the modal ranges are slightly higher than the treatise.

Length of the Spritsail Yard to the Length of the Hull: (L.BwY_ L.H)

The length of the spritsail yard to the length of the hull ratio for the caravels sample has a one standard deviation from 0.21 to 0.47, which is consistent with the primary mode in the histogram graph (Figure 342) from 0.35 to 0.30. The main distribution is 0.15 to 0.35 and there are two outliers from 0.40 to 0.45 (MA15.1524.07 and MA15.1519.17), one from 0.45 to 0.50 (MA16.1505-16), and another two from 0.60 to 0.65 (MA15.1533.14 and MA13.10). The galleon sample has a one standard deviation from 0.17 to 0.49 and a main distribution from 0.30 to 0.50 with an outlier from 0.10 to 0.20 (EN04.02). The primary mode in the histogram graph (Figure 343) is from 0.30 to 0.40. The one standard deviation of the nau sample is from 0.22 to 0.46 and the main distribution in the histogram graph (Figure 344) ranges from 0.10 to 0.60 with an outlier at 0.71 (MA15.1528.01). There are two equal primary modes from 0.20 to 0.25 and 0.35 to 0.40 in the nau sample.

The one standard deviation of the three ship types shows that there is relative consistency between the samples with only a few percentage points difference in the ranges. The center of distribution for these samples demonstrate that there is even less variation between the caravels with a range of 0.26 to 0.43, the galleons with 0.23 to

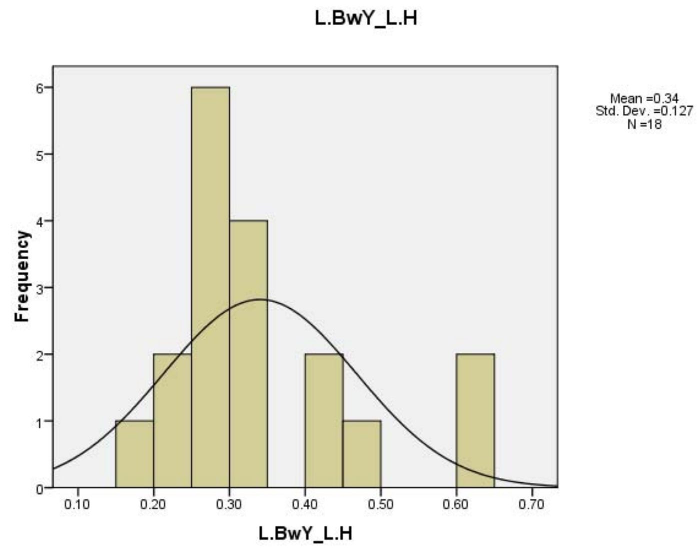


Figure 342: Histogram of the length of the spritsail yard to the length of the hull in four-masted caravels. Refer to Appendix 35 for data.

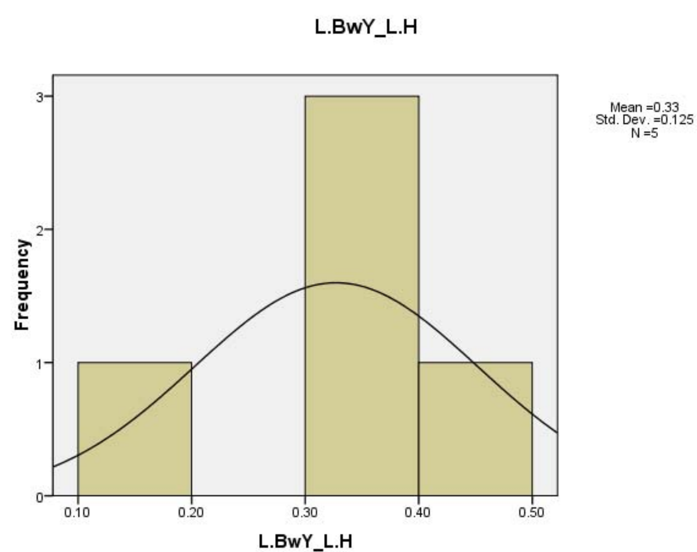


Figure 343: Histogram of the length of the spritsail yard to the length of the hull in galleons. Refer to Appendix 35 for data.

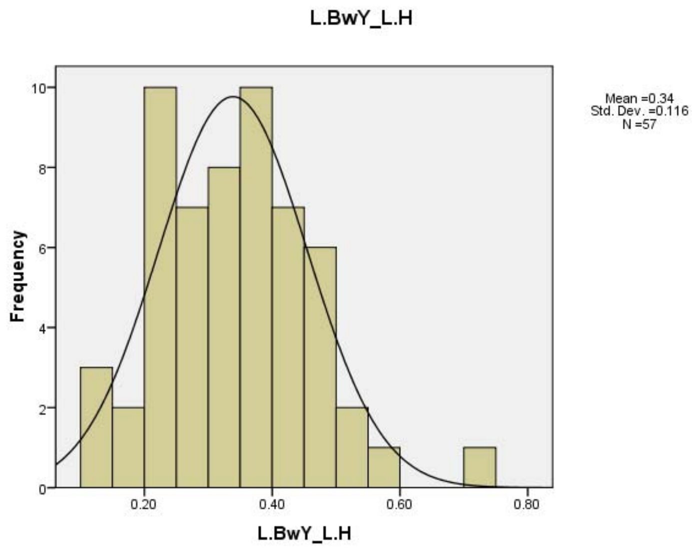


Figure 344: Histogram of the length of the spritsail yard to the length of the hull in naus. Refer to Appendix 35 for data.

0.43, and the naus with 0.24 to 0.42 than indicated by the one standard deviation figures. The modal ranges demonstrate that the galleons (0.30 to 0.40) have somewhat longer spritsail yards to the length of the hull compared to the caravels (0.25 to 0.30) and the naus (0.20 to 0.40) both of which have ranges that are skewed slightly lower. Overall, it appears that the length of the spritsail yard is about 20% to 40% of the length of the hull.

Length of the Spritsail Yard to the Length of the Main Yard: (L.BwY_ L.MaY)

The length of the spritsail yard to the length of the main yard ratio for the four-masted caravel sample has a one standard deviation from 0.37 to 0.64 which is consistent with the main distribution in the histogram graph (Figure 345) from 0.30 to 0.90. The primary mode for the sample is from 0.40 to 0.50. The galleon sample has the smallest one standard deviation from 0.45 to 0.58. The main distribution is from 0.30 to 0.50 and the secondary distribution is from 0.60 to 0.70. There are two equal primary modes in the histogram graph (Figure 346) from 0.30 to 0.40 and from 0.60 to 0.70 each of which is in one of the two distributions. The one standard deviation of the nau sample is similar to the four-masted caravels at 0.38 to 0.62 and the main distribution ranges from 0.25 to 0.75 with an outlier at 0.13 (MA14.08) and another at 1.00 (MA15.1528.01). The primary mode in the histogram graph (Figure 347) is from 0.46 to 0.52.

The one standard deviation of the three ship types show relative consistency between the caravel and nau samples while the galleons have the least amount of variability, which is verified by the center of distribution figures. The modal ranges

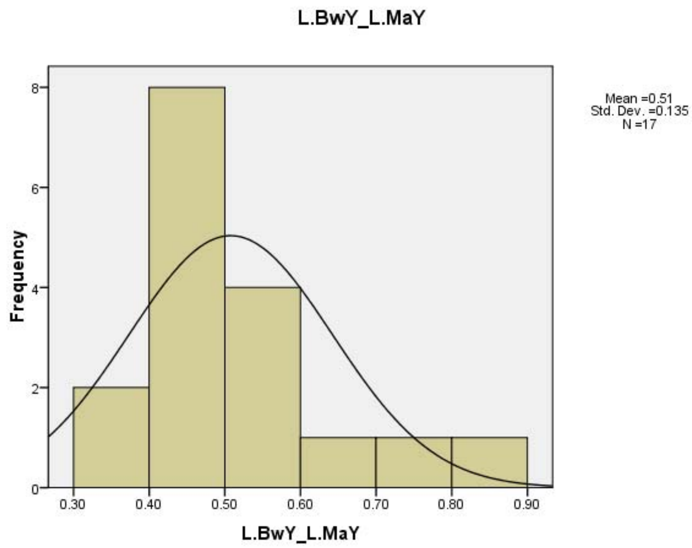


Figure 345: Histogram of the length of the spritsail yard to the length of the main yard in four-masted caravels. Refer to Appendix 35 for data.

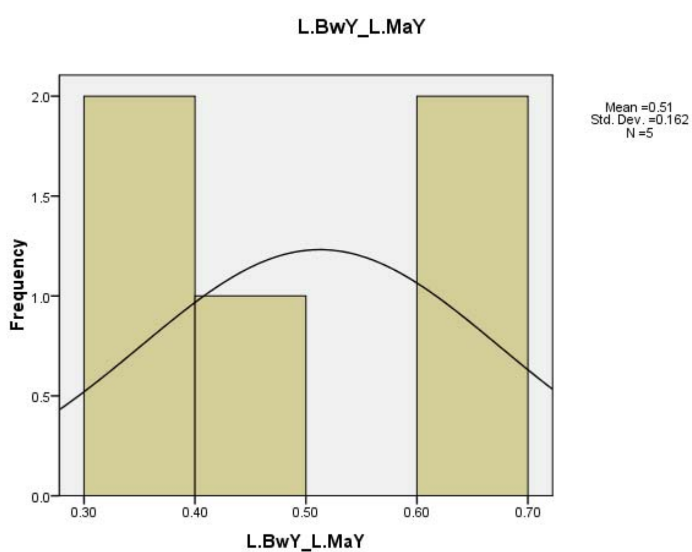


Figure 346: Histogram of the length of the spritsail yard to the length of the main yard in galleons. Refer to Appendix 35 for data.

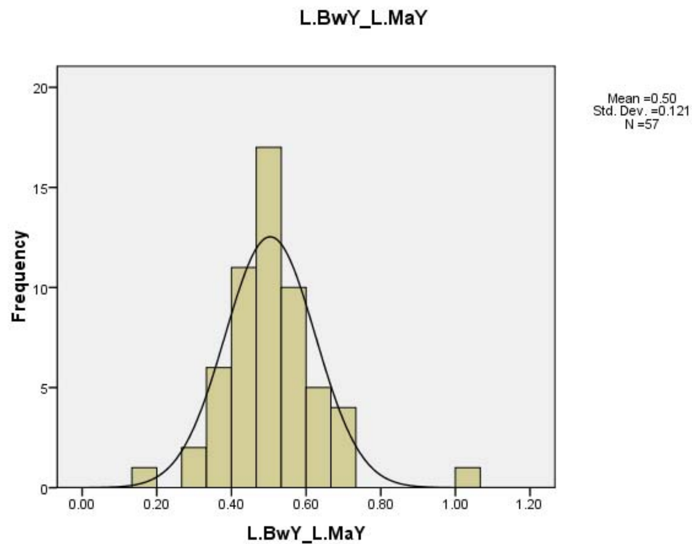


Figure 347: Histogram of the length of the spritsail yard to the length of the main yard in naus. Refer to Appendix 35 for data.

indicate an even higher level of correlation between the caravels (0.40-0.50) and the naus (0.46-0.52); however, the galleons exhibit more variation within the modal peaks of 0.30 to 0.70 than the other ranges. Based on all the data, it appears that the spritsail yard is roughly 40% to 50% of the length of the main yard. These results conflict with the information provided by Palacio who indicates the spritsail was 75% of the length of the main yard. It is possible that this discrepancy is due to the exaggeration of the lengths of the main yards in the iconography.

Length of the Spritsail Yard to the Length of the Fore Yard: (L.BwY_ L.FrY)

The length of the spritsail yard to the length of the fore yard ratio for the caravels sample has a one standard deviation from 0.49 to 0.84, which is consistent with the primary mode in the histogram graph (Figure 348) from 0.60 to 0.70 and the secondary mode at 0.80 to 0.90. The main distribution ranges from 0.40 to 0.70 and there is a secondary distribution which is comprised of the secondary mode at 0.80 to 0.90 and an outlier at 1.05 (MA13.10). One standard deviation for the galleon sample is from 0.58 to 0.65. The corresponding histogram graph (Figure 349) has a primary mode of 0.50 to 0.60 with the main distribution ranging from 0.50 to 0.65 and an outlier at 0.72 (CA15.04). The naus have a one standard deviation of 0.51 to 0.84 and a main distribution from 0.45 to 1.20 with an outlier at 0.21 (MA14.08). The primary mode in the histogram graph (Figure 350) is from 0.50 to 0.60. The one standard deviation for the caravel and nau samples are very similar with ranges of 0.49 to 0.84 and 0.51 to .84

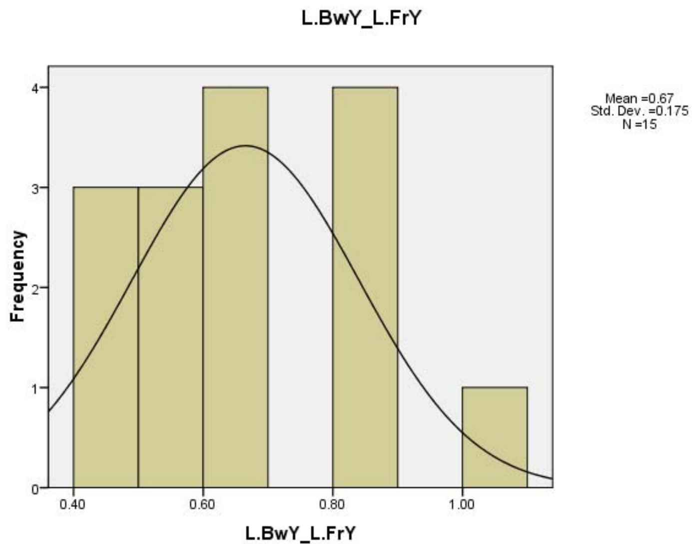


Figure 348: Histogram of the length of the spritsail yard to the length of the fore yard in four-masted caravels. Refer to Appendix 35 for data.

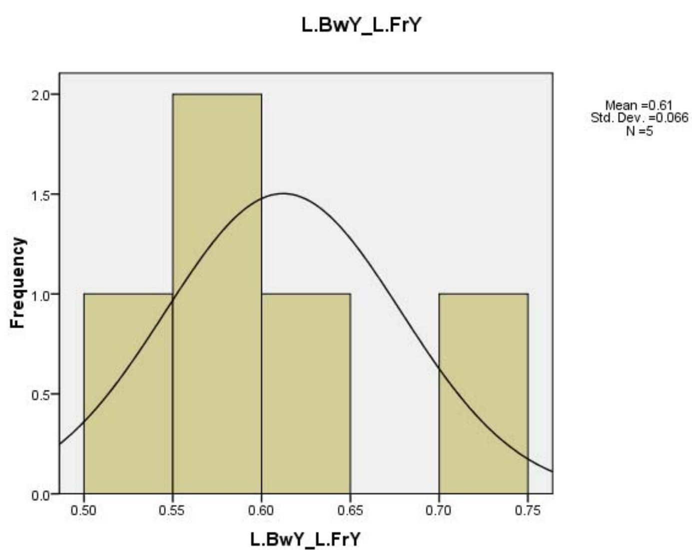


Figure 349: Histogram of the length of the spritsail yard to the length of the fore yard in galleons. Refer to Appendix 35 for data.

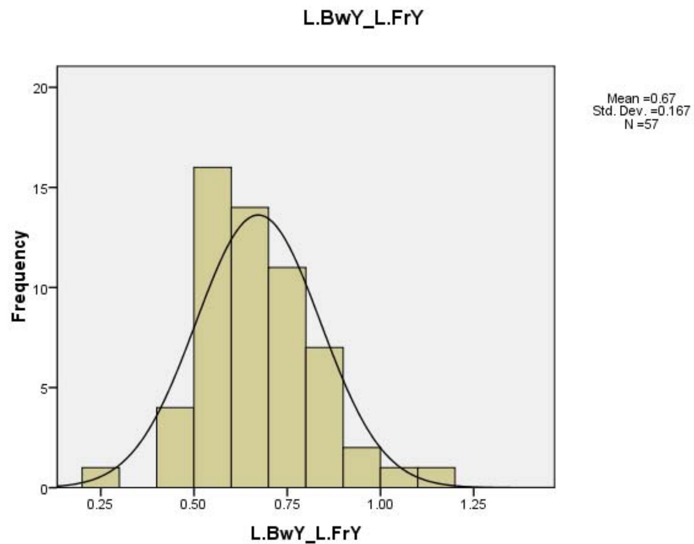


Figure 350: Histogram of the length of the spritsail yard to the length of the fore yard in naus. Refer to Appendix 35 for data.

respectively while the galleons have the least variability with a range from 0.58 to 0.75; these results are also verified by the center of distribution figures.

The modal ranges demonstrate, however, more consistency between the galleons (0.50-0.60) and the naus (0.50-0.70) while the caravels have a broader range from 0.60 to 0.90 suggesting a higher level of inconsistency within the sample. The length of the spritsail yard was reported as being four-fifths of the length of the fore yard which produces an expected ratio of 0.80. The caravels and naus both reach this ratio in the one standard deviation ranges but only the caravels have a modal peak around 0.80 while the galleons and naus fall short by 20% and 10%. Overall, the spritsail yard is roughly 60% to 70% of the length of the fore yard in the iconography. Again, it is suspected that the main and fore yards were depicted proportionally too long in order to emphasize the sail area.

Spritsail Yard Width Ratios

Middle Width of the Spritsail Yard to the Length of the Spritsail Yard: (W.MBwY_ L.BwY)

The middle width of the spritsail yard to the length of the spritsail yard ratio has a broad one standard deviation of 0.01 to 0.11 for the caravels with a main distribution from 0.00 to 0.15 and an outlier at 0.21 (CA27.05); refer to Table 69 for the tabulation of the width ratios. The primary mode in the histogram graph (Figure 351) is from 0.025 to 0.05. The galleons have a one standard deviation from 0.03 to 0.10 and a main

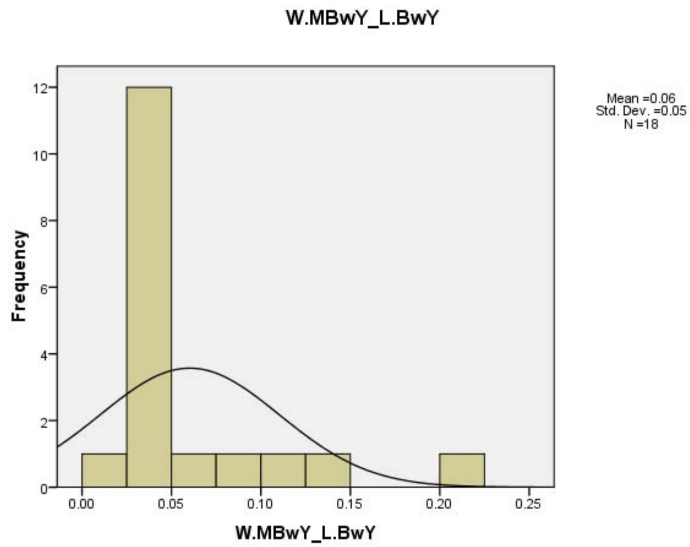


Figure 351: Histogram of the middle width of the spritsail yard to the length of the spritsail yard in four-masted caravels. Refer to Appendix 35 for data.

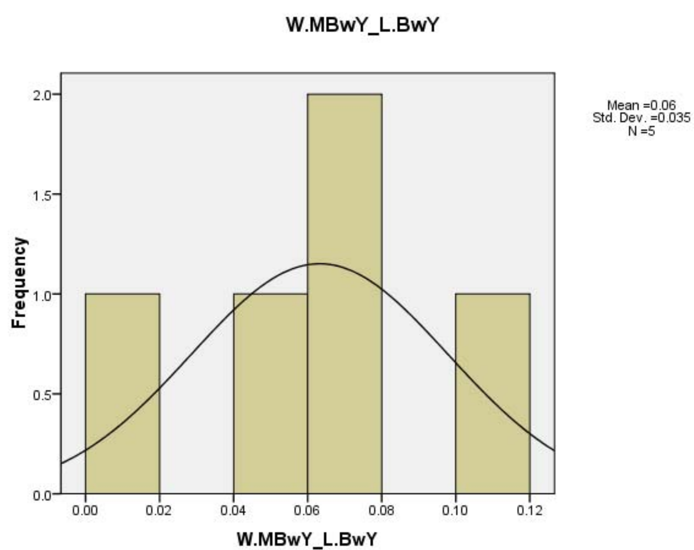


Figure 352: Histogram of the middle width of the spritsail yard to the length of the spritsail yard in galleons. Refer to Appendix 35 for data.

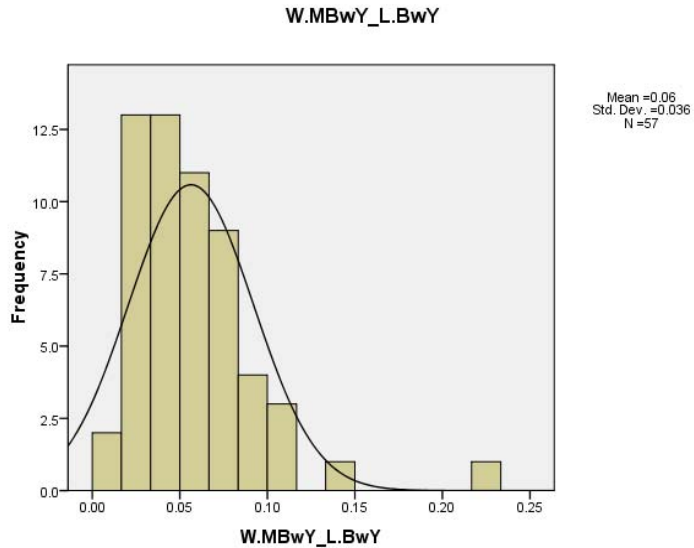


Figure 353: Histogram of the middle width of the spritsail yard to the length of the spritsail yard in naus. Refer to Appendix 35 for data.

distribution from 0.04 to 0.08 with an outlier at 0.01 (PA09.01) and another at 0.11 (EN04.02). The primary mode in the histogram graph (Figure 352) is from 0.06 to 0.08. The one standard deviation for naus is 0.02 to 0.09. The main distribution in the histogram graph (Figure 353) is from 0.00 to 0.12 with an outlier at 0.14 (CA27.04) and 0.22 (CA27.06). There are two equal primary modes from 0.02 to 0.035 and from 0.035 to 0.05 in the nau sample.

The one standard deviation of the middle width of the spritsail yard to the length of the spritsail yard is consistently broad throughout the caravels, galleons, and naus. Although these results generally suggest significant variability within the samples, there is only a difference of only a few percentages between the three ship types. The center of distribution figures narrow the ranges and demonstrate a higher degree of correlation between the samples with both the caravels and naus having a range of 0.03 to 0.07 and the galleons having a similar range from 0.03 to 0.09. The modal ranges verify the similarities between the caravels (0.025 to 0.05) and the naus (0.02 to 0.05) while the galleons have a primary mode that is skewed higher at 0.06 to 0.08 which is indicative of relatively thicker spritsail yards.

Middle Width of the Spritsail Yard to the End Width of the Spritsail Yard: (W.MBwY_ W.EBwY)

The middle width of the spritsail yard to the end width of the spritsail yard ratio is a direct 1:1 relationship for the caravel, galleons, and nau samples, which is supported by the one standard deviation, center of distribution, and modal peaks of 1.00 for every sample. Although the measurements in the *Livro Náutico* indicate that a middle to end width ratio should be around 0.60 there is no horizontal tapering of the spritsail yard evident in the iconography.

Middle Width of the Spritsail Yard to the Middle Width of the Fore Yard: (W.MBwY_ W.MFrY)

The middle width of the spritsail yard to the middle width of the fore yard ratio has a one standard deviation for the caravel sample from 0.69 to 1.08 and a distribution in the histogram graph (Figure 354) from 0.50 to 1.20; the primary mode is from 1.00 to 1.10. The galleon sample has a one standard deviation from 0.70 to 1.08. There is no main distribution; rather, the histogram graph (Figure 355) shows a primary mode of 1.00 to 1.10 with an outlier at 0.57 (PA09.01) and another at 0.89 (MA13.15). One standard deviation of the nau sample is from 0.55 to 1.19 and there is a broad main distribution from 0.40 to 1.60 with an outlier at 2.00 (CA31.06). The primary mode in the histogram graph (Figure 356) is from 0.75 to 1.00.

The caravels and galleons have nearly identical one standard deviation ranges of 0.69 to 1.08 and 0.70 to 1.08 respectively while the naus have a broader range of 0.55 to 1.19. Overall there is relatively high consistency in the one standard deviation ranges, which is further confirmed by the center of distribution figures. The modal ranges of the caravels and galleons are identical at 1.00 to 1.10 suggesting no difference in the middle widths between the spritsail yard and the fore yard while the naus exhibit more variation

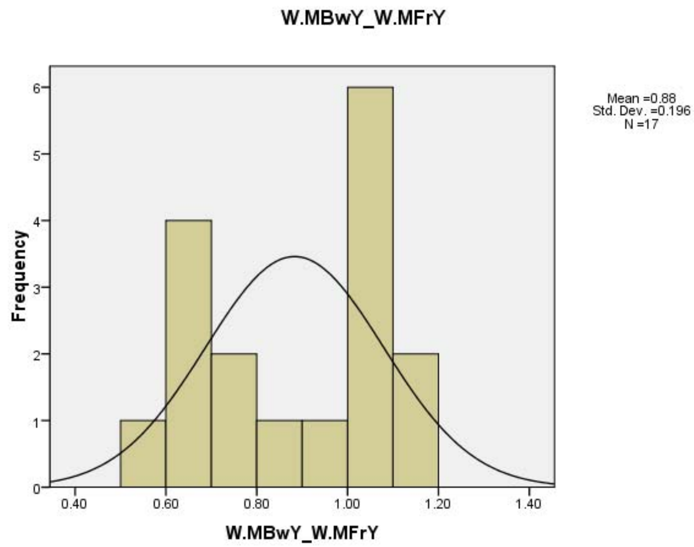


Figure 354: Histogram of the middle width of the spritsail yard to the middle width of the fore yard in four-masted caravels. Refer to Appendix 35 for data.

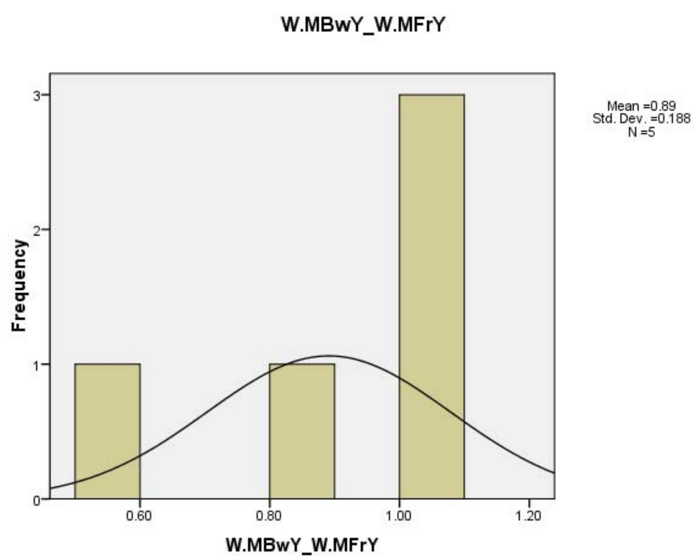


Figure 355: Histogram of the middle width of the spritsail yard to the middle width of the fore yard in galleons. Refer to Appendix 35 for data.

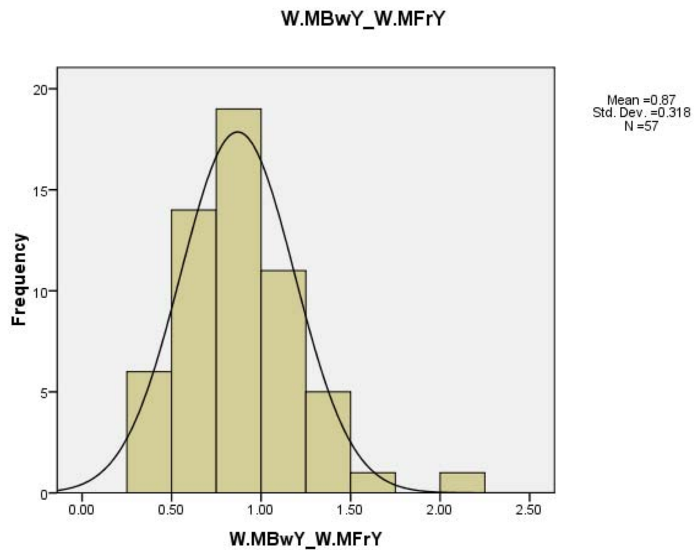


Figure 356: Histogram of the middle width of the spritsail yard to the middle width of the fore yard in naus. Refer to Appendix 35 for data.

with a modal peak of 0.75 to 1.00. The length of the spritsail yard was cited by Cano as being 80% of the length of the fore yard, which is supported by both the one standard deviation and the center of distribution ranges (Smith, 1993: 103). The modal ranges, however, indicate that the caravels and galleons had longer spritsail yards, but this expected ratio is verified by the nau sample.

As mentioned in Chapter X, it was previously suspected that the main and fore masts and yards were exaggerated in the iconography in order to create a more commanding presence of the sails that frequently displayed the cross of the Order of Christ. Like the main mast and yard analysis, there are fore mast and yard ratios that exceeded the proportions dictated by the archival documentation providing evidence for disproportionately long yards and tall masts. Again there was almost no horizontal tapering on the majority of the yards.

An important result of this analysis was that proportional relationships between well established features were determined to be strong enough to allow for the logical inference of some elements using others. Although it was not possible to directly calculate the beam or the length of the keel in the iconography, using the *ah, dos, tres* rule these features are known to be respectively one-third and two-thirds of the length on deck. This analysis also produced an immense amount of new data on the proportional dimensions of the bonaventure, mizzen, main and fore mast and yards as well as the boomkin and bowsprit. The statistical analysis of the sterncastle, waist, and forecastle will be conducted in the next chapter using the same methodology.

CHAPTER XII

DESCRIPTIVE STATISTICS OF THE FORECASTLE, STERNCASTLE, AND WAIST IN THE ICONOGRAPHY

Similar to the chapters on the dimensions of the masts and yards, the lengths and heights of the forecastle, sterncastle, and waist are analyzed using the frequencies tool within SPSS program in order to establish a normal range based on one standard deviation and the center of distribution. Although an in-depth examination of the sample distribution was not conducted for the dimensions of the forecastle, sterncastle, and waist, each frequencies table and histogram was examined to ascertain any sample that is not valid.

12.1 FORECASTLE, STERNCASTLE, AND WAIST DIMENSIONS

Forecastle Dimensions

In the statistical analysis of the forecastle there are 39 four-masted caravels, 21 galleons, and 169 naus; refer to Appendix 36 for the frequency tables of all ship types. The length of the forecastle was measured from the aft most portion of the deck to the forward most point excluding the beakhead (Figure 357). Likewise, the height was calculated from the main deck level in the waist to the highest position of the deck. There is no information regarding the dimensions of the forecastle in any contemporary

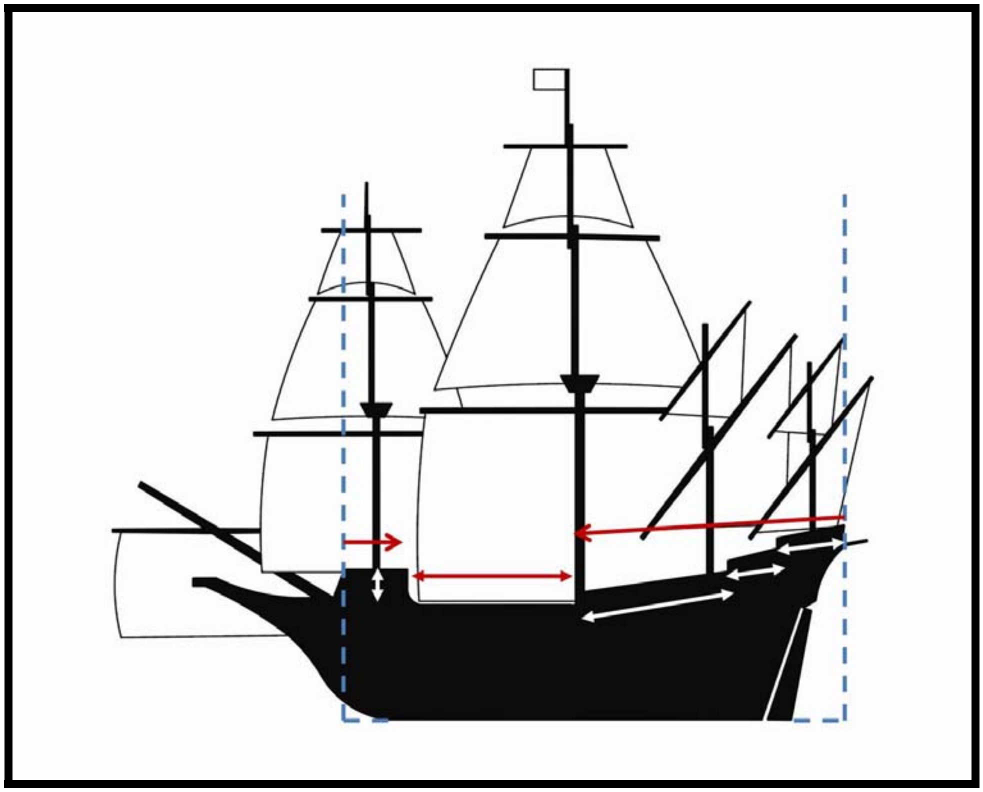


Figure 357: Illustration of the forecastle, waist, sterncastle, half deck, quarter deck, and poop deck measurements.

treatise. The tabulation of the one standard deviation and modes for the forecastle ratios can be viewed in Tables 70 and 71.

Forecastle Length Ratios

Length of the Forecastle to the Length of the Hull: (L.Fc_L.H)

The length of the forecastle to the length of the hull ratio for the four-masted caravels sample has a one standard deviation from 0.17 to 0.32, which is consistent with the histogram graph (Figure 358) showing the main distribution from 0.10 to 0.43. The primary mode is from 0.17 to 0.20 and there are two equal secondary modes from 0.24 to 0.27 and from 0.27 to 0.30. The galleon sample has a one standard deviation from0.16 to 0.28 and a main distribution in the histogram graph (Figure 359) from 0.10 to 0.40 with a primary mode of 0.15 to 0.20 and two equal secondary modes from 0.20 to 0.25 and 0.25 to 0.30. The naus have a one standard deviation from 0.20 to 0.33 and a primary mode in the histogram graph (Figure 360) from 0.25 to 0.275, and a secondary mode from .275 to .30. The main distribution is from 0.08 to0 .42 and there is an outlier at 0.51 (MA16.1505-13). The one standard deviation of the length of the forecastle to the length of the hull produces concise ranges that are relatively consistent throughout the caravel (0.17 to 0.32), galleon (0.16 to 0.28), and nau (0.20 to 0.33) samples. The center of distribution figures show even less variation between the samples and more similar ranges for the caravels and galleons with the nau sample skewed higher implying slightly longer forecastles. The similarity between the caravels and naus is verified by

TABLE 70: One Standard Deviation and Center of Distribution Figures for the Forecastle Ratios by Ship Type

L.Fc_L.H	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Four-masted Caravels	0.17 to 0.32	0.18 to 0.32
Galleons	0.16 to 0.28	0.18 to 0.27
Naus	0.20 to 0.33	0.22 to 0.31
L.Fc _ L.Sc	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Four-masted Caravels	0.36 to 0.80	0.41 to 0.68
Galleons	0.38 to 0.65	0.42 to 0.59
Naus	0.43 to 0.84	0.50 to 0.75
L.Fc_L.Wa	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Four-masted Caravels	0.58 to 1.23	0.62 to 1.17
Galleons	0.46 to 1.30	0.55 to 1.13
Naus	0.64 to 1.41	0.76 to 1.22
H.Fc _ H.Sc	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Four-masted Caravels	0.49 to 0.89	0.50 to 0.86
Galleons	0.40 to 0.94	0.48 to 0.80
Naus	0.53 to 0.99	0.61 to 0.92
H.Fc _L.Fc	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Four-masted Caravels	0.33 to 0.98	0.41 to 0.84
Galleons	0.29 to 0.74	0.35 to 0.67
Naus	0.44 to 1.01	0.52 to 0.94

TABLE 71: Primary and Secondary Modes for the Forecastle Ratios by Ship Type

L.Fc_L.H	**Primary Mode(s)**	**(Range)**	**Secondary Mode(s)**
Four-masted Caravels	0.17 to 0.20	**(0.17-0.30)**	0.24-0.27; 0.27-0.30
Galleons	0.15 to 0.20	**(0.15-0.30)**	0.20-0.25; 0.25-0.30
Naus	0.25 to 0.275	**(0.25-0.30)**	0.275 to 0.30
L.Fc _ L.Sc	**Primary Mode(s)**	**(Range)**	**Secondary Mode(s)**
Four-masted Caravels	0.40 to 0.50	**(0.40-0.70)**	0.60 to 0.70
Galleons	0.40-0.50; 0.50-0.60	**(0.40-0.60)**	NA
Naus	0.52 to 0.60	**(0.52-0.68)**	0.60 to 0.68
L.Fc_L.Wa	**Primary Mode(s)**	**(Range)**	**Secondary Mode(s)**
Four-masted Caravels	0.50-0.70; 1.00-1.08	**(0.50-1.08)**	NA
Galleons	0.25 to 0.50	**(0.25-1.00)**	0.75 to 1.00
Naus	0.82 to 1.00	**(0.82-1.17)**	1.00 to 1.17
H.Fc _ H.Sc	**Primary Mode(s)**	**(Range)**	**Secondary Mode(s)**
Four-masted Caravels	0.40 to 0.50	**(0.40-0.80)**	0.70 to 0.80
Galleons	0.40 to 0.60	**(0.40-0.80)**	0.60 to 0.80
Naus	0.86 to 0.93	**(0.86-1.07)**	1.00 to 1.07
H.Fc _L.Fc	**Primary Mode(s)**	**(Range)**	**Secondary Mode(s)**
Four-masted Caravels	0.33 to 0.50	**(0.33-0.84)**	0.50-0.67; 0.67-0.84
Galleons	0.20 to 0.40	**(0.20-0.40)**	.NA
Naus	0.52 to 0.60	**(0.46-0.68)**	0.46-0.52; 0.60-0.68

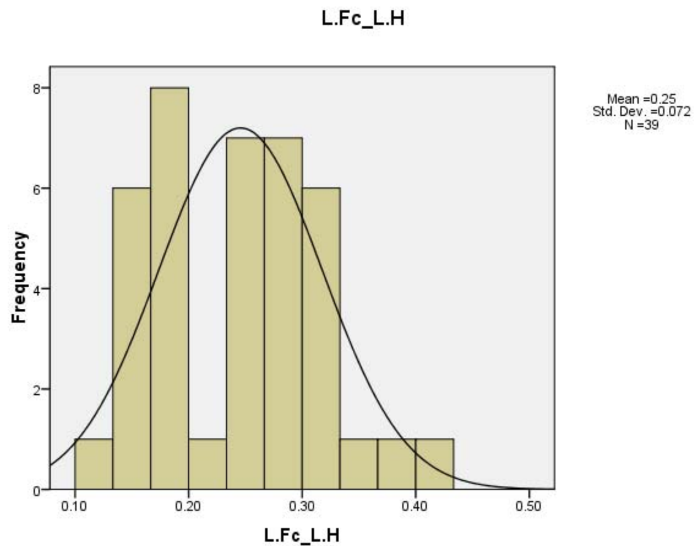


FIGURE 358: Histogram of the length of forecastle to the length of the hull in four-masted caravels. Refer to Appendix 36 for data.

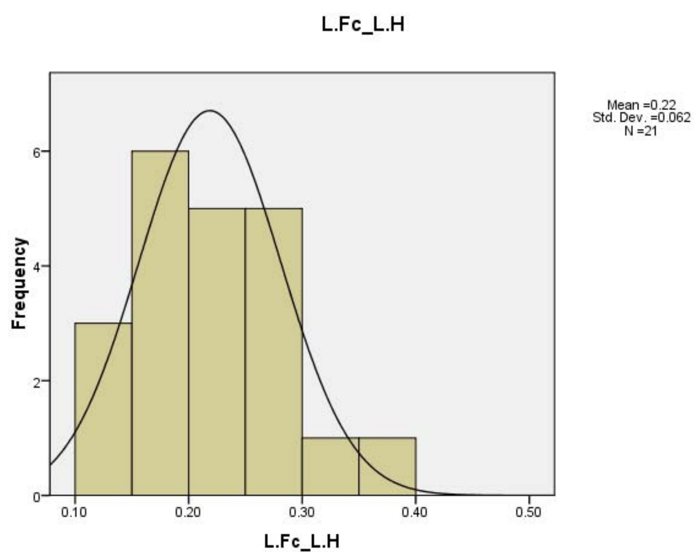


FIGURE 359: Histogram of the length of forecastle to the length of the hull in galleons. Refer to Appendix 36 for data.

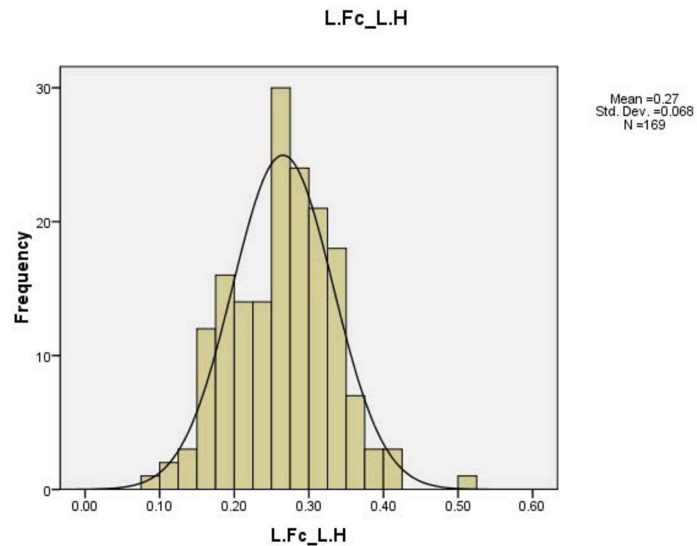


FIGURE 360: Histogram of the length of forecastle to the length of the hull in naus.
Refer to Appendix 36 for data.

the modal ranges of 0.17 to 0.30 and 0.15 to 0.30 respectively. The nau sample has a more precise modal range of 0.25 to 0.30 that is somewhat higher than the other two samples. Overall, it appears that the forecastle was roughly one-fourth of the length of the hull and there are no significant differences between the ship types.

Length of the Forecastle to the Length of the Sterncastle: (L.Fc_L.Sc)

The one standard deviation of the length of the forecastle to the length of the sterncastle ratio for the four-masted caravels sample has a one standard deviation from 0.36 to 0.80 and a main distribution in the histogram graph (Figure 361) from 0.20 to 0.84 with two outliers at 1.00 to 1.10 (EN03.01 and CA28.01) and one at 1.24 (CA27.05). The primary mode is from 0.17 to 0.20 and there are two equal secondary modes from 0.24 to 0.27 and from 0.27 to 0.30. The galleons have a one standard deviation from 0.38 to 0.65 and two equal primary modes in the histogram graph (Figure 362) from 0.40 to 0.50 and 0.50 to 0.60. The main distribution is from0.20 to 0.70 and there is an outlier at 0.86 (MA20.02). The one standard deviation of the nau sample is from 0.43 to 0.84 and the main distribution broadly ranges from 0.20 to 1.15 with two outliers (CA07.04 and MA16.1505-30) at 1.25 and another (PA02.01) at 1.35. The primary mode in the histogram graph (Figure 363) is from 0.52 to 0.60 while the secondary is from 0.60 to 0.68.

The one standard deviation ranges of the caravel and nau samples are broader from 0.36 to 0.80 and 0.43 to 0.84 respectively, while the galleons have a smaller range from 0.38 to 0.65. The center of distribution figures emphasize the closer relationship

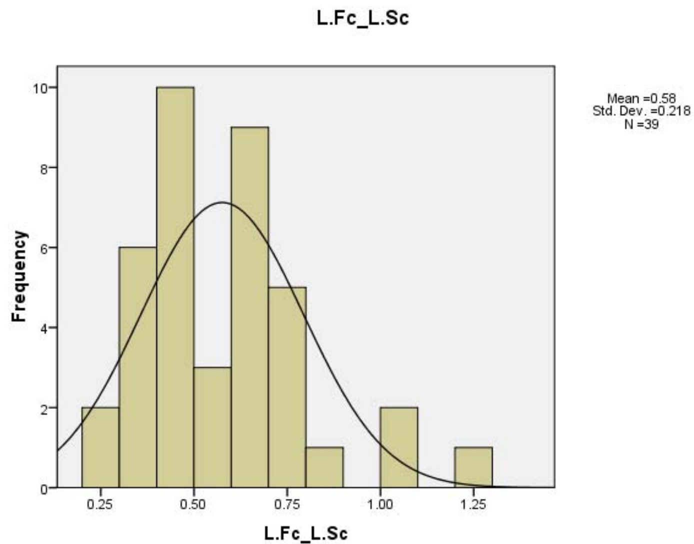


FIGURE 361: Histogram of the length of the forecastle to the length of the sterncastle in four-masted caravels. Refer to Appendix 36 for data.

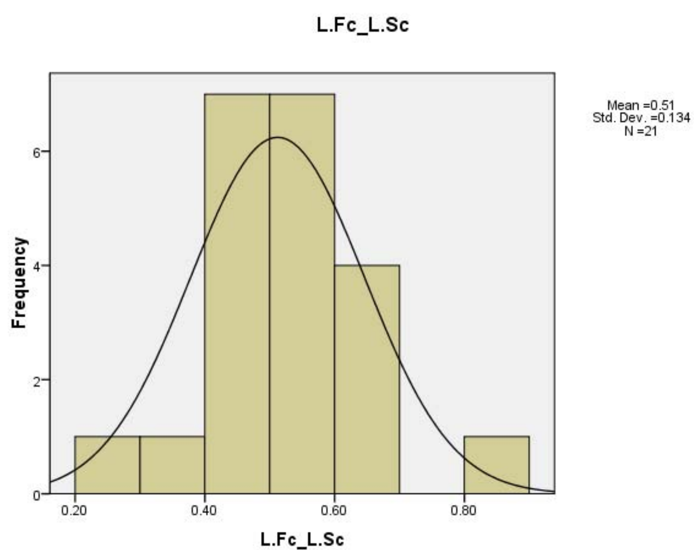


FIGURE 362: Histogram of the length of the forecastle to the length of the sterncastle in galleons. Refer to Appendix 36 for data.

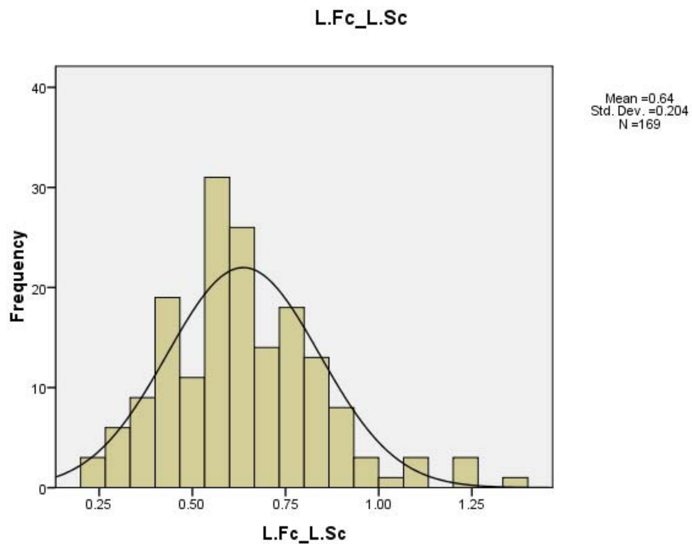


FIGURE 363: Histogram of the length of the forecastle to the length of the sterncastle in naus. Refer to Appendix 36 for data.

between the caravels (0.41 to 0.68) and galleons (0.42 to 0.59) and show that the naus have a somewhat higher range from 0.50 to 0.75. The modal ranges for the caravels and galleons are from the 0.40 to 0.70 and from 0.40 to 0.60 while the naus are again skewed higher from 0.52 to 0.68. Overall, the length of the forecastle is about 50% to 60% of the length of the sterncastle with slight variations between the ship types.

Length of the Forecastle to the Length of the Waist: (L.Fc_L.Wa)

The one standard deviation for the length of the forecastle to the length of the waist for the four-masted caravels is 0.58 to 1.23, which is consistent with the main distribution in the histogram graph shown in Figure 364 is from 0.40 to 1.50 with an outlier (MA14.09) at 1.66; there are three equal primary modes from 0.50 to 0.62, 0.62 to 0.70, and from 1.00 to 1.08. The one standard deviation of the galleon sample is from 0.46 to 1.30 and the primary mode is from 0.25 to 0.50 and the secondary mode is higher at 0.75 to 1.00. The main distribution in the histogram graph (Figure 365) is also broad from 0.25 to 2.00. The naus have a one standard deviation of 0.64 to 1.41 and an extensive main distribution from 0.15 to 2.35 and an outlier at 2.71 (CA13.01). The primary mode in the histogram graph (Figure 366) is from 0.82 to 1.00 while the secondary mode is from 1.00 to 1.17.

The one standard deviations of the length of the forecastle to the length of the waist is fairly consistent between the caravels, the galleons, and the naus with only moderate differences. The one standard deviation ranges and the center of distribution figures indicate a high degree of variability within the samples, which suggests little

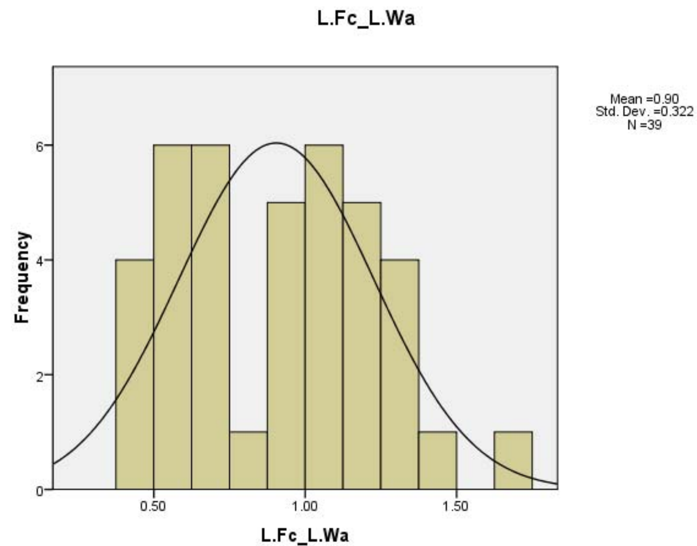


FIGURE 364: Histogram length of the forecastle to the length of the waist in four-masted caravels. Refer to Appendix 36 for data.

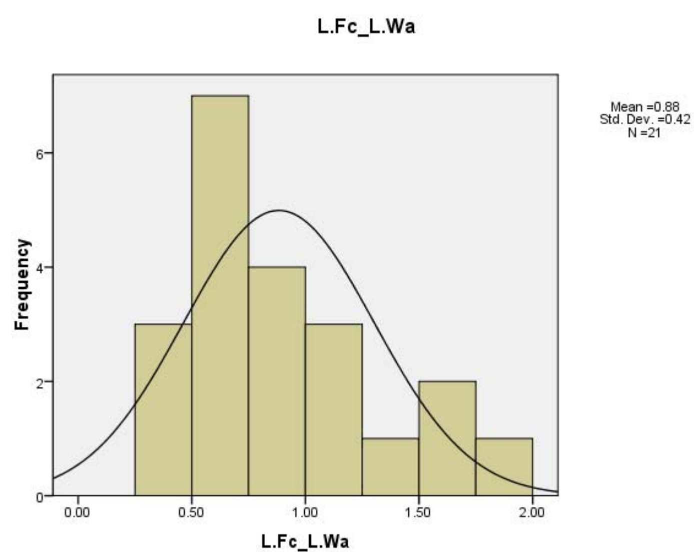


FIGURE 365: Histogram length of the forecastle to the length of the waist in galleons. Refer to Appendix 36 for data.

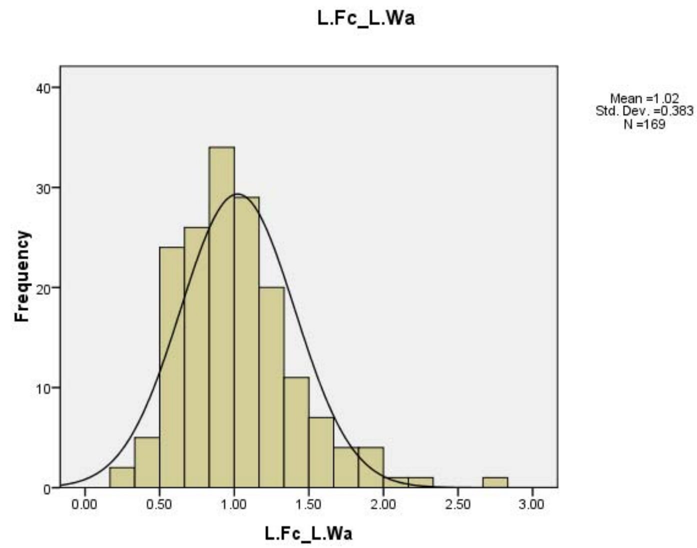


FIGURE 366: Histogram length of the forecastle to the length of the waist in naus. Refer to Appendix 36 for data.

uniformity in the length of the waist compared to the castle. Unfortunately, the modal ranges do not narrow the ranges considerably and are virtually useless for the caravels (0.50 to 1.08) and the galleons (0.25 to 1.00). The nau sample alone has a viable range for reconstructing a vessel: 0.82 to 1.17. The degree of variance suggests that there is little to no correlation between the length of the forecastle to the length of the waist. As such, only the length of the waist to the length of the hull should be considered reliable.

Length of the Waist to the Length of the Hull: (L.Wa_L.H)

In the statistical analysis of the waist there are 38 four-masted caravels, 22 galleons, and 181 naus. The length of the waist was measured from the forward most position of the sterncastle to the aft most portion of the forecastle. The length of the waist for the two- and three-masted caravels is included in the sterncastle section as these samples do not have a forecastle. The one standard deviation for the length of the waist to the length of the hull for the four-masted caravels is 0.23 to 0.33. The main distribution in the histogram graph shown in Figure 367 is from 0.15 to 0.40 while the primary mode is from 0.25 to 0.30. The one standard deviation of the galleon sample is from 0.19 to 0.40 and there are two equal primary modes from 0.20 to 0.30 and 0.30 to 0.40. The main distribution in the histogram graph (Figure 368) is from 0.10 to 0.40 and there is an outlier at 0.50 (MA13.04) and another from 0.62 (MA20.02). The nau sample has an identical one standard deviation of 0.19 to 0.40 to the galleons. The main distribution in the histogram graph (Figure 369) is from 0.15 to 0.45 with four outliers from 0.50 to 0.55 (MA11.07, MA03.03, CA22.30, and CA29.04), four outliers from

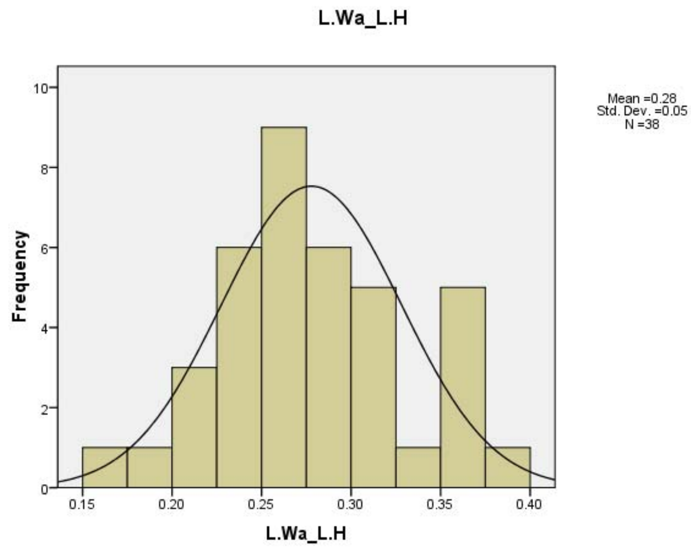


FIGURE 367: Histogram of the length of the waist to the length of the hull in four-masted caravels. Refer to Appendix 36 for data.

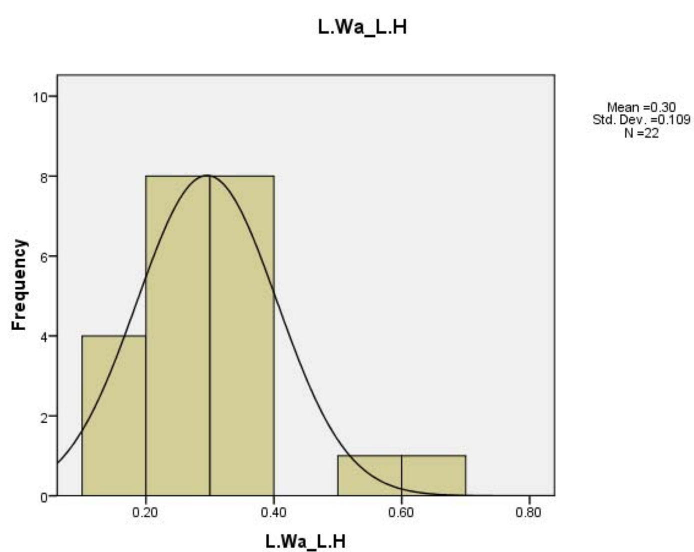


FIGURE 368: Histogram of the length of the waist to the length of the hull in galleons. Refer to Appendix 36 for data.

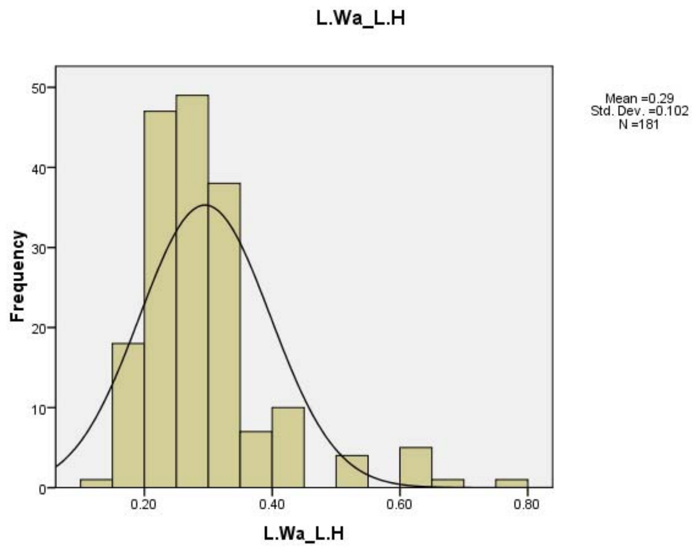


FIGURE 369: Histogram of the length of the waist to the length of the hull in naus.
Refer to Appendix 36 for data.

0.60 to 0.65 (CA22.36, MA04.01, MA03.07, and PA03.02), two outliers from 0.65 to 0.70 (MA03.11 and CA27.03), and another at 0.77 (CA27.06). The primary mode is from 0.25 to 0.30 with a secondary mode from 0.20 to 0.25.

The one standard deviations of the length of the waist to the length of the hull is fairly consistent between the caravels with a range of 0.23 to 0.33 and the galleons and naus with the same range of 0.19 to 0.40. The center of distribution figures also indicates a high degree of regularity and show even less variation between the samples than the one standard deviation ranges. The modal ranges narrow the ranges considerably and show that the galleon sample has the widest range from 0.20 to 0.40 while the naus and caravels have proportionally shorter waists with ranges of 0.20 to 0.30 and 0.25 to 0.30 respectively. In general it appears that the caravels, galleons, and naus have waists that are one-fourth to one-third the length of the hull, which is roughly the same size as the forecastle.

Forecastle Height Ratios

Height of the Forecastle to the Height of the Sterncastle: (H.Fc_H.Sc)

The height of the forecastle to the height of the sterncastle ratio for the four-masted caravel sample has a one standard deviation from 0.49 to 0.89, which is consistent with the histogram graph (Figure 370) showing the main distribution ranging extensively from 0.30 to 1.10. The primary mode is from 0.40 to 0.50 and the secondary mode is higher from 0.70 to 0.80. Like the caravels, the galleon sample has a broad one

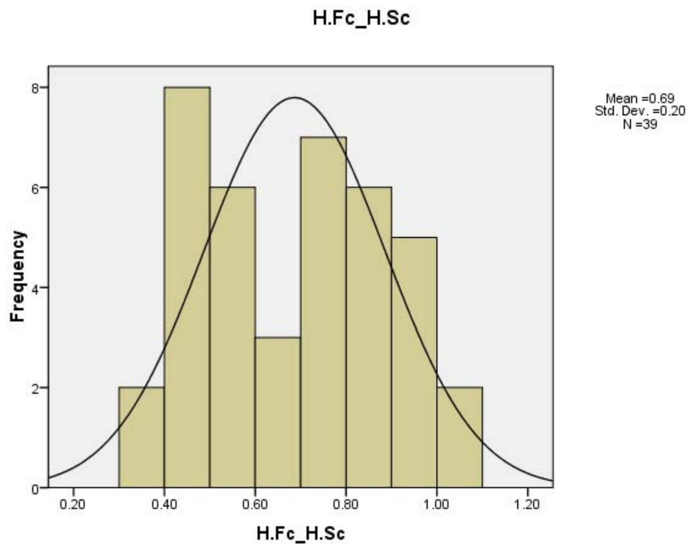


FIGURE 370: Histogram of the height of the forecastle to the height of the sterncastle in four-masted caravels. Refer to Appendix 36 for data.

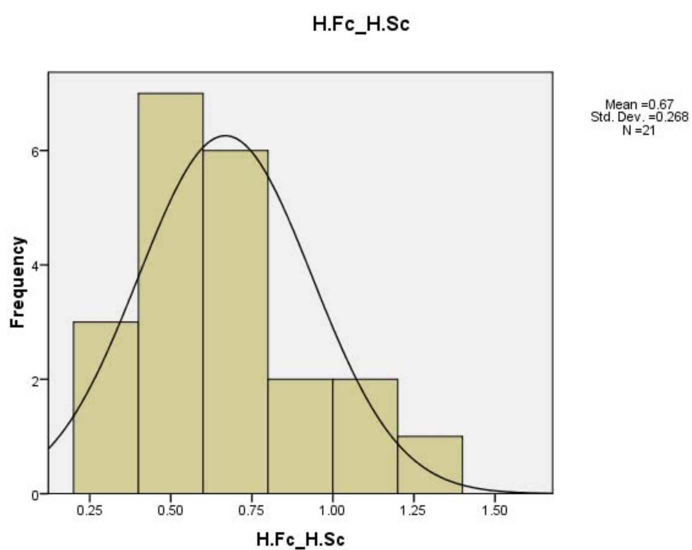


FIGURE 371: Histogram of the height of the forecastle to the height of the sterncastle in galleons. Refer to Appendix 36 for data.

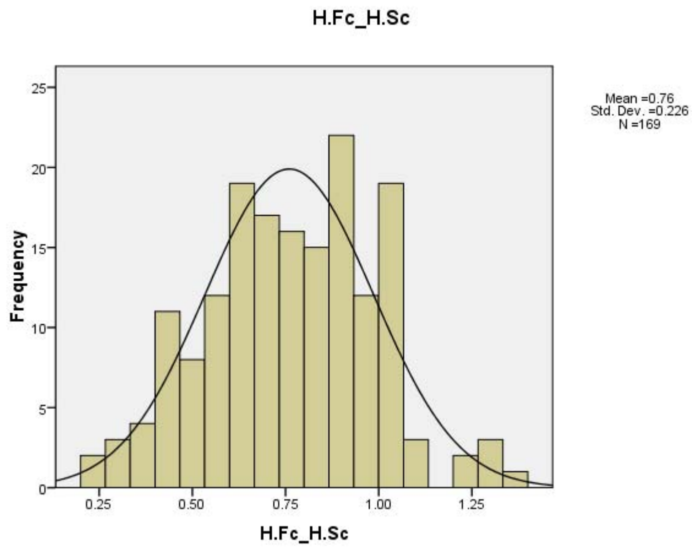


FIGURE 372: Histogram of the height of the forecastle to the height of the sterncastle in naus. Refer to Appendix 36 for data.

standard deviation from 0.40 to 0.94 with the main distribution ranging from 0.20 to 1.40 in the histogram graph (Figure 371) and a primary mode from 0.40 to 0.60 and a secondary mode from 0.60 to 0.80. The nau sample has a similar one standard deviation from 0.53 to 0.99. The main distribution from 0.20 to 1.15 is further extended by a cluster of outliers at 1.23 and 1.24 (CA15.02 and MA03.03), 1.27 (CA03.07 and MA03.02) and 1.29 to 1.34 (MA16.1501-01 and CA04.24). The primary mode in the histogram graph (Figure 372) is from 0.86 to 0.93, and the secondary mode is from 1.00 to 1.07.

The one standard deviation of the height of the forecastle to the height of the sterncastle ratio are highly uniform for the caravel, galleon, and nau samples which extend roughly from the 50th to the 90th. The modal ranges of the caravels and galleons are identical at 0.40 to 0.80 and the naus have a higher range of 0.86 to 1.07. The respective modes, listed in Table 71, demonstrate that the forecastles on the caravels and galleons, which have very similar primary modes from 0.40 to 0.50 for the former and roughly 0.40 to 0.60 for the latter, are roughly half of the height of the sterncastle. The modal peaks of the nau sample, shows a clear distinction between this ship type and the caravel and galleon samples. The naus have much more pronounced forecastles, which are only slightly shorter than the sterncastle and in some cases actually exceed this height.

Height of the Forecastle to the Length of the Forecastle: (H.Fc_L.H)

The height of the forecastle to the length of the hull ratio for the caravel sample has a relatively large one standard deviation from 0.33 to 0.98 which is consistent with the histogram graph (Figure 373), which shows the main distribution ranging extensively from 0.15 to 1.65. The primary mode is from 0.33 to 0.50 and there are two equal secondary modes from 0.50 to 0.67 and from 0.67 to 0.84. The one standard deviation of the galleon sample is from 0.29 to 0.74 with the main distribution ranging from 0.20 to 0.80 and an outlier at 1.17 (PA09.01). The corresponding histogram graph (Figure 374) shows a primary mode from 0.20 to 0.40. The nau sample also has a broad one standard deviation from 0.44 to 1.01. The main distribution in the histogram graph (Figure 375) is from 0.20 to 1.40 and the primary mode is from 0.52 to 0.60 with two equal secondary modes from 0.46 to 0.52 and 0.60 to 0.68.

The one standard deviation of height of the fore mast to the length of the hull ratio progressively increases from the galleons (0.29 to 0.74) to the caravels (0.33 to 0.98) to the naus (0.44 to 1.01). All three ranges are very broad, which is suggestive of high variance and an uncorrelated sample. The ranges are not necessarily reduced by the center of distribution figures. Likewise, the modal peaks of the caravel samples are extensive and it is necessary to use only the dominant primary mode of 0.33 to 0.50 to effectively narrow the range. The modes and the one standard deviation indicate that the galleons (0.20 to 0.40) have the shortest forecastles in comparison to its length. The caravels have slightly taller castles with a primary mode of 0.33 to 0.50 and the naus have the largest forecastle with a modal range of 0.52 to 0.60.

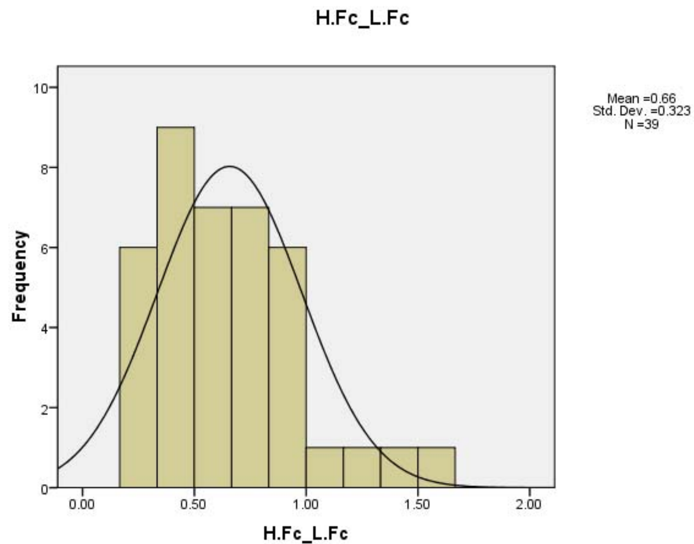


FIGURE 373: Histogram of the height of the forecastle to the length of the forecastle in four-masted caravels. Refer to Appendix 36 for data.

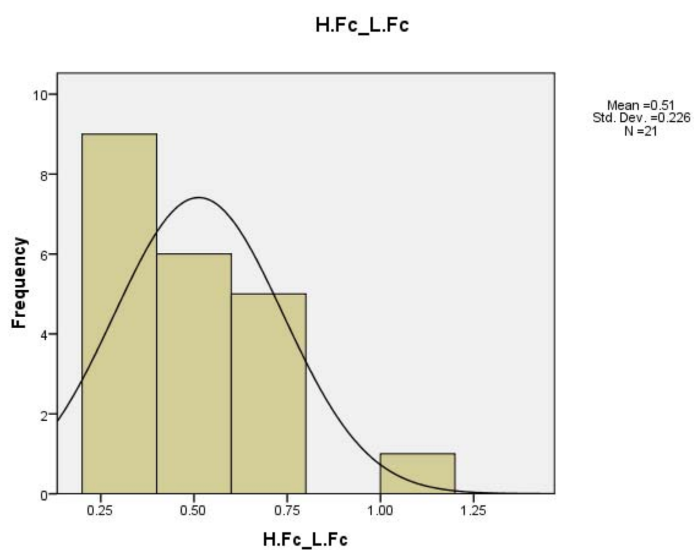


FIGURE 374: Histogram of the height of the forecastle to the length of the forecastle in galleons. Refer to Appendix 36 for data.

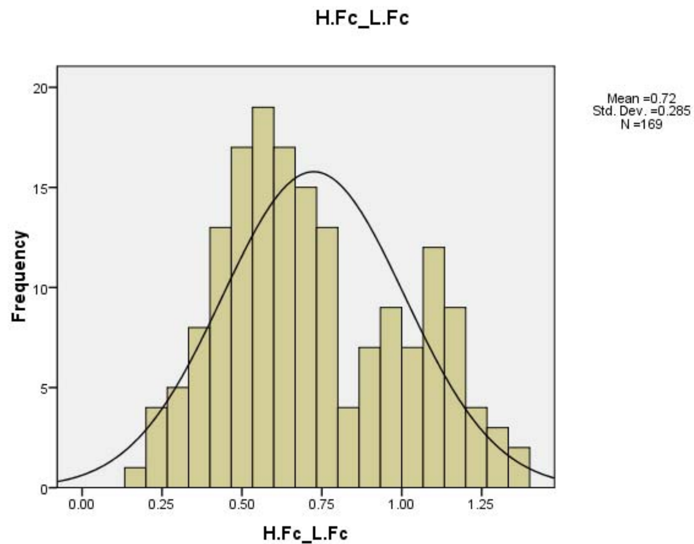


FIGURE 375: Histogram of the height of the forecastle to the length of the forecastle in naus. Refer to Appendix 36 for data.

Sterncastle Dimensions

In the statistical analysis of the forecastle there are 36 four-masted caravels, 18 galleons, and 157 naus (see Appendix 36). The length of the sterncastle as well as the poop deck was measured from the aft most portion of the deck to the forward most point. The measurement of the lowest deck, the quarter deck, was taken from the end of the poop deck to the end of quarter deck. Thus it represents the amount that the quarter deck extends beyond the poop deck. Likewise, the height was calculated from the main deck level in the waist to the highest position of the deck. The analysis of the two- and three-masted caravels is conducted at the end of this section as they represent two unique variants of ships with a sterncastle but no forecastle. The tabulation of the one standard deviation and modes for the sterncastle ratios can be viewed in Tables 72 and 73.

<u>Sterncastle Length Ratios</u>

Length of the Sterncastle to the Length of the Hull: (L.Sc_L.H)

The length of the sterncastle to the length of the hull ratio for the four-masted caravel sample has a one standard deviation from 0.39 to 0.50, which is consistent with the histogram graph (Figure 376) with a main distribution of 0.30 to 0.60 and a primary mode from 0.40 to 0.45. The galleons have a one-standard deviation of 0.36 to 0.52 and a main distribution of 0.25 to 0.55 with an outlier at 0.63 (MA14.05). The histogram graph (Figure 377) indicates that there is strong primary mode at 0.40 to 0.45. One standard deviation for the nau sample is from 0.37 to 0.49. The main distribution is from

TABLE 72: One Standard Deviation and Center of Distribution Figures for the Sterncastle Ratios by Ship Type

L.Sc_L.H	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Four-masted Caravels	0.39 to 0.50	0.42 to 0.47
Galleons	0.36 to 0.52	0.38 to 0.48
Naus	0.37 to 0.49	0.40 to 0.46
L.Pd _ L.Sc	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Four-masted Caravels	0.41 to 0.62	0.45 to 0.55
Galleons	0.41 to 0.64	0.42 to 0.63
Naus	0.45 to 0.68	0.49 to 0.63
L.Qd_L.Sc	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Four-masted Caravels	0.38 to 0.59	0.45 to 0.55
Galleons	0.37 to 0.59	0.37 to 0.58
Naus	0.32 to 0.54	0.37 to 0.51
H.Pd _ H.Sc	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Four-masted Caravels	0.25 to 0.51	0.27 to 0.46
Galleons	0.40 to 0.58	0.44 to 0.53
Naus	0.28 to 0.54	0.30 to 0.51
H.Qd _H.Sc	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Four-masted Caravels	0.29 to 0.58	0.31 to 0.57
Galleons	0.38 to 0.56	0.42 to 0.53
Naus	0.35 to 0.61	0.40 to 0.57
H.Sc _L.Sc	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Four-masted Caravels	0.36 to 0.66	0.38 to 0.63
Galleons	0.24 to 0.57	0.28 to 0.49
Naus	0.40 to 0.77	0.45 to 0.74

TABLE 73: Primary and Secondary Modes for the Sterncastle Ratios by Ship Type

L.Sc_L.H	**Primary Mode(s)**	**(Range)**	**Secondary Mode**
Four-masted Caravels	0.40 to 0.45	**(0.40-0.45)**	NA
Galleons	0.40 to 0.45	**(0.40-0.45)**	NA
Naus	0.43 to 0.46	**(0.40-0.46)**	0.40 to 0.43
L.Pd _ L.Sc	**Primary Mode(s)**	**(Range)**	**Secondary Mode**
Four-masted Caravels	0.45 to 0.50	**(0.45-0.55)**	0.50 to 0.55
Galleons	0.40 to 0.45	**(0.40-0.45)**	NA
Naus	0.57 to 0.60	**(0.57-0.63)**	0.60 to 0.63
L.Qd_L.Sc	**Primary Mode(s)**	**(Range)**	**Secondary Mode**
Four-masted Caravels	0.50 to 0.55	**(0.45-0.55)**	0.45 to 0.50
Galleons	0.55 to 0.60	**(0.55-0.60)**	NA
Naus	0.40 to 0.44	**(0.40-0.44)**	NA
H.Pd _ H.Sc	**Primary Mode(s)**	**(Range)**	**Secondary Mode**
Four-masted Caravels	0.35 to 0.40	**(0.35-0.40)**	NA
Galleons	0.50 to 0.55	**(0.50-0.55)**	NA
Naus	0.40 to 0.45	**(0.40-0.45)**	NA
H.Qd _H.Sc	**Primary Mode(s)**	**(Range)**	**Secondary Mode**
Four-masted Caravels	0.40 to 0.50	**(0.20-0.50)**	0.20-0.30; 0.30-0.40
Galleons	0.45 to 0.50	**(0.45-0.50)**	.NA
Naus	0.43 to 0.46	**(0.43-0.55)**	0.52 to 0.55
H.Sc _L.Sc	**Primary Mode(s)**	**(Range)**	**Secondary Mode**
Four-masted Caravels	0.50 to 0.60	**(0.50-0.70)**	0.60 to 0.70
Galleons	0.20 to 0.30	**(0.20-0.30)**	.NA
Naus	0.45 to 0.50	**(0.45-0.50)**	.NA

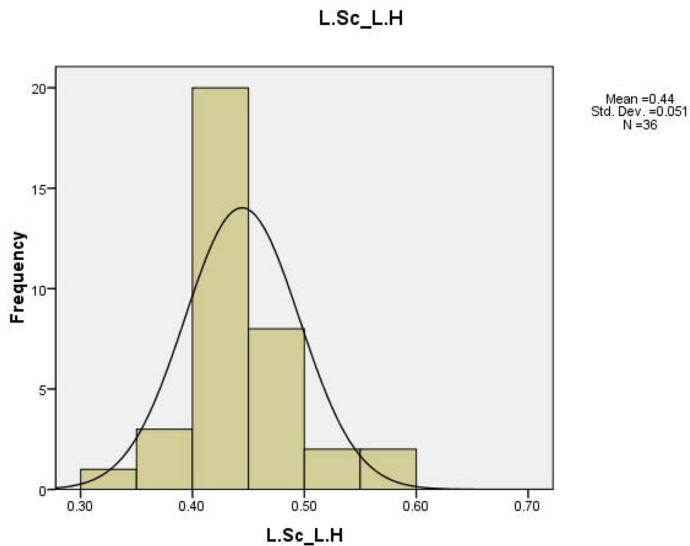


FIGURE 376: Histogram of the length of the sterncastle to the length of the hull in four-masted caravels. Refer to Appendix 36 for data.

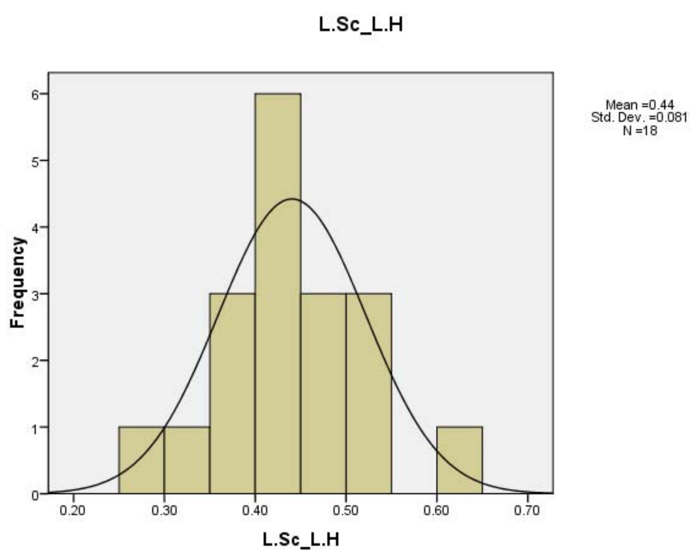


FIGURE 377: Histogram of the length of the sterncastle to the length of the hull in galleons. Refer to Appendix 36 for data.

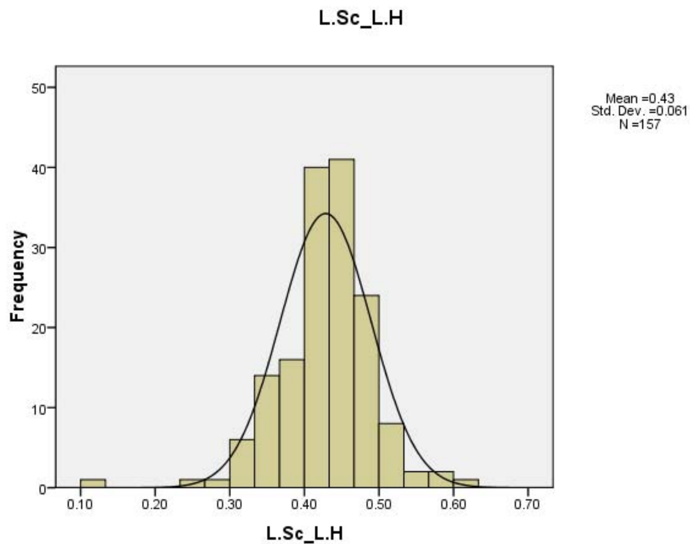


FIGURE 378: Histogram of the length of the sterncastle to the length of the hull in naus. Refer to Appendix 36 for data.

0.23 to 0.63 and there is an outlier at 0.13 (MA16.1503-06). The primary mode in the histogram graph (Figure 378) is from 0.40 to 0.43 and the secondary mode is 0.43 to 0.46.

The one standard deviation of the length of the forecastle to the length of the hull ratio are highly uniform for the caravel, galleon, and nau samples, which extend roughly from the 30th to the 50th percentile. The modal ranges of the caravels and galleons are identical at 0.40 to 0.45 and the naus are practically the same at 0.40 to 0.46. The respective modes demonstrate that the length of the sterncastles is about 40% to 45% of the length of the hull for all three ship types, which is consistent with the modal ranges of the length of the forecastle (about 25%) and the length of the waist (about 25% to 33%).

Length of the Poop Deck to the Length of the Sterncastle: (L.Pd_L.H)

The length of the poop deck to the length of the sterncastle ratio for the four-masted caravel sample has a one standard deviation from 0.41 to 0.62 and a main distribution in the histogram graph (Figure 379) from 0.30 to 0.70 with an outlier at 0.79 (EN03.01) and at 0.85 (CA22.18). The primary mode is from 0.45 to 0.50 and from 0.50 to 0.55. The galleon sample has a one standard deviation of 0.41 to 0.64 and a small main distribution in the histogram graph (Figure 380) from 0.50 to 0.75. The primary mode of 0.40 to 0.45, however, is not found within the main distribution. There is one outlier at 0.33 (MA15.1555.00). The one standard deviation of the nau sample is from 0.45 to 0.68 while the main distribution is from 0.30 to 0.76 with three outliers from 0.80

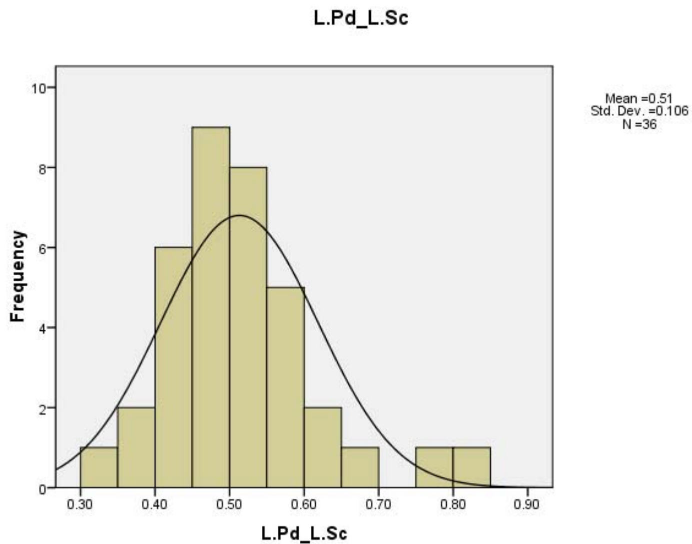


FIGURE 379: Histogram of the length of the poop deck to the length of the sterncastle in four-masted caravels. Refer to Appendix 36 for data.

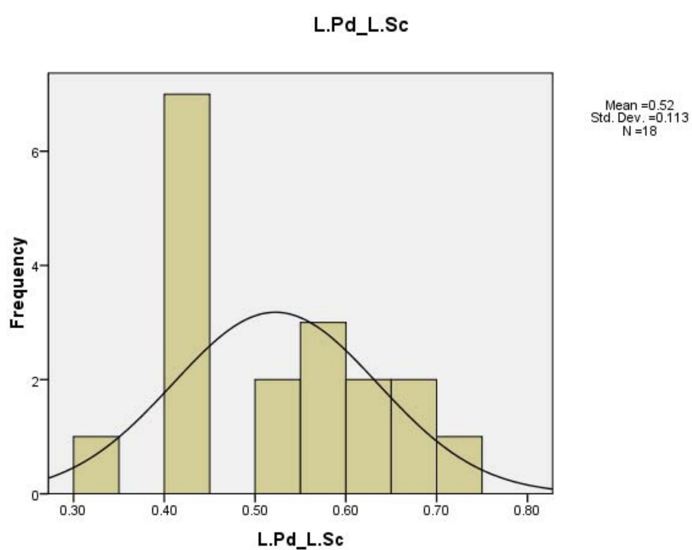


FIGURE 380: Histogram of the length of the poop deck to the length of the sterncastle in galleons. Refer to Appendix 36 for data.

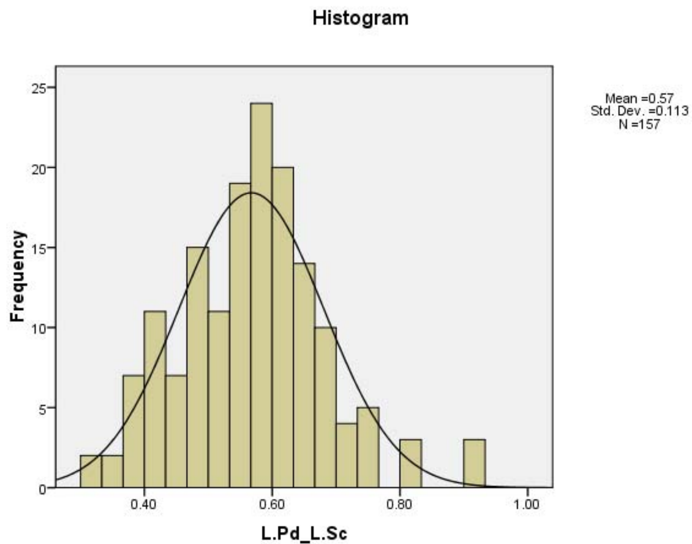


FIGURE 381: Histogram of the length of the poop deck to the length of the sterncastle in naus. Refer to Appendix 36 for data.

to 0.85 (CA22.19, CA12.01, and CA22.10) and three more from 0.90 to 0.95 (MA12.04, MA04.02, and MA16.1503-06). The primary mode in the histogram graph (Figure 381) is 0.57 to 0.60 and there is a congruent secondary mode from 0.60 to 0.63.

The caravels and galleons have nearly the same one standard deviation ranges from 0.41 to 0.62 and 0.41 to 0.64 respectively, while the naus have a range that is skewed a few points higher from 0.45 to 0.68. The modal ranges, however, indicate that the there is variation between the three samples. Although the samples are similar, the ranges become increasingly larger from the galleons with the lowest peak from 0.40 to 0.45 to the caravels with a range of 0.45 to 0.55 to the naus with highest modes from0.57 to 0.63. Overall, the length of the poop deck is roughly 40% to 60% of the length of the sterncastle depending on the ship type.

Length of the Quarter Deck to the Length of the Sterncastle: (L.Qd_L.Sc)

The length of the quarter deck to the length of the sterncastle ratio for the four-masted caravel sample has a one standard deviation from 0.38 to 0.59, which is consistent with the histogram graph (Figure 382) showing the main distribution ranging extensively from 0.30 to 0.70 and two outliers at 0.15 (CA22.18) and at 0.21 (EN03.01). The primary mode is from 0.50 to 0.55 and the secondary mode is from 0.45 to 0.50. The galleon sample has a one standard deviation from 0.37 to 0.59 with the main distribution ranging from 0.25 to 0.50 and an outlier at 0.67 (MA15.1555.00). The corresponding histogram graph (Figure 383) shows that the primary mode is from 0.55 to 0.60 and is thus separate from the main distribution. The one standard deviation of the

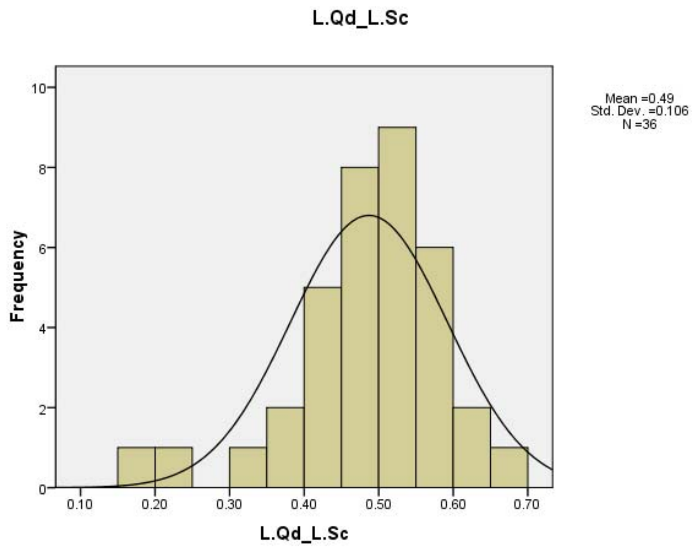


FIGURE 382: Histogram of the length of the quarter deck to the length of the sterncastle in four-masted caravels. Refer to Appendix 36 for data.

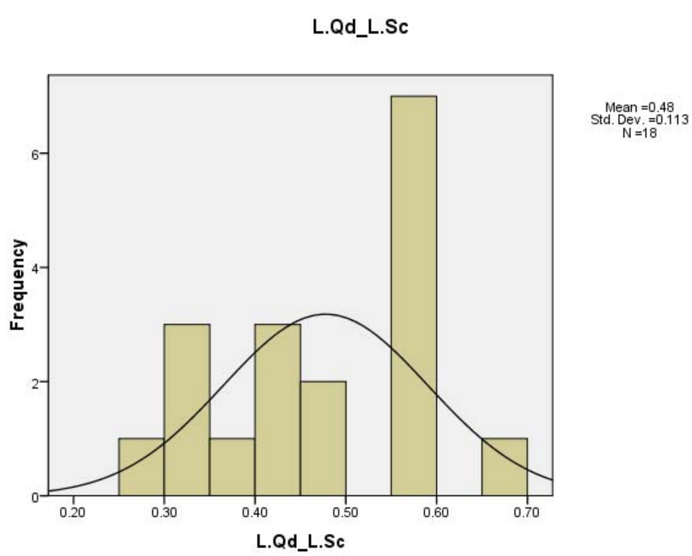


FIGURE 383: Histogram of the length of the quarter deck to the length of the sterncastle in galleons. Refer to Appendix 36 for data.

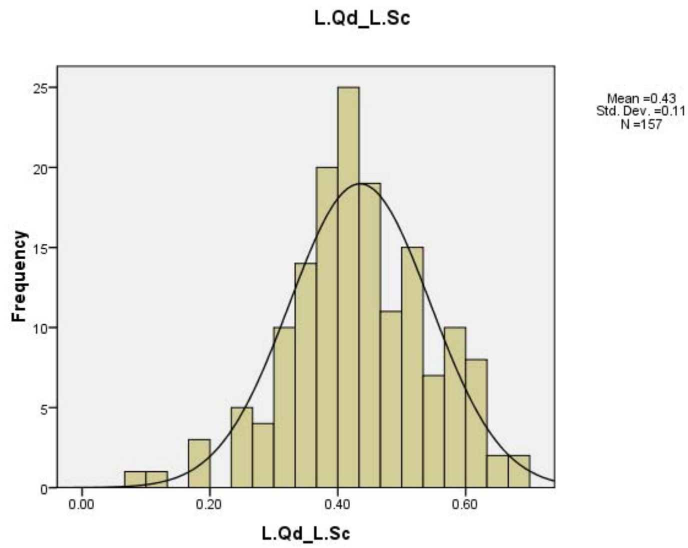


FIGURE 384: Histogram of the length of the quarter deck to the length of the sterncastle in naus. Refer to Appendix 36 for data.

nau sample is from 0.32 to 0.54 while the primary mode is from 0.40 to 0.44. The main distribution in the histogram graph (Figure 384) is from 0.24 to 0.70 and there is an outlier at 0.08 (MA12.04), 0.10 (MA04.02), and three from 0.15 to 0.20 (CA22.10, CA12.01, and CA22.19).

The one standard deviation of the length of the quarter deck to the length of the sterncastle ratio is consistent between the three samples with the caravels and galleons having ranges that differ by one percentage point (0.38 to 0.59 versus 0.37 to 0.59) while the naus have a somewhat lower range from 0.32 to 0.54. Although the center of distribution figures shows that the galleons and naus are more similar with ranges of 0.37 to 0.58 and 0.37 to 0.51 respectively as compared to the higher range of the caravels from 0.45 to 0.55, this is not supported by the modal ranges. The modal peaks indicate a clear progression in the length of the quarter deck from the naus with the lowest range of 0.40 to 0.44 to the caravels with a range of 0.45 to 0.55 to the galleons with the highest range of 0.55 to 0.60. The length of the quarter deck to the length of the sterncastle ratio corresponds almost perfectly with the same ratio for the length of the poop deck the analysis of which produced the following figures: galleons (0.40 to 0.45), caravels (0.45 to 0.55), naus (0.57 to 0.63). From this comparison it appears that the caravels and galleons had poop decks that were roughly 50% of the length of the sterncastle with the quarter decks projecting out an additional 50%. The naus had the shortest poop decks accounting for only 40% of the length of the sterncastle and the quarter decks extended an additional 60%.

Sterncastle Height Ratios

Height of the Poop Deck to the Height of the Sterncastle: (H.Pd_H.Sc)

The height of the poop deck to the height of the sterncastle ratio for the four-masted caravels is from 0.25 to 0.51 and the main distribution is from 0.15 to 0.60 with an outlier (MA15.1502.05) at 0.66 and another (MA14.03) at 0.71. The primary mode in the histogram graph (Figure 385) is from 0.35 to 0.40. The one standard deviation for the galleons is from 0.40 to 0.58, which is consistent with the primary mode from 0.50 to 0.55. The main distribution in the histogram graph shown in Figure 386 is from 0.30 to 0.70. The naus have a one standard deviation of 0.28 to 0.54 and the primary mode is from 0.40 to 0.45. The main distribution in the histogram graph (Figure 387) is from 0.75 to 0.70 with an outlier (MA10.10) at 0.77 and another at 0.90 (MA16.1565-03). The one standard deviation of the height of the poop deck to the height of the sterncastle ratio is similar for the caravel (0.25 to 0.51) and the naus (0.28 to 0.54) while the galleon range is skewed higher at 0.40 to 0.58. The modal ranges demonstrate that there is variation between the three samples and the height of the poop deck increases in size from the caravels with the lowest peak from 0.35 to 00.40 to the naus with a range of 0.40 to 0.45 to the galleons with highest modes from 0.50 to 0.55. On average the height of the poop deck accounts for roughly 40% to 50% of the height of the sterncastle with minor variations depending on the ship type.

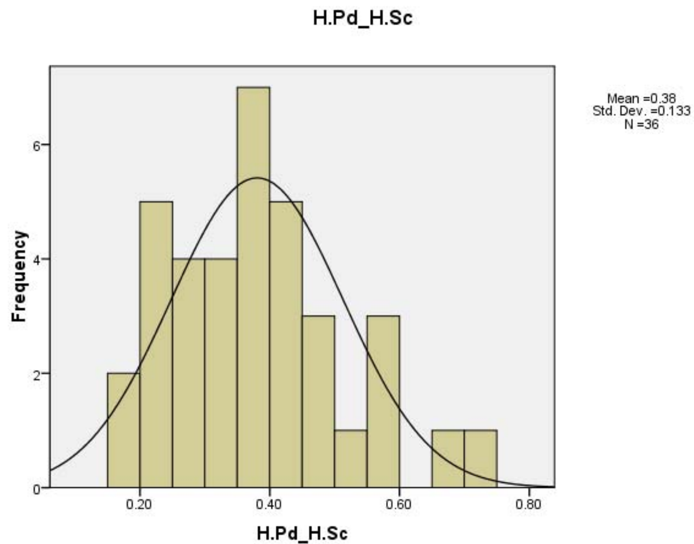


FIGURE 385: Histogram of the height of the poop deck to the height of the sterncastle in four-masted caravels. Refer to Appendix 36 for data.

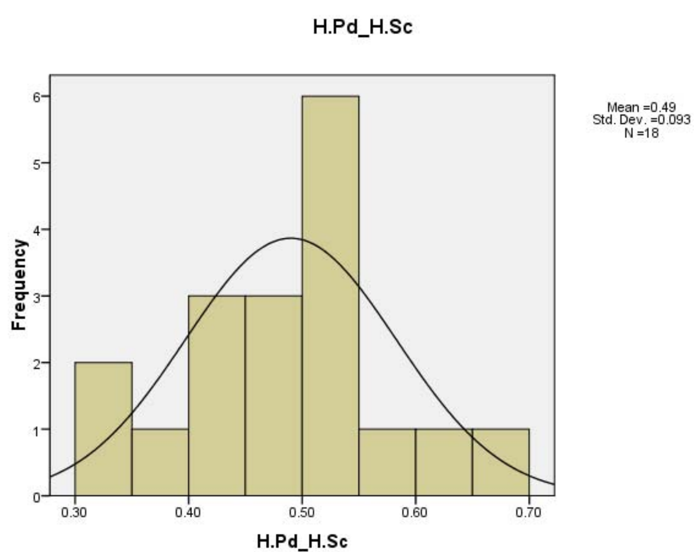


FIGURE 386: Histogram of the height of the poop deck to the height of the sterncastle in galleons. Refer to Appendix 36 for data.

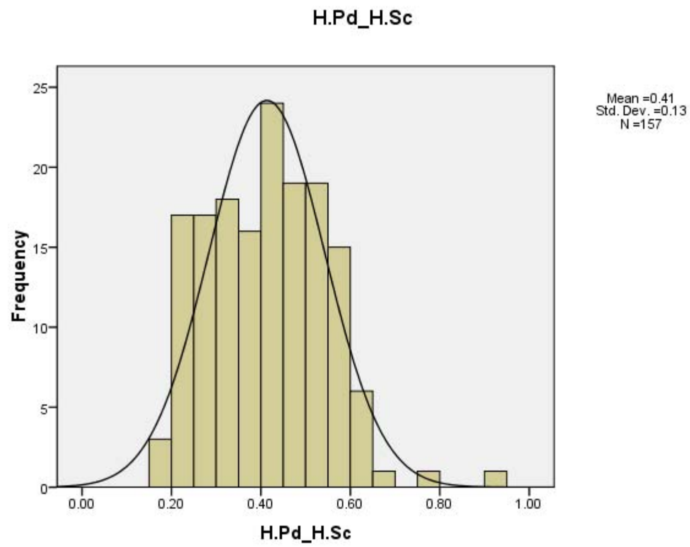


FIGURE 387: Histogram of the height of the poop deck to the height of the sterncastle in naus. Refer to Appendix 36 for data.

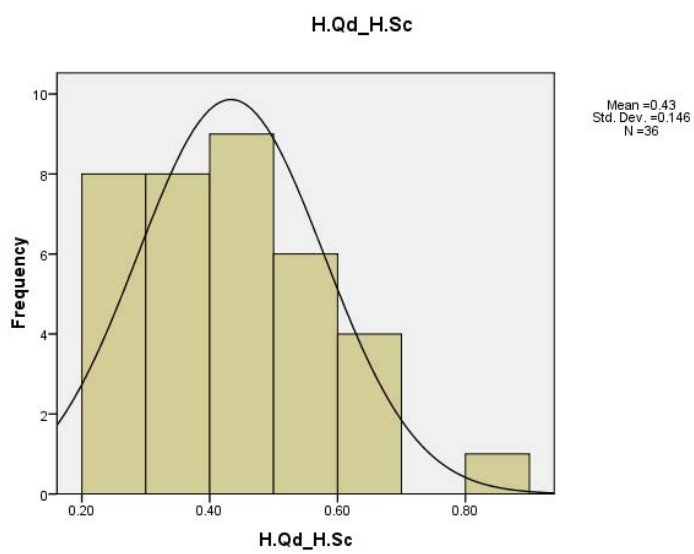


FIGURE 388: Histogram of the height of the quarter deck to the height of the sterncastle in four-masted caravels. Refer to Appendix 36 for data.

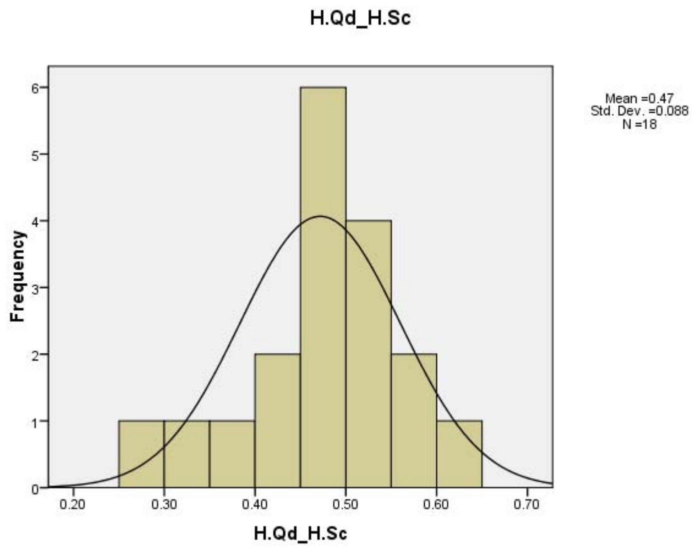


FIGURE 389: Histogram of the height of the quarter deck to the height of the sterncastle in galleons. Refer to Appendix 36 for data.

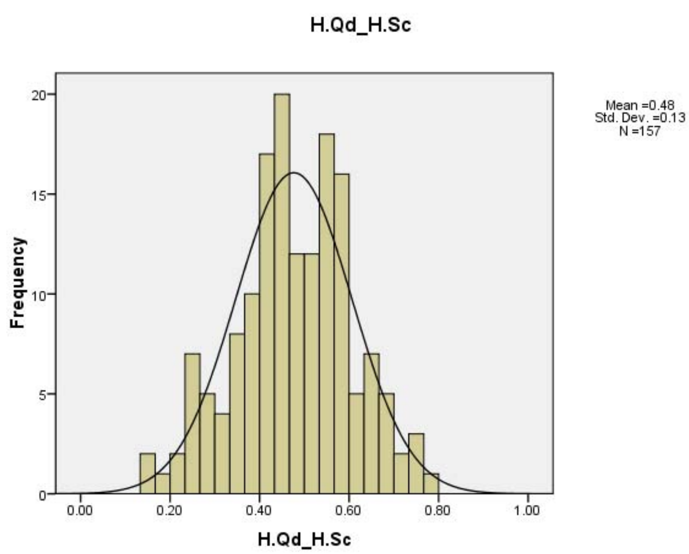


FIGURE 390: Histogram of the height of the quarter deck to the height of the sterncastle in naus. Refer to Appendix 36 for data.

Height of the Quarter Deck to the Height of the Sterncastle: (H.Qd_H.Sc)

The height of the quarter deck to the height of the sterncastle ratio for the four-masted caravels has a one standard deviation of 0.29 to 0.58. The primary mode in the histogram graph (Figure 388) is from 0.40 to 0.50 and there are two equal secondary modes from 0.20 to 0.30 and from 0.30 to 0.40 all of which are consistent with the main distribution of 0.20 to 0.70. There is one outlier from 0.80 to 0.85 (MA15.1501.09). The galleons have a one standard deviation from 0.38 to 0.56 and a main distribution in the histogram graph (Figure 389) from 0.25 to 0.65 and a primary mode from 0.45 to 0.50. One standard deviation for nau sample is 0.35 to 0.61 and the main distribution in the histogram graph (Figure 390) is from 0.14 to 0.80. The primary mode is from 0.43 to 0.46 while the secondary mode is from 0.52 to 0.55.

Although the one standard deviation of the height of the quarter deck to the height of the sterncastle ratio shows moderate variation between the caravels, galleons, and naus all the ranges are around the 30th through the 50th percentile. The primary modes are fairly consistent throughout the samples ranging from 0.40 to 0.50; however, a more nuanced view is possible through the overall modal peaks with the addition of the secondary modes. The galleons and naus have relatively similar ranges of 0.45 to 0.50 and 0.43 to 0.55 respectively while the caravels have a ranged skewed much lower from 0.20 to 0.50 suggesting high variability within this sample. In general, it appears that the height of the quarter deck is roughly 40% to 50% of the height of the sterncastle, which is consistent with the height of the poop deck which was also determined to be 40% to 50%.

Height of the Sterncastle to the Length of the Sterncastle: (H.Sc_L.Sc)

The height of the sterncastle to the length of the sterncastle ratio for the four-masted caravel sample has a one standard deviation from 0.36 to 0.66 and a main distribution is from 0.20 to 0.90. The primary mode in the histogram graph (Figure 391) is from 0.50 to 0.60 with a secondary mode from 0.60 to 0.70. The galleons have a one standard deviation of 0.24 to 0.57 and a main distribution in the histogram graph (Figure 392) of 0.20 to 0.70 with an outlier at 0.82 (PA09.01). The primary mode of the galleon sample is from 0.20 to 0.30. The one standard deviation for the nau sample is from 0.40 to 0.77. The primary mode in the histogram graph (Figure 393) is from 0.45 to 0.50 and the main distribution is from 0.20 to 1.10.

There are distinct differences in the one standard deviations of the height of the sterncastle to the length of the sterncastle ratio. The height of the sterncastle to the length of the sterncastle progresses from the galleons with the lowest range from 0.24 to 0.57 while the caravels are slightly higher at 0.36 to 0.66 and the naus have the highest range from 0.40 to 0.77. This disparity between the samples is emphasized in the modal ranges in which the caravels have the highest sterncastles with a range of 0.50 to 0.70 while the naus have slightly shorter sterncastles with a range of 0.45 to 0.50. For the galleons the sterncastles are remarkably lower with heights that are only 20% to 30% of the length.

Two-masted and Three-masted Caravels Sterncastle and Waist Ratios

In the statistical analysis of the forecastle there are 17 two-masted caravels and seven three-masted caravels with a poop and quarter deck in the sterncastle structure.

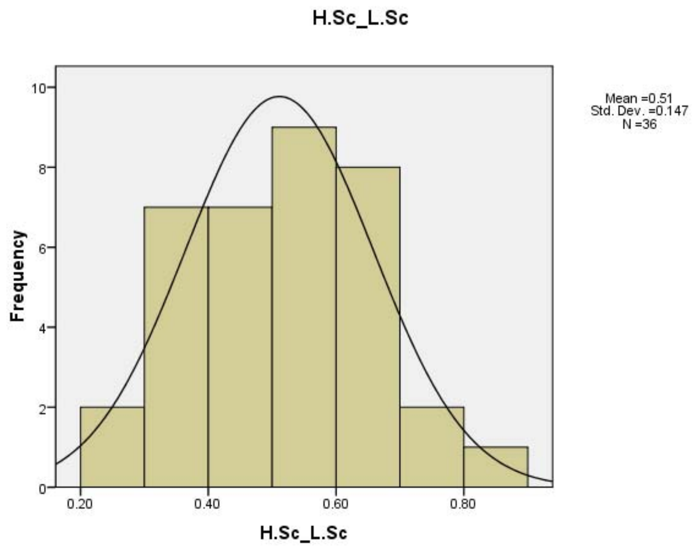


FIGURE 391: Histogram of the height of the sterncastle to the length of the sterncastle in four-masted caravels. Refer to Appendix 36 for data.

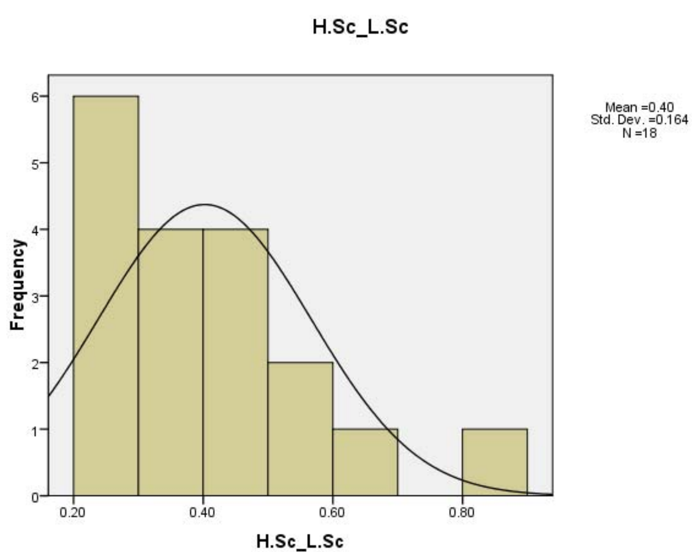


FIGURE 392: Histogram of the height of the sterncastle to the length of the sterncastle in galleons. Refer to Appendix 36 for data.

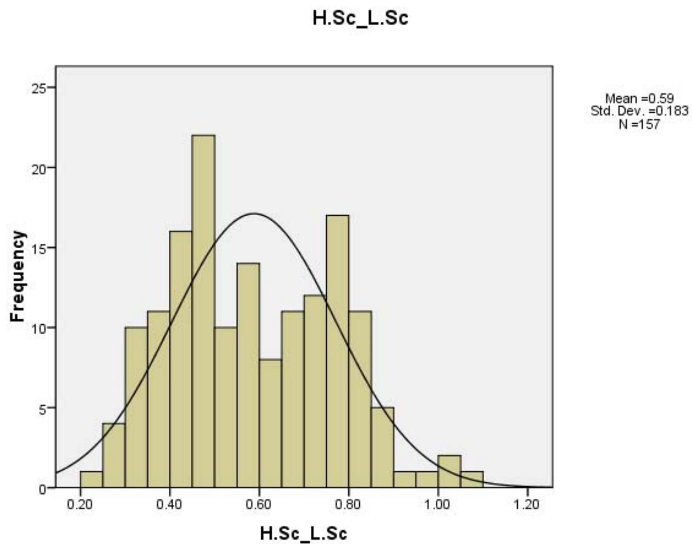


FIGURE 393: Histogram of the height of the sterncastle to the length of the sterncastle in naus. Refer to Appendix 36 for data.

There are an additional 15 two-masted caravels and six three-masted caravels with a quarter deck only. The length of the sterncastle as well as the individual decks was measured from the aft most portion of the deck to the forward most point. Likewise, the height of the sterncastle was calculated from the main deck level in the waist to the highest position of the deck and each deck was measured from the start of the previous one. The analysis of the two- and three-masted caravels with poop and quarter decks is conducted together with those with a quarter deck only; however, the corresponding ratios reflect the number of vessels with the deck under analysis. The tabulation of the one standard deviation and primary modes of the sterncastle ratios can be viewed in Tables 74 and 75.

Length of the Sterncastle to the Length of the Hull: (L.Sc_L.H)

The length of the sterncastle to the length of the hull ratio for the two-masted caravel sample has a one standard deviation from 0.40 to 0.49 which is consistent with the histogram graph (Figure 394) showing a main distribution of 0.325 to 0.525 and an outlier at 0.59 (MA10.06). The primary mode for this distribution is from 0.40 to 0.425 and there are two equal secondary modes from 0.45 to 0.475 and from 0.475 to 0.50. The three-masted caravels have a one-standard deviation of 0.30 to 0.51 and a main distribution of 0.28 to 0.52 with an outlier at 0.19 (CA04.13) and another at 0.60 (CA09.01). The histogram graph (Figure 395) indicates that there is strong primary mode at 0.40 to 0.45 and a secondary mode from 0.45 to 0.50.

TABLE 74: One Standard Deviation and Center of Distribution Figures for the Sterncastle Ratios by Ship Type

L.Sc_L.H	One Standard Deviation (68%)	Center of Distribution (50%)
Two-masted Caravels	0.40 to 0.49	0.42 to 0.48
Three-masted Caravels	0.30 to 0.51	0.34 to 0.48
L.Pd _ L.Sc	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Two-masted Caravels	0.53 to 0.81	0.56 to 0.82
Three-masted Caravels	0.40 to 0.61	0.38 to 0.60
L.Qd_L.Sc	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Two-masted Caravels	0.29 to 1.00	0.32 to 1.00
Three-masted Caravels	0.46 to 1.00	0.44 to 1.00
H.Pd _ H.Sc	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Two-masted Caravels	0.41 to 0.60	0.46 to 0.60
Three-masted Caravels	0.35 to 0.64	0.43 to 0.62
H.Qd _H.Sc	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Two-masted Caravels	0.41 to 1.00	0.41 to 1.00
Three-masted Caravels	0.37 to 1.00	0.41 to 1.00
H.Sc _L.Sc	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Two-masted Caravels	0.27 to 0.56	0.32 to 0.49
Three-masted Caravels	0.37 to 0.56	0.40 to 0.52
L.Wa _L.H	**One Standard Deviation (68%)**	**Center of Distribution (50%)**
Two-masted Caravels	0.41 to 0.63	0.51 to 0.58
Three-masted Caravels	0.33 to 0.70	0.36 to 0.68

TABLE 75: Primary and Secondary Modes for the Sterncastle Ratios by Ship Type

L.Sc_L.H	**Primary Mode(s)**	**(Range)**	**Secondary Mode**
Two-masted Caravels	0.40 to 0.425	**(0.40-0.50)**	0.45-0.475; 0.475-0.50
Three-masted Caravels	0.40 to 0.45	**(0.40-0.50)**	0.45 to 0.50
L.Pd _ L.Sc	**Primary Mode(s)**	**(Range)**	**Secondary Mode**
Two-masted Caravels	0.55-0.60; 0.65-0.70; 0.80-0.85	**(0.55-0.80)**	NA
Three-masted Caravels	0.35-0.40; 0.55-0.60	**(0.35-0.60)**	NA
L.Qd_L.Sc	**Primary Mode(s)**	**(Range)**	**Secondary Mode**
Two-masted Caravels	1	**(0.10-1.00)**	0.10-0.20; 0.40-0.50
Three-masted Caravels	1	**(0.40-1.00)**	0.40-0.50
H.Pd _ H.Sc	**Primary Mode(s)**	**(Range)**	**Secondary Mode**
Two-masted Caravels	0.45 to 0.50	**(0.45-0.50)**	NA
Three-masted Caravels	0.40 to 0.50	**(0.40-0.50)**	NA
H.Qd _H.Sc	**Primary Mode(s)**	**(Range)**	**Secondary Mode**
Two-masted Caravels	1	**(0.50-1.00)**	0.50 to 0.60
Three-masted Caravels	1	**(0.40-1.00)**	0.40 to 0.60
H.Sc _L.Sc	**Primary Mode(s)**	**(Range)**	**Secondary Mode**
Two-masted Caravels	0.27 to 0.35	**(0.27-0.47)**	0.40 to 0.47
Three-masted Caravels	0.40 to 0.50	**(0.40-0.50)**	NA
L.Wa _L.H	**Primary Mode(s)**	**(Range)**	**Secondary Mode**
Two-masted Caravels	0.50 to 0.55	**(0.50-0.60)**	0.55 to 0.60
Three-masted Caravels	0.30 to 0.40	**(0.30-0.60)**	0.50 to 0.60

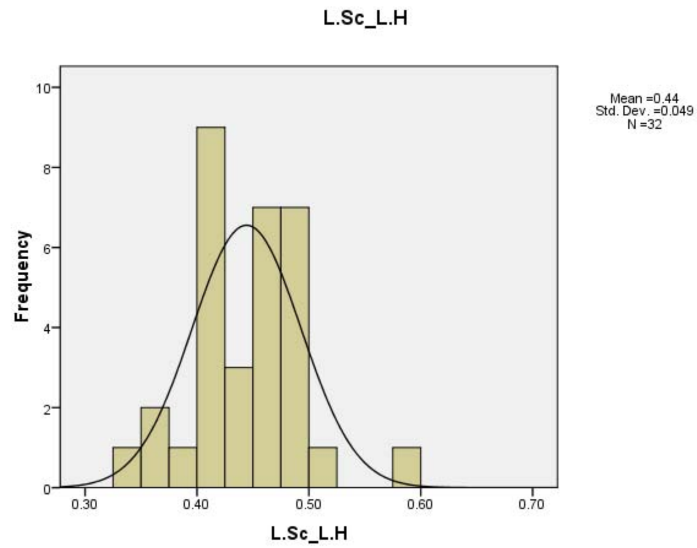


FIGURE 394: Histogram of the length of the sterncastle to the length of the hull in two-masted caravels.

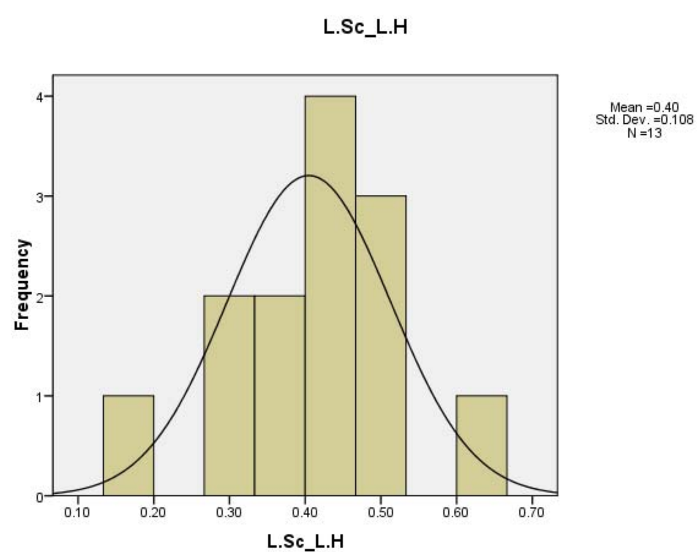


FIGURE 395: Histogram of the length of the sterncastle to the length of the hull in three-masted caravels.

The one standard deviation and the center of distribution figures demonstrate that there is a high degree of consistency between the two samples, but that the three-masted caravels have a broader range than the two-masted ships. The modal ranges, however, are identical for the two caravel samples and show that the length of the sterncastle is40% to 50% of the length of the vessel. It appears that this is slightly larger than the galleons, naus, and four-masted caravels which have sterncastles that, in general, are 40% to 45% of the length of the hull. The primary modes of the two- and three-masted caravels are between 0.425 to 0.45 and 0.40 to 0.45 which minimize the differences between all of the samples. Although these results appear to be surprising given the fact that the two- and three-masted caravels did not have forecastles, it is actually quite logical. The caravels had long sterncastles that ran nearly to the main mast, which was in a centralized location on the hull; as such, the presence of a forecastle only makes a difference in the length of the waist.

Length of the Poop Deck to the Length of the Sterncastle: (L.Pd_L.Sc)

The length of the poop deck to the length of the sterncastle ratio for the two-masted caravel sample has a one standard deviation from 0.53 to 0.81 and a main distribution in the histogram graph (Figure 396) from 0.45 to 0.75 and a secondary distribution from 0.80 to 0.90. There are three equal primary modes from 0.55 to 0.60, 0.65 to 0.70 and from 0.80 to 0.85. The three-masted caravels have a one standard deviation of 0.40 to 0.61 and a split distribution in the histogram graph (Figure 397)

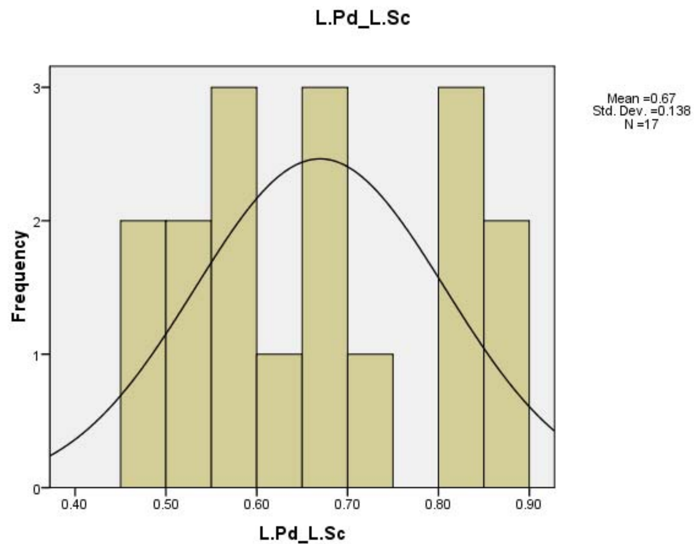


FIGURE 396: Histogram length of the poop deck to the length of the sterncastle in two-masted caravels.

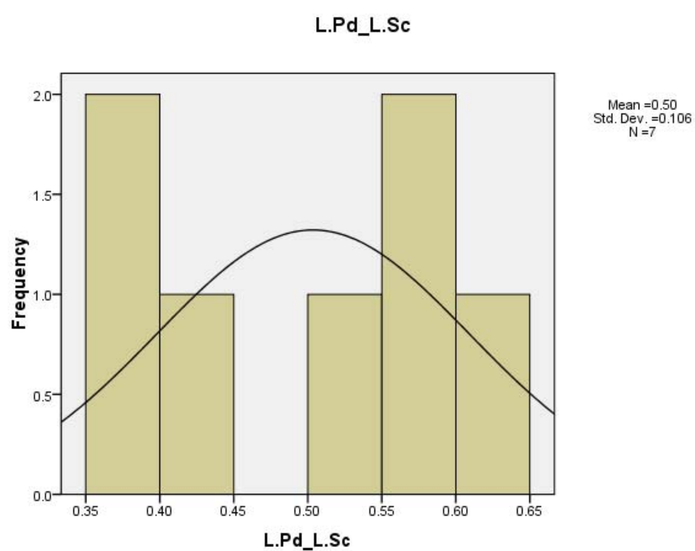


FIGURE 397: Histogram length of the poop deck to the length of the sterncastle in three-masted caravels.

from 0.35 to 0.45 and from 0.50 to 0.65 with a primary mode in each distribution from 0.35 to 0.40 and from 0.55 to 0.60.

The two-masted caravels have a broader one standard deviation and center of distribution than the three-masted ones. The modal ranges are almost identical to the one standard deviation ranges suggesting there is a high level of variability and little consistency within the length of the poop deck for the caravels. The three-masted caravels have a lower range of 0.35 to 0.60 while the two-masted caravels appear to have longer poop decks with a modal range of 0.55 to 0.80. The length of the poop deck varies anywhere from 35% to 80% of the length of the sterncastle depending upon the caravel. In comparison, the length of the poop deck is roughly 40% to 60% of the length of the sterncastle for four-masted caravels, galleons, and nau samples.

Length of the Quarter Deck to the Length of the Sterncastle: (L.Qd_L.Sc)

The length of the quarter deck to the length of the sterncastle ratio for the two-masted caravel sample has a relatively large one standard deviation from 0.29 to 1.00 which is consistent with the histogram graph (Figure 398) showing the main distribution ranging extensively from 0.20 to 0.60 and the primary mode separate from the distribution at 1.00. The one standard deviation of the four-masted caravels is from 0.46 to 1.00 while the main distribution in the histogram graph (Figure 399) is from 0.30 to 0.70 and the primary mode is again separate from the main distribution at 1.00.

Although the one standard deviation for these two samples are extensive and the main distributions are completely divided from the main grouping there is a very logical

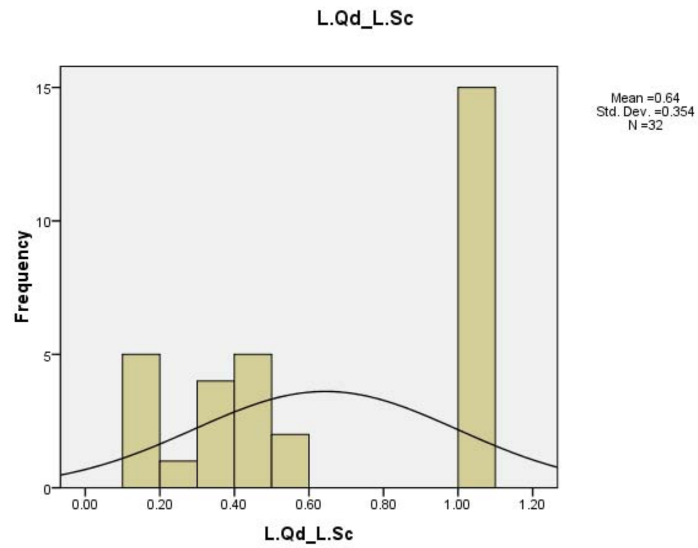


FIGURE 398: Histogram of the length of the quarter deck to the length of the sterncastle in two-masted caravels.

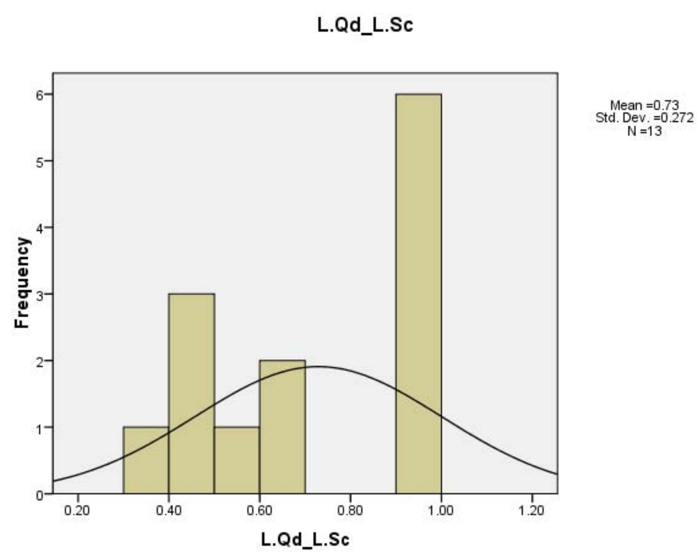


FIGURE 399: Histogram of the length of the quarter deck to the length of the sterncastle in three-masted caravels.

explanation. Within each sample, there are caravels which have a poop deck and a quarter deck and others with only a quarter deck. For the two-masted caravel sample, the 15 vessels with only a quarter deck all have a ratio of 1.00 because the sterncastle is comprised only of this one deck; as such, it naturally becomes the primary mode. The main distribution is composed of those two-masted caravels with both a poop and a quarter deck and the histogram graph shows that this grouping has two primary modes from 0.10 to 0.20 and from 0.40 to 0.50. Likewise, the three-masted caravel sample has six vessels with a single quarter deck all of which have a corresponding ratio of 1.00. The main distribution is again those three-masted caravels with the poop and quarter decks and the primary mode of this group is 0.40 to 0.50 and the secondary mode is 0.60 to 0.70. The length of the quarter deck ratio perfectly complements the poop deck ratios. The two-masted caravels have a poop deck that is 55% to 80% of the sterncastle and a quarter deck that is an additional 10% to 20% and 40% to 50%. Likewise, the poop deck in the three-masted caravel samples are 35% and 60%, while the quarter decks is between 40% to 50% and 60% to 70% of the length of the sterncastle.

Height of the Poop Deck to the Height of the Sterncastle: (H.Pd_H.Sc)

The two-masted caravel sample has a one standard deviation of the height of the poop deck to the height of the sterncastle ratio from 0.41 to 0.60 with the main distribution ranging from 0.40 to 0.70 and an outlier at 0.32 (PA03.01). The corresponding histogram graph (Figure 400) shows a primary mode from 0.45 to 0.50. The one standard deviation of the three-masted galleons is from 0.35 to 0.64 while the

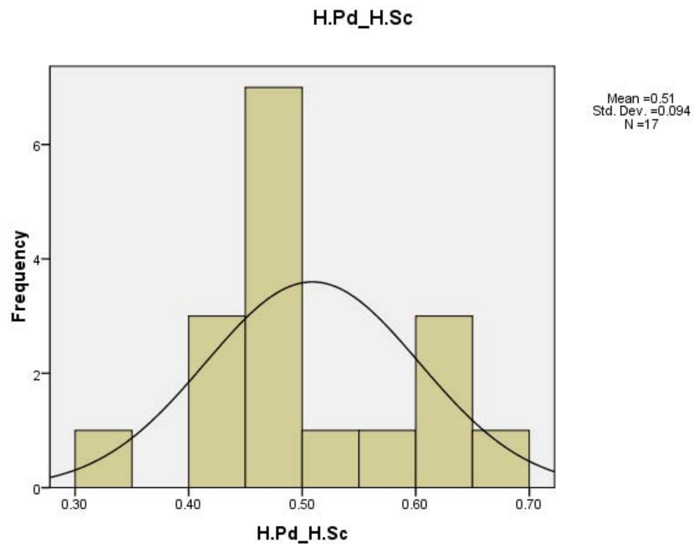


FIGURE 400: Histogram of the height of the poop deck to the height of the sterncastle in two-masted caravels.

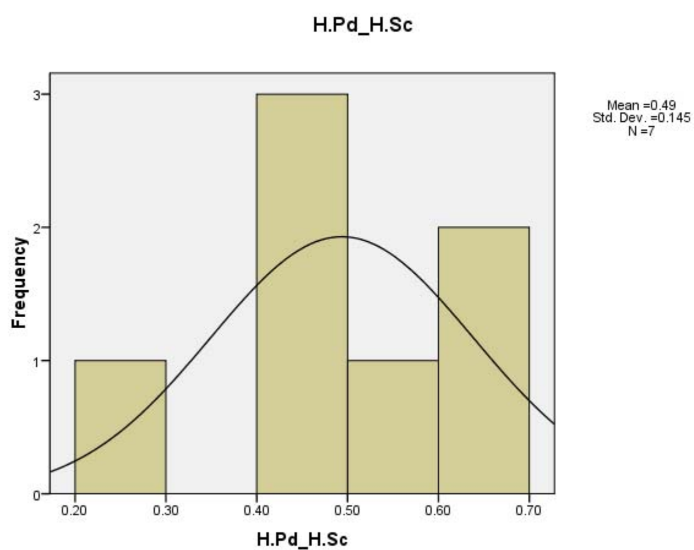


FIGURE 401: Histogram of the height of the poop deck to the height of the sterncastle in three-masted caravels.

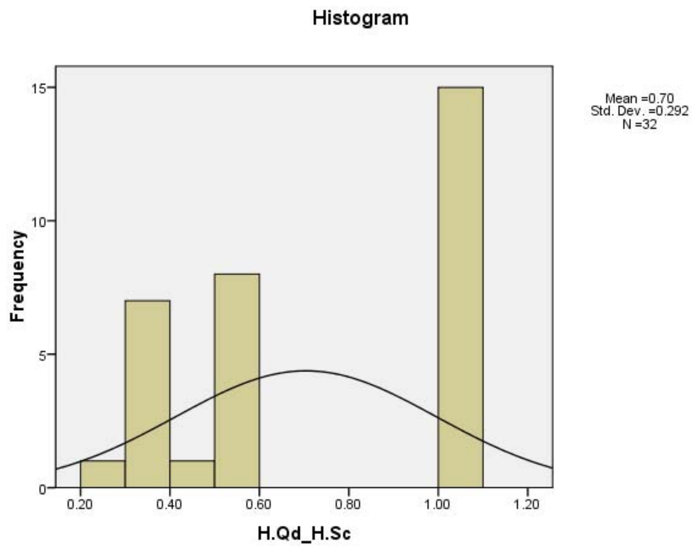


FIGURE 402: Histogram of the height of the quarter deck to the height of the sterncastle in two-masted caravels.

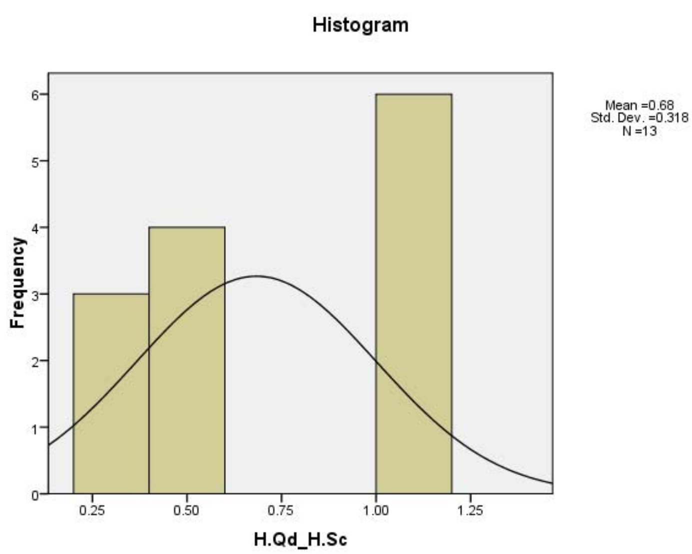


FIGURE 403: Histogram of the height of the quarter deck to the height of the sterncastle in three-masted caravels.

primary mode is from 0.40 to 0.50. The main distribution in the histogram graph (Figure 401) is from 0.40 to 0.70 and there is an outlier 0.25 (MA13.16).

The one standard deviation of the height of the poop deck to the height of the sterncastle is relatively concise and consistent between the two samples. Likewise, the modal ranges of 0.45 to 0.50 for the two-masted caravels and 0.40 to 0.50 for the three-masted caravels correspond exactly to the averages from the four-masted caravels, the galleons, and the naus. Throughout the samples, the height of the poop deck accounts for roughly 40% to 50% of the height of the sterncastle with minor variations depending on the ship type.

Height of the Quarter Deck to the Height of the Sterncastle: (H.Qd_H.Sc)

The one standard deviation for height of the quarter deck to the height of the sterncastle ratio for the two-masted caravels is 0.41 to 1.00. The main distribution in the histogram graph shown in Figure 402 is from 0.20 to 0.60 and the primary mode is 1.00. The three-masted caravels have a one standard deviation of 0.05 to 0.10 and main distribution from 0.25 to 0.55 and a primary mode in the histogram graph (Figure 403) of 1.00.

The height of the quarter deck to the length of the sterncastle ratio, much like the corresponding length ratio, actually represents to the two different groupings of ships: those with two decks in the sterncastle and those with only one deck. The broad one standard deviations and center of distribution reflect this split distribution and are therefore not reliable indicators of normal variance within the sample. Within the two-masted caravel sample, 15 vessels have only a quarter deck with a ratio of 1.00 while the main distribution is comprised of the remaining 17 vessels, which have a primary mode of 0.50 to 0.60 and a secondary mode from 0.30 to 0.40. Likewise, the three-masted caravel sample has seven vessels with two decks in the sterncastle making up the main distribution in the histogram graph, which has a primary mode of 0.40 to 0.60 and a secondary mode of 0.20 to 0.40. The remaining six vessels have a single quarter deck with a ratio of 1.00. Given the small nature of the samples, the primary mode is a more reliable indicator of a normal range of variance within the samples. The modal ranges demonstrate that the height of the quarter deck accounts for 50% to 60% and 40% to 60% of the height of the sterncastle for the two- and three-masted caravels respectively. These results correlate well with the height of the poop deck for the two- and three-masted caravels modal ranges of 40% to 50% indicating that the sterncastle was divided fairly equally between the two decks. Furthermore, the height of the quarter deck is consistent with the results of the four-masted caravels, the galleons, and the naus all of which had an average of 40% to 50% of the height of the sterncastle.

Height of the Sterncastle to the Length of the Sterncastle: (H.Sc_L.Sc)

The height of the sterncastle to the length of the sterncastle ratio for the two-masted caravel sample has a one standard deviation from 0.27 to 0.56, which is consistent with the histogram graph (Figure 404) showing a main distribution of 0.20 to 0.68 and an outlier at 0.76 (PA03.01) and another at 0.90 (CA01.02). The primary mode for this distribution is from 0.27 to 0.35 and the secondary mode is from 0.40 to 0.47.

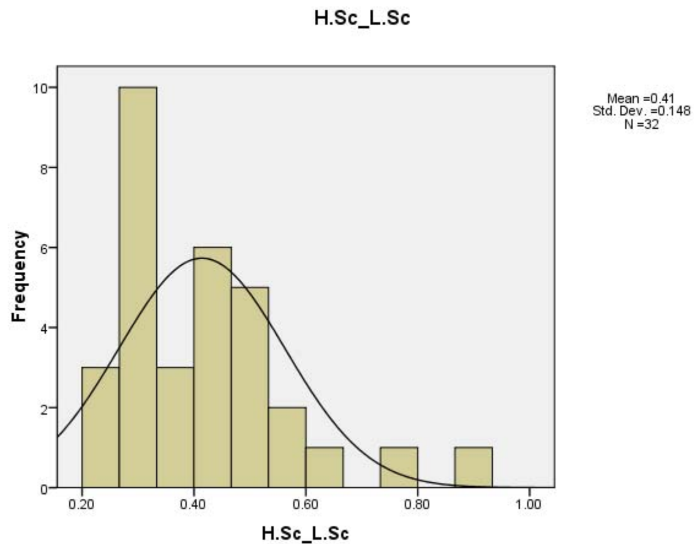


FIGURE 404: Histogram of the height of the sterncastle to the length of the sterncastle in two-masted caravels.

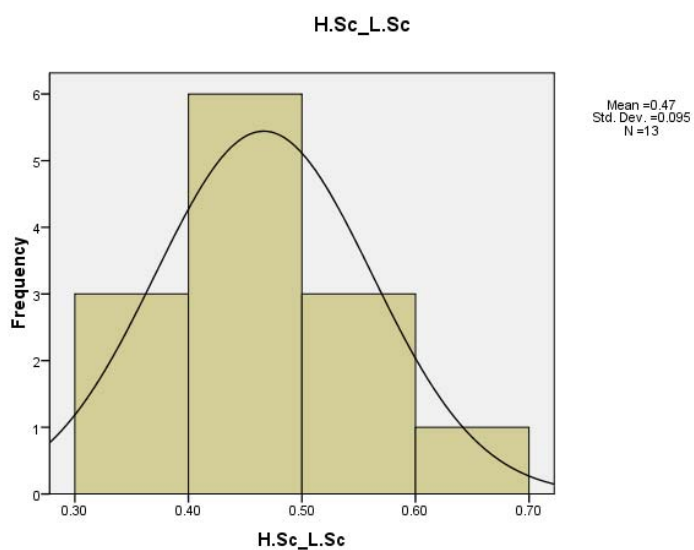


FIGURE 405: Histogram of the height of the sterncastle to the length of the sterncastle in three-masted caravels.

The three-masted caravels have a one-standard deviation of 0.37 to 0.56 and a main distribution of 0.30 to 0.70 in the histogram graph (Figure 405) and a primary mode from 0.40 to 0.50.

The one standard deviation of the height of the sterncastle to the length of the sterncastle ratio is relatively uniform between the two samples but shows that the two-masted caravels have a broader range of 0.27 to 0.56 than the three-masted caravels with a range of 0.37 to 0.56. The two-masted caravels also have a wider modal range from 0.27 to 0.47, while the three-masted caravels have a concise range from 0.40 to 0.50. The secondary mode for the two-masted caravels of 0.40 to 0.47 is almost identical to the three- masted caravels; however, the primary mode suggests that some of the vessels in the sample had relatively low and long sterncastles. The same ratio for the four-masted caravel sample had a higher modal range of 0.50 to 0.70 while the naus were similar to the three-masted caravels with a range of 0.45 to 0.50. The mode of the galleon sample of 0.20 to 0.30 was similar to the lower end of the two-masted caravel modal range of 0.27 to 0.35. Overall, the four-masted caravels have the tallest sterncastles that are 50% to 70% of the length while some of the two-masted caravels as well as the three-masted caravels and naus have an average height that is 40% to 50% of the length. While the remaining two-masted caravels and galleons have the lowest sterncastles that are roughly 20% to 30% of the length.

Length of Waist to the Length of the Hull: (L.Wa_L.H)

The length of the waist to the length of the hull ratio for the two-masted caravel sample has a one standard deviation from 0.41 to 0.63 and main distribution from 0.45 to 0.65 with outliers at 0.15 to 0.20 (MA10.06 and MA11.04) and 0.30 to 0.35 (MA03.05). The primary mode in the histogram graph (Figure 406) is from 0.50 to 0.55 and the secondary mode is from 0.55 to 0.60. The three-masted caravel sample has a one standard deviation of 0.33 to 0.70 and a main distribution of 0.20 to 0.90 in the histogram graph (Figure 407) with a primary mode from 0.30 to 0.40 and a secondary mode from 0.50 to 0.60.

The one standard deviation of the length of the waist to the length of the hull ratio is broader for the three-masted caravel sample which is further emphasized by the center of distribution figures. Although the modal ranges narrow, the ranges the three-masted caravels have a dispersed primary and secondary mode from 0.30 to 0.40 and 0.50 to 0.60 respectively. The two-masted caravels have a concise modal range of 0.50 to 0.60 that is identical to the secondary range of the three-masted caravels. The modes of 50% and 60% correspond perfectly to the length of the sterncastle ratio modes of 40% to 50% for the two- and three-masted caravels. The three-masted caravels with waists that are only 30% to 40% of the hull are most likely outliers that are emphasized because of the small sample size.

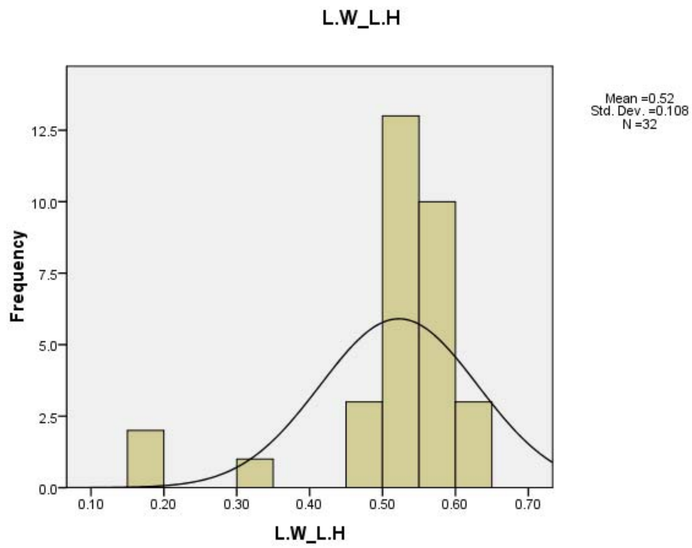


FIGURE 406: Histogram of the length of waist to the length of the hull in two-masted caravels.

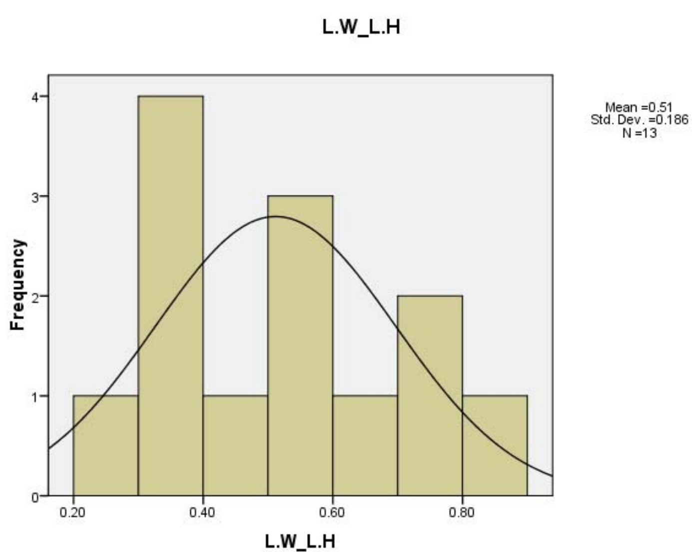


FIGURE 407: Histogram of the length of waist to the length of the hull in three-masted caravels.

Overall, the hulls of the two- and three-masted caravels were divided nearly equally between the sterncastle and the waist, which is logical given these ships had long sterncastles that ran nearly to the main mast. Whereas, the modal ranges of the vessels with forecastles, four-masted caravels, galleons, and naus, demonstrate that the length of the sterncastles is about 40% to 45% of the length of the hull, while the length of the forecastle is about 25% and the length of the waist is from 25% to 33% of the length of the hull. Regarding the height of the forecastle, the naus were found to have much more pronounced forecastles which were only slightly shorter than the sterncastle and in some cases actually exceeded the sterncastle's height. Galleons had the shortest forecastles while caravels had slightly taller castles in relation to their length. The heights and lengths of the forecastle, waist, and sterncastle were surprisingly consistent between the ship types and resulting proportions correlated almost perfectly to one another and as a group. This proved the existence of the reliable proportions throughout the iconography that can greatly assist in the reconstruction of vessels.

CHAPTER XIII

CONCLUSION

13.1 REVIEW OF RESEARCH QUESTIONS AND HYPOTHESES

The primary research question and hypotheses were posed to determine whether or not iconographic sources could provide enough data to identify construction characteristics and temporal evolution for the *caravela latina*, *caravela redonda*, *caravela de armada*, as well as the galleon and the nau. Additionally, due to the lack of theoretical and methodological considerations regarding the use of iconography as a source of data, the secondary research question and hypotheses were posed to test whether or not it is possible to determine the accuracy of caravel and nau depictions.

Research Question 1: Can iconography provide information on construction characteristics of each of the three caravel types and the galleon and nau that will determine typology, evolution, and design changes?

Due to the lack of archaeological and historical evidence, the construction details of the caravel, galleon, and nau are poorly understood, thus other sources of data are needed. This question was based on one such source, the iconographic record. A list of construction elements was determined through the representational trends analysis of the iconography. These elements were then statistically analyzed to establish the proportional relationships between each of the characteristics for the three types of caravels, the galleons, and the naus.

Hypothesis 1A: The iconography indicates different construction and rigging characteristics for each of the three caravels as well as the galleon and the nau.

The representational trends analysis of the vessel rigging configurations confirmed that there are typological differences in the rigs of the caravels, the galleons, and the naus. Furthermore, the iconography provided a more precise timeline for the introduction and primary use of the caravel, galleon, and nau rig types that follow the traditional century of the caravel (1430's to the 1530's), the intermediary preference for larger ships (1530's to the 1570's), and the resurgence of caravel use in the 1570's when smaller ships once again became popular. Based on the analysis of the rigging alone, it became evident that the one-masted caravels were the *caravela pescarezas* and the three-masted caravels were the *caravela latinas*. It was not possible, however, to distinguish between the two-masted *caravela latinas* and potential *caravela pescarezas* or *caravelões*; as well as between the *caravela redonda* and the *caravela da armada* without viewing the presence or absence of castles, the shape of the stem, and the proportions of construction features. Likewise, it was discovered that the galleons and naus both have three-masted and four-masted variants with parallel construction characteristics.

The statistical analysis of the vessels was accomplished using a basic distribution analysis which determined the normal range of variation for the relationship between two features. As evident from the statistical testing, it was not possible to concretely determine the relative size of a ship, which can only be inferred through the number of masts and a direct comparison to other vessels depicted within the vicinity of the ship in question. The study was quite successful, however, in evaluating the proportional sizes of various features. The distribution analysis of the ratios comparing two features clearly exhibited the differences and similarities between the caravel, the galleon, and the nau as ship types, including their individual subtypes.

The first hypothesis, that there are different construction and rigging characteristics for each of the three caravels as well as the galleon and the nau, was proven valid. The only exception was the clause regarding the relative size of hulls, for which calculations were unattainable without beam measurements.

Hypothesis 1B: The construction characteristics of the three types of caravels will be proportionally more similar to the contemporary galleon than the nau.

The four-masted caravels, the *caravela redonda* and the *caravela da armada*, were compared to the four-masted galleons in an attempt to determine proportional similarities in the construction features of these vessels. This test was not successful due to the fact that it is not yet possible to distinguish between the *caravela redonda* and the *caravela da armada* in the iconography; there was not a statistically significant relationship between these two subtypes. As stated previously, the methods used in this study were not able to calculate the size of the vessel. As the beam of the ship is rarely visible in a profile view, neither the length to beam ratio nor the tonnage could be determined. Additionally, in the representational trends analysis of armament it was discovered that very few galleons in general and even fewer caravels in particular were depicted with cannon or gun decks. Collectively, the question regarding the true distinction between the typological differences of the *caravela redonda* and the *caravela da armada* as well as their proportional relationship to the galleon remains unanswered.

However, it can be concluded that the conditions under which this hypothesis would be rejected do not fully apply to this study as it was found that: 1) In the representational trends analysis, there were no real differences in the presence and absence of important construction characteristics of the two caravel subtypes and the galleon; 2) There was a proportional relationship between the two caravel subtypes and some of the galleons; 3) Statistics and representational trends analyses alone cannot fully determine the relationship between galleons, caravels, and naus. Unfortunately, our understanding of the taxonomy and the construction features behind the galleon ship type is far too limited to produce meaningful results from the iconography alone. To answer this question more archaeological and archival evidence is needed to corroborate and comprehend the iconographic evidence produced by the dissertation.

Hypothesis 1C: The iconography indicates a temporal evolution for each of the three caravels types as well as the galleon and the nau.

The degree to which these ship types evolved over the course of their use is implicit in terms of the differentiation of the *caravela latina*, *caravela redonda*, and the *caravela da armada* as well as the galleon and the nau. The analysis of the typology of the caravel, galleon, and nau as a ship type was a necessary precursor to understanding potential temporal construction and rigging changes. This typology was produced by using both the terminology and short descriptions provided within archival documents as well as the iconographic evidence. In this typology, the first caravel rig type represented the small *caravela pescarezas*, while the second and third rig types were the traditional classification of *caravela latinas* and the fourth was the *caravela redondas* and *caravela de armadas.* The first rig type was the one-masted, lateen-rigged caravel which was dated from 1509 to 1572 indicating that this small vessel was retained throughout the 16th century (this was verified by the archival record).

The second rig type consisted of two-masted caravels with lateen-rigged mizzen and main masts and a type used by the first caravels adapted for the purpose of exploration. Two-masted caravels were represented by eleven images with a date range of 1500-1598; however, nine dated before 1535, most of them to the second and third decades of the 16th century. The other two were from the last three decades of the 16th century, with a gap in the representation between 1535 and 1572. It was concluded that these results could be explained by the ending of the century of the caravel (1430's to the 1530's) and the resurgence of caravel use in the 1570's when smaller ships once again became popular (Elbl and Rahn Phillips, 1994: 96). The third caravel rig type was found to be the three-masted vessels with a lateen-rigged bonaventure, mizzen, and main mast. The three-masted caravels had a date range of 1500-1588. The dispersion of images throughout this period corroborated the pattern noted for the two-masted caravels: five of the seven sources were dated before 1540 and two were from 1572-88. It was decided that this reflected the archival record of the known use, discard, and re-use of the smaller caravels.

The fourth type was comprised of four-masted caravels with lateen bonaventure, mizzen, and main masts and a square fore and fore topmast. The date range of this fourth type was from 1485-1593; there are 18 different images, 16 of which date after 1538 and the other two from the late 15th century to the early 16th century. After examining the dates of the later sources, it was discovered that there were eight vessels from 1538-1566. This date range suggests that these larger mixed-rig caravels were primarily utilized during period of larger ship types, before the preference for smaller ships re-appeared. However, it was established that these ships did not entirely disappear and were used throughout the 16th century.

There were 34 galleons in the representational trends dataset ranging in date from 1500 to 1616. These were separated into two basic groupings based on rig types found in the iconography, with variations in the combination of sail types. The first rig type was the three-masted galleon with a lateen mizzen and square main and fore lower masts and topmasts. Three-masted galleons appear in 1509 and are consistent in the images to the end of the 16th century. The presence of a mizzen topmast is rare, for it is present on only two galleons. The second rig type was the four-masted galleon with a lateen bonaventure and mizzen and a square-rigged main and fore mast and topmasts. This standard four-masted rig is seen in the iconography, first in an image dated to the first quarter of the 16th century and continuing throughout the century.

The remaining four-masted galleons have more complex rigs with the varying presence of main and fore topgallants as well as bonaventure and mizzen topmasts. Topgallant masts are only present on six galleons, three of which have only a main topgallant and the other three have both main and fore topgallants. The first use of topgallants on galleons dates to 1538, although this mast seems to be common for the remainder of the 16th century. Likewise, lateen-rigged mizzen topmasts were present on three galleons with a date range from 1538 to 1558 that coincided with the intermediary period of preferred large vessels. The bonaventure topmast was only found on one galleon image dating from 1538-1540, which represented the most complex rig of the entire dataset complete since it also had a mizzen topmast and both the main and fore topgallant masts. In general it appears that smaller four-masted galleons were used in the beginning of the 16th century with minimal use of top and topgallant masts. Starting in the third and fourth decades, however, the larger typical rigging configuration dominated through the end of the century.

There were 292 naus in the representational trends dataset ranging in date from 1485 to the end of the 16th century. Like the galleons, these were separated into two basic groupings based on rig types and variants within the combination of sail types. The first type was the three-masted naus, which had the typical ship rig with a lateen mizzen and square main and fore mast and topmasts. The date range of the images, from 1485 to 1600, showed it was consistently used throughout the period of study. There were two naus shown without main and fore topmasts and 16 naus without a fore topmast. It was concluded that vessels with a rigged main topmast were common throughout the first half of the century and that the unrigged main topmast mast was an early variant that was abandoned for the advantages of having a main topsail. The fore topmast appeared to have a similar start as it is unrigged on four nau images dating from 1517 to 1579.

Topgallant main and fore masts were present on one nau from 1525, while three other naus dating from 1535 to 1570 had only the main topgallant mast. Additionally, there were two naus that had both the main and fore topgallants but also a mizzen topmast, which was lateen rigged on a nau from 1535-70. Topgallant masts were present on six galleons, three of which had only a main topgallant and the other three had both main and fore topgallants. The first use of topgallants on naus (1525) predated the galleons by a decade and although they were seen throughout the 16th century on both ship types, it was not a common rigging configuration. It is important to note that it was previously believed that topgallants were introduced in the 17th century (i.e. Elbl and Rahn Phillips, 1994: 114), which will be discussed later in the conclusion.

The three-masted ship rig was consistently used throughout the 16th century. The other three-masted variants with simpler rig configurations date to the first four decades of that century, with more complex rigs dating to the last three decades, and an intermediary period in the middle decades where the only major change was the addition of topgallant masts.

Four-masted naus (1519-1568), having lateen bonaventure and mizzen masts and square main and fore masts and topmasts were split between the 1510-20's and the 1550-60's. This suggests that the nau rig was experimented with prior to the 1530 to 1570 intermediary period when larger ships prevailed. The three-masted naus and both the three- and four-masted galleons did not follow this pattern of preference; hence, it was posited that the versatility of the ship rig could accommodate a very wide range of tonnage and vessel types. Likewise, there was relatively little variance in the rigging configurations of naus.

Iconography provided a more precise timeline for the introduction and use of different caravel, galleon, and nau rig types. It is evident from the typologies created in this dissertation that this hypothesis is generally valid as rigging did become larger and more complex during the 16th century. Nonetheless, the research also proved that the temporal progression was not a linear function where one rig completely replaced another. Rather, the size and complexity of the vessels followed the historically documented preference for smaller and then larger ships as the exploratory voyages turned into trading expeditions. The conditions under which this hypothesis would be rejected do not fully apply as: 1) Although it is not quantifiable, there was a noticeable difference in the relative size of the hull and the complexity of rigging; 2) There were significant differences in the types and complexity of the rigging within the caravel, galleon, and nau samples; 3) There was no linear evolution of caravels in the iconography but depictions of subtypes correlate to the historical documentation of their use.

Research Question 2: Are the ships represented in the iconography accurate enough to be of use to the researcher?

Before using representational trends in the iconography as research tools it was necessary to first determine which images were accurate portrayals of the caravel, galleon, and nau and which might have been distorted by artistic license. In the preliminary examination of the iconography inaccurate images were easily identified due to distortions caused by the medium (e.g. sculpture) in which it was depicted or overly stylized representation; however, the majority of the images needed further scrutiny to determine accuracy. Due to the lack of theoretical and methodological considerations regarding the use of iconography as a source of data, two hypotheses tested whether or not it was possible to determine the accuracy of the depicted caravels, galleons, and naus. The third hypothesis tested whether or not multiple vessels depicted within one source of iconography were stock images and is important in determining the accuracy of the iconography as it related to the use of representational trends.

Hypothesis 2A: The accuracy of some of the depicted caravels or naus can be determined using art-historical background research on the artist.

The quality of the iconography could only be established through evidentiary lines of reasoning which determined if a ship is represented in a logical and realistic manner. The first question that needed to be addressed, however, was whether or not Portuguese artists of this era had enough familiarity with ships to depict them accurately. For artists living in Lisbon or along the extensive Portuguese coast, ships like these were a common sight. The caravel, galleon, and nau were well-known not only due to the importance of the voyages of discovery, but also because of the long established maritime commerce of Portugal. At that time, ships were the most advanced form of transportation technology and the unlikely artist who had never been on or seen a ship would merely have to go down to the Tagus River at Lisbon and see numerous vessels at anchor. Thus, it was a logical assumption that, within reason, artists could fairly accurately depict these ships much as an artist today can depict a modern ship or an airplane. These artists may not have actually understood the construction details or even how the ship worked, just as most people do not really understand the thorough workings of an airplane; however, this should not have prevented a skilled artist from creating an accurate artistic representation of one.

In an ideal situation when the artist is known, conducting art-historical research and answering the primary question about artist’s credentials and background would lead to enough information to establish the quality of the iconography. The historic records would contain a sufficient amount of details to recognize if it was a single artist or a group working within a workshop. We would be able to fully recognize if the artist was acknowledged as a person who researched their subjects and was true to the nature of the object or prone to stylized or romanticized representations. In reality, however, there is little information available about Portuguese artists and most of the iconography cannot be accredited to any individual.

Ascertaining the quality of the iconography by analyzing the representation of the ship as well as the represented details is a far more manageable task; it was also one that was difficult to quantify numerically. Examining the significance of the ship within the artwork was fundamental to this approach. When ships were the principal subject, there was repeatedly a high level of accuracy and detail. However, this seldom occurs in Portuguese iconography during this time period of predominant religious themes. Likewise, the placement of the ship in the foreground often suggested a more reliable source of details whereas those in the background were subjected to more scrutiny. This argument is based on the simple fact that ships depicted in the foreground tended to be larger with more visible details, while those in the background were, by nature, smaller with more obscured details. The discrepancy in the level of detail between the ships that were placed in the foreground and those in the background of the same painting was significant. The ships depicted in a larger scale provided a wealth of information including small details such as people or pikes in the crowsnest readied for battle, rudder chains on the stern panel, clearly painted heraldic shields, or intricate rigging elements. In contrast, the ships shown in the background often only had the most characteristic elements of a vessel such as masts and sails but lack rigging or castle details and had no defined decks.

Another useful guideline was analyzing the complexity of the representation and the style in which it was portrayed. Complex representations of ships depicted with numerous construction and rigging components were considered far more dependable source of information than a vessel that was portrayed with just enough details to be identifiable as a certain ship type. Additionally, there was the need to identify those images that were subjected to artistic license. The determination of inaccuracies introduced by the artist was difficult because the Portuguese had a relatively insignificant artistic tradition and their ship building and outfitting tradition is poorly understood. As stated previously, the artist, even a talented one, was not a shipwright. Although many artists did represent ships with surprising complexity, attention to details, and in a seemingly accurate manner, some artists relied more on imagination than reality.

Images that were either constricted by the medium in which they were depicted, overly stylized, or a clear product of artistic license were easily recognizable. Other iconography, however, straddled the line between a plausible depiction of a particular type of vessel and one that was merely a generic representation of a ship. When there was only limited information available about the artist and the image, it became necessary to look at the details of the ship. Although maritime archaeologists and historians may not fully understand the nuances of artistic techniques or be able to attribute a work of art to a particular artist, those who study the construction and sailing properties of sailing vessels are trained to notice unfounded details and illogical arrangements or proportions. Furthermore, statistical analysis has proven useful for recognizing vessels which fall outside the normal range of variation and are sorted as clear outliers within the scatter plot graphs.

The first and second conditions under which this hypothesis would be rejected, do apply to this research: 1a) There was not enough documented information on the artist to determine their credentials; 1b) It was not possible to determine if there were poor or overly stylized depictions by artists with strong credentials. These conditions were important for determining the quality of representations using art historical research; unfortunately, most Portuguese artists do not show up in the historic record. It is for this reason that the quality of the iconography can only be determined through observed representational and statistical trends in the iconography. The remaining conditions, under which this hypothesis would be rejected, however, do not apply to this research: 2) In general, poorly depicted or overly stylized ships were not the predominant subject; 3) There was a significant number of ships in the background that were accurately portrayed.

Hypothesis 2B: The accuracy of the depicted caravel or nau can be deduced by determining the technical accuracy of secondary ships in the iconography.

It was originally believed that another means of ascertaining quality, in the absence of solid historical information on the artist and shipbuilding tradition, was to examine auxiliary vessels. It was found, however, that there are actually very few auxiliary ships in this dataset. Caravels, galleons, and naus were sometimes depicted alongside galleys about which we have a modest amount of archival, pictorial, and archaeological evidence. The iconographic representations of these auxiliary vessels have to be separately analyzed and compared to the historic and archaeological record on their own before being used as a reliable gauge of accuracy. This process is not only time consuming and difficult, but also an impractical solution in most of the instances. Collectively, this hypothesis was rejected under the following conditions: 1a) There were too few auxiliary ships in the iconographic dataset used for this dissertation; 1b) The historical or archaeological information for the secondary ships has not been correlated to the iconographic representation of these vessels.

Hypothesis 2C: The use of stock images in the representation of the caravel, galleon, or nau can be determined statistically by examining proportionality.

Identifying stock imagery in the iconography is a complicated task due to the fact that it involves very specific statistical testing of individual ships that were suspected of being copied. Furthermore, it is assumed that although some ships may be copied based on visual evidence of similarity, there will always be differences. The proportions of certain construction features on questionable ship representations can be compared to one another using the statistical methodology outlined in this dissertation; however, it is an in-depth analysis that would prove to be a lengthy process outside the scope of this dissertation. Likewise, evaluating all the vessel features using the representational trends analysis provided a more systematic visual inspection of the ships in question. Detecting these ships in the broader testing of the iconography was more problematic as there is a natural range of variation and there was a general level of proportional similarity between most vessels. In the analysis of the entire iconographic sample, however, there were evident trends of similarity between certain ships that were consistently sorted as outliers in the statistical testing. Caution should be exercised in this example, however, as this was not conclusive proof of stock imagery. Rather, it was more likely indicative of a very broadly defined use of stock imagery that is more accurately characterized as an artistic styling.

The naus in two particular manuscripts, the *Livro de Lisuarte de Abreu* (MA15) and the *Memória das Armadas* (MA16), seem the most likely suspects for the use of stock imagery. Although there was a striking similarity between each vessel that easily identified them as the work of the same artist, the vessels are not identical to one another. This can be easily proven using statistical analysis of the proportions of certain features, which are very similar but not exactly the same. However, few indicators of temporal changes could be expected from a manuscript depicting the yearly fleets of vessels throughout the 16th century.

This hypothesis was not rejected because of the following conditions: 1a) The depicted vessels did show a statistically significant range of proportionality and can be visually discerned as different vessels based on presence or absence of construction features; 1b) In the instance of the two manuscripts mentioned previously, there was a noticeable difference in the ranges of proportionality of ships shown by the same artist than those from several different artists. It became clear from the iconography that artists were not portraying individual ships; rather, they were creating a number of vessels based on their approximations of how the ships should appear. The overly critical view that artists merely copied from each other can most likely be supported in some isolated instances and if researchers develop the ability to identify these examples our knowledge will greatly expand. It is a far stretch of the imagination, however, to believe that all artists over the century practiced stock imagery when these ships were so accessible to the general public and part of the daily life of Portugal. It is perhaps better to evaluate whether or not the existence of a few examples of stock imagery invalidates the analysis of the iconography as a whole. The benefit of such a large sample is that outliers were easily recognized and a range of variation was established. In any case, the impact of a few examples of stock imagery was so minimal that it should not be of concern for the dataset as a whole.

13.2 REVIEW OF THEORY FOR NAUTICAL ARCHAEOLOGICAL RESEARCH

The concept of the ship as a symbol was analyzed in this dissertation as part of a growing discussion within the field of nautical archaeology. In maritime studies, the symbolic interpretation of ships is often separated from the practical affairs of seafaring effectively creating a divide between two aspects that essentially have a symbiotic relationship. The symbolism of ships is seen as either a product of ritual behavior or socio-economics when, in fact, both are correlated. Ritualistic behavior and subsequent specialized beliefs are only present because seafaring was central to daily life. Likewise, the strong symbolic values that developed out of the ship's socio-economic position can be defined as specialized beliefs. Consequently, the one does not exist without the other. If ships were not vital to the daily life of seafaring societies, there would have been no need to construct symbolic meaning around them.

Zbigniew Kobyliński (1995:11) contends that symbols are culturally created and maintained, hence archaeologist are often faced with the challenge of determining if a material object had symbolic meaning to the past culture. Two mechanisms for determining the meaning of techno-utilitarian artefacts, a category which includes ships: "the moving of things in space and time", and "the distortion of the pragmatics of an artefact" (Kobyliński, 1995: 11). Kobyliński suggests that based on this rationale, if the presence of ships or boats but also the pictorial representation of them differs from its recognized techno-utilitarian function as a means of transportation, these ships had symbolic meaning.

It is difficult to apply this concept to the art of early modern Europe because of the complex media in which ships were depicted such as manuscript illuminations, engravings within printed books, maps, paintings, sculptures, and metal works. Furthermore, ships are often portrayed in their utilitarian function either under sail or at anchor. Maps and charts have an inherent technical function; however, many of those containing images of ships were designed for royal or other wealthy patrons and were never used on board ships. Likewise, the occurrence of ships in illuminations, engravings, and paintings also corresponds to traditional functions, but they are typically not the main subject and instead have an illustrative or symbolic role within the composition. Their presence within what can be considered high culture or the fine arts automatically places them outside a utilitarian role.

The ship has been a powerful symbol in European art from ancient seafaring in the Mediterranean region through to the modern world (Villain-Gandossi, 1979: 169). At the start of the post-medieval era the growing positive view of the sea was further reinforced by the rise of mercantile seafaring empires throughout Europe (Flatman, 2004: 1281). Ships themselves were known to be signs of not only economic success, but military strength as it is reasonable that this symbolism would extend into their representation in art.

This dissertation also examined the inherent problem associated with using iconographic evidence of nautical technology to bridge the gap between art and archaeological science. Problems with technical accuracy are evident for in the Middle Ages, artists generally had little knowledge of perspective and regardless of their artistic medium few worked in traditions concerned with realism (Friel, 1995: 18). However, starting in the 15^{th}- and 16^{th}-century maritime art, ship depictions show greater attention to details. Moreover, the understanding of perspective became more developed starting in the 15^{th} century, although according to Ian Friel, “these too are not without their contentious aspects” (Friel, 1995: 18). The natural limitation of the art form on which the ship is depicted also had an effect on the accuracy of proportions and perspective (Villain-Gandossi, 1979: 172-174).

Another problem related to the use iconography is that of schematism and stylization of an object, which is a means of simplifying forms by only expressing their most characteristic elements (Villain-Gandossi, 1979: 174). Problems of proportionality and distortion, however, are more apparent to a scholar of nautical archaeology than to one of art history. Stylization is more often caused by the artist's intentional or unintentional error; the artist was more concerned with completeness, clarity, or elegance of design than factual precision (Humphreys, 1978:79).

Friel (1995:19) suggests that the solution to dealing with these associated problems is to not rely on one pictorial source or type, but to examine representational trends or the repeated occurrence of construction features in the images. Ellmers and Hagedron also note that it is necessary to use 'the greatest possible number of different depictions of the same ship-type' regardless of the precision or revelatory nature of any given source (Ellmers, 1972: 13; Hagedron, 1914: 13).

Problems of interpretation and validity have limited the use of iconography as a source of data within nautical archaeology. The analysis of iconographic images requires a shrewd application of judgment as well as the realization that there is innate accuracy in most images. It also necessitates the creation of a tenable methodology for establishing the inherent limitations of iconography as a source of data. The first method used in this dissertation, representational trends analysis, is based directly on the theoretical suggestions of Friel and Ellmers and Hagedron. Whereas, the second method, descriptive statistical analysis, is the result of trying to answer the vital question of how one determines a valid image from one that has been stylized.

13.3 REVIEW OF METHODOLOGY FOR NAUTICAL ARCHAEOLOGICAL RESEARCH

The two methodological approaches used in this dissertation were intended as a broad analysis of the iconography in order to generate as much new data as possible. It was posited that the evolution and typology of construction characteristics could be better understood by determining representational trends in the iconography and by using basic statistical distribution analysis of the data. The two methodological approaches, representational trends analysis and descriptive statistical analysis, used in this dissertation can effortlessly be applied to the study of iconographic images of any ship type or period of study in the field of Nautical Archaeology. Its primary utility is through the creation of quantifiable methods of assessing ship construction and rigging.

Representational Trends Analysis

Representation trends analysis was adopted in this dissertation based on the notion that the solution to dealing with the inherent problems of iconography is to examine the repeated occurrence of construction features in the depictions of ships. The foundation of representational trends analysis as used by Friel (1995) was expanded in this dissertation and an attempt was made to clearly define how it is used as a methodological approach. The representational trends analysis method as used in this dissertation was based on Hagedron (1914) and Ellmers (1972) both of whom argue that it is essential to use the greatest possible number of different depictions of the same ship type regardless of the accuracy or revelatory nature of any given source. As such, the decision was made to use iconography from all European sources and not just Portuguese art.

In this dissertation, the representational trends of 542 ships, chosen from a dataset of numerous works of art, a majority of which containing examples of different ship types were analyzed. Representational trends were assessed by the presence or absence of a total of 164 predetermined construction and rigging features as well as by country of origin and date when possible. The list, which is presented in Appendix 3, was primarily composed of characteristics noted in maritime or ship building literature, along with features noticed in preliminary observations while working with the iconography. It was expected that this checklist of construction features would provide a list of features encountered within the iconography, and by showing when construction changes entered into popular awareness indicate the evolution of hull features and rigs.

The representational trends analysis of rigging configurations and sail settings in Chapter V was one of the most significant and useful results of this dissertation. The typologies and evolution of caravels and galleons were not well understood and were often a confusing mix of different names for essentially the same ship. It was expected that a checklist of construction components would define features encountered within the iconography, and by showing the period when certain changes came into popular awareness would indicate the evolution of hull features and rigs. Although it was found that the construction and rigging features of the caravels, galleons, and naus were relatively static throughout the 16th century, the iconographic analysis provided a more precise timeline for the introduction and primary use of the different caravel rig types in particular, as well as for rig changes in galleons and naus in general. The representational trends analysis also revealed that there was more diversity in the rigging of the galleons and naus than was previously reported as both ship types have three- and four-masted subtypes.

Further, it was discovered through the representational trends analysis of the galleons that the earliest galleon in the iconography was incorrectly identified. According to Barata, the Portuguese galleon was mentioned in the archival records for the first time in 1521 and represented in the iconography in 1519. He also contended that the Portuguese galleon was the first square-rigged ship conceived and built exclusively for warfare (Barata, 1989: 328). Before 1550, only the tonnage of Portuguese galleons was mentioned in the archival documents and there was no technical data listed. Barata (1989: 330) maintains that the galleon design originated between the end of the 15th century and the beginning of the 16th century and from that time on the morphology of the galleons essentially did not change as ships retained their proportions, dimensions, and methods of construction for very long periods of time. In contrast to Barata's first claim, the date of the first three-masted galleon image (MA03.09) is from 1509 and the earliest four-masted galleon images date from 1500-1525 (MA06.02), 1502 (MA02.01), and 1509 (MA03.08). Barata's second assertion that the design of the galleon began around the turn of the 16th century, however, correlates well to the iconographic evidence of this dissertation.

Additionally, the introduction of topgallant masts has been refined through the representational trends analysis of the rigging configurations in Chapter V. It was previously believed that topgallants were not introduced until the 17th century (Elbl and Rahn Phillips, 1994: 114); however, this study proved that the main and fore topgallant masts were represented on four-masted galleons as early as 1538-1540 (MA13.04 and MA13.09) and 1558 (CA15.04). Main and fore topgallants masts dated even earlier in nau images, to 1525 (EN01.01) and 1535-1570 (MA12.06). Another important result in this chapter was determining the sail and yard settings of caravels, galleons, and naus, descriptions of which are completely absent from the literature. This information is vital to understanding the working of ships and goes beyond the data provided by a reconstructed shipwreck. Knowing the sail and yard settings provided a greater understanding of not only how the ships sailed, but also how they were operated; which, in turn, illustrated their favorable sailing qualities or potential deficiencies.

The overall analysis of the standing and running rigging in Chapter VI indicated remarkable consistency considering the fact that the iconography was produced by numerous artists, most or all of whom, we can assume were not shipwrights, and over the course of a century. With the exception of the mizzen stays, the research provided no major revelations as to the temporal development of the rigging throughout the 16th century. This was expected, however, as these ships belong to a transitional period of maritime technology dating from the 15th to the 18th centuries (Bradley, 2007a: IV-23). Rigging, and to some extent hull design, were largely fixed by the 16th century and remained relatively static through the 18th century. Regardless, the analysis of the iconography provided more insight into the nuances of the standing and running rigging. The exact placement of the backstays and sheets on the boomkin was better understood as was the running of the sheets from this point forward. The number and placement of the shrouds at first seemed highly variable. However, the averages reflected standards within the variation for the caravels, galleons, and naus as well as between these three ship types. Furthermore, the representational trends analysis of the rigging suggested a crucial role for captains in determining the rig of a ship and the fine distinction between individual rigs.

The representational trends analysis of the hull and ship decorations in Chapter VII revealed that stern galleries appear in the iconographic record decades before previously reported. According to Barker (2003), stern galleries only occurred in dated depictions from about 1546 onwards. Although they were described in chronicles such as Correia regarding events that happened in 1510, the document itself was written in 1560. Iconographic evidence has clearly refuted these dates of origin. All three ship types predate 1546 and the naus extend the presence of stern galleries nearly half a century earlier, to the begining of the 16th century. The first stern gallery on a caravel (MA14.03) and on a galleon (MA13.01 and MA13.15) are both dated to 1538. In the case of the naus there are 15 vessels that predate 1546 with the earliest occuring at 1500 for a nau (MA07.03). The earliest representation of a quarter gallery on a galleon is 1552 (PA06.01) and 1500 on a nau (PA01.01). Although it was previously assumed that most of the vessels with quarter galleries also had stern galleries, the study could not discern this because of the varying perspectives with which the ships were depicted. It is logical to have both the stern and quarter galleries as connected structures such as is seen on the galleon depicted by Vroom (PA08.01) shown in Figure 32, as well as on the archaeological remains of the Swedish Royal warwship *Vasa*, which sank in 1628.

As described in Correia's chronicle, at the stern gallery: "the royal Ladies simply took over the whole sterncastle for several decks down" and a gallery was built in order for the seamen to get at the rudder (Barker, 2003: 15). Additionally, for this voyage a second gallery was added above the first "to provide accommodation for the numerous *fidalgos* on board" (Barker, 2003: 15). Significantly, this description of a second gallery placed above the first, has been corroborated by the iconography. There were six naus from the *Livro de Lisuarte de Abreu* (MA15), shown in Figure 33, dated to 1558-1561 and representing fleets from 1509 to 1529 with two covered stern galleries. Likewise, another nau (MA10.08), shown in Figure 30 and dated to 1517-1526, had two uncovered stern galleries. The stern galleries from the iconography have been considered as separate, because it was not possible to discern whether or not these were integrated structures with access between each gallery. It is more probable that access to each of the stern galleries was from the individual decks as opposed to stairs between the galleries.

In Chapter VII it was also discovered that Portuguese vessels of the 16th century employed very few decorative elements. Given that it was not from a lack of resources as the capital gained in this era was substantial, the presence or absence of decorative elements was related to the concept of ship specialization. In Portugal, there was little ship specialization beyond the emergence of the galleon function as a warship, which was reflected in the iconography with a higher percentage of decorative elements on this ship type as compared to the caravel and the nau. Specialization began to occur in Atlantic Europe in the 16th century because of the factors of trade, war, and power. European monarchies were on the verge of becoming absolute and modern states. Thus, ship decorations in this era reflected not only specialization, but also consolidation of royal power. The armed trading vessels of the 16th century had little to no decorative elements beyond general indicators of nationality. Although trading vessels of the 17th century attained a modest level of ornamentation, warships were notable for their lavishly decorated hulls. There is a simple correlation between warships and decoration that begun in the 16th century and continued throughout the 17th century. The level of decoration on warships was indicative of status as it was the flagship that received the highest level of complex embellishment (for example the Swedish warship *Vasa* and contemporary paintings of the English warship *Sovereign of the Seas*) (Lavery, 2003: 158-160).

As the monarchs consolidated power, they built standing royal navies; the Enlgish started in the 16th century under Henry VII and Henry VIII and the Swedish, among others, followed suit in the 17th century. Prior to this private vessels (merchantmen) were pressed into service or hired and armed for battle on an ad hoc basis. Fleets of purpose-built warships were the product of standing navies, which is not to say that kings did not have vessels associated with them before. What it does imply is that the specialization of vessels and the construction of naval ships were a reflection of the power and might of the nation and of the king himself, which is seen in the symbols contained in the decorative elements. Specialization of ship design was a necessary precursor to a standing navy, which is evident when we consider the Portuguese in the 16th century, whose vessels were not specialized and who never developed a true royal navy. Rather, their primary emphasis was on royal fleets of large armed trading vessels. The predominant symbol of this era in Portuguese history was (and remains to this day) the Cross of the Order of Christ.

Statistical Analysis

In the statistical analysis dataset for this dissertation there were 492 vessels and 148 measurements of various hull features per each ship (see Appendix 4 for a complete list). These measurements were transformed into 210 ratios for each ship (see Appendix 5). Furthermore, an attempt was made in this study to find the simplest statistical method of analyzing and interpreting the data that is accessible to all scholars with a moderate understanding of statistical methods.

It was anticipated that representational trends in the iconography as well as descriptive statistical analysis of the hull and rigging proportions would provide a more specific set of typological characteristics that could permit more informed conjecture on the lines and appearance of caravels, galleons, and naus. The logical projection of certain features to the lower portion of the hull (not depicted in the iconography) could help identify ship types in archaeological studies of structural remains.

The result of any iconographic study tends to be greatly generalized. Representational trends and statistical methodologies enable the scholar to interpret the generalities in order to make informed conjecture about the particulars. The results of this dissertation will not permit the identification of a shipwreck as a caravel, galleon, or nau because of the natural limitations of the iconography and the limitation of all depictions to what is visible above the waterline.

As illustrated in Chapter V, representational trends methodology was quite successful in establishing typological rigging and upper hull characteristics of caravels, galleons, and to a certain extent naus. Likewise, the statistical methods in Chapters VIII through XII produced an immense amount of new data about the proportional relationship between various features. The rakes and placement of the individual masts were analyzed using basic statistical distribution analysis and histogram graphs. Although there were moderate differences between the rakes of masts of the caravel and galleon rig configurations, there was actually relatively little variation within the entire dataset and the ranges are essentially a few degrees forward and aft of a vertical position for each mast. Until more information is obtained from archaeological or archival evidence, the overall averages should not only be considered indicators of mast rakes, but also valuable whenever specific ranges are needed in the reconstruction of different types of caravels and galleons. The range of rakes for naus produced by one standard deviation is consistent with the rakes mentioned in the *Livro Náutico* and by Fernandez. Based on this very limited archival evidence, it appears that the mast rake data generated from the iconography is exceptionally reliable.

It was originally thought that mast rakes would follow a general pattern in caravels, galleons, and naus (i.e., all masts on any given ship type would essentially have the similar range). Although there are no observable trends within the rakes of all the masts for each ship type, there is surprising consistency in the ranges of the individual masts among the caravels, galleons, and naus. It appears that within the Iberian shipbuilding tradition, the masts were raked according to some general standard and this essentially did not differ much between the three ship types. The one standard deviation, center of distribution, and modal range figures for the caravels, galleons, and naus are summarized in Table 76; refer to Appendix 28 for the one standard deviation, center of distribution, and modal range figures for all vessel subtypes. From the modal ranges listed in Table 77, it can be concluded that the individual mast rakes only varied by a few degrees from each other. For instance, the modal peak for the main mast is 0° to 2.5° for both caravels and galleons and 0° to 1.5° for naus. Due to the fact that average mast rakes correspond perfectly to the little that has been described in the historical record, the measurements seem to produce sound and logical ranges.

There is no documentary information on the placement of masts specifically for caravels and galleons. In spite of the modest differences in the placement of individual masts of the caravel and galleon rig configurations (see Appendix 30), there is actually relatively little variation within the entire dataset. In the reconstruction of different types of caravels and galleons the more specific ranges can be extremely useful; however, until more information is obtained from archaeological or archival evidence the overall averages can be considered sufficient indicators for the placement of masts. There is surprising consistency in the overall placement of bonaventure, main, and fore masts between the caravels, galleons, and naus; but there is significant variation in the placement of the mizzen mast between the ship types. The modal ranges demonstrated

TABLE 76: Comparison of the One Standard Deviation, Center of Distribution, and Modal Range Figures for all Vessel Types

ALL MAST RAKES			
BOOMKIN	**One Standard Deviation (68%)**	**Center of Distribution (50%)**	**Modal Range**
Caravel	5.82° to 26.10°	9° to 24°	13° to 16°
Galleon	-3.2° to 26.4°	0° to 21.8°	0° to 10°
Nau	5.3° to 30.5°	9° to 25°	10° to 15°
BOWSPRIT	**One Standard Deviation (68%)**	**Center of Distribution (50%)**	**Modal Range**
Caravel	9.12° to 38.64°	10° to 37°	10° to 15°
Galleon	15.4° to 51.9°	30.3° to 46.9°	30° to 50°
Nau	17.5° to 49.5°	18° to 47°	45° to 50°
BONAVENTURE	**One Standard Deviation (68%)**	**Center of Distribution (50%)**	**Modal Range**
Caravel	-4.68° to 4.79°	-2.4° to 1.9°	0° to 2.5°
Galleon	-1.7° to 1.7°	0° to 0°	0° to 2°
MIZZEN	**One Standard Deviation (68%)**	**Center of Distribution (50%)**	**Modal Range**
Caravel	-5.67° to 7.19°	-2.5° to 4°	0° to 2.5°
Galleon	-3.6° to 3.2 °	-2.7° to 2°	0° to 2.5°
Nau	-6.1° to 2.2°	-4° to 0°	0° to 1.5°
MAIN	**One Standard Deviation (68%)**	**Center of Distribution (50%)**	**Modal Range**
Caravel	-3.90° to 9.28°	-.95° to 5.9°	0° to 2.5°
Galleon	-4.5° to 2.4°	-4° to 1°	-3° to 0°
Nau	-6° to 2.2°	-4.3° to 0°	-3° to -1.5°
FORE	**One Standard Deviation (68%)**	**Center of Distribution (50%)**	**Modal Range**
Caravel	-5.33° to 6.88°	-2.6° to 3.7°	0° to 2.5°
Galleon	-3.9° to 3.3°	-3.1° to 2.6°	0° to 4°
Nau	-5.6° to 3.4°	-4° to 1°	0° to 1.5°

TABLE 77: Comparison of the Mast Placement One Standard Deviation, Center of Distribution, and Modal Range Figures for all Vessel Types

ALL MAST PLACEMENT			
BONAVENTURE	**One Standard Deviation (68%)**	**Center of Distribution (50%)**	**Modal Range**
Caravel	.01 to .09	.02 to .08	.00 to .025
Galleon	.01 to .06	.01 to .06	.00 to .02
MIZZEN	**One Standard Deviation (68%)**	**Center of Distribution (50%)**	**Modal Range**
Caravel	.12 to .29	.14 to .25	.175 to .20
Galleon	.07 to .22	.09 to .22	.20 to .25
Nau	.05 to .14	.07 to .11	.10 to .13
MAIN	**One Standard Deviation (68%)**	**Center of Distribution (50%)**	**Modal Range**
Caravel	.42 to .56	.44 to .52	.42 to .50
Galleon	.37 to .48	.40 to .45	.40 to .45
Nau	.39 to .49	.41 to .47	.40 to .43
FORE	**One Standard Deviation (68%)**	**Center of Distribution (50%)**	**Modal Range**
Caravel	.75 to .87	.76 to .86	.765 to .78
Galleon	.73 to .89	.75 to .88	.85 to .90
Nau	.74 to .84	.76 to .83	.77 to .80

that naus had their mizzen mast furthest aft at 10% to 13% of the length of the hull measured from the stern. Caravels (17.5% to 20%) and galleons (20% to 25%), depending on the rigging configuration, had the mizzen mast stepped further forward to accommodate the presence of the bonaventure mast. Like the mast rakes, it appeared that within the Iberian shipbuilding tradition, masts were placed according to some general standard and did not significantly differ with the exception of the mizzen mast between the caravels, galleons, and naus.

A serious limitation of using iconography is that it is necessary to utilize ratios to express proportional relationships of construction features on ships. The only value available to measure the placement of the individual masts is the overall length of the vessel on deck, which does not necessarily correspond to the lengths used by shipwrights when stepping individual masts. Referring again to the archival evidence, contemporary writers describe stepping the mast in relation to a deck and not as a percentage of the overall length of the ship. For instance, Fernandez indicates that the mizzen mast should be stepped at the level of the main deck or slightly above on the transom structure and the fore mast should be stepped forward on the forecastle near the stem at the level of the lower deck (Castro 2005b, 117). While these descriptions can be roughly equated to the percentages acquired through the statistical study of iconography, it is not possible to confirm the validity of the results. Although the dates are not listed for each ship in the mast rake and placement sections, the research did not provide any evident temporal trends, suggesting homogenous mast rakes and placement throughout the 16th century.

In Chapters IX, X, and XI the dimensions of the masts and yards were statistically analyzed and compared to the archival records when possible. The individual results of these chapters generally indicate that the iconography was often almost a perfect match to the archival documents when such evidence was available. The results of the various tests suggested the iconography was reliable, and offered practical ranges of variation for the height and widths of the masts and yard. In particular the following ratios corresponded well to the historical evidence: the heights of the mizzen mast, main mast, main topmast, fore mast, and fore topmast; and the vertical tapering of the main mast. The only written documentation of the height of the bonaventure mast was compared to the bowsprit and the mizzen mast. One of the most interesting findings, however, was that the height of the bonaventure mast in the iconography far exceeded the proportions dictated in the archival records.

It has been suspected by many scholars that the main and fore courses and topsails were greatly exaggerated in the iconography to create a more imposing vessel and to display the prominent Cross of the Order of Christ. In order to expand the sail area, it was thought that the lengths of the main and fore yards and topyards were disproportionately increased. To date, there has not been a method to quantify it or tangible data to prove it. This dissertation research proved there are some yard length ratios comparable to the archival evidence: the length of the main yard to the ship's beam; the length of the main topyard to that of the main yard; the length of the fore yard to that of the main yard; the length of the fore topyard to that of the main topyard; and the width of the fore topsail yard. From these ratios it would at first appear that the length of the main yards, fore yards, and topyards, in general, were well proportioned. There were other indications within the statistical testing that would suggest otherwise and provided evidence for the lengthening of the yards.

Although the normal range of variation for the yard ratios established through the statistical testing matched the archival documentation, the one standard deviation ranges are far broader than those found on the heights and widths of the masts. What this indicated was that there were many vessels depicted with exaggerated yard lengths in spite of the core sample of ships with proportionately correct spars. Significantly, these results not only supported the methodological importance of using a large enough sample, but also confirmed the ability of researchers to detect inconsistent proportions in the iconography. To conclude whether or not the yards and sail area was, in fact, disproportionately increased in the iconography, the proportions of the sails would need to be measured and analyzed. This method of determining exaggerated sails through longer yards was only a secondary way to approach the matter. Although the iconographic analysis did not provide overwhelming proof that the majority of ships were subjected to this artistic embellishment through the lengths of the yards, it did clearly indicate exaggeration on a good portion of vessels that can now be identified using this methodology, providing tangible data as evidence of this practice.

A clear example of this was found in the comparison of the length of the fore yard to the length of the main yard. The length of the fore yard was described in the *Livro Náutico* as being three-quarters of the length of the main yard, whereas Palacio specified the fore yard should be one-third less than the length of main yard (Bankston, 1986: 124), which would result in ratios ranging from 66% to 75%. The one standard deviation figures were relatively consistent between the samples and the four-masted caravels and the three-masted galleons had the lowest range from 30% to 80%, while the four-masted galleons and the naus were skewed higher from respectively 40% and 50% to roughly 90%. Examining the modes allowed for a more precise look at highest concentrations within the sample. The primary and secondary modes showed that the four-masted caravels with a range of 30% to 50% had the smallest fore yards out of all the samples whereas the three-masted galleons actually had the highest peak from 70% to 80% contradicting the one standard deviation data. The nau sample had a similar modal range of 60% to 70%, while the four-masted galleons had the same primary mode of 60% to 70% but a much lower secondary mode from 30% to 40%. The expected range from the *Livro Náutico* and Palacio is congruent with both the one standard deviation ranges and all modal peaks which fall around 60% to 80% except for the four-masted caravels which only reach 50%.

Additionally, in almost every instance the widths to the length of the yards as well as the tapering of the yards did not correspond to the archival evidence. For example, in the *Livro Náutico* the widths of the fore yards were determined to be 51 cm tapering to 19 cm (63%) while Fernandez gave a maximum diameter of 51 cm tapering to 22 cm (57%) (Castro, 2005a: 118). From the analysis of the modal ranges, it became apparent that there was almost no horizontal tapering on the majority of the fore yards. The four-masted caravels and four-masted galleons both had a modal peak of 90% to 100% while the three-masted galleons and naus were at 100%. The reason for this discrepancy in the tapering of the yards reported in the archival documents and the lack of tapering in the iconography is unknown; however, it is highly plausible to assume a level of artistic error. In the overall representation of the vessels, these spars were often small and it was highly probable that there was more detailed attention paid to the length of the yards than the widths and horizontal tapering.

Another important result from the iconographic analysis was that proportional relationships between well established features were strong enough to allow for the logical inference of some elements using others. An example of which comes from the calculation of the height of the main topmast to the ship's beam. According to Palacio, the main topmast should be as long as the ship's beam and half again (1.5 x beam) and the fore topmast should be one-fifth of this (Bankston, 1986: 120). Although it was not possible to directly calculate the beam in the iconography, using the *ah, dos, tres* rule it was indirectly estimated to about one-third of the length on deck. As a result, the length of the upper mast must have been one-third of this measurement and half again, or roughly 50% (3/6). On average, for all of the ship types, the height of the main topmast seems to be within 20% to 30% of the length of the hull for the galleons and 30% to 40% for the naus. The modal ranges of the galleons and the naus, however, suggested that a more accurate calculation would be somewhere between the ship's beam and one and a half times the ship's beam.

The dimensions of the forecastle, waist, and sterncastle were analyzed in Chapter XII using basic statistical distribution analysis and histogram graphs. Although there was no archival evidence available to corroborate the findings of this chapter, the average proportions of these three construction features all correlated to one another. The forecastle was found to be roughly 25% of the length of the hull with no significant differences between the ship types. The length of the forecastle was determined to be about 50% to 60% of the length of the sterncastle with slight variations between the ship types. It was interesting to note that the degree of variance between the length of the forecastle to the length of the waist suggested that there was little to no correlation between the two. The three ship types had waists of about 25% to 33% of the length of the hull, which is roughly the same size as the forecastle. Regarding the height of the forecastle, the naus were found to have much more pronounced forecastles which were only slightly shorter than the sterncastle and in some cases actually exceeded the sterncastle's height. Galleons had the shortest forecastles while caravels had slightly taller castles in relation to their length.

The respective modes demonstrated that the length of the sterncastles was about 40% to 45% of the length of the hull for all three ship types, which was consistent with the results of the length of the forecastle (about 25%) and the length of the waist (about 25% to 33%). The length of the quarter deck to the length of the sterncastle ratio corresponded almost perfectly with the length of the poop deck to the length of the sterncastle ratio. The proportional results of the analysis of ratios for the lengths of the poop deck to the length of the quarter deck were: galleons (40% to 45%), caravels (45% to 55%), naus (57% to 63%). From this comparison it appears that caravels and galleons had poop decks and quarter decks that each accounted for roughly 50% of the length of the sterncastle. Naus had the shortest poop decks which represented only up to 40% of the length of the sterncastle, while the quarter decks were 60% of the length of the sterncastle. In general, it appeared that the height of the quarter deck is roughly 40% to 50% of the height of the sterncastle; a figure consistent with the height of the poop deck. There were distinct differences in the modal ranges: caravels had the highest sterncastles (50% to 70%), the naus were somewhere in the middle (45% to 50%); and the galleons, remarkably, were the lowest with heights only 20% to 30% of the length.

The two- and three-masted caravels were analyzed separately from the other ship subtypes due to the fact that these vessels do not have forecastles. The length of the sterncastle was determined to fluctuate between 40% and 50% of the length of the vessel for both of these types. It appeared that they had sterncastle that were only minimally longer than those on galleons, naus, and four-masted caravels; which had sterncastles that, in general, were 40% to 45% of the length of the hull. The analysis indicated that the two- and three-masted caravels had waists that were 40% to 45% of the length of the hull. These results appeared to be surprising given the fact that two- and three-masted caravels did not have forecastles, but it is actually quite logical. Caravels had long sterncastles that ran nearly to the main mast, which was in a centralized location on the hull; as such, the presence of a forecastle only makes a difference in the length of the waist.

The two-masted caravels had a poop deck that was 55% to 80% of the length of the sterncastle and a quarter deck that was an additional 10% to 20%, and 40% to 50%. Likewise, the poop deck in the three-masted caravel samples was 35% and 60%, while the quarter deck was between 40% to 50%, and 60% to 70% of the length of the sterncastle. In comparison, the length of the poop deck was roughly 40% to 60% of the length of the sterncastle for four-masted caravel, galleon, and nau samples. For both caravels, the height of the poop deck accounted for roughly 40% to 50% of the height of the sterncastle with minor variations depending on the ship type, a range which corresponded exactly to the averages from the four-masted caravels, the galleons, and the naus. The height of the quarter deck was 50% to 60% of the height of the sterncastle for the two-masted caravels and 40% to 60% for the three-masted caravels. These results correlated well with the height of the poop deck for the two- and three-masted caravels with modal ranges of 40% to 50% indicating that the sterncastle was divided fairly equally between the two decks. Furthermore, the height of the quarter deck was consistent with the results of the four-masted caravels, the galleons, and the naus all of which had an average of 40% to 50% of the height of the sterncastle.

In general, the hulls of the two- and three-masted caravels were divided nearly equally between the sterncastle and the waist, whereas the modal ranges of the vessels with forecastles (such as four-masted caravels, galleons, and naus) demonstrated that the length of the sterncastles was about 40% to 45% of the length. At the same time, the length of the forecastle was about 25% and the length of the waist and ranged from 25% to 33% of the length of the hull. The heights and lengths of the forecastle, waist, and sterncastle were surprisingly consistent between the ship types and resulting proportions correlated almost perfectly to one another and as a group. This proved the existence of the reliable proportions throughout the iconography that can greatly assist in the reconstruction of vessels.

In this dissertation construction features and proportional relationships were analyzed using representational trends and statistical analyses on an individual basis. The results of the different analyses were then sorted and compared by ship type designation: caravels, galleons, and naus; including vessel sub-types. An alternative approach would have been to take all the construction and rigging features of a caravel, a galleon, and a nau and analyze each ship type individually. This would have resulted in an insular analysis and greatly limited comparisons between the types. The decision to analyze individual features and not a typological set of features was primarily due to the lack of reliable information for a typical caravel, galleon, or nau. The analysis of the features separately provided a relatively high degree of flexibility to compare the specific data produced about one ship type in relation to another.

13.4 BROADER IMPACT FOR NAUTICAL ARCHAEOLOGICAL RESEARCH

On a broader level, this dissertation proved that iconography is a viable data source within nautical archaeology. The representational trends and general construction proportions analyzed in the iconographic record did provide an ample amount of information about the different ship types to greatly assist in the reconstruction of a caravel, galleon, or nau. The vast quantities of new data generated using these methodologies have the potential to significantly advance the study of these three ship types when paired with current and future archaeological evidence. Likewise, there are many applications to the fields of maritime history and history. In particular, the representational trends analysis of ship elements beyond the hull construction can be of value to those researching ship armament or naval battles, decorative elements on ships, and even utility of sail and yard settings for the greater understanding of how ship's sailed in certain geographic areas.

This research was designed as the first step in the process and the results opened many new questions and lines of investigation. Because these methodological approaches were applied to such a large dataset of iconographic images, there was only a limited amount of interpretation possible. The description of the data in a detailed manner that could assist other scholars took precedence over in-depth analysis of the individual results. It is hoped that future applications of the representational trends and statistical analysis will not only refine the methodologies, but also find new answers to old archaeological questions of ship typology.

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APPENDIX 1

CATALOG OF ICONOGRAPHIC IMAGES

CHART/ATLAS		
CATALOG #	POSITION	SHIP TYPE
CA01	***Carta de la Juan de Cosa***	**1500**
CA01.01	STARBOARD PROFILE	CARAVEL
CA01.02	STARBOARD PROFILE	CARAVEL
CA01.03	STARBOARD PROFILE	CARAVEL
CA01.04	STARBOARD PROFILE	CARAVEL
CA01.05	STARBOARD PROFILE	CARAVEL
CA01.06	STARBOARD PROFILE	CARAVEL
CA01.07	STARBOARD PROFILE	CARAVEL
CA02	***Anonimo, Jorge Reinel***	**1510**
CA02.01	STARBOARD 3/4 PROFILE	NAU
CA02.02	PORT 3/4 PROFILE	NAU
CA02.03	PORT 3/4 PROFILE	NAU
CA02.04	STARBOARD 3/4 PROFILE	NAU
CA02.05	PORT 3/4 PROFILE	NAU
CA02.06	STARBOARD 3/4 PROFILE	NAU
CA03	***Carta Atlântica de Piri Reis***	**1513**
CA03.01	STARBOARD PROFILE	NAU
CA03.02	STARBOARD PROFILE	NAU
CA03.03	STARBOARD PROFILE	CARAVEL
CA03.04	PORT PROFILE	CARAVEL
CA03.05	STARBOARD PROFILE	NAU
CA03.06	STARBOARD PROFILE	CARAVEL
CA03.07	PORT PROFILE	NAU
CA03.08	PORT PROFILE	CARAVEL
CA04	***Lopo Homem-Reneis - Atlas Miller***	**1519**
CA04.01	STARBOARD PROFILE	NAU
CA04.02	STARBOARD PROFILE	NAU
CA04.03	PORT 3/4 PROFILE	NAU
CA04.04	STARBOARD PROFILE	NAU
CA04.05	STARBOARD 3/4 PROFILE	NAU

CA04.06	PORT PROFILE	NAU
CA04.09	STARBOARD PROFILE	CARAVEL
CA04.10	STARBOARD PROFILE	CARAVEL
CA04.11	STARBOARD PROFILE	NAU
CA04.12	STARBOARD PROFILE	CARAVEL
CA04.13	PORT PROFILE	CARAVEL
CA04.14	STARBOARD PROFILE	NAU
CA04.15	PORT PROFILE	NAU
CA04.16	PORT 3/4 PROFILE	NAU
CA04.17	STARBOARD 3/4 PROFILE	NAU
CA04.18	PORT PROFILE	NAU
CA04.19	STARBOARD 3/4 PROFILE	NAU
CA04.20	STERN	NAU
CA04.21	STARBOARD 3/4 PROFILE	NAU
CA04.22	STARBOARD PROFILE	NAU
CA04.23	STERN	NAU
CA04.24	STARBOARD PROFILE	NAU
CA04.25	PORT PROFILE	NAU
CA04.26	STARBOARD PROFILE	GALLEON
CA04.27	PORT PROFILE	GALLEON
CA04.28	PORT PROFILE	GALLEON
CA04.29	STARBOARD PROFILE	GALLEON
CA04.30	PORT PROFILE	NAU
CA04.31	STARBOARD PROFILE	CARAVEL
CA04.33	STARBOARD PROFILE	GALLEON
CA04.34	STARBOARD PROFILE	NAU
CA05	***Anonimo, Jorge Reinel***	**1519**
CA05.01	STARBOARD 3/4 PROFILE	NAU
CA05.02	STARBOARD 3/4 PROFILE	NAU
CA05.03	STARBOARD 3/4 PROFILE	CARAVEL
CA06	***Diogo Ribiero***	**1527**
CA06.01	STARBOARD PROFILE	NAU
CA06.02	PORT PROFILE	NAU
CA06.03	PORT PROFILE	NAU
CA06.04	STERN	NAU
CA06.05	PORT PROFILE	NAU

CA07	***Diogo Ribiero***	**1529**
CA07.01	PORT PROFILE	NAU
CA07.02	PORT PROFILE	NAU
CA07.03	PORT PROFILE	NAU
CA07.04	PORT PROFILE	NAU
CA07.05	STERN	NAU
CA07.06	STARBOARD PROFILE	NAU
CA07.07	PORT PROFILE	NAU
CA07.08	STERN	NAU
CA07.09	PORT PROFILE	NAU
CA08	***Anonimo, Diogo Ribiero***	**1532**
CA08.01	PORT PROFILE	NAU
CA09	***Carta Atlântica do Atlas, Luso-Francês***	**1538**
CA09.01	STARBOARD PROFILE	CARAVEL
CA09.02	STARBOARD 3/4 PROFILE	NAU
CA09.03	STERN	NAU
CA09.04	PORT 3/4 PROFILE	NAU
CA10	***Anonimo, Panoramica de Lisboa***	**1541**
CA10.02	STARBOARD PROFILE	CARAVEL
CA10.01	STARBOARD PROFILE	GALLEON
CA11	***Joao Freire, Atlas of Seven Charts***	**1546**
CA11.01	STARBOARD PROFILE	NAU
CA11.02	STARBOARD 3/4 PROFILE	NAU
CA11.03	STERN	NAU
CA12	***Mapa-Mundi, Harleian***	**1547**
CA12.01	STARBOARD PROFILE	NAU
CA12.02	PORT PROFILE	NAU
CA13	***Carta Anonimo***	**1550**
CA13.01	PORT PROFILE	NAU
CA13.02	PORT PROFILE	CARAVEL
CA14	***Cosmographie Universelle***	**1556**
CA14.01	STARBOARD 3/4 PROFILE	NAU
CA14.02	PORT PROFILE	CARAVEL
CA14.03	PORT 3/4 PROFILE	CARAVEL
CA14.04	PORT 3/4 PROFILE	GALLEON

CA15	***Mapa de Diogo Homem***	**1558**
CA15.01	PORT PROFILE	NAU
CA15.02	PORT PROFILE	NAU
CA15.03	PORT PROFILE	NAU
CA15.04	PORT PROFILE	GALLEON
CA15.05	PORT PROFILE	NAU
CA15.06	PORT PROFILE	GALLEON
CA15.07	PORT PROFILE	NAU
CA15.08	STARBOARD PROFILE	NAU
CA16	***André Homem***	**1559**
CA16.01	STARBOARD PROFILE	NAU
CA16.02	PORT PROFILE	NAU
CA16.03	STARBOARD PROFILE	NAU
CA16.04	STARBOARD 3/4 PROFILE	NAU
CA16.05	PORT PROFILE	NAU
CA17	***Fernando Álvares Seco, Mapa de Portugal***	**1560**
CA17.01	PORT PROFILE	CARAVEL
CA17.02	PORT 3/4 PROFILE	NAU
CA18	***Lázaro Luis***	**1563**
CA18.01	STARBOARD PROFILE	NAU
CA19	***Fernando Álvares Seco***	**1565**
CA19.01	STARBOARD PROFILE	NAU
CA19.02	PORT PROFILE	NAU
CA20	***Anonimo, Sebastiao Lopes***	**1565**
CA20.01	STARBOARD PROFILE	CARAVEL
CA20.02	STERN	NAU
CA20.03	STERN	NAU
CA20.04	STERN	NAU
CA20.05	BOW	NAU
CA21	***Fernao Vaz Dourado***	**1568**
CA21.01	PORT PROFILE	NAU
CA21.02	PORT PROFILE	NAU
CA21.03	PORT PROFILE	NAU
CA21.04	STERN	NAU
CA21.05	STERN	NAU
CA21.06	STERN	NAU

CA21.07	STERN	NAU
CA21.08	PORT PROFILE	NAU
CA22	***Civitates Orbis Terrarum, Vol. 1***	**1572**
CA22.01	PORT PROFILE	CARAVEL
CA22.02	PORT PROFILE	CARAVEL
CA22.03	PORT PROFILE	CARAVEL
CA22.04	STARBOARD 3/4 PROFILE	CARAVEL
CA22.05	PORT PROFILE	CARAVEL
CA22.06	PORT PROFILE	NAU
CA22.07	PORT PROFILE	CARAVEL
CA22.08	STARBOARD PROFILE	CARAVEL
CA22.09	PORT PROFILE	CARAVEL
CA22.10	PORT PROFILE	NAU
CA22.11	PORT PROFILE	NAU
CA22.12	PORT PROFILE	NAU
CA22.13	PORT PROFILE	CARAVEL
CA22.14	STARBOARD PROFILE	CARAVEL
CA22.15	STARBOARD PROFILE	NAU
CA22.16	PORT PROFILE	CARAVEL
CA22.17	PORT PROFILE	NAU
CA22.18	STARBOARD PROFILE	CARAVEL
CA22.19	STARBOARD PROFILE	NAU
CA22.20	STARBOARD PROFILE	CARAVEL
CA22.21	STARBOARD 3/4 PROFILE	NAU
CA22.22	PORT PROFILE	GALLEON
CA22.23	PORT PROFILE	CARAVEL
CA22.24	PORT PROFILE	NAU
CA22.25	PORT PROFILE	CARAVEL
CA22.26	PORT PROFILE	NAU
CA22.27	PORT PROFILE	NAU
CA22.28	PORT PROFILE	NAU
CA22.29	STARBOARD PROFILE	CARAVEL
CA22.30	PORT PROFILE	NAU
CA22.31	PORT PROFILE	CARAVEL
CA22.32	PORT PROFILE	CARAVEL
CA22.33	PORT PROFILE	CARAVEL
CA22.34	STARBOARD PROFILE	CARAVEL

CA22.35	STARBOARD PROFILE	CARAVEL
CA22.36	STARBOARD PROFILE	NAU
CA22.37	STARBOARD 3/4 PROFILE	NAU
CA23	***Civitates Orbis Terrarum, Vol. 4***	**1574**
CA23.01	STARBOARD PROFILE	GALLEON
CA24	***Americae Sive Novi Orbis, Nova Descriptio***	**1579**
CA24.01	STARBOARD 3/4 PROFILE	NAU
CA24.02	STARBOARD 3/4 PROFILE	NAU
CA25	***Fernao Vaz Dourado***	**1580**
CA25.01	STERN	NAU
CA26	***Anonimo, Luis Teixeira***	**1582**
CA26.01	PORT PROFILE	NAU
CA26.02	STERN	NAU
CA27	***Linschoten , A Vista de Angra***	**1583-1588**
CA27.01	PORT 3/4 PROFILE	NAU
CA27.02	PORT PROFILE	CARAVEL
CA27.03	PORT PROFILE	NAU
CA27.04	PORT PROFILE	NAU
CA27.05	PORT PROFILE	CARAVEL
CA27.06	STARBOARD PROFILE	NAU
CA28	***Anonimo, Luis Teixeira***	**1584**
CA28.01	STARBOARD PROFILE	CARAVEL
CA29	***Teodoro de Bry, Indiae Orientalis***	**1588-1598**
CA29.01	STARBOARD PROFILE	CARAVEL
CA29.02	STARBOARD PROFILE	CARAVEL
CA29.03	PORT PROFILE	CARAVEL
CA29.04	PORT PROFILE	GALLEON
CA29.05	PORT PROFILE	NAU
CA29.06	PORT PROFILE	NAU
CA29.07	STERN	NAU
CA29.08	STERN	NAU
CA30	***Linschoten , Cabo da Boa Esperanca***	**1589**
CA30.01	PORT 3/4 PROFILE	NAU
CA30.02	STARBOARD 3/4 PROFILE	NAU
CA31	***Unidentified***	**1589**
CA031.01	PORT 3/4 PROFILE	NAU
CA031.02	PORT 3/4 PROFILE	NAU

CA031.03	PORT PROFILE	NAU
CA031.04	PORT 3/4 PROFILE	NAU
CA031.05	PORT PROFILE	NAU
CA031.06	PORT 3/4 PROFILE	NAU
CA32	***Duarte Lopes, In Pigafetta***	**1590**
CA32.01	STERN	NAU
CA33	***Anonimo, Bartolomeu Lasso – Pterus Planicus***	**1592-94**
CA33.01	STARBOARD 3/4 PROFILE	NAU
CA33.02	STERN	NAU
CA33.03	STERN	NAU
CA33.04	STERN	NAU
CA35.05	PORT PROFILE	NAU
CA33.06	STERN	NAU
CA33.07	STARBOARD 3/4 PROFILE	NAU
CA34	***Brauni, Panaramica de Lisboa***	**1593**
CA34.01	STARBOARD PROFILE	CARAVEL
CA34.02	STARBOARD PROFILE	CARAVEL
CA34.03	STARBOARD PROFILE	GALLEON
CA34.04	STARBOARD PROFILE	NAU
CA34.05	PORT 3/4 PROFILE	NAU
CA34.06	PORT PROFILE	NAU
CA35	***Luis Teixiera***	**1595**
CA35.01	STERN	NAU
CA35.02	STARBOARD PROFILE	NAU
CA36	***Bartolomeu Lasso, Arnoldus Florentius Van Langren***	**1596**
CA36.01	STERN	NAU
CA36.02	STERN	NAU
CA37	***Atlas MS176, Fol.15-16***	**XVI**
CA37.01	STERN	NAU
CA38	***Luis Teixiero***	**1600**
CA38.01	STERN	NAU

ENGRAVINGS		
CATALOG #	**POSITION**	**SHIP TYPE**
EN01	***La Armada***	**1525**
EN01.01	STARBOARD 3/4 PROFILE	NAU

EN02	***Livro dos Regimentos dos Officaes Mecanicos***	**1572**
EN02.01	PORT PROFILE	NAU
EN03	***Manuscript Pilot Jacques DeVaulx***	**1583**
EN03.01	STARBOARD PROFILE	CARAVEL
EN04	***Boazio, Sir Francis Drake's West Indian Voyage***	**1589**
EN04.01	STARBOARD 3/4 PROFILE	GALLEON
EN04.02	STARBOARD 3/4 PROFILE	GALLEON
EN04.03	STARBOARD 3/4 PROFILE	GALLEON
EN05	***Francoforte, Lisboa no Século XVI***	**1592**
EN05.01	STERN	NAU
EN05.02	STERN	NAU
EN05.03	STERN	NAU
EN05.04	STARBOARD 3/4 PROFILE	NAU
EN06	***Unidentified***	**XVI**
EN06.01	PORT 3/4 PROFILE	NAU

MANUSCRIPTS		
CATALOG #	**POSITION**	**SHIP TYPE**
MA01	***Il Compasso da Navigre***	**1485**
MA01.01	STARBOARD 3/4 PROFILE	NAU
MA01.02	STARBOARD 3/4 PROFILE	CARAVEL
MA02	***Livro de Regimento dos Vereadores e Officias de Camara***	**1502**
MA02.01	PORT PROFILE	GALLEON
MA03	***Livro de Fortalezas***	**1509**
MA03.01	PORT PROFILE	NAU
MA03.02	STARBOARD PROFILE	NAU
MA03.03	STARBOARD PROFILE	NAU
MA03.04	STARBOARD PROFILE	NAU
MA03.05	STARBOARD PROFILE	CARAVEL
MA03.06	STARBOARD PROFILE	CARAVEL
MA03.07	STARBOARD PROFILE	NAU
MA03.08	STARBOARD PROFILE	GALLEON
MA03.09	PORT PROFILE	GALLEON
MA03.10	PORT PROFILE	CARAVEL
MA03.11	PORT PROFILE	NAU
MA03.12	PORT PROFILE	NAU

MA03.13	PORT PROFILE	NAU
MA03.14	PORT PROFILE	NAU
MA03.15	PORT PROFILE	NAU
MA03.16	PORT PROFILE	CARAVEL
MA04	***Livro Segundo dos Misticos da Leitura Nova***	**1510**
MA04.01	STARBOARD PROFILE	NAU
MA04.02	STERN	NAU
MA04.03	STARBOARD 3/4 PROFILE	NAU
MA05	***Livros Forais Novos D'Entre Douro***	**1500-25**
MA05.01	PORT PROFILE	CARAVEL
MA06	***Leitura Nova***	**1500-1525**
MA06.01	STARBOARD PROFILE	CARAVEL
MA06.02	PORT 3/4 PROFILE	GALLEON
MA07	***Livro das Inquirições da Beira e Além Douro***	**1500-1525**
MA07.01	BOW	NAU
MA07.02	PORT PROFILE	NAU
MA07.03	STERN	NAU
MA08	***Chronica d'el Rei Dom Affonso Henriques***	**1515-25**
MA08.01	STARBOARD PROFILE	CARAVEL
MA08.02	STARBOARD PROFILE	CARAVEL
MA08.03	PORT 3/4 PROFILE	NAU
MA09	***Livro de Horas da Condessa de Bertiandos***	**1515-30**
MA09.01	STARBOARD PROFILE	NAU
MA09.02	PORT PROFILE	NAU
MA10	***Livro de Horas de Dom Manuel***	**1517-1526**
MA10.01	PORT 3/4 PROFILE	NAU
MA10.02	BOW	NAU
MA10.03	PORT PROFILE	NAU
MA10.04	STARBOARD PROFILE	NAU
MA10.05	BOW	NAU
MA10.06	STARBOARD PROFILE	CARAVEL
MA10.07	STARBOARD PROFILE	CARAVEL
MA10.08	STARBOARD 3/4 PROFILE	NAU
MA10.09	STARBOARD PROFILE	CARAVEL
MA10.10	STERN	NAU
MA10.11	STERN	NAU
MA10.12	STERN	NAU

MA10.13	STERN	NAU
MA10.14	STERN	NAU
MA10.15	STERN	NAU
MA11	**Árvore Genealógica da Casa Real Portuguesa**	**1530-1534**
MA11.01	STARBOARD 3/4 PROFILE	NAU
MA11.03	PORT PROFILE	NAU
MA11.04	STARBOARD PROFILE	CARAVEL
MA11.05	PORT PROFILE	CARAVEL
MA11.07	PORT PROFILE	NAU
MA11.08	STERN	NAU
MA11.09	PORT PROFILE	CARAVEL
MA12	***Vista de Lisboa***	**1535-1570**
MA12.01	PORT PROFILE	NAU
MA12.02	BOW	NAU
MA12.03	STARBOARD 3/4 PROFILE	CARAVEL
MA12.04	PORT PROFILE	NAU
MA12.05	PORT 3/4 PROFILE	NAU
MA12.06	PORT PROFILE	NAU
MA12.07	STARBOARD 3/4 PROFILE	NAU
MA13	***Roteiro do Mar Roxo de Dom João de Castro***	**1538-1540**
MA13.01	PORT PROFILE	GALLEON
MA13.02	PORT PROFILE	NAU
MA13.03	PORT PROFILE	CARAVEL
MA13.04	PORT PROFILE	GALLEON
MA13.05	PORT PROFILE	GALLEON
MA13.06	STERN	NAU
MA13.07	STARBOARD 3/4 PROFILE	NAU
MA13.08	STARBOARD 3/4 PROFILE	NAU
MA13.09	PORT PROFILE	GALLEON
MA13.10	PORT PROFILE	CARAVEL
MA13.11	PORT PROFILE	NAU
MA13.12	STARBOARD PROFILE	GALLEON
MA13.13	STARBOARD PROFILE	NAU
MA13.14	STARBOARD 3/4 PROFILE	NAU
MA13.15	STARBOARD PROFILE	GALLEON
MA13.16	PORT PROFILE	CARAVEL
MA13.17	PORT PROFILE	NAU

MA13.18	PORT 3/4 PROFILE	NAU
MA13.19	PORT PROFILE	NAU
MA13.20	PORT PROFILE	NAU
MA13.21	PORT PROFILE	NAU
MA13.22	PORT PROFILE	NAU
MA13.23	PORT PROFILE	NAU
MA13.24	PORT PROFILE	NAU
MA14	***Lendas da India de Gaspar Correa***	**1538-1550**
MA14.01	STARBOARD PROFILE	NAU
MA14.02	STARBOARD PROFILE	NAU
MA14.03	PORT PROFILE	CARAVEL
MA14.04	STARBOARD PROFILE	NAU
MA14.05	STARBOARD PROFILE	GALLEON
MA14.06	STARBOARD PROFILE	NAU
MA14.07	PORT PROFILE	NAU
MA14.08	PORT PROFILE	NAU
MA14.09	PORT PROFILE	CARAVEL
MA14.10	STARBOARD PROFILE	NAU
MA15	***Livro de Lisuarte De Abreu***	**1558-1561**
MA15.1497.01	STARBOARD PROFILE	NAU
MA15.1501.02	PORT PROFILE	NAU
MA15.1501.08	STARBOARD PROFILE	NAU
MA15.1501.09	STARBOARD PROFILE	CARAVEL
MA15.1501.12	STARBOARD PROFILE	CARAVEL
MA15.1502.01	STARBOARD PROFILE	NAU
MA15.1502.02	STARBOARD PROFILE	CARAVEL
MA15.1502.05	STARBOARD PROFILE	CARAVEL
MA15.1504.02	STARBOARD PROFILE	NAU
MA15.1504.08	STARBOARD PROFILE	NAU
MA15.1505.05	STARBOARD PROFILE	CARAVEL
MA15.1505.12	STARBOARD PROFILE	NAU
MA15.1505.18	STARBOARD PROFILE	CARAVEL
MA15.1508.01	STARBOARD PROFILE	NAU
MA15.1509.11	STARBOARD PROFILE	NAU
MA15.1509.16	STARBOARD PROFILE	NAU
MA15.1510.05	STARBOARD PROFILE	NAU
MA15.1512.04	STERN	NAU

MA15.1512.09	STARBOARD PROFILE	NAU
MA15.1513.03	STARBOARD PROFILE	NAU
MA15.1515.03	STARBOARD PROFILE	NAU
MA15.1517.07	STARBOARD PROFILE	NAU
MA15.1519.17	STARBOARD PROFILE	CARAVEL
MA15.1519.19	STARBOARD PROFILE	NAU
MA15.1521.09	STARBOARD PROFILE	NAU
MA15.1523.06	STARBOARD PROFILE	NAU
MA15.1524.07	STARBOARD PROFILE	CARAVEL
MA15.1524.10	STARBOARD PROFILE	NAU
MA15.1528.01	STARBOARD PROFILE	CARAVEL
MA15.1529.02	STARBOARD PROFILE	NAU
MA15.1532.02	STARBOARD 3/4 PROFILE	NAU
MA15.1533.14	STARBOARD PROFILE	CARAVEL
MA15.1533.15	STARBOARD PROFILE	CARAVEL
MA15.1534.02	STARBOARD 3/4 PROFILE	NAU
MA15.1538.01	STERN	NAU
MA15.1542.03	STERN	NAU
MA15.1545.02	STERN	NAU
MA15.1545.05	STARBOARD 3/4 PROFILE	NAU
MA15.1550.02	STERN	NAU
MA15.1553.01	STARBOARD 3/4 PROFILE	NAU
MA15.1554.03	STARBOARD PROFILE	CARAVEL
MA15.1554.12	STARBOARD PROFILE	CARAVEL
MA15.1555.00	STARBOARD PROFILE	GALLEON
MA15.1556.01	STERN	NAU
MA15.1561.04	STERN	NAU
MA15.1563.01	STARBOARD 3/4 PROFILE	NAU
MA16	***Memória das Armadas***	**C.1566**
MA16.1497-01	STERN	NAU
MA16.1497-02	STERN	NAU
MA16.1497-03	PORT 3/4 PROFILE	NAU
MA16.1497-04	PORT PROFILE	NAU
MA16.1500-01	PORT PROFILE	NAU
MA16.1500-02	PORT PROFILE	NAU
MA16.1500-03	STARBOARD PROFILE	NAU
MA16.1501-01	STARBOARD PROFILE	NAU

MA16.1501-02	STARBOARD PROFILE	NAU
MA16.1501-03	STARBOARD PROFILE	NAU
MA16.1501-04	STARBOARD PROFILE	CARAVEL
MA16.1502-02	STARBOARD 3/4 PROFILE	CARAVEL
MA16.1502-03	STARBOARD PROFILE	NAU
MA16.1502-04	STARBOARD PROFILE	NAU
MA16.1502-05	STARBOARD PROFILE	NAU
MA16.1502-06	STERN	NAU
MA16.1502-07	STERN	NAU
MA16.1502-08	STERN	NAU
MA16.1502-09	STARBOARD PROFILE	NAU
MA16.1502-10	STARBOARD PROFILE	NAU
MA16.1502-11	STARBOARD PROFILE	CARAVEL
MA16.1502-12	STARBOARD PROFILE	NAU
MA16.1502-13	STARBOARD PROFILE	CARAVEL
MA16.1503-06	STARBOARD PROFILE	NAU
MA16.1503-07	STARBOARD 3/4 PROFILE	NAU
MA16.1503-08	STARBOARD PROFILE	NAU
MA16.1503-09	STERN	NAU
MA16.1504-02	STERN	NAU
MA16.1504-09	STERN	NAU
MA16.1504-11	STARBOARD 3/4 PROFILE	NAU
MA16.1505-05	STERN	NAU
MA16.1505-10	STARBOARD PROFILE	NAU
MA16.1505-11	STARBOARD PROFILE	CARAVEL
MA16.1505-13	STARBOARD PROFILE	NAU
MA16.1505-16	STARBOARD PROFILE	CARAVEL
MA16.1505-30	STERN	NAU
MA16.1506-02	STERN	NAU
MA16.1506-04	STARBOARD PROFILE	NAU
MA16.1506-15	STARBOARD PROFILE	NAU
MA16.1507-11	STARBOARD PROFILE	NAU
MA16.1508-04	STERN	NAU
MA16.1508-07	STARBOARD PROFILE	NAU
MA16.1508-13	STARBOARD PROFILE	NAU
MA16.1508-14	STARBOARD 3/4 PROFILE	NAU
MA16.1509-06	STERN	NAU

MA16.1509-08	STARBOARD PROFILE	NAU
MA16.1510-10	STARBOARD PROFILE	NAU
MA16.1511-03	STARBOARD PROFILE	NAU
MA16.1511-04	STARBOARD PROFILE	NAU
MA16.1512-03	STERN	NAU
MA16.1512-07	STARBOARD PROFILE	NAU
MA16.1512-09	STARBOARD PROFILE	NAU
MA16.1512-10	STERN	NAU
MA16.1513-02	STARBOARD PROFILE	NAU
MA16.1514-02	STARBOARD 3/4 PROFILE	NAU
MA16.1514-03	STERN	NAU
MA16.1515-02	STARBOARD PROFILE	NAU
MA16.1515-10	STARBOARD PROFILE	NAU
MA16.1516-01	STARBOARD 3/4 PROFILE	NAU
MA16.1516-03	STARBOARD PROFILE	NAU
MA16.1517-01	STARBOARD PROFILE	NAU
MA16.1517-02	STARBOARD 3/4 PROFILE	NAU
MA16.1518-02	STERN	NAU
MA16.1518-07	STARBOARD PROFILE	NAU
MA16.1519-01	STERN	NAU
MA16.1519-02	STARBOARD PROFILE	NAU
MA16.1520-02	STERN	NAU
MA16.1521-04	STARBOARD 3/4 PROFILE	NAU
MA16.1523-07	STARBOARD 3/4 PROFILE	NAU
MA16.1524-01	STERN	NAU
MA16.1524-07	STERN	NAU
MA16.1524-11	STARBOARD PROFILE	CARAVEL
MA16.1524-12	STARBOARD PROFILE	CARAVEL
MA16.1524-14	STARBOARD PROFILE	CARAVEL
MA16.1525-02	STARBOARD PROFILE	NAU
MA16.1527-03	STARBOARD PROFILE	NAU
MA16.1528-01	STARBOARD PROFILE	NAU
MA16.1528-03	STARBOARD PROFILE	CARAVEL
MA16.1528-08	STARBOARD PROFILE	NAU
MA16.1528-10	STARBOARD PROFILE	CARAVEL
MA16.1528-13	STERN	NAU
MA16.1530-02	STARBOARD PROFILE	CARAVEL

MA16.1530-05	STERN	NAU
MA16.1530-06	STARBOARD PROFILE	CARAVEL
MA16.1530-07	STARBOARD PROFILE	NAU
MA16.1531-03	STARBOARD 3/4 PROFILE	NAU
MA16.1532-02	STERN	NAU
MA16.1533-03	STERN	NAU
MA16.1533-07	STARBOARD PROFILE	NAU
MA16.1533-08	STARBOARD PROFILE	CARAVEL
MA16.1533-10	STARBOARD PROFILE	CARAVEL
MA16.1533-11	STARBOARD PROFILE	CARAVEL
MA16.1533-12	STARBOARD PROFILE	CARAVEL
MA16.1533-14	STARBOARD PROFILE	CARAVEL
MA16.1533-15	STARBOARD PROFILE	CARAVEL
MA16.1533-16	STARBOARD PROFILE	CARAVEL
MA16.1533-17	STARBOARD PROFILE	CARAVEL
MA16.1533-19	STARBOARD PROFILE	CARAVEL
MA16.1534-03	STERN	NAU
MA16.1536-04	STARBOARD PROFILE	NAU
MA16.1536-05	STERN	NAU
MA16.1537-01	STERN	NAU
MA16.1537-04	STERN	NAU
MA16.1537-05	STARBOARD PROFILE	NAU
MA16.1537-08	STERN	NAU
MA16.1537-10	STERN	NAU
MA16.1538-05	STARBOARD PROFILE	NAU
MA16.1538-07	STERN	NAU
MA16.1539-04	STERN	NAU
MA16.1540-03	STERN	NAU
MA16.1540-04	STARBOARD PROFILE	NAU
MA16.1541-02	STERN	NAU
MA16.1542-01	STARBOARD 3/4 PROFILE	NAU
MA16.1543-02	STERN	NAU
MA16.1543-05	STERN	NAU
MA16.1544-01	STERN	NAU
MA16.1544-03	STERN	NAU
MA16.1545-02	STERN	NAU
MA16.1545-06	STERN	NAU

MA16.1546-03	STERN	NAU
MA16.1546-04	STERN	NAU
MA16.1547-02	STERN	NAU
MA16.1547-06	STARBOARD PROFILE	NAU
MA16.1548-01	STERN	NAU
MA16.1548-08	STERN	NAU
MA16.1548-09	STARBOARD 3/4 PROFILE	NAU
MA16.1548-13	STERN	NAU
MA16.1549-01	STERN	NAU
MA16.1549-04	STERN	NAU
MA16.1550-01	STERN	NAU
MA16.1550-02	STERN	NAU
MA16.1551-03	STERN	NAU
MA16.1551-04	STERN	NAU
MA16.1551-08	STERN	NAU
MA16.1552-02	STARBOARD PROFILE	NAU
MA16.1552-05	STERN	NAU
MA16.1553-01	STARBOARD PROFILE	NAU
MA16.1554-01	STARBOARD PROFILE	NAU
MA16.1554-05	STARBOARD 3/4 PROFILE	NAU
MA16.1555-01	STARBOARD 3/4 PROFILE	NAU
MA16.1555-03	STERN	NAU
MA16.1556-02	STARBOARD 3/4 PROFILE	NAU
MA16.1557-03	STARBOARD 3/4 PROFILE	NAU
MA16.1557-04	STARBOARD PROFILE	NAU
MA16.1558-02	STARBOARD PROFILE	NAU
MA16.1559-01	STARBOARD 3/4 PROFILE	NAU
MA16.1559-04	STARBOARD PROFILE	NAU
MA16.1559-06	STERN	NAU
MA16.1560-04	STARBOARD 3/4 PROFILE	NAU
MA16.1561-02	STARBOARD 3/4 PROFILE	NAU
MA16.1561-05	STARBOARD 3/4 PROFILE	NAU
MA16.1562-03	STARBOARD 3/4 PROFILE	NAU
MA16.1563-01	STARBOARD 3/4 PROFILE	NAU
MA16.1564-01	STARBOARD 3/4 PROFILE	NAU
MA16.1565-01	STARBOARD	NAU
MA16.1565-03	STARBOARD 3/4 PROFILE	NAU

MA16.1566-02	STARBOARD 3/4 PROFILE	NAU
MA17	***Circu de Diu***	**1574**
MA17.01	STARBOARD 3/4 PROFILE	NAU
MA17.02	STARBOARD 3/4 PROFILE	NAU
MA18	***Roteiro da Costa do Brasil***	**1579**
MA18.01	STERN	NAU
MA19	***Livro das Plantas da Casa de Cadaval***	**XVI**
MA19.01	STARBOARD PROFILE	NAU
MA19.02	STARBOARD PROFILE	NAU
MA20	***Livro de Traças de Carpintaria***	**1616**
MA20.01	STARBOARD PROFILE	CARAVEL
MA20.02	STARBOARD PROFILE	GALLEON
MA20.03	STARBOARD PROFILE	GALLEON

PAINTINGS		
CATALOG #	**POSITION**	**SHIP TYPE**
PA01	***Sao Vicente***	**1500-1550**
PA01.01	STARBOARD PROFILE	NAU
PA02	***Sao João em Patmos***	**1514**
PA02.01	PORT PROFILE	NAU
PA03	***Painel de Santa Auta***	**1520**
PA03.01	PORT PROFILE	CARAVEL
PA03.02	PORT 3/4 PROFILE	NAU
PA03.03	STARBOARD 3/4 PROFILE	NAU
PA03.04	PORT 3/4 PROFILE	NAU
PA03.05	PORT PROFILE	NAU
PA04	**Portuguese Carracks on a Rocky Coast**	**1521-1530**
PA04.01	STARBOARD 3/4 PROFILE	NAU
PA04.02	PORT 3/4 PROFILE	NAU
PA04.03	PORT PROFILE	GALLEON
PA04.04	PORT PROFILE	CARAVEL
PA06	***Galeáo Portugues***	**1552**
PA06.01	PORT PROFILE	GALLEON
PA07	***Biombos Namban***	**1573-1603**
PA07.01	STARBOARD PROFILE	NAU
PA07.02	STARBOARD PROFILE	NAU

PA07.03	STARBOARD PROFILE	NAU
PA08	***São Martinho***	**1593**
PA08.01	STARBOARD PROFILE	GALLEON
PA09	***Invincible Armada***	**END XVI**
PA09.01	STARBOARD 3/4 PROFILE	GALLEON
PA09.02	STARBOARD 3/4 PROFILE	GALLEON
PA09.03	STERN	GALLEON

APPENDIX 2

PROVENIENCE OF ICONOGRAPHY

CHARTS / ATLASES

CA01	*Carta de la Juan de Cosa* Museu Naval de Madrid	1500
CA02	*Anonimo, Jorge Reinel* Museu da Marinha, Lisbon	1510
CA03	*Carta Atlântica de Piri Reis* Topkapi Sarayi Müzesi Müdürlügü Museum, Istanbul	1513
CA04	*Lopo Homem-Reneis - Atlas Miller* Bibliothéque Nationale, Paris	1519
CA05	*Anonimo, Jorge Reinel* Museu da Marinha, Lisbon	1519
CA06	*Diogo Ribiero* Thuringische Landesbibliothek, Weimar	1527
CA07	*Diogo Ribiero* Bibliotecca Vaticana, Rome	1529
CA08	*Anonimo, Diogo Ribiero* Herzog August Bibliothek, Wolfenbuttel	1532
CA09	*Carta Atlântica do Atlas, Luso-Francês* Koniklijke Bibliotheck, The Hague	1538
CA10	*Anonimo, Panoramica de Lisboa* Museu da Cidade, Lisbon - MC.GRA.0034	1541
CA11	*Joao Freire, Atlas of Seven Charts* Huntington Library, California	1546
CA12	*Mapa-Mundi, Harleian* British Library, London	1547

CA13	*Anonimo* Bodleian Library, Oxford	1550
CA14	*Cosmographie Universelle* Le Testu, Guillaume and Service Historique de la Defense, 2008, *Cosmographie Universelle*, France.	1556
CA15	*Mapa de Diogo Homem* British Museum, London	1558
CA16	*André Homem* Bibliothéque Nationale, Paris	1559
CA17	*Fernando Álvares Seco, Mapa de Portugal* Museu de Cidade, Lisbon	1560
CA18	*Lázaro Luis* Academia das Ciéncias de Lisboa	1563
CA19	*Fernando Álvares Seco* Bibliothéque Nationale, Paris	1565
CA20	*Anonimo, Sebastiao Lopes* The Newberry Library, Chicago	1565
CA21	*Fernao Vaz Dourado* Biblioteca Duques de Alba, Madrid	1568
CA22	*Civitates Orbis Terrarum, Vol. 1* Braun, Georg; Franz Hogenberg; Stephan Fussel; Benedikt Taschen, 2008, *Civitates orbis terrarum - Cities of the world: 363 engravings revolutionize the view of the world: complete edition of the colour plates of 1572-1617*. London.	1572
CA23	*Civitates Orbis Terrarum, Vol. 4* Braun, Georg; Franz Hogenberg; Stephan Fussel; Benedikt Taschen, 2008, *Civitates orbis terrarum - Cities of the world: 363 engravings revolutionize the view of the world: complete edition of the colour plates of 1572-1617*. London.	1574

CA24	*Americae Sive Novi Orbis, Nova Descriptio* Dijkman, Marjolijn, 2007, *Theatrum orbis terrarum*. Aberdeen.	1579
CA25	*Fernao Vaz Dourado* Bayerische Staatsbibliothek, Munchen	1580
CA26	*Anonimo, Luis Teixeira* In Orteluis, Theatrum Orbis Terrarum Bibliothéque Nationale, Paris	1582
CA27	*Linschoten , A Vista de Angra* Museu de Cidade, Lisbon	1583-1588
CA28	*Anonimo, Luis Teixeira* In Orteluis, Theatrum Orbis Terrarum Bibliothéque Nationale, Paris	1584
CA29	*Teodoro de Bry, Indiae Orientalis* Bernard J. Shapero Rare Books, 2006, *Indiae orientalis*, London.	1588-1598
CA30	*Linschoten , Cabo da Boa Esperanca* Museu de Cidade, Lisbon	1589
CA31	*Unidentified*	1589
CA32	*Duarte Lopes, In Pigafetta* Pigafetta, Antonio; Paula Spurlin Paige; William L. Clements Library; Jay I. Kislak Reference Collection (Library of Congress), 1969, *The voyage of Magellan; the journal of Antonio Pigafetta*. Englewood Cliffs, N.J	1590
CA33	*Anonimo, Bartolomeu Lasso – Pterus Planicus* Linschoten, Jan Huygen van, 1910, *Itinerario, Voyage ofte Schipvaert...naer oost ofte Portugaels Indien. [Part II:] Reys-Gheschrift vande Navigatien der Portugaloysers in Orienten. [Part III:] Beschryvinghe van de gantsche Custe van Guinea, Manicongo, Angola, Monomotapa, ende tegen over de Cabo de S. Augustijn in Brasilien*. Germany.	1592-94
CA34	*Brauni, Panaramica de Lisboa* Museu de Cidade, Lisbon	1593

CA35	*Luis Teixiera* Ortelio, Abramo and Giorgio Mangani, 2007, *Teatro del Mondo : [nel quale fi dà notizia distinta in tutte le Provincie, Regni, e Paesi del Mondo; con la descrittione delle Città, Territorii, Castelli, Monti, Mari, Laghi, e Fiumi, le Popolationi, i costumi, le ricchezze, & ogn'altra particolarità]*. Italy.	1595
CA36	*Bartolomeu Lasso, Arnoldus Florentius Van Langren* Linschoten, Jan Huygen van, 1910, *Itinerario, Voyage ofte Schipvaert...naer oost ofte Portugaels Indien. [Part II:] Reys-Gheschrift vande Navigatien der Portugaloysers in Orienten. [Part III:] Beschryvinghe van de gantsche Custe van Guinea, Manicongo, Angola, Monomotapa, ende tegen over de Cabo de S. Augustijn in Brasilien*. Germany.	1596
CA37	*Atlas MS176, Fol.15-16* Bibliothéque de Lyon, MS.176 FOL.15-16	XVI
CA38	*Luis Teixiero* British Museum	1600

ENGRAVINGS

EN01	*La Armada* Canedo, Lino Gómez, 1991, *Los gallegos en los descubrimientos y las exploraciones*. Spain.	1525
EN02	*Livro dos Regimentos dos Officaes Mecanicos* Viterbo, Sousa, 1898, *Trabalhos Nauticos dos Portugueses nos Séculos XVI e XVII*, Parte I. Lisbon.	1572
EN03	*Manuscript Pilot Jacques DeVaulx* Barata, J. da G. P., 1989, *Estudos de Arqueologia Naval*, 2 Vols. Lisbon.	1583
EN04	*Boazio, Sir Francis Drake's West Indian Voyage* Library of Congress - Jay I. Kislak Collection	1589
EN05	*Francoforte, Lisboa no Século XVI*	1592
EN06	*Unidentified*	XVI

MANUSCRIPTS

MA01	*Il Compasso da Navigre* Motzo, Bacchisio Raimondo, 1883- ed., *Il Compasso da Navigre,* Cagliari, Italy.	1485
MA02	*Livro de Regimento dos Vereadores e Officias de Camara* Arquivo Historico de Camara Municipal de Lisboa	1502
MA03	*Livro de Fortalezas* Armas, Duarte de, and João de Almeida, 1943, *Reprodução anotada do Livro das Fortalezas de Duarte Darmas*. Lisbon.	1509
MA04	*Livro Segundo dos Misticos da Leitura Nova* Arquivo Nacional Torre do Tombo, PT-TT-LN-31	1510
MA05	*Livros Forais Novos D'Entre Douro, da Leitura Nova* Arquivo Nacional Torre do Tombo	1500-1525
MA06	*Leitura Nova* Arquivo Nacional Torre do Tombo	1500-1525
MA07	*Livro das Inquirições da Beira e Além Douro, da Leitura Nova* Arquivo Nacional Torre do Tombo, PT-TT-LN-04c0003	1500-1525
MA08	*Chronica d'el Rei Dom Affonso Henriques* Galvão, Duarte and Gabriel Pereira, 1906, *Chronica de el-rei D. Affonso Henriques*, Lisbon	1515-1525
MA09	*Livro de Horas da Condessa de Bertiandos* Academia das Ciéncias de Lisboa, 2004, edição fac-simile, *Livro de Horas da Condessa de Bertiandos*. Lisbon.	1515-1530
MA10	*Livro de Horas de Dom Manuel* Arquivo Nacional Torre do Tombo	1517-1526
MA11	Árvore Genealógica da Casa Real Portuguesa Simon Benning, Á*rvore Genealógica da Casa Real Portuguesa*, British Library	1530-153
MA12	*Vista de Lisboa* University de Leiden	1535-1570

MA13	*Roteiro do Mar Roxo de Dom João de Castro* Castro, João de and Luís de Albuquerque, 1991, *Roteiro do Mar Roxo de Dom João de Castro: MS. COTT. TIB. DIX DA, British Library*. London.	1538-1540
MA14	*Lendas da India de Gaspar Correa* Correa, Gaspar and Henry Edward John 3rd baron Stanley of Alderley, 1869, *The Three voyages of Vasco de Gama and his viceroyalty, from the Lendas da India of Gaspar Correa, accompanied by original documents, translated from the Portuguese with notes and an introduction, by the hon. Henry E. J. Stanley*. London.	1538-1550
MA15	*Livro de Lisuarte De Abreu* CNCDP & Caixa Geral de Depósitos, 1993, edição fac-simile, *Livro de Lisuarte De Abreu*. Lisbon.	1558-1561
MA16	*Memória das Armadas* Academia das Ciéncias de Lisboa, 1979. *Memória das Armadas que de Portugal Passaram à India*. Lisbon.	1566
MA17	*Circu de Diu* Arquivo Nacional Torre do Tombo, PT-TT-CCDV31-c0009	1574
MA18	*Roteiro da Costa do Brasil* Oliveira, Manuel Antonio Vital de, 1988, *Roteiro da Costa do Brasil do Rio Mossoro'ao Rio S. Francisco do Norte*. Lisbon.	1579
MA19	*Livro das Plantas da Casa de Cadaval* Arquivo Nacional Torre do Tombo	XVI
MA20	*Livro de Traças de Carpintaria* Fernandez, Manoel, 1989, Fac-simile, *Livro de Traças de Carpintaria*. Lisbon.	1616

PAINTINGS

PA01	*Sao Vicente*, Escola do Mestre Sardoal Museu Regional de Beja	1500-1550
PA02	*Sao João em Patmos* Do Mestre da Lourinhã, Museu da Misericórdia da Lourinhã	1514

PA03	*Painel de Santa Auta* Museu Nacional de Arte Antiga, Lisbon	1520
PA04	*Portuguese Carracks on a Rocky Coast* National Maritime Museum, London.	1521-1530
PA06	*Galeáo Portugues* Museu da Marinha, Lisbon	1552
PA07	*Biombos Namban* Museu Nacional de Arte Antiga, Lisbon	1573-1603
PA08	*São Martinho*, Hendrik Cornelisz Vroom National Maritime Museum, London.	1593
PA09	*Invincible Armada* National Maritime Museum, London	END XVI

APPENDIX 3

LIST OF REPRESENTATONAL TRENDS ANALYSIS HULL AND RIGGING FEATURES

REPRESENTATIONAL TRENDS ANALYSIS	
BONAVENTURE MAST	**MIZZEN MAST**
BONAVENTURE SAIL - LATEEN/SQUARE	MIZZEN SAIL - LATEEN/SQUARE
BONAVENTURE SAIL - FURLED/UNFURLED	MIZZEN SAIL - FURLED/UNFURLED
BONAVENTURE SAIL - RAISED/LOWERED	MIZZEN YARD - RAISED/LOWERED
BONAVENTURE SAIL HALIYARDS	MIZZEN SAIL HALIYARDS
BONAVENTURE SAIL BRACES	MIZZEN SAIL BRACES
BONAVENTURE TOP SAIL - LATEEN/SQUARE	MIZZEN TOP SAIL - LATEEN/SQUARE
BONAVENTURE TOP SAIL HALIYARDS	MIZZEN TOP SAIL - FURLED/UNFURLED
BONAVNETURE TOP SAIL BRACES	MIZZEN TOP YARD - RAISED/LOWERED
BONAVENTURE SHROUDS - NUMBER	MIZZEN TOP SAIL HALIYARDS
BONAVENTURE SHROUDS - POSITION	MIZZEN TOP SAIL BRACES
BONAVENTURE SHROUDS RATLINES	MIZZEN SHROUDS - NUMBER
BONAVENTURE TOP SHROUDS - NUMBER	MIZZEN SHROUDS - POSITION
BONAVENTURE TOP SHROUDS - POSITION	MIZZEN SHROUD RATLINES
BONAVENTURE FORE STAYS - POSITION	MIZZEN TOP SHROUDS- NUMBER
BONAVENTURE TOP FORE STAYS - POSITION	MIZZEN TOP SHROUDS - POSITION
BONAVENTURE BACK STAYS - POSITION	MIZZEN TOP SHROUDS RATLINES
BONAVENTURE TOP BACK STAYS - POSITION	MIZZEN FORE STAYS - POSITION
BONAVENTURE CROWSNEST- TYPE	MIZZEN TOP FORE STAYS - POSITION
BONAVENTURE MAST - WOOLDINGS	MIZZEN BACK STAYS - POSITION
MAIN MAST	MIZZEN TOP BACK STAYS - POSITION
MAIN SAIL- LATEEN/SQUARE	MIZZEN CROWSNEST- TYPE
MAIN SAIL - FURLED/UNFURLED	MIZZEN MAST - WOOLDINGS
MAIN YARD - RAISED/LOWERED	**FORE MAST**
MAIN SAIL HALIYARDS	FORE SAIL - LATEEN/SQUARE
MAIN SAIL BRACES	FORE SAIL - FURLED/UNFURLED
MAIN SAIL BONNETS /#	FORE YARD - RAISED/LOWERED
MAIN TOP SAIL - LATEEN/SQUARE	FORE SAIL HALIYARDS

MAIN TOP SAIL - FURLED/UNFURLED	FORE SAIL BRACES
MAIN TOP YARD - RAISED/LOWERED	FORE SAIL BONNETS
MAIN TOP SAIL HALIYARDS	FORE TOP SAIL - LATEEN/SQUARE
MAIN TOP SAIL BRACES	FORE TOP SAIL - FURLED/UNFURLED
MAIN TOP SAIL BONNETS /#	FORE TOP YARD - RAISED/LOWERED
MAIN ROYAL SAIL - LATEEN/SQUARE	FORETOP SAIL HALIYARDS
MAIN ROYAL SAIL - FURLED/UNFURLED	FORE TOP SAIL BRACES
MAIN ROYAL YARD - RAISED/LOWERED	FORE ROYAL SAIL - LATEEN/SQUARE
MAIN ROYAL SAIL HALIYARDS	FORE ROYAL SAIL - FURLED/UNFURLED
MAIN ROYAL SAIL BRACES	FOREROYAL YARD - RAISED/LOWERED
MAIN ROYAL SAIL BONNETS /#	FORE ROYAL SAIL HALIYARDS
MAIN SHROUDS - NUMBER	FORE ROYAL SAIL BRACES
MAIN SHROUDS - POSITION	FORE ROYAL SAIL BONNETS /#
MAIN SHROUDS RATLINES	FORE SHROUDS - NUMBER
MAIN TOP SHROUDS - NUMBER	FORE SHROUDS - POSITION
MAIN TOP SHROUDS - POSITION	FORE SHROUDS RATLINES
MAIN TOP SHROUDS RATLINES	FORE TOP SHROUDS - NUMBER
MAIN ROYAL SHROUDS - NUMBER	FORE TOP SHROUDS - POSITION
MAIN ROYAL SHROUDS - POSITION	FORE TOP SHROUDS RATLINES
MAIN ROYAL SHROUDS RATLINES	FORE ROYAL SHROUDS - NUMBER
MAIN FORE STAYS - POSITION	FORE ROYAL SHROUDS - POSITION
MAIN TOP FORE STAYS - POSITION	FORE ROYAL SHROUDS RATLINES
MAIN ROYAL FORE STAYS - POSITION	FORE STAYS - POSITION
MAIN BACK STAYS - POSITION	FORE TOP FORE STAYS - POSITION
MAIN TOP BACK STAYS - POSITION	FORE ROYAL FORE STAYS - POSITION
MAIN ROYAL BACK STAYS - POSITION	FORE BACK STAYS - POSITION
MAIN CROWSNEST - BASKET/PLATFORM	FORE TOP BACK STAYS - POSITION
MAIN TOP CROWSNEST-BASKET/PLATFORM	FORE ROYAL BACK STAYS - POSITION
MAIN LOWER MAST - WOOLDINGS	FORE CROWSNEST- TYPE
MAST UPPER MAST - WOOLDINGS	FORE TOP CROWSNEST-BASKET/PLATFORM
MAST ROYAL MAST - WOOLDINGS	FORE LOWER MAST - WOOLDINGS
DECORATIONS	FORE UPPER MAST - WOOLDINGS
PENDANTS - BONAVENTURE MAST	**BOWSPRIT**
PENDANTS - MIZZEN MAST	SPRIT SAIL - TYPE
PENDANTS - MAIN MAST	SPRIT TOP SAIL - TYPE
PENDANTS - FORE MAST	DOLPHIN STRIKER

FLAGS - BONAVENTURE MAST	**HULL CONSTRUCTION**
FLAGS - MIZZEN MAST	TRANSOM - SQUARE/ROUND
FLAGS - MAIN MAST	STERN GALLERY - COVERED/UNCOVERED
FLAGS - FORE MAST	QUARTER GALLERY - COVERED/UNCOVERED
PAINT - POSITION/COLOR	STERN CASTLE
FIGUREHEAD - TYPE	STERN CASTLE RAILING
STATUES - POSITION	FORECASTLE
STATUES - TYPE	FORECASTLE RAILING
STERNCASTLE - RAILING SHIELDS	FORECASTLE - UPPER DECK
STERNCASTLE - FLAGS	POOP DECK
FORECASTLE - RAILING SHIELDS	QUARTER DECK
FORECASTLE - FLAGS	HALF DECK
FORE CROWSNESTRALING SHIELDS	LOWER GUN DECK
MAIN CROWSNESTRAILING SHIELDS	UPPER WALE
DECORATION ON BONAVENTURE SAIL	LOWER WALE
DECORATION ON MIZZEN SAIL	HAWSER HOLES - BOW
DECORATION ON MAIN SAIL	RUDDER CHAINS
DECORATION ON MAIN TOP SAIL	GUNS ON STERN CASTLE
DECORATION ON FORE SAIL	GUNS ON FORECASTLE
DECORATION ON FORE TOP SAIL	ANCHOR
DECORATION ONSPRITSAIL	SHIPS BOATS

APPENDIX 4

DIMENSION LABELING SYSTEM FOR STATISTICAL ANALYSIS MEASUREMENTS

DIMENSION LABELING SYSTEM	
L.H	Length of Hull
L.Wl	Length of Hull at Waterline
R.S	Rise to Stern
R.B	Rise to Bow
L.Fc	Length of Forecastle
L.Sc	Length of Sterncastle
H.Pd	Height of Poop Deck
L.Pd	Length of Poop Deck
L.Qd	Length of Quarter Deck
H.Qd	Height of Quarter Deck
L.Wa	Length of Waist
H.Wa	Height of Waist
W.Wa	Width of Waist
H.Fc	Height of Forecastle
H.Sc	Height of Sterncastle
D.UW	Depth of Upper Wale
D.LW	Depth of Lower Wale
L.Bh	Length of Beakhead
H.Bh	Height of Beakhead
D.Bh	Depth to Beakhead
L.Bm	Length of Boomkin
D.Bm	Depth of Boomkin
Rk.Bm	Rake Boomkin
L.Bw	Length of Bowsprit
Rk.Bw	Rake of Bowsprit
L.BwY	Length of Bowsprit Yard
W.MBwY	Width at Mid Bowsprit Yard
W.EBwY	Width at End Bowsprit Yard
Rk.T	Rake of Transom
Rk.Sc	Rake of Sterncastle
LS.Bn	Length from Stern to Bonaventure Mast

LB.Bn	Length from Bow to Bonaventure Mast
W.BtBn	Width of Bottom Lower Bonaventure Mast
W.TpBn	Width of Top Lower Bonaventure Mast
H.Bn	Height of Bonaventure Mast
H.LBn	Height of Lower Bonaventure Mast
H.UBn	Height of Upper Bonaventure Mast
W.BtUBn	Width of Bottom Upper Bonaventure Mast
W.TpUBn	Width of Top Upper Bonaventure Mast
L.BnY	Length of Bonaventure Yard
W.MBnY	Width of Mid Bonaventure Yard
W.EBnY	Width of End Bonaventure Yard
L.BnTpY	Length of Bonaventure Top Yard
W.MBnTpY	Width of Mid Bonaventure Top Yard
W.EBnTpY	Width of End Bonaventure Top Yard
H.BnCw	Height of Bonaventure Crowsnest
W.TpBnCw	Width of Top of Bonaventure Crowsnest
W.BtBnCw	Width of Bottom of Bonaventure Crowsnest
Rk.Bn	Rake of Bonaventure Mast
Bn Sa	Bonaventure Sail
BnTpSa	Bonaventure Top Sail
LS.Mz	Length from Stern to Mizzen Mast
LB.Mz	Length from Bow to Mizzen Mast
W.BtLMz	Width of Bottom of Lower Mizzen Mast
W.TpLMz	Width of of Top of Lower Mizzen Mast
H.Mz	Height of Mizzen Mast
H.LMz	Height of Lower Mizzen Mast
H.UMz	Height of Upper Mizzen Mast
W.BtUMz	Width of Bottom Upper Mizzen Mast
W.TpUMz	Width of Top Upper Mizzen Mast
Rk.Mz	Rake of Mizzen Mast
L.MzY	Length of Mizzen Yard
W.MMzY	Width of Mid Mizzen Yard
W.EMzY	Width of End Mizzen Yard
L.MzTY	Length of Mizzen Top Yard
W.MMzTY	Width of Mid Mizzen Top Yard
W.EMzTY	Width of End Mizzen Top Yard
H.MzCw	Height of Mizzen Crowsnest

W.TpMzCw	Width of Top Mizzen Crowsnest
W.BtMzCw	Width of Bottom Mizzen Crowsnest
MzSa	Mizzen Sail
MzTSa	Mizzen Top Sail
LS.Ma	Length from Stern to Main Mast
LB.Ma	Length from Bow to Main Mast
W.BtLMa	Width of Bottom of Lower Main Mast
W.TpLMa	Width of Top of Lower Main Mast
H.Ma	Height of Main Mast
H.LMa	Height of Lower Main Mast
H.UMa	Height of Upper Main Mast
H.RMa	Height of Royal Main Mast
Rk.Ma	Rake of Main Mast
W.BtUMa	Width of Bottom of Upper Main Mast
W.TpUMa	Width of Top of Upper Main Mast
W.BtRMa	Width of Bottom of Main Royal Mast
W.URMa	Width of Top of Main Royal Mast
H.MCw	Height of Main Crowsnest
W.TpMCw	Width of Top Main Crowsnest
W.BtMCw	Width of Bottom Main Crowsnest
H.MTpCw	Height of Main Top Crowsnest
W.TpMTpCw	Width of Top Main Top Crowsnest
W.BtMTpCw	Width of Bottom Main Top Crowsnest
MaSa	Main Sail
MaTSa	Main Top Sail
MaRSa	Main Royal Sail
L.MaY	Length of Main Yard
W.MMaY	Width of Mid Main Yard
W.EMaY	Width of End Main Yard
L.MaTy	Length of Main Top Yard
W.MMaTpY	Width of Mid Main Top Yard
W.EMaTpY	Width of End Main Top Yard
L.MaRY	Length of Main Royal Yard
W.MMaRY	Width of Mid Main Royal Yard
W.EMaRY	Width of End Main Royal Yard
LS.Fr	Length from Stern to Fore Mast
LB.Fr	Length from Bow to Fore Mast

W.BtLFr	Width of Bottom of lower Fore Mast
W.TpLFr	Width of Top of lower Fore Mast
H.Fr	Max Height of Fore Mast
H.LFr	Height of Lower Fore Mast
H.UFr	Height of Upper Fore Mast
H.RFr	Height of Royal Fore Mast
W.BtUFr	Width of Bottom of Upper Fore Mast
W.TpUFr	Width of Top of Upper Fore Mast
H.FCw	Height of Fore Crowsnest
W.TpFCw	Width of Top Fore Crowsnest
W.BtFCw	Width of Bottom Fore Crowsnest
W.BtRFr	Width of Bottom of Royal Fore Mast
W.URFr	Width of Top of Royal Fore Mast
H.FrTpCw	Height of Fore Top Crowsnest
W.TpFrTpCw	Width of Top Fore Top Crowsnest
W.BtFrTpCw	Width of Bottom Fore Top Crowsnest
FrSa	Fore Sail
FrTSa	Fore Top Sail
FrRSa	Fore Royal Sail
L.FrY	Length of Fore Yard
W.MFrY	Width of Mid Fore Yard
W.EFrY	Width of End Fore Yard
L.FrTpY	Length Fore Top Yard
W.MFrTpY	Width of Mid Fore Top Yard
W.EFrTpY	Width of End Fore Top Yard
L.FrRY	Length Fore Royal Yard
W.MFrRY	Width of Mid Fore Royal Yard
W.EFrRY	Width of End Fore Royal Yard
Rk.Fr	Rake Fore Mast
H.S	Height of Stern
W.S	Max Width of Stern
H.Ac	Height of Aftercastle
W.UAc	Width of Upper Aftercastle
W.LAc	Width of Lower Aftercastle
H.Sg	Height of Stern Gallery
W.Sg	Width of Stern Gallery
H.Md	Height of Mid Deck

W.LMd	Width of Lower Mid Deck
H.Tr	Height of Transom
W.LTr	Width of Lower Transom
H.Rd	Height of Rudder
W.Rd	Width of Rudder
Dg.Tp	Degree Taper of Stern

APPENDIX 5

RATIO LABELING SYSTEM FOR STATISTICAL ANALYSIS MEASUREMENTS

RATIO LABELING SYSTEM	
HULL CONSTRUCTION	
L.Wl_L.H	Length of Waterline: Length of Hull
R.S_L.H	Rise to Stern: Length of Hull
R.B_L.H	Rise to Bow: Length of Hull
R.B_R.S	Rise to Bow: Rise to Stern
L.Fc_L.H	Length of Forecastle: Length of Hull
L.Sc_L.H	Length of Sterncastle: Length of Hull
L.Fc_L.Sc	Length of Forecastle: Length of Sterncastle
L.Pd_L.Sc	Length of Poop Deck: Length of Sterncastle
L.Qd_L.Pd	Length of Quarter Deck: Length of Poop Deck:
H.Pd_H.Sc	Height of Poop Deck: Height of Sterncastle
H.Pd_H.Qd	Height of Poop Deck: Height of Quarter Deck
L.Qd_L.Sc	Length of Quarter Deck: Length of Sterncastle
L.Wa_L.H	Length of Waist: Length of Hull
L.Fc_L.Wa	Length of Forecastle: Length of Waist
L.Wa_L.Sc	Length of Waist :Length of Sterncastle
H.Wa_L.H	Height of Waist: Length of Hull
H.Fc_H.Sc	Height of Forecastle: Height of Sterncastle
H.Fc_L.Fc	Height of Forecastle: Length of Forecastle
H.Sc_L.Sc	Height of Sterncastle: Length of Sterncastle
D.UW_L.H	Depth of Upper Wale: Length of Hull
D.LW_L.H	Depth of Lower Wale: Length of Hull
L.Bh_L.H	Length of Beakhead: Length of Hull
H.Bh_H.Fc	Height of Beakhead: Height of Forecastle
D.Bh_H.Fc	Depth to Beakhead:Height of Forecastle
D.Bh_D.Bm	Depth to Beakhead: Depth of Boomkin
L.Bm_L.H	Length of Boomkin: Length of Hull
L.Bh_L.Bm	Length of Beakhead: Length of Boomkin
L.Bm_L.Bw	Length of Boomkin: Length of Bowsprit
D.Bm_H.Sc	Depth of Boomkin: Height of Sterncastle
L.Bw_L.H	Length of Bowsprit: Length of Hull

W.MBwY_L.BwY	Width at Mid Bowsprit Yard: Length of Bowsprit Yard
W.MBwY_W.EBwY	Width at Mid Bowsprit Yard: Width at End Bowsprit Yard
BONAVENTURE MAST	
LS.Bn_L.H	Length from Stern to Bon. Mast: Length of Hull
LS.Bn_L.Wl	Length from Stern to Bon. Mast: Length of Hull at Waterline
LB.Bn_L.H	Length from Bow to Bon. Mast: Length of Hull
W.BtLBn_H.Bn	Width of Bottom Lower Bon. Mast: Height of Bon. Mast
W.TpLBn_W.BtLBn	Width of Top Lower Bon. Mast: Width of Bottom Lower Bon. Mast
W.BtLBn_W.BtUBn	Width of Bottom Lower Bon. Mast: Width of Bottom Bon. Topmast
W.TpLBn_H.Bn	Width of Top Lower Bon. Mast: Height of Bon. Mast
W.TpLBn_W.TpUBn	Width of Top Lower Bon. Mast: Width of Top Bon. Topmast
H.Bn_L.H	Height of Bon. Mast: Length of Hull
H.LBn_H.Bn	Height of Lower Bon. Mast: Height of Bon. Mast
H.LBn_L.H	Height of Lower Bon. Mast: Length of Hull
H.UBn_H.Bn	Height of Bon. Topmast: Height of Bon. Mast
H.UBn_H.LBn	Height of Bon. Topmast: Height of Lower Bon. Mast
H.UBn_L.H	Height of Bon. Topmast: Length of Hull
W.BtUBn_H.UBn	Width of Bottom Bon. Topmast: Height of Bon. Topmast
W.BtUBn_W.TpUBn	Width of Bottom Bon. Topmast: Width of Top Bon. Topmast
W.TpUBn_H.UBn	Width of Top Bon. Topmast: Height of Bon. Topmast
L.BnY_L.H	Length of Bon. Yard: Length of Hull
L.BnTpY_L.BnY	Length of Bon. Top Yard: Length of Bon. Yard
W.EBnY_W.MBnY	Width of End Bon. Yard: Width of Mid Bon. Yard
W.MBnTpY_W.MBnY	Width of Mid Bon. Top Yard: Width of Mid Bon. Yard
W.EBnTpY_W.EBnY	Width of End Bon. Top Yard: Width of End Bon. Yard
L.BnTpY_L.H	Length of Bon. Top Yard: Length of Hull
W.MBnTpY_W.EBnTpY	Width of Mid Bon. Top Yard: Width of End Bon. Top Yard
H.BnCw_H.Bn	Height of Bon. Crowsnest: Height of Bon. Mast
W.TpBnCw_H.BnCw	Width of Top of Bon. Crowsnest: Height of Bon. Crowsnest
W.BtBnCw_H.BnCw	Width of Bottom of Bon. Crowsnest: Height of Bon. Crowsnest
W.BtBnCw_W.TpBnCw	Width of Bottom of Bon. Crowsnest: Width of Top of Bon. Crowsnest
MIZZEN MAST	
LS.Mz_L.H	Length from Stern to Miz. Mast: Length of Hull
LS.Mz_L.Wl	Length from Stern to Miz. Mast: Length of Hull at Waterline
LB.Mz_L.H	Length from Bow to Miz. Mast: Length of Hull

W.BtLMz_H.Mz	Width of Bottom of Lower Miz. Mast: Height of Miz. Mast
W.TpLMz_W.BtLMz	Width of Top of Lower Miz. Mast: Width of Bottom of Lower Miz. Mast
W.BtUMz_W.BtLMz	Width of Bottom Miz. Topmast: Width of Bottom of Lower Miz. Mast
W.TpLMz_H.Mz	Width of Top of Lower Miz. Mast: Height of Miz. Mast
W.TpUMz_W.TpLMz	Width of Top Miz. Topmast: Width of of Top of Lower Miz. Mast
H.Mz_L.H	Height of Miz. Mast: Length of Hull
H.LMz_H.Mz	Height of Lower Miz. Mast: Height of Miz. Mast
H.LMz_L.H	Height of Lower Miz. Mast: Length of Hull
H.UMz_H.Mz	Height of Miz. Topmast: Height of Miz. Mast
H.UMz_H.LMz	Height of Miz. Topmast: Height of Lower Miz. Mast
H.UMz_L.H	Height of Miz. Topmast: Length of Hull
W.TpUMz_H.UMz	Width of Top Miz. Topmast: Height of Miz. Topmast
W.BtUMz_H.UMz	Width of Bottom Miz. Topmast: Height of Miz. Topmast
W.TpUMz_W.BtUMz	Width of Top Miz. Topmast: Width of Bottom Miz. Topmast
L.MzY_L.H	Length of Miz. Yard: Length of Hull
L.MzTpY_L.MzY	Length of Miz. Top Yard: Length of Miz. Yard
W.EMzY_W.MMzY	Width of End Miz. Yard: Width of Mid Miz. Yard
W.MMzTpY_W.MMzY	Width of Mid Miz. Top Yard: Width of Mid Miz. Yard
W.EMzTpY_W.EMzY	Width of End Miz. Top Yard: Width of End Miz. Yard
L.MzTpY_L.H	Length of Miz. Top Yard: Length of Hull
W.EMzTpY_W.MMzTpY	Width of End Miz. Top Yard: Width of Mid Miz. Top Yard
H.MzCw_H.Mz	Height of Miz. Crowsnest: Height of Miz. Mast
H.MzCw_W.TpMzCw	Height of Miz. Crowsnest: Width of Top Miz. Crowsnest
W.BtMzCw_H.MzCw	Width of Bottom Miz. Crowsnest: Height of Miz. Crowsnest
W.BtMzCw_W.TpMzCw	Width of Bottom Miz. Crowsnest: Width of Top Miz. Crowsnest
MAIN MAST	
LS.Ma_L.H	Length from Stern to Main Mast: Length of Hull
LS.Ma_L.Wl	Length from Stern to Main Mast: Length of Hull at Waterline
LB.Ma_L.H	Length from Bow to Main Mast: Length of Hull
W.BtLMa_H.LMa	Width of Bottom of Lower Main Mast: Height of Lower Main Mast
W.TpLMa_W.BtLMa	Width of Top of Lower Main Mast: Width of Bottom of Lower Main Mast
W.BtUMa_W.BtLMa	Width of Bottom of Main Topmast: Width of Bottom of Lower Main Mast
W.TpLMa_H.LMa	Width of Top of lower Main Mast: Height of Lower Main Mast
W.TpUMa_W.TpLMa	Height of Main Mast: Length of Hull

H.Ma_L.H	Height of Lower Main Mast: Length of Hull
H.LMa_H.Ma	Height of Lower Main Mast: Height of Main Mast
H.LMa_L.H	Height of Main Topmast: Length of Hull
H.UMa_H.Ma	Height of Main Topmast: Height of Main Mast
H.UMa_H.LMa	Height of Main Topmast: Height of Lower Main Mast
H.UMa_L.H	Height of Royal Main Mast: Height of Main Mast
H.RMa_H.Ma	Height of Royal Main Mast: Length of Hull
H.RMa_L.H	Height of Royal Main Mast: Height of Lower Main Mast
H.RMa_H.LMa	Height of Royal Main Mast: Height of Main Topmast
H.Rma_H.Uma	Height of Royal Main Mast: Height of Main Topmast
W.BtUMa_H.UMa	Width of Bottom of Main Topmast: Height of Main Topmast
W.TpUMa_W.BtUMa	Width of Top of Main Topmast: Width of Bottom of Main Topmast
W.TpUMa_H.UMa	Width of Top of Main Topmast: Height of Main Topmast
W.BtRMa_H.RMa	Width of Bottom of Main Royal Mast: Height of Royal Main Mast
W.BtRMa_W.TpRMa	Width of Bottom of Main Royal Mast: Width of Top Main Top Crowsnest
W.TpRMa_H.RMa	Width of Top of Main Royal Mast: Height of Main Royal Mast
H.MCw_H.Ma	Height of Main Crowsnest: Height of Main Mast
H.MCw_W.TpMCw	Height of Main Crowsnest: Width of Top Main Crowsnest
H.MCw_W.BtMCw	Height of Main Crowsnest: Width of Bottom Main Top Crowsnest
W.BtMCw_W.TpMCw	Width of Bottom Main Top Crowsnest: Width of Top Main Top Crowsnest
H.MTpCw_H.Ma	Width of Top Main Top Crowsnest: Height of Main Mast
H.MTpCw_H.UMa	Width of Top Main Top Crowsnest: Height of Main Topmast
H.MTpCw_W.TpMTpCw	Width of Top Main Top Crowsnest: Width of Top Main Top Crowsnest
W.BtMTpCw_H.MTpCw	Width of Bottom Main Top Crowsnest: Height of Main Top Crowsnest
H.MTpCw_H.MCw	Width of Top Main Top Crowsnest: Height of Main Crowsnest
W.BtMTpCw_W.TpMTpCw	Width of Bottom Main Top Crowsnest: Width of Top Main Top Crowsnest
W.TpMTpCw_W.TpMCw	Width of Top Main Top Crowsnest: Width of Top Main Crowsnest
W.BtMTpCw_W.BtMCw	Width of Bottom Main Top Crowsnest: Width of Bottom Main Crowsnest
L.MaY_L.H	Length of Main Yard: Length of Hull
L.MaTpY_L.MaY	Length of Main Top Yard: Length of Main Yard
L.MaRY_L.MaY	Length of Main Royal Yard: Length of Main Yard
W.EMaY_W.MMaY	Width of End Main Yard: Width of Mid Main Yard
W.MMaTpY_W.MMaY	Width of Mid Main Top Yard: Width of Mid Main Yard
W.MMaRY_W.MMaY	Width of Mid Main Royal Yard: Width of Mid Main Yard

W.EMaRY_W.EMaY	Width of End Main Royal Yard: Width of End Main Yard
W.EMaTpY_W.EMaY	Width of End Main Top Yard: Width of End Main Yard
L.MaTpY_L.H	Length of Main Top Yard: Length of Hull
L.MaRY_L.MaTpY	Length of Main Royal Yard: Length of Main Top Yard
W.EMaTpY_W.MMaTpY	Width of End Main Top Yard: Width of Mid Main Top Yard
L.MaRY_L.H	Length of Main Royal Yard: Length of Hull
W.MMaRY_W.EMaRY	Width of Mid Main Royal Yard: Width of End Main Royal Yard
W.MMaRY_W.MMaTpY	Width of Mid Main Royal Yard: Width of Mid Main Top Yard
W.EMaRY_W.EMaTpY	Width of End Main Royal Yard: Width of End Main Top Yard
FORE MAST	
LS.Fr_L.H	Length from Stern to Fore Mast: Length of Hull
LS.Fr_L.Wl	Length from Stern to Fore Mast: Length of Waterline
LB.Fr_L.H	Length from Bow to Fore Mast: Length of Hull
W.BtLFr_H.LFr	Width of Bottom of lower Fore Mast: Height of Lower Fore Mast
W.TpLFr_W.BtLFr	Width of Top of lower Fore Mast: Width of Bottom of lower Fore Mast
W.BtUFr_W.BtLFr	Width of Bottom of Fore Topmast: Width of Bottom of lower Fore Mast
W.TpLFr_H.LFr	Width of Top of lower Fore Mast: Height of Lower Fore Mast
W.TpUFr_W.TpLFr	Width of Top of Fore Topmast: Width of Top of lower Fore Mast
H.Fr_L.H	Max Height of Fore Mast: Length of Hull
H.LFr_H.Fr	Height of Lower Fore Mast: Max Height of Fore Mast
H.LFr_L.H	Height of Lower Fore Mast: Length of Hull
H.UFr_H.Fr	Height of Fore Topmast: Max Height of Fore Mast
H.UFr_H.LFr	Height of Fore Topmast: Height of Lower Fore Mast
H.UFr_L.H	Height of Fore Topmast: Length of Hull
H.RFr_H.Fr	Height of Royal Fore Mast: Max Height of Fore Mast
H.RFr_L.H	Height of Royal Fore Mast: Length of Hull
H.RFr_H.LFr	Height of Royal Fore Mast: Height of Lower Fore Mast
H.RFr_H.UFr	Height of Royal Fore Mast: Height of Fore Topmast
W.BtUFr_H.Ufr	Width of Bottom of Fore Topmast: Height of Fore Topmast
W.TpUFr_W.BtUFr	Width of Top of Fore Topmast: Width of Bottom of Fore Topmast
W.TpUFr_H.Ufr	Width of Top of Fore Topmast: Height of Fore Topmast
H.FCw_H.Fr	Height of Fore Crowsnest: Max Height of Fore Mast
H.FCw_H.LFr	Height of Fore Crowsnest: Height of Lower Fore Mast
H.FCw_W.TpFCw	Height of Fore Crowsnest: Width of Top Fore Crowsnest
H.FCw_W.BtFCw	Height of Fore Crowsnest: Width of Bottom Fore Crowsnest

W.BtFCw_W.TpFCw	Width of Bottom Fore Crowsnest: Width of Top Fore Crowsnest
W.BtRFr_H.RFr	Width of Bottom of Royal Fore Mast: Height of Royal Fore Mast
W.BtRFr_W.TpRFr	Width of Bottom of Royal Fore Mast: Width of Top of Royal Fore Mast
W.TpRFr_H.RFr	Width of Top of Royal Fore Mast: Height of Royal Fore Mast
H.FTpCw_H.Fr	Height of Fore Top Crowsnest: Max Height of Fore Mast
H.FTpCw_H.UFr	Height of Fore Top Crowsnest: Height of Fore Topmast
H.FTpCw_W.TpFTpCw	Height of Fore Top Crowsnest: Width of Top Fore Top Crowsnest
H.FTpCw_W.BtFTpCw	Height of Fore Top Crowsnest: Width of Bottom Fore Top Crowsnest
H.FTpCw_H.FCw	Height of Fore Top Crowsnest: Height of Fore Top Crowsnest
W.BtFTpCw_W.TpFTpCw	Width of Bottom Fore Top Crowsnest: Width of Top Fore Top Crowsnest
W.TpFTpCw_W.TpFCw	Width of Top Fore Top Crowsnest: Width of Top Fore Crowsnest
W.BtFTpCw_W.BtFCw	Width of Bottom Fore Top Crowsnest: Width of Bottom Fore Crowsnest
L.FrY_L.H	Length of Fore Yard: Length of Hull
L.FrTpY_L.FrY	Length Fore Top Yard: Length of Fore Yard
L.FrRY_L.FrY	Length Fore Royal Yard: Length of Fore Yard
W.EFrY_W.MFrY	Width of End Fore Yard: Width of Mid Fore Yard
W.MFrTpY_W.MFrY	Width of Mid Fore Top Yard: Width of Mid Fore Yard
W.MFrRY_W.MFrY	Width of End Fore Royal Yard: Width of Mid Fore Yard
W.EFrRY_W.EFrY	Width of End Fore Royal Yard: Width of End Fore Yard
W.EFrTpY_W.EFrY	Width of End Fore Top Yard: Width of End Fore Yard
L.FrTpY_L.H	Length Fore Top Yard: Length of Hull
L.FrRY_L.FrTpY	Length Fore Royal Yard: Length Fore Top Yard
W.EFrTpY_W.MFrTpY	Width of End Fore Top Yard: Width of Mid Fore Top Yard
L.FrRY_L.H	Length Fore Royal Yard: Length of Hull
W.MFrRY_W.EFrRY	Width of Mid Fore Royal Yard: Width of End Fore Royal Yard
W.MFrRY_W.MFrTpY	Width of Mid Fore Royal Yard: Width of Mid Fore Top Yard
W.EFrRY_W.EFrTpY	Width of End Fore Royal Yard: Width of End Fore Top Yard
STERN	
W.S_H.S	Max Width of Stern: Height of Stern
H.Ac_H.S	Height of Aftercastle: Height of Stern
H.Ac_W.Uac	Height of Aftercastle: Width of Upper Aftercastle
W.UAc_W.S	Width of Upper Aftercastle: Max Width of Stern
H.Ac_W.Lac	Height of Aftercastle: Width of Lower Aftercastle
W.LAc_W.S	Width of Lower Aftercastle: Max Width of Stern

H.Sg_H.S	Height of Stern Gallery: Height of Stern
H.Sg_W.Sg	Height of Stern Gallery: Width of Stern Gallery
W.Sg_W.S	Width of Stern Gallery: Max Width of Stern
H.Md_H.S	Height of Mid Deck: Height of Stern
H.Md_W.LMd	Height of Mid Deck: Width of Lower Mid Deck
W.LMd_W.S	Width of Lower Mid Deck: Max Width of Stern
H.Tr_H.S	Height of Transom: Height of Stern
H.Tr_W.LMd	Height of Transom: Width of Lower Mid Deck
H.Tr_W.LTr	Height of Transom: Width of Lower Transom
W.LTr_W.S	Width of Lower Transom: Max Width of Stern
H.Rd_H.S	Height of Rudder: Height of Stern
W.Rd_H.Rd	Width of Rudder: Height of Rudder
W.Rd_W.S	Width of Rudder: Max Width of Stern

APPENDIX 6

CARAVEL RIG CONFIGURATIONS

1 MASTED	**LATEEN MAIN**
MA03.16	1509
CA22.03	1572
2 MASTED	**LATEEN MAIN, FORE**
CA29.01	1588-98
2 MASTED	**LATEEN MIZZEN, MAIN**
CA01.01	1500
CA01.02	1500
CA01.04	1500
CA01.05	1500
CA01.07	1500
MA03.05	1509
MA03.06	1509
MA03.10	1509
CA03.03	1513
CA03.04	1513
CA03.06	1513
CA03.08	1513
MA08.01	1515-25
MA10.06	1517-26
MA10.07	1517-26
MA10.09	1517-26
PA03.01	1520
PA04.04	1521-30
MA11.04	1530-34
MA11.05	1530-34
MA11.09	1530-34
CA22.01	1572
CA22.02	1572
CA22.04	1572
CA22.05	1572
CA22.07	1572
CA22.08	1572

CA22.09	1572
CA22.13	1572
CA22.14	1572
CA22.16	1572
CA22.23	1572
CA22.25	1572
CA22.31	1572
CA22.32	1572
CA22.33	1572
CA29.02	1588-98
CA29.03	1588-98
3 MASTED	**LATEEN BONAVENTURE, MIZZEN, MAIN**
CA01.03	1500
CA01.06	1500
MA08.02	1515-25
CA04.09	1519
CA04.10	1519
CA04.12	1519
CA04.13	1519
CA04.31	1519
MA12.03	1535-70
CA09.01	1538
MA13.16	1538-40
CA22.34	1572
CA22.35	1572
CA27.02	1583-88
3 MASTED	**LATEEN MIZZEN, MAIN, FORE**
MA20.01	1616
4 MASTED	**LATEEN BONAVENTURE, MIZZEN, MAIN, FORE**
CA27.02	1583-88
CA27.05	1583-88
4 MASTED	**LATEEN BONAVENTURE, MIZZEN, MAIN AND SQUARE FORE**
MA06.01	1500-25
MA14.03	1538-50
MA14.09	1538-50
CA20.01	1565

4 MASTED	LATEEN BONAVENTURE, MIZZEN, MAIN SQUARE FORE, UPPER FORE
MA01.02	1485
MA13.03	1538-40
MA13.10	1538-40
CA10.02	1541
CA13.02	1550
CA14.02	1556
CA14.03	1556
CA22.18	1572
CA22.20	1572
CA22.29	1572
MA15.1501.09	1558-61
MA15.1501.12	1558-61
MA15.1502.02	1558-61
MA15.1502.05	1558-61
MA15.1505.05	1558-61
MA15.1505.18	1558-61
MA15.1519.17	1558-61
MA15.1524.07	1558-61
MA15.1528.01	1558-61
MA15.1533.14	1558-61
MA15.1533.15	1558-61
MA15.1554.03	1558-61
MA15.1554.12	1558-61
MA15.1501.04	1566
MA15.1502.01	1566
MA15.1502.02	1566
MA15.1502.11	1566
MA15.1502.13	1566
MA15.1505.11	1566
MA15.1505.16	1566
MA15.1524.11	1566
MA15.1524.12	1566
MA15.1524.14	1566
MA15.1528.03	1566
MA15.1528.10	1566
MA15.1530.02	1566

MA15.1530.06	1566
MA15.1533.08	1566
MA15.1533.10	1566
MA15.1533.11	1566
MA15.1533.12	1566
MA15.1533.14	1566
MA15.1533.15	1566
MA15.1533.16	1566
MA15.1533.17	1566
MA15.1533.19	1566
EN03.01	1583
CA28.01	1584
CA34.01	1593
CA34.02	1593

APPENDIX 7

CARAVEL SAIL SETTINGS

ONE-MASTED CARAVELS			
LATEEN MAIN MAST			
IMAGE #	**POSITION**	**MAIN SAIL**	**MAIN YARD**
MA03.16	Anch	Furled	Raised
CA22.03	Sail	Unfurled	Raised

TWO-MASTED CARAVELS					
LATEEN MAIN AND FORE MAST					
IMAGE #	**POSITION**	**MAIN SAIL**	**MAIN YARD**	**FORE SAIL**	**FORE YARD**
CA29.01	Anch	No Sail	No Yard	No Sail	No Yard
LATEEN MIZZEN AND MAIN MAST					
IMAGE #	**POSITION**	**MIZ. SAIL**	**MIZ. YARD**	**MAIN SAIL**	**MAIN YARD**
CA22.25	Anch	Furled	Lowered	Furled	Lowered
CA22.07	Anch	Furled	Raised	Furled	Lowered
MA03.05	Anch	Furled	Raised	Furled	Raised
MA03.06	Anch	Furled	Raised	Furled	Raised
MA03.10	Anch	Furled	Raised	Furled	Raised
MA10.06	Anch	Furled	Raised	Furled	Raised
MA10.07	Anch	Furled	Raised	Furled	Raised
MA10.09	Anch	Furled	Raised	Furled	Raised
CA22.01	Anch	Furled	Raised	Furled	Raised
CA22.02	Anch	Furled	Raised	Furled	Raised
CA22.04	Anch	Furled	Raised	Furled	Raised
CA22.09	Anch	Furled	Raised	Furled	Raised
CA22.13	Anch	Furled	Raised	Furled	Raised
CA22.14	Anch	Furled	Raised	Furled	Raised
CA22.16	Anch	Furled	Raised	Furled	Raised
CA22.23	Anch	Furled	Raised	Furled	Raised

CA22.31	Anch	Furled	Raised	Furled	Raised
CA22.32	Anch	Furled	Raised	Furled	Raised
CA29.03	Anch	Furled	Raised	Furled	Raised
CA01.01	Sail	Furled	Raised	Unfurled	Raised
CA01.04	Sail	Furled	Raised	Unfurled	Raised
CA01.05	Sail	Furled	Raised	Unfurled	Raised
CA03.03	Sail	Furled	Raised	Unfurled	Raised
CA03.04	Sail	Furled	Raised	Unfurled	Raised
CA03.08	Sail	Furled	Raised	Unfurled	Raised
PA03.01	Sail	Furled	Raised	Unfurled	Raised
MA11.04	Sail	Furled	Raised	Unfurled	Raised
CA22.33	Sail	Furled	Raised	Unfurled	Raised
CA01.07	Sail	Unfurled	Raised	Unfurled	Raised
PA04.04	Sail	Unfurled	Raised	Unfurled	Raised
CA03.06	Sail	Unfurled	Raised	Unfurled	Raised
MA08.01	Sail	Unfurled	Raised	Unfurled	Raised
MA11.05	Sail	Unfurled	Raised	Unfurled	Raised
MA11.09	Sail	Unfurled	Raised	Unfurled	Raised
CA09.01	Sail	Unfurled	Raised	Unfurled	Raised
CA22.05	Sail	Unfurled	Raised	Unfurled	Raised
CA22.08	Sail	Unfurled	Raised	Unfurled	Raised
CA29.02	Sail	Unfurled	Raised	Unfurled	Raised
CA01.02	Sail	No Sail	No Yard	Unfurled	Raised

THREE-MASTED CARAVELS					
LATEEN BONAVENTURE, MIZZEN, AND MAIN MAST					
IMAGE #	**POSITION**	**BON. SAIL**	**BON. YARD**	**MIZ. SAIL**	**MIZ. YARD**
CA01.06	Anch	Furled	Raised	Furled	Raised
CA22.35	Anch	Furled	Raised	Furled	Raised
CA27.02	Anch	Furled	Raised	Furled	Raised
CA01.03	Sail	Furled	Raised	Furled	Raised

CA04.09	Sail	Furled	Raised	Furled	Raised
CA04.10	Sail	Furled	Raised	Furled	Raised
CA04.12	Sail	Furled	Raised	Furled	Raised
CA04.31	Sail	Furled	Raised	Furled	Raised
MA08.02	Sail	Furled	Raised	Unfurled	Raised
CA04.13	Sail	Furled	Raised	Unfurled	Raised
CA05.03	Sail	Unfurled	Raised	Furled	Raised
MA12.03	Sail	Unfurled	Raised	Unfurled	Raised
CA22.34	Sail	Unfurled	Raised	Unfurled	Raised
IMAGE # Cont.	**MAIN SAIL**	**MAIN YARD**			
CA01.06	Furled	Raised			
CA22.35	Furled	Raised			
CA27.02	Furled	Raised			
CA01.03	Unfurled	Raised			
CA04.09	Unfurled	Raised			
CA04.10	Unfurled	Raised			
CA04.12	Unfurled	Raised			
CA04.31	Unfurled	Raised			
MA08.02	Unfurled	Raised			
CA04.13	Unfurled	Raised			
CA05.03	Unfurled	Raised			
MA12.03	Unfurled	Raised			
CA22.34	Unfurled	Raised			
LATEEN MIZZEN, MAIN, AND FORE MAST					
IMAGE #	**POSITION**	**MIZ. SAIL**	**MIZ. YARD**	**MAIN SAIL**	**MAIN YARD**
MA13.16	Sail	Unfurled	Raised	Furled	Raised
IMAGE # Cont.	**FORE SAIL**	**FORE YARD**	**BOWSPRIT**	**SPRITSAIL**	
MA13.16	Unfurled	Raised	Present	Absent	

FOUR-MASTED CARAVELS							
LATEEN BONAVENTURE, MIZZEN, MAIN, AND FORE MAST							
IMAGE #	**POSITION**	**BON. SAIL**	**BON. YARD**	**MIZ. SAIL**	**MIZ. YARD**	**MAIN SAIL**	
CA27.05	Anch	Furled	Raised	Furled	Raised	Furled	
IMAGE # Cont.	**MAIN YARD**	**FORE SAIL**	**FORE YARD**	**BOW SPRIT**	**SPRIT SAIL**		
CA27.05	Raised	Furled	Raised	Present	Furled		
LATEEN BONAVENTURE, MIZZEN, AND MAIN MAST				SQUARE FORE MAST			
IMAGE #	**POSITION**	**BON. SAIL**	**BON. YARD**	**MIZ. SAIL**	**MIZ. YARD**	**MAIN SAIL**	
MA14.03	Anch	Furled	Raised	Furled	Raised	Furled	
MA14.09	Anch	Furled	Raised	Furled	Raised	Furled	
MA06.01	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled	
MA15.1554.03	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled	
CA20.01	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled	
IMAGE # Cont.	**MAIN YARD**	**FORE SAIL**	**FORE YARD**	**BOW SPRIT**	**SPRIT SAIL**		
MA14.03	Raised	Furled	Half Raised	Present	Absent		
MA14.09	Raised	Furled	Half Raised	Present	Absent		
MA06.01	Raised	Unfurled	Raised	Present	Unfurled		
MA15.1554.03	Raised	Unfurled	Raised	Present	Absent		
CA20.01	Raised	Unfurled	Raised	Present	Absent		
LATEEN BONAVENTURE, MIZZEN, AND MAIN MAST				SQUARE FORE AND UPPER FORE MAST			
IMAGE #	**POSITION**	**BON. SAIL**	**BON. YARD**	**MIZ. SAIL**	**MIZ. YARD**	**MAIN SAIL**	**MAIN YARD**
MA16.1524-12	Battle	Furled	Raised	Being Furled	Raised	Being Furled	Raised
MA16.1528-03	Anch	Furled	Raised	Being Furled	Raised	Being Furled	Raised
MA16.1524-14	Battle	Furled	Raised	Being Furled	Raised	Being Furled	Raised
MA16.1524-11	Battle	Furled	Raised	Furled	Raised	Being Furled	Raised
CA10.02	Anch	Furled	Raised	Furled	Raised	Furled	Raised
CA22.29	Anch	Furled	Raised	Furled	Raised	Furled	Raised
CA22.20	Anch	Furled	Raised	Furled	Raised	Furled	Raised
CA34.01	Anch	Furled	Raised	Furled	Raised	Furled	Raised

CA34.02	Anch	Furled	Raised	Furled	Raised	Furled	Raised
MA13.10	Anch	Furled	Raised	Furled	Raised	Furled	Raised
MA15.1505.05	Sail	Furled	Raised	Furled	Raised	Furled	Raised
MA15.1505.18	Sail	Furled	Raised	Furled	Raised	Furled	Raised
MA15.1524.07	Battle	Furled	Raised	Furled	Raised	Unfurled	Raised
MA15.1533.14	Sail	Furled	Raised	Furled	Raised	Unfurled	Raised
MA16.1502-11	Sail	Furled	Raised	Furled	Raised	Unfurled	Raised
MA16.1505-16	Sail	Furled	Raised	Furled	Raised	Unfurled	Raised
MA16.1533-12	Sail	Furled	Raised	Furled	Raised	Unfurled	Raised
MA16.1533-17	Sail	Furled	Raised	Furled	Raised	Unfurled	Raised
CA22.18	Sail	Furled	Raised	Furled	Raised	Unfurled	Raised
MA16.1528-10	Sail	Furled	Raised	Furled	Raised	Unfurled	Raised
MA16.1533-16	Sail	Furled	Raised	Furled	Raised	Unfurled	Raised
EN03.01	Sail	Furled	Raised	Unfurled	Raised	Unfurled	Raised
MA15.1501.09	Sail	Furled	Raised	Unfurled	Raised	Unfurled	Raised
MA16.1533-08	Sail	Furled	Raised	Unfurled	Raised	Unfurled	Raised
MA16.1501-04	Sail	Furled	Raised	Unfurled	Raised	Unfurled	Raised
MA16.1502-02	Sail	Furled	Raised	Unfurled	Raised	Unfurled	Raised
MA16.1502-13	Sail	Furled	Raised	Unfurled	Raised	Unfurled	Raised
MA16.1505-11	Sail	Furled	Raised	Unfurled	Raised	Unfurled	Raised
MA16.1530-02	Sail	Furled	Raised	Unfurled	Raised	Unfurled	Raised
MA16.1530-06	Sail	Furled	Raised	Unfurled	Raised	Unfurled	Raised
MA16.1533-10	Sail	Furled	Raised	Unfurled	Raised	Unfurled	Raised
MA16.1533-11	Sail	Furled	Raised	Unfurled	Raised	Unfurled	Raised
MA16.1533-14	Sail	Furled	Raised	Unfurled	Raised	Unfurled	Raised
MA16.1533-15	Sail	Furled	Raised	Unfurled	Raised	Unfurled	Raised
MA16.1533-19	Sail	Furled	Raised	Unfurled	Raised	Unfurled	Raised
MA15.1501.12	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled	Raised
MA15.1533.15	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled	Raised
CA28.01	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled	Raised
MA15.1502.02	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled	Raised
CA13.02	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled	Raised
MA01.02	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled	Raised

CA14.02	Battle	Unfurled	Raised	Unfurled	Raised	Unfurled	Raised
MA15.1519.17	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled	Raised
MA15.1554.12	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled	Raised
MA13.03	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled	Raised
MA15.1502.05	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled	Raised
IMAGE # Cont.	**FORE SAIL**	**FORE YARD**	**FORE T.SAIL**	**FORE T.YARD**	**BOW SPRIT**	**SPRIT SAIL**	
MA16.1524-12	Furled	Raised	Furled	Lowered	Present	Absent	
MA16.1528-03	Furled	Raised	Furled	Lowered	Present	Absent	
MA16.1524-14	Unfurled	Half Raised	Furled	Lowered	Present	Absent	
MA16.1524-11	Furled	Raised	Furled	Lowered	Present	Absent	
CA10.02	Furled	Half Raised	Furled	Lowered	Present	Absent	
CA22.29	Furled	Half Raised	Furled	Lowered	Present	Absent	
CA22.20	Furled	Half Raised	Furled	Raised	Present	Absent	
CA34.01	Furled	Half Raised	Furled	Half Raised	Present	Absent	
CA34.02	Furled	Half Raised	Furled	Half Raised	Present	Absent	
MA13.10	Furled	Raised	Furled	Lowered	Present	Absent	
MA15.1505.05	Unfurled	Raised	Furled	Lowered	Present	Absent	
MA15.1505.18	Unfurled	Raised	Furled	Lowered	Present	Absent	
MA15.1524.07	Half Unfurled	Half Raised	Furled	Lowered	Present	Absent	
MA15.1533.14	Unfurled	Raised	Unfurled	Raised	Present	Absent	
MA16.1502-11	Unfurled	Raised	Furled	Lowered	Present	Absent	
MA16.1505-16	Unfurled	Raised	Furled	Lowered	Present	Absent	
MA16.1533-12	Unfurled	Raised	Furled	Lowered	Present	Absent	
MA16.1533-17	Unfurled	Raised	Furled	Lowered	Present	Absent	
CA22.18	Unfurled	Raised	Furled	Lowered	Present	Absent	
MA16.1528-10	Furled	Raised	Furled	Lowered	Present	Absent	
MA16.1533-16	Furled	Raised	Furled	Lowered	Present	Absent	
EN03.01	Unfurled	Raised	Unfurled	Raised	Present	Absent	
MA15.1501.09	Unfurled	Raised	Furled	Lowered	Present	Absent	
MA16.1533-08	Unfurled	Raised	Furled	Lowered	Present	Absent	

MA16.1501-04	Furled	Raised	Furled	Lowered	Present	Absent	
MA16.1502-02	Furled	Raised	Furled	Lowered	Present	Absent	
MA16.1502-13	Furled	Raised	Furled	Lowered	Present	Absent	
MA16.1505-11	Furled	Raised	Furled	Lowered	Present	Absent	
MA16.1530-02	Furled	Raised	Furled	Lowered	Present	Absent	
MA16.1530-06	Furled	Raised	Furled	Lowered	Present	Absent	
MA16.1533-10	Furled	Raised	Furled	Lowered	Present	Absent	
MA16.1533-11	Furled	Raised	Furled	Lowered	Present	Absent	
MA16.1533-14	Furled	Raised	Furled	Lowered	Present	Absent	
MA16.1533-15	Furled	Raised	Furled	Lowered	Present	Absent	
MA16.1533-19	Furled	Raised	Furled	Lowered	Present	Absent	
MA15.1501.12	Unfurled	Raised	Furled	Lowered	Present	Absent	
MA15.1533.15	Unfurled	Raised	Furled	Lowered	Present	Absent	
CA28.01	Unfurled	Raised	Furled	Lowered	Present	Unfurled	
MA15.1502.02	Unfurled	Raised	Furled	Half Raised	Present	Absent	
CA13.02	Unfurled	Raised	Unfurled	Raised	Present	Unfurled	
MA01.02	Unfurled	Raised	Unfurled	Raised	Present	Absent	
CA14.02	Unfurled	Raised	Unfurled	Raised	Present	Absent	
MA15.1519.17	Unfurled	Raised	Unfurled	Raised	Present	Absent	
MA15.1554.12	Unfurled	Raised	Unfurled	Raised	Present	Absent	
MA13.03	Furled	Half Raised	Furled	Half Raised	Present	Absent	
MA15.1502.05	Furled	Raised	Furled	Lowered	Present	Absent	

APPENDIX 8

CARAVEL SAIL SETTINGS BY GROUPINGS

ONE-MASTED CARAVELS				
LATEEN MAIN MAST				
GROUP #	**POSITION**	**MAIN SAIL**	**MAIN YARD**	**#**
1C-A	Anch	Furled	Raised	**N=1**
1C-B	Sail	Unfurled	Raised	**N=1**

TWO-MASTED CARAVELS						
LATEEN MAIN AND FORE MAST						
GROUP #	**POSITION**	**MAIN SAIL**	**MAIN YARD**	**FORE SAIL**	**FORE YARD**	**#**
2C-1	Anch	No Sail	No Yard	No Sail	No Yard	**N=1**
LATEEN MIZZEN AND MAIN MAST						
GROUP #	**POSITION**	**MIZ. SAIL**	**MIZ. YARD**	**MAIN SAIL**	**MAIN YARD**	**#**
2C-2	Anch	Furled	Lowered	Furled	Lowered	**N=1**
2C-3	Anch	Furled	Raised	Furled	Lowered	**N=1**
2C-4	Anch	Furled	Raised	Furled	Raised	**N=17**
2C-5	Sail	Furled	Raised	Unfurled	Raised	**N=9**
2C-6	Sail	Unfurled	Raised	Unfurled	Raised	**N=10**
2C-7	Sail	No Sail	No Yard	Unfurled	Raised	**N=1**

THREE-MASTED CARAVELS							
LATEEN BONAVENTURE, MIZZEN, AND MAIN MAST							
GROUP #	**POSITION**	**BON. SAIL**	**BON. YARD**	**MIZ. SAIL**	**MIZ. YARD**	**MAIN SAIL**	
3C-1	Anch	Furled	Raised	Furled	Raised	Furled	
3C-2	Sail	Furled	Raised	Furled	Raised	Unfurled	
3C-3	Sail	Furled	Raised	Unfurled	Raised	Unfurled	
3C-4	Sail	Unfurled	Raised	Furled	Raised	Unfurled	

3C-5	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled	
GROUP # Cont.	**MAIN YARD**	**#**					
3C-1	Raised	**N=3**					
3C-2	Raised	**N=5**					
3C-3	Raised	**N=2**					
3C-4	Raised	**N=1**					
3C-5	Raised	**N=2**					
LATEEN MIZZEN, MAIN, AND FORE MAST							
GROUP #	**POSITION**	**MIZ. SAIL**	**MIZ. YARD**	**MAIN SAIL**	**MAIN YARD**	**FORE SAIL**	**FORE YARD**
3C-6	Sail	Unfurled	Raised	Furled	Raised	Unfurled	Raised
GROUP # Cont.	**BOW SPRIT**	**SPRIT SAIL**	**#**				
3C-6	Present	Absent	**N=1**				

FOUR-MASTED CARAVELS							
LATEEN BONAVENTURE, MIZZEN, MAIN, AND FORE MAST							
GROUP #	**POSITION**	**BON. SAIL**	**BON. YARD**	**MIZ. SAIL**	**MIZ. YARD**	**MAIN SAIL**	**MAIN YARD**
4C-1	Anch	Furled	Raised	Furled	Raised	Furled	Raised
GROUP # Cont.	**FORE SAIL**	**FORE YARD**	**BOW SPRIT**	**SPRIT SAIL**	**#**		
4C-1	Furled	Raised	Present	Furled	**N=1**		
LATEEN BONAVENTURE, MIZZEN, AND MAIN MAST				SQUARE FORE MAST			
GROUP #	**POSITION**	**BON. SAIL**	**BON. YARD**	**MIZ. SAIL**	**MIZ. YARD**	**MAIN SAIL**	**MAIN YARD**
4C-2	Anch	Furled	Raised	Furled	Raised	Furled	Raised
4C-3	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled	Raised
4C-4	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled	Raised
GROUP # Cont.	**FORE SAIL**	**FORE YARD**	**BOW SPRIT**	**SPRIT SAIL**	**#**		
4C-2	Furled	Half Raised	Present	Absent	**N=2**		
4C-3	Unfurled	Raised	Present	Unfurled	**N=1**		
4C-4	Unfurled	Raised	Present	Absent	**N=2**		

LATEEN BONAVENTURE, MIZZEN, AND MAIN MAST				SQUARE FORE AND UPPER FORE MAST			
GROUP #	**POSITION**	**BON. SAIL**	**BON. YARD**	**MIZ. SAIL**	**MIZ. YARD**	**MAIN SAIL**	**MAIN YARD**
4C-5	Battle, Anch	Furled	Raised	Being Furled	Raised	Being Furled	Raised
4C-6	Battle	Furled	Raised	Being Furled	Raised	Being Furled	Raised
4C-7	Battle	Furled	Raised	Furled	Raised	Being Furled	Raised
4C-8	Anch	Furled	Raised	Furled	Raised	Furled	Raised
4C-9	Anch	Furled	Raised	Furled	Raised	Furled	Raised
4C-10	Anch	Furled	Raised	Furled	Raised	Furled	Raised
4C-11	Anch	Furled	Raised	Furled	Raised	Furled	Raised
4C-12	Sail	Furled	Raised	Furled	Raised	Furled	Raised
4C-13	Battle	Furled	Raised	Furled	Raised	Unfurled	Raised
4C-14	Sail	Furled	Raised	Furled	Raised	Unfurled	Raised
4C-15	Sail	Furled	Raised	Furled	Raised	Unfurled	Raised
4C-16	Sail	Furled	Raised	Furled	Raised	Unfurled	Raised
4C-17	Sail	Furled	Raised	Unfurled	Raised	Unfurled	Raised
4C-18	Sail	Furled	Raised	Unfurled	Raised	Unfurled	Raised
4C-19	Sail	Furled	Raised	Unfurled	Raised	Unfurled	Raised
4C-20	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled	Raised
4C-21	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled	Raised
4C-22	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled	Raised
4C-23	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled	Raised
4C-24	Battle, Sail	Unfurled	Raised	Unfurled	Raised	Unfurled	Raised
4C-25	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled	Raised
4C-26	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled	Raised
GROUP # Cont.	**FORE SAIL**	**FORE YARD**	**FORE T.SAIL**	**FORE T.YARD**	**BOW SPRIT**	**SPRIT SAIL**	**#**
4C-5 Cont.	Furled	Raised	Furled	Lowered	Present	Absent	**N=2**
4C-6 Cont.	Unfurled	Half Raised	Furled	Lowered	Present	Absent	**N=1**
4C-7 Cont.	Furled	Raised	Furled	Lowered	Present	Absent	**N=1**
4C-8 Cont.	Furled	Half Raised	Furled	Lowered	Present	Absent	**N=2**
4C-9 Cont.	Furled	Half Raised	Furled	Raised	Present	Absent	**N=1**

4C-10 Cont.	Furled	Half Raised	Furled	Half Raised	Present	Absent	**N=2**
4C-11 Cont.	Furled	Raised	Furled	Lowered	Present	Absent	**N=1**
4C-12 Cont.	Unfurled	Raised	Furled	Lowered	Present	Absent	**N=2**
4C-13 Cont.	Half Unfurled	Half Raised	Furled	Lowered	Present	Absent	**N=1**
4C-14 Cont.	Unfurled	Raised	Unfurled	Raised	Present	Absent	**N=1**
4C-15 Cont.	Unfurled	Raised	Furled	Lowered	Present	Absent	**N=5**
4C-16 Cont.	Furled	Raised	Furled	Lowered	Present	Absent	**N=2**
4C-17 Cont.	Unfurled	Raised	Unfurled	Raised	Present	Absent	**N=1**
4C-18 Cont.	Unfurled	Raised	Furled	Lowered	Present	Absent	**N=2**
4C-19 Cont.	Furled	Raised	Furled	Lowered	Present	Absent	**N=11**
4C-20 Cont.	Unfurled	Raised	Furled	Lowered	Present	Unfurled	**N=1**
4C-21 Cont.	Unfurled	Raised	Furled	Lowered	Present	Absent	**N=2**
4C-22 Cont.	Unfurled	Raised	Furled	Half Raised	Present	Absent	**N=1**
4C-23 Cont.	Unfurled	Raised	Furled	Half Raised	Present	Unfurled	**N=1**
4C-24 Cont.	Unfurled	Raised	Unfurled	Raised	Present	Unfurled	**N=4**
4C-25 Cont.	Furled	Half Raised	Furled	Half Raised	Present	Absent	**N=1**
4C-26 Cont.	Furled	Raised	Furled	Lowered	Present	Absent	**N=1**

APPENDIX 9

GALLEON RIG CONFIGURATIONS

3 MASTED	**LATEEN MIZZEN AND SQUARE MAIN, FORE**
MA03.09	1509
CA04.26	1519
CA04.32	1519
3 MASTED	**LATEEN MIZZEN AND SQUARE MAIN, FORE, UPPER FORE**
CA04.27	1519
3 MASTED	**LATEEN MIZZEN AND SQUARE MAIN, UPPER MAIN, FORE, UPPER FORE**
CA04.28	1519
CA04.29	1519
CA04.33	1519
CA04.34	1519
MA14.05	1538-50
PA06.01	1552
MA15.1502.01	1558-61
EN04.03	1589
PA08.01	1593
PA09.01	END XVI
PA09.03	END XVI
4 MASTED	**LATEEN BONAVENTURE, MIZZEN AND SQUARE MAIN, UPPER MAIN, FORE**
MA02.01	1502
CA05.03	1519
4 MASTED	**LATEEN BONAVENTURE, MIZZEN AND SQUARE MAIN, UPPER MAIN, FORE, UPPER FORE**
PA04.03	1521-30
MA13.12	1538-40
MA13.15	1538-40
CA10.01	1541
CA15.06	1558
MA15.1555.00	1558-61
EN04.01	1589
EN04.02	1589
PA09.02	END XVI

4 MASTED	LATEEN BONAVENTURE, MIZZEN AND SQUARE MAIN, UPPER MAIN, MAIN TOPGALLANT, FORE, UPPER FORE
MA13.04	1538-40
CA22.22	1572
CA34.03	1593
4 MASTED	**LATEEN BONAVENTURE, MIZZEN AND SQUARE MAIN, UPPER MAIN, MAIN TOPGALLANT, FORE, UPPER FORE, FORE TOPGALLANT**
CA15.04	1558
4 MASTED	**LATEEN BONAVENTURE, MIZZEN UPPER MIZZEN AND SQUARE MAIN, UPPER MAIN, MAIN TOPGALLANT, FORE, UPPER FORE, FORE TOPGALLANT**
MA13.01	1538-40
MA13.09	1538-40

APPENDIX 10

GALLEON SAIL SETTINGS

THREE-MASTED GALLEONS							
LATEEN MIZZEN			**SQUARE MAIN AND FORE**				
IMAGE #	**POSITION**	**MIZ. SAIL**	**MIZ. YARD**	**MAIN SAIL**	**MAIN YARD**	**FORE SAIL**	**FORE YARD**
CA14.04	Anch	Furled	Lowered	Half Unfurled	Half Raised	Furled	Lowered
CA23.01	Anch	Furled	Raised	Furled	Half Raised	Furled	Lowered
MA03.09	Anch	Furled	Raised	Furled	Lowered	No Sail	No Yard
CA04.26	Anch	Furled	Raised	Furled	Raised	Furled	Raised
IMAGE # Cont.	**BOW SPRIT**	**SPRIT SAIL**					
CA14.04	Present	Furled					
CA23.01	Absent	Absent					
MA03.09	Present	Absent					
CA04.26	Present	Absent					
LATEEN MIZZEN			**SQUARE MAIN, FORE, AND FORE TOP**				
IMAGE #	**POSITION**	**MIZ. SAIL**	**MIZ. YARD**	**MAIN SAIL**	**MAIN YARD**	**FORE SAIL**	**FORE YARD**
CA04.27	Sail	Furled	Raised	Unfurled	Raised	Furled	Lowered
IMAGE # Cont.	**FORE T.SAIL**	**FORE T.YARD**	**BOW SPRIT**	**SPRIT SAIL**			
CA04.27	Furled	Lowered	Present	Absent			
LATEEN MIZZEN			**SQUARE MAIN, MAIN TOP, FORE, AND FORE TOP**				
IMAGE #	**POSITION**	**MIZ. SAIL**	**MIZ. YARD**	**MAIN SAIL**	**MAIN YARD**	**MAIN T.SAIL**	**MAIN T.YARD**
MA14.05	Anch	Furled	Raised	Furled	Half Raised	Furled	Lowered
PA08.01	Battle	Furled	Raised	Unfurled	Raised	Unfurled	Raised
CA04.28	Sail	Unfurled	Raised	Unfurled	Raised	Furled	Lowered
CA04.29	Sail	Unfurled	Raised	Unfurled	Raised	Furled	Lowered
CA04.33	Sail	Unfurled	Raised	Unfurled	Raised	Furled	Lowered
MA13.05	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled	Raised

IMAGE # Cont.	FORE SAIL	FORE YARD	FORE T.SAIL	FORE T.YARD	BOW SPRIT	SPRIT SAIL	
MA14.05	Furled	Half Raised	Furled	Lowered	Present	Furled	
PA08.01	Unfurled	Raised	Unfurled	Raised	Present	Furled	
CA04.28	Unfurled	Raised	Furled	Lowered	Present	Absent	
CA04.29	Unfurled	Raised	Furled	Lowered	Present	Absent	
CA04.33	Unfurled	Raised	Furled	Lowered	Present	Absent	
MA13.05	No Sail	No Yard	Furled	Lowered	Absent	Absent	
LATEEN MIZZEN			**SQUARE MIZZEN TOP, MAIN, MAIN TOP, FORE, FORE TOP**				
IMAGE #	**POSITION**	**MIZ. SAIL**	**MIZ. YARD**	**MIZ. T.SAIL**	**MIZ T.YARD**	**MAIN YARD**	**MAIN T.SAIL**
PA06.01	Sail	Unfurled	Raised	Furled	Lowered	Unfurled	Raised
IMAGE # Cont.	**MAIN T.YARD**	**FORE SAIL**	**FORE YARD**	**FORE T.SAIL**	**FORE T.YARD**	**BOW SPRIT**	**SPRIT SAIL**
PA06.01	Unfurled	Raised	Unfurled	Raised	Unfurled	Raised	Furled

FOUR-MASTED GALLEONS						
LATEEN BON. AND MIZZEN			**SQUARE MAIN AND FORE**			
IMAGE #	**POSITION**	**BON. SAIL**	**BON. YARD**	**MIZ. SAIL**	**MIZ. YARD**	**MAIN SAIL**
MA03.08	Anch	Furled	Raised	Furled	Raised	Unfurled
IMAGE # Cont.	**MAIN YARD**	**FORE SAIL**	**FORE YARD**	**BOW SPRIT**	**SPRIT SAIL**	
MA03.08	Raised	Furled	Raised	Present	Absent	
LATEEN BON. AND MIZZEN			**SQUARE MAIN, MAIN TOP, AND FORE**			
IMAGE #	**POSITION**	**BON. SAIL**	**BON. YARD**	**MIZ. SAIL**	**MIZ. YARD**	**MAIN SAIL**
MA02.01	Anch	Furled	Raised	Furled	Raised	Furled
IMAGE # Cont.	**MAIN YARD**	**MAIN T.SAIL**	**MAIN T.YARD**	**FORE SAIL**	**FORE YARD**	
MA02.01	Half Raised	Furled	Lowered	Furled	Half Raised	
IMAGE # Cont.	**BOW SPRIT**	**SPRIT SAIL**				
MA02.01	Absent	Absent				
LATEEN BON. AND MIZZEN			**SQUARE MAIN, MAIN TOP, FORE, AND FORE TOP**			
IMAGE #	**POSITION**	**BON. SAIL**	**BON. YARD**	**MIZ. SAIL**	**MIZ. YARD**	**MAIN SAIL**
MA13.12	Anch	Furled	Raised	Furled	Raised	Furled

MA13.15	Anch	Furled	Raised	Furled	Raised	Furled
EN04.02	Anch	Furled	Raised	Furled	Raised	Furled
EN04.03	Anch	Furled	Raised	Furled	Raised	Furled
CA10.01	Anch	Furled	Raised	Furled	Raised	Furled
MA15.1555.00	Anch	Furled	Raised	Furled	Raised	Furled
PA09.01	Battle	Furled	Raised	Furled	Raised	Unfurled
CA15.06	Sail	Unfurled	Raised	Furled	Raised	Furled
EN04.01	Anch	Unfurled	Raised	Unfurled	Raised	Unfurled
PA09.02	Battle	Unfurled	Raised	Unfurled	Raised	Unfurled
IMAGE # Cont.	**MAIN YARD**	**MAIN T.SAIL**	**MAIN T.YARD**	**FORE SAIL**	**FORE YARD**	
MA13.12	Raised	Furled	Lowered	Furled	Raised	
MA13.15	Raised	Furled	Lowered	Furled	Raised	
EN04.02	Raised	Furled	Lowered	Furled	Raised	
EN04.03	Raised	Furled	Lowered	Furled	Raised	
CA10.01	Half Raised	Furled	Raised	Furled	Half Raised	
MA15.1555.00	Half Raised	Furled	Lowered	Furled	Half Raised	
PA09.01	Raised	Unfurled	Raised	Unfurled	Raised	
CA15.06	Lowered	Furled	Lowered	Unfurled	Raised	
EN04.01	Raised	Unfurled	Raised	Unfurled	Raised	
PA09.02	Raised	Unfurled	Raised	Unfurled	Raised	
IMAGE # Cont.	**FORE T.SAIL**	**FORE T.YARD**	**BOW SPRIT**	**SPRIT SAIL**		
MA13.12	Furled	Lowered	Present	Furled		
MA13.15	Furled	Lowered	Present	Absent		
EN04.02	Furled	Lowered	Present	Furled		
EN04.03	Furled	Lowered	Present	Furled		
CA10.01	Furled	Raised	Present	Absent		
MA15.1555.00	Furled	Lowered	Present	Furled		
PA09.01	Furled	Lowered	Present	Absent		
CA15.06	Furled	Lowered	Present	Furled		
EN04.01	Unfurled	Raised	Present	Unfurled		
PA09.02	Unfurled	Raised	Present	Absent		

LATEEN BON. AND MIZZEN			SQUARE MAIN, MAIN TOP, MAIN TOPGALLANT, FORE, AND FORE TOP			
IMAGE #	**POSITION**	**BON. SAIL**	**BON. YARD**	**MIZ. SAIL**	**MIZ. YARD**	**MAIN SAIL**
CA22.22	Anch	Furled	Raised	Furled	Raised	Furled
CA34.03	Anch	Furled	Raised	Furled	Raised	Furled
MA13.04	Sail	Unfurled	Raised	Furled	Raised	Unfurled
IMAGE # Cont.	**MAIN YARD**	**MAIN T.SAIL**	**MAIN T.YARD**	**MAIN TG.SAIL**	**MAIN TG.YARD**	**FORE SAIL**
CA22.22	Half Raised	Furled	Raised	Furled	Raised	Furled
CA34.03	Half Raised	Furled	Raised	Furled	Raised	Furled
MA13.04	Raised	Furled	Lowered	Furled	Lowered	Unfurled
IMAGE # Cont.	**FORE YARD**	**FORE T.SAIL**	**FORE T.YARD**	**BOW SPRIT**	**SPRIT SAIL**	
CA22.22	Half Raised	Furled	Raised	Present	Absent	
CA34.03	Half Raised	Furled	Raised	Present	Absent	
MA13.04	Raised	Unfurled	Raised	Present	Furled	
LATEEN BON. AND MIZZEN			**SQUARE MAIN, MAIN TOP, MAIN TOPGALLANT, FORE, FORE TOP, AND FORE TOPGALLANT**			
IMAGE #	**POSITION**	**BON. SAIL**	**BON. YARD**	**MIZ. SAIL**	**MIZ. YARD**	**MAIN SAIL**
CA15.04	Sail	Furled	Raised	Unfurled	Raised	Furled
IMAGE # Cont.	**MAIN YARD**	**MAIN T.SAIL**	**MAIN T.YARD**	**MAIN TG.SAIL**	**MAIN TG.YARD**	**FORE SAIL**
CA15.04	Raised	Furled	Lowered	Furled	Lowered	Unfurled
IMAGE # Cont.	**FORE YARD**	**FORE T.SAIL**	**FORE T.YARD**	**FORE TG.SAIL**	**FORE TG.YARD**	
CA15.04	Raised	Furled	Lowered	Furled	Lowered	
IMAGE # Cont.	**BOW SPRIT**	**SPRIT SAIL**				
CA15.04	Present	No Sail				
LATEEN BON., MIZZEN, AND MIZZEN TOP			**SQUARE MAIN, MAIN TOP, MAIN TOPGALLANT, FORE, FORE TOP, AND FORE TOPGALLANT**			
IMAGE #	**POSITION**	**BON. SAIL**	**BON. YARD**	**MIZ. SAIL**	**MIZ. YARD**	**MIZ. T.SAIL**
MA13.01	Sail	Unfurled	Raised	Furled	Raised	Furled
IMAGE # Cont.	**MIZ. T.YARD**	**MAIN SAIL**	**MAIN YARD**	**MAIN T.SAIL**	**MAIN T.YARD**	**MAIN TG.SAIL**
MA13.01	Raised	Furled	Raised	Unfurled	Raised	Furled

IMAGE # Cont.	MAIN TG.YARD	FORE SAIL	FORE YARD	FORE T.SAIL	FORE T.YARD	FORE TG.SAIL
MA13.01	Lowered	Unfurled	Raised	Furled	Lowered	Furled
IMAGE # Cont.	**FORE TG.YARD**	**BOW SPRIT**	**SPRIT SAIL**			
MA13.01	Raised	Present	Unfurled			
LATEEN BONAVENTURE, BONAVENTURE TOP, MIZZEN, MIZZEN TOP			**SQUARE MAIN, MAIN TOP, MAIN TOPGALLANT, FORE, FORE TOP, AND FORE TOPGALLANT**			
IMAGE #	**POSITION**	**BON. SAIL**	**BON. YARD**	**BON. T.SAIL**	**BON. T.YARD**	**MIZ. SAIL**
MA13.09	Anch	Furled	Raised	No Sail	Raised	Furled
IMAGE # Cont.	**MIZ. YARD**	**MIZ. T.SAIL**	**MIZ. T.YARD**	**MAIN SAIL**	**MAIN YARD**	**MAIN T.SAIL**
MA13.09	Raised	No Sail	Raised	Furled	Lowered	Furled
IMAGE # Cont.	**MAIN T.YARD**	**MAIN TG.SAIL**	**MAIN TG.YARD**	**FORE SAIL**	**FORE YARD**	**FORE T.SAIL**
MA13.09	Lowered	Furled	Lowered	Furled	Raised	Furled
IMAGE # Cont.	**FORE T.YARD**	**FORE TG.SAIL**	**FORE TG.YARD**	**BOW SPRIT**	**SPRIT SAIL**	
MA13.09	Lowered	Furled	Lowered	Present	Furled	

APPENDIX 11

GALLEON SAIL SETTINGS BY GROUPINGS

THREE-MASTED GALLEONS							
LATEEN MIZZEN			**SQUARE MAIN AND FORE**				
IMAGE #	**POSITION**	**MIZ. SAIL**	**MIZ. YARD**	**MAIN SAIL**	**MAIN YARD**	**FORE SAIL**	
3G-1	Anch	Furled	Lowered	Half Unfurled	Half Raised	Furled	
3G-2	Anch	Furled	Raised	Furled	Half Raised	Furled	
3G-3	Anch	Furled	Raised	Furled	Lowered	No Sail	
3G-4	Anch	Furled	Raised	Furled	Raised	Furled	
IMAGE # Cont.	**FORE YARD**	**BOW SPRIT**	**SPRIT SAIL**	**#**			
3G-1	Lowered	Present	Furled	**N=1**			
3G-2	Lowered	Absent	Absent	**N=1**			
3G-3	No Yard	Present	Absent	**N=1**			
3G-4	Raised	Present	Absent	**N=1**			
LATEEN MIZZEN			**SQUARE MAIN, FORE, AND FORE TOP**				
IMAGE #	**POSITION**	**MIZ. SAIL**	**MIZ. YARD**	**MAIN SAIL**	**MAIN YARD**	**FORE SAIL**	**FORE YARD**
3G-5	Sail	Furled	Raised	Unfurled	Raised	Furled	Lowered
IMAGE # Cont.	**FORE T.SAIL**	**FORE T.YARD**	**BOW SPRIT**	**SPRIT SAIL**	**#**		
3G-5	Furled	Lowered	Present	Absent	**N=1**		
LATEEN MIZZEN			**SQUARE MAIN, MAIN TOP, FORE, AND FORE TOP**				
IMAGE #	**POSITION**	**MIZ. SAIL**	**MIZ. YARD**	**MAIN SAIL**	**MAIN YARD**	**MAIN T.SAIL**	**MAIN T.YARD**
3G-6	Anch	Furled	Raised	Furled	Half Raised	Furled	Lowered
3G-7	Battle	Furled	Raised	Unfurled	Raised	Unfurled	Raised
3G-8	Sail	Unfurled	Raised	Unfurled	Raised	Furled	Lowered
3G-9	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled	Raised
IMAGE # Cont.	**FORE SAIL**	**FORE YARD**	**FORE T.SAIL**	**FORE T.YARD**	**BOW SPRIT**	**SPRIT SAIL**	**#**
3G-6	Furled	Half Raised	Furled	Lowered	Present	Furled	**N=1**

3G-7	Unfurled	Raised	Unfurled	Raised	Present	Furled	**N=1**
3G-8	Unfurled	Raised	Furled	Lowered	Present	Absent	**N=3**
3G-9	No Sail	No Yard	Furled	Lowered	Absent	Absent	**N=1**
LATEEN MIZZEN			**SQUARE MIZZEN TOP, MAIN, MAIN TOP, FORE, AND FORE TOP**				
IMAGE #	**POSITION**	**MIZ. SAIL**	**MIZ. YARD**	**MIZ. T.SAIL**	**MIZ. T.YARD**	**MAIN SAIL**	**MAIN YARD**
3G-10	Sail	Unfurled	Raised	Furled	Lowered	Unfurled	Raised
IMAGE # Cont.	**MAIN T.SAIL**	**MAIN T.YARD**	**FORE SAIL**	**FORE YARD**	**FORE T.SAIL**	**FORE T.YARD**	
3G-10	Unfurled	Raised	Unfurled	Raised	Unfurled	Raised	
IMAGE # Cont.	**BOW SPRIT**	**SPRIT SAIL**	**#**				
3G-10	Present	Furled	**N=1**				

FOUR-MASTED GALLEONS						
LATEEN BON. AND MIZZEN			**SQUARE MAIN AND FORE**			
GROUP #	**POSITION**	**BON. SAIL**	**BON. YARD**	**MIZ. SAIL**	**MIZ. YARD**	**MAIN SAIL**
4G-1	Anch	Furled	Raised	Furled	Raised	Unfurled
GROUP # Cont.	**MAIN YARD**	**FORE SAIL**	**FORE YARD**	**BOW SPRIT**	**SPRIT SAIL**	**#**
4G-1	Raised	Furled	Raised	Present	Absent	**N=1**
LATEEN BON. AND MIZZEN			**SQUARE MAIN, MAIN TOP, AND FORE**			
GROUP #	**POSITION**	**BON. SAIL**	**BON. YARD**	**MIZ. SAIL**	**MIZ. YARD**	**MAIN SAIL**
4G-2	Anch	Furled	Raised	Furled	Raised	Furled
GROUP # Cont.	**MAIN YARD**	**MAIN T.SAIL**	**MAIN T.YARD**	**FORE SAIL**	**FORE YARD**	**BOW SPRIT**
4G-2	Half Raised	Furled	Lowered	Furled	Half Raised	Absent
GROUP # Cont.	**SPRIT SAIL**	**#**				
4G-2	Absent	**N=1**				
LATEEN BON. AND MIZZEN			**SQUARE MAIN, MAIN TOP, FORE, AND FORE TOP**			
GROUP #	**POSITION**	**BON. SAIL**	**BON. YARD**	**MIZ. SAIL**	**MIZ. YARD**	**MAIN SAIL**
4G-3	Anch	Furled	Raised	Furled	Raised	Furled
4G-4	Anch	Furled	Raised	Furled	Raised	Furled

4G-5	Anch	Furled	Raised	Furled	Raised	Furled
4G-6	Battle	Furled	Raised	Furled	Raised	Unfurled
4G-7	Sail	Unfurled	Raised	Furled	Raised	Furled
4G-8	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
4G-9	Battle	Unfurled	Raised	Unfurled	Raised	Unfurled
GROUP # Cont.	**MAIN YARD**	**MAIN T.SAIL**	**MAIN T.YARD**	**FORE SAIL**	**FORE YARD**	**FORE T.SAIL**
4G-3	Raised	Furled	Lowered	Furled	Raised	Furled
4G-4	Half Raised	Furled	Raised	Furled	Half Raised	Furled
4G-5	Half Raised	Furled	Lowered	Furled	Half Raised	Furled
4G-6	Raised	Unfurled	Raised	Unfurled	Raised	Furled
4G-7	Lowered	Furled	Lowered	Unfurled	Raised	Furled
4G-8	Raised	Unfurled	Raised	Unfurled	Raised	Unfurled
4G-9	Raised	Unfurled	Raised	Unfurled	Raised	Unfurled
GROUP # Cont.	**FORE T.YARD**	**BOW SPRIT**	**SPRIT SAIL**	**#**		
4G-3	Lowered	Present	Furled	**N=4**		
4G-4	Raised	Present	Absent	**N=1**		
4G-5	Lowered	Present	Furled	**N=1**		
4G-6	Lowered	Present	Absent	N=1		
4G-7	Lowered	Present	Furled	N=1		
4G-8	Raised	Present	Unfurled	N=1		
4G-9	Raised	Present	Absent	N=1		
LATEEN BON. AND MIZZEN			**SQUARE MAIN, MAIN TOP, MAIN TOPGALLANT, FORE, AND FORE TOP**			
GROUP #	**POSITION**	**BON. SAIL**	**BON. YARD**	**MIZ. SAIL**	**MIZ. YARD**	**MAIN SAIL**
4G-10	Anch	Furled	Raised	Furled	Raised	Furled
4G-11	Sail	Unfurled	Raised	Furled	Raised	Unfurled
GROUP # Cont.	**MAIN YARD**	**MAIN T.SAIL**	**MAIN T.YARD**	**MAIN TG.SAIL**	**MAIN TG.YARD**	**FORE SAIL**
4G-10	Half Raised	Furled	Raised	Furled	Raised	Furled
4G-11	Raised	Furled	Lowered	Furled	Lowered	Unfurled

GROUP # Cont.	**FORE YARD**	**FORE T.SAIL**	**FORE T.YARD**	**BOW SPRIT**	**SPRIT SAIL**	**#**
4G-10	Half Raised	Furled	Raised	Present	Absent	**N=2**
4G-11	Raised	Unfurled	Raised	Present	Furled	**N=1**
LATEEN BON. AND MIZZEN			**SQUARE MAIN, MAIN TOP, MAIN TOPGALLANT, FORE, FORE TOP, AND FORE TOPGALLANT**			
GROUP #	**POSITION**	**BON. SAIL**	**BON. YARD**	**MIZ. SAIL**	**MIZ. YARD**	**MAIN SAIL**
4G-12	Sail	Furled	Raised	Unfurled	Raised	Furled
GROUP # Cont.	**MAIN YARD**	**MAIN T.SAIL**	**MAIN T.YARD**	**MAIN TG.SAIL**	**MAIN TG.YARD**	**FORE SAIL**
4G-12	Raised	Furled	Lowered	Furled	Lowered	Unfurled
GROUP # Cont.	**FORE YARD**	**FORE T.SAIL**	**FORE T.YARD**	**FORE TG.SAIL**	**FORE TG.YARD**	**BOW SPRIT**
4G-12	Raised	Furled	Lowered	Furled	Lowered	Present
GROUP # Cont.	**SPRIT SAIL**	**#**				
4G-12	No Sail	**N=1**				
LATEEN BON., MIZZEN, AND MIZZEN TOP			**SQUARE MAIN, MAIN TOP, MAIN TOPGALLANT, FORE, FORE TOP, AND FORE TOPGALLANT**			
GROUP #	**POSITION**	**BON. SAIL**	**BON. YARD**	**MIZ. SAIL**	**MIZ. YARD**	**MIZZEN T.SAIL**
4G-13	Sail	Unfurled	Raised	Furled	Raised	Furled
GROUP # Cont.	**MIZZEN T.YARD**	**MAIN SAIL**	**MAIN YARD**	**MAIN T.SAIL**	**MAIN T.YARD**	**MAIN TG.SAIL**
4G-13	Raised	Furled	Raised	Unfurled	Raised	Furled
GROUP # Cont.	**MAIN TG.YARD**	**FORE SAIL**	**FORE YARD**	**FORE T.SAIL**	**FORE T.YARD**	**FORE TG.SAIL**
4G-13	Lowered	Unfurled	Raised	Furled	Lowered	Furled
GROUP # Cont.	**FORE TG.YARD**	**BOW SPRIT**	**SPRIT SAIL**	**#**		
4G-13	Raised	Present	Unfurled	**N=1**		
LATEEN BON., BON. TOP, MIZZEN, MIZZEN TOP			**SQUARE MAIN, MAIN TOP, MAIN TOPGALLANT, FORE, FORE TOP, AND FORE TOPGALLANT**			
GROUP #	**POSITION**	**BON. SAIL**	**BON. YARD**	**MIZ. SAIL**	**MIZ. YARD**	**MIZZEN SAIL**
4G-14	Anch	Furled	Raised	No Sail	Raised	Furled
GROUP # Cont.	**MIZZEN YARD**	**MIZZEN T.SAIL**	**MIZZEN T.YARD**	**MAIN SAIL**	**MAIN YARD**	**MAIN T.SAIL**
4G-14	Raised	No Sail	Raised	Furled	Lowered	Furled

GROUP # Cont.	MAIN T.YARD	MAIN TG.SAIL	MAIN TG.YARD	FORE SAIL	FORE YARD	FORE T.SAIL
4G-14	Lowered	Furled	Lowered	Furled	Raised	Furled
GROUP # Cont.	**FORE T.YARD**	**FORE TG.SAIL**	**FORE TG.YARD**	**BOW SPRIT**	**SPRIT SAIL**	**#**
4G-14	Lowered	Furled	Lowered	Present	Furled	**N=1**

APPENDIX 12

NAU RIG CONFIGURATIONS

3 MASTED	LATEEN MI SQUARE MAIN, UPPER MAIN, FORE, UPPER FORE		
MA01.01	1485	CA15.02	1558
CA03.01	1513	CA15.03	1558
CA03.02	1513	CA15.05	1558
CA03.07	1513	CA15.07	1558
PA02.01	1514	CA15.08	1558
MA08.03	1515-25	MA15.1497.01	1558-1561
MA10.03	1517-1526	MA15.1501.02	1558-1561
CA04.01	1519	MA15.1501.08	1558-1561
CA04.03	1519	MA15.1504.02	1558-1561
CA04.04	1519	MA15.1504.08	1558-1561
CA04.05	1519	MA15.1505.12	1558-1561
CA04.06	1519	MA15.1508.01	1558-1561
CA04.07	1519	MA15.1509.11	1558-1561
CA04.08	1519	MA15.1509.16	1558-1561
CA04.14	1519	MA15.1510.05	1558-1561
CA04.15	1519	MA15.1512.04	1558-1561
CA04.16	1519	MA15.1512.09	1558-1561
CA04.17	1519	MA15.1513.03	1558-1561
CA04.18	1519	MA15.1515.03	1558-1561
CA04.19	1519	MA15.1517.07	1558-1561
CA04.21	1519	MA15.1519.19	1558-1561
CA04.22	1519	MA15.1521.09	1558-1561
CA04.24	1519	MA15.1523.06	1558-1561
CA04.25	1519	MA15.1524.10	1558-1561
CA04.30	1519	MA15.1529.02	1558-1561
CA04.34	1519	MA15.1532.02	1558-1561
PA03.02	1520	MA15.1534.02	1558-1561
PA03.03	1520	MA15.1538.01	1558-1561
PA03.04	1520	MA16.1505-13	1566
PA03.05	1520	MA16.1506-04	1566
CA06.01	1527	MA16.1506-15	1566
CA06.02	1527	MA16.1507-11	1566

CA06.03	1527	MA16.1508-04	1566
CA06.04	1527	MA16.1508-07	1566
CA06.05	1527	MA16.1508-13	1566
CA07.01	1529	MA16.1508-14	1566
CA07.02	1529	MA16.1509-08	1566
CA07.03	1529	MA16.1510-10	1566
CA07.04	1529	MA16.1511-03	1566
CA07.05	1529	MA16.1511-04	1566
CA07.06	1529	MA16.1512-03	1566
CA07.07	1529	MA16.1512-07	1566
CA07.08	1529	MA16.1512-09	1566
CA07.09	1529	MA16.1513-02	1566
MA11.01	1530-1534	MA16.1514-02	1566
MA11.03	1530-1534	MA16.1515-02	1566
MA11.07	1530-1534	MA16.1515-10	1566
MA11.08	1530-1534	MA16.1516-01	1566
CA08.01	1532	MA16.1516-03	1566
MA12.01	1535-1570	MA16.1517-01	1566
MA12.04	1535-1570	MA16.1517-02	1566
CA09.02	1538	MA16.1518-07	1566
CA09.03	1538	MA16.1519-02	1566
CA09.04	1538	MA16.1521-04	1566
MA13.02	1538-40	MA16.1523-07	1566
MA13.11	1538-40	MA16.1525-02	1566
MA13.13	1538-40	MA16.1527-03	1566
MA13.14	1538-40	MA16.1528-01	1566
MA13.18	1538-40	MA16.1528-08	1566
MA13.19	1538-40	MA16.1530-07	1566
MA13.20	1538-40	MA16.1531-03	1566
MA13.21	1538-40	MA16.1533-07	1566
MA13.22	1538-40	MA16.1536-04	1566
MA13.23	1538-40	MA16.1537-05	1566
MA13.24	1538-40	MA16.1538-05	1566
MA14.01	1538-1550	MA16.1540-04	1566
MA14.02	1538-1550	CA31.05	1589
MA14.04	1538-1550	CA31.06	1589
MA14.06	1538-1550	EN05.01	1592
MA14.07	1538-1550	EN05.02	1592
MA15.1542.03	1558-1561	EN05.03	1592

MA15.1545.02	1558-1561	EN05.04	1592
MA15.1553.01	1558-1561	CA33.01	1592-94
MA15.1556.01	1558-1561	CA33.02	1592-94
MA15.1561.04	1558-1561	CA33.03	1592-94
MA15.1563.01	1558-1561	CA33.04	1592-94
CA16.01	1559	CA33.05	1592-94
CA16.02	1559	CA33.06	1592-94
CA16.03	1559	MA16.1542-01	1566
CA16.04	1559	MA16.1546-04	1566
CA16.05	1559	MA16.1547-06	1566
CA17.02	1560	MA16.1548-09	1566
CA19.01	1565	MA16.1549-01	1566
CA19.02	1565	MA16.1550-01	1566
CA20.04	1565	MA16.1551-03	1566
MA16.1497-01	1566	MA16.1552-02	1566
MA16.1497-02	1566	MA16.1553-01	1566
MA16.1497-03	1566	MA16.1554-01	1566
MA16.1500-01	1566	MA16.1557-04	1566
MA16.1500-02	1566	MA16.1558-02	1566
MA16.1500-03	1566	MA16.1559-04	1566
MA16.1501-01	1566	MA16.1561-02	1566
MA16.1501-02	1566	MA16.1564-01	1566
MA16.1501-03	1566	MA16.1565-01	1566
MA16.1502-03	1566	MA16.1565-03	1566
MA16.1502-04	1566	CA21.01	1568
MA16.1502-05	1566	CA21.02	1568
MA16.1502-06	1566	CA21.03	1568
MA16.1502-07	1566	CA22.06	1572
MA16.1502-08	1566	CA22.10	1572
MA16.1502-09	1566	CA22.11	1572
MA16.1502-10	1566	CA22.12	1572
MA16.1502-12	1566	CA22.15	1572
MA16.1503-06	1566	CA22.19	1572
MA16.1503-07	1566	CA22.21	1572
MA16.1503-08	1566	CA22.27	1572
MA16.1504-11	1566	CA22.28	1572
MA16.1505-10	1566	CA22.30	1572
CA27.01	1583-88	CA22.36	1572

CA27.03	1583-88	CA22.37	1572
CA27.04	1583-88	EN02.01	1572
CA27.06	1583-88	MA18.01	1579
CA29.04	1588-98	PA07.03	1573-1603
CA29.05	1588-98	CA24.01	1579
CA29.06	1588-98	CA24.02	1579
CA30.01	1589	CA26.01	1582
CA31.01	1589	CA33.07	1592-94
CA31.02	1589	CA34.04	1593
CA31.03	1589	CA34.05	1593
CA31.04	1589	CA34.06	1593
MA14.08	1538-1550	CA35.02	1595
MA14.10	1538-1550	CA36.01	1596
CA11.02	1546	CA36.02	1596
CA13.01	1550	CA38.01	1600
CA14.01	1556	EN06.01	XVI
CA14.04	1556	MA19.01	XVI
CA15.01	1558	MA19.02	XVI
3 MASTED	**LATEEN MIZZEN AND SQUARE MAIN, FORE**		
MA03.14	1509		
MA03.15	1509		
3 MASTED	**LATEEN MIZZEN SQUARE MAIN, UPPER MAIN, FORE**		
CA02.03	1510	MA03.07	1509
CA03.05	1513	MA03.11	1509
CA12.01	1547	MA03.12	1509
CA12.02	1547	MA03.13	1509
MA03.01	1509	MA04.03	1510
MA03.02	1509	MA10.08	1517-1526
MA03.03	1509	MA13.17	1538-40
MA03.04	1509	PA01.01	1500-50
3 MASTED	**LATEEN MIZZEN SQUARE MAIN, UPPER MAIN, FORE**		
MA10.03	1517-1526		
PA03.05	1520		
CA24.01	1579		
CA24.02	1579		

3 MASTED	**LATEEN MIZZEN SQUARE MAIN, UPPER MAIN, TOPGALLANT MAIN, FORE, UPPER FORE**
MA12.05	1535-1570
MA13.07	1538-40
MA13.08	1538-40
3 MASTED	**LATEEN MIZZEN SQUARE MAIN, UPPER MAIN, TOPGALLANT MAIN, FORE, UPPER FORE, TOPGALLANT FORE**
EN01.01	1525
3 MASTED	**LATEEN MIZZEN, UPPER MIZZEN SQUARE MAIN, UPPER MAIN, TOPGALLANT MAIN, FORE, UPPER FORE, TOPGALLANT FORE**
PA07.01	1573-1603
MA12.06	1535-1570
3 MASTED	**LATEEN MIZZEN, UPPER MIZZEN SQUARE MAIN, UPPER MAIN, FORE**
CA26.02	1582
CA32.01	1590
3 MASTED	**LATEEN MIZZEN, UPPER MIZZEN SQUARE MAIN, UPPER MAIN, FORE**
CA29.08	1588-98
CA35.01	1595
PA07.02	1573-1603
CA30.02	1589
4 MASTED	**LATEEN BONAVENTURE, MIZZEN AND SQUARE MAIN, FORE**
MA15.1528.01	1558-1561

APPENDIX 13

NAU SAIL SETTINGS BY INDIVIDUAL SHIPS

THREE-MASTED NAUS						
LATEEN MIZZEN			**SQUARE MAIN AND FORE**			
IMAGE #	**POSITION**	**MIZ. SAIL**	**MIZ. YARD**	**MAIN SAIL**	**MAIN YARD**	**FORE SAIL**
MA03.14	Anch	Unfurled	Raised	Furled	Raised	Furled
IMAGE # Cont.	**FORE YARD**	**BOW SPRIT**	**SPRIT SAIL**			
MA03.14	Raised	Present	Absent			
LATEEN MIZZEN			**SQUARE MAIN, MAIN TOP, AND FORE**			
IMAGE #	**POSITION**	**MIZ. SAIL**	**MIZ. YARD**	**MAIN SAIL**	**MAIN YARD**	**MAIN T.SAIL**
MA03.11	Anch	Furled	Lowered	No Sail	No Yard	No Sail
MA03.07	Anch	Furled	Raised	Furled	Lowered	No Sail
MA03.15	Anch	Furled	Raised	Furled	Raised	Furled
MA03.02	Anch	Furled	Raised	Furled	Raised	Furled
MA03.03	Anch	Furled	Raised	Furled	Raised	Furled
MA03.12	Anch	Furled	Raised	Furled	Raised	Furled
MA10.08	Anch	Furled	Raised	Furled	Raised	Furled
CA03.05	Sail	Furled	Raised	Unfurled	Raised	Furled
MA03.04	Sail	Unfurled	Raised	Unfurled	Raised	Furled
MA13.17	Sail	Unfurled	Raised	Unfurled	Raised	Furled
CA12.01	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
CA12.02	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
MA03.01	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
IMAGE # Cont.	**MAIN T.YARD**	**FORE SAIL**	**FORE YARD**	**BOW SPRIT**	**SPRIT SAIL**	
MA03.11	No Yard	No Sail	No Yard	Present	Absent	
MA03.07	No Yard	No Sail	No Yard	Present	Absent	
MA03.15	Lowered	Furled	Raised	Present	Absent	
MA03.02	Lowered	Furled	Raised	Present	Absent	
MA03.03	Lowered	Furled	Raised	Present	Absent	

MA03.12	Lowered	Furled	Raised	Present	Absent	
MA10.08	Lowered	Furled	Raised	Present	Absent	
CA03.05	Raised	Unfurled	Raised	Present	Absent	
MA03.04	Lowered	Unfurled	Raised	Present	Absent	
MA13.17	Raised	Unfurled	Raised	Present	Absent	
CA12.01	Raised	Unfurled	Raised	Present	Absent	
CA12.02	Raised	Unfurled	Raised	Present	Absent	
MA03.01	Raised	Unfurled	Raised	Present	Unfurled	
LATEEN MIZZEN			**SQUARE MAIN, MAIN TOP, FORE, AND FORE TOP**			
IMAGE #	**POSITION**	**MIZ. SAIL**	**MIZ. YARD**	**MAIN SAIL**	**MAIN YARD**	**MAIN T.SAIL**
EN05.04	Anch	Furled	Half Raised	Unfurled	Half Raised	Furled
PA03.04	Anch	Furled	Lowered	Furled	Lowered	Furled
CA22.21	Anch	Furled	Raised	Furled	Half Raised	Furled
CA22.06	Anch	Furled	Raised	Furled	Half Raised	Furled
CA22.28	Anch	Furled	Raised	Furled	Half Raised	Furled
CA22.12	Anch	Furled	Raised	Furled	Half Raised	Furled
CA22.15	Anch	Furled	Raised	Furled	Half Raised	Furled
CA22.37	Anch	Furled	Raised	Furled	Half Raised	Furled
CA34.04	Anch	Furled	Raised	Furled	Half Raised	Furled
CA34.05	Anch	Furled	Raised	Furled	Half Raised	Furled
MA11.03	Anch	Furled	Raised	Furled	Half Raised	Furled
MA11.07	Anch	Furled	Raised	Furled	Half Raised	Furled
MA14.01	Anch	Furled	Raised	Furled	Half Raised	Furled
MA14.02	Anch	Furled	Raised	Furled	Half Raised	Furled
MA14.04	Anch	Furled	Raised	Furled	Half Raised	Furled
MA14.08	Anch	Furled	Raised	Furled	Half Raised	Furled
MA15.1563.01	Anch	Furled	Raised	Furled	Half Raised	Furled
MA14.06	Anch	Furled	Raised	Furled	Half Raised	Furled

CA22.36	Anch	Furled	Raised	Furled	Lowered	Furled
MA12.01	Anch	Furled	Raised	Furled	Lowered	Furled
MA13.13	Anch	Furled	Raised	Furled	Raised	Furled
MA13.14	Anch	Furled	Raised	Furled	Raised	Furled
CA22.10	Anch	Furled	Raised	Furled	Raised	Furled
CA22.11	Anch	Furled	Raised	Furled	Raised	Furled
CA03.02	Anch	Furled	Raised	Furled	Raised	Furled
PA03.02	Anch	Furled	Raised	Furled	Raised	Furled
CA29.05	Anch	Furled	Raised	Furled	Raised	Furled
CA29.06	Anch	Furled	Raised	Furled	Raised	Furled
CA27.03	Anch	Furled	Raised	Furled	Raised	Furled
CA27.04	Anch	Furled	Raised	Furled	Raised	Furled
CA31.01	Anch	Furled	Raised	Furled	Raised	Furled
CA31.02	Anch	Furled	Raised	Furled	Raised	Furled
CA31.05	Anch	Furled	Raised	Furled	Raised	Furled
CA31.06	Anch	Furled	Raised	Furled	Raised	Furled
CA31.03	Anch	Furled	Raised	Furled	Raised	Furled
CA31.04	Anch	Furled	Raised	Furled	Raised	Furled
CA03.07	Anch	Furled	Raised	Furled	Raised	Furled
CA22.27	Anch	Furled	Raised	Furled	Raised	Furled
PA02.01	Anch	Furled	Raised	Furled	Raised	Furled
PA07.03	Anch	Furled	Raised	Furled	Raised	Furled
MA19.01	Sail	Furled	Raised	Furled	Raised	Furled
EN06.01	Anch	Furled	Raised	Unfurled	Half Raised	Furled
MA15.1515.03	Sail	Furled	Raised	Unfurled	Half Raised	Furled
MA15.1524.10	Battle	Furled	Raised	Unfurled	Half Raised	Furled
CA15.01	Sail	Furled	Raised	Unfurled	Raised	Furled
CA16.01	Sail	Furled	Raised	Unfurled	Raised	Furled
CA03.01	Sail	Furled	Raised	Unfurled	Raised	Furled
MA01.01	Sail	Furled	Raised	Unfurled	Raised	Furled
MA15.1505.12	Sail	Furled	Raised	Unfurled	Raised	Furled
MA15.1509.16	Sail	Furled	Raised	Unfurled	Raised	Furled
MA16.1503-08	Sail	Furled	Raised	Unfurled	Raised	Furled

MA16.1509-08	Sail	Furled	Raised	Unfurled	Raised	Furled
MA16.1510-10	Sail	Furled	Raised	Unfurled	Raised	Furled
MA16.1512-03	Sail	Furled	Raised	Unfurled	Raised	Furled
MA16.1515-10	Sail	Furled	Raised	Unfurled	Raised	Furled
MA16.1557-04	Sail	Furled	Raised	Unfurled	Raised	Furled
MA16.1530-07	Sail	Furled	Raised	Unfurled	Raised	Furled
MA15.1521.09	Sail	Furled	Raised	Unfurled	Raised	Furled
CA14.01	Battle	Furled	Raised	Unfurled	Raised	Furled
MA13.21	Sail	Furled	Raised	Unfurled	Raised	Unfurled
CA22.19	Sail	Furled	Raised	Unfurled	Raised	Unfurled
MA15.1532.02	Sail	Furled	Raised	Unfurled	Raised	Unfurled
MA16.1504-11	Sail	Furled	Raised	Unfurled	Raised	Unfurled
MA16.1508-14	Sail	Furled	Raised	Unfurled	Raised	Unfurled
MA16.1564-01	Sail	Furled	Raised	Unfurled	Raised	Unfurled
MA15.1508.01	Sail	Furled	Raised	Unfurled	Raised	Unfurled
MA15.1513.03	Sail	Furled	Raised	Unfurled	Raised	Unfurled
MA15.1534.02	Sail	Furled	Raised	Unfurled	Raised	Unfurled
MA16.1503-07	Sail	Furled	Raised	Unfurled	Raised	Unfurled
MA16.1505-10	Sail	Furled	Raised	Unfurled	Raised	Unfurled
MA16.1505-13	Sail	Furled	Raised	Unfurled	Raised	Unfurled
MA16.1506-04	Sail	Furled	Raised	Unfurled	Raised	Unfurled
MA16.1511-03	Sail	Furled	Raised	Unfurled	Raised	Unfurled
MA16.1512-09	Sail	Furled	Raised	Unfurled	Raised	Unfurled
MA16.1518-07	Sail	Furled	Raised	Unfurled	Raised	Unfurled
MA16.1519-02	Sail	Furled	Raised	Unfurled	Raised	Unfurled
MA16.1521-04	Sail	Furled	Raised	Unfurled	Raised	Unfurled
MA16.1523-07	Sail	Furled	Raised	Unfurled	Raised	Unfurled
MA16.1531-03	Sail	Furled	Raised	Unfurled	Raised	Unfurled
MA16.1540-04	Sail	Furled	Raised	Unfurled	Raised	Unfurled
MA16.1542-01	Sail	Furled	Raised	Unfurled	Raised	Unfurled
MA16.1548-09	Sail	Furled	Raised	Unfurled	Raised	Unfurled
MA16.1558-02	Sail	Furled	Raised	Unfurled	Raised	Unfurled
MA16.1565-01	Sail	Furled	Raised	Unfurled	Raised	Unfurled
CA17.02	Sail	Furled	Raised	Unfurled	Raised	Unfurled

MA16.1565-03	Sail	Furled	Raised	Unfurled	Raised	Unfurled
MA15.1504.02	Sail	Furled	Raised	Unfurled	Raised	Unfurled
MA16.1497-03	Sail	Furled	Raised	Unfurled	Raised	Unfurled
MA15.1510.05	Sail	Furled	Raised	Unfurled	Raised	Unfurled
MA15.1523.06	Sail	Furled	Raised	Unfurled	Raised	Unfurled
MA16.1508-07	Sail	Furled	Raised	Unfurled	Raised	Unfurled
MA16.1516-01	Sail	Furled	Raised	Unfurled	Raised	Unfurled
MA16.1538-05	Sail	Furled	Raised	Unfurled	Raised	Unfurled
MA16.1561-02	Sail	Furled	Raised	Unfurled	Raised	Unfurled
EN02.01	Sail	Unfurled	Raised	Furled	Lowered	Furled
MA13.02	Sail	Unfurled	Raised	Furled	Raised	Furled
CA04.22	Sail	Unfurled	Raised	Unfurled	Half Raised	Furled
CA04.18	Sail	Unfurled	Raised	Unfurled	Raised	Furled
CA04.04	Sail	Unfurled	Raised	Unfurled	Raised	Furled
CA04.05	Sail	Unfurled	Raised	Unfurled	Raised	Furled
CA04.06	Sail	Unfurled	Raised	Unfurled	Raised	Furled
CA04.16	Sail	Unfurled	Raised	Unfurled	Raised	Furled
CA04.17	Sail	Unfurled	Raised	Unfurled	Raised	Furled
CA04.19	Sail	Unfurled	Raised	Unfurled	Raised	Furled
CA04.24	Sail	Unfurled	Raised	Unfurled	Raised	Furled
CA04.30	Sail	Unfurled	Raised	Unfurled	Raised	Furled
CA04.34	Sail	Unfurled	Raised	Unfurled	Raised	Furled
CA09.02	Sail	Unfurled	Raised	Unfurled	Raised	Furled
CA09.04	Sail	Unfurled	Raised	Unfurled	Raised	Furled
MA08.03	Sail	Unfurled	Raised	Unfurled	Raised	Furled
MA11.01	Sail	Unfurled	Raised	Unfurled	Raised	Furled
MA16.1559-04	Sail	Unfurled	Raised	Unfurled	Raised	Furled
MA13.18	Sail	Unfurled	Raised	Unfurled	Raised	Furled
MA15.1509.11	Sail	Unfurled	Raised	Unfurled	Raised	Furled
MA15.1519.19	Sail	Unfurled	Raised	Unfurled	Raised	Furled
MA16.1511-04	Sail	Unfurled	Raised	Unfurled	Raised	Furled
MA16.1514-02	Sail	Unfurled	Raised	Unfurled	Raised	Furled
MA16.1554-01	Sail	Unfurled	Raised	Unfurled	Raised	Furled
MA16.1516-03	Sail	Unfurled	Raised	Unfurled	Raised	Furled

MA16.1503-06	Sail	Unfurled	Raised	Unfurled	Raised	Furled
CA22.30	Sail	Unfurled	Raised	Unfurled	Raised	Furled
CA33.05	Sail	Unfurled	Raised	Unfurled	Raised	Furled
CA04.25	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
CA33.01	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
MA12.04	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
CA16.03	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
MA16.1508-03	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
MA16.1508-13	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
MA16.1513-02	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
MA16.1506-15	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
MA16.1515-02	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
MA16.1517-01	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
MA16.1525-02	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
MA16.1533-07	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
MA16.1536-04	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
MA16.1537-05	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
MA16.1547-06	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
MA19.02	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
CA24.02	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
CA15.03	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
MA13.11	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
CA21.08	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
MA16.1500-02	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
CA15.02	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
CA15.08	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
CA16.02	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
CA16.05	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
CA06.01	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
CA06.02	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
CA06.03	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
CA06.05	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
CA07.01	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
CA07.02	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled

CA07.04	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
CA07.06	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
CA07.07	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
CA07.11	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
CA08.01	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
CA13.01	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
CA15.05	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
CA15.07	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
CA19.01	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
CA19.02	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
CA26.01	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
CA27.01	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
CA27.06	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
CA35.02	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
MA13.19	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
MA13.20	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
MA13.22	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
MA13.23	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
MA13.24	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
MA15.1497.01	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
MA15.1501.02	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
MA15.1501.08	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
MA15.1502.01	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
MA15.1504.08	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
MA15.1512.09	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
MA15.1517.07	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
MA15.1529.02	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
MA15.1553.01	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
MA16.1500-01	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
MA16.1501-01	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
MA16.1501-02	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
MA16.1501-03	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
MA16.1502-03	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
MA16.1502-12	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled

MA16.1507-11	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
MA16.1512-07	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
MA16.1517-02	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
MA16.1528-01	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
MA16.1528-08	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
MA16.1552-02	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
MA16.1553-01	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
IMAGE # Cont.	**MAIN T.YARD**	**FORE SAIL**	**FORE YARD**	**FORE T.SAIL**	**FORE T.YARD**	
EN05.04	Half Raised	Furled	Half Raised	Furled	Half Raised	
PA03.04	Lowered	Furled	Lowered	Furled	Raised	
CA22.21	Raised	Unfurled	Raised	Furled	Raised	
CA22.06	Raised	Furled	Raised	Furled	Raised	
CA22.28	Raised	Furled	Half Raised	Furled	Raised	
CA22.12	Lowered	Furled	Half Raised	Furled	Lowered	
CA22.15	Lowered	Furled	Half Raised	Furled	Lowered	
CA22.37	Lowered	Furled	Half Raised	Furled	Lowered	
CA34.04	Lowered	Furled	Half Raised	Furled	Lowered	
CA34.05	Lowered	Furled	Half Raised	Furled	Lowered	
MA11.03	Lowered	Furled	Half Raised	Furled	Lowered	
MA11.07	Lowered	Furled	Half Raised	Furled	Lowered	
MA14.01	Lowered	Furled	Half Raised	Furled	Lowered	
MA14.02	Lowered	Furled	Half Raised	Furled	Lowered	
MA14.04	Lowered	Furled	Half Raised	Furled	Lowered	
MA14.08	Lowered	Furled	Half Raised	Furled	Lowered	
MA15.1563.01	Lowered	Furled	Half Raised	Furled	Lowered	
MA14.06	Half Raised	Unfurled	Half Raised	Furled	Half Raised	
CA22.36	Lowered	Furled	Lowered	Furled	Lowered	
MA12.01	Raised	Furled	Lowered	Furled	Raised	
MA13.13	Half Raised	Furled	Raised	Furled	Half Raised	
MA13.14	Half Raised	Furled	Raised	Furled	Half Raised	
CA22.10	Lowered	Furled	Half Raised	Furled	Raised	
CA22.11	Lowered	Furled	Half Raised	Furled	Lowered	

CA03.02	Lowered	Furled	Raised	Furled	Raised	
PA03.02	Lowered	Furled	Raised	Furled	Raised	
CA29.05	Lowered	Furled	Raised	Furled	Lowered	
CA29.06	Lowered	Furled	Raised	Furled	Lowered	
CA27.03	Lowered	Furled	Raised	Furled	Lowered	
CA27.04	Lowered	Furled	Raised	Furled	Lowered	
CA31.01	Lowered	Furled	Raised	Furled	Lowered	
CA31.02	Lowered	Furled	Raised	Furled	Lowered	
CA31.05	Lowered	Furled	Raised	Furled	Lowered	
CA31.06	Lowered	Furled	Raised	Furled	Lowered	
CA31.03	Lowered	Unfurled	Raised	Furled	Lowered	
CA31.04	Lowered	Unfurled	Raised	Furled	Lowered	
CA03.07	Raised	Furled	Raised	Furled	Raised	
CA22.27	Raised	Furled	Raised	Furled	Raised	
PA02.01	Raised	Furled	Raised	Furled	Raised	
PA07.03	Raised	Furled	Raised	Furled	Raised	
MA19.01	Raised	Unfurled	Raised	Furled	Lowered	
EN06.01	Lowered	Furled	Half Raised	Furled	Lowered	
MA15.1515.03	Half Raised	Unfurled	Half Raised	Furled	Half Raised	
MA15.1524.10	Lowered	Furled	Lowered	Furled	Lowered	
CA15.01	Lowered	Unfurled	Raised	Furled	Raised	
CA16.01	Lowered	Unfurled	Raised	Furled	Raised	
CA03.01	Lowered	Unfurled	Raised	Furled	Lowered	
MA01.01	Lowered	Unfurled	Raised	Furled	Lowered	
MA15.1505.12	Lowered	Unfurled	Raised	Furled	Lowered	
MA15.1509.16	Lowered	Unfurled	Raised	Furled	Lowered	
MA16.1503-08	Lowered	Unfurled	Raised	Furled	Lowered	
MA16.1509-08	Lowered	Unfurled	Raised	Furled	Lowered	
MA16.1510-10	Lowered	Unfurled	Raised	Furled	Lowered	
MA16.1512-03	Lowered	Unfurled	Raised	Furled	Lowered	
MA16.1515-10	Lowered	Unfurled	Raised	Furled	Lowered	
MA16.1557-04	Lowered	Unfurled	Raised	Furled	Lowered	
MA16.1530-07	Lowered	Unfurled	Raised	Unfurled	Raised	
MA15.1521.09	Lowered	Unfurled	Raised	Unfurled	Raised	

CA14.01	Raised	Unfurled	Raised	Furled	Raised	
MA13.21	Raised	Furled	Raised	Unfurled	Raised	
CA22.19	Raised	Unfurled	Raised	Furled	Lowered	
MA15.1532.02	Raised	Unfurled	Raised	Furled	Lowered	
MA16.1504-11	Raised	Unfurled	Raised	Furled	Lowered	
MA16.1508-14	Raised	Unfurled	Raised	Furled	Lowered	
MA16.1564-01	Raised	Unfurled	Raised	Furled	Lowered	
MA15.1508.01	Raised	Unfurled	Raised	Furled	Lowered	
MA15.1513.03	Raised	Unfurled	Raised	Furled	Lowered	
MA15.1534.02	Raised	Unfurled	Raised	Furled	Lowered	
MA16.1503-07	Raised	Unfurled	Raised	Furled	Lowered	
MA16.1505-10	Raised	Unfurled	Raised	Furled	Lowered	
MA16.1505-13	Raised	Unfurled	Raised	Furled	Lowered	
MA16.1506-04	Raised	Unfurled	Raised	Furled	Lowered	
MA16.1511-03	Raised	Unfurled	Raised	Furled	Lowered	
MA16.1512-09	Raised	Unfurled	Raised	Furled	Lowered	
MA16.1518-07	Raised	Unfurled	Raised	Furled	Lowered	
MA16.1519-02	Raised	Unfurled	Raised	Furled	Lowered	
MA16.1521-04	Raised	Unfurled	Raised	Furled	Lowered	
MA16.1523-07	Raised	Unfurled	Raised	Furled	Lowered	
MA16.1531-03	Raised	Unfurled	Raised	Furled	Lowered	
MA16.1540-04	Raised	Unfurled	Raised	Furled	Lowered	
MA16.1542-01	Raised	Unfurled	Raised	Furled	Lowered	
MA16.1548-09	Raised	Unfurled	Raised	Furled	Lowered	
MA16.1558-02	Raised	Unfurled	Raised	Furled	Lowered	
MA16.1565-01	Raised	Unfurled	Raised	Furled	Lowered	
CA17.02	Raised	Unfurled	Raised	Furled	Raised	
MA16.1565-03	Raised	Unfurled	Raised	Unfurled	Lowered	
MA15.1504.02	Raised	Unfurled	Raised	Unfurled	Raised	
MA16.1497-03	Raised	Unfurled	Raised	Unfurled	Raised	
MA15.1510.05	Raised	Unfurled	Raised	Unfurled	Raised	
MA15.1523.06	Raised	Unfurled	Raised	Unfurled	Raised	
MA16.1508-07	Raised	Unfurled	Raised	Unfurled	Raised	
MA16.1516-01	Raised	Unfurled	Raised	Unfurled	Raised	

MA16.1538-05	Raised	Unfurled	Raised	Unfurled	Raised	
MA16.1561-02	Raised	Unfurled	Raised	Unfurled	Raised	
EN02.01	Lowered	Unfurled	Raised	Furled	Lowered	
MA13.02	Lowered	Unfurled	Raised	Unfurled	Raised	
CA04.22	Raised	Furled	Lowered	Furled	Lowered	
CA04.18	Lowered	Furled	Raised	Furled	Lowered	
CA04.04	Lowered	Unfurled	Raised	Furled	Lowered	
CA04.05	Lowered	Unfurled	Raised	Furled	Lowered	
CA04.06	Lowered	Unfurled	Raised	Furled	Lowered	
CA04.16	Lowered	Unfurled	Raised	Furled	Lowered	
CA04.17	Lowered	Unfurled	Raised	Furled	Lowered	
CA04.19	Lowered	Unfurled	Raised	Furled	Lowered	
CA04.24	Lowered	Unfurled	Raised	Furled	Lowered	
CA04.30	Lowered	Unfurled	Raised	Furled	Lowered	
CA04.34	Lowered	Unfurled	Raised	Furled	Lowered	
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CA09.04	Lowered	Unfurled	Raised	Furled	Lowered	
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MA11.01	Lowered	Unfurled	Raised	Furled	Lowered	
MA16.1559-04	Lowered	Unfurled	Raised	Furled	Lowered	
MA13.18	Lowered	Unfurled	Raised	Furled	Lowered	
MA15.1509.11	Lowered	Unfurled	Raised	Furled	Lowered	
MA15.1519.19	Lowered	Unfurled	Raised	Furled	Lowered	
MA16.1511-04	Lowered	Unfurled	Raised	Furled	Lowered	
MA16.1514-02	Lowered	Unfurled	Raised	Furled	Lowered	
MA16.1554-01	Lowered	Unfurled	Raised	Furled	Lowered	
MA16.1516-03	Lowered	Unfurled	Raised	Unfurled	Raised	
MA16.1503-06	Lowered	Unfurled	Raised	Unfurled	Raised	
CA22.30	Raised	Unfurled	Raised	Furled	Raised	
CA33.05	Raised	Unfurled	Raised	Unfurled	Raised	
CA04.25	Raised	Unfurled	Raised	Furled	Lowered	
CA33.01	Raised	Unfurled	Raised	Furled	Lowered	
MA12.04	Raised	Unfurled	Raised	Furled	Lowered	
CA16.03	Raised	Unfurled	Raised	Furled	Lowered	

MA16.1508-03	Raised	Unfurled	Raised	Furled	Lowered	
MA16.1508-13	Raised	Unfurled	Raised	Furled	Lowered	
MA16.1513-02	Raised	Unfurled	Raised	Furled	Lowered	
MA16.1506-15	Raised	Unfurled	Raised	Furled	Lowered	
MA16.1515-02	Raised	Unfurled	Raised	Furled	Lowered	
MA16.1517-01	Raised	Unfurled	Raised	Furled	Lowered	
MA16.1525-02	Raised	Unfurled	Raised	Furled	Lowered	
MA16.1533-07	Raised	Unfurled	Raised	Furled	Lowered	
MA16.1536-04	Raised	Unfurled	Raised	Furled	Lowered	
MA16.1537-05	Raised	Unfurled	Raised	Furled	Lowered	
MA16.1547-06	Raised	Unfurled	Raised	Furled	Lowered	
MA19.02	Raised	Unfurled	Raised	Furled	Lowered	
CA24.02	Raised	Unfurled	Raised	Furled	Lowered	
CA15.03	Raised	Unfurled	Raised	Furled	Raised	
MA13.11	Raised	Unfurled	Raised	Furled	Raised	
CA21.08	Raised	Unfurled	Raised	Furled	Raised	
MA16.1500-02	Raised	Unfurled	Raised	Unfurled	Lowered	
CA15.02	Raised	Unfurled	Raised	Unfurled	Raised	
CA15.08	Raised	Unfurled	Raised	Unfurled	Raised	
CA16.02	Raised	Unfurled	Raised	Unfurled	Raised	
CA16.05	Raised	Unfurled	Raised	Unfurled	Raised	
CA06.01	Raised	Unfurled	Raised	Unfurled	Raised	
CA06.02	Raised	Unfurled	Raised	Unfurled	Raised	
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CA07.04	Raised	Unfurled	Raised	Unfurled	Raised	
CA07.06	Raised	Unfurled	Raised	Unfurled	Raised	
CA07.07	Raised	Unfurled	Raised	Unfurled	Raised	
CA07.11	Raised	Unfurled	Raised	Unfurled	Raised	
CA08.01	Raised	Unfurled	Raised	Unfurled	Raised	
CA13.01	Raised	Unfurled	Raised	Unfurled	Raised	
CA15.05	Raised	Unfurled	Raised	Unfurled	Raised	

CA15.07	Raised	Unfurled	Raised	Unfurled	Raised	
CA19.01	Raised	Unfurled	Raised	Unfurled	Raised	
CA19.02	Raised	Unfurled	Raised	Unfurled	Raised	
CA26.01	Raised	Unfurled	Raised	Unfurled	Raised	
CA27.01	Raised	Unfurled	Raised	Unfurled	Raised	
CA27.06	Raised	Unfurled	Raised	Unfurled	Raised	
CA35.02	Raised	Unfurled	Raised	Unfurled	Raised	
MA13.19	Raised	Unfurled	Raised	Unfurled	Raised	
MA13.20	Raised	Unfurled	Raised	Unfurled	Raised	
MA13.22	Raised	Unfurled	Raised	Unfurled	Raised	
MA13.23	Raised	Unfurled	Raised	Unfurled	Raised	
MA13.24	Raised	Unfurled	Raised	Unfurled	Raised	
MA15.1497.01	Raised	Unfurled	Raised	Unfurled	Raised	
MA15.1501.02	Raised	Unfurled	Raised	Unfurled	Raised	
MA15.1501.08	Raised	Unfurled	Raised	Unfurled	Raised	
MA15.1502.01	Raised	Unfurled	Raised	Unfurled	Raised	
MA15.1504.08	Raised	Unfurled	Raised	Unfurled	Raised	
MA15.1512.09	Raised	Unfurled	Raised	Unfurled	Raised	
MA15.1517.07	Raised	Unfurled	Raised	Unfurled	Raised	
MA15.1529.02	Raised	Unfurled	Raised	Unfurled	Raised	
MA15.1553.01	Raised	Unfurled	Raised	Unfurled	Raised	
MA16.1500-01	Raised	Unfurled	Raised	Unfurled	Raised	
MA16.1501-01	Raised	Unfurled	Raised	Unfurled	Raised	
MA16.1501-02	Raised	Unfurled	Raised	Unfurled	Raised	
MA16.1501-03	Raised	Unfurled	Raised	Unfurled	Raised	
MA16.1502-03	Raised	Unfurled	Raised	Unfurled	Raised	
MA16.1502-12	Raised	Unfurled	Raised	Unfurled	Raised	
MA16.1507-11	Raised	Unfurled	Raised	Unfurled	Raised	
MA16.1512-07	Raised	Unfurled	Raised	Unfurled	Raised	
MA16.1517-02	Raised	Unfurled	Raised	Unfurled	Raised	
MA16.1528-01	Raised	Unfurled	Raised	Unfurled	Raised	
MA16.1528-08	Raised	Unfurled	Raised	Unfurled	Raised	
MA16.1552-02	Raised	Unfurled	Raised	Unfurled	Raised	
MA16.1553-01	Raised	Unfurled	Raised	Unfurled	Raised	

IMAGE # Cont.	BOW SPRIT	SPRIT SAIL				
EN05.04	Present	Absent				
PA03.04	Present	Absent				
CA22.21	Present	Absent				
CA22.06	Present	Absent				
CA22.28	Present	Absent				
CA22.12	Present	Absent				
CA22.15	Present	Absent				
CA22.37	Present	Absent				
CA34.04	Present	Absent				
CA34.05	Present	Absent				
MA11.03	Present	Absent				
MA11.07	Present	Furled				
MA14.01	Present	Furled				
MA14.02	Present	Furled				
MA14.04	Present	Furled				
MA14.08	Present	Furled				
MA15.1563.01	Present	Furled				
MA14.06	Present	Furled				
CA22.36	Present	Furled				
MA12.01	Present	Absent				
MA13.13	Present	Furled				
MA13.14	Present	Furled				
CA22.10	Present	Absent				
CA22.11	Present	Absent				
CA03.02	Present	Absent				
PA03.02	Present	Absent				
CA29.05	Present	Absent				
CA29.06	Present	Absent				
CA27.03	Present	Furled				
CA27.04	Present	Furled				
CA31.01	Present	Furled				
CA31.02	Present	Furled				
CA31.05	Present	Furled				

CA31.06	Present	Furled				
CA31.03	Present	Furled				
CA31.04	Present	Furled				
CA03.07	Present	Absent				
CA22.27	Present	Absent				
PA02.01	Present	Absent				
PA07.03	Present	Furled				
MA19.01	Present	Absent				
EN06.01	Present	Absent				
MA15.1515.03	Present	Unfurled				
MA15.1524.10	Present	Unfurled				
CA15.01	Present	Absent				
CA16.01	Present	Absent				
CA03.01	Present	Absent				
MA01.01	Present	Absent				
MA15.1505.12	Present	Unfurled				
MA15.1509.16	Present	Unfurled				
MA16.1503-08	Present	Unfurled				
MA16.1509-08	Present	Unfurled				
MA16.1510-10	Present	Unfurled				
MA16.1512-03	Present	Unfurled				
MA16.1515-10	Present	Unfurled				
MA16.1557-04	Present	Unfurled				
MA16.1530-07	Present	Unfurled				
MA15.1521.09	Present	Unfurled				
CA14.01	Present	Absent				
MA13.21	Present	Unfurled				
CA22.19	Present	Absent				
MA15.1532.02	Present	Furled				
MA16.1504-11	Present	Furled				
MA16.1508-14	Present	Furled				
MA16.1564-01	Present	Furled				
MA15.1508.01	Present	Unfurled				
MA15.1513.03	Present	Unfurled				

MA15.1534.02	Present	Unfurled				
MA16.1503-07	Present	Unfurled				
MA16.1505-10	Present	Unfurled				
MA16.1505-13	Present	Unfurled				
MA16.1506-04	Present	Unfurled				
MA16.1511-03	Present	Unfurled				
MA16.1512-09	Present	Unfurled				
MA16.1518-07	Present	Unfurled				
MA16.1519-02	Present	Unfurled				
MA16.1521-04	Present	Unfurled				
MA16.1523-07	Present	Unfurled				
MA16.1531-03	Present	Unfurled				
MA16.1540-04	Present	Unfurled				
MA16.1542-01	Present	Unfurled				
MA16.1548-09	Present	Unfurled				
MA16.1558-02	Present	Unfurled				
MA16.1565-01	Present	Unfurled				
CA17.02	Present	Absent				
MA16.1565-03	Present	Unfurled				
MA15.1504.02	Present	Furled				
MA16.1497-03	Present	Furled				
MA15.1510.05	Present	Unfurled				
MA15.1523.06	Present	Unfurled				
MA16.1508-07	Present	Unfurled				
MA16.1516-01	Present	Unfurled				
MA16.1538-05	Present	Unfurled				
MA16.1561-02	Present	Unfurled				
EN02.01	Present	Furled				
MA13.02	Present	Unfurled				
CA04.22	Present	Absent				
CA04.18	Present	Absent				
CA04.04	Present	Absent				
CA04.05	Present	Absent				
CA04.06	Present	Absent				

CA04.16	Present	Absent				
CA04.17	Present	Absent				
CA04.19	Present	Absent				
CA04.24	Present	Absent				
CA04.30	Present	Absent				
CA04.34	Present	Absent				
CA09.02	Present	Absent				
CA09.04	Present	Absent				
MA08.03	Present	Furled				
MA11.01	Present	Furled				
MA16.1559-04	Present	Furled				
MA13.18	Present	Unfurled				
MA15.1509.11	Present	Unfurled				
MA15.1519.19	Present	Unfurled				
MA16.1511-04	Present	Unfurled				
MA16.1514-02	Present	Unfurled				
MA16.1554-01	Present	Unfurled				
MA16.1516-03	Present	Unfurled				
MA16.1503-06	Present	Unfurled				
CA22.30	Present	Furled				
CA33.05	Present	Absent				
CA04.25	Present	Absent				
CA33.01	Present	Absent				
MA12.04	Present	Absent				
CA16.03	Present	Furled				
MA16.1508-03	Present	Furled				
MA16.1508-13	Present	Furled				
MA16.1513-02	Present	Furled				
MA16.1506-15	Present	Unfurled				
MA16.1515-02	Present	Unfurled				
MA16.1517-01	Present	Unfurled				
MA16.1525-02	Present	Unfurled				
MA16.1533-07	Present	Unfurled				
MA16.1536-04	Present	Unfurled				

MA16.1537-05	Present	Unfurled				
MA16.1547-06	Present	Unfurled				
MA19.02	Present	Unfurled				
CA24.02	Present	Unfurled				
CA15.03	Present	Absent				
MA13.11	Present	Absent				
CA21.08	Present	Unfurled				
MA16.1500-02	Present	Unfurled				
CA15.02	Present	Absent				
CA15.08	Present	Absent				
CA16.02	Present	Furled				
CA16.05	Present	Furled				
CA06.01	Present	Unfurled				
CA06.02	Present	Unfurled				
CA06.03	Present	Unfurled				
CA06.05	Present	Unfurled				
CA07.01	Present	Unfurled				
CA07.02	Present	Unfurled				
CA07.04	Present	Unfurled				
CA07.06	Present	Unfurled				
CA07.07	Present	Unfurled				
CA07.11	Present	Unfurled				
CA08.01	Present	Unfurled				
CA13.01	Present	Unfurled				
CA15.05	Present	Unfurled				
CA15.07	Present	Unfurled				
CA19.01	Present	Unfurled				
CA19.02	Present	Unfurled				
CA26.01	Present	Unfurled				
CA27.01	Present	Unfurled				
CA27.06	Present	Unfurled				
CA35.02	Present	Unfurled				
MA13.19	Present	Unfurled				
MA13.20	Present	Unfurled				

MA13.22	Present	Unfurled				
MA13.23	Present	Unfurled				
MA13.24	Present	Unfurled				
MA15.1497.01	Present	Unfurled				
MA15.1501.02	Present	Unfurled				
MA15.1501.08	Present	Unfurled				
MA15.1502.01	Present	Unfurled				
MA15.1504.08	Present	Unfurled				
MA15.1512.09	Present	Unfurled				
MA15.1517.07	Present	Unfurled				
MA15.1529.02	Present	Unfurled				
MA15.1553.01	Present	Unfurled				
MA16.1500-01	Present	Unfurled				
MA16.1501-01	Present	Unfurled				
MA16.1501-02	Present	Unfurled				
MA16.1501-03	Present	Unfurled				
MA16.1502-03	Present	Unfurled				
MA16.1502-12	Present	Unfurled				
MA16.1507-11	Present	Unfurled				
MA16.1512-07	Present	Unfurled				
MA16.1517-02	Present	Unfurled				
MA16.1528-01	Present	Unfurled				
MA16.1528-08	Present	Unfurled				
MA16.1552-02	Present	Unfurled				
MA16.1553-01	Present	Unfurled				
LATEEN MIZZEN			**SQUARE MAIN, MAIN TOP, MAIN TOPGALLANT, FORE, AND FORE TOP**			
IMAGE #	**POSITION**	**MIZ. SAIL**	**MIZ. YARD**	**MAIN SAIL**	**MAIN YARD**	**MAIN T.SAIL**
MA13.07	Anch	Furled	Raised	Furled	Lowered	Furled
MA13.08	Anch	Furled	Raised	Furled	Lowered	Furled
MA12.05	Sail	Furled	Raised	Unfurled	Raised	Unfurled
IMAGE # Cont.	**MAIN T.YARD**	**MAIN TG.SAIL**	**MAIN TG.YARD**	**FORE SAIL**	**FORE YARD**	**FORE T.SAIL**
MA13.07	Lowered	Furled	Lowered	Furled	Lowered	Furled
MA13.08	Lowered	Furled	Lowered	Furled	Lowered	Furled

MA12.05	Raised	Furled	Raised	Unfurled	Raised	Furled
IMAGE # Cont.	**FORE T.YARD**	**BOW SPRIT**	**SPRIT SAIL**			
MA13.07	Lowered	Present	Absent			
MA13.08	Raised	Present	Absent			
MA12.05	Raised	Present	Absent			
LATEEN MIZZEN			**SQUARE MAIN, MAIN TOP, MAIN TOPGALLANT, FORE, FORE TOP, AND FORE TOPGALLANT**			
IMAGE #	**POSITION**	**MIZ. SAIL**	**MIZ. YARD**	**MAIN SAIL**	**MAIN YARD**	**MAIN T.SAIL**
EN01.01	Sail	Unfurled	Raised	Furled	Raised	Unfurled
IMAGE # Cont.	**MAIN T.YARD**	**MAIN TG.SAIL**	**MAIN TG.YARD**	**FORE SAIL**	**FORE YARD**	**FORE T.SAIL**
EN01.01	Raised	Unfurled	Raised	Furled	Raised	Unfurled
IMAGE # Cont.	**FORE T.YARD**	**FORE TG.SAIL**	**FORE TG.YARD**	**BOW SPRIT**	**SPRIT SAIL**	
EN01.01	Raised	Furled	Lowered	Present	Furled	
LATEEN MIZZEN AND MIZZEN TOP			**SQUARE MAIN, MAIN TOP, MAIN TOPGALLANT, FORE, FORE TOP, AND FORE TOPGALLANT**			
IMAGE #	**POSITION**	**MIZ. SAIL**	**MIZ. YARD**	**MIZ. T.SAIL**	**MIZ. T.YARD**	**MAIN SAIL**
PA07.01	Anch	No Sail	No Yard	No Sail	No Yard	No Sail
MA12.06	Anch	Furled	Raised	Furled	Raised	Furled
IMAGE # Cont.	**MAIN YARD**	**MAIN T.SAIL**	**MAIN T.YARD**	**MAIN TG.SAIL**	**MAIN TG.YARD**	**FORE SAIL**
PA07.01	No Yard	No Sail	No Yard	No Sail	No Yard	Furled
MA12.06	Half Raised	Furled	Half Raised	Furled	Raised	Furled
IMAGE # Cont.	**FORE YARD**	**FORE T.SAIL**	**FORE T.YARD**	**FORE TG.SAIL**	**FORE TG.YARD**	
PA07.01	Raised	No Sail	No Yard	No Sail	No Yard	
MA12.06	Half Raised	Furled	Half Raised	Furled	Raised	
IMAGE # Cont.	**BOW SPRIT**	**SPRIT SAIL**				
PA07.01	Present	Absent				
MA12.06	Present	Absent				
LATEEN MIZZEN AND MIZZEN TOP			**SQUARE MAIN, MAIN TOP, AND FORE,**			
IMAGE #	**POSITION**	**MIZ. SAIL**	**MIZ. YARD**	**MIZ. T.SAIL**	**MIZ. T.YARD**	**MAIN SAIL**
CA26.02	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
CA32.02	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled

IMAGE # Cont.	MAIN YARD	MAIN T.SAIL	MAIN T.YARD	FORE SAIL	FORE YARD	
CA26.02	Raised	Unfurled	Raised	Unfurled	Raised	
CA32.02	Raised	Unfurled	Raised	Unfurled	Raised	
IMAGE # Cont.	**BOW SPRIT**	**SPRIT SAIL**				
CA26.02	Present	Absent				
CA32.02	Present	Unfurled				
LATEEN MIZZEN AND MIZZEN TOP			**SQUARE MAIN, MAIN TOP, FORE, AND FORE TOP**			
IMAGE #	**POSITION**	**MIZ. SAIL**	**MIZ. YARD**	**MIZ. T.SAIL**	**MIZ. T.YARD**	**MAIN SAIL**
CA29.08	Anch	Furled	Raised	Furled	Lowered	Furled
PA07.02	Sail	Furled	Raised	No Sail	No Yard	Furled
IMAGE # Cont.	**MAIN YARD**	**MAIN T.SAIL**	**MAIN T.YARD**	**FORE SAIL**	**FORE YARD**	**FORE T.SAIL**
CA29.08	Raised	Furled	Lowered	Furled	Raised	Furled
PA07.02	Raised	Unfurled	Raised	Unfurled	Raised	Unfurled
IMAGE # Cont.	**FORE T.YARD**	**BOW SPRIT**	**SPRIT SAIL**			
CA29.08	Lowered	Present	Absent			
PA07.02	Raised	Present	Unfurled			

FOUR-MASTED NAUS						
LATEEN BON. AND MIZZEN			**SQUARE MAIN AND FORE**			
IMAGE #	**POSITION**	**BON. SAIL**	**BON. YARD**	**MIZ. SAIL**	**MIZ. YARD**	**MAIN SAIL**
MA15.1528.01	Sail	Furled	Raised	Furled	Raised	Unfurled
IMAGE # Cont.	**MAIN YARD**	**FORE SAIL**	**FORE YARD**	**BOW SPRIT**	**SPRIT SAIL**	
MA15.1528.01	Raised	Unfurled	Raised	Absent	Absent	
LATEEN BON. AND MIZZEN			**SQUARE MAIN, MAIN TOP, FORE, AND FORE TOP**			
IMAGE #	**POSITION**	**BON. SAIL**	**BON. YARD**	**MIZ. SAIL**	**MIZ. YARD**	**MAIN SAIL**
PA04.03	Anch	Furled	Raised	Furled	Raised	Furled
CA21.08	Sail	Furled	Raised	Unfurled	Raised	Unfurled
CA05.01	Wreck	Unfurled	Raised	Furled	Raised	Unfurled
CA05.02	Sail	Unfurled	Raised	Furled	Raised	Unfurled

PA04.01	Sail	Unfurled	Raised	Furled	Raised	Unfurled
PA04.02	Sail	Unfurled	Raised	Unfurled	Raised	Furled
IMAGE # Cont.	**MAIN YARD**	**MAIN T.SAIL**	**MAIN T.YARD**	**FORE SAIL**	**FORE YARD**	**FORE T.SAIL**
PA04.03	Raised	Furled	Raised	Furled	Raised	Furled
CA21.08	Raised	Unfurled	Raised	Unfurled	Raised	Furled
CA05.01	Raised	Furled	Lowered	Unfurled	Raised	Furled
CA05.02	Raised	Unfurled	Raised	Unfurled	Raised	Furled
PA04.01	Raised	Furled	Raised	Unfurled	Raised	Furled
PA04.02	Raised	Furled	Lowered	Unfurled	Raised	Furled
IMAGE # Cont.	**FORE T.YARD**	**BOW SPRIT**	**SPRIT SAIL**			
PA04.03	Raised	Present	Absent			
CA21.08	Lowered	Present	Unfurled			
CA05.01	Lowered	Present	Absent			
CA05.02	Lowered	Present	Absent			
PA04.01	Raised	Present	Absent			
PA04.02	Raised	Present	Absent			

APPENDIX 14

NAU SAIL SETTINGS BY GROUPINGS

THREE-MASTED NAUS						
LATEEN MIZZEN			**SQUARE MAIN AND FORE**			
IMAGE #	**POSITION**	**MIZ. SAIL**	**MIZ. YARD**	**MAIN SAIL**	**MAIN YARD**	**FORE SAIL**
3N-1	Anch	Unfurled	Raised	Furled	Raised	Furled
IMAGE # Cont.	**FORE YARD**	**BOW SPRIT**	**SPRIT SAIL**	**#**		
3N-1	Raised	Present	Absent	**N=1**		
LATEEN MIZZEN			**SQUARE MAIN, MAIN TOP, AND FORE**			
IMAGE #	**POSITION**	**MIZ. SAIL**	**MIZ. YARD**	**MAIN SAIL**	**MAIN YARD**	**MAIN T.SAIL**
3N-2	Anch	Furled	Lowered	No Sail	No Yard	No Sail
3N-3	Anch	Furled	Raised	Furled	Lowered	No Sail
3N-4	Anch	Furled	Raised	Furled	Raised	Furled
3N-5	Sail	Furled	Raised	Unfurled	Raised	Furled
3N-6	Sail	Unfurled	Raised	Unfurled	Raised	Furled
3N-7	Sail	Unfurled	Raised	Unfurled	Raised	Furled
3N-8	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
3N-9	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
IMAGE # Cont.	**MAIN T.YARD**	**FORE SAIL**	**FORE YARD**	**BOW SPRIT**	**SPRIT SAIL**	**#**
3N-2	No Yard	No Sail	No Yard	Present	Absent	**N=1**
3N-3	No Yard	No Sail	No Yard	Present	Absent	**N=1**
3N-4	Lowered	Furled	Raised	Present	Absent	**N=5**
3N-5	Raised	Unfurled	Raised	Present	Absent	**N=1**
3N-6	Lowered	Unfurled	Raised	Present	Absent	**N=1**
3N-7	Raised	Unfurled	Raised	Present	Absent	**N=1**
3N-8	Raised	Unfurled	Raised	Present	Absent	**N=2**
3N-9	Raised	Unfurled	Raised	Present	Unfurled	**N=1**

LATEEN MIZZEN			SQUARE MAIN, MAIN TOP, FORE, AND FORE TOP			
IMAGE #	**POSITION**	**MIZ. SAIL**	**MIZ. YARD**	**MAIN SAIL**	**MAIN YARD**	**MAIN T.SAIL**
3N-10	Anch	Furled	Half Raised	Unfurled	Half Raised	Furled
3N-11	Anch	Furled	Lowered	Furled	Lowered	Furled
3N-12	Anch	Furled	Raised	Furled	Half Raised	Furled
3N-13	Anch	Furled	Raised	Furled	Half Raised	Furled
3N-14	Anch	Furled	Raised	Furled	Half Raised	Furled
3N-15	Anch	Furled	Raised	Furled	Half Raised	Furled
3N-16	Anch	Furled	Raised	Furled	Half Raised	Furled
3N-17	Anch	Furled	Raised	Furled	Lowered	Furled
3N-18	Anch	Furled	Raised	Furled	Lowered	Furled
3N-19	Anch	Furled	Raised	Furled	Raised	Furled
3N-20	Anch	Furled	Raised	Furled	Raised	Furled
3N-21	Anch	Furled	Raised	Furled	Raised	Furled
3N-22	Anch	Furled	Raised	Furled	Raised	Furled
3N-23	Anch	Furled	Raised	Furled	Raised	Furled
3N-24	Anch	Furled	Raised	Furled	Raised	Furled
3N-25	Anch	Furled	Raised	Furled	Raised	Furled
3N-26	Anch	Furled	Raised	Furled	Raised	Furled
3N-27	Anch	Furled	Raised	Furled	Raised	Furled
3N-28	Sail	Furled	Raised	Furled	Raised	Furled
3N-29	Anch	Furled	Raised	Unfurled	Half Raised	Furled
3N-30	Sail	Furled	Raised	Unfurled	Half Raised	Furled
3N-31	Battle	Furled	Raised	Unfurled	Half Raised	Furled
3N-32	Sail	Furled	Raised	Unfurled	Raised	Furled
3N-33	Sail	Furled	Raised	Unfurled	Raised	Furled
3N-34	Sail	Furled	Raised	Unfurled	Raised	Furled
3N-35	Sail	Furled	Raised	Unfurled	Raised	Furled

3N-36	Battle	Furled	Raised	Unfurled	Raised	Furled
3N-37	Sail	Furled	Raised	Unfurled	Raised	Unfurled
3N-38	Sail	Furled	Raised	Unfurled	Raised	Unfurled
3N-39	Sail	Furled	Raised	Unfurled	Raised	Unfurled
3N-40	Sail	Furled	Raised	Unfurled	Raised	Unfurled
3N-41	Sail	Furled	Raised	Unfurled	Raised	Unfurled
3N-42	Sail	Furled	Raised	Unfurled	Raised	Unfurled
3N-43	Sail	Furled	Raised	Unfurled	Raised	Unfurled
3N-44	Sail	Furled	Raised	Unfurled	Raised	Unfurled
3N-45	Sail	Unfurled	Raised	Furled	Lowered	Furled
3N-46	Sail	Unfurled	Raised	Furled	Raised	Furled
3N-47	Sail	Unfurled	Raised	Unfurled	Half Raised	Furled
3N-48	Sail	Unfurled	Raised	Unfurled	Raised	Furled
3N-49	Sail	Unfurled	Raised	Unfurled	Raised	Furled
3N-50	Sail	Unfurled	Raised	Unfurled	Raised	Furled
3N-51	Sail	Unfurled	Raised	Unfurled	Raised	Furled
3N-52	Sail	Unfurled	Raised	Unfurled	Raised	Furled
3N-53	Sail	Unfurled	Raised	Unfurled	Raised	Furled
3N-54	Sail	Unfurled	Raised	Unfurled	Raised	Furled
3N-55	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
3N-56	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
3N-57	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
3N-58	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
3N-59	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
3N-60	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
3N-61	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
3N-62	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
3N-63	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
IMAGE # Cont.	**MAIN T.YARD**	**FORE SAIL**	**FORE YARD**	**FORE T.SAIL**	**FORE T.YARD**	
3N-10	Half Raised	Furled	Half Raised	Furled	Half Raised	
3N-11	Lowered	Furled	Lowered	Furled	Raised	
3N-12	Raised	Unfurled	Raised	Furled	Raised	
3N-13	Raised	Furled	Raised	Furled	Raised	

3N-14	Raised	Furled	Half Raised	Furled	Raised	
3N-15	Lowered	Furled	Half Raised	Furled	Lowered	
3N-16	Half Raised	Unfurled	Half Raised	Furled	Half Raised	
3N-17	Lowered	Furled	Lowered	Furled	Lowered	
3N-18	Raised	Furled	Lowered	Furled	Raised	
3N-19	Half Raised	Furled	Raised	Furled	Half Raised	
3N-20	Lowered	Furled	Half Raised	Furled	Raised	
3N-21	Lowered	Furled	Half Raised	Furled	Lowered	
3N-22	Lowered	Furled	Raised	Furled	Raised	
3N-23	Lowered	Furled	Raised	Furled	Lowered	
3N-24	Lowered	Furled	Raised	Furled	Lowered	
3N-25	Lowered	Unfurled	Raised	Furled	Lowered	
3N-26	Raised	Furled	Raised	Furled	Raised	
3N-27	Raised	Furled	Raised	Furled	Raised	
3N-28	Raised	Unfurled	Raised	Furled	Lowered	
3N-29	Lowered	Furled	Half Raised	Furled	Lowered	
3N-30	Half Raised	Unfurled	Half Raised	Furled	Half Raised	
3N-31	Lowered	Furled	Lowered	Furled	Lowered	
3N-32	Lowered	Unfurled	Raised	Furled	Raised	
3N-33	Lowered	Unfurled	Raised	Furled	Lowered	
3N-34	Lowered	Unfurled	Raised	Furled	Lowered	
3N-35	Lowered	Unfurled	Raised	Unfurled	Raised	
3N-36	Raised	Unfurled	Raised	Furled	Raised	
3N-37	Raised	Furled	Raised	Unfurled	Raised	
3N-38	Raised	Unfurled	Raised	Furled	Lowered	
3N-39	Raised	Unfurled	Raised	Furled	Lowered	
3N-40	Raised	Unfurled	Raised	Furled	Lowered	
3N-41	Raised	Unfurled	Raised	Furled	Raised	
3N-42	Raised	Unfurled	Raised	Unfurled	Lowered	
3N-43	Raised	Unfurled	Raised	Unfurled	Raised	
3N-44	Raised	Unfurled	Raised	Unfurled	Raised	

3N-45	Lowered	Unfurled	Raised	Furled	Lowered	
3N-46	Lowered	Unfurled	Raised	Unfurled	Raised	
3N-47	Raised	Furled	Lowered	Furled	Lowered	
3N-48	Lowered	Furled	Raised	Furled	Lowered	
3N-49	Lowered	Unfurled	Raised	Furled	Lowered	
3N-50	Lowered	Unfurled	Raised	Furled	Lowered	
3N-51	Lowered	Unfurled	Raised	Furled	Lowered	
3N-52	Lowered	Unfurled	Raised	Unfurled	Raised	
3N-53	Raised	Unfurled	Raised	Furled	Raised	
3N-54	Raised	Unfurled	Raised	Unfurled	Raised	
3N-55	Raised	Unfurled	Raised	Furled	Lowered	
3N-56	Raised	Unfurled	Raised	Furled	Lowered	
3N-57	Raised	Unfurled	Raised	Furled	Lowered	
3N-58	Raised	Unfurled	Raised	Furled	Raised	
3N-59	Raised	Unfurled	Raised	Furled	Raised	
3N-60	Raised	Unfurled	Raised	Unfurled	Lowered	
3N-61	Raised	Unfurled	Raised	Unfurled	Raised	
3N-62	Raised	Unfurled	Raised	Unfurled	Raised	
3N-63	Raised	Unfurled	Raised	Unfurled	Raised	
IMAGE # Cont.	**BOW SPRIT**	**SPRIT SAIL**	**#**			
3N-10	Present	Absent	**N=1**			
3N-11	Present	Absent	**N=1**			
3N-12	Present	Absent	**N=1**			
3N-13	Present	Absent	**N=1**			
3N-14	Present	Absent	**N=1**			
3N-15	Present	Absent	**N=12**			
3N-16	Present	Furled	**N=1**			
3N-17	Present	Furled	**N=1**			
3N-18	Present	Absent	**N=1**			
3N-19	Present	Furled	**N=2**			
3N-20	Present	Absent	**N=1**			
3N-21	Present	Absent	**N=1**			
3N-22	Present	Absent	**N=2**			
3N-23	Present	Absent	**N=2**			

3N-24	Present	Furled	**N=6**			
3N-25	Present	Furled	**N=2**			
3N-26	Present	Absent	**N=3**			
3N-27	Present	Furled	**N=1**			
3N-28	Present	Absent	**N=1**			
3N-29	Present	Absent	**N=1**			
3N-30	Present	Unfurled	**N=1**			
3N-31	Present	Unfurled	N=1			
3N-32	Present	Absent	**N=2**			
3N-33	Present	Absent	**N=2**			
3N-34	Present	Unfurled	**N=8**			
3N-35	Present	Unfurled	**N=2**			
3N-36	Present	Absent	N=1			
3N-37	Present	Unfurled	**N=1**			
3N-38	Present	Absent	**N=1**			
3N-39	Present	Furled	**N=4**			
3N-40	Present	Unfurled	**N=19**			
3N-41	Present	Absent	**N=1**			
3N-42	Present	Unfurled	**N=1**			
3N-43	Present	Furled	**N=2**			
3N-44	Present	Unfurled	**N=6**			
3N-45	Present	Furled	**N=1**			
3N-46	Present	Unfurled	**N=1**			
3N-47	Present	Absent	**N=1**			
3N-48	Present	Absent	**N=1**			
3N-49	Present	Absent	**N=11**			
3N-50	Present	Furled	**N=3**			
3N-51	Present	Unfurled	**N=6**			
3N-52	Present	Unfurled	**N=2**			
3N-53	Present	Furled	**N=1**			
3N-54	Present	Absent	**N=1**			
3N-55	Present	Absent	**N=3**			
3N-56	Present	Furled	**N=4**			
3N-57	Present	Unfurled	**N=10**			

3N-58	Present	Absent	**N=2**			
3N-59	Present	Unfurled	**N=1**			
3N-60	Present	Unfurled	**N=1**			
3N-61	Present	Absent	**N=2**			
3N-62	Present	Furled	**N=2**			
3N-63	Present	Unfurled	**N=47**			
LATEEN MIZZEN			**SQUARE MAIN, MAIN TOP, MAIN TOPGALLANT, FORE, AND FORE TOP**			
IMAGE #	**POSITION**	**MIZ. SAIL**	**MIZ. YARD**	**MAIN SAIL**	**MAIN YARD**	**MAIN T.SAIL**
3N-64	Anch	Furled	Raised	Furled	Lowered	Furled
3N-65	Anch	Furled	Raised	Furled	Lowered	Furled
3N-66	Sail	Furled	Raised	Unfurled	Raised	Unfurled
IMAGE # Cont.	**MAIN T.YARD**	**MAIN TG.SAIL**	**MAIN TG.YARD**	**FORE SAIL**	**FORE YARD**	**FORE T.SAIL**
3N-64	Lowered	Furled	Lowered	Furled	Lowered	Furled
3N-65	Lowered	Furled	Lowered	Furled	Lowered	Furled
3N-66	Raised	Furled	Raised	Unfurled	Raised	Furled
IMAGE # Cont.	**FORE T.YARD**	**BOW SPRIT**	**SPRIT SAIL**	**#**		
3N-64	Lowered	Present	Absent	**N=1**		
3N-65	Raised	Present	Absent	**N=1**		
3N-66	Raised	Present	Absent	**N=1**		
LATEEN MIZZEN			**SQUARE MAIN, MAIN TOP, MAIN TOPGALLANT, FORE, FORE TOP, AND FORE TOPGALLANT**			
IMAGE #	**POSITION**	**MIZ. SAIL**	**MIZ. YARD**	**MAIN SAIL**	**MAIN YARD**	**MAIN T.SAIL**
3N-67	Sail	Unfurled	Raised	Furled	Raised	Unfurled
IMAGE # Cont.	**MAIN T.YARD**	**MAIN TG.SAIL**	**MAIN TG.YARD**	**FORE SAIL**	**FORE YARD**	**FORE T.SAIL**
3N-67	Raised	Unfurled	Raised	Furled	Raised	Unfurled
IMAGE # Cont.	**FORE T.YARD**	**FORE TG.SAIL**	**FORE TG.YARD**	**BOW SPRIT**	**SPRIT SAIL**	**#**
3N-67	Raised	Furled	Lowered	Present	Furled	**N=1**
LATEEN MIZZEN AND MIZZEN TOP			**SQUARE MAIN, MAIN TOP, MAIN TOPGALLANT, FORE, FORE TOP, AND FORE TOPGALLANT**			
IMAGE #	**POSITION**	**MIZ. SAIL**	**MIZ. YARD**	**MIZ. T.SAIL**	**MIZ. T.YARD**	**MAIN SAIL**
3N-68	Anch	No Sail	No Yard	No Sail	No Yard	No Sail

3N-69	Anch	Furled	Raised	Furled	Raised	Furled
IMAGE # Cont.	**MAIN YARD**	**MAIN T.SAIL**	**MAIN T.YARD**	**MAIN TG.SAIL**	**MAIN TG.YARD**	**FORE SAIL**
3N-68	No Yard	No Sail	No Yard	No Sail	No Yard	Furled
3N-69	Half Raised	Furled	Half Raised	Furled	Raised	Furled
IMAGE # Cont.	**FORE YARD**	**FORE T.SAIL**	**FORE T.YARD**	**FORE TG.SAIL**	**FORE TG.YARD**	
3N-68	Raised	No Sail	No Yard	No Sail	No Yard	
3N-69	Half Raised	Furled	Half Raised	Furled	Raised	
IMAGE # Cont.	**BOW SPRIT**	**SPRIT SAIL**	**#**			
3N-68	Present	Absent	**N=1**			
3N-69	Present	Absent	**N=1**			
LATEEN MIZZEN AND MIZZEN TOP			**SQUARE MAIN, MAIN TOP, AND FORE,**			
IMAGE #	**POSITION**	**MIZ. SAIL**	**MIZ. YARD**	**MIZ. T.SAIL**	**MIZ. T.YARD**	**MAIN SAIL**
3N-70	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
3N-71	Sail	Unfurled	Raised	Unfurled	Raised	Unfurled
IMAGE # Cont.	**MAIN YARD**	**MAIN T.SAIL**	**MAIN T.YARD**	**FORE SAIL**	**FORE YARD**	
3N-70	Raised	Unfurled	Raised	Unfurled	Raised	
3N-71	Raised	Unfurled	Raised	Unfurled	Raised	
IMAGE # Cont.	**BOW SPRIT**	**SPRIT SAIL**	**#**			
3N-70	Present	Absent	**N=1**			
3N-71	Present	Unfurled	**N=1**			
LATEEN MIZZEN AND MIZZEN TOP			**SQUARE MAIN, MAIN TOP, FORE, AND FORE TOP**			
IMAGE #	**POSITION**	**MIZ. SAIL**	**MIZ. YARD**	**MIZ. T.SAIL**	**MIZ. T.YARD**	**MAIN SAIL**
3N-72	Anch	Furled	Raised	Furled	Lowered	Furled
3N-73	Sail	Furled	Raised	No Sail	No Yard	Furled
IMAGE # Cont.	**MAIN YARD**	**MAIN T.SAIL**	**MAIN T.YARD**	**FORE SAIL**	**FORE YARD**	**FORE T.SAIL**
3N-72	Raised	Furled	Lowered	Furled	Raised	Furled
3N-73	Raised	Unfurled	Raised	Unfurled	Raised	Unfurled
IMAGE # Cont.	**FORE T.YARD**	**BOW SPRIT**	**SPRIT SAIL**	**#**		
3N-72	Lowered	Present	Absent	**N=1**		
3N-73	Raised	Present	Unfurled	**N=1**		

FOUR-MASTED NAUS						
LATEEN BON. AND MIZZEN			SQUARE MAIN AND FORE			
IMAGE #	POSITION	BON. SAIL	BON. YARD	MIZ. SAIL	MIZ. YARD	MAIN SAIL
4N-1	Sail	Furled	Raised	Furled	Raised	Unfurled
IMAGE # Cont.	MAIN YARD	FORE SAIL	FORE YARD	BOW SPRIT	SPRIT SAIL	#
4N-1	Raised	Unfurled	Raised	Absent	Absent	N=1
LATEEN BON. AND MIZZEN			SQUARE MAIN, MAIN TOP, FORE, ANDFORE TOP			
IMAGE #	POSITION	BON. SAIL	BON. YARD	MIZ. SAIL	MIZ. YARD	MAIN SAIL
4N-2	Anch	Furled	Raised	Furled	Raised	Furled
4N-3	Sail	Furled	Raised	Unfurled	Raised	Unfurled
4N-4	Wreck	Unfurled	Raised	Furled	Raised	Unfurled
4N-5	Sail	Unfurled	Raised	Furled	Raised	Unfurled
4N-6	Sail	Unfurled	Raised	Furled	Raised	Unfurled
4N-7	Sail	Unfurled	Raised	Unfurled	Raised	Furled
IMAGE # Cont.	MAIN YARD	MAIN T.SAIL	MAIN T.YARD	FORE SAIL	FORE YARD	FORE T.SAIL
4N-2	Raised	Furled	Raised	Furled	Raised	Furled
4N-3	Raised	Unfurled	Raised	Unfurled	Raised	Furled
4N-4	Raised	Furled	Lowered	Unfurled	Raised	Furled
4N-5	Raised	Unfurled	Raised	Unfurled	Raised	Furled
4N-6	Raised	Furled	Raised	Unfurled	Raised	Furled
4N-7	Raised	Furled	Lowered	Unfurled	Raised	Furled
IMAGE # Cont.	FORE T.YARD	BOW SPRIT	SPRIT SAIL	#		
4N-2	Raised	Present	Absent	N=1		
4N-3	Lowered	Present	Unfurled	N=1		
4N-4	Lowered	Present	Absent	N=1		
4N-5	Lowered	Present	Absent	N=1		
4N-6	Raised	Present	Absent	N=1		
4N-7	Raised	Present	Absent	N=1		

APPENDIX 15

PLACEMENT OF THE BONAVENTURE MAST SHROUDS

BY SHROUDS				
# of Shrouds	# of Vessels	Vessel Types	Date Range	Shroud Position
1	11	CARAVEL	1566-1572	1 FORE
1	1	GALLEON	1538-40	1 AFT
1	1	CARAVEL	1538-40	1 AFT
2	8	CARAVEL	1538-1566	1 FORE / 1 AFT
2	1	GALLEON	1558-1561	1 FORE / 1 AFT
2	1	GALLEON	1538-1540	2 AFT
2	3	CARAVEL	1538-1583	2 AFT
2	1	GALLEON	1593	2 FORE
2	2	CARAVEL	1572	2 FORE
3	1	CARAVEL	C.1566	1 FORE / 2 AFT
3	3	CARAVEL	1538-1572	2 FORE / 1 AFT
3	1	GALLEON	1500-1525	2 FORE / 1 AFT
3	1	NAU	1510	3 AFT
3	1	GALLEON	1538-1540	3 AFT
3	1	CARAVEL	1485	3 AFT
3	1	NAU	1510	3 FORE
3	1	CARAVEL	1509	3 FORE
4	1	NAU	1510	1 FORE / 3 AFT
4	1	NAU	1558-1561	2 FORE / 2 AFT
4	1	GALLEON	1572	2 FORE / 2 AFT
4	6	CARAVEL	1558-1566	2 FORE / 2 AFT
5	5	CARAVEL	1558-1561	2 FORE / 3 AFT
5	1	GALLEON	1502	5 AFT
7	1	CARAVEL	1558-1561	2 FORE / 5 AFT
7	1	CARAVEL	1558-1561	3 FORE / 4 AFT
7	1	CARAVEL	1558-1561	4 FORE / 3 AFT

BY VESSEL				
Vessel Types	**# of Shrouds**	**# of Vessels**	**Date Range**	**Shroud Position**
CARAVEL	1	11	1566-1572	1 FORE
CARAVEL	1	1	1538-40	1 AFT
CARAVEL	2	8	1538-1566	1 FORE / 1 AFT
CARAVEL	2	2	1572	2 FORE
CARAVEL	2	3	1538-1583	2 AFT
CARAVEL	3	1	C.1566	1 FORE / 2 AFT
CARAVEL	3	3	1538-1572	2 FORE / 1 AFT
CARAVEL	3	1	1509	3 FORE
CARAVEL	3	1	1485	3 AFT
CARAVEL	4	6	1558-1566	2 FORE / 2 AFT
CARAVEL	5	5	1558-1561	2 FORE / 3 AFT
CARAVEL	7	1	1558-1561	2 FORE / 5 AFT
CARAVEL	7	1	1558-1561	3 FORE / 4 AFT
CARAVEL	7	1	1558-1561	4 FORE / 3 AFT
GALLEON	1	1	1538-40	1 AFT
GALLEON	2	1	1558-1561	1 FORE / 1 AFT
GALLEON	2	1	1593	2 FORE
GALLEON	2	1	1538-1540	2 AFT
GALLEON	3	1	1500-1525	2 FORE / 1 AFT
GALLEON	3	1	1538-1540	3 AFT
GALLEON	5	1	1502	5 AFT
GALLEON	4	1	1572	2 FORE / 2 AFT
NAU	3	1	1510	3 FORE
NAU	3	1	1510	3 AFT
NAU	4	1	1510	1 FORE / 3 AFT
NAU	4	1	1558-1561	2 FORE / 2 AFT

BY DATE				
Date Range	**# of Shrouds**	**# of Vessels**	**Vessel Types**	**Shroud Position**
1485	3	1	CARAVEL	3 AFT
1500-1525	3	1	GALLEON	2 FORE / 1 AFT
1502	5	1	GALLEON	5 AFT
1509	3	1	CARAVEL	3 FORE
1510	3	1	NAU	3 AFT
1510	3	1	NAU	3 FORE
1510	4	1	NAU	1 FORE / 3 AFT
1538-1540	1	1	GALLEON	1 AFT
1538-1540	1	1	CARAVEL	1 AFT
1538-1540	2	1	GALLEON	2 AFT
1538-1540	3	1	GALLEON	3 AFT
1538-1566	2	8	CARAVEL	1 FORE / 1 AFT
1538-1572	3	3	CARAVEL	2 FORE / 1 AFT
1538-1583	2	3	CARAVEL	2 AFT
1558-1561	2	1	GALLEON	1 FORE / 1 AFT
1558-1561	4	1	NAU	2 FORE / 2 AFT
1558-1561	5	5	CARAVEL	2 FORE / 3 AFT
1558-1561	7	1	CARAVEL	2 FORE / 5 AFT
1558-1561	7	1	CARAVEL	3 FORE / 4 AFT
1558-1561	7	1	CARAVEL	4 FORE / 3 AFT
1558-1566	4	6	CARAVEL	2 FORE / 2 AFT
1566	3	1	CARAVEL	1 FORE / 2 AFT
1566-1572	1	11	CARAVEL	1 FORE
1572	4	1	GALLEON	2 FORE / 2 AFT
1572	2	2	CARAVEL	2 FORE
1593	2	1	GALLEON	2 FORE

APPENDIX 16

PLACEMENT OF THE MIZZEN MAST AND TOPMAST SHROUDS

MIZZEN SHROUDS

BY SHROUDS				
# of Shrouds	**# of Vessels**	**Vessel Types**	**Date Range**	**Shroud Position**
1	2	NAU	1485-1540	1 AFT
1	1	GALLEON	1538-1540	1 AFT
1	2	CARAVEL	1500	1 AFT
1	2	NAU	1517-1572	1 FORE
2	7	NAU	1509-1572	1 FORE / 1 AFT
2	8	CARAVEL	1513-1572	1 FORE / 1 AFT
2	10	NAU	1509-1582	2 AFT
2	2	GALLEON	1500-1540	2 AFT
2	5	CARAVEL	1500-1513	2 AFT
2	13	NAU	1513-1598	2 FORE
2	1	GALLEON	1509	2 FORE
2	5	CARAVEL	1500-1598	2 FORE
3	8	NAU	1500-1594	1 FORE / 2AFT
3	11	NAU	1513-1595	2 FORE / 1 AFT
3	9	CARAVEL	1509-1572	2 FORE / 1 AFT
3	8	NAU	1510-1598	3 AFT
3	2	GALLEON	1519-1540	3 AFT
3	4	CARAVEL	1509-1598	3 AFT
3	19	NAU	1509-1579	3 FORE
4	6	CARAVEL	1500-1566	1 FORE / 3 AFT
4	2	GALLEON	1558-1574	1 FORE / 3 AFT
4	9	NAU	1500-1572	1 FORE / 3 AFT
4	7	CARAVEL	1520-1572	2 FORE / 2 AFT
4	2	GALLEON	1500-1572	2 FORE / 2 AFT
4	41	NAU	1558-1566	2 FORE / 2 AFT
4	1	NAU	1509	3 FORE / 1 AFT
4	4	CARAVEL	1495-1583	4 AFT
4	3	GALLEON	1538-1540	4 AFT
4	6	NAU	1510-1592	4 AFT

4	20	NAU	1556-1594	4 FORE
5	1	NAU	1566	1 FORE / 4 AFT
5	9	NAU	1500-1566	2 FORE / 3 AFT
5	3	CARAVEL	1531-1561	2 FORE / 3 AFT
5	6	NAU	1558-1566	3 FORE / 2 AFT
5	1	GALLEON	1538-1550	3 FORE / 2 AFT
5	1	NAU	1558-1561	4 FORE / 1 AFT
5	1	CARAVEL	1558-1561	4 FORE / 1 AFT
5	3	NAU	1510-1603	5 AFT
5	1	GALLEON	1593	5 AFT
5	1	CARAVEL	1538-1540	5 AFT
6	1	CARAVEL	1558-1561	1 FORE / 5 AFT
6	1	NAU	1538-1550	2 FORE / 4 AFT
6	8	NAU	1530-1566	3 FORE / 3 AFT
6	2	NAU	1558-1566	4 FORE / 2 AFT
6	1	NAU	1573-1603	6 AFT
6	1	GALLEON	1593	6 AFT
7	1	NAU	1558-1561	2 FORE / 5 AFT
7	4	NAU	1558-1561	3 FORE / 4 AFT
7	2	NAU	1538-1561	4 FORE / 3 AFT
7	2	CARAVEL	1558-1561	4 FORE / 3 AFT
8	1	NAU	1558-1561	3 FORE / 5 AFT
8	2	CARAVEL	1558-1561	3 FORE / 5 AFT
8	4	NAU	1558-1561	4 FORE / 4 AFT
8	1	GALLEON	1558-1561	4 FORE / 4 AFT
8	1	CARAVEL	1558-1561	4 FORE / 4 AFT
9	1	GALLEON	1552	2 FORE / 7 AFT
9	1	NAU	1558-1561	6 FORE / 3 AFT
12	1	GALLEON	1502	7 AFT - 5 FORE
14	1	NAU	1573-1603	7 AFT - 7 FORE

BY VESSEL				
Vessel Types	**# of Shrouds**	**# of Vessels**	**Date Range**	**Shroud Position**
CARAVEL	1	2	1500	1 AFT
CARAVEL	2	8	1513-1572	1 FORE / 1 AFT
CARAVEL	2	5	1500-1513	2 AFT

CARAVEL	2	5	1500-1598	2 FORE
CARAVEL	3	9	1509-1572	2 FORE / 1 AFT
CARAVEL	3	4	1509-1598	3 AFT
CARAVEL	4	6	1500-1566	1 FORE / 3 AFT
CARAVEL	4	7	1520-1572	2 FORE / 2 AFT
CARAVEL	4	4	1495-1583	4 AFT
CARAVEL	5	3	1531-1561	2 FORE / 3 AFT
CARAVEL	5	1	1558-1561	4 FORE / 1 AFT
CARAVEL	5	1	1538-1540	5 AFT
CARAVEL	6	1	1558-1561	1 FORE / 5 AFT
CARAVEL	7	2	1558-1561	4 FORE / 3 AFT
CARAVEL	8	2	1558-1561	3 FORE / 5 AFT
CARAVEL	8	1	1558-1561	4 FORE / 4 AFT
GALLEON	1	1	1538-1540	1 AFT
GALLEON	2	2	1500-1540	2 AFT
GALLEON	2	1	1509	2 FORE
GALLEON	3	2	1519-1540	3 AFT
GALLEON	4	2	1558-1574	1 FORE / 3 AFT
GALLEON	4	2	1500-1572	2 FORE / 2 AFT
GALLEON	4	3	1538-1540	4 AFT
GALLEON	5	1	1538-1550	3 FORE / 2 AFT
GALLEON	5	1	1593	5 AFT
GALLEON	6	1	1593	6 AFT
GALLEON	8	1	1558-1561	4 FORE / 4 AFT
GALLEON	9	1	1552	2 FORE / 7 AFT
GALLEON	12	1	1502	7 AFT - 5 FORE
NAU	1	2	1485-1540	1 AFT
NAU	1	2	1517-1572	1 FORE
NAU	2	7	1509-1572	1 FORE / 1 AFT
NAU	2	10	1509-1582	2 AFT
NAU	2	13	1513-1598	2 FORE
NAU	3	8	1500-1594	1 FORE / 2AFT
NAU	3	11	1513-1595	2 FORE / 1 AFT

NAU	3	8	1510-1598	3 AFT
NAU	3	19	1509-1579	3 FORE
NAU	4	9	1500-1572	1 FORE / 3 AFT
NAU	4	41	1558-1566	2 FORE / 2 AFT
NAU	4	1	1509	3 FORE / 1 AFT
NAU	4	6	1510-1592	4 AFT
NAU	4	20	1556-1594	4 FORE
NAU	5	1	1566	1 FORE / 4 AFT
NAU	5	9	1500-1566	2 FORE / 3 AFT
NAU	5	6	1558-1566	3 FORE / 2 AFT
NAU	5	1	1558-1561	4 FORE / 1 AFT
NAU	5	3	1510-1603	5 AFT
NAU	6	1	1538-1550	2 FORE / 4 AFT
NAU	6	8	1530-1566	3 FORE / 3 AFT
NAU	6	2	1558-1566	4 FORE / 2 AFT
NAU	6	1	1573-1603	6 AFT
NAU	7	1	1558-1561	2 FORE / 5 AFT
NAU	7	4	1558-1561	3 FORE / 4 AFT
NAU	7	2	1538-1561	4 FORE / 3 AFT
NAU	8	1	1558-1561	3 FORE / 5 AFT
NAU	8	4	1558-1561	4 FORE / 4 AFT
NAU	9	1	1558-1561	6 FORE / 3 AFT
NAU	14	1	1573-1603	7 AFT - 7 FORE

BY DATE				
Date Range	**# of Shrouds**	**# of Vessels**	**Vessel Types**	**Shroud Position**
1485-1540	1	2	NAU	1 AFT
1495-1583	4	4	CARAVEL	4 AFT
1500-1513	2	5	CARAVEL	2 AFT
1500-1540	2	2	GALLEON	2 AFT
1500-1566	4	6	CARAVEL	1 FORE / 3 AFT
1500-1566	5	9	NAU	2 FORE / 3 AFT
1500-1572	4	9	NAU	1 FORE / 3 AFT
1500-1572	4	2	GALLEON	2 FORE / 2 AFT

1500-1594	3	8	NAU	1 FORE / 2AFT
1500-1598	2	5	CARAVEL	2 FORE
1500	1	2	CARAVEL	1 AFT
1502	12	1	GALLEON	7 AFT - 5 FORE
1509	2	1	GALLEON	2 FORE
1509	4	1	NAU	3 FORE / 1 AFT
1509-1572	2	7	NAU	1 FORE / 1 AFT
1509-1572	3	9	CARAVEL	2 FORE / 1 AFT
1509-1579	3	19	NAU	3 FORE
1509-1582	2	10	NAU	2 AFT
1509-1598	3	4	CARAVEL	3 AFT
1510-1592	4	6	NAU	4 AFT
1510-1598	3	8	NAU	3 AFT
1510-1603	5	3	NAU	5 AFT
1513-1572	2	8	CARAVEL	1 FORE / 1 AFT
1513-1595	3	11	NAU	2 FORE / 1 AFT
1513-1598	2	13	NAU	2 FORE
1517-1572	1	2	NAU	1 FORE
1519-1540	3	2	GALLEON	3 AFT
1520-1572	4	7	CARAVEL	2 FORE / 2 AFT
1530-1566	6	8	NAU	3 FORE / 3 AFT
1531-1561	5	3	CARAVEL	2 FORE / 3 AFT
1538-1540	1	1	GALLEON	1 AFT
1538-1540	4	3	GALLEON	4 AFT
1538-1540	5	1	CARAVEL	5 AFT
1538-1550	5	1	GALLEON	3 FORE / 2 AFT
1538-1550	6	1	NAU	2 FORE / 4 AFT
1538-1561	7	2	NAU	4 FORE / 3 AFT
1552	9	1	GALLEON	2 FORE / 7 AFT
1566	5	1	NAU	1 FORE / 4 AFT
1556-1594	4	20	NAU	4 FORE
1558-1561	5	1	CARAVEL	4 FORE / 1 AFT
1558-1561	5	1	NAU	4 FORE / 1 AFT
1558-1561	6	1	CARAVEL	1 FORE / 5 AFT
1558-1561	7	2	CARAVEL	4 FORE / 3 AFT
1558-1561	7	1	NAU	2 FORE / 5 AFT
1558-1561	7	4	NAU	3 FORE / 4 AFT

1558-1561	8	2	CARAVEL	3 FORE / 5 AFT
1558-1561	8	1	CARAVEL	4 FORE / 4 AFT
1558-1561	8	1	GALLEON	4 FORE / 4 AFT
1558-1561	8	1	NAU	3 FORE / 5 AFT
1558-1561	8	4	NAU	4 FORE / 4 AFT
1558-1561	9	1	NAU	6 FORE / 3 AFT
1558-1566	4	41	NAU	2 FORE / 2 AFT
1558-1566	5	6	NAU	3 FORE / 2 AFT
1558-1566	6	2	NAU	4 FORE / 2 AFT
1558-1574	4	2	GALLEON	1 FORE / 3 AFT
1573-1603	6	1	NAU	6 AFT
1573-1603	14	1	NAU	7 AFT - 7 FORE
1593	5	1	GALLEON	5 AFT
1593	6	1	GALLEON	6 AFT

MIZZEN TOPMAST SHROUDS

BY SHROUDS				
# of Shrouds	**# of Vessels**	**Vessel Types**	**Date Range**	**Shroud Position**
1	1	GALLEON	1538-40	1 FORE
2	1	NAU	1556	1 FORE / 1 AFT
4	1	NAU	1573-1603	4 AFT

APPENDIX 17

PLACEMENT OF THE MAIN MAST AND TOPMAST SHROUDS

MAIN MAST SHROUDS

BY SHROUDS				
# of Shrouds	**# of Vessels**	**Vessel Types**	**Date Range**	**Shroud Position**
1	1	CARAVEL	1500	1 AFT
2	2	CARAVEL	1572	1 FORE / 1 AFT
2	8	CARAVEL	1500-1598	2 AFT
2	2	CARAVEL	1500	2 FORE
3	6	CARAVEL	1566-1572	1 FORE / 2 AFT
3	6	CARAVEL	1513-1572	2 FORE / 1 AFT
3	5	CARAVEL	1509-1598	3 AFT
3	1	NAU	1568	3 AFT
3	2	NAU	1510-1540	3 FORE
4	1	CARAVEL	1583-1588	4 FORE
4	2	NAU	1538-1566	1 FORE / 3 AFT
4	1	GALLEON	1519	1 FORE / 3 AFT
4	3	CARAVEL	1566	1 FORE / 3 AFT
4	1	NAU	1588-1598	2 FORE / 2 AFT
4	8	CARAVEL	1513-1572	2 FORE / 2 AFT
4	1	CARAVEL	1566	3 FORE / 1 AFT
4	21	NAU	1509-1594	4 AFT
4	1	GALLEON	1616	4 AFT
4	6	CARAVEL	1485-1583	4 AFT
4	8	NAU	1565-1596	4 FORE
4	1	GALLEON	1500-25	4 FORE
4	1	CARAVEL	1515-25	4 FORE
5	4	CARAVEL	1509-1561	1 FORE / 4 AFT
5	3	NAU	1538-1566	1 FORE / 4 AFT
5	7	NAU	1510-1589	2 FORE / 3 AFT

5	3	CARAVEL	1513-1566	2 FORE / 3 AFT
5	1	GALLEON	1500-1525	2 FORE / 3 AFT
5	3	CARAVEL	1531-1561	3 FORE / 2 AFT
5	4	NAU	1572-1589	3 FORE - 2 AFT
5	13	NAU	1509-1594	5 AFT
5	4	GALLEON	1519-1540	5 AFT
5	2	CARAVEL	1520	5 AFT
5	3	NAU	1566	5 FORE
5	1	CARAVEL	1588-98	5 FORE
6	7	NAU	1519-1566	1 FORE / 5 AFT
6	1	GALLEON	1519	1 FORE / 5 AFT
6	1	CARAVEL	1558-1561	1 FORE / 5 AFT
6	9	NAU	1513-1572	2 FORE / 4 AFT
6	1	GALLEON	1509	2 FORE / 4 AFT
6	1	CARAVEL	1572	2 FORE / 4 AFT
6	3	NAU	1538-1589	3 FORE / 3 AFT
6	4	CARAVEL	1500-1572	3 FORE / 3 AFT
6	3	NAU	1514-1566	4 FORE / 2 AFT
6	1	CARAVEL	1558-1561	4 FORE / 2 AFT
6	17	NAU	1510-1594	6 AFT
6	3	GALLEON	1519-1566	6 AFT
6	1	CARAVEL	1556	6 AFT
6	6	NAU	1538-1595	6 FORE
7	6	NAU	1517-1566	1 FORE - 6 AFT
7	11	NAU	1500-1566	2 FORE / 5 AFT
7	8	NAU	1500-1598	3 FORE / 4 AFT
7	1	GALLEON	1574	3 FORE / 4 AFT
7	1	CARAVEL	1558-1561	3 FORE / 4 AFT
7	5	NAU	1500-1572	4 FORE / 3 AFT
7	1	NAU	1592	6 FORE / 1 AFT
7	1	CARAVEL	1572	6 FORE / 1 AFT
7	9	NAU	1509-1566	7 AFT
8	4	NAU	1509-1566	1 FORE / 7 AFT

8	1	CARAVEL	1558-1561	1 FORE / 7 AFT
8	9	NAU	1565-1572	2 FORE / 6 AFT
8	1	GALLEON	1558-1561	2 FORE / 6 AFT
8	2	CARAVEL	1558-1566	2 FORE / 6 AFT
8	12	NAU	1538-1598	3 FORE / 5 AFT
8	1	GALLEON	1538-1550	3 FORE / 5 AFT
8	5	NAU	1520-1572	4 FORE / 4 AFT
8	1	CARAVEL	1558-1561	4 FORE / 4 AFT
8	1	NAU	1558-1561	5 FORE / 3 AFT
8	3	NAU	1566	8 AFT
9	1	NAU	1566	1 FORE / 8 AFT
9	1	NAU	1566	2 FORE / 7 AFT
9	5	NAU	1558-1566	3 FORE / 6 AFT
9	1	CARAVEL	1558-1561	3 FORE / 6 AFT
9	1	NAU	1538-1550	4 FORE / 5 AFT
9	2	NAU	1535-1570	9 AFT
9	1	GALLEON	1538-1540	9 AFT
10	2	NAU	1509-1566	2 FORE / 8 AFT
10	2	NAU	1558-1566	3 FORE / 7 AFT
10	2	NAU	1510-1572	4 FORE / 6 AFT
10	1	GALLEON	1558-1561	4 FORE / 6 AFT
10	2	CARAVEL	1558-1561	4 FORE / 6 AFT
10	1	NAU	1558-1561	5 FORE / 5 AFT
10	1	NAU	1558-1561	6 FORE / 4 AFT
10	1	CARAVEL	1558-1561	6 FORE / 4 AFT
10	1	NAU	1572	7 FORE /3 AFT
10	1	GALLEON	1573-1603	10 AFT
10	1	NAU	1593	10 AFT
11	1	NAU	1519	3 FORE / 8 AFT
11	1	GALLEON	1572	4 FORE / 7 AFT
11	2	NAU	1556-1572	5 FORE / 6 AFT
11	1	NAU	1558-1561	7 FORE / 4 AFT
11	1	NAU	1573-1603	11 AFT

12	1	GALLEON	1593	2 FORE / 10 AFT
12	2	NAU	1558-1561	4 FORE / 8 AFT
12	1	GALLEON	1552	4 FORE / 8 AFT
12	1	NAU	1558-1561	5 FORE / 8 AFT
12	2	NAU	1558-1561	6 FORE / 6AFT
14	1	GALLEON	1502	9 AFT - 5 FORE
24	1	NAU	1573-1603	12 AFT - 12 FORE

BY VESSEL				
Vessel Types	**# of Shrouds**	**# of Vessels**	**Date Range**	**Shroud Position**
CARAVEL	1	1	1500	1 AFT
CARAVEL	2	2	1572	1 FORE / 1 AFT
CARAVEL	2	8	1500-1598	2 AFT
CARAVEL	2	2	1500	2 FORE
CARAVEL	3	6	1566-1572	1 FORE / 2 AFT
CARAVEL	3	6	1513-1572	2 FORE / 1 AFT
CARAVEL	3	5	1509-1598	3 AFT
CARAVEL	4	1	1583-1588	4 FORE
CARAVEL	4	3	1566	1 FORE / 3 AFT
CARAVEL	4	8	1513-1572	2 FORE / 2 AFT
CARAVEL	4	1	1566	3 FORE / 1 AFT
CARAVEL	4	6	1485-1583	4 AFT
CARAVEL	4	1	1515-25	4 FORE
CARAVEL	5	4	1509-1561	1 FORE / 4 AFT
CARAVEL	5	3	1513-1566	2 FORE / 3 AFT
CARAVEL	5	3	1531-1561	3 FORE / 2 AFT
CARAVEL	5	2	1520	5 AFT
CARAVEL	5	1	1588-98	5 FORE
CARAVEL	6	1	1558-1561	1 FORE / 5 AFT
CARAVEL	6	1	1572	2 FORE / 4 AFT
CARAVEL	6	4	1500-1572	3 FORE / 3 AFT
CARAVEL	6	1	1558-1561	4 FORE / 2 AFT

CARAVEL	6	1	1556	6 AFT
CARAVEL	7	1	1558-1561	3 FORE / 4 AFT
CARAVEL	7	1	1572	6 FORE / 1 AFT
CARAVEL	8	1	1558-1561	1 FORE / 7 AFT
CARAVEL	8	2	1558-1566	2 FORE / 6 AFT
CARAVEL	8	1	1558-1561	4 FORE / 4 AFT
CARAVEL	9	1	1558-1561	3 FORE / 6 AFT
CARAVEL	10	2	1558-1561	4 FORE / 6 AFT
CARAVEL	10	1	1558-1561	6 FORE / 4 AFT
GALLEON	4	1	1519	1 FORE / 3 AFT
GALLEON	4	1	1616	4 AFT
GALLEON	4	1	1500-25	4 FORE
GALLEON	5	1	1500-1525	2 FORE / 3 AFT
GALLEON	5	4	1519-1540	5 AFT
GALLEON	6	1	1519	1 FORE / 5 AFT
GALLEON	6	1	1509	2 FORE / 4 AFT
GALLEON	6	3	1519-1566	6 AFT
GALLEON	7	1	1574	3 FORE / 4 AFT
GALLEON	8	1	1558-1561	2 FORE / 6 AFT
GALLEON	8	1	1538-1550	3 FORE / 5 AFT
GALLEON	9	1	1538-1540	9 AFT
GALLEON	10	1	1558-1561	4 FORE / 6 AFT
GALLEON	10	1	1573-1603	10 AFT
GALLEON	11	1	1572	4 FORE / 7 AFT
GALLEON	12	1	1593	2 FORE / 10 AFT
GALLEON	12	1	1552	4 FORE / 8 AFT
GALLEON	14	1	1502	9 AFT - 5 FORE
NAU	3	1	1568	3 AFT
NAU	3	2	1510-1540	3 FORE
NAU	4	2	1538-1566	1 FORE / 3 AFT
NAU	4	1	1588-1598	2 FORE / 2 AFT
NAU	4	21	1509-1594	4 AFT
NAU	4	8	1565-1596	4 FORE

NAU	5	3	1538-1566	1 FORE / 4 AFT
NAU	5	7	1510-1589	2 FORE / 3 AFT
NAU	5	4	1572-1589	3 FORE - 2 AFT
NAU	5	13	1509-1594	5 AFT
NAU	5	3	1566	5 FORE
NAU	6	7	1519-1566	1 FORE / 5 AFT
NAU	6	9	1513-1572	2 FORE / 4 AFT
NAU	6	3	1538-1589	3 FORE / 3 AFT
NAU	6	3	1514-1566	4 FORE / 2 AFT
NAU	6	17	1510-1594	6 AFT
NAU	6	6	1538-1595	6 FORE
NAU	7	6	1517-1566	1 FORE - 6 AFT
NAU	7	11	1500-1566	2 FORE / 5 AFT
NAU	7	8	1500-1598	3 FORE / 4 AFT
NAU	7	5	1500-1572	4 FORE / 3 AFT
NAU	7	1	1592	6 FORE / 1 AFT
NAU	7	9	1509-1566	7 AFT
NAU	8	4	1509-1566	1 FORE / 7 AFT
NAU	8	9	1565-1572	2 FORE / 6 AFT
NAU	8	12	1538-1598	3 FORE / 5 AFT
NAU	8	5	1520-1572	4 FORE / 4 AFT
NAU	8	1	1558-1561	5 FORE / 3 AFT
NAU	8	3	1566	8 AFT
NAU	9	1	1566	1 FORE / 8 AFT
NAU	9	1	1566	2 FORE / 7 AFT
NAU	9	5	1558-1566	3 FORE / 6 AFT
NAU	9	1	1538-1550	4 FORE / 5 AFT
NAU	9	2	1535-1570	9 AFT
NAU	10	2	1509-1566	2 FORE / 8 AFT
NAU	10	2	1558-1566	3 FORE / 7 AFT
NAU	10	2	1510-1572	4 FORE / 6 AFT
NAU	10	1	1558-1561	5 FORE / 5 AFT
NAU	10	1	1558-1561	6 FORE / 4 AFT

NAU	10	1	1572	7 FORE /3 AFT
NAU	10	1	1593	10 AFT
NAU	11	1	1519	3 FORE / 8 AFT
NAU	11	2	1556-1572	5 FORE / 6 AFT
NAU	11	1	1558-1561	7 FORE / 4 AFT
NAU	11	1	1573-1603	11 AFT
NAU	12	2	1558-1561	4 FORE / 8 AFT
NAU	12	1	1558-1561	5 FORE / 8 AFT
NAU	12	2	1558-1561	6 FORE / 6AFT
NAU	24	1	1573-1603	12 AFT - 12 FORE

BY DATE				
Date Range	**# of Shrouds**	**# of Vessels**	**Vessel Types**	**Shroud Position**
1485-1583	4	6	CARAVEL	4 AFT
1500	1	1	CARAVEL	1 AFT
1500	2	2	CARAVEL	2 FORE
1500-25	4	1	GALLEON	4 FORE
1500-1525	5	1	GALLEON	2 FORE / 3 AFT
1500-1566	7	11	NAU	2 FORE / 5 AFT
1500-1572	6	4	CARAVEL	3 FORE / 3 AFT
1500-1572	7	5	NAU	4 FORE / 3 AFT
1500-1598	7	8	NAU	3 FORE / 4 AFT
1500-1598	2	8	CARAVEL	2 AFT
1502	14	1	GALLEON	9 AFT - 5 FORE
1509	6	1	GALLEON	2 FORE / 4 AFT
1509-1561	5	4	CARAVEL	1 FORE / 4 AFT
1509-1566	7	9	NAU	7 AFT
1509-1566	8	4	NAU	1 FORE / 7 AFT
1509-1566	10	2	NAU	2 FORE / 8 AFT
1509-1598	3	5	CARAVEL	3 AFT
1509-1594	4	21	NAU	4 AFT
1509-1594	5	13	NAU	5 AFT

1510-1540	3	2	NAU	3 FORE
1510-1572	10	2	NAU	4 FORE / 6 AFT
1510-1589	5	7	NAU	2 FORE / 3 AFT
1510-1594	6	17	NAU	6 AFT
1513-1566	5	3	CARAVEL	2 FORE / 3 AFT
1513-1572	3	6	CARAVEL	2 FORE / 1 AFT
1513-1572	4	8	CARAVEL	2 FORE / 2 AFT
1513-1572	6	9	NAU	2 FORE / 4 AFT
1514-1566	6	3	NAU	4 FORE / 2 AFT
1515-25	4	1	CARAVEL	4 FORE
1517-1566	7	6	NAU	1 FORE - 6 AFT
1519	4	1	GALLEON	1 FORE / 3 AFT
1519	6	1	GALLEON	1 FORE / 5 AFT
1519	11	1	NAU	3 FORE / 8 AFT
1519-1540	5	4	GALLEON	5 AFT
1519-1566	6	7	NAU	1 FORE / 5 AFT
1519-1566	6	3	GALLEON	6 AFT
1520	5	2	CARAVEL	5 AFT
1520-1572	8	5	NAU	4 FORE / 4 AFT
1531-1561	5	3	CARAVEL	3 FORE / 2 AFT
1535-1570	9	2	NAU	9 AFT
1538-1540	9	1	GALLEON	9 AFT
1538-1550	8	1	GALLEON	3 FORE / 5 AFT
1538-1550	9	1	NAU	4 FORE / 5 AFT
1538-1566	4	2	NAU	1 FORE / 3 AFT
1538-1566	5	3	NAU	1 FORE / 4 AFT
1538-1598	8	12	NAU	3 FORE / 5 AFT
1538-1589	6	3	NAU	3 FORE / 3 AFT
1538-1595	6	6	NAU	6 FORE
1552	12	1	GALLEON	4 FORE / 8 AFT
1556	6	1	CARAVEL	6 AFT
1566	4	3	CARAVEL	1 FORE / 3 AFT
1566	4	1	CARAVEL	3 FORE / 1 AFT

1566	5	3	NAU	5 FORE
1566	8	3	NAU	8 AFT
1566	9	1	NAU	1 FORE / 8 AFT
1566	9	1	NAU	2 FORE / 7 AFT
1556-1572	11	2	NAU	5 FORE / 6 AFT
1558-1561	6	1	CARAVEL	1 FORE / 5 AFT
1558-1561	6	1	CARAVEL	4 FORE / 2 AFT
1558-1561	7	1	CARAVEL	3 FORE / 4 AFT
1558-1561	8	1	CARAVEL	1 FORE / 7 AFT
1558-1561	8	1	GALLEON	2 FORE / 6 AFT
1558-1561	8	1	CARAVEL	4 FORE / 4 AFT
1558-1561	8	1	NAU	5 FORE / 3 AFT
1558-1561	9	1	CARAVEL	3 FORE / 6 AFT
1558-1561	10	1	GALLEON	4 FORE / 6 AFT
1558-1561	10	2	CARAVEL	4 FORE / 6 AFT
1558-1561	10	1	NAU	5 FORE / 5 AFT
1558-1561	10	1	NAU	6 FORE / 4 AFT
1558-1561	10	1	CARAVEL	6 FORE / 4 AFT
1558-1561	11	1	NAU	7 FORE / 4 AFT
1558-1561	12	2	NAU	4 FORE / 8 AFT
1558-1561	12	1	NAU	5 FORE / 8 AFT
1558-1561	12	2	NAU	6 FORE / 6AFT
1558-1566	8	2	CARAVEL	2 FORE / 6 AFT
1558-1566	9	5	NAU	3 FORE / 6 AFT
1558-1566	10	2	NAU	3 FORE / 7 AFT
1565-1572	8	9	NAU	2 FORE / 6 AFT
1565-1596	4	8	NAU	4 FORE
1566-1572	3	6	CARAVEL	1 FORE / 2 AFT
1568	3	1	NAU	3 AFT
1572	2	2	CARAVEL	1 FORE / 1 AFT
1572	6	1	CARAVEL	2 FORE / 4 AFT
1572	7	1	CARAVEL	6 FORE / 1 AFT
1572	10	1	NAU	7 FORE /3 AFT

1572	11	1	GALLEON	4 FORE / 7 AFT
1572-1589	5	4	NAU	3 FORE - 2 AFT
1573-1603	10	1	GALLEON	10 AFT
1573-1603	11	1	NAU	11 AFT
1573-1603	24	1	NAU	12 AFT - 12 FORE
1574	7	1	GALLEON	3 FORE / 4 AFT
1583-1588	4	1	CARAVEL	4 FORE
1588-1598	4	1	NAU	2 FORE / 2 AFT
1588 -1598	5	1	CARAVEL	5 FORE
1592	7	1	NAU	6 FORE / 1 AFT
1593	10	1	NAU	10 AFT
1593	12	1	GALLEON	2 FORE / 10 AFT
1616	4	1	GALLEON	4 AFT

MAIN TOPMAST SHROUDS

BY SHROUDS				
# of Shrouds	**# of Vessels**	**Vessel Types**	**Date Range**	**Shroud Position**
1	2	NAU	1509	1 AFT
1	1	NAU	1566	1 CENTER
2	1	CARAVEL	1566	1 FORE / 1 AFT
2	13	NAU	1509-1598	1 FORE / 1 AFT
2	1	GALLEON	1538-1540	2 AFT
2	9	NAU	1510-1594	2 AFT
2	1	GALLEON	1538-1540	2 FORE
2	6	NAU	1515-1579	2 FORE
3	10	NAU	1510-1572	1 FORE / 2 AFT
3	5	NAU	1500-1566	2 FORE / 1 AFT
3	9	NAU	1565-1595	3 AFT
3	2	GALLEON	1538-1540	3 AFT
3	6	NAU	1510-1596	3 FORE
4	1	GALLEON	1558-1561	1 FORE / 3 AFT
4	4	NAU	1519-1566	1 FORE / 3 AFT

4	1	GALLEON	1558-1561	2 FORE / 2 AFT
4	42	NAU	1509-1598	2 FORE / 2 AFT
4	7	NAU	1519-1566	3 FORE / 1 AFT
4	3	NAU	1572-1579	4 AFT
4	1	NAU	1517-1526	4 FORE
5	1	NAU	1565	1 FORE / 4 AFT
5	1	GALLEON	1572	2 FORE / 3 AFT
5	17	NAU	1538-1566	2 FORE / 3 AFT
5	8	NAU	1558-1572	3 FORE / 2 AFT
5	1	NAU	1592	5 FORE
6	1	GALLEON	1593	1 FORE / 5 AFT
6	15	NAU	1515-1566	3 FORE / 3 AFT
6	1	GALLEON	1593	6 AFT
7	1	NAU	1573-1603	1 FORE / 6 AFT
7	1	NAU	1558-1561	4 FORE / 3 AFT
8	1	NAU	1558-1561	4 FORE / 4 AFT
10	1	NAU	1558-1561	4 FORE / 6AFT

BY VESSEL				
Vessel Types	**# of Vessels**	**# of Shrouds**	**Date Range**	**Shroud Position**
CARAVEL	1	2	1566	1 FORE / 1 AFT
GALLEON	1	2	1538-1540	2 AFT
GALLEON	1	2	1538-1540	2 FORE
GALLEON	2	3	1538-1540	3 AFT
GALLEON	1	4	1558-1561	1 FORE / 3 AFT
GALLEON	1	4	1558-1561	2 FORE / 2 AFT
GALLEON	1	5	1572	2 FORE / 3 AFT
GALLEON	1	6	1593	1 FORE / 5 AFT
GALLEON	1	6	1593	6 AFT
NAU	2	1	1509	1 AFT
NAU	1	1	1566	1 CENTER
NAU	13	2	1509-1598	1 FORE / 1 AFT

NAU	9	2	1510-1594	2 AFT
NAU	6	2	1515-1579	2 FORE
NAU	10	3	1510-1572	1 FORE / 2 AFT
NAU	5	3	1500-1566	2 FORE / 1 AFT
NAU	9	3	1565-1595	3 AFT
NAU	6	3	1510-1596	3 FORE
NAU	4	4	1519-1566	1 FORE / 3 AFT
NAU	42	4	1509-1598	2 FORE / 2 AFT
NAU	7	4	1519-1566	3 FORE / 1 AFT
NAU	3	4	1572-1579	4 AFT
NAU	1	4	1517-1526	4 FORE
NAU	1	5	1565	1 FORE / 4 AFT
NAU	17	5	1538-1566	2 FORE / 3 AFT
NAU	8	5	1558-1572	3 FORE / 2 AFT
NAU	1	5	1592	5 FORE
NAU	15	6	1515-1566	3 FORE / 3 AFT
NAU	1	7	1573-1603	1 FORE / 6 AFT
NAU	1	7	1558-1561	4 FORE / 3 AFT
NAU	1	8	1558-1561	4 FORE / 4 AFT
NAU	1	10	1558-1561	4 FORE / 6AFT

BY DATE				
Date Range	**# of Shrouds**	**# of Vessels**	**Vessel Types**	**Shroud Position**
1500-1566	3	5	NAU	2 FORE / 1 AFT
1509	1	2	NAU	1 AFT
1509-1598	2	13	NAU	1 FORE / 1 AFT
1509-1598	4	42	NAU	2 FORE / 2 AFT
1510-1572	3	10	NAU	1 FORE / 2 AFT
1510-1594	2	9	NAU	2 AFT
1510-1596	3	6	NAU	3 FORE
1515-1566	6	15	NAU	3 FORE / 3 AFT
1515-1579	2	6	NAU	2 FORE

1517-1526	4	1	NAU	4 FORE
1519-1566	4	4	NAU	1 FORE / 3 AFT
1519-1566	4	7	NAU	3 FORE / 1 AFT
1538-1540	2	1	GALLEON	2 AFT
1538-1540	2	1	GALLEON	2 FORE
1538-1540	3	2	GALLEON	3 AFT
1538-1566	5	17	NAU	2 FORE / 3 AFT
1558-1561	4	1	GALLEON	1 FORE / 3 AFT
1558-1561	4	1	GALLEON	2 FORE / 2 AFT
1558-1561	7	1	NAU	4 FORE / 3 AFT
1558-1561	8	1	NAU	4 FORE / 4 AFT
1558-1561	10	1	NAU	4 FORE / 6AFT
1558-1572	5	8	NAU	3 FORE / 2 AFT
1565	5	1	NAU	1 FORE / 4 AFT
1565-1595	3	9	NAU	3 AFT
1566	1	1	NAU	1 CENTER
1566	2	1	CARAVEL	1 FORE / 1 AFT
1572	5	1	GALLEON	2 FORE / 3 AFT
1572-1579	4	3	NAU	4 AFT
1573-1603	7	1	NAU	1 FORE / 6 AFT
1592	5	1	NAU	5 FORE
1593	6	1	GALLEON	1 FORE / 5 AFT
1593	6	1	GALLEON	6 AFT

APPENDIX 18

PLACEMENT OF THE FORE MAST AND FORE TOPMAST SHROUDS

FORE MAST SHROUDS

BY SHROUDS				
# of Shrouds	**# of Vessels**	**Vessel Types**	**Date Range**	**Shroud Position**
1	1	NAU	1588-98	1 AFT
1	1	CARAVEL	1538-40	1 AFT
1	1	NAU	1517-1526	1 FORE
2	3	NAU	1568	1 FORE / 1 AFT
2	1	CARAVEL	1566	1 FORE / 1 AFT
2	3	NAU	1509-1540	2 AFT
2	1	GALLEON	1558-1561	2 AFT
2	1	CARAVEL	1588-98	2 AFT
2	1	NAU	1535-1570	2 FORE
3	2	NAU	1509-1572	1 FORE / 2 AFT
3	3	CARAVEL	1566-1572	1 FORE / 2 AFT
3	1	CARAVEL	1566	2 FORE / 1 AFT
3	8	NAU	1509-1572	3 AFT
3	2	GALLEON	1509-1540	3 AFT
3	3	CARAVEL	1485-1583	3 AFT
3	2	NAU	1525-1594	3 FORE
4	2	CARAVEL	1558-1566	1 FORE / 3 AFT
4	1	GALLEON	1574	1 FORE / 3 AFT
4	4	NAU	1500-1600	1 FORE / 3 AFT
4	3	NAU	1513-1589	2 FORE / 2 AFT
4	10	CARAVEL	1538-1566	2 FORE / 2 AFT
4	1	NAU	1572	3 FORE / 1 AFT
4	2	CARAVEL	1538-1566	3 FORE / 1 AFT
4	16	NAU	1500-1600	4 AFT
4	3	GALLEON	1538-1556	4 AFT

4	5	NAU	1519-1573	4 FORE
5	1	NAU	1566	1 FORE / 4 AFT
5	1	CARAVEL	1556	1 FORE / 4 AFT
5	8	NAU	1513-1572	2 FORE / 3 AFT
5	3	CARAVEL	1558-1566	2 FORE / 3 AFT
5	5	NAU	1538-1572	3 FORE / 2 AFT
5	2	CARAVEL	1566-1572	3 FORE / 2 AFT
5	5	NAU	1500-1600	5 AFT
5	1	GALLEON	1538-1540	5 AFT
5	2	CARAVEL	1558-1572	5 AFT
5	4	NAU	1515-1592	5 FORE
6	1	CARAVEL	1566	2 FORE / 4 AFT
6	4	NAU	1558-1566	2 FORE / 4 AFT
6	5	NAU	1530-1566	3 FORE / 3 AFT
6	1	CARAVEL	1558-1561	3 FORE / 3 AFT
6	4	NAU	1538-1572	4 FORE / 2 AFT
6	1	CARAVEL	1566	4 FORE / 2 AFT
6	7	NAU	1558-1579	6 AFT
6	1	GALLEON	1593	6 AFT
6	1	CARAVEL	1558-1561	6 AFT
6	2	NAU	1519-1572	6 FORE
7	3	NAU	1558-1572	1 FORE / 6 AFT
7	8	NAU	1515-1598	3 FORE / 4 AFT
7	1	CARAVEL	1558-1561	3 FORE / 4 AFT
7	1	GALLEON	1538-1550	3 FORE / 4 AFT
7	1	NAU	1558-1561	7 AFT
8	1	NAU	1538-1550	3 FORE / 5 AFT
8	1	GALLEON	1572	5 FORE / 3 AFT
9	1	NAU	1558-1561	9 AFT
10	1	CARAVEL	1558-1561	2 FORE / 8AFT
12	1	GALLEON	1502	8 AFT - 4 FORE

BY DATE				
Date Range	**# of Shrouds**	**# of Vessels**	**Vessel Types**	**Shroud Position**
1502	12	1	GALLEON	8 AFT - 4 FORE
1556	5	1	CARAVEL	1 FORE / 4 AFT
1566	2	1	CARAVEL	1 FORE / 1 AFT
1566	3	1	CARAVEL	2 FORE / 1 AFT
1566	5	1	NAU	1 FORE / 4 AFT
1566	6	1	CARAVEL	2 FORE / 4 AFT
1566	6	1	CARAVEL	4 FORE / 2 AFT
1568	2	3	NAU	1 FORE / 1 AFT
1572	4	1	NAU	3 FORE / 1 AFT
1572	8	1	GALLEON	5 FORE / 3 AFT
1574	4	1	GALLEON	1 FORE / 3 AFT
1593	6	1	GALLEON	6 AFT
1485-1583	3	3	CARAVEL	3 AFT
1500-1600	4	4	NAU	1 FORE / 3 AFT
1500-1600	4	16	NAU	4 AFT
1500-1600	5	5	NAU	5 AFT
1509-1540	2	3	NAU	2 AFT
1509-1540	3	2	GALLEON	3 AFT
1509-1572	3	2	NAU	1 FORE / 2 AFT
1509-1572	3	8	NAU	3 AFT
1513-1572	5	8	NAU	2 FORE / 3 AFT
1513-1589	4	3	NAU	2 FORE / 2 AFT
1515-1592	5	4	NAU	5 FORE
1515-1598	7	8	NAU	3 FORE / 4 AFT
1517-1526	1	1	NAU	1 FORE
1519-1572	6	2	NAU	6 FORE
1519-1573	4	5	NAU	4 FORE
1525-1594	3	2	NAU	3 FORE
1530-1566	6	5	NAU	3 FORE / 3 AFT

1535-1570	2	1	NAU	2 FORE
1538-1540	5	1	GALLEON	5 AFT
1538-1550	7	1	GALLEON	3 FORE / 4 AFT
1538-1550	8	1	NAU	3 FORE / 5 AFT
1538-1556	4	3	GALLEON	4 AFT
1538-1566	4	10	CARAVEL	2 FORE / 2 AFT
1538-1566	4	2	CARAVEL	3 FORE / 1 AFT
1538-1572	5	5	NAU	3 FORE / 2 AFT
1538-1572	6	4	NAU	4 FORE / 2 AFT
1538-40	1	1	CARAVEL	1 AFT
1558-1561	2	1	GALLEON	2 AFT
1558-1561	6	1	CARAVEL	3 FORE / 3 AFT
1558-1561	6	1	CARAVEL	6 AFT
1558-1561	7	1	CARAVEL	3 FORE / 4 AFT
1558-1561	7	1	NAU	7 AFT
1558-1561	9	1	NAU	9 AFT
1558-1561	10	1	CARAVEL	2 FORE / 8AFT
1558-1566	4	2	CARAVEL	1 FORE / 3 AFT
1558-1566	5	3	CARAVEL	2 FORE / 3 AFT
1558-1566	6	4	NAU	2 FORE / 4 AFT
1558-1572	5	2	CARAVEL	5 AFT
1558-1572	7	3	NAU	1 FORE / 6 AFT
1558-1579	6	7	NAU	6 AFT
1566-1572	3	3	CARAVEL	1 FORE / 2 AFT
1566-1572	5	2	CARAVEL	3 FORE / 2 AFT
1588-98	1	1	NAU	1 AFT
1588-98	2	1	CARAVEL	2 AFT

BY VESSEL				
Vessel Types	**# of Shrouds**	**# of Vessels**	**Date Range**	**Shroud Position**
CARAVEL	1	1	1538-40	1 AFT
CARAVEL	2	1	1566	1 FORE / 1 AFT

CARAVEL	2	1	1588-98	2 AFT
CARAVEL	3	3	1566-1572	1 FORE / 2 AFT
CARAVEL	3	1	1566	2 FORE / 1 AFT
CARAVEL	3	3	1485-1583	3 AFT
CARAVEL	4	2	1558-1566	1 FORE / 3 AFT
CARAVEL	4	10	1538-1566	2 FORE / 2 AFT
CARAVEL	4	2	1538-1566	3 FORE / 1 AFT
CARAVEL	5	1	1556	1 FORE / 4 AFT
CARAVEL	5	3	1558-1566	2 FORE / 3 AFT
CARAVEL	5	2	1566-1572	3 FORE / 2 AFT
CARAVEL	5	2	1558-1572	5 AFT
CARAVEL	6	1	1566	2 FORE / 4 AFT
CARAVEL	6	1	1558-1561	3 FORE / 3 AFT
CARAVEL	6	1	1566	4 FORE / 2 AFT
CARAVEL	6	1	1558-1561	6 AFT
CARAVEL	7	1	1558-1561	3 FORE / 4 AFT
CARAVEL	10	1	1558-1561	2 FORE / 8AFT
GALLEON	2	1	1558-1561	2 AFT
GALLEON	3	2	1509-1540	3 AFT
GALLEON	4	1	1574	1 FORE / 3 AFT
GALLEON	4	3	1538-1556	4 AFT
GALLEON	5	1	1538-1540	5 AFT
GALLEON	6	1	1593	6 AFT
GALLEON	7	1	1538-1550	3 FORE / 4 AFT
GALLEON	8	1	1572	5 FORE / 3 AFT
GALLEON	12	1	1502	8 AFT - 4 FORE
NAU	1	1	1588-98	1 AFT
NAU	1	1	1517-1526	1 FORE
NAU	2	3	1568	1 FORE / 1 AFT
NAU	2	3	1509-1540	2 AFT
NAU	2	1	1535-1570	2 FORE
NAU	3	2	1509-1572	1 FORE / 2 AFT
NAU	3	8	1509-1572	3 AFT

NAU	3	2	1525-1594	3 FORE
NAU	4	4	1500-1600	1 FORE / 3 AFT
NAU	4	3	1513-1589	2 FORE / 2 AFT
NAU	4	1	1572	3 FORE / 1 AFT
NAU	4	16	1500-1600	4 AFT
NAU	4	5	1519-1573	4 FORE
NAU	5	1	1566	1 FORE / 4 AFT
NAU	5	8	1513-1572	2 FORE / 3 AFT
NAU	5	5	1538-1572	3 FORE / 2 AFT
NAU	5	5	1500-1600	5 AFT
NAU	5	4	1515-1592	5 FORE
NAU	6	4	1558-1566	2 FORE / 4 AFT
NAU	6	5	1530-1566	3 FORE / 3 AFT
NAU	6	4	1538-1572	4 FORE / 2 AFT
NAU	6	7	1558-1579	6 AFT
NAU	6	2	1519-1572	6 FORE
NAU	7	3	1558-1572	1 FORE / 6 AFT
NAU	7	8	1515-1598	3 FORE / 4 AFT
NAU	7	1	1558-1561	7 AFT
NAU	8	1	1538-1550	3 FORE / 5 AFT
NAU	9	1	1558-1561	9 AFT

FORE TOPMAST SHROUDS

BY SHROUDS				
# of Shrouds	**# of Vessels**	**Vessel Types**	**Date Range**	**Shroud Position**
1	1	NAU	1566	1 FORE
2	1	GALLEON	1538-1550	1 FORE / 1 AFT
2	12	NAU	1519-1598	1 FORE / 1 AFT
2	16	CARAVEL	1566-1572	1 FORE / 1 AFT
2	2	CARAVEL	1558-1566	2 AFT

2	2	GALLEON	1538-1561	2 AFT
2	1	NAU	1538-1540	2 AFT
2	1	CARAVEL	1566	2 FORE
2	1	NAU	1566	2 FORE
3	3	CARAVEL	1558-1566	1 FORE / 2 AFT
3	1	GALLEON	1572	1 FORE / 2 AFT
3	8	NAU	1538-1572	1 FORE / 2 AFT
3	1	CARAVEL	1566	2 FORE / 1 AFT
3	9	NAU	1538-1572	2 FORE / 1 AFT
3	2	GALLEON	1538-1593	3 AFT
3	5	NAU	1572-1594	3 AFT
3	3	NAU	1566-1592	3 FORE
4	1	CARAVEL	1558-1561	1 FORE / 3 AFT
4	7	NAU	1509-1566	1 FORE / 3 AFT
4	3	CARAVEL	1558-1566	2 FORE / 2 AFT
4	26	NAU	1530-1566	2 FORE / 2 AFT
4	1	NAU	1558-1561	3 FORE / 1 AFT
4	1	NAU	1592	4 FORE
5	2	NAU	1558-1566	2 FORE / 3 AFT
5	1	CARAVEL	1558-1561	2 FORE / 3 AFT
5	5	NAU	1558-1566	3 FORE / 2 AFT
6	1	NAU	1566	1 FORE / 5 AFT
6	1	NAU	1566	2 FORE / 4 AFT
6	4	NAU	1515-1566	3 FORE / 3 AFT
9	1	NAU	1558-1561	4 FORE / 5 AFT

BY DATE				
Date Range	**# of Shrouds**	**# of Vessels**	**Vessel Types**	**Shroud Position**
1566	1	1	NAU	1 FORE
1566	2	1	CARAVEL	2 FORE
1566	2	1	NAU	2 FORE
1566	3	1	CARAVEL	2 FORE / 1 AFT

1566	6	1	NAU	1 FORE / 5 AFT
1566	6	1	NAU	2 FORE / 4 AFT
1572	3	1	GALLEON	1 FORE / 2 AFT
1592	4	1	NAU	4 FORE
1509-1566	4	7	NAU	1 FORE / 3 AFT
1515-1566	6	4	NAU	3 FORE / 3 AFT
1519-1598	2	12	NAU	1 FORE / 1 AFT
1530-1566	4	26	NAU	2 FORE / 2 AFT
1538-1540	2	1	NAU	2 AFT
1538-1550	2	1	GALLEON	1 FORE / 1 AFT
1538-1561	2	2	GALLEON	2 AFT
1538-1572	3	8	NAU	1 FORE / 2 AFT
1538-1572	3	9	NAU	2 FORE / 1 AFT
1538-1593	3	2	GALLEON	3 AFT
1558-1561	4	1	CARAVEL	1 FORE / 3 AFT
1558-1561	4	1	NAU	3 FORE / 1 AFT
1558-1561	5	1	CARAVEL	2 FORE / 3 AFT
1558-1561	9	1	NAU	4 FORE / 5 AFT
1558-1566	2	2	CARAVEL	2 AFT
1558-1566	3	3	CARAVEL	1 FORE / 2 AFT
1558-1566	4	3	CARAVEL	2 FORE / 2 AFT
1558-1566	5	2	NAU	2 FORE / 3 AFT
1558-1566	5	5	NAU	3 FORE / 2 AFT
1566-1572	2	16	CARAVEL	1 FORE / 1 AFT
1566-1592	3	3	NAU	3 FORE
1572-1594	3	5	NAU	3 AFT

BY VESSEL				
Vessel Types	**# of Shrouds**	**# of Vessels**	**Date Range**	**Shroud Position**
CARAVEL	2	16	1566-1572	1 FORE / 1 AFT
CARAVEL	2	2	1558-1566	2 AFT
CARAVEL	2	1	1566	2 FORE
CARAVEL	3	3	1558-1566	1 FORE / 2 AFT

CARAVEL	3	1	1566	2 FORE / 1 AFT
CARAVEL	4	1	1558-1561	1 FORE / 3 AFT
CARAVEL	4	3	1558-1566	2 FORE / 2 AFT
CARAVEL	5	1	1558-1561	2 FORE / 3 AFT
GALLEON	2	1	1538-1550	1 FORE / 1 AFT
GALLEON	2	2	1538-1561	2 AFT
GALLEON	3	1	1572	1 FORE / 2 AFT
GALLEON	3	2	1538-1593	3 AFT
NAU	1	1	1566	1 FORE
NAU	2	12	1519-1598	1 FORE / 1 AFT
NAU	2	1	1538-1540	2 AFT
NAU	2	1	1566	2 FORE
NAU	3	8	1538-1572	1 FORE / 2 AFT
NAU	3	9	1538-1572	2 FORE / 1 AFT
NAU	3	5	1572-1594	3 AFT
NAU	3	3	1566-1592	3 FORE
NAU	4	7	1509-1566	1 FORE / 3 AFT
NAU	4	26	1530-1566	2 FORE / 2 AFT
NAU	4	1	1558-1561	3 FORE / 1 AFT
NAU	4	1	1592	4 FORE
NAU	5	2	1558-1566	2 FORE / 3 AFT
NAU	5	5	1558-1566	3 FORE / 2 AFT
NAU	6	1	1566	1 FORE / 5 AFT
NAU	6	1	1566	2 FORE / 4 AFT
NAU	6	4	1515-1566	3 FORE / 3 AFT
NAU	9	1	1558-1561	4 FORE / 5 AFT

FORE TOPGALLANT MAST SHROUDS

BY SHROUDS				
# of Shrouds	**# of Vessels**	**Vessel Types**	**Date Range**	**Shroud Position**
1	1	GALLEON	1538-1540	1 AFT
2	2	NAU	1510-1526	2 AFT

3	2	NAU	1538-1550	2 FORE / 1 AFT
4	2	NAU	1530-1550	2 FORE / 2 AFT
4	1	NAU	1517-1526	4 FORE
5	1	NAU	1538-1550	2 FORE / 3 AFT
6	1	NAU	1515-1525	3 FORE / 3 AFT

BY DATE				
Date Range	**# of Shrouds**	**# of Vessels**	**Vessel Types**	**Shroud Position**
1510-1526	2	2	NAU	2 AFT
1515-1525	6	1	NAU	3 FORE / 3 AFT
1517-1526	4	1	NAU	4 FORE
1530-1550	4	2	NAU	2 FORE / 2 AFT
1538-1540	1	1	GALLEON	1 AFT
1538-1550	3	2	NAU	2 FORE / 1 AFT
1538-1550	5	1	NAU	2 FORE / 3 AFT

BY VESSEL				
Vessel Types	**# of Shrouds**	**# of Vessels**	**Date Range**	**Shroud Position**
GALLEON	1	1	1538-1540	1 AFT
NAU	2	2	1510-1526	2 AFT
NAU	3	2	1538-1550	2 FORE / 1 AFT
NAU	4	2	1530-1550	2 FORE / 2 AFT
NAU	4	1	1517-1526	4 FORE
NAU	5	1	1538-1550	2 FORE / 3 AFT
NAU	6	1	1515-1525	3 FORE / 3 AFT

APPENDIX 19

STANDING AND RUNNING RIGGING COMBINATIONS OF THE BONAVENTURE MAST IN THE ICONOGRAPHY

BONAVENTURE RIGGING

SHROUDS ONLY		N=25	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	13	1485-1583	18.06%
GALLEONS	5	1500-1593	6.94%
NAUS	7	1510	9.72%
HALYARDS ONLY		N=4	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	1	1566	1.39%
GALLEONS	2	1538-40	2.78%
NAUS	1	1510	1.39%
BRACES ONLY		N=1	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	1	1566	1.39%
BACKSTAYS ONLY		N=2	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	2	1584	2.78%
BACKSTAYS, HALYARDS		N=1	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	1	1566	1.39%
BACKSTAYS, HALYARDS, BRACES		N=1	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	1	1566	1.39%

SHROUDS, BRACES		N=5	
VESSEL	# OF VESSELS	DATE	% OF SAMPLE
CARAVELS	4	1558-1561	5.56%
NAUS	1	1558-1561	1.39%

SHROUDS, HALYARDS		N=7	
VESSEL	# OF VESSELS	DATE	% OF SAMPLE
CARAVELS	3	1538-1566	4.17%
GALLEONS	3	1502-1540	4.17%
NAUS	1	1510	1.39%

SHROUDS, HALYARDS, BRACES		N=2	
VESSEL	# OF VESSELS	DATE	% OF SAMPLE
CARAVELS	2	1558-1561	2.78%

SHROUDS, FORESTAY		N=2	
VESSEL	# OF VESSELS	DATE	% OF SAMPLE
CARAVELS	2	1538-1550	2.78%

SHROUDS, BACKSTAYS, HALYARDS		N=17	
VESSEL	# OF VESSELS	DATE	% OF SAMPLE
CARAVELS	17	1558-1566	23.61%

SHROUDS, BACKSTAYS, HALYARDS, BRACES		N=4	
VESSEL	# OF VESSELS	DATE	% OF SAMPLE
CARAVELS	4	1558-1566	5.56%

HALYARDS, BRACES		N=1	
VESSEL	# OF VESSELS	DATE	% OF SAMPLE
GALLEONS	1	1589	1.39%

APPENDIX 20

STANDING AND RUNNING RIGGING COMBINATIONS OF THE MIZZEN MAST

IN THE ICONOGRAPHY

MIZZEN MAST RIGGING

SHROUDS ONLY		N=30	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	7	1500-1583	3.08%
GALLEONS	3	1509-15972	1.32%
NAUS	20	1500-1600	8.81%
HALYARDS ONLY		N=2	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	1	1520	0.44%
NAUS	1	1560	0.44%
BRACES ONLY		N=2	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	1	1572	0.44%
NAUS	1	1579	0.44%
BACKSTAY ONLY		N=6	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	5	1566-1584	2.20%
NAUS	1	1509-1589	0.44%
FORESTAY ONLY		N=2	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
NAUS	2	1572-1598	0.88%
SHROUDS, HALYARDS		N=2	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	1	1538-1540	0.44%
GALLEONS	1	1558-1561	0.44%

SHROUDS, BRACES		N=3	
VESSEL	# OF VESSELS	DATE	% OF SAMPLE
NAUS	3	1566-1592	1.32%
SHROUDS, HALYARDS, BRACES		N=10	
VESSEL	# OF VESSELS	DATE	% OF SAMPLE
CARAVELS	2	1558-1566	0.88%
NAUS	8	1538-1594	3.52%
SHROUDS, FORESTAY		N=3	
VESSEL	# OF VESSELS	DATE	% OF SAMPLE
CARAVELS	3	1538-1572	1.32%
SHROUDS, FORESTAY, HALYARDS		N=1	
VESSEL	# OF VESSELS	DATE	% OF SAMPLE
CARAVELS	1	1538-1540	0.44%
SHROUDS, FORESTAYS, BRACES		N=2	
VESSEL	# OF VESSELS	DATE	% OF SAMPLE
CARAVELS	1	1558-1561	0.44%
GALLEONS	1	1552	0.44%
SHROUD, BACKSTAY		N=12	
VESSEL	# OF VESSELS	DATE	% OF SAMPLE
CARAVELS	1	1566	0.44%
GALLEONS	1	1593	0.44%
NAUS	10	1530-1603	4.41%
SHROUD, BACKSTAY, BRACE		N=30	
VESSEL	# OF VESSELS	DATE	% OF SAMPLE
NAUS	30	1530-1603	13.22%
SHROUDS, BACKSTAY, HALYARDS		N=22	
VESSEL	# OF VESSELS	DATE	% OF SAMPLE
CARAVELS	7	1558-1566	3.08%
NAUS	15	1566-1592	6.61%

SHROUDS, BACKSTAY, HALYARDS, BRACES		N=40	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
NAUS	40	1566	17.62%
BACKSTAYS, HALYARDS		N=23	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	2	1566-1594	0.88%
NAUS	21	1566-1594	9.25%
BACKSTAY, BRACES		N=7	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	2	1558-1566	0.88%
NAUS	5	1566	2.20%
HALYARDS, BRACES		N=4	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
NAUS	4	1566-1589	1.76%

APPENDIX 21

STANDING AND RUNNING RIGGING COMBINATIONS OF THE MAIN MAST

IN THE ICONOGRAPHY

LOWER MAIN MAST RIGGING

HALYARDS ONLY		**N=11**	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	3	1535-1570	27.27%
NAUS	8	1519-1546	72.73%
BRACES ONLY		**N=24**	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	2	1500	8.33%
NAUS	22	1509-1566	91.67%
SHROUDS ONLY		**N=43**	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	31	1485-1598	72.09%
GALLEONS	1	1500-1525	2.33%
NAUS	11	1500-1603	25.58%
FORESTAYS ONLY		**N=2**	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	1	1519	50.00%
NAUS	1	1517-1526	50.00%
BACKSTAYS ONLY		**N=3**	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	3	1541-1566	100.00%
HALYARDS, BRACES, SHROUDS, FORESTAYS, BACKSTAYS		**N=10**	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	1	1558-1561	10.00%
GALLEONS	3	1519-1593	30.00%
NAUS	6	1515-1582	60.00%

HALYARDS, BRACES, SHROUDS, FORESTAYS		N=45	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	1	1558-1561	100.00%
GALLEONS	2	1519-1540	200.00%
NAUS	42	1509-1600	420.00%
HALYARDS, BRACES, SHROUDS, BACKSTAYS		N=9	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
GALLEONS	2	1519	22.22%
NAUS	7	1535-1592	77.78%
HALYARDS, BRACES, SHROUDS		N=89	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	5	1500-1566	5.62%
GALLEONS	6	1502-1561	6.74%
NAUS	78	1510-1579	87.64%
HALYARDS, BRACES, FORESTAYS, BACKSTAYS		N=3	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
GALLEONS	1	1589	33.33%
NAUS	2	1593	66.67%
HALYARDS, BRACES, FORESTAY		N=4	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
GALLEONS	1	1589	25.00%
NAUS	3	1485-1589	75.00%
HALYARDS, BRACES, BACKSTAY		N=1	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
NAUS	1	1568	100.00%
HALYARDS, BRACES		N=72	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	1	1500-1525	1.39%
GALLEONS	3	1519-1589	4.17%
NAUS	68	1500-1598	94.44%

HALYARDS, SHROUDS, FORESTAYS, BACKSTAYS		N=4	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
GALLEONS	1	1574	25.00%
NAUS	3	1517-1600	75.00%
HALYARDS, SHROUDS, FORESTA		N=10	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	2	1572-1598	18.18%
GALLEONS	3	1538-1556	27.27%
NAUS	6	1513-1572	54.55%
HALYARDS, SHROUDS, BACKSTA		N=3	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
NAUS	3	1510-1526	100.00%
HALYARDS, SHROUDS, FORESTA		N=2	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
NAUS	2	1509-1570	100.00%
HALYARDS, SHROUDS		N=9	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	2	1509-1561	22.22%
GALLEONS	1	1500-25	11.11%
NAUS	7	1510-1598	77.78%
HALYARDS, FORESTAYS		N=4	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
NAUS	4	1500-1534	100.00%
HALYARDS, FORESTAYS, BACKSTAYS		N=2	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	2	1593	100.00%
BRACES, SHROUDS, FORESTAYS		N=14	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	1	1558-1561	7.14%
GALLEONS	2	1552-1593	14.29%
NAUS	11	1500-1603	78.57%

BRACES, SHROUDS, FORESTAYS, BACKSTAYS		N=9	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	5	1520-1566	55.56%
NAUS	4	1500-1550	44.44%
BRACES, SHROUDS, BACKSTAYS		N=4	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	1	1566	25.00%
GALLEONS	1	1558-1561	25.00%
NAUS	2	1558-1566	50.00%
BRACES, SHROUDS		N=33	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	6	1538-1566	18.18%
NAUS	27	1515-1600	81.82%
BRACES, FORESTAYS		N=2	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
NAUS	2	1530-1561	100.00%
SHROUDS, FORESTAYS, BACKST/		N=6	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	1	1538-1540	16.67%
GALLEONS	1	1509	16.67%
NAUS	4	1572-1603	66.67%
SHROUDS, FORESTAYS		N=14	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	9	1509-1572	64.29%
GALLEONS	1	1616	7.14%
NAUS	4	1509-1572	28.57%
SHROUDS, BACKSTAYS		N=15	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	15	1515-1572	100.00%
FORESTAYS, BACKSTAYS		N=3	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	3	1517-1566	100.00%

MAIN TOPMAST RIGGING

HALYARDS ONLY		N=26	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	1	1558	3.85%
GALLEONS	2	1519-1550	7.69%
NAUS	23	1519-1592	88.46%
BRACES ONLY		N=17	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	1	1566	5.88%
NAUS	16	1529-1566	94.12%
SHROUDS ONLY		N=6	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
NAUS	6	1509-1566	100.00%
FORESTAY ONLY		N=6	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	1	1520	16.67%
GALLEONS	1	1552	16.67%
NAUS	4	1509-1603	66.67%
HALYARDS, BRACES, SHROUDS, FORESTAYS, BACKSTAYS		N=5	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
GALLEONS	2	1572-1593	40.00%
NAUS	3	1500-1595	60.00%
HALYARDS, BRACES, SHROUDS, FORESTAYS		N=56	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
GALLEONS	2	1538-1540	3.57%
NAUS	54	1500-1594	96.43%
HALYARDS, BRACES, SHROUDS		N=52	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	1	1566	1.92%
NAUS	51	1500-1603	98.08%

HALYARDS, BRACES, FORESTAYS, BACKSTAYS		N=3	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
GALLEONS	1	1589	33.33%
NAUS	2	1520-1534	66.67%
HALYARDS, BRACES, FORESTAYS		N=21	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
GALLEONS	1	1589	4.76%
NAUS	20	1485-1594	95.24%
HALYARDS, BRACES, BACKSTAYS		N=1	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
NAUS	1	1596	100.00%
HALYARDS, BRACES		N=60	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	1	1500-1525	1.67%
GALLEONS	4	1519-1589	6.67%
NAUS	55	1500-1600	91.67%
HALYARDS, SHROUDS, FORESTAYS		N=21	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
GALLEONS	2	1538-1540	9.52%
NAUS	19	1515-1566	90.48%
HALYARDS, SHROUDS		N=8	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
GALLEONS	1	1558-1561	12.50%
NAUS	7	1519-1592	87.50%
HALYARDS, SHROUDS, BACKSTAYS		N=2	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
NAUS	2	1500-1600	100.00%
HALYARDS, FORESTAYS, BACKSTAYS		N=1	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
NAUS	1	1500-1600	100.00%

HALYARDS, FORESTAYS		N=6	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
NAUS	6	1509-1570	100.00%
HALYARDS, BACKSTAYS		N=1	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
NAUS	1	1532	100.00%
BRACES, SHROUDS, FORESTAYS, BACKSTAYS		N=1	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
NAUS	1	1558-1561	100.00%
BRACES, SHROUDS, FORESTAYS		N=11	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
GALLEONS	2	1558-1593	18.18%
NAUS	9	1558-1603	81.82%
BRACES, SHROUDS		N=9	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
NAUS	9	1513-1592	100.00%
BRACES, FORESTAYS, BACKSTAYS		N=1	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
NAUS	1	1520	100.00%
BRACES, FORESTAYS		N=8	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
NAUS	8	1566-1600	100.00%
SHROUDS, FORESTAYS, BACKSTAY		N=1	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
NAUS	1	1573-1603	100.00%
SHROUDS, FORESTAYS		N=4	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
NAUS	4	1509-1566	100.00%
FORESTAY, BACKSTAY		N=3	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	1	1584	33.33%
NAUS	2	1514-1582	66.67%

MAIN TOPGALLANT MAST

HALYARDS ONLY		N=2	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
GALLEONS	1	1530-1534	50.00%
NAUS	1	1538-1550	50.00%
SHROUDS ONLY		N=3	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
NAUS	3	1510-1540	100.00%
FORESTAYS ONLY		N=2	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
NAUS	2	1510-1570	100.00%
BACKSTAYS ONLY		N=1	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
NAUS	1	1514	100.00%
HALYARDS, BRACES, SHROUDS, FORESTAY, BACKSTAY		N=1	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
GALLEONS	1	1572	100.00%
HALYARDS, BRACES, SHROUDS, FORESTAYS		N=2	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
NAUS	2	1538-1550	100.00%
HALYARDS, BRACES, SHROUDS		N=5	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
GALLEONS	1	1593	20.00%
NAUS	4	1500-1550	80.00%
HALYARDS, BRACES, FORESTAYS		N=3	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
NAUS	3	1500-1534	100.00%
HALYARDS, BRACES		N=5	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
GALLEONS	1	1538-1540	20.00%
NAUS	4	1500-1525	80.00%

HALYARDS, SHROUDS		N=1	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
GALLEONS	1	1538-1540	100.00%
HALYARDS, SHROUDS, FORESTAYS		N=2	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
NAUS	2	1515-1534	100.00%
HALYARDS, SHROUDS		N=1	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
NAUS	1	1515-1534	100.00%
HALYARDS, FORESTAYS		N=4	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
GALLEONS	1	1538-1540	25.00%
NAUS	3	1530-1570	75.00%
BRACES, FORESTAYS		N=3	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
NAUS	3	1500-1603	100.00%
SHROUDS, FORESTAY, BACKSTAY		N=1	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
NAUS	1	1500-1603	100.00%
SHROUDS, FORESTAY, BACKSTAY		N=1	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
NAUS	1	1573-1603	100.00%

APPENDIX 22

STANDING AND RUNNING RIGGING COMBINATIONS OF THE FORE MAST IN THE ICONOGRAPHY

LOWER FORE MAST RIGGING

HALYARDS ONLY		N=6	
VESSEL	# OF VESSELS	DATE	% OF SAMPLE
CARAVELS	1	1566	16.67%
GALLEONS	2	1519-1541	33.33%
NAUS	3	1513-1540	50.00%
BRACES ONLY		N=9	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	1	1556	11.11%
GALLEONS	2	1500-1558	22.22%
NAUS	6	1519-1566	66.67%
SHROUDS ONLY		N=11	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	3	1572-1598	27.27%
NAUS	8	1500-1603	72.73%
FORESTAY ONLY		N=21	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	2	1541-1584	9.52%
GALLEONS	3	1519-1540	14.29%
NAUS	16	1509-1600	76.19%
HALYARDS, BRACES, SHROUDS, FORESTAYS, BACKSTAYS		N=3	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	1	1538-1540	33.33%
GALLEONS	1	1593	33.33%
NAUS	1	1509	33.33%

HALYARDS, BRACES, SHROUDS, FORESTAYS		N=65	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	20	1538-1572	30.77%
GALLEONS	4	1538-1572	6.15%
NAUS	41	1509-1594	63.08%
HALYARDS, BRACES, SHROUDS		N=13	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	1	1566	7.69%
GALLEONS	3	1502-1574	23.08%
NAUS	9	1513-1572	69.23%
HALYARDS, BRACES, SHROUDS, BACKSTAYS		N=1	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
NAUS	1	1565	100.00%
HALYARDS, BRACES, FORESTAYS		N=44	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	3	1558	6.82%
GALLEONS	5	1519-1550	11.36%
NAUS	36	1519-1592	81.82%
HALYARDS, BRACES		N=14	4.58%
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	1	1550	7.14%
NAUS	13	1550-1596	92.86%
HALYARDS, SHROUDS, FORESTAYS, BACKSTAYS		N=2	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
NAUS	2	1530-1600	100.00%
HALYARDS, SHROUDS, FORESTAYS		N=9	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	2	1485-1556	22.22%
GALLEONS	2	1538-1556	22.22%
NAUS	5	1513-1600	55.56%

HALYARDS, SHROUDS		N=5	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
NAUS	5	1568-1598	100.00%
HALYARDS, FORESTAYS		N=8	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	1	1566	12.50%
NAUS	7	1500-1570	87.50%
BRACES, SHROUDS, FORESTAYS, BACKSTAYS		N=4	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
NAUS	4	1500-1603	100.00%
BRACES, SHROUDS, FORESTAYS		N=38	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	8	1538-1561	21.05%
GALLEONS	1	1519-1593	2.63%
NAUS	29	1515-1592	76.32%
BRACES, SHROUDS		N=4	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	1	1572	25.00%
GALLEONS	1	1552	25.00%
NAUS	2	1514-1594	50.00%
BRACES, FORESTAYS		N=37	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	5	1558-1566	13.51%
GALLEONS	1	1558-1561	2.70%
NAUS	31	1500-1566	83.78%
BRACES, BACKSTAYS		N=1	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
NAUS	1	1531-1534	100.00%
SHROUDS, FORESTAY, BACKSTAY		N=2	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
NAUS	2	1572-1600	100.00%

SHROUDS, FORESTAY		N=14	
VESSEL	# OF VESSELS	DATE	% OF SAMPLE
CARAVELS	3	1566-1583	21.43%
GALLEONS	2	1509	14.29%
NAUS	9	1509-1603	64.29%
SHROUDS, BACKSTAY		N=1	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
NAUS	1	1572-1600	100.00%

FORE TOPMAST RIGGING

HALYARDS ONLY		N=17	
VESSEL	# OF VESSELS	DATE	% OF SAMPLE
CARAVELS	4	1538-1584	23.53%
GALLEONS	1	1519	5.88%
NAUS	12	1538-1600	70.59%
BRACES ONLY		N=2	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	1	1556	50.00%
NAUS	1	1595	50.00%
SHROUDS ONLY		N=5	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
NAUS	5	1509-1594	100.00%
FORESTAY ONLY		N=15	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	1	1541	6.67%
NAUS	14	1500-1603	93.33%
HALYARDS, BRACES, SHROUDS, FORESTAYS, BACKSTAYS		N=1	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
GALLEONS	1	1593	100.00%

HALYARDS, BRACES, SHROUDS, FORESTAYS		N=39	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	5	1558-1561	12.82%
GALLEONS	2	1572-1593	5.13%
NAUS	32	1538-1593	82.05%
HALYARDS, BRACES, SHROUDS, FORESTAYS		N=17	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	4	1558-1572	23.53%
GALLEONS	2	1538-1561	11.76%
NAUS	11	1500-1598	64.71%
HALYARDS, BRACES, SHROUDS		N=10	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	3	1566-1572	30.00%
NAUS	7	1519-1594	70.00%
HALYARDS, SHROUDS, FORESTAYS		N=47	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	17	1566	36.17%
NAUS	30	1519-1592	63.83%
HALYARDS, SHROUDS		N=5	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	1	1566	20.00%
GALLEONS	2	1538-1550	40.00%
NAUS	2	1519-1594	40.00%
HALYARDS, BRACES, FORESTAYS, BACKSTAYS		N=1	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
NAUS	1	1500-1525	100.00%
HALYARDS, BRACES, FORESTAYS		N=44	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	7	1485-1593	15.91%
GALLEONS	5	1538-1589	11.36%
NAUS	32	1485-1595	72.73%

HALYARDS, BRACES		N=12	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
GALLEONS	1	1541	8.33%
NAUS	11	1500-1598	91.67%
HALYARDS, FORESTAYS, BACKSTAYS		N=1	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
NAUS	1	1519	100.00%
HALYARDS, FORESTAYS		N=22	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	3	1558-1583	13.64%
GALLEONS	2	1519-1540	9.09%
NAUS	17	1530-1600	77.27%
BRACES, SHROUDS, FORESTAYS		N=5	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
NAUS	5	1558-1561	100.00%
BRACES, FORESTAYS, BACKSTAYS		N=1	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
NAUS	1	1520	100.00%
BRACES, FORESTAYS		N=16	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
CARAVELS	2	1566	12.50%
GALLEONS	1	1558-1561	6.25%
NAUS	13	1520-1566	81.25%
SHROUDS, FORESTAYS, BACKSTAYS		N=1	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
NAUS	1	1573-1603	100.00%
SHROUDS, FORESTAYS		N=4	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
GALLEONS	2	1552-1593	50.00%
NAUS	2	1515-1603	50.00%
FORESTAY, BACKSTAYS		N=1	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
NAUS	1	1509	100.00%

FORE TOPGALLANT MAST

SHROUDS ONLY		N=3	
VESSEL	# OF VESSELS	DATE	% OF SAMPLE
GALLEONS	1	1552	33.33%
NAUS	2	1510-1526	66.67%
FORESTAYS ONLY		N=3	
VESSEL	# OF VESSELS	DATE	% OF SAMPLE
GALLEONS	1	1593	33.33%
NAUS	2	1535-1603	66.67%
HALYARDS, BRACES, SHROUDS, FORESTAYS		N=3	
VESSEL	# OF VESSELS	DATE	% OF SAMPLE
NAUS	3	1500-1550	100.00%
HALYARDS, BRACES, SHROUDS		N=2	
VESSEL	# OF VESSELS	DATE	% OF SAMPLE
NAUS	2	1538-1550	100.00%
HALYARDS, BRACES, FORESTAYS		N=3	
VESSEL	# OF VESSELS	DATE	% OF SAMPLE
GALLEONS	1	1538-1540	33.33%
NAUS	2	1500-1534	66.67%
HALYARDS, BRACES		N=5	
VESSEL	# OF VESSELS	DATE	% OF SAMPLE
NAUS	5	1500-1525	31.25%
HALYARDS, SHROUDS, FORESTAYS		N=2	
VESSEL	# OF VESSELS	DATE	% OF SAMPLE
NAUS	2	1515-1534	100.00%
HALYARDS, SHROUDS		N=1	
VESSEL	# OF VESSELS	DATE	% OF SAMPLE
GALLEONS	1	1538-1540	100.00%
HALYARDS, FORESTAYS		N=2	
VESSEL	# OF VESSELS	DATE	% OF SAMPLE
NAUS	2	1530-1534	100.00%

BRACES, FORESTAYS		N=2	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
GALLEONS	1	1538-1550	50.00%
NAUS	1	1530-1534	50.00%
BRACES, FORESTAYS		N=3	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
NAUS	3	1500-1603	100.00%
SHROUDS, FORESTAYS		N=2	
VESSEL	**# OF VESSELS**	**DATE**	**% OF SAMPLE**
NAUS	2	1517-1603	100.00%

APPENDIX 23

PENDANTS AND FLAGS IN THE REPRESENTATIONAL TRENDS DATABASE

PENDANTS

BONAVENTURE MAST		N=17	**ALL**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
7	CARAVEL	1519-1593	41.18%
9	GALLEON	1500-1600	52.94%
1	NAU	1519	5.88%
BONAVENTURE MAST		N=2	**RED PENDANTS**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
1	CARAVEL	1519	5.88%
1	GALLEON	1558-1561	5.88%
BONAVENTURE MAST		N=15	**WHITE PENDANTS**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
6	CARAVEL	1519-1593	35.29%
8	GALLEON	1500-1600	47.06%
1	NAU	1519	5.88%
MIZZEN MAST		N=46	**ALL**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
4	CARAVEL	1519-1593	8.70%
12	GALLEON	1500-1600	26.09%
30	NAU	1485-1603	65.22%
MIZZEN MAST		N=1	**STRIPED**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
1	NAU	1566	2.17%
MIZZEN MAST		N=1	**BLUE**
# OF VESSELS	**SHIP TYPE**	**DATE**	% OF SAMPLE
1	GALLEON	1519	2.17%
MIZZEN MAST		N=5	**RED**
# OF VESSELS	**SHIP TYPE**	**DATE**	% OF SAMPLE
1	CARAVEL	1519	2.17%
3	GALLEON	1558-1600	6.52%
1	NAU	1519	2.17%

MIZZEN MAST		N=39	WHITE
# OF VESSELS	SHIP TYPE	DATE	% OF SAMPLE
3	CARAVEL	1535-1590	6.52%
8	GALLEON	1500-1600	17.39%
28	NAU	1485-1603	60.87%
MAIN MAST		N=65	**ALL**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
10	CARAVEL	1500-1593	15.38%
12	GALLEON	1500-1600	18.46%
43	NAU	1500-1603	66.15%
MAIN MAST		N=5	**RED**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
1	CARAVEL	1519	1.54%
2	GALLEON	1558-1600	3.08%
2	NAU	1538-1579	3.08%
MAIN MAST		N=7	**ORDER OF CHRIST CROSS**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
7	NAU	1566	10.77%
MAIN MAST		N=53	**WHITE**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
9	CARAVEL	1500-1593	13.85%
10	GALLEON	1500-1600	15.38%
34	NAU	1500-1603	52.31%
FOREMAST		N=36	**ALL**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
2	CARAVEL	1500-1541	5.56%
7	GALLEON	1500-1600	19.44%
27	NAU	1485-1603	75.00%
FOREMAST		N=2	**RED**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
2	NAU	1519-1579	5.56%
FOREMAST		N=1	**RED & BLUE**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
1	NAU	1519	2.78%
FOREMAST		N=33	**WHITE**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**

2	CARAVEL	1500-1541	5.56%
7	GALLEON	1500-1600	19.44%
24	NAU	1485-1603	66.67%

FLAGS

BONAVENTURE MAST		**N=7**	**ALL**
# OF VESSELS	**SHIP TYPE**	**DATE**	% OF SAMPLE
3	CARAVEL	1558-1566	42.86%
3	GALLEON	1502-1600	42.86%
1	NAU	1520	14.29%
BONAVENTURE MAST		N=4	**WHITE**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
1	CARAVEL	1558	14.29%
2	GALLEON	1502-1600	28.57%
1	NAU	1520	14.29%
BONAVENTURE MAST		N=2	**ORDER OF CHRIST CROSS**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
2	CARAVEL	1566	28.57%
BONAVENTURE MAST		N=1	**YELLOW/RED**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
1	GALLEON	1600	14.29%
MIZZEN MAST		N=22	**WHITE**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
2	CARAVEL	1515-1558	6.45%
4	GALLEON	1502-1600	12.90%
16	NAU	1510-1603	51.61%
MIZZEN MAST		N=3	**ORDER OF CHRIST CROSS**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
1	GALLEON	1600	3.23%
2	NAU	1566	6.45%
MIZZEN MAST		N=3	**RED**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
3	NAU	1556-1588	9.68%
MIZZEN MAST		N=3	**RED W/ BLACK CROSS**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
1	CARAVEL	1519	3.23%

1	GALLEON	1519	3.23%
1	NAU	1519	3.23%
MAIN MAST		N=216	**ALL**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
55	CARAVEL	1485-1593	25.46%
14	GALLEON	1519-1616	6.48%
147	NAU	1485-1603	68.06%
MAIN MAST		N=155	**WHITE**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
43	CARAVEL	1500-1593	19.91%
10	GALLEON	1519-1616	4.63%
102	NAU	1485-1603	47.22%
MAIN MAST		N=35	**ORDER OF CHRIST CROSS**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
4	CARAVEL	1485-1565	1.85%
2	GALLEON	1558-1561	0.93%
29	NAU	1515-1600	13.43%
MAIN MAST		N=4	**BLUE**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
4	NAU	1519	1.85%
MAIN MAST		N=4	**PORTUGUESE *QUINA***
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
4	NAU	1510-1565	1.85%
MAIN MAST		N=3	**RED**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
1	CARAVEL	1556	0.46%
2	NAU	1538-1556	0.93%
MAIN MAST		N=3	**RED TRIANGLE W/ WHITE & RED *QUINA***
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
3	CARAVEL	1500	1.39%
MAIN MAST		N=3	**RED TRIANGLE W/ WHITE SQUARE**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
3	CARAVEL	1500	1.39%
MAIN MAST		N=2	**RED W/ BLUE CROSS**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
2	NAU	1583-88	0.93%

MAIN MAST		N=2	**WHITE & RED *QUINA***
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
2	NAU	1558-1561	0.93%
MAIN MAST		N=1	**WHITE W/ RED X**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
1	CARAVEL	1584	0.46%
MAIN MAST		N=1	**2 TONE BLUE STRIPES**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
1	NAU	1500-1600	0.46%
MAIN MAST		N=1	**BLUE W/ RED CROSS**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
1	NAU	1589	0.46%
MAIN MAST		N=1	**CREST**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
1	GALLEON	1519-1616	0.46%
MAIN MAST		N=1	**CATALONIAN FLAG**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
1	GALLEON	1519-1616	0.46%
FOREMAST		N=84	**ALL**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
6	CARAVEL	1541-1572	7.14%
10	GALLEON	1502-1600	11.90%
68	NAU	1500-1600	80.95%
FOREMAST		N=66	**WHITE**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
5	CARAVEL	1535-1570	5.95%
7	GALLEON	1502-1574	8.33%
54	NAU	1500-1600	64.29%
FOREMAST		N=5	**ORDER OF CHRIST CROSS**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
1	CARAVEL	1565	1.19%
1	GALLEON	1593	1.19%
3	NAU	1510-1566	3.57%
FOREMAST		N=5	**RED**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
1	CARAVEL	1584	1.19%
4	NAU	1519	4.76%

FOREMAST		N=2	BLUE W/ RED CROSS
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
2	NAU	1589	2.38%
FOREMAST		N=2	**PORTUGUESE *QUINA***
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
1	GALLEON	1519	1.19%
1	NAU	1510	1.19%
FOREMAST		N=2	**RED W/ BLACK CROSS**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
1	GALLEON	1519	1.19%
1	NAU	1519	1.19%
FOREMAST		N=1	**RED W/ BLUE CROSS**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
1	NAU	1583-1588	1.19%

APPENDIX 24

STERNCASTLE RAILING SHIELDS AND FLAGS IN THE REPRESENTATIONAL TRENDS DATABASE

STERNCASTLE RAILING SHIELDS

RAILING SHIELDS		N=33	**ALL**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
8	CARAVEL	1513-1534	24.24%
3	GALLEON	1502-1519	9.09%
22	NAU	1513-1603	66.67%
RAILING SHIELDS		N=7	**RED**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
5	CARAVEL	1513-1526	15.15%
2	NAU	1517-1603	6.06%
RAILING SHIELDS		N=7	**RED/BLUE**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
7	NAU	1519	21.21%
RAILING SHIELDS		N=7	**RED/YELLOW**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
2	CARAVEL	1515-25	6.06%
5	NAU	1513-1530	15.15%
RAILING SHIELDS		N=3	**ORDER OF CHRIST CROSS**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
3	NAU	1520	9.09%
RAILING SHIELDS		N=2	**RED/GREEN**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
2	GALLEON	1519	6.06%
RAILING SHIELDS		N=1	**RED/WHITE**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
1	NAU	1513	3.03%
RAILING SHIELDS		N=1	**RED W/BLUE CROSS; GREEN W/ YELLOW CROSS**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
1	GALLEON	1502	3.03%

RAILING SHIELDS		N=1	GREEN/WHITE
# OF VESSELS	SHIP TYPE	DATE	% OF SAMPLE
1	NAU	1565	3.03%
RAILING SHIELDS		N=1	YELLOW/BROWN
# OF VESSELS	SHIP TYPE	DATE	% OF SAMPLE
1	NAU	1592	3.03%
RAILING SHIELDS		N=1	YELLOW/GREEN
# OF VESSELS	SHIP TYPE	DATE	% OF SAMPLE
1	CARAVEL	1530-1534	3.03%
RAILING SHIELDS		N=2	UNDETERMINED
# OF VESSELS	SHIP TYPE	DATE	% OF SAMPLE
2	NAU	1519	6.06%

STERNCASTLE FLAGS

FLAGS		N=22	ALL
# OF VESSELS	SHIP TYPE	DATE	% OF SAMPLE
4	CARAVEL	1556-1558	18.18%
5	GALLEON	1552-1600	22.73%
13	NAU	1500-1588	59.09%
FLAGS		N=6	ORDER OF CHRIST CROSS
# OF VESSELS	SHIP TYPE	DATE	% OF SAMPLE
2	CARAVEL	1556-1588	9.09%
4	NAU	1520-1566	18.18%
FLAGS		N=3	RED W/ BLUE CROSS
# OF VESSELS	SHIP TYPE	DATE	% OF SAMPLE
3	NAU	1583-88	13.64%
FLAGS		N=1	RED/YELLOW
# OF VESSELS	SHIP TYPE	DATE	% OF SAMPLE
1	GALLEON	1600	4.55%
FLAGS		N=2	ORANGE
# OF VESSELS	SHIP TYPE	DATE	% OF SAMPLE
2	NAU	1500-1525	9.09%
FLAGS		N=1	ORANGE/WHITE
# OF VESSELS	SHIP TYPE	DATE	% OF SAMPLE
1	NAU	1510	4.55%

FLAGS		N=1	WHITE
# OF VESSELS	SHIP TYPE	DATE	% OF SAMPLE
1	NAU	1510	4.55%
FLAGS		N=1	**GREEN**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
1	GALLEON	1600	4.55%
FLAGS		N=1	**FLAG W/ SHIELD**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
1	GALLEON	1552	4.55%

APPENDIX 25

FORECASTLES RAILING SHIELDS AND FLAGS IN THE

REPRESENTATIONAL TRENDS DATABASE

FORECASTLES RAILING SHIELDS

RAILING SHIELDS		N=31	**ALL**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
3	CARAVEL	1515-1526	9.68%
3	GALLEON	1502-1519	9.68%
25	NAU	1513-1603	80.65%
RAILING SHIELDS		N=8	**RED/BLUE**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
8	NAU	1519	25.81%
RAILING SHIELDS		N=6	**RED/YELLOW**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
2	CARAVEL	1515-1525	6.45%
4	NAU	1513-1530	12.90%
RAILING SHIELDS		N=4	**RED**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
1	CARAVEL	1517-1526	3.23%
3	NAU	1517-1603	9.68%
RAILING SHIELDS		N=3	**ORDER OF CHRIST CROSS**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
3	NAU	1520	9.68%
RAILING SHIELDS		N=2	**RED/GREEN**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
2	GALLEON	1519	6.45%
RAILING SHIELDS		N=2	**YELLOW**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
2	NAU	1517-1526	6.45%
RAILING SHIELDS		N=2	**UNDETERMINED**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
2	NAU	1519	6.45%

RAILING SHIELDS		N=1	RED W/BLUE CROSS; GREEN W/ YELLOW CROSS
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
1	GALLEON	1502	3.23%
RAILING SHIELDS		N=1	**RED/WHITE**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
1	NAU	1513	3.23%
RAILING SHIELDS		N=1	**GREEN/WHITE**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
1	NAU	1565	3.23%
RAILING SHIELDS		N=1	**YELLOW/BROWN**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
1	NAU	1592	3.23%

FORECASTLE FLAGS

FLAGS		N=17	ALL
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
6	CARAVEL	1515-1598	35.29%
2	GALLEON	1572-1593	11.76%
9	NAU	1500-1572	52.94%
FLAGS		N=8	**ORDER OF CHRIST CROSS**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
3	CARAVEL	1515-1526	17.65%
5	NAU	1520-1566	29.41%
FLAGS		N=2	**RED - ON BOW**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
2	CARAVEL	1519-1598	11.76%
FLAGS		N=1	**RED**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
1	NAU	1500-1524	5.88%
FLAGS		N=1	**RED W/ WHITE CROSS**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
1	CARAVEL	1519	5.88%
FLAGS		N=5	**UNDETERMINED**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
2	GALLEON	1572-1593	11.76%
3	NAU	1519-1572	17.65%

APPENDIX 26

SAIL DECORATIONS IN THE REPRESENTATIONAL TRENDS DATABASE

BONAVENTURE SAIL		N=5	**ORDER OF CHRIST CROSS**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
5	CARAVEL	1558-1561	100.00%
MIZZEN SAIL		N=106	**ORDER OF CHRIST CROSS**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
24	CARAVEL	1500-1566	22.64%
2	GALLEON	1519-1561	1.89%
80	NAU	1519-1579	75.47%
MAIN SAIL		N=253	**ALL**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
43	CARAVEL	1500-1566	17.00%
5	GALLEON	1519-1589	1.98%
205	NAU	1513-1579	81.03%
MAIN SAIL		N=246	**ORDER OF CHRIST CROSS**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
41	CARAVEL	1500-1566	16.21%
4	GALLEON	1519-1589	1.58%
201	NAU	1513-1579	79.45%
MAIN SAIL		N=4	**SMALL RED CROSSES**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
2	CARAVEL	1513	0.79%
2	NAU	1513	0.79%
MAIN SAIL		N=1	**MADONNA AND CHILD**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
1	GALLEON	1593	0.40%
MAIN SAIL		N=2	**PORTUGUESE CREST**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
2	NAU	1568	0.79%
MAIN TOPSAIL		N=146	**ALL**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
2	CARAVEL	1500-1566	1.37%
2	GALLEON	1558-1593	1.37%

142	NAU	1519-1579	97.26%
MAIN TOPSAIL		N=145	**ORDER OF CHRIST CROSS**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
2	CARAVEL	1500-1566	1.37%
1	GALLEON	1558-1561	0.68%
142	NAU	1519-1579	97.26%
MAIN TOPSAIL		N=1	**RED CREST**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
1	GALLEON	1593	0.68%
FORE SAIL		N=148	**ORDER OF CHRIST CROSS**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
23	CARAVEL	1500-1566	15.33%
2	GALLEON	1519-1561	1.33%
123	NAU	1519-1579	82.00%
FORE SAIL		N=1	**RED X W/ MADONNA AND CHILD**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
1	GALLEON	1593	0.67%
FORE SAIL		N=1	**SMALL RED CROSSES**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
1	NAU	1513	0.67%
FORE TOPSAIL		N=50	**ORDER OF CHRIST CROSS**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
6	CARAVEL	1500-1566	12.00%
1	GALLEON	1558-1561	2.00%
43	NAU	1558-1579	86.00%
SPRITSAIL		N=79	**ORDER OF CHRIST CROSS**
# OF VESSELS	**SHIP TYPE**	**DATE**	**% OF SAMPLE**
2	CARAVEL	1500-1566	2.53%
1	GALLEON	1558-1561	1.27%
76	NAU	1558-1579	96.20%

APPENDIX 27

MAST RAKES FREQUENCY TABLES FOR THE CARAVEL, GALLEON, AND NAU SAMPLES

All Caravel Rakes

		Boom.	Bow.	Bon.	Miz.	Main	Fore
N	VALID	65	51	60	98	101	51
	MISSING	36	50	41	3	0	50
Mean		15.9754	23.8863	.0550	.7592	2.6960	.7706
Std. Error of Mean		1.25991	2.06682	.61209	.65031	.65651	.85564
Median		15.0000	26.0000	.0000	.0000	1.5000	.0000
Mode		15.00	10.00(**a**)	.00	.00	.00	.00
Std. Deviation		10.15773	14.76008	4.74125	6.43774	6.59786	6.11053
Skewness		.258	.138	1.052	.358	-.104	-.166
Std. Error of Skewness		.297	.333	.309	.244	.240	.333
Kurtosis		-.542	-1.307	2.700	2.379	1.591	2.329
Std. Error of Kurtosis		.586	.656	.608	.483	.476	.656
Range		40.00	55.00	26.00	43.80	40.40	33.40
Minimum		.00	.00	-10.00	-20.00	-20.40	-18.40
Maximum		40.00	55.00	16.00	23.80	20.00	15.00
Percentiles	25	9.0000	10.0000	-2.4750	-2.5500	-.9500	-2.6000
	50	15.0000	26.0000	.0000	.0000	1.5000	.0000
	75	24.0000	37.0000	1.9750	4.0000	5.9000	3.7000

Two-Masted Caravel Rakes

		Boom.	Miz.	Main
N	VALID	14	37	38
	MISSING	24	1	0
Mean		14.4786	2.3541	5.5789
Std. Error of Mean		3.33903	1.02816	.95539
Median		10.0500	1.2000	4.6000
Mode		1.00(a)	.00	.00
Std. Deviation		12.49352	6.25405	5.88944
Variance		156.088	39.113	34.685
Skewness		.811	1.467	.459
Std. Error of Skewness		.597	.388	.383
Kurtosis		-.530	3.020	.047
Std. Error of Kurtosis		1.154	.759	.750
Range		36.00	29.80	25.30
Minimum		1.00	-6.00	-5.30
Maximum		37.00	23.80	20.00
Percentiles	25	3.5000	-1.8500	1.8000
	50	10.0500	1.2000	4.6000
	75	26.1500	5.1000	9.0250

(**a**) Multiple modes exist. The smallest value is shown

Three-Masted Caravel Rakes

		Boom.	Bow.	Bon.	Miz.	Main
N	VALID	4	2	11	12	12
	MISSING	8	10	1	0	0
Mean		22.1500	24.6500	1.7909	-2.6333	1.9083
Std. Error of Mean		3.12903	18.35000	2.15476	2.49440	2.45701
Median		24.5500	24.6500	1.9000	-1.1500	1.6500
Mode		12.90(a)	6.30(a)	-7.70(a)	.00	.00
Std. Deviation		6.25806	25.95082	7.14653	8.64085	8.51132
Variance		39.163	673.445	51.073	74.664	72.443
Skewness		-1.826		.615	-.563	-.746
Std. Error of Skewness		1.014		.661	.637	.637
Kurtosis		3.453		.074	.732	1.516
Std. Error of Kurtosis		2.619		1.279	1.232	1.232
Range		13.70	36.70	23.70	32.00	31.90
Minimum		12.90	6.30	-7.70	-20.00	-17.50
Maximum		26.60	43.00	16.00	12.00	14.40
Percentiles	25	15.6750	6.3000	-3.9000	-6.3250	-1.7250
	50	24.5500	24.6500	1.9000	-1.1500	1.6500
	75	26.2250	43.0000	6.7000	1.5500	8.9750

(**a**) Multiple modes exist. The smallest value is shown

Four-Masted Caravel Rakes

		Boom.	Bow.	Bon.	Miz.	Main	Fore
N	VALID	47	49	49	49	49	49
	MISSING	2	0	0	0	0	0
Mean		15.8957	23.8551	-.3347	.3857	.5327	1.1531
Std. Error of Mean		1.40580	2.08435	.57402	.81224	.84224	.79648
Median		15.0000	26.0000	.0000	-1.0000	.0000	.0000
Mode		15.00	10.00(a)	.00	-1.00(a)	.00	.00
Std. Deviation		9.63765	14.59048	4.01811	5.68565	5.89570	5.57536
Variance		92.884	212.882	16.145	32.327	34.759	31.085
Skewness		.176	.145	.920	.458	-.123	.441
Std. Error of Skewness		.347	.340	.340	.340	.340	.340
Kurtosis		-.299	-1.252	3.951	1.255	3.534	1.674
Std. Error of Kurtosis		.681	.668	.668	.668	.668	.668
Range		40.00	55.00	25.00	30.30	35.40	30.30
Minimum		.00	.00	-10.00	-13.30	-20.40	-15.30
Maximum		40.00	55.00	15.00	17.00	15.00	15.00
Percentiles	25	9.0000	10.5000	-2.2500	-2.7000	-2.0000	-2.3000
	50	15.0000	26.0000	.0000	-1.0000	.0000	.0000
	75	22.8000	37.0000	.5000	3.1000	3.1500	3.8500

(**a**) Multiple modes exist. The smallest value is shown

All Galleon Rakes

		Boom.	Bow.	Bon.	Miz.	Main	Fore
N	VALID	23	23	23	23	23	23
	MISSING	0	0	0	0	0	0
Mean		11.5652	33.6870	.0391	-.2304	-1.0398	-.2957
Std. Error of Mean		3.08395	3.80370	.35563	.71097	.71501	.74676
Median		12.9000	37.1000	.0000	.0000	-1.5000	.0000
Mode		.00	.00	.00	-2.70	-4.40(a)	.00
Std. Deviation		14.79013	18.2418 9	1.70554	3.40967	3.42906	3.58133
Variance		218.748	332.767	2.909	11.626	11.758	12.826
Skewness		.515	-.756	1.481	.149	1.157	-.291
Std. Error of Skewness		.481	.481	.481	.481	.481	.481
Kurtosis		-.793	.246	7.661	-.047	1.889	-.363
Std. Error of Kurtosis		.935	.935	.935	.935	.935	.935
Range		49.30	68.00	10.00	14.50	14.40	14.30
Minimum		-9.10	.00	-4.00	-7.50	-5.40	-8.00
Maximum		40.20	68.00	6.00	7.00	9.00	6.30
Sum		266.00	774.80	.90	-5.30	-23.91	-6.80
Percentiles	25	.0000	30.3000	.0000	-2.7000	-4.0000	-3.1000
	50	12.9000	37.1000	.0000	.0000	-1.5000	.0000
	75	21.8000	46.9000	.0000	2.0000	1.0000	2.6000

(**a**) Multiple modes exist. The smallest value is shown

Three-Masted Galleon Rakes

		Boom.	Bow.	Miz.	Main	Fore
N	VALID	12	12	12	12	12
	MISSING	0	0	0	0	0
Mean		11.2917	30.6583	-.0167	.0000	.7833
Std. Error of Mean		4.29980	5.62398	.90100	1.10241	.91700
Median		6.4500	38.0500	.4000	-.6500	.7000
Mode		.00	.00	-2.70	-5.40(a)	-4.00(a)
Std. Deviation		14.89493	19.48204	3.12114	3.81885	3.17657
Variance		221.859	379.550	9.742	14.584	10.091
Skewness		.500	-.942	.801	.996	.153
Std. Error of Skewness		.637	.637	.637	.637	.637
Kurtosis		-.720	-.687	.944	1.867	-.894
Std. Error of Kurtosis		1.232	1.232	1.232	1.232	1.232
Range		49.30	52.60	11.30	14.40	10.30
Minimum		-9.10	.00	-4.30	-5.40	-4.00
Maximum		40.20	52.60	7.00	9.00	6.30
Sum		135.50	367.90	-.20	.00	9.40
Percentiles	25	.0000	7.6750	-2.7000	-2.2000	-1.9500
	50	6.4500	38.0500	.4000	-.6500	.7000
	75	22.7750	45.5000	1.8000	2.1250	3.6500

(**a**) Multiple modes exist. The smallest value is shown

Four-Masted Galleon Rakes

		Boom.	Bow.	Bon.	Miz.	Main	Fore
N	VALID	11	11	11	11	11	11
	MISSING	0	0	0	0	0	0
Mean		11.8636	32.5000	.0818	-.4636	-2.1740	-1.4727
Std. Error of Mean		4.64183	7.59696	.76251	1.15784	.80419	1.13603
Median		15.0000	37.0000	.0000	-1.0000	-3.0000	-1.0000
Mode		-7.90(a)	-24.70(a)	.00	-7.50(a)	-5.00(a)	-8.00(a)
Std. Deviation		15.39521	25.19627	2.52896	3.84012	2.66721	3.76778
Variance		237.013	634.852	6.396	14.747	7.114	14.196
Skewness		.610	-1.267	1.054	-.152	1.114	-.386
Std. Error of Skewness		.661	.661	.661	.661	.661	.661
Kurtosis		-.605	2.008	2.781	-.470	1.105	-.975
Std. Error of Kurtosis		1.279	1.279	1.279	1.279	1.279	1.279
Range		46.40	92.70	10.00	12.70	8.80	11.40
Minimum		-7.90	-24.70	-4.00	-7.50	-5.00	-8.00
Maximum		38.50	68.00	6.00	5.20	3.80	3.40
Sum		130.50	357.50	.90	-5.10	-23.91	-16.20
Percentiles	25	-1.0000	30.3000	-1.1000	-2.8000	-4.4000	-5.1000
	50	15.0000	37.0000	.0000	-1.0000	-3.0000	-1.0000
	75	18.0000	48.0000	.9000	3.6000	-.4000	2.4000

(**a**) Multiple modes exist. The smallest value is shown

Three-Masted Nau Rakes

		Boom.	Bow.	Miz.	Main	Fore
N	VALID	131	150	152	152	152
	MISSING	21	2	0	0	0
Mean		17.8939	33.5387	-1.9921	-1.9566	-1.0974
Std. Error of Mean		1.10411	1.30791	.33922	.33514	.36753
Median		15.0000	35.1500	-1.8000	-2.0000	-.9000
Mode		.00(a)	15.00	.00	.00	.00
Std. Deviation		12.63715	16.01856	4.18223	4.13192	4.53126
Variance		159.698	256.594	17.491	17.073	20.532
Skewness		.694	-.173	-.196	-.291	.122
Std. Error of Skewness		.212	.198	.197	.197	.197
Kurtosis		.097	-1.057	1.886	1.875	1.679
Std. Error of Kurtosis		.420	.394	.391	.391	.391
Range		56.00	65.00	28.80	26.50	32.20
Minimum		.00	.00	-16.00	-16.50	-15.20
Maximum		56.00	65.00	12.80	10.00	17.00
Sum		2344.10	5030.80	-302.80	-297.40	-166.80
Percentiles	25	9.0000	18.0000	-4.0000	-4.2750	-4.0000
	50	15.0000	35.1500	-1.8000	-2.0000	-.9000
	75	25.0000	47.0000	.0000	.0000	1.0750

(**a**) Multiple modes exist. The smallest value is shown

APPENDIX 28

ONE STANDARD DEVIATION, CENTER OF DISTRIBUTION, AND MODAL RANGE FIGURES OF MAST RAKES BY SHIP TYPE

CARAVEL MAST RAKES			
BOOMKIN	**One Standard Deviation (68%)**	**Center of Distribution (50%)**	**Modal Range**
All	5.82° to 26.10°	9° to 24°	13° to 16°
Two Masted	1.98° to 26.96°	3.5° to 26.15°	0° to 10°
Three Masted	15.9° to 28.4°	15.67° to 26.22°	25° to 27.5°
Four Masted	6.23° to 25.5°	9° to 22.8°	13° to 16°
BOWSPRIT	**One Standard Deviation (68%)**	**Center of Distribution (50%)**	**Modal Range**
All	9.12° to 38.64°	10° to 37°	10° to 15°
Four Masted	14.26° to 38.44°	10.5 to 37	10° to 15°
BONAVENTURE	**One Standard Deviation (68%)**	**Center of Distribution (50%)**	**Modal Range**
All	-4.68° to 4.79°	-2.4° to 1.9°	0° to 2.5°
Three Masted	-5.35° to 8.93°	-3.9° to 6.7°	0° to 5°
Four Masted	-4.35° to 3.68°	-2.25 to .5	0° to 2.5°
MIZZEN	**One Standard Deviation (68%)**	**Center of Distribution (50%)**	**Modal Range**
All	-5.67° to 7.19°	-2.5° to 4°	0° to 2.5°
Two Masted	-3.72° to 3.37°	-1.8° to 5.1°	0° to 5°
Three Masted	-11.27° to 6°	-6.32° to 1.55°	0° to 5°
Four Masted	-5.29° to 6.06°	-2.7 to 3.1	-2.5° to 0°
MAIN	**One Standard Deviation (68%)**	**Center of Distribution (50%)**	**Modal Range**
All	-3.90° to 9.28°	-.95° to 5.9°	0° to 2.5°
Two Masted	-0.31° to 11.45°	1.8° to 9°	2.5° to 5°
Three Masted	-6.6° to 10.41°	-1.72° to 8.97°	0° to 5°
Four Masted	-5.35° to 6.42°	-2 to 3.15	0° to 5°
FORE	**One Standard Deviation (68%)**	**Center of Distribution (50%)**	**Modal Range**
All	-5.33° to 6.88°	-2.6° to 3.7°	0° to 2.5°
Four Masted	-4.41° to 6.72°	-2.3 to 3.85	0° to 2.5°
GALLEON MAST RAKES			
BOOMKIN	**One Standard Deviation (68%)**	**Center of Distribution (50%)**	**Modal Range**
All	-3.2° to 26.4°	0° to 21.8°	0° to 10°
Three Masted	-3.6° to 26.2°	0° to 22.7°	0° to 10°

Four Masted	-3.5° to 27.3°	-1° to 18°	10° to 20°
BOWSPRIT	**One Standard Deviation (68%)**	**Center of Distribution (50%)**	**Modal Range**
All	15.4° to 51.9°	30.3° to 46.9°	30° to 50°
Three Masted	11.2° to 50.1°	7.6° to 45.5°	30° to 50°
Four Masted	7.3° to 57.7°	30.3° to 48°	25° to 45°
BONAVENTURE	**One Standard Deviation (68%)**	**Center of Distribution (50%)**	**Modal Range**
Four Masted	-2.4° to 2.6°	-1.1° to .9°	-2° to 2°
MIZZEN	**One Standard Deviation (68%)**	**Center of Distribution (50%)**	**Modal Range**
All	-3.6° to 3.2 °	-2.7° to 2°	0° to 2.5°
Three Masted	-3.1° to 3.1°	-2.7° to 1.8°	0° to 2.5°
Four Masted	-4.3° to 3.4°	-2.8° to 3.6°	-4° to -2°
MAIN	**One Standard Deviation (68%)**	**Center of Distribution (50%)**	**Modal Range**
All	-4.5° to 2.4°	-4° to 1°	0° to 2.5°
Three Masted	-3.8° to 3.8°	-2.2° to 2.1°	-3° to 3°
Four Masted	-4.8° to 0.5°	-4.4° to -.4°	-6° to 0°
FORE	**One Standard Deviation (68%)**	**Center of Distribution (50%)**	**Modal Range**
All	-3.9° to 3.3°	-3.1° to 2.6°	0° to 2.5°
Three Masted	-2.4° to 4°	-1.9° to 3.6°	0° to 2°
Four Masted	-5.2° to 2.3°	-5.1° to 2.4°	2° to 4°
NAU MAST RAKES			
BOOMKIN	**One Standard Deviation (68%)**	**Center of Distribution (50%)**	**Modal Range**
Three Masted	5.3° to 30.5°	9° to 25°	10° to 15°
BOWSPRIT	**One Standard Deviation (68%)**	**Center of Distribution (50%)**	**Modal Range**
Three Masted	17.5° to 49.5°	18° to 47°	45° to 50°
MIZZEN	**One Standard Deviation (68%)**	**Center of Distribution (50%)**	**Modal Range**
Three Masted	-6.1° to 2.2°	-4° to 0°	0° to 1.5°
MAIN	**One Standard Deviation (68%)**	**Center of Distribution (50%)**	**Modal Range**
Three Masted	-6° to 2.2°	-4.3° to 0°	-3° to -1.5°
FORE	**One Standard Deviation (68%)**	**Center of Distribution (50%)**	**Modal Range**
Three Masted	-5.6° to 3.4°	-4° to 1°	0° to 1.5°

APPENDIX 29

MAST PLACEMENT FREQUENCY TABLES FOR THE CARAVEL, GALLEON, AND NAU SAMPLES

All Caravel Mast Placement

	LS.Bn_L.H	LS.Mz_L.H	LS.Ma_L.H	LS.Fr_L.H
N VALID	60	102	104	54
MISSING	44	2	0	50
Mean	.0550	.2022	.4864	.8120
Std. Error of Mean	.00579	.00862	.00674	.00787
Median	.0446	.2043	.4818	.8100
Mode	.01	.04(a)	.49	.72(a)
Std. Deviation	.04484	.08710	.06878	.05784
Variance	.002	.008	.005	.003
Skewness	1.670	.215	.573	.264
Std. Error of Skewness	.309	.239	.237	.325
Kurtosis	4.802	-.038	.501	-.991
Std. Error of Kurtosis	.608	.474	.469	.639
Range	.24	.41	.34	.22
Minimum	.01	.04	.34	.72
Maximum	.25	.45	.68	.93
Sum	3.30	20.63	50.59	43.85
Percentiles 25	.0185	.1361	.4377	.7622
50	.0446	.2043	.4818	.8100
75	.0766	.2547	.5244	.8639

(**a**) Multiple modes exist. The smallest value is shown

Two-Masted Caravel Mast Placement

		LS.Mz_L.H	LS.Ma_L.H
N	VALID	34	35
	MISSING	1	0
Mean		.1388	.5172
Std. Error of Mean		.01410	.00915
Median		.1136	.5132
Mode		.04(a)	.43(a)
Std. Deviation		.08221	.05413
Variance		.007	.003
Skewness		1.346	1.063
Std. Error of Skewness		.403	.398
Kurtosis		1.530	1.574
Std. Error of Kurtosis		.788	.778
Range		.33	.25
Minimum		.04	.43
Maximum		.37	.68
Sum		4.72	18.10
Percentiles	25	.0801	.4813
	50	.1136	.5132
	75	.1761	.5407

(**a**) Multiple modes exist. The smallest value is shown

Three-Masted Caravel Mast Placement

		LS.Bn_L.H	LS.Mz_L.H	LS.Ma_L.H
N	VALID	12	14	14
	MISSING	2	0	0
Mean		.0682	.2550	.4968
Std. Error of Mean		.01764	.02151	.02053
Median		.0558	.2448	.4852
Mode		.02(a)	.13(a)	.39(a)
Std. Deviation		.06110	.08049	.07683
Variance		.004	.006	.006
Skewness		2.742	.768	.794
Std. Error of Skewness		.637	.597	.597
Kurtosis		8.463	1.733	.385
Std. Error of Kurtosis		1.232	1.154	1.154
Range		.23	.33	.27
Minimum		.02	.13	.39
Maximum		.25	.45	.66
Sum		.82	3.57	6.96
Percentiles	25	.0303	.2140	.4451
	50	.0558	.2448	.4852
	75	.0713	.3064	.5370

(**a**) Multiple modes exist. The smallest value is shown

Four-Masted Caravel Mast Placement

		LS.Bn_L.H	LS.Mz_L.H	LS.Ma_L.H	LS.Fr_L.H
N	VALID	47	47	47	47
	MISSING	0	0	0	0
Mean		.0507	.2361	.4628	.8105
Std. Error of Mean		.00580	.00828	.00857	.00839
Median		.0342	.2311	.4652	.8006
Mode		.01	.15(a)	.34(a)	.72(a)
Std. Deviation		.03977	.05679	.05878	.05752
Variance		.002	.003	.003	.003
Skewness		.744	1.102	.914	.395
Std. Error of Skewness		.347	.347	.347	.347
Kurtosis		-.352	2.413	1.663	-.835
Std. Error of Kurtosis		.681	.681	.681	.681
Range		.15	.29	.31	.22
Minimum		.01	.15	.34	.72
Maximum		.16	.44	.65	.93
Sum		2.38	11.10	21.75	38.10
Percentiles	25	.0119	.1953	.4172	.7629
	50	.0342	.2311	.4652	.8006
	75	.0767	.2667	.4941	.8559

(**a**) Multiple modes exist. The smallest value is shown

All Galleon Mast Placement

		LS.Bn_L.H	LS.Mz_L.H	LS.Ma_L.H	LS.Fr_L.H
N	VALID	22	22	22	22
	MISSING	0	0	0	0
Mean		.0211	.1442	.4265	.8123
Std. Error of Mean		.00579	.01649	.01115	.01683
Median		.0100	.1444	.4224	.8260
Mode		.00	.00(a)	.32(a)	.65(a)
Std. Deviation		.02718	.07732	.05232	.07895
Variance		.001	.006	.003	.006
Skewness		1.317	-.107	.224	-.454
Std. Error of Skewness		.491	.491	.491	.491
Kurtosis		1.055	-1.087	1.024	-1.038
Std. Error of Kurtosis		.953	.953	.953	.953
Range		.10	.26	.24	.26
Minimum		.00	.00	.32	.65
Maximum		.10	.26	.55	.91
Sum		.46	3.17	9.38	17.87
Percentiles	25	.0000	.0896	.4005	.7476
	50	.0100	.1444	.4224	.8260
	75	.0443	.2171	.4515	.8838

(**a**) Multiple modes exist. The smallest value is shown

Three-Masted Galleon Mast Placement

		LS.Mz_L.H	LS.Ma_L.H	LS.Fr_L.H
N	VALID	9	9	9
	MISSING	0	0	0
Mean		.0946	.4510	.8332
Std. Error of Mean		.02008	.01736	.02535
Median		.0932	.4478	.8590
Mode		.03(a)	.38(a)	.69(a)
Std. Deviation		.06025	.05209	.07606
Variance		.004	.003	.006
Skewness		1.651	.911	-1.086
Std. Error of Skewness		.717	.717	.717
Kurtosis		4.062	.868	-.027
Std. Error of Kurtosis		1.400	1.400	1.400
Range		.21	.17	.21
Minimum		.03	.38	.69
Maximum		.24	.55	.90
Sum		.85	4.06	7.50
Percentiles	25	.0531	.4098	.7718
	50	.0932	.4478	.8590
	75	.1080	.4820	.8978

(**a**) Multiple modes exist. The smallest value is shown

Four-Masted Galleon Mast Placement

		LS.Bn_L.H	LS.Mz_L.H	LS.Ma_L.H	LS.Fr_L.H
N	VALID	13	13	13	13
	MISSING	0	0	0	0
Mean		.0356	.1785	.4095	.7979
Std. Error of Mean		.00749	.01946	.01306	.02236
Median		.0344	.2028	.4200	.7724
Mode		.01	.00(a)	.32(a)	.65(a)
Std. Deviation		.02702	.07017	.04707	.08062
Variance		.001	.005	.002	.006
Skewness		.827	-1.251	-.472	-.161
Std. Error of Skewness		.616	.616	.616	.616
Kurtosis		.176	2.074	.039	-.965
Std. Error of Kurtosis		1.191	1.191	1.191	1.191
Range		.09	.26	.17	.26
Minimum		.01	.00	.32	.65
Maximum		.10	.26	.49	.91
Sum		.46	2.32	5.32	10.37
Percentiles	25	.0100	.1444	.3727	.7416
	50	.0344	.2028	.4200	.7724
	75	.0553	.2275	.4399	.8774

(**a**) Multiple modes exist. The smallest value is shown

Three-Masted Nau Mast Placement

		LS.Mz_L.H	LS.Ma_L.H	LS.Fr_L.H
N	VALID	166	166	166
	MISSING	0	0	0
Mean		.0971	.4403	.7929
Std. Error of Mean		.00358	.00388	.00402
Median		.0954	.4374	.7909
Mode		.00(a)	.25(a)	.60(a)
Std. Deviation		.04615	.05003	.05178
Variance		.002	.003	.003
Skewness		1.146	.096	-.104
Std. Error of Skewness		.188	.188	.188
Kurtosis		3.149	1.238	.939
Std. Error of Kurtosis		.375	.375	.375
Range		.31	.34	.34
Minimum		.00	.25	.60
Maximum		.31	.59	.94
Sum		16.12	73.09	131.62
Percentiles	25	.0678	.4098	.7605
	50	.0954	.4374	.7909
	75	.1148	.4696	.8252

(**a**) Multiple modes exist. The smallest value is shown

APPENDIX 30

ONE STANDARD DEVIATION, CENTER OF DISTRIBUTION, AND MODAL RANGE FIGURES OF MAST PLACEMENT BY SHIP TYPE

CARAVEL MAST PLACEMENT			
BONAVENTURE	**One Standard Deviation (68%)**	**Center of Distribution (50%)**	**Modal Range**
All	.01 to .09	.02 to .08	.00 to .025
Three-Masted	.01 to .13	.03 to .07	.00 to .05
Four-Masted	.01 to .09	.01 to .08	.00 to .02
MIZZEN	**One Standard Deviation (68%)**	**Center of Distribution (50%)**	**Modal Range**
All	.12 to .29	.14 to .25	.175 to .20
Two-Masted	.06 to .22	.08 to .18	.07 to .10
Three-Masted	.17 to .34	.21 to .31	.20 to .25
Four-Masted	.18 to .29	.20 to .27	.175 to .20
MAIN	**One Standard Deviation (68%)**	**Center of Distribution (50%)**	**Modal Range**
All	.42 to .56	.44 to .52	.42 to .50
Two-Masted	.46 to .57	.48 to .54	.475 to .50
Three-Masted	.42 to .57	.44 to .54	.45 to .50
Four-Masted	.40 to .52	.42 to .49	.40 to .425
FORE	**One Standard Deviation (68%)**	**Center of Distribution (50%)**	**Modal Range**
All	.75 to .87	.76 to .86	.765 to .78
Four-Masted	.75 to .87	.76 to .86	.765 to .78
GALLEON MAST PLACEMENT			
BONAVENTURE	**One Standard Deviation (68%)**	**Center of Distribution (50%)**	**Modal Range**
All	.01 to .06	.01 to .06	.00 to .02
Four-Masted	.01 to .06	.01 to .06	.00 to .02
MIZZEN	**One Standard Deviation (68%)**	**Center of Distribution (50%)**	**Modal Range**
All	.07 to .22	.09 to .22	.20 to .25
Three-Masted	.03 to .15	.05 to .11	.05 to .10
Four-Masted	.11 to .25	.14 to .23	.20 to .25
MAIN	**One Standard Deviation (68%)**	**Center of Distribution (50%)**	**Modal Range**
All	.37 to .48	.40 to .45	.40 to .45
Three-Masted	.40 to .50	.41 to .48	.44 to .46
Four-Masted	.36 to .46	.37 to .44	.40 to .425

FORE	One Standard Deviation (68%)	Center of Distribution (50%)	Modal Range
All	.73 to .89	.75 to .88	.85 to .90
Three-Masted	.78 to .91	.77 to .90	.81 to .87
Four-Masted	.72 to .88	.74 to .88	.85 to .90
NAU MAST PLACEMENT			
MIZZEN	**One Standard Deviation (68%)**	**Center of Distribution (50%)**	**Modal Range**
Three-Masted	.05 to .14	.07 to .11	.10 to .13
MAIN	**One Standard Deviation (68%)**	**Center of Distribution (50%)**	**Modal Range**
Three-Masted	.39 to .49	.41 to .47	.40 to .43
FORE	**One Standard Deviation (68%)**	**Center of Distribution (50%)**	**Modal Range**
Three-Masted	.74 to .84	.76 to .83	.77 to .80

APPENDIX 31

BONAVENTURE MAST AND YARD FREQUENCY TABLES FOR THE CARAVELS AND GALLEONS

Three-Masted Caravels Mast and Yard Data

	W.BtLBn_H.Bn	W.TpLBn_W.BtLBn	W.TpLBn_H.Bn	H.Bn_L.H	H.Bn_H.Mz	L.BnY_L.H	L.BnY_H.Bn	W.EBnY_W.MBnY
N VALID	12	12	12	12	12	12	12	12
MISSING	0	0	0	0	0	0	0	0
Mean	.0921	.8536	.0758	.3078	.8054	.6195	.4987	.9090
Std. Error of Mean	.01282	.04791	.00923	.02211	.06445	.05432	.02981	.05593
Median	.0791	.9125	.0642	.3124	.7709	.5588	.4928	.9526
Mode	.06(a)	1.00	.04(a)	.19(a)	.47(a)	.37(a)	.37(a)	1.00
Std. Deviation	.04441	.16597	.03196	.07658	.22327	.18817	.10326	.19375
Variance	.002	.028	.001	.006	.050	.035	.011	.038
Skewness	2.249	-.455	2.358	.062	.814	.732	1.235	-.207
Std. Error of Skewness	.637	.637	.637	.637	.637	.637	.637	.637
Kurtosis	5.944	-1.097	6.530	-1.166	1.025	-.750	2.284	1.879
Std. Error of Kurtosis	1.232	1.232	1.232	1.232	1.232	1.232	1.232	1.232
Range	.16	.50	.12	.24	.82	.58	.38	.80
Minimum	.06	.59	.04	.19	.47	.37	.37	.50
Maximum	.22	1.09	.17	.43	1.29	.95	.75	1.30
Sum	1.11	10.24	.91	3.69	9.66	7.43	5.98	10.91
Percentiles 25	.0621	.6798	.0606	.2361	.6906	.4867	.4239	.7815
50	.0791	.9125	.0642	.3124	.7709	.5588	.4928	.9526
75	.1055	.9881	.0794	.3663	.9487	.8194	.5467	1.0000

Four-Masted Caravels Mast and Yard Data

	W.BtLBn_H.Bn	W.TpLBn_W.BtLBn	W.TpLBn_H.Bn	H.Bn_L.H	H.Bn_H.Mz	H.Bn_L.Bw	L.BnY_L.H	L.BnY_H.Bn	W.EBnY_W.MBnY
N VALID	41	41	41	41	41	41	41	41	41
MISSING	0	0	0	0	0	0	0	0	0
Mean	.0888	.6794	.0586	.2484	.7448	.7393	.4777	.5202	.8087
Std. Error of Mean	.00615	.03843	.00499	.01081	.02375	.04240	.01776	.01961	.02975
Median	.0773	.6053	.0546	.2300	.7340	.6608	.4669	.4774	.8810
Mode	.04(a)	.50(a)	.06	.21	.45(a)	.45(a)	.28(a)	.29(a)	1.00
Std. Deviation	.03938	.24608	.03195	.06923	.15209	.27149	.11375	.12558	.19049
Variance	.002	.061	.001	.005	.023	.074	.013	.016	.036
Skewness	2.423	1.920	3.134	1.137	.681	1.654	.759	1.160	-.969
Std. Error of Skewness	.369	.369	.369	.369	.369	.369	.369	.369	.369
Kurtosis	8.092	5.783	13.703	.125	1.020	2.098	.788	1.330	-.070
Std. Error of Kurtosis	.724	.724	.724	.724	.724	.724	.724	.724	.724
Range	.22	1.36	.19	.24	.72	1.06	.51	.61	.67
Minimum	.04	.32	.03	.17	.45	.45	.28	.29	.33
Maximum	.26	1.68	.21	.41	1.17	1.50	.79	.90	1.00
Sum	3.64	27.86	2.40	10.19	30.54	30.31	19.59	21.33	33.16
Percentiles 25	.0668	.5196	.0384	.1988	.6555	.5554	.3945	.4455	.6518
50	.0773	.6053	.0546	.2300	.7340	.6608	.4669	.4774	.8810
75	.1029	.8054	.0668	.2688	.8289	.7800	.5327	.5884	.9567

Four-Masted Galleons Mast and Yard Data

		W.BtLBn_H.Bn	W.TpLBn_W.BtLBn	W.TpLBn_H.Bn	H.Bn_L.H	H.Bn_H.Mz	H.Bn_H.Bw	L.BnY_L.H	L.BnY_H.Bn	W.EBnY_W.MBnY
N	VALID	12	12	12	12	12	12	12	12	12
	MISSING	0	0	0	0	0	0	0	0	0
Mean		.0886	.6616	.0592	.3033	.7117	.7737	.5204	.5954	.7708
Std. Error of Mean		.00899	.05374	.00835	.02613	.03900	.06093	.03231	.05368	.07409
Median		.0906	.6574	.0546	.3013	.7457	.8122	.4901	.5823	.8082
Mode		.03(a)	.50	.02(a)	.16(a)	.43(a)	.41(a)	.35(a)	.38(a)	1.00
Std. Deviation		.03116	.18618	.02893	.09053	.13512	.21105	.11192	.18594	.25665
Variance		.001	.035	.001	.008	.018	.045	.013	.035	.066
Skewness		-.031	.329	1.073	.926	-1.102	-.224	.748	1.040	-2.239
Std. Error of Skewness		.637	.637	.637	.637	.637	.637	.637	.637	.637
Kurtosis		.785	-1.093	2.071	2.557	.856	-.022	.462	.787	5.920
Std. Error of Kurtosis		1.232	1.232	1.232	1.232	1.232	1.232	1.232	1.232	1.232
Range		.12	.57	.11	.36	.47	.74	.38	.62	.95
Minimum		.03	.43	.02	.16	.43	.41	.35	.38	.05
Maximum		.15	1.00	.13	.52	.90	1.15	.73	1.00	1.00
Sum		1.06	7.94	.71	3.64	8.54	9.28	6.24	7.15	9.25
Percentiles	25	.0733	.5000	.0403	.2566	.6520	.6325	.4653	.4583	.7544
	50	.0906	.6574	.0546	.3013	.7457	.8122	.4901	.5823	.8082
	75	.1026	.8186	.0781	.3434	.7991	.8835	.5682	.6679	.9169

APPENDIX 32

MIZZEN MAST AND YARD FREQUENCY TABLES FOR THE CARAVELS, GALLEONS, AND NAUS

Two-Masted Caravels Mast Data

		W.BtLMz_H.Mz	W.BtLMz_W.TpLMz	W.TpLMz_H.Mz	H.LMz_L.H	H.LMz_H.LMa
N	Valid	34	34	34	34	34
	Missing	0	0	0	0	0
Mean		.0926	.6825	.0618	.4110	.5552
Std. Error of Mean		.00604	.03607	.00413	.01882	.01914
Median		.0838	.6708	.0584	.4093	.5580
Mode		.05(a)	.50(a)	.02(a)	.33	.31(a)
Std. Deviation		.03521	.21032	.02408	.10977	.11159
Variance		.001	.044	.001	.012	.012
Skewness		1.519	2.023	.637	.638	.071
Std. Error of Skewness		.403	.403	.403	.403	.403
Kurtosis		2.676	7.553	.081	-.420	-.103
Std. Error of Kurtosis		.788	.788	.788	.788	.788
Range		.15	1.21	.10	.39	.50
Minimum		.05	.33	.02	.26	.31
Maximum		.20	1.54	.12	.66	.81
Sum		3.15	23.20	2.10	13.97	18.88
Percentiles	25	.0671	.5530	.0426	.3224	.4815
	50	.0838	.6708	.0584	.4093	.5580
	75	.1092	.7747	.0757	.4785	.6427

Two-Masted Caravels Yard Data

Statistics

		L.MzY_ L.H	H.Mz_ L.MzY	L.FrY_ L.MzY	W.MMzY_ L.MzY	W.EMzY _L.MzY	W.EMzY_ W.MMzY
N	Valid	33	33	33	33	33	33
	Missing	0	0	0	0	0	0
Mean		.8832	.4720	.0000	.0351	.0285	.7929
Std. Error of Mean		.03014	.02298	.00000	.00339	.00286	.04057
Median		.8830	.4419	.0000	.0270	.0241	.8824
Mode		.54[a]	.29[a]	.00	.00[a]	.00[a]	1.00
Std. Deviation		.17317	.13198	.00000	.01945	.01646	.23305
Variance		.030	.017	.000	.000	.000	.054
Skewness		.167	.885		1.900	1.549	-1.459
Std. Error of Skewness		.409	.409	.409	.409	.409	.409
Kurtosis		.248	-.104		6.048	4.052	2.658
Std. Error of Kurtosis		.798	.798	.798	.798	.798	.798
Range		.76	.48	.00	.11	.09	1.00
Minimum		.54	.29	.00	.00	.00	.00
Maximum		1.30	.77	.00	.11	.09	1.00
Sum		29.15	15.58	.00	1.16	.94	26.17
Percentiles	25	.7839	.3745	.0000	.0233	.0181	.6438
	50	.8830	.4419	.0000	.0270	.0241	.8824
	75	.9880	.5417	.0000	.0463	.0384	1.0000

a. Multiple modes exist. The smallest value is shown

Three-Masted Caravels Mast Data

		W.BtLMz_H.Mz	W.BtLMz_W.TpLMz	W.TpLMz_H.Mz	H.LMz_L.H	H.LMz_H.LMa
N	Valid	12	12	12	12	12
	Missing	0	0	0	0	0
Mean		.0828	.6925	.0586	.3938	.6811
Std. Error of Mean		.00939	.06244	.01013	.02495	.04735
Median		.0770	.7158	.0504	.4060	.6940
Mode		.06(a)	.33(a)	.02(a)	.25(a)	.35(a)
Std. Deviation		.03254	.21630	.03508	.08642	.16401
Variance		.001	.047	.001	.007	.027
Skewness		2.922	-.033	2.404	-.190	-.682
Std. Error of Skewness		.637	.637	.637	.637	.637
Kurtosis		9.368	-1.157	6.942	-1.015	.063
Std. Error of Kurtosis		1.232	1.232	1.232	1.232	1.232
Range		.12	.67	.14	.27	.57
Minimum		.06	.33	.02	.25	.35
Maximum		.18	1.00	.16	.52	.91
Sum		.99	8.31	.70	4.73	8.17
Percentiles	25	.0648	.5269	.0408	.3292	.5701
	50	.0770	.7158	.0504	.4060	.6940
	75	.0816	.8946	.0644	.4773	.8187

Three-Masted Caravels Yard Data

Statistics

		L.MzY_ L.H	H.Mz_ L.MzY	W.MMzY _L.MzY	W.EMzY _L.MzY	W.EMzY_ W.MMzY
N	Valid	14	14	14	14	14
	Missing	0	0	0	0	0
Mean		.8786	.4677	.0225	.0196	.7993
Std. Error of Mean		.06535	.03085	.00309	.00305	.07389
Median		.8212	.4376	.0239	.0203	.8896
Mode		.53[a]	.35[a]	.00[a]	.00[a]	1.00
Std. Deviation		.24450	.11542	.01157	.01141	.27646
Variance		.060	.013	.000	.000	.076
Skewness		.676	1.391	-.065	.353	-2.069
Std. Error of Skewness		.597	.597	.597	.597	.597
Kurtosis		.135	2.035	-.009	.150	5.019
Std. Error of Kurtosis		1.154	1.154	1.154	1.154	1.154
Range		.88	.41	.04	.04	1.00
Minimum		.53	.35	.00	.00	.00
Maximum		1.41	.76	.04	.04	1.00
Sum		12.30	6.55	.31	.27	11.19
Percentiles	25	.6589	.3767	.0131	.0102	.6661
	50	.8212	.4376	.0239	.0203	.8896
	75	1.0469	.5079	.0308	.0265	1.0000

a. Multiple modes exist. The smallest value is shown

Four-Masted Caravels Mast Data

		W.BtLMz_H.Mz	W.BtLMz_W.TpLMz	W.TpLMz_H.Mz	H.LMz_L.H	H.LMz_H.LMa	H.LMz_L.Bw
N	Valid	40	40	40	40	40	40
	Missing	0	0	0	0	0	0
Mean		.0727	.6575	.0465	.3499	.5936	1.1033
Std. Error of Mean		.00399	.02957	.00347	.01609	.02325	.05719
Median		.0734	.6698	.0406	.3381	.5995	1.0980
Mode		.03(a)	.68	.02(a)	.22(a)	.34(a)	.44(a)
Std. Deviation		.02527	.18700	.02192	.10175	.14703	.36172
Variance		.001	.035	.000	.010	.022	.131
Skewness		.572	.017	2.538	.759	.258	-.238
Std. Error of Skewness		.374	.374	.374	.374	.374	.374
Kurtosis		.322	-.562	9.290	-.147	-.653	-.598
Std. Error of Kurtosis		.733	.733	.733	.733	.733	.733
Range		.11	.77	.12	.37	.55	1.41
Minimum		.03	.27	.02	.22	.34	.44
Maximum		.14	1.03	.14	.59	.89	1.85
Sum		2.91	26.30	1.86	14.00	23.74	44.13
Percentiles	25	.0516	.5017	.0315	.2711	.4764	.8933
	50	.0734	.6698	.0406	.3381	.5995	1.0980
	75	.0876	.8017	.0529	.4091	.6760	1.3957

Four-Masted Caravels Yard Data

Statistics

		L.MzY_ L.H	H.Mz_ L.MzY	L.FrY_ L.MzY	W.MMzY_ L.MzY	W.EMzY_ L.MzY	W.EMzY_ W.MMzY
N	Valid	42	42	42	42	42	42
	Missing	0	0	0	0	0	0
Mean		.6699	.5405	.5940	.0268	.0214	.7563
Std. Error of Mean		.02003	.02355	.05679	.00255	.00270	.03703
Median		.6460	.4849	.5747	.0227	.0153	.8370
Mode		.37[a]	.28[a]	.00	.00[a]	.00[a]	1.00
Std. Deviation		.12979	.15262	.36803	.01650	.01748	.23996
Variance		.017	.023	.135	.000	.000	.058
Skewness		-.008	.435	-.120	2.468	2.708	-1.075
Std. Error of Skewness		.365	.365	.365	.365	.365	.365
Kurtosis		-.567	-.533	-.260	9.076	9.598	1.004
Std. Error of Kurtosis		.717	.717	.717	.717	.717	.717
Range		.56	.62	1.42	.10	.10	1.02
Minimum		.37	.28	.00	.00	.00	.00
Maximum		.93	.90	1.42	.10	.10	1.02
Sum		28.14	22.70	24.95	1.12	.90	31.77
Percentiles	25	.5719	.4216	.4602	.0172	.0124	.5886
	50	.6460	.4849	.5747	.0227	.0153	.8370
	75	.7893	.6476	.7634	.0322	.0255	.9631

a. Multiple modes exist. The smallest value is shown

Three-Masted Galleons Mast Data

		W.BtLMz_H.Mz	W.BtLMz_W.TpLMz	W.TpLMz_H.Mz	H.LMz_L.H	H.LMz_H.LMa	H.LMz_L.Bw
N	Valid	10	10	10	10	10	10
	Missing	0	0	0	0	0	0
Mean		.0769	.7005	.0498	.3674	.5331	1.0229
Std. Error of Mean		.01045	.07920	.00512	.02788	.06201	.07106
Median		.0723	.6239	.0513	.3816	.4520	1.0240
Mode		.04(a)	.32(a)	.02(a)	.19(a)	.35(a)	.73(a)
Std. Deviation		.03303	.25045	.01619	.08816	.19610	.22471
Variance		.001	.063	.000	.008	.038	.050
Skewness		.781	.897	-.411	-.208	2.169	.723
Std. Error of Skewness		.687	.687	.687	.687	.687	.687
Kurtosis		-.081	1.152	.055	2.117	5.179	-.034
Std. Error of Kurtosis		1.334	1.334	1.334	1.334	1.334	1.334
Range		.10	.89	.05	.34	.69	.72
Minimum		.04	.32	.02	.19	.35	.73
Maximum		.14	1.21	.07	.53	1.03	1.45
Sum		.77	7.01	.50	3.67	5.33	10.23
Percentiles	25	.0458	.5634	.0410	.3253	.4376	.8331
	50	.0723	.6239	.0513	.3816	.4520	1.0240
	75	.1024	.8274	.0588	.4050	.5677	1.1542

Three-Masted Galleons Yard Data

Statistics

		L.MzY_ L.H	H.Mz_ L.MzY	L.FrY_ L.MzY	W.MMzY_ L.MzY	W.EMzY_ L.MzY	W.EMzY_ W.MMzY
N	Valid	9	9	9	9	9	9
	Missing	0	0	0	0	0	0
Mean		.8031	.6477	.4066	.0200	.0142	.5567
Std. Error of Mean		.04991	.05692	.10749	.00409	.00345	.13158
Median		.7649	.6000	.4303	.0218	.0127	.4444
Mode		.58[a]	.48[a]	.00	.00	.00	.00[a]
Std. Deviation		.14972	.17077	.32246	.01226	.01036	.39474
Variance		.022	.029	.104	.000	.000	.156
Skewness		.838	1.233	.319	-1.029	-.037	-.295
Std. Error of Skewness		.717	.717	.717	.717	.717	.717
Kurtosis		1.636	1.093	-.435	-.192	-.838	-1.346
Std. Error of Kurtosis		1.400	1.400	1.400	1.400	1.400	1.400
Range		.53	.52	.97	.03	.03	1.00
Minimum		.58	.48	.00	.00	.00	.00
Maximum		1.11	1.00	.97	.03	.03	1.00
Sum		7.23	5.83	3.66	.18	.13	5.01
Percentiles	25	.7215	.5109	.0931	.0098	.0048	.2083
	50	.7649	.6000	.4303	.0218	.0127	.4444
	75	.8841	.7664	.6358	.0300	.0222	.9667

a. Multiple modes exist. The smallest value is shown

Four-Masted Galleons Mast Data

		W.BtLMz_H.Mz	W.BtLMz_W.TpLMz	W.TpLMz_H.Mz	H.LMz_L.H	H.LMz_H.LMa	H.LMz_L.Bw
N	Valid	23	23	23	23	23	23
	Missing	0	0	0	0	0	0
Mean		.0769	.6124	.0438	.4481	.7137	.9778
Std. Error of Mean		.00724	.04224	.00344	.03267	.03863	.05102
Median		.0743	.6000	.0431	.4019	.6943	.9871
Mode		.03(a)	1.00	.02(a)	.22(a)	.43(a)	.52(a)
Std. Deviation		.03474	.20255	.01649	.15669	.18528	.24471
Variance		.001	.041	.000	.025	.034	.060
Skewness		1.708	.406	1.270	1.013	.556	.366
Std. Error of Skewness		.481	.481	.481	.481	.481	.481
Kurtosis		3.634	-.479	3.317	.908	-.305	.220
Std. Error of Kurtosis		.935	.935	.935	.935	.935	.935
Range		.15	.75	.08	.62	.66	1.00
Minimum		.03	.25	.02	.22	.43	.52
Maximum		.18	1.00	.10	.83	1.09	1.52
Sum		1.77	14.09	1.01	10.31	16.42	22.49
Percentiles	25	.0560	.4466	.0315	.3630	.5735	.8427
	50	.0743	.6000	.0431	.4019	.6943	.9871
	75	.0877	.7204	.0518	.5292	.8647	1.0988

Four-Masted Galleons Yard Data

Statistics

		L.MzY_ L.H	H.Mz_ L.MzY	L.FrY_ L.MzY	W.MMzY_ L.MzY	W.EMzY_ L.MzY	W.EMzY_ W.MMzY
N	Valid	23	23	23	23	23	23
	Missing	0	0	0	0	0	0
Mean		.7710	.6271	.6025	.0295	.0236	.7801
Std. Error of Mean		.07507	.05263	.08114	.00290	.00304	.03511
Median		.6587	.5769	.6532	.0264	.0175	.8000
Mode		.26[a]	.34[a]	.00	.01[a]	.01[a]	1.00
Std. Deviation		.36002	.25239	.38911	.01391	.01456	.16836
Variance		.130	.064	.151	.000	.000	.028
Skewness		1.049	2.787	.696	.981	1.536	-.082
Std. Error of Skewness		.481	.481	.481	.481	.481	.481
Kurtosis		.214	10.003	1.313	.991	2.368	-1.351
Std. Error of Kurtosis		.935	.935	.935	.935	.935	.935
Range		1.33	1.26	1.64	.06	.06	.49
Minimum		.26	.34	.00	.01	.01	.51
Maximum		1.60	1.60	1.64	.07	.07	1.00
Sum		17.73	14.42	13.86	.68	.54	17.94
Percentiles	25	.5139	.4787	.3652	.0166	.0135	.6000
	50	.6587	.5769	.6532	.0264	.0175	.8000
	75	.9427	.7006	.7731	.0360	.0352	.9677

a. Multiple modes exist. The smallest value is shown

Three-Masted Naus Mast Data

		W.BtLMz_H.Mz	W.BtLMz_W.TpLMz	W.TpLMz_H.Mz	H.LMz_L.H	H.LMz_H.LMa	H.LMz_L.Bw
N	Valid	195	195	195	195	195	195
	Missing	0	0	0	0	0	0
Mean		.0750	.6606	.0501	.3872	.5791	1.0804
Std. Error of Mean		.00189	.01609	.00174	.00886	.01220	.02688
Median		.0720	.6500	.0440	.3614	.5393	1.0372
Mode		.05(a)	1.00	.04(a)	.18(a)	.73	.20(a)
Std. Deviation		.02637	.22473	.02428	.12368	.17032	.37533
Variance		.001	.051	.001	.015	.029	.141
Skewness		1.544	.635	1.479	1.561	1.396	.411
Std. Error of Skewness		.174	.174	.174	.174	.174	.174
Kurtosis		5.175	2.489	2.923	3.701	3.165	.051
Std. Error of Kurtosis		.346	.346	.346	.346	.346	.346
Range		.18	1.69	.14	.77	1.12	2.23
Minimum		.02	.11	.02	.18	.28	.20
Maximum		.21	1.80	.16	.95	1.40	2.44
Sum		14.63	128.82	9.77	75.50	112.93	210.67
Percentiles	25	.0587	.5000	.0337	.3055	.4635	.8007
	50	.0720	.6500	.0440	.3614	.5393	1.0372
	75	.0879	.8000	.0591	.4389	.6709	1.3308

Three-Masted Naus Yard Data

Statistics

		L.MzY_L.H	H.Mz_L.MzY	L.FrY_L.MzY	W.MMzY_L.MzY	W.EMzY_L.MzY	W.EMzY_W.MMzY
N	Valid	206	205	206	206	206	206
	Missing	0	1	0	0	0	0
Mean		.7373	.5733	.5116	.0290	.0238	.8005
Std. Error of Mean		.01476	.01490	.03256	.00124	.00110	.01713
Median		.7307	.5218	.5441	.0259	.0207	.8214
Mode		.21[a]	.22[a]	.00	.00	.00	1.00
Std. Deviation		.21181	.21326	.46727	.01784	.01583	.24580
Variance		.045	.045	.218	.000	.000	.060
Skewness		.545	2.199	.768	2.538	2.283	-.839
Std. Error of Skewness		.169	.170	.169	.169	.169	.169
Kurtosis		.862	9.209	.406	10.215	6.962	1.750
Std. Error of Kurtosis		.337	.338	.337	.337	.337	.337
Range		1.17	1.71	1.92	.14	.11	1.48
Minimum		.21	.22	.00	.00	.00	.00
Maximum		1.38	1.93	1.92	.14	.11	1.48
Sum		151.88	117.52	105.40	5.98	4.90	164.90
Percentiles	25	.5965	.4392	.0000	.0191	.0141	.6658
	50	.7307	.5218	.5441	.0259	.0207	.8214
	75	.8409	.6703	.7870	.0335	.0265	1.0000

a. Multiple modes exist. The smallest value is shown

APPENDIX 33

MAIN MAST AND YARD FREQUENCY TABLES FOR THE CARAVELS, GALLEONS, AND NAUS

Two-Masted Caravels Lower Main Mast Data

		H.LMa_ L.H	W.TpLMa_ H.LMa	W.BtLMa_H .LMa	W.TpLMa_ W.BtLMa
N	Valid	36	36	36	36
	Missing	0	0	0	0
Mean		.7483	.0389	.0643	.6024
Std. Error of Mean		.02825	.00248	.00299	.02292
Median		.7271	.0346	.0587	.6026
Mode		.52(a)	.02(a)	.04(a)	.50
Std. Deviation		.16951	.01488	.01791	.13754
Variance		.029	.000	.000	.019
Skewness		1.186	1.051	1.045	.573
Std. Error of Skewness		.393	.393	.393	.393
Kurtosis		1.824	.189	.585	.928
Std. Error of Kurtosis		.768	.768	.768	.768
Range		.77	.06	.08	.69
Minimum		.52	.02	.04	.31
Maximum		1.29	.08	.11	1.00
Sum		26.94	1.40	2.32	21.69
Percentiles	25	.6298	.0263	.0515	.5000
	50	.7271	.0346	.0587	.6026
	75	.7994	.0460	.0766	.6856

Two-Masted Caravels Main Yard Data

Statistics

		L.MaY_L.H	L.MaY_H.Ma	W.MMaY_L.MaY	W.EMaY_L.MaY	W.EMaY_W.MMaY	W.MMaY_W.BtLMa
N	Valid	32	32	32	32	32	32
	Missing	0	0	0	0	0	0
Mean		1.2555	.6569	.0268	.0215	.8136	.6904
Std. Error of Mean		.05453	.06167	.00177	.00144	.02992	.03636
Median		1.3279	.5191	.0246	.0191	.8404	.6500
Mode		.44[a]	.38[a]	.01[a]	.01[a]	1.00	.50[a]
Std. Deviation		.30845	.34888	.00999	.00816	.16924	.20566
Variance		.095	.122	.000	.000	.029	.042
Skewness		-1.022	2.558	1.765	1.028	-.538	.486
Std. Error of Skewness		.414	.414	.414	.414	.414	.414
Kurtosis		.684	7.831	4.761	.207	-.600	-.527
Std. Error of Kurtosis		.809	.809	.809	.809	.809	.809
Range		1.30	1.68	.05	.03	.59	.83
Minimum		.44	.38	.01	.01	.41	.33
Maximum		1.74	2.06	.06	.04	1.00	1.17
Sum		40.17	21.02	.86	.69	26.03	22.09
Percentiles	25	1.0998	.4903	.0196	.0153	.6735	.5220
	50	1.3279	.5191	.0246	.0191	.8404	.6500
	75	1.4561	.6873	.0318	.0280	1.0000	.8188

a. Multiple modes exist. The smallest value is shown

Three-Masted Caravels Lower Main Mast Data

		H.LMa_L.H	W.TpLMa_H.LMa	W.BtLMa_H.LMa	W.TpLMa_W.BtLMa
N	Valid	12	12	12	12
	Missing	0	0	0	0
Mean		.6248	.0401	.0640	.6406
Std. Error of Mean		.03681	.00353	.00353	.05717
Median		.5978	.0388	.0639	.6094
Mode		.47(a)	.02(a)	.04(a)	.84
Std. Deviation		.12753	.01223	.01224	.19805
Variance		.016	.000	.000	.039
Skewness		.805	.452	-.353	.262
Std. Error of Skewness		.637	.637	.637	.637
Kurtosis		-.260	-.545	-.526	-.775
Std. Error of Kurtosis		1.232	1.232	1.232	1.232
Range		.39	.04	.04	.67
Minimum		.47	.02	.04	.33
Maximum		.87	.06	.08	1.00
Sum		7.50	.48	.77	7.69
Percentiles	25	.5108	.0319	.0568	.4713
	50	.5978	.0388	.0639	.6094
	75	.7109	.0512	.0761	.8180

Three-Masted Caravels Main Yard Data

Statistics

		L.MaY_ L.H	L.MaY_ H.Ma	W.MMaY_ L.MaY	W.EMaY _L.MaY	W.EMaY_ W.MMaY	W.MMaY_ W.BtLMa
N	Valid	13	13	13	13	13	13
	Missing	0	0	0	0	0	0
Mean		1.1325	.6052	.0240	.0198	.8257	.5567
Std. Error of Mean		.10202	.09009	.00478	.00378	.04728	.05428
Median		1.2733	.4902	.0178	.0152	.8824	.5510
Mode		.43[a]	.35[a]	.01[a]	.01[a]	1.00	.26[a]
Std. Deviation		.36784	.32482	.01725	.01363	.17045	.19570
Variance		.135	.106	.000	.000	.029	.038
Skewness		-.375	1.779	2.252	1.954	-.785	-.282
Std. Error of Skewness		.616	.616	.616	.616	.616	.616
Kurtosis		-.235	2.211	5.526	3.854	-.416	-1.375
Std. Error of Kurtosis		1.191	1.191	1.191	1.191	1.191	1.191
Range		1.34	1.04	.07	.05	.50	.56
Minimum		.43	.35	.01	.01	.50	.26
Maximum		1.77	1.39	.07	.06	1.00	.82
Sum		14.72	7.87	.31	.26	10.73	7.24
Percentiles	25	.8156	.4006	.0156	.0115	.7090	.3643
	50	1.2733	.4902	.0178	.0152	.8824	.5510
	75	1.3477	.6791	.0256	.0219	.9938	.7410

a. Multiple modes exist. The smallest value is shown

Four-Masted Caravels Lower Main Mast Data

		H.LMa_ L.H	W.TpLMa_ H.LMa	W.BtLMa_H .LMa	W.TpLMa_ W.BtLMa
N	Valid	41	41	41	41
	Missing	0	0	0	0
Mean		.6130	.0370	.0556	.6815
Std. Error of Mean		.02643	.00234	.00234	.03271
Median		.5950	.0352	.0515	.6341
Mode		.32(a)	.01(a)	.03(a)	1.00
Std. Deviation		.16921	.01498	.01496	.20942
Variance		.029	.000	.000	.044
Skewness		.283	1.652	.658	.244
Std. Error of Skewness		.369	.369	.369	.369
Kurtosis		-.710	5.440	.123	-.938
Std. Error of Kurtosis		.724	.724	.724	.724
Range		.67	.08	.06	.83
Minimum		.32	.01	.03	.28
Maximum		.99	.10	.10	1.11
Sum		25.13	1.52	2.28	27.94
Percentiles	25	.5007	.0252	.0417	.5185
	50	.5950	.0352	.0515	.6341
	75	.7406	.0451	.0657	.8634

Four-Masted Caravels Main Yard Data

Statistics

		L.MaY_L.H	L.MaY_H.Ma	W.MMaY_L.MaY	W.EMaY_L.MaY	W.EMaY_W.MMaY	W.MMaY_W.BtLMa
N	Valid	41	41	41	41	41	39
	Missing	0	0	0	0	0	2
Mean		.8300	.8148	.0265	.0194	.7560	.5944
Std. Error of Mean		.03607	.06168	.00258	.00217	.03726	.03900
Median		.8417	.7715	.0261	.0152	.8000	.5888
Mode		.24[a]	.33[a]	.01[a]	.06	1.00	.07[a]
Std. Deviation		.23097	.39495	.01652	.01387	.23857	.24355
Variance		.053	.156	.000	.000	.057	.059
Skewness		-.251	1.102	2.067	2.010	-.507	.289
Std. Error of Skewness		.369	.369	.369	.369	.369	.378
Kurtosis		-.336	1.738	6.643	4.072	-1.032	.322
Std. Error of Kurtosis		.724	.724	.724	.724	.724	.741
Range		.98	1.79	.09	.06	.76	1.10
Minimum		.24	.33	.01	.01	.24	.07
Maximum		1.22	2.11	.09	.06	1.00	1.17
Sum		34.03	33.41	1.09	.80	31.00	23.18
Percentiles	25	.6375	.5172	.0151	.0099	.5580	.4580
	50	.8417	.7715	.0261	.0152	.8000	.5888
	75	1.0202	1.0252	.0311	.0234	1.0000	.7129

a. Multiple modes exist. The smallest value is shown

Three-Masted Galleons Lower Main Mast Data

		H.Ma_L.H	H.LMa_H.Ma	H.LMa_L.H	W.BtLMa_H.LMa	W.TpLMa_H.LMa	W.TpLMa_W.BtLMa
N	Valid	8	8	8	8	8	8
	Missing	0	0	0	0	0	0
Mean		1.1175	.7510	.8235	.0432	.0308	.7103
Std. Error of Mean		.08585	.06466	.07224	.00501	.00470	.04900
Median		1.1722	.7265	.8487	.0401	.0260	.6843
Mode		.73(a)	1.00	.47(a)	.03(a)	.02(a)	.53(a)
Std. Deviation		.24281	.18290	.20432	.01417	.01331	.13859
Variance		.059	.033	.042	.000	.000	.019
Skewness		-.785	.353	-.395	.703	1.914	.338
Std. Error of Skewness		.752	.752	.752	.752	.752	.752
Kurtosis		-.815	-1.271	.210	-.559	3.971	-1.397
Std. Error of Kurtosis		1.481	1.481	1.481	1.481	1.481	1.481
Range		.65	.48	.65	.04	.04	.37
Minimum		.73	.52	.47	.03	.02	.53
Maximum		1.37	1.00	1.12	.07	.06	.90
Sum		8.94	6.01	6.59	.35	.25	5.68
Percentiles	25	.8651	.5957	.6820	.0298	.0218	.5934
	50	1.1722	.7265	.8487	.0401	.0260	.6843
	75	1.3227	.9564	.9844	.0542	.0355	.8651

Three-Masted Galleons Main Top Mast Data

		H.UMa_H.Ma	H.UMa_H.LMa	H.UMa_L.H	W.BtUMa_H.UMa	W.TpUMa_H.UMa	W.TpUMa_W.BtUMa	W.TpUMa_W.TpLMa	W.BtUMa_W.BtLMa
N	Valid	6	6	6	6	6	6	7	8
	Missing	2	2	2	2	2	2	1	0
Mean		.3329	.5382	.3932	.0587	.0537	.9038	.7177	.4505
Std. Error of Mean		.04846	.11219	.06670	.01325	.01304	.03263	.05883	.10707
Median		.3474	.5343	.3815	.0563	.0526	.8795	.7500	.5259
Mode		.17(a)	.21(a)	.21(a)	.01(a)	.01(a)	1.00	.53(a)	.00
Std. Deviation		.11870	.27481	.16338	.03244	.03194	.07993	.15564	.30283
Variance		.014	.076	.027	.001	.001	.006	.024	.092
Skewness		-.147	.362	.414	-.038	.295	.500	-.173	-.811
Std. Error of Skewness		.845	.845	.845	.845	.845	.845	.794	.752
Kurtosis		-1.154	-.634	-1.112	-.751	-.274	-2.171	-2.209	-.766
Std. Error of Kurtosis		1.741	1.741	1.741	1.741	1.741	1.741	1.587	1.481
Range		.32	.74	.42	.09	.09	.18	.37	.79
Minimum		.17	.21	.21	.01	.01	.82	.53	.00
Maximum		.49	.95	.63	.10	.10	1.00	.90	.79
Sum		2.00	3.23	2.36	.35	.32	5.42	5.02	3.60
Percentiles	25	.2105	.2676	.2322	.0322	.0273	.8359	.5405	.1038
	50	.3474	.5343	.3815	.0563	.0526	.8795	.7500	.5259
	75	.4343	.7713	.5405	.0901	.0787	1.0000	.8500	.6742

Three-Masted Galleons Main Yard Data

Statistics

		L.MaY_ L.H	L.MaY _H.Ma	W.MMaY_ L.MaY	W.EMaY_ L.MaY	W.EMaY_ W.MMaY	W.MMaY_ W.BtLMa
N	Valid	9	9	9	9	9	9
	Missing	0	0	0	0	0	0
Mean		.6586	1.6405	.0420	.0369	.8467	.5750
Std. Error of Mean		.13974	.27253	.00935	.00904	.06404	.05192
Median		.4825	1.6724	.0271	.0248	.9091	.5979
Mode		.30[a]	.33[a]	.01[a]	.01[a]	1.00	.38[a]
Std. Deviation		.41922	.81758	.02804	.02712	.19213	.15575
Variance		.176	.668	.001	.001	.037	.024
Skewness		1.529	-.382	.486	.549	-1.228	.956
Std. Error of Skewness		.717	.717	.717	.717	.717	.717
Kurtosis		2.448	-.331	-1.668	-1.255	.030	1.730
Std. Error of Kurtosis		1.400	1.400	1.400	1.400	1.400	1.400
Range		1.29	2.52	.07	.07	.49	.52
Minimum		.30	.33	.01	.01	.51	.38
Maximum		1.59	2.85	.08	.08	1.00	.90
Sum		5.93	14.76	.38	.33	7.62	5.17
Percentiles	25	.3421	1.0169	.0196	.0121	.6861	.4433
	50	.4825	1.6724	.0271	.0248	.9091	.5979
	75	.8729	2.2985	.0747	.0635	1.0000	.6388

a. Multiple modes exist. The smallest value is shown

Three-Masted and Four-Masted Galleons Main Top Yard Data

Statistics

		L.MaTpY_L.H	L.MaTpY_L.MaY	W.MMaTpY_L.MaTpY	W.EMaTpY_L.MaTpY	W.EMaTpY_W.MMaTpY	W.MMaTpY_W.MMaY
N	Valid	17	17	17	17	17	17
	Missing	0	0	0	0	0	0
Mean		.3564	.5405	.0581	.0542	.9158	.7702
Std. Error of Mean		.04245	.03010	.00591	.00630	.02416	.04461
Median		.2972	.5243	.0486	.0471	.9434	.8000
Mode		.18[a]	.32[a]	.03[a]	.02[a]	1.00	1.00
Std. Deviation		.17504	.12412	.02438	.02596	.09961	.18395
Variance		.031	.015	.001	.001	.010	.034
Skewness		1.878	-.171	1.398	1.356	-1.193	-.358
Std. Error of Skewness		.550	.550	.550	.550	.550	.550
Kurtosis		4.149	-.934	1.662	1.808	.850	-.627
Std. Error of Kurtosis		1.063	1.063	1.063	1.063	1.063	1.063
Range		.70	.43	.09	.10	.33	.60
Minimum		.18	.32	.03	.02	.67	.41
Maximum		.88	.74	.12	.12	1.00	1.01
Sum		6.06	9.19	.99	.92	15.57	13.09
Percentiles	25	.2339	.4403	.0398	.0349	.8429	.6250
	50	.2972	.5243	.0486	.0471	.9434	.8000
	75	.4359	.6429	.0700	.0632	1.0000	.9417

a. Multiple modes exist. The smallest value is shown

Four-Masted Galleons Lower Main Mast Data

		H.Ma_L.H	H.LMa_H.Ma	H.LMa_L.H	W.TpLMa_H.LMa	W.BtLMa_H.LMa	W.TpLMa_W.BtLMa
N	Valid	23	23	23	23	23	23
	Missing	1	1	1	1	1	1
Mean		.9037	.6985	.6108	.0406	.0701	.5962
Std. Error of Mean		.05972	.03969	.04170	.00277	.00490	.02505
Median		.9383	.6299	.5761	.0432	.0720	.5778
Mode		.53(a)	1.00	.35(a)	.02(a)	.03(a)	.57
Std. Deviation		.28642	.19032	.19999	.01331	.02350	.12013
Variance		.082	.036	.040	.000	.001	.014
Skewness		.340	.898	.898	.434	-.020	.183
Std. Error of Skewness		.481	.481	.481	.481	.481	.481
Kurtosis		-.943	-.880	.526	-.038	-.536	-.272
Std. Error of Kurtosis		.935	.935	.935	.935	.935	.935
Range		.94	.52	.76	.05	.09	.48
Minimum		.53	.48	.35	.02	.03	.36
Maximum		1.47	1.00	1.11	.07	.12	.83
Sum		20.79	16.06	14.05	.93	1.61	13.71
Percentiles	25	.6093	.5556	.4961	.0266	.0532	.5000
	50	.9383	.6299	.5761	.0432	.0720	.5778
	75	1.1232	1.0000	.7823	.0450	.0896	.6825

Four-Masted Galleons Main Top Mast Data

		H.UMa_H.Ma	H.UMa_H.LMa	H.UMa_L.H	W.BtUMa_H.UMa	W.TpUMa_H.UMa	W.TpUMa_W.BtUMa
N	Valid	17	17	17	17	17	17
	Missing	7	7	7	7	7	7
Mean		.3403	.5800	.3318	.0692	.0554	.8072
Std. Error of Mean		.01898	.03502	.03608	.00354	.00401	.03898
Median		.3521	.5585	.2644	.0735	.0556	.8000
Mode		.20(a)	.31(a)	.18(a)	.04(a)	.03(a)	1.00
Std. Deviation		.07825	.14439	.14877	.01461	.01654	.16071
Variance		.006	.021	.022	.000	.000	.026
Skewness		-.308	.126	1.151	-.661	.338	-.013
Std. Error of Skewness		.550	.550	.550	.550	.550	.550
Kurtosis		-.772	.295	.489	.494	-.632	-1.684
Std. Error of Kurtosis		1.063	1.063	1.063	1.063	1.063	1.063
Range		.26	.57	.51	.06	.06	.43
Minimum		.20	.31	.18	.04	.03	.57
Maximum		.47	.87	.68	.09	.09	1.00
Sum		5.79	9.86	5.64	1.18	.94	13.72
Percentiles	25	.2713	.5192	.2291	.0599	.0378	.6436
	50	.3521	.5585	.2644	.0735	.0556	.8000
	75	.3967	.6577	.4352	.0781	.0684	1.0000

Four-Masted Galleons Main Yard Data

Statistics

		L.MaY_L.H	L.MaY_H.Ma	W.MMaY_L.MaY	W.EMaY_L.MaY	W.EMaY_W.MMaY	W.MMaY_W.BtLMa
N	Valid	23	23	23	23	23	23
	Missing	0	0	0	0	0	0
Mean		.8632	1.0898	.0327	.0264	.7680	.6554
Std. Error of Mean		.07929	.11286	.00344	.00370	.03749	.04855
Median		.8899	1.2899	.0275	.0195	.8000	.6504
Mode		.36[a]	.14[a]	.01[a]	.01[a]	1.00	.32[a]
Std. Deviation		.38024	.54124	.01649	.01775	.17979	.23285
Variance		.145	.293	.000	.000	.032	.054
Skewness		.497	-.007	2.021	2.144	.016	.588
Std. Error of Skewness		.481	.481	.481	.481	.481	.481
Kurtosis		-.558	-.977	5.253	6.195	-1.549	-.286
Std. Error of Kurtosis		.935	.935	.935	.935	.935	.935
Range		1.32	2.04	.07	.08	.52	.87
Minimum		.36	.14	.01	.01	.48	.32
Maximum		1.68	2.18	.09	.09	1.00	1.19
Sum		19.85	25.07	.75	.61	17.66	15.07
Percentiles	25	.4723	.5963	.0225	.0153	.6154	.4316
	50	.8899	1.2899	.0275	.0195	.8000	.6504
	75	1.0943	1.4798	.0404	.0351	.9524	.7857

a. Multiple modes exist. The smallest value is shown

Three-Masted Naus Lower Main Mast Data

		H.Ma_L.H	H.LMa_H.Ma	H.LMa_L.H	W.TpLMa_H.LMa	W.BtLMa_H.LMa	W.TpLMa_W.BtLMa
N	Valid	192	192	192	192	192	192
	Missing	0	0	0	0	0	0
Mean		1.0808	.6674	.7187	.0424	.0618	.6588
Std. Error of Mean		.02211	.00488	.01493	.00308	.00280	.01261
Median		1.0128	.6811	.6829	.0357	.0544	.6374
Mode		.94	.62	.58	.03(a)	.06	.67
Std. Deviation		.30637	.06759	.20684	,	.03875	.17478
Variance		.094	.005	.043	.002	.002	.031
Skewness		1.880	-.681	1.766	8.273	7.821	.565
Std. Error of Skewness		.175	.175	.175	.175	.175	.175
Kurtosis		5.540	.721	5.261	80.552	85.790	-.022
Std. Error of Kurtosis		.349	.349	.349	.349	.349	.349
Range		2.07	.41	1.40	.49	.48	.87
Minimum		.49	.39	.30	.01	.02	.35
Maximum		2.56	.80	1.70	.50	.50	1.22
Sum		207.51	128.14	138.00	8.15	11.87	126.48
Percentiles	25	.8786	.6215	.5838	.0261	.0435	.5325
	50	1.0128	.6811	.6829	.0357	.0544	.6374
	75	1.2081	.7190	.8055	.0472	.0715	.7894

Three-Masted Naus Main Top Mast Data

		H.UMa_H.Ma	H.UMa_H.LMa	H.UMa_L.H	W.TpUMa_H.UMa	W.BtUMa_H.UMa	W.BtUMa_W.TpUMa
N	Valid	192	192	192	192	192	192
	Missing	0	0	0	0	0	0
Mean		.3433	.5178	.3652	.0624	.0731	.8354
Std. Error of Mean		.00509	.01010	.00861	.00631	.00588	.03858
Median		.3315	.4804	.3467	.0438	.0599	.7927
Mode		.38	.62	.36	.03(a)	.05(a)	1.00
Std. Deviation		.07057	.13991	.11935	.08738	.08153	.53454
Variance		.005	.020	.014	.008	.007	.286
Skewness		1.597	.918	1.665	6.552	7.326	8.030
Std. Error of Skewness		.175	.175	.175	.175	.175	.175
Kurtosis		5.230	.785	5.111	48.139	59.084	72.949
Std. Error of Kurtosis		.349	.349	.349	.349	.349	.349
Range		.49	.74	.81	.83	.83	5.74
Minimum		.22	.28	.17	.01	.01	.26
Maximum		.71	1.02	.98	.84	.84	6.00
Sum		65.92	99.43	70.12	11.98	14.04	160.39
Percentiles	25	.2951	.4170	.2879	.0327	.0479	.6545
	50	.3315	.4804	.3467	.0438	.0599	.7927
	75	.3792	.6032	.4204	.0660	.0785	.9504

Three-Masted Naus Main Yard Data

Statistics

		L.MaY_L.H	H.Ma_L.MaY	H.LMa_L.MaY	W.MMaY_L.MaY	W.EMaY_L.MaY	W.EMaY_W.MMaY	W.MMaY_W.BtLMa
N	Valid	181	181	181	181	181	181	171
	Missing	0	0	0	0	0	0	10
Mean		.8336	1.3296	.9103	.0316	.0255	.7945	.5830
Std. Error of Mean		.02283	.02914	.01734	.00134	.00125	.01347	.01429
Median		.7632	1.3569	.8963	.0275	.0207	.8000	.5750
Mode		.35[a]	.37[a]	.37[a]	.01[a]	.02	1.00	.80
Std. Deviation		.30718	.39201	.23323	.01799	.01688	.18128	.18682
Variance		.094	.154	.054	.000	.000	.033	.035
Skewness		1.431	-.179	.126	2.494	2.439	-.475	.410
Std. Error of Skewness		.181	.181	.181	.181	.181	.181	.186
Kurtosis		2.380	.293	-.102	10.456	9.655	-.874	-.089
Std. Error of Kurtosis		.359	.359	.359	.359	.359	.359	.369
Range		1.67	2.15	1.18	.13	.12	.66	.96
Minimum		.35	.37	.37	.01	.01	.34	.19
Maximum		2.02	2.52	1.56	.14	.13	1.00	1.15
Sum		150.89	240.66	164.76	5.72	4.62	143.81	99.69
Percentiles	25	.6129	1.1147	.7687	.0199	.0140	.6626	.4500
	50	.7632	1.3569	.8963	.0275	.0207	.8000	.5750
	75	.9604	1.6015	1.0628	.0387	.0317	1.0000	.6875

a. Multiple modes exist. The smallest value is shown

Three-Masted Naus Main Top Yard Data

Statistics

		L.MaTpY_L.H	L.MaTpY_L.MaY	W.MMaTpY_L.MaTpY	W.EMaTpY_L.MaTpY	W.EMaTpY_W.MMaTpY	W.MMaTpY_W.MMaY
N	Valid	155	155	155	155	155	155
	Missing	0	0	0	0	0	0
Mean		.3750	.4911	.0532	.0470	.8661	.8207
Std. Error of Mean		.01179	.00974	.00204	.00207	.01307	.02024
Median		.3582	.4682	.0492	.0419	.9375	.8235
Mode		.11[a]	.27[a]	.07[a]	.05[a]	1.00	1.00
Std. Deviation		.14681	.12123	.02541	.02577	.16266	.25200
Variance		.022	.015	.001	.001	.026	.064
Skewness		.974	.925	.809	.882	-1.059	.002
Std. Error of Skewness		.195	.195	.195	.195	.195	.195
Kurtosis		2.076	1.750	.232	.305	.098	-.043
Std. Error of Kurtosis		.387	.387	.387	.387	.387	.387
Range		.87	.76	.11	.12	.63	1.47
Minimum		.11	.27	.02	.01	.37	.08
Maximum		.98	1.03	.13	.13	1.00	1.55
Sum		58.13	76.13	8.24	7.28	134.25	127.20
Percentiles	25	.2680	.4067	.0336	.0259	.7407	.6296
	50	.3582	.4682	.0492	.0419	.9375	.8235
	75	.4599	.5702	.0714	.0636	1.0000	1.0000

a. Multiple modes exist. The smallest value is shown

APPENDIX 34

FORE MAST AND YARD FREQUENCY TABLES FOR THE CARAVELS, GALLEONS, AND NAUS

Four-Masted Caravels Lower Fore Mast Data

Statistics

		H.Fr_ L.H	H.LFr_ H.Fr	H.LFr_ L.H	W.BtLFr_ H.LFr	W.TpLFr_ H.LFr	W.TpLFr_ W.BtLFr
N	Valid	34	34	34	34	34	34
	Missing	0	0	0	0	0	0
Mean		.7503	.5359	.3994	.0644	.0475	.7571
Std. Error of Mean		.02799	.01967	.02025	.00394	.00375	.03798
Median		.7524	.5588	.3654	.0604	.0427	.7514
Mode		.41[a]	.36[a]	.24[a]	.01[a]	.01[a]	1.00
Std. Deviation		.16319	.11469	.11808	.02298	.02189	.22146
Variance		.027	.013	.014	.001	.000	.049
Skewness		.266	-.074	.664	.323	1.635	.262
Std. Error of Skewness		.403	.403	.403	.403	.403	.403
Kurtosis		.557	-1.193	-.669	.491	3.750	-.388
Std. Error of Kurtosis		.788	.788	.788	.788	.788	.788
Range		.76	.41	.41	.11	.11	.95
Minimum		.41	.36	.24	.01	.01	.35
Maximum		1.18	.77	.65	.12	.12	1.30
Sum		25.51	18.22	13.58	2.19	1.62	25.74
Percentiles	25	.6517	.4075	.3061	.0489	.0355	.5661
	50	.7524	.5588	.3654	.0604	.0427	.7514
	75	.8452	.6298	.4780	.0815	.0546	.9516

Statistics

		H.Fr_ L.H	H.LFr_ H.Fr	H.LFr_ L.H	W.BtLFr_ H.LFr	W.TpLFr_ H.LFr	W.TpLFr_ W.BtLFr
N	Valid	34	34	34	34	34	34
	Missing	0	0	0	0	0	0
Mean		.7503	.5359	.3994	.0644	.0475	.7571
Std. Error of Mean		.02799	.01967	.02025	.00394	.00375	.03798
Median		.7524	.5588	.3654	.0604	.0427	.7514
Mode		.41[a]	.36[a]	.24[a]	.01[a]	.01[a]	1.00
Std. Deviation		.16319	.11469	.11808	.02298	.02189	.22146
Variance		.027	.013	.014	.001	.000	.049
Skewness		.266	-.074	.664	.323	1.635	.262
Std. Error of Skewness		.403	.403	.403	.403	.403	.403
Kurtosis		.557	-1.193	-.669	.491	3.750	-.388
Std. Error of Kurtosis		.788	.788	.788	.788	.788	.788
Range		.76	.41	.41	.11	.11	.95
Minimum		.41	.36	.24	.01	.01	.35
Maximum		1.18	.77	.65	.12	.12	1.30
Sum		25.51	18.22	13.58	2.19	1.62	25.74
Percentiles	25	.6517	.4075	.3061	.0489	.0355	.5661
	50	.7524	.5588	.3654	.0604	.0427	.7514
	75	.8452	.6298	.4780	.0815	.0546	.9516

a. Multiple modes exist. The smallest value is shown

Four-Masted Caravels Fore Top Mast Data

Statistics

		H.UFr_H.Fr	H.UFr_H.LFr	H.UFr_L.H	W.BtUFr_H.Ufr	W.TpUFr_H.Ufr	W.BtUFr_W.TpUFr
N	Valid	34	34	34	34	34	34
	Missing	0	0	0	0	0	0
Mean		.4553	.9394	.3438	.0643	.0508	.7873
Std. Error of Mean		.02052	.07760	.02043	.00635	.00573	.02928
Median		.4305	.7564	.3299	.0612	.0459	.8000
Mode		.25[a]	.33[a]	.15[a]	.01[a]	.01[a]	1.00
Std. Deviation		.11966	.45248	.11915	.03705	.03343	.17070
Variance		.014	.205	.014	.001	.001	.029
Skewness		.144	.575	.080	.243	.666	-.499
Std. Error of Skewness		.403	.403	.403	.403	.403	.403
Kurtosis		-1.239	-1.275	-.955	-.812	-.631	-.397
Std. Error of Kurtosis		.788	.788	.788	.788	.788	.788
Range		.39	1.49	.44	.13	.11	.63
Minimum		.25	.33	.15	.01	.01	.37
Maximum		.64	1.81	.59	.14	.12	1.00
Sum		15.48	31.94	11.69	2.19	1.73	26.77
Percentiles	25	.3628	.5703	.2401	.0267	.0190	.6667
	50	.4305	.7564	.3299	.0612	.0459	.8000
	75	.5925	1.4540	.4355	.0916	.0790	.9350

a. Multiple modes exist. The smallest value is shown

Four-Masted Caravels Fore Yard Data

Statistics

		L.FrY_L.H	L.FrY_ L.MaY	W.MFrY_ L.FrY	W.EFrY_L .FrY	W.EFrY_ W.MFrY	W.MFrY_ W.MMaY
N	Valid	35	35	35	35	35	35
	Missing	0	0	0	0	0	0
Mean		.4553	.5663	.0377	.0337	.8905	.8059
Std. Error of Mean		.02565	.04178	.00409	.00384	.02649	.04711
Median		.4328	.4969	.0278	.0224	1.0000	.8611
Mode		.07[a]	.07[a]	.01[a]	.02	1.00	1.00
Std. Deviation		.15172	.24718	.02421	.02273	.15671	.27871
Variance		.023	.061	.001	.001	.025	.078
Skewness		.391	.338	1.652	1.371	-1.268	-.825
Std. Error of Skewness		.398	.398	.398	.398	.398	.398
Kurtosis		1.196	-.579	2.281	.624	.877	.488
Std. Error of Kurtosis		.778	.778	.778	.778	.778	.778
Range		.80	1.00	.10	.08	.59	1.23
Minimum		.07	.07	.01	.01	.41	.05
Maximum		.87	1.07	.12	.09	1.00	1.29
Sum		15.94	19.82	1.32	1.18	31.17	28.21
Percentiles	25	.3678	.3946	.0224	.0200	.7692	.6389
	50	.4328	.4969	.0278	.0224	1.0000	.8611
	75	.5839	.7443	.0455	.0433	1.0000	1.0000

a. Multiple modes exist. The smallest value is shown

Four-Masted Caravels Fore Top Yard Data

Statistics

		L.FrTpY_L.H	L.FrTpY_L.FrY	L.FrTpY_L.MaTpY	W.MFrTpY_L.FrTpY	W.EFrTpY_L.FrTpY	W.EFrTpY_W.MFrTpY	W.MFrTpY_W.MMaTpY
N	Valid	34	34	15	34	34	34	14
	Missing	0	0	19	0	0	0	20
Mean		.2745	.6095	.8488	.0573	.0510	.8905	.9794
Std. Error of Mean		.01150	.02189	.04997	.00773	.00692	.02516	.07137
Median		.2640	.6043	.8000	.0418	.0315	.9762	1.0385
Mode		.17[a]	.34[a]	.54[a]	.03[a]	.01[a]	1.00	1.00
Std. Deviation		.06704	.12762	.19353	.04507	.04034	.14670	.26706
Variance		.004	.016	.037	.002	.002	.022	.071
Skewness		.481	1.217	.787	2.007	1.757	-1.182	-1.611
Std. Error of Skewness		.403	.403	.580	.403	.403	.403	.597
Kurtosis		-.248	4.490	1.109	3.858	2.637	.149	3.586
Std. Error of Kurtosis		.788	.788	1.121	.788	.788	.788	1.154
Range		.27	.73	.72	.19	.17	.49	1.08
Minimum		.17	.34	.54	.01	.01	.51	.25
Maximum		.44	1.07	1.25	.21	.18	1.00	1.33
Sum		9.33	20.72	12.73	1.95	1.73	30.28	13.71
Percentiles	25	.2183	.5431	.7677	.0288	.0255	.8247	.8173
	50	.2640	.6043	.8000	.0418	.0315	.9762	1.0385
	75	.3226	.6670	.9159	.0665	.0665	1.0000	1.1571

a. Multiple modes exist. The smallest value is shown

Three-Masted and Four-Masted Galleons Lower Fore Mast Data

Statistics

		H.Fr_L.H	H.LFr_ H.Fr	H.LFr_ L.H	W.BtLFr _H.LFr	W.TpLFr _H.LFr	W.TpLFr _W.BtLFr
N	Valid	23	23	23	23	23	23
	Missing	0	0	0	0	0	0
Mean		.7665	.6040	.4621	.0756	.0538	.7454
Std. Error of Mean		.04995	.01459	.03149	.00655	.00396	.04181
Median		.7269	.5917	.3950	.0657	.0518	.7625
Mode		.42[a]	.50[a]	.26[a]	.04[a]	.03[a]	1.00
Std. Deviation		.23955	.06997	.15102	.03140	.01899	.20049
Variance		.057	.005	.023	.001	.000	.040
Skewness		.651	.827	.583	1.920	.662	-.146
Std. Error of Skewness		.481	.481	.481	.481	.481	.481
Kurtosis		-.375	.587	-1.021	4.482	-.294	-.790
Std. Error of Kurtosis		.935	.935	.935	.935	.935	.935
Range		.87	.28	.47	.14	.07	.76
Minimum		.42	.50	.26	.04	.03	.35
Maximum		1.29	.78	.73	.18	.10	1.11
Sum		17.63	13.89	10.63	1.74	1.24	17.14
Percentiles	25	.5785	.5602	.3485	.0580	.0393	.6000
	50	.7269	.5917	.3950	.0657	.0518	.7625
	75	.9326	.6539	.6119	.0842	.0628	.8841

a. Multiple modes exist. The smallest value is shown

Three-Masted and Four-Masted Galleons Fore Top Mast Data

Statistics

		H.UFr_ H.Fr	H.UFr_ H.LFr	H.UFr _L.H	W.BtUF r_H.Ufr	W.TpUFr _H.Ufr	W.BtUFr_ W.TpUFr
N	Valid	23	23	23	23	23	23
	Missing	0	0	0	0	0	0
Mean		.3812	.6458	.2945	.0769	.0649	.8425
Std. Error of Mean		.01520	.03518	.0251 5	.00502	.00476	.02859
Median		.4068	.6858	.2541	.0762	.0653	.8400
Mode		.22[a]	.29[a]	.16[a]	.05	.05	1.00
Std. Deviation		.07291	.16870	.1206 4	.02405	.02285	.13713
Variance		.005	.028	.015	.001	.001	.019
Skewness		-.642	-.151	.962	.136	.131	-.155
Std. Error of Skewness		.481	.481	.481	.481	.481	.481
Kurtosis		-.187	.114	-.160	-.906	-1.140	-1.552
Std. Error of Kurtosis		.935	.935	.935	.935	.935	.935
Range		.28	.71	.41	.08	.07	.38
Minimum		.22	.29	.16	.04	.03	.62
Maximum		.50	1.00	.57	.12	.10	1.00
Sum		8.77	14.85	6.77	1.77	1.49	19.38
Percentiles	25	.3422	.5292	.2023	.0534	.0488	.7000
	50	.4068	.6858	.2541	.0762	.0653	.8400
	75	.4355	.7619	.3596	.1000	.0855	1.0000

a. Multiple modes exist. The smallest value is shown

Three-Masted Galleons Fore Yard Data

Statistics

		L.FrY_L.H	L.FrY_ L.MaY	W.MFrY_ L.FrY	W.EFrY_L .FrY	W.EFrY_ W.MFrY	W.MFrY_ W.MMaY
N	Valid	7	7	7	7	7	7
	Missing	0	0	0	0	0	0
Mean		.3192	.5744	.0742	.0665	.8593	.8690
Std. Error of Mean		.06477	.08157	.01014	.01166	.06753	.08064
Median		.2453	.6644	.0707	.0667	.9000	.7200
Mode		.21[a]	.22[a]	.02[a]	.02[a]	1.00	.72
Std. Deviation		.17136	.21581	.02684	.03084	.17867	.21336
Variance		.029	.047	.001	.001	.032	.046
Skewness		2.384	-.959	-1.209	-.728	-1.093	.692
Std. Error of Skewness		.794	.794	.794	.794	.794	.794
Kurtosis		5.912	-.599	1.897	-.518	-.332	-1.512
Std. Error of Kurtosis		1.587	1.587	1.587	1.587	1.587	1.587
Range		.49	.58	.08	.08	.44	.52
Minimum		.21	.22	.02	.02	.56	.69
Maximum		.70	.80	.10	.10	1.00	1.20
Sum		2.23	4.02	.52	.47	6.02	6.08
Percentiles	25	.2325	.3328	.0667	.0393	.6667	.6917
	50	.2453	.6644	.0707	.0667	.9000	.7200
	75	.3206	.7183	.0973	.0938	1.0000	1.0566

a. Multiple modes exist. The smallest value is shown

Four-Masted Galleons Fore Yard Data

Statistics

		L.FrY_L.H	L.FrY_ L.MaY	W.MFrY_ L.FrY	W.EFrY_ L.FrY	W.EFrY_ W.MFrY	W.MFrY_ W.MMaY
N	Valid	20	20	20	20	20	20
	Missing	0	0	0	0	0	0
Mean		.4530	.6647	.0410	.0355	.8601	.8069
Std. Error of Mean		.03284	.05961	.00323	.00342	.04320	.04702
Median		.4446	.6626	.0383	.0319	.9600	.7804
Mode		.24[a]	.26[a]	.02[a]	.01[a]	1.00	.49[a]
Std. Deviation		.14684	.26657	.01445	.01530	.19319	.21028
Variance		.022	.071	.000	.000	.037	.044
Skewness		.837	.164	.375	.681	-1.357	.307
Std. Error of Skewness		.512	.512	.512	.512	.512	.512
Kurtosis		.621	-1.028	-.574	-.026	.675	-1.217
Std. Error of Kurtosis		.992	.992	.992	.992	.992	.992
Range		.56	.87	.05	.06	.59	.65
Minimum		.24	.26	.02	.01	.41	.49
Maximum		.80	1.13	.07	.07	1.00	1.14
Sum		9.06	13.29	.82	.71	17.20	16.14
Percentiles	25	.3551	.3945	.0304	.0251	.8083	.6163
	50	.4446	.6626	.0383	.0319	.9600	.7804
	75	.4961	.8963	.0524	.0471	1.0000	.9881

a. Multiple modes exist. The smallest value is shown

Three-Masted and Four-Masted Galleons Fore Top Yard Data

Statistics

		L.FrTpY_L.H	L.FrTpY_L.FrY	L.FrTpY_L.MaTpY	W.MFrTpY_L.FrTpY	W.EFrTpY_L.FrTpY	W.EFrTpY_W.MFrTpY	W.MFrTpY_W.MMaTpY
N	Valid	20	20	14	20	20	20	14
	Missing	0	0	6	0	0	0	6
Mean		.2473	.5830	.7971	.0726	.0658	.8991	.9915
Std. Error of Mean		.01411	.04328	.03091	.00691	.00700	.02984	.07995
Median		.2410	.5340	.7608	.0720	.0533	1.0000	.9434
Mode		.16[a]	.35[a]	.62[a]	.10	.01[a]	1.00	.75[a]
Std. Deviation		.06312	.19354	.11564	.03090	.03132	.13345	.29916
Variance		.004	.037	.013	.001	.001	.018	.089
Skewness		1.020	1.175	.593	.514	.919	-.931	.508
Std. Error of Skewness		.512	.512	.597	.512	.512	.512	.597
Kurtosis		.884	.826	-.328	.369	1.133	-.692	-.769
Std. Error of Kurtosis		.992	.992	1.154	.992	.992	.992	1.154
Range		.23	.68	.41	.13	.14	.36	.94
Minimum		.16	.35	.62	.02	.01	.64	.57
Maximum		.39	1.02	1.03	.15	.15	1.00	1.51
Sum		4.95	11.66	11.16	1.45	1.32	17.98	13.88
Percentiles	25	.1991	.4485	.7193	.0514	.0441	.7796	.7477
	50	.2410	.5340	.7608	.0720	.0533	1.0000	.9434
	75	.2682	.6690	.9047	.0982	.0915	1.0000	1.2443

a. Multiple modes exist. The smallest value is shown

Three-Masted Naus Lower Fore Mast Data

		H.Fr_L.H	H.LFr_ H.Fr	H.LFr_ L.H	W.BtLFr_ H.LFr	W.TpLFr _H.LFr	W.TpLFr _W.BtLFr
N	Valid	131	131	131	131	131	131
	Missing	0	0	0	0	0	0
Mean		.7621	.5857	.4420	.0789	.0534	.7026
Std. Error of Mean		.01793	.00796	.01102	.00281	.00183	.01606
Median		.7407	.6035	.4232	.0728	.0502	.6923
Mode		.37[a]	.35[a]	.21[a]	.11	.07	1.00
Std. Deviation		.20520	.09107	.12609	.03220	.02096	.18378
Variance		.042	.008	.016	.001	.000	.034
Skewness		.425	-.700	.655	1.409	1.163	-.031
Std. Error of Skewness		.212	.212	.212	.212	.212	.212
Kurtosis		-.515	.009	.209	2.964	2.395	-.613
Std. Error of Kurtosis		.420	.420	.420	.420	.420	.420
Range		.93	.41	.63	.20	.12	.72
Minimum		.37	.35	.21	.02	.02	.28
Maximum		1.30	.76	.84	.22	.14	1.00
Sum		99.83	76.73	57.90	10.34	6.99	92.04
Percentiles	25	.6077	.5359	.3488	.0559	.0387	.5652
	50	.7407	.6035	.4232	.0728	.0502	.6923
	75	.9169	.6454	.5123	.0951	.0647	.8320

a. Multiple modes exist. The smallest value is shown

Three-Masted Naus Fore Top Mast Data

		H.UFr_ H.Fr	H.UFr_ H.LFr	H.UFr_ L.H	W.BtUFr _H.Ufr	W.TpUF r_H.Ufr	W.BtUFr_ W.TpUFr
N	Valid	131	131	131	131	131	131
	Missing	0	0	0	0	0	0
Mean		.4128	.7533	.3186	.0712	.0578	.7991
Std. Error of Mean		.00803	.02835	.01118	.00274	.00274	.01603
Median		.3961	.6570	.2915	.0713	.0526	.8182
Mode		.19[a]	.25[a]	.13[a]	.10	.05[a]	1.00
Std. Deviation		.09193	.32444	.12797	.03131	.03140	.18350
Variance		.008	.105	.016	.001	.001	.034
Skewness		.633	1.427	1.142	.462	.857	-.702
Std. Error of Skewness		.212	.212	.212	.212	.212	.212
Kurtosis		.126	1.470	1.197	.459	.751	-.007
Std. Error of Kurtosis		.420	.420	.420	.420	.420	.420
Range		.46	1.57	.59	.15	.15	.86
Minimum		.19	.25	.13	.01	.01	.14
Maximum		.65	1.82	.72	.16	.16	1.00
Sum		54.07	98.68	41.74	9.32	7.57	104.68
Percentiles	25	.3560	.5505	.2280	.0506	.0338	.6630
	50	.3961	.6570	.2915	.0713	.0526	.8182
	75	.4518	.8661	.3887	.0862	.0753	.9901

a. Multiple modes exist. The smallest value is shown

Three-Masted Naus Fore Yard Data

Statistics

		L.FrY_L.H	L.FrY_ L.MaY	W.MFrY_ L.FrY	W.EFrY_ L.FrY	W.EFrY_ W.MFrY
N	Valid	135	135	135	135	135
	Missing	0	0	0	0	0
Mean		.4934	.6918	.0434	.0382	.8766
Std. Error of Mean		.01574	.01462	.00191	.00190	.01385
Median		.4629	.6936	.0399	.0352	1.0000
Mode		.14[a]	.33[a]	.05	.02	1.00
Std. Deviation		.18287	.16985	.02224	.02208	.16088
Variance		.033	.029	.000	.000	.026
Skewness		.971	.198	1.947	1.964	-1.040
Std. Error of Skewness		.209	.209	.209	.209	.209
Kurtosis		1.340	.002	7.652	8.365	-.027
Std. Error of Kurtosis		.414	.414	.414	.414	.414
Range		1.06	.88	.16	.16	.59
Minimum		.14	.33	.01	.01	.41
Maximum		1.20	1.21	.17	.17	1.00
Sum		66.61	93.40	5.86	5.16	118.34
Percentiles	25	.3632	.5916	.0287	.0200	.7647
	50	.4629	.6936	.0399	.0352	1.0000
	75	.5734	.7944	.0526	.0497	1.0000

a. Multiple modes exist. The smallest value is shown

Three-Masted Naus Fore Top Yard Data

Statistics

		L.FrTpY_L.H	L.FrTpY_L.FrY	L.FrTpY_L.MaTpY	W.MFrTpY_L.FrTpY	W.EFrTpY_L.FrTpY	W.EFrTpY_W.MFrTpY	W.MFrTpY_W.MMaTpY
N	Valid	20	20	14	20	20	20	14
	Missing	0	0	6	0	0	0	6
Mean		.2473	.5830	.7971	.0726	.0658	.8991	.9915
Std. Error of Mean		.01411	.04328	.03091	.00691	.00700	.02984	.07995
Median		.2410	.5340	.7608	.0720	.0533	1.0000	.9434
Mode		.16[a]	.35[a]	.62[a]	.10	.01[a]	1.00	.75[a]
Std. Deviation		.06312	.19354	.11564	.03090	.03132	.13345	.29916
Variance		.004	.037	.013	.001	.001	.018	.089
Skewness		1.020	1.175	.593	.514	.919	-.931	.508
Std. Error of Skewness		.512	.512	.597	.512	.512	.512	.597
Kurtosis		.884	.826	-.328	.369	1.133	-.692	-.769
Std. Error of Kurtosis		.992	.992	1.154	.992	.992	.992	1.154
Range		.23	.68	.41	.13	.14	.36	.94
Minimum		.16	.35	.62	.02	.01	.64	.57
Maximum		.39	1.02	1.03	.15	.15	1.00	1.51
Sum		4.95	11.66	11.16	1.45	1.32	17.98	13.88
Percentiles	25	.1991	.4485	.7193	.0514	.0441	.7796	.7477
	50	.2410	.5340	.7608	.0720	.0533	1.0000	.9434
	75	.2682	.6690	.9047	.0982	.0915	1.0000	1.2443

a. Multiple modes exist. The smallest value is shown

APPENDIX 35

BOOMKIN AND BOWSPRIT SPAR FREQUENCY TABLES FOR THE CARAVELS, GALLEONS, AND NAUS

All Caravels Boomkin and Four-Masted Caravels Bowsprit Data

		L.Bm_L.H
N	Valid	67
	Missing	0
Mean		.1826
Std. Error of Mean		.00769
Median		.1804
Mode		.07[a]
Std. Deviation		.06294
Variance		.004
Skewness		.756
Std. Error of Skewness		.293
Kurtosis		.879
Std. Error of Kurtosis		.578
Range		.30
Minimum		.07
Maximum		.37
Sum		12.24
Percentiles	25	.1361
	50	.1804
	75	.2185

Statistics

		L.Bw_L.H
N	Valid	41
	Missing	0
Mean		.3675
Std. Error of Mean		.01882
Median		.3685
Mode		.12[a]
Std. Deviation		.12054
Variance		.015
Skewness		.343
Std. Error of Skewness		.369
Kurtosis		-.267
Std. Error of Kurtosis		.724
Range		.53
Minimum		.12
Maximum		.65
Sum		15.07
Percentiles	25	.2798
	50	.3685
	75	.4528

a. Multiple modes exist. The smallest value is shown

Four -Masted Caravels Spritsail Data

		L.BwY_ L.FrY	W.MBwY _L.BwY	W.EBwY_ L.BwY	W.MBwY_ W.EBwY
N	Valid	15	18	18	18
	Missing	3	0	0	0
Mean		.6650	.0602	.0602	1.0000
Std. Error of Mean		.04523	.01185	.01185	.00000
Median		.6250	.0389	.0389	1.0000
Mode		.44[a]	.02[a]	.02[a]	1.00
Std. Deviation		.17517	.05026	.05026	.00000
Variance		.031	.003	.003	.000
Skewness		.684	2.170	2.170	
Std. Error of Skewness		.580	.536	.536	.536
Kurtosis		-.118	4.609	4.609	
Std. Error of Kurtosis		1.121	1.038	1.038	1.038
Range		.61	.19	.19	.00
Minimum		.44	.02	.02	1.00
Maximum		1.05	.21	.21	1.00
Sum		9.98	1.08	1.08	18.00
Percentiles	25	.5194	.0311	.0311	1.0000
	50	.6250	.0389	.0389	1.0000
	75	.8091	.0660	.0660	1.0000

Three-Masted Galleons Boomkin and Bowsprit Data

		L.Bm_L.H
N	Valid	6
	Missing	0
Mean		.1776
Std. Error of Mean		.01894
Median		.1671
Mode		.13[a]
Std. Deviation		.04639
Variance		.002
Skewness		.718
Std. Error of Skewness		.845
Kurtosis		-.567
Std. Error of Kurtosis		1.741
Range		.12
Minimum		.13
Maximum		.25
Sum		1.07
Percentiles	25	.1373
	50	.1671
	75	.2234

Statistics

		L.Bw_L.H
N	Valid	7
	Missing	0
Mean		.3989
Std. Error of Mean		.03418
Median		.3514
Mode		.32[a]
Std. Deviation		.09042
Variance		.008
Skewness		1.061
Std. Error of Skewness		.794
Kurtosis		-.786
Std. Error of Kurtosis		1.587
Range		.22
Minimum		.32
Maximum		.54
Sum		2.79
Percentiles	25	.3342
	50	.3514
	75	.5097

a. Multiple modes exist. The smallest value is shown

Three-Masted and Four-Masted Galleons Spritsail Data

		L.BwY_ L.FrY	W.MBwY _L.BwY	W.EBwY_ L.BwY	W.MBwY _W.EBwY
N	Valid	5	5	5	5
	Missing	0	0	0	0
Mean		.6121	.0632	.0632	1.0000
Std. Error of Mean		.02969	.01550	.01550	.00000
Median		.5953	.0656	.0656	1.0000
Mode		.54[a]	.01[a]	.01[a]	1.00
Std. Deviation		.06638	.03465	.03465	.00000
Variance		.004	.001	.001	.000
Skewness		1.334	-.111	-.111	
Std. Error of Skewness		.913	.913	.913	.913
Kurtosis		2.334	1.136	1.136	
Std. Error of Kurtosis		2.000	2.000	2.000	2.000
Range		.18	.10	.10	.00
Minimum		.54	.01	.01	1.00
Maximum		.72	.11	.11	1.00
Sum		3.06	.32	.32	5.00
Percentiles	25	.5629	.0335	.0335	1.0000
	50	.5953	.0656	.0656	1.0000
	75	.6698	.0917	.0917	1.0000

Four-Masted Galleons Boomkin and Bowsprit Data

		L.Bm_L.H
N	Valid	20
	Missing	0
Mean		.1673
Std. Error of Mean		.01389
Median		.1732
Mode		.05[a]
Std. Deviation		.06210
Variance		.004
Skewness		-.206
Std. Error of Skewness		.512
Kurtosis		-1.014
Std. Error of Kurtosis		.992
Range		.21
Minimum		.05
Maximum		.26
Sum		3.35
Percentiles	25	.1163
	50	.1732
	75	.2306

Statistics

		L.Bw_L.H
N	Valid	24
	Missing	0
Mean		.4104
Std. Error of Mean		.02796
Median		.3852
Mode		.17[a]
Std. Deviation		.13698
Variance		.019
Skewness		.418
Std. Error of Skewness		.472
Kurtosis		-.113
Std. Error of Kurtosis		.918
Range		.54
Minimum		.17
Maximum		.70
Sum		9.85
Percentiles	25	.3259
	50	.3852
	75	.4886

a. Multiple modes exist. The smallest value is shown

Three-Masted Naus Boomkin Data

		L.Bm_L.H
N	Valid	187
	Missing	0
Mean		.2113
Std. Error of Mean		.00647
Median		.1910
Mode		.07[a]
Std. Deviation		.08843
Variance		.008
Skewness		1.300
Std. Error of Skewness		.178
Kurtosis		2.818
Std. Error of Kurtosis		.354
Range		.55
Minimum		.07
Maximum		.62
Sum		39.52
Percentiles	25	.1495
	50	.1910
	75	.2613

Statistics

		L.Bw_L.H
N	Valid	191
	Missing	0
Mean		.4008
Std. Error of Mean		.00927
Median		.3867
Mode		.11[a]
Std. Deviation		.12813
Variance		.016
Skewness		.663
Std. Error of Skewness		.176
Kurtosis		.596
Std. Error of Kurtosis		.350
Range		.73
Minimum		.11
Maximum		.84
Sum		76.55
Percentiles	25	.3061
	50	.3867
	75	.4765

a. Multiple modes exist. The smallest value is shown

Three-Masted Naus Spritsail Data

		L.BwY_ L.FrY	W.MBwY _L.BwY	W.EBwY _L.BwY	W.MBwY _W.EBwY
N	Valid	57	57	57	57
	Missing	0	0	0	0
Mean		.6724	.0564	.0564	1.0000
Std. Error of Mean		.02211	.00474	.00474	.00000
Median		.6538	.0540	.0540	1.0000
Mode		.21[a]	.02[a]	.02[a]	1.00
Std. Deviation		.16693	.03580	.03580	.00000
Variance		.028	.001	.001	.000
Skewness		.469	2.025	2.025	
Std. Error of Skewness		.316	.316	.316	.316
Kurtosis		1.420	6.868	6.868	
Std. Error of Kurtosis		.623	.623	.623	.623
Range		.98	.20	.20	.00
Minimum		.21	.02	.02	1.00
Maximum		1.20	.22	.22	1.00
Sum		38.33	3.21	3.21	57.00
Percentiles	25	.5525	.0283	.0283	1.0000
	50	.6538	.0540	.0540	1.0000
	75	.7760	.0725	.0725	1.0000

a. Multiple modes exist. The smallest value is shown

APPENDIX 36

STERNCASTLE, WAIST, AND FORECASTLE FREQUENCY TABLES FOR THE CARAVELS, GALLEONS, AND NAUS

Four-Masted Caravels Forecastle Data

Statistics

		L.Fc_L.H	L.Fc_L.Sc	L.Fc_L.Wa	H.Fc_H.Sc	H.Fc_L.Fc
N	Valid	39	39	39	39	39
	Missing	0	0	0	0	0
Mean		.2457	.5756	.9046	.6864	.6578
Std. Error of Mean		.01153	.03498	.05158	.03196	.05174
Median		.2571	.5821	.9524	.7471	.6083
Mode		.13[a]	.25[a]	.38[a]	.35[a]	.22[a]
Std. Deviation		.07203	.21842	.32212	.19962	.32310
Variance		.005	.048	.104	.040	.104
Skewness		.216	1.060	.117	.000	1.130
Std. Error of Skewness		.378	.378	.378	.378	.378
Kurtosis		-.665	1.222	-.788	-1.214	1.456
Std. Error of Kurtosis		.741	.741	.741	.741	.741
Range		.28	.96	1.28	.69	1.41
Minimum		.13	.25	.38	.35	.22
Maximum		.41	1.21	1.66	1.03	1.63
Sum		9.58	22.45	35.28	26.77	25.65
Percentiles	25	.1833	.4130	.6158	.4946	.4068
	50	.2571	.5821	.9524	.7471	.6083
	75	.2924	.6816	1.1743	.8571	.8397

a. Multiple modes exist. The smallest value is shown

Four-Masted Caravels Sterncastle Data

Statistics

		L.Sc_L.H	L.Pd_L.Sc	L.Qd_L.Sc	H.Pd_H.Sc	H.Qd_H.Sc	H.Sc_L.Sc
N	Valid	36	36	36	36	36	36
	Missing	0	0	0	0	0	0
Mean		.4443	.5131	.4869	.3806	.4332	.5112
Std. Error of Mean		.00853	.01760	.01760	.02210	.02427	.02450
Median		.4364	.5031	.4969	.3747	.4360	.5115
Mode		.31[a]	.33[a]	.15[a]	.19[a]	.21[a]	.23[a]
Std. Deviation		.05120	.10558	.10558	.13258	.14564	.14702
Variance		.003	.011	.011	.018	.021	.022
Skewness		.604	1.285	-1.285	.611	.515	.074
Std. Error of Skewness		.393	.393	.393	.393	.393	.393
Kurtosis		2.047	2.661	2.661	-.189	-.413	-.572
Std. Error of Kurtosis		.768	.768	.768	.768	.768	.768
Range		.28	.51	.51	.51	.59	.59
Minimum		.31	.33	.15	.19	.21	.23
Maximum		.59	.85	.67	.71	.81	.82
Sum		16.00	18.47	17.53	13.70	15.60	18.40
Percentiles	25	.4179	.4458	.4472	.2705	.3126	.3805
	50	.4364	.5031	.4969	.3747	.4360	.5115
	75	.4667	.5528	.5542	.4642	.5692	.6275

a. Multiple modes exist. The smallest value is shown

Four-Masted Caravels Waist Data

Statistics

		L.Wa_L.H	H.Wa_L.H
N	Valid	38	38
	Missing	0	0
Mean		.2778	.1214
Std. Error of Mean		.00816	.00583
Median		.2747	.1207
Mode		.15[a]	.04[a]
Std. Deviation		.05032	.03595
Variance		.003	.001
Skewness		.053	.517
Std. Error of Skewness		.383	.383
Kurtosis		-.018	1.168
Std. Error of Kurtosis		.750	.750
Range		.22	.19
Minimum		.15	.04
Maximum		.38	.23
Sum		10.56	4.61
Percentiles	25	.2425	.0944
	50	.2747	.1207
	75	.3108	.1461

a. Multiple modes exist. The smallest value is shown

Three-Masted and Four-Masted Galleons Forecastle Data

Statistics

		L.Fc_L.H	L.Fc_L.Sc	L.Fc_L.Wa	H.Fc_H.Sc	H.Fc_L.Fc
N	Valid	21	21	21	21	21
	Missing	0	0	0	0	0
Mean		.2186	.5120	.8833	.6682	.5127
Std. Error of Mean		.01363	.02928	.09155	.05841	.04932
Median		.2100	.5250	.8072	.6111	.4104
Mode		.13[a]	.22[a]	.29[a]	.30[a]	.23[a]
Std. Deviation		.06246	.13418	.41952	.26768	.22603
Variance		.004	.018	.176	.072	.051
Skewness		.566	.288	.804	.824	1.321
Std. Error of Skewness		.501	.501	.501	.501	.501
Kurtosis		-.236	1.801	-.197	.021	2.069
Std. Error of Kurtosis		.972	.972	.972	.972	.972
Range		.23	.65	1.51	.93	.94
Minimum		.13	.22	.29	.30	.23
Maximum		.36	.86	1.80	1.23	1.17
Sum		4.59	10.75	18.55	14.03	10.77
Percentiles	25	.1735	.4174	.5477	.4769	.3467
	50	.2100	.5250	.8072	.6111	.4104
	75	.2690	.5904	1.1317	.7993	.6726

a. Multiple modes exist. The smallest value is shown

Three-Masted and Four-Masted Galleons Sterncastle Data

Statistics

		L.Sc_L.H	L.Pd_L.Sc	L.Qd_L.Sc	H.Pd_H.Sc	H.Qd_H.Sc	H.Sc_L.Sc
N	Valid	18	18	18	18	18	18
	Missing	0	0	0	0	0	0
Mean		.4404	.5223	.4777	.4900	.4717	.4022
Std. Error of Mean		.01914	.02662	.02662	.02189	.02081	.03871
Median		.4435	.5071	.4929	.4949	.4752	.3376
Mode		.28[a]	.33[a]	.29[a]	.32[a]	.27[a]	.20[a]
Std. Deviation		.08120	.11292	.11292	.09285	.08829	.16421
Variance		.007	.013	.013	.009	.008	.027
Skewness		.233	.171	-.171	.172	-.788	1.204
Std. Error of Skewness		.536	.536	.536	.536	.536	.536
Kurtosis		1.053	-1.148	-1.148	.280	.528	1.087
Std. Error of Kurtosis		1.038	1.038	1.038	1.038	1.038	1.038
Range		.35	.38	.38	.37	.34	.62
Minimum		.28	.33	.29	.32	.27	.20
Maximum		.63	.71	.67	.68	.61	.82
Sum		7.93	9.40	8.60	8.82	8.49	7.24
Percentiles	25	.3880	.4249	.3731	.4370	.4249	.2750
	50	.4435	.5071	.4929	.4949	.4752	.3376
	75	.4835	.6269	.5751	.5322	.5323	.4889

a. Multiple modes exist. The smallest value is shown

Three-Masted and Four-Masted Galleons Waist Data

Statistics

		L.Wa_L.H	H.Wa_L.H
N	Valid	22	22
	Missing	0	0
Mean		.2954	.1340
Std. Error of Mean		.02334	.00769
Median		.2838	.1332
Mode		.16[a]	.07[a]
Std. Deviation		.10948	.03608
Variance		.012	.001
Skewness		1.356	.584
Std. Error of Skewness		.491	.491
Kurtosis		2.589	.127
Std. Error of Kurtosis		.953	.953
Range		.45	.15
Minimum		.16	.07
Maximum		.62	.22
Sum		6.50	2.95
Percentiles	25	.2182	.1017
	50	.2838	.1332
	75	.3369	.1544

a. Multiple modes exist. The smallest value is shown

Three-Masted Naus Forecastle Data

Statistics

		L.Fc_L.H	L.Fc_L.Sc	L.Fc_L.Wa	H.Fc_H.Sc	H.Fc_L.Fc
N	Valid	169	169	169	169	169
	Missing	0	0	0	0	0
Mean		.2652	.6368	1.0229	.7601	.7243
Std. Error of Mean		.00519	.01572	.02946	.01737	.02190
Median		.2673	.6145	.9736	.7613	.6737
Mode		.31[a]	.90	.17[a]	1.00	.64[a]
Std. Deviation		.06751	.20438	.38299	.22586	.28476
Variance		.005	.042	.147	.051	.081
Skewness		.046	.735	1.012	.007	.394
Std. Error of Skewness		.187	.187	.187	.187	.187
Kurtosis		.333	1.053	2.099	-.240	-.717
Std. Error of Kurtosis		.371	.371	.371	.371	.371
Range		.43	1.13	2.54	1.16	1.22
Minimum		.08	.21	.17	.23	.17
Maximum		.51	1.35	2.71	1.39	1.40
Sum		44.83	107.62	172.87	128.45	122.41
Percentiles	25	.2164	.5026	.7591	.6104	.5183
	50	.2673	.6145	.9736	.7613	.6737
	75	.3113	.7532	1.2155	.9226	.9447

a. Multiple modes exist. The smallest value is shown

Three-Masted Naus Sterncastle Data

Statistics

		L.Sc_L.H	L.Pd_L.Sc	L.Qd_L.Sc	H.Pd_H.Sc	H.Qd_H.Sc	H.Sc_L.Sc
N	Valid	157	157	157	157	157	157
	Missing	0	0	0	0	0	0
Mean		.4286	.5717	.4346	.4131	.4764	.5878
Std. Error of Mean		.00487	.01058	.00878	.01034	.01037	.01461
Median		.4331	.5686	.4314	.4195	.4822	.5618
Mode		.13[a]	.31[a]	.08[a]	.18[a]	.16[a]	.50
Std. Deviation		.06097	.13253	.11003	.12954	.12993	.18303
Variance		.004	.018	.012	.017	.017	.033
Skewness		-.759	1.899	-.241	.373	-.131	.281
Std. Error of Skewness		.194	.194	.194	.194	.194	.194
Kurtosis		3.729	9.928	.522	.280	-.245	-.734
Std. Error of Kurtosis		.385	.385	.385	.385	.385	.385
Range		.47	1.09	.61	.72	.61	.85
Minimum		.13	.31	.08	.18	.16	.22
Maximum		.60	1.39	.69	.90	.77	1.06
Sum		67.28	89.76	68.24	64.86	74.80	92.29
Percentiles	25	.4001	.4928	.3721	.3042	.4001	.4453
	50	.4331	.5686	.4314	.4195	.4822	.5618
	75	.4642	.6325	.5072	.5058	.5671	.7431

a. Multiple modes exist. The smallest value is shown

Three-Masted Naus Waist Data

Statistics

		L.Wa_L.H	H.Wa_L.H
N	Valid	181	181
	Missing	0	0
Mean		.2949	.1347
Std. Error of Mean		.00760	.00309
Median		.2693	.1311
Mode		.12[a]	.03[a]
Std. Deviation		.10230	.04158
Variance		.010	.002
Skewness		1.995	.563
Std. Error of Skewness		.181	.181
Kurtosis		5.050	.862
Std. Error of Kurtosis		.359	.359
Range		.66	.27
Minimum		.12	.03
Maximum		.77	.29
Sum		53.38	24.39
Percentiles	25	.2365	.1067
	50	.2693	.1311
	75	.3238	.1602

a. Multiple modes exist. The smallest value is shown

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