

THE SPANISH REGULATIONS FOR SHIPBUILDING (*ORDENANZAS*) OF THE SEVENTEENTH CENTURY

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Abstract

Spanish shipbuilding and navigation reached a peak during the 17th century. The need to communicate the ports of the Empire, to convey goods across the Atlantic and the Pacific added to the need to defend the atlantic and mediterranean fronts in Europe and North Africa. Private, merchant ships were strategically important and they were frequently armed by the Crown to join the few ships built at its expense. Philip II had started the technical approach to shipbuilding with the galleons that joined the Armada in 1588. The *Ordenanza* of 1607 was a consequence of that approach and represent a pioneer effort to define forms and dimensions. The lessons learned from its application were incorporated in the *Ordenanza* of 1618 that remained as the official regulation for all Spanish shipbuilding in all the Empire. The development of the navies in France, Holland and England, the behavior of their ships in combat and their presence in the West Indies influenced the modifications of the *Ordenanzas* in the last quarter of the century and opened the way for the construction of the largest ships in the 17th century. The meaning and the technical content of the *Ordenanzas* is analyzed and compared and a personal translation of the articles on ship design of 1618 is included.

1. Introduction

When Philip II became King of Portugal in 1580, one dream of his grand-grand parents Isabel and Fernando, the Catholic Queen and King, came true and ‘the Sun was never setting over Spanish territories’. But a universal responsibility was also put upon the shoulders of Philip, who had to care for distant lands separated by seas too often ploughed by ships of European competitors, eager to bite a piece of the Spanish cake. The royal eyes that the Emperor had focused on Europe were turned to the oceans, and the Atlantic road to the Indies and the Pacific trail gained a priority attention from the Crown, while matters related to ships and shipping were treated with a new care.

Maritime matters had deserved a special and distinct attention since the creation of the *Casa de Contratación* in 1503, in Seville (the House of Contracts, or just The House) as the only authority over the fleets departing and arriving from the Indies through Sanlúcar, with capacity to legislate on maritime commerce, ships and navigation. After the creation of the title of *Piloto Mayor* (Higher Pilot) in 1508, an association was established in Seville where shipowners, pilots and masters of the traffic with the Indies gathered to discuss maritime matters. This was followed by the Consulate of Merchants (*Lonja*, and also Bourse) in 1543 and a royal decree founded the Chair of Art of Navigation and Cosmography in 1552. The University of Navigators (*Universidad de Mareantes*, “seagoers”) was created in 1569, and the House obtained from the King the

conversion of the Consulate to *Colegio de San Telmo* (1681), the House school of pilots that were demanded for the *Carrera de Indias* (Indies Run).

2. Spanish Galleons in the 16th century

The Spanish Galleon represents a unique contribution to naval architecture. Conceived as a vessel equipped to protect the Fleets sailing to the Indies they became a preferred source of inspiration to roman writers and film makers that distorted their figure.¹ Don Álvaro de Bazán *el Viejo* (the Elder) is credited with the idea of building few, special, high sided vessels to patrol the coasts of Spain while awaiting the fleets coming from the Indies. That was around 1545, shortly after the conquest of Peru and before the Silver Fleets system was established. Then it was the Adelantado Pedro Menéndez de Avilés who, after settling in Florida (1568) built the first *galeones agalerados* (galley-like galleons) to cruise the Spanish lake of the Caribbean, especially after Drake had crossed the straits of Magellan and piraced in the Pacific, until then another Spanish Lake. But they were not real galleons, not yet. The assumption of the Crown of Portugal with belligerent opposition of England and France forced Phillip II in 1580 to design the first Spanish galleons under the direction of don Alvaro de Bazán, *el Mozo* (the Younger). They were not only the first galleons designed as such but their construction brought about the first debate on Naval Architecture that is recorded. The King called together the most prominent experts in shipbuilding and navigation in Spain to discuss how the new galleons should be. Renown captains like Diego Flórez de Valdés, Pedro Sarmiento de Gamboa and general Diego de Sotomayor, all in Seville, exchanged their opinions with experienced ship designers and builders in Santander like Cristóbal de Barros, Pedro de Busturria and Juan Martínez de Recalde.² For almost one year the Juntas of Santander and Seville discussed forms, dimensions, structures and details of the nine new galleons that were finally built in Guarnizo and sailed successfully in the Armada of 1588 as the Castille Squadron.³ Seven galleons were launched in less than two months, from April 20 to June 19, and two more in July 1583, setting a historical reference to shipbuilding.⁴

Table 1. Dimensions of the first Spanish galleons

Year	galleons	Tons	L	K	B	HB	D1	D2	D3
1568	P. Menéndez	240	44	30	12	4	3.5	3.5	---
1582	7 Small	420	52	34	15	6	3.5	3.5	---
1582	2 Large	550	56	36	16	4	3.5	3.5	3.75
1589	4 small	574	54	34	17	4	3.5	3.5	---
1589	4 medium	742	59	38	18.5	4	4	3.5	3.5
1589	4 large	974	64	42	20.5	4	5	3.5	3.5

All dimensions are in Shipbuilders or Royal Cubits of 0.57468 m

Tons are Spanish tons of burthen or tonnage = 8 cubic cubits

L = length; K = clean keel; B = breadth; HB = depth from floor to hold beams;

D1 = from hold beams to deck; D2 = 1st 'tweendeck; D3 = 2nd 'tweendeck.

The discussions on the galleons of 1582 set the style that would be used for future ship specifications and architecture and reached its highest level in the Regulations of the 17th century. They were very strong ships, “for they had to support much sail to chase and escape and the sides to suffer much and heavy artillery”.⁵

The failure of the Armada campaign in 1588 and the ship losses were but a small blow to the Spanish sea power and the Crown launched an immediate plan to build twenty one large galleons. Six were built in Portugal for the Eastern Run and twelve between Bilbao and Guarnizo.⁶

Again, expert shipbuilders and sea captains were consulted to define the design of the new galleons that were to serve in two different scenarios: the *Carrera de Indias* and the North Atlantic. These designs were inspired in the nine galleons of 1583 but they were built in three sizes to allow for different missions.

The need to counteract on the growing sea power of England drove Spain’s dedication to investigate the best vessels to respond to emerging threats in all seas. Any solution had to tackle an eternal problem of the naval architect: to combine seakeeping and hull strength with cargo capacity, low draft and artillery. The solutions applied to merchant and combatant vessels thus configuring the Spanish galleon. The Crown had to maintain the Fleets of the Indies and secure the commerce with northern European ports.

The galleons of 1589 were built during a period when English ships ran over the coasts of Galicia and they complemented the preparation of a new Armada for 1590. One hundred large vessels and more than eighty small ones were listed and measured in Lisbon and Santander for that campaign.⁷

The twelve galleons built in Guarnizo and Bilbao had larger beam/keel ratios than before to keep their draft low enough to pass the bars of Sanlúcar and San Juan de Ulúa and shallow waters in the Caribbean. Conceived to be of 500, 700 and 800 tons, the smaller and larger ones were launched with larger sizes.

3. The Regulations

The *Compilation of the Laws for the Kingdoms of the Indies*, ordered by King Charles II and published in 1681 include the whole corpus of legislation created and applied by Spain in her possessions in the New World since the years of discovery.

Four volumes with over 2,500 pages offer a unique source for researchers of every aspect of life in Spain and her ultramarine vicekingdoms. They cover the laws that organized the nation with regard to: the Catholic Faith and the Inquisition, Universities, the Council of the Indies, the House of Contracts and the University of Navigators, Courts, Hearers, Surveyors, *Presidios*, Settlements, Mining, Foundries, Fishing, Taxation, Notaries, Physicians, Mayors and Sheriffs, *Encomiendas*, Treasury, *Estancos*, Jails, Accounting, Fleets and *Armadas*, Immigration, Insurance and Shipbuilding.

Titles 28 and 29 of Volume Four deal with the Fabrication, Caulking, Outfitting and Tonnage of Ships, while titles 30 thru 35 regulate the organization and sailing of the Armadas and Fleets, freights, registry, loading, unloading and surveying. Titles 36 thru

46 cover the commerce and navigation to the Indies and in the Weatherly Isles, *Terra Firme*, the Southern Sea, New Spain, China and the Philipines.

Many of these Laws were kept invariable for almost two centuries, as illustrated by these few samples:

Law I of Title XXVI: That nobody, either natural or foreigner can go to the Indies without a license by the King, or by the House of Seville in the cases where it could give such license.

Given by the Emperor as House Ordinance 113 and renewed by Philip II in 1560, Philip III in 1604 and Charles II in 1681.

Law II of Title XXVI: Fixing the penalties for Generals, Captains, Officers and Ministers of the Armadas that take or hide passengers to the Indies without a license.

Was issued by the Emperor as House Ordinance 114, and renewed by Philip II in 1595, Philip III in 1604 and 1607, and by Philip IV in 1621, 1614 and 1638.

Philip II had ordered in 1584 that any license to pass to the Indies was valid only for two years. (Law VI)

The control of the passage was especially strict for Priests and Friars by an order of the Emperor dictated in 1535. (Law XI)

A similar restriction applied to those born in the Indies to Spanish residents, who needed a royal license to enter Spain. (Law XIII, 1559)

Converted Moors, Indians and their children also needed a royal license to pass the the Indies. (Law XV, 1512)

And the prohibition to pass to the Indies was total for the reconciled or descendants of those burnt, condemned or heretic. (Law XVI, 1518 and 1539)

Title XXVIII deals with the Fabricators and Caulkers as well as the fabrication and outfitting of Ships and their tonnage.

Law I, 1624. That in Seville should reside one High Master of Shipbuilding and Carpentry of Armadas and Fleets.

Law II, 1597. That fabricators of ships should be assisted in accordance with this Law. With the desire to favor and help the fabricators of our Kingdoms, to encourage them to fabricate many ships with the art and goodness that are convenient to the effect of the service, especially for the Armadas and Fleets of the Course of the Indies, on which relays a great part of the strength of these Kingdoms and the security and growth of their commerce. We were pleased that the assistance of four thousand ducats that we gave them be increased by one third more, and that they enjoy in the interim each one sells his ship for three years time, counted from the time of the launching. For these and other reasons convenient to our Royal service, we order the Ministers in charge of these adjustments and assistance that they be obliged in form and be in charge of the fabrication of ships of the burthen, design, perfection and goodness they should be, to give assistance in accordance with the previous order and make sure that they will fabricate those ships and will reimburse the amount they receive when they sell the ship whose fabrication was assisted; and if during those three years they sell them or lose the property in all or in part, in any form, take the three years period as finished.

4. Need to regulate

Many instructions, royal decrees and official rules of all kinds were dictated along the 17th century concerning shipbuilding, shipping and other maritime matters but only a few were *Ordenanzas*: those given in 1607, 1613 and 1618, plus the modifications of 1666 and 1679.

Several reasons explain why Spain was the first nation in Europe to produce such detail Regulations for ships and shipping:

The *Carrera de Indias* had become a vital artery for the Empire but the ships that crossed the Atlantic were less and less reliable.

The Crown needed that merchant ships were built so that they could serve in the *armadas* when they were seized by *embargo*.

Portugal had added new ocean routes and strategic needs that required a global organization of shipbuilding and shipping.

The war with France, England and Holland had called for a new approach to shipbuilding.

Consequently, ships that were eligible for the *Carrera* would have to comply with:

Naval Architecture and solid construction suitable for navigation in all oceans.

Limited draft to be able to cross the bar of Sanlúcar and other shallow waters.

Large cargo capacity.

Possibility to be converted into armed vessels when needed.

5. 1607 Regulations

The *Ordenanzas* of 1607 were the result of discussions of experts in shipbuilding and navigation in the Ocean and the *Carrera*, in merchant and armed ships, assembled by the War Council. They tried to agree on a general type of vessel that was:

Multifunctional, to be used as merchant and armed alternatively.

To gain stability, which required lower decks and broader floors, like in Holland.

Higher length-to-beam ratio, to compensate for the loss of depth and to gain speed

These *Ordenanzas* gave the dimensions needed to define the hull and a detailed description of hull structure elements and joints, and how to assemble the hull. Only five main dimensions were actually necessary to define a hull: beam, keel, length, depth and rising line. With these, the traditional expertise of shipwrights was able to complete the forms of the hull using just circular arcs. Halfdeck and Bridge were specified also. (Table 2)

Vessels were classified by their beam in shipwright cubits: *navíos* (10-12), small galleons (*galeoncetes*, 13) and galleons (14-22). The larger galleons reached 1351 tons.

Before sailing to the Indies, all ships were inspected by surveyors of the House, two iron rings were nailed to the stem and the stern post to mark the maximum draft allowed and their freeboard to the helm port and the stem head was registered in a book.

Contravention of this rule was punished with the loss of half the value of the vessel, one third for the judge and two thirds for the denouncer.

Cargo capacity in volume and ship tonnage were calculated using a general rule that assumed the same shape and structures for all vessels:

Cargo capacity = (Depth x Beam x Length / 2) x 95/100, cubic cubits

Armada Tonnage = Cargo capacity / 8, *toneles machos* (male casks)

Commercial Tonnage = Armada Tonnage x 120/100, *toneladas* (tons)

5% was deducted for narrow ends and 20% added as compensation (*refacción*) to those taken for royal service, which were paid 8.5 reales per *tonelada* each month.

Hull forms followed traditional Cantabrian designs and showed influences of Adriatic shipbuilders of Venice and Ragusa, and hull structures shared common solutions with Portugal.

Several articles detailed the obligations and salary of the workers at the shipyards (*Maestranza*). Each worker had to carry his own tools and keep them in good condition of use. Admitting to a shipyard a worker without his tools was fined with 200 ducats or serving 5 years at the row in galleys. Taking any materials out of the shipyard, including nails, chips and oakum, was also punished with 100 ducats or serving 5 years at the row in galleys. One ducat was worth 11 reales or about two average daily salaries, thence the severity of the fines that were always split for the denouncer and the judge.

These *Ordenanzas* were signed in Madrid on Dec.21st, 1607 but they were of limited life and so contested by shipbuilders and shippers that their actual application was almost nil.

The same year, Tomé Cano wrote his *Arte de Fabricar y Fortificar Naos*, published in 1611, dedicated to Diego Brochero, where he proposed to deviate from the *Ordenanzas* and follow the practice of captain Juan de Veas, especially with regard to the rising and narrowing of the floors, the rakes and the use of the *joba* for the first time.⁸

6. 1613 Regulations

After the Peace of London (1604) and the Twelve Years Truce (1609), the need for a multifunctional vessel lost its validity as navigation in the *Carrera* was normalized. Cantabrian shipbuilders requested freedom to build more-commercial ships and the Crown started a new period of consults and discussions to revise the *Ordenanzas*.

A new Builders Board (*Junta de Constructores*) was assembled in Madrid to find a solution to the problems posed by the multifunctional character of the ships in the *Ordenanzas* of 1607. With the advice of Diego Brochero they decided to distinguish the ships built for the *Carrera* from those built to serve in the *Armada del Océano* (the Ocean Fleet). The use of the *joba* proposed by Juan de Veas moved the widest beam down providing a vertical zone at the side that produced the effect sought by vicious bulging or doubling (*embono*). The importance of the rakes of the stem and the stern was recognized and they were regulated for the first time to cut the builders freedom to shape the stem *at will*.

The dimensions on these *Ordenanzas* transpire a mathematical scent probably due to the contribution of J.B.Lavanha, tutor and advisor of Philip III in Madrid, who wrote his ideas of ship design, inspired in Portuguese practice, in the unfinished *Livro Primeiro de Architectura Naval*, ca.1608.⁹ However, Lavanha's work was superseded by the implementation of the system of Juan de Veas and remained unpublished until 1996.

The new Regulations of 1613 were approved by Philip III and signed by Martín de Aróztegui in San Lorenzo, on July 6th, 1613. They are a complete text on ship design and shipbuilding, explained in 106 articles that cover all ships from 8 to 22 cubits in breadth, their dimensions to define the forms, specifications and scantlings to fabricate the hulls and dimensions for masting. They regulated 35 dimensions for each ship versus only 7 in 1607. (Table 3)

Following the same lines of 1607, several articles regulated the salary and obligations of the workers at the shipyards in Sevilla, Cadiz and along the Guadalquivir river, and the same punishment was dictated for those failing to have their tools in good order or taking any materials away from the shipyards. As in 1607, the importance of water aboard dictated that each Armada Galleon should carry as many casks (*pipotes*) as possible, each of four barrels capacity, hooped with ten iron rings four fingers wide, filled with fresh water, that once emptied be used to protect the sails from rats when wintering, and refilled with salt water for ballast in campaign.

Under these Regulations, merchant vessels were differentiated from *navíos de armada* from their very design. The deck of merchant vessels was located at the height of the breadth, or maximum beam, while armada ships would have their deck one half cubit (287.3 mm) above that height. That meant that armada ships would have better stability for the same depth of hold. To gain hold volume, the rising at the stern was reduced. More important was the change of conception of the hull to respond to pitching on waves and avoid dismasting. The keel was increased for each beam, what arose the protests of merchants that had narrower holds for the same keel. At the same time, the length was reduced for all beams above 16 cubits, up to 5 cubits of the 76 previously established for beams of 22. It was a drastic change that meant less rake and hull proportions adjusted for better seakeeping and strength while increasing the ship speed, in line with the old navigators saying "*dame quillas y te daré millas*" (give me keels and I'll give you miles).

Merchant vessels built by private owners and those built to bring silver from the Indies were limited to 17 cubits in breadth. All ships were visited before being allowed to sail to the Indies and the surveyors of the House nailed two iron rings on both sides, at midship to mark the deck line and limit the draft for the bars of Sanlúcar and San Juan de Ulúa. The draft, freeboard and location of the marks were registered in a book and the contravenor of this rule would lose half the value of his ship that was divided in four parts, one for the Crown, one for the judge and two for the denouncer. Only ships up to 17-1/2 cubits in breadth and 8-1/2 cubits in depth were admitted in the Fleets. Ships with side doubling or bulging or with a flush bridge were refused also.

Building and fitting the ships required the previous approval of the superintendent of shipbuilding who had to give the dimensions and supervise the works. The fabricator of a vessel exceeding the *Ordenanzas* would lose one fourth of the value of the vessel, that was allotted in halves to the superintendent and the denouncer and the superintendent

that failed to give the dimensions of these *Ordenanzas* would be separated from office and pay 1,000 ducats to the fabricator.

7. 1618 Regulations

The end of the Crown's search for a model for shipbuilding ended in 1618 with the publication of the last *Ordenanzas* of the century. During twelve years all knowledge on shipbuilding and navigation was put on the table of the War Council and all matters were discussed openly and thoroughly in an unprecedented, organized and shared effort to build up science and technology for shipbuilding. And it was done under the auspices of a king that seldom sailed but had inherited an Empire that needed the seas and ships for survival.

The *Ordenanzas of 1618* were in force for over one hundred years regulating the design and construction of ships in Spain and all her possessions in America and the Pacific. This doesn't mean that they were complied with always, everywhere and by everybody and several special cases or exceptions were approved, especially in the last third of the century, when two modifications of the *Ordenanzas* were dictated in 1666 and 1679 for ships of 500, 700 and 800 tons.

The Regulations of 1613 were followed on next Oct. 19th by an accompanying Rule of Tonnage approved by the King in Ventosilla.¹⁰ The measurement of tonnage determined the official, fiscal value of a ship for commerce or for *embargo* by the Crown and the Rule was a tool in the hands of ship designers as well as a fiscal instrument.

In 1618, ships from 9 to 22 cubits in breadth were specified using the same items of 1613. The terms *patache* and galleon were abandoned and all sizes are referred to as *navíos*. There was no distinction between ships for commerce and for armada. Compared to the ships of 1613, the new *Ordenanzas* requested lower depth of hold, the deck to be half a cubit above the height of the breadth. The length of keel was defined by linear function of the beam, between the values of 1607 and 1613, which shows the conviction of the rulers in this matter. The length of the hull, however, was shortened once more with the clear purpose of improving the behavior of the ships at sea and their endurance. (Table 4)

Merchant ships built by private owners or ordered by the royal Treasury for the Fleets (to the Indies) were limited to 18 cubits in breadth, one cubit more than in 1613. The inspection (visit) of the ships before sailing to the Indies was strictly done by House visitors that fixed two iron rings to the sides, amidships, at the maximum breadth with the same requirements of 1613 and the same punishment for contravenors. Ships over 18 cubits in breadth and 8-1/2 cubits in depth were excluded from the Fleets. Ships with a halfdeck connected to the forecastle (flush bridge) or with sides doubling or with a rised helm port were refused also.

Fines for building ships that didn't comply with these *Ordenanzas* were 500 ducats for the fabricator, 100 ducats for the master shipwright, but the superintendent who failed to give the dimensions of these *Ordenanzas* would lose his office and pay 1,000 ducats. These fines were split in halves for the judge and the denouncer.

Main chapters of the Regulations were dedicated to:

Dimensions and general arrangement of 14 classes, from 9 to 22 cubits in breadth
General rule to assemble all the *navíos* (art. 15-23)
Strength of the vessels: scantlings, wales, clamps, planking, etc. (art. 24-71)
Dimensions of masts and spars (art. 72-91)
Rules for the workers (*maestranza*) (art. 92-100)
Enforcement of the *Ordenanzas* and Inspection of the ships (art. 101-106)

Dimensions and forms different from the *Ordenanzas* were permitted in many occasions along the century. To warships built under *asiento* (contract) with private builders, usually agreed on special proportions for the vessels, private owners added several experimental constructions with the approval of the Crown that encouraged such practice, and albeit the *Ordenanzas* prohibited the use of three-deckers in the Fleets to the Indies, merchant vessels with three decks were built and used elsewhere since the 1630's.¹¹ The use of *embonos* had the effect of increasing the transverse stability without altering the draft, but also allowed the increase of cargo on deck and thus the completion of the third deck, which was prohibited again by a royal decree of August 28, 1628. However, *embonos* were permitted by a new royal decree on October 17, 1628 with the condition of not to complete the third deck.¹² Furthermore, galleons fabricated for the *Carrera* were three deckers by 1640, with preference over the ones with *pozo* (open waist) "for its great inconvenience to the infantry".¹³

8. Modifications of 1666 and 1679

Ships of 500 tons and larger built to the specifications of 1618 had difficulties to pass the bar at Sanlúcar and many accidents produced losses and delayed the putting to sea of the Fleets.

Problems with larger sizes started with the new war with Holland in 1621 and were aggravated by the permanent conflict between shipbuilders in the Cantabrian and in Andalusia. Shipyards in the north could use better wood than their competitors in the south, and it was needed to fabricate larger ships. The royal choice of the Cantabrian yards to build the galleons for the Ocean Fleet was responded by the south by building their ships in the Indies; with better timber and lower costs the *criollos* proved excellent competitors and very durable.

Larger galleons couldn't pass the bar of Sanlúcar to go upstream to Seville and Cadiz emerged as a natural base for the larger vessels. Iron guns were introduced on board about 1630 and the space taken by artillery modified the conception of the galleons in a period of continuous war at sea. General Francisco Díaz Pimienta offered to build four galleons of 500 tons in Havana and wrote new specifications for them. After the Peace of Westfalia (1648) and the English Fighting Instructions of 1653 ships were built with larger sizes. The Dutch-English wars, the emergence of France as a sea power, and the need for larger merchant vessels for the Indies contributed to deviate from the rules of 1618 that had been written with the goal of using Seville as the only terminal port of the Fleets.

This was the scenario where the modifications of 1666 and 1679 were composed and specified for galleons of 500, 700 and 800 *toneladas*. These ships, with beams of 17-1/2, 18-1/2 and 19 cubits were longer than in 1607 and had longer keels and much

longer lengths than in 1618. For the same beams, the ships of 1618 would have burthens of 577, 689 and 721 tons, respectively. (Table 5)

9. The last galleons

Among the last ships built with the *Ordenanzas* of 1618 was *Nuestra Señora de la Concepción y las Ánimas*, a 90-gun, three-decker, Capitana del Mar Océano, the last one to use the single circle for the midship section moulds.¹⁴ Her hull was studied by Antonio de Gaztañeta while supervising her construction in Colindres in 1688. His detailed manuscript has helped understand Spanish shipbuilding in the seventeenth century,¹⁵ and he combined his hands-on learning at the shipyard with his many years of navigation to produce a new proposal for ship design that meant the end of the *Ordenanzas* and the galleons and the birth of eighteenth century *navíos*. For the first time in Spain, ship lines were defined completely and the instructions to do it were published in 1712 and 1720.¹⁶

Table 2. Dimensions established by *Ordenanzas* of 1607.

Shipbuilder cubit of 574, 68 mm

Tonnage	Breadth		Length		<i>Rising</i>	<i>Puente</i>	Halfdeck
-----	-----	Depth	---	Keel	Rasel	Bridge	<i>Alcázar</i>
-----	-----	-----	---	---	-----	-----	-----
<i>Navíos</i>							
151-1/2	10	5-1/2	38	29	3-1/4	+2-2/3	---
168-6/8	11	6	40	33	3-1/2	+2-2/3	---
238-2/8	12	6-1/2	43	36	3-3/4	+2-2/3	---
<i>Galeoncete</i>							
297-5/8	13	7	46	37	5	+2-2/3	---
<i>Galeones</i>							
373-3/8	14	7-1/2	50	39	5-1/4	+3	+3
487-1/8	15	8	52	40	5-1/2	+3	+3
567-7/8	16	8-3/4	57	42	5-3/4	+3	+3
669-3/8	17	9-1/4	60	43	6	+3	+3
755-	18	9-1/2	62	44	6-1/2	+3	+3

897-3/8	19	10	65	47	6-3/4	+3	+3
1033-	20	10-1/2	69	48	7	+3	+3
1184-5/8	21	11	72	51	7-1/4	+3	+3
1351-5/8	22	11-1/2	75	53	7-1/2	+3	+3

Breadth = widest measure, not always at the main beam.

Rising: is given at the stern; Rising at the stem was half of this.

Depth: of hold, from ceiling of floor to deck planking, at the breadth.

Ships for armada had the deck 1 cubit above the breadth.

Bridge: cubits above the Deck; Halfdeck: cubits above the Bridge.

Depth = Beam / 2 + 1/2 cubit (+ 3/4 for Beams of 16 and 17 cubits)

Other dimensions don't have a fixed relation to the Beam.

Navíos = ships (merchant; general name); *Galeoncete* = small galleon

Table 3. Dimensions established by *Ordenanzas of 1613*.

Shipbuilder cubit of 574, 68 mm

	<i>Patache</i>	<-----	<i>Galeones</i>	----->
Breadth	8	17	18	20 22
Tonnage	55	539-1/4	632	833-5/8 1073-1/3
For <i>armada</i>	---	555-1/4	651	858-5/8 1105-1/2
Floor	4	8-1/2	9	10 11
Depth	3-3/4	8-1/2	9	10 11
The widest		<----	at the depth, for merchant	----->
The widest		<----	1/2 cubit below for <i>armada</i>	----->
Keel	28	46	48	51 54
Length	33-3/4	58-3/4	61-1/2	66 70-1/2
Rake stem	4	8-1/2	9	10 11-1/2
Rake stern	1-3/4	<-----	la mitad	-----> 5
Rising Aft	2-1/2	5-2/3	6	6-2/3 7
Rising Fwd		<-----	one half of rising Aft	----->
Transom		<-----	same as the floor	----->
Timbers	25	37	39	41 43
Rise of floor	1	1-1/16	1-1/8	1-1/4 1-3/8
Dead rise	<-----	2/3	for the 3 midship timbers for all	----->
Distributed	<-----	1/3	of the rise for all	----->
<i>Joba</i> Fwd	1/2	1	1-1/8	1-1/4 1-3/8
from # F	2	2	2	2 2
<i>Joba</i> Aft		----	half of the <i>joba</i> fore for all	----
from # A	6	(9)	10	11 12
Sheer F		----	1/2 cubit for all	-----
Sheer A		---	1 cubit for all	-----
Wale sheer F	1	2	2	2-1/2 2-1/2
Wale sheer A	1-1/2	2-1/2	2-1/2	3 3

'tweendeck	3-1/8	3-1/6	3-1/4	3-1/4
Hold beams	<-----	3-1/2 cubits below deck		----->
<i>Redeles</i>	<-----	floor /2 + floor /50 all		----->
<i>Cuadra</i> at	<-----	Length /4 + 2 cubits from Sternpost		----->
Beam at <i>cuadra</i>	<-----	Breadth - 2 cubits		----->
<i>Mura</i>	<-----	Length /4 + 1 cubit from Stem		----->
Beam at <i>mura</i> .	<-----	Breadth - 1 cubit		----->
Beam at bridge	<-----	the same as the hold beams		----->
Toptimbers	<-----	to be straighten for better shape		----->

All sections to be shaped using the same one Mould.

Mura and *Cuadra* = sections defined at about quarter length fore and aft, respectively.

Redel = beam at the last timbers that have floors (*maderos de cuenta*) fore and aft

Joba = widening of the hull sides at the timbers, measured at the deck beams

Bridge = *punte*, a deck connecting the halfdeck and the forecastle over the main deck

Timbers = number of main floors laid on the keel

For all other classes, only two data are given in the reference

	Breadth	Tonnage
<i>patache</i>	9	70-1/2
<i>patache</i>	10	94-1/2
<i>navío</i>	11	148
<i>navío</i>	12	207-3/4
<i>navío</i>	13	258-1/8
<i>galeoncete</i>	14	316
<i>galeón</i>	15	381
<i>galeón</i>	16	456
<i>galeón</i>	19	721-3/4
<i>galeón</i>	21	956-5/8

Table 4. Dimensions established by *Ordenanzas of 1618*.

Shipbuilder cubit of 574, 68 mm

Breadth	9	10	11	12	13
Tonnage	80-3/4	106-1/8		198	251
Floor	4-1/2	5	5-1/2	6	6-1/2
Depth	4	4-1/2	5	5-1/2	6
Deck		--- 1/2 cubit above the Depth		-----	
Keel	28	30	32	34	36
Length	34	36	39	41	45
Rake Stem	4	4	4-3/4	5	6
Rake Stern	2	2	2-1/4	2-1/2	3
Rising Aft	3	3-1/3	3-2/3	4	4-1/3
Rising Fwd		--- one third in all <i>navios</i>	---		
Transom	---	5-1/4	5-3/4	6-1/4	6-3/4
Timbers	25	27	29	31	31

Floor Rise	1/2	1/2	5/8	11/16	3/4
Dead Rise		--- two thirds in all	---		
Distributed		--- from 2nd Timbers Fwd and Aft	---		
<i>Joba</i> Fwd	1/2	1/2	5/8	11/16	3/4
from #		--- 2nd Timber Fwd in all <i>navíos</i>	---		
<i>Joba</i> Aft		--- half the <i>Joba</i> Fwd, in all	---		
from #	6	6	7	7	7
Sheer Aft		--- 1 cubit at Deck in all <i>navíos</i>	---		
Sheer Fwd		--- 1/2 cubit	id. id. id.	---	
Wale sheer A	1-1/2	1-1/2	1-1/2	2	2
Wale sheer F	1	1	1	1-1/2	1-1/2
C/Sternpost	1/4	1/4	1/4	1/3	1/3
Quarterdeck	---	low	2-1/2	---	---
Halfdeck	no	no	no	3	3
Bridge	no	no	no	no	3
Breaks	no	no	no	no	1-1/2

C/Sternpost = counter stern post

Table 4. Continued. Dimensions established by *Ordenanzas of 1618*.

Breadth	14	15	16	17	18
Tonnage	409-1/2	371-1/2	444-1/2	530	624-1/4
Floor	7	7-1/2	8	8-1/2	9
Depth	6-1/2	7	7-1/2	8	8-1/2
Deck		--- 1/2 cubit above the Depth	-----		
Keel	38	40	42	44	46
Length	48	50-1/2	53	56	59
Rake Stem	7	7-1/4	7-3/4	8	8-1/2
Rake Stern	3	3-1/4	3-1/4	4	4-1/2
Rising Aft	4-2/3	5	5-1/3	5-2/3	6
Rising Fwd		--- one third in all <i>navíos</i>	---		
Transom	7-1/4	7-3/4	8-1/4	8-3/4	9-1/4
Timbers	33	35	35	37	37
Rise of Floor	13/16	7/8	15/16	1	1-1/16
Dead Rise		--- two thirds in all	---		
Distributed		--- from 2nd Timbers Fwd and Aft	---		
<i>Joba</i> Fwd	13/16	7/8	15/16	1	1-1/16
from #		--- 2nd Timber Fwd in all <i>navíos</i>	---		
<i>Joba</i> Aft		--- half the <i>Joba</i> Fwd, in all	---		
from #	8	8	8	9	9
Sheer Aft		--- 1 cubit at Deck in all <i>navíos</i>	---		
Sheer Fwd		--- 1/2 cubit	id. id. id.	---	
Wale sheer A	2-1/4	2-1/4	2-1/4	2-1/4	2-1/4
Wale sheer F	1-3/4	1-3/4	1-3/4	1-3/4	1-3/4
C/Sternpost	2	1/2	1/3+	1/2+	2/3
Quarterdeck	---	---	---	---	---
Halfdeck	3	3	3	3	3
Bridge	3	3	3	3	3
Breaks	1-1/2	1-1/2	1	1	1

Table 4. Continued. Dimensions established by *Ordenanzas of 1618*.

Breadth	19	20	21	22
Tonnage	721-3/4	840	946-1/2	1074-3/4
Floor	9-1/2	10	10-1/2	11
Depth	9	9-1/2	10	10-1/2
Deck		--- 1/2 cubit above the Depth		-----
Keel	48	49	51	53
Length	61-1/2	63	66	68
Rake Stem	9	9-1/2	10	10
Rake Stern	4-1/2	4-1/2	5	5
Rising Aft	6-1/3	6-2/3	7	7-1/3
Rising Fwd		--- one third in all <i>navíos</i>	---	
Transom	9-3/4	10	10-1/2	11
Timbers	39	39	41	41
Rise of Floor	1-1/8	1-3/16	1-1/4	1-5/16
Dead Rise		--- two thirds in all	---	
Distributed		--- from 2nd Timbers Fwd and Aft	---	
<i>Joba</i> Fwd	1-1/8	1-3/16	1-1/4	1-5/16
from #		--- 2nd Timber Fwd in all <i>navíos</i>	---	
<i>Joba</i> Aft		--- half the <i>Joba</i> Fwd, in all	---	
from #	10	10	11	11
Sheer Aft		--- 1 cubit at Deck in all <i>navíos</i>	---	
Sheer Fwd		--- 1/2 cubit	id. id. id.	---
Wale sheer A	2-1/4	2-1/4	2-1/2	2-1/2
Wale sheer F	1-3/4	1-3/4	2	2
C/Sternpost	2/3	2/3	2/3	2/3
Quarterdeck	---	---	---	---
Halfdeck	3	3	3	3
Bridge	3	3	3	3
Breaks	1	1	1	1

Notes

All vessels are named *Navíos*, not galleons or *pataches*

The widest Beam, or Breadth, is at the Depth

Floor = Beam / 2

Keel = 2 x Beam + 10; (or 2 x Beam + 9, from 20 cubits up)

Transom = Floor + 1/4 cubit

Fore Rake = half the Stern post Rake

Rising Aft = 1/3 Breadth

Joba = Rise of floor

Aft and Fore Breaks, at the Bridge

Rowlock and Galleries, at the Halfdeck Break

Hawse holes, under the Forecastle, by the carlings

The Tiller, at the carlings of the Halfdeck Break

The Bitt, next to the Forecastle Break, aft of it

The Bitt Crossbar, 1 cubit above the Bridge

Table 5. Modifications to *Ordenanzas of 1618*
Dictated in 1666 and 1679 to diminish the Draft

Year	-----	1666	-----	1679
Tonnage		700	500	800
Breadth (M)		18-1/2	17-1/2	19
Mura		18-1/2	17-1/2	19-1/3
Cuadra		---	---	17
Floor		M/2+1/3	M/2+1/4	9-3/4
Depth		8-3/4	8-1/4	9-1/4
Deck				1/2 below the Breadth
Keel		53	50	55-1/2
Length		65	62	67-1/2
Rake Stern		10	10	11
Rake Stem		2	2	1
Rising Aft		6-1/3	6	7-1/4
Rising Fwd		2-1/3	2-1/4	2-1/2
Transom		10	9-1/2	12-1/3
Timbers		-----	as per their account	-----
Rise of Floor	1		3/4	2/3
<i>Joba</i>		---	according to proportion	---
Bridge		3	3	3
Halfdeck		3-1/3	3-1/4	3-1/4

Notes

Essentially, Keel and Length are increased by 6 cubits, Breadth is reduced a little and Floor increased by 1/3 cubit, Rise of Floor is reduced and the Transom increased

Some Spanish units used in 17th century

Ducado (account) = 11 reales = 374 maravedís

Escudo (gold) = 10 reales = 340 maravedís

Peso (silver) = 8 reales = 272 maravedís

Real (silver) = 34 maravedís

Vara (yard) = 835,9 mm

Codo (cubit, commercial) = 2/3 vara = 557,23 mm

Pie (foot) = 1/3 vara = 278,61 mm

Codo real (shipbuilders) = 33/32 codo = 578,64 mm

Quintal (hundredweight) = 100 libras = 46 kilograms

Tonelada (ton) = 20 quintales = 920 kilograms

10. Articles on shipbuilding in the *ORDENANZAS* of 1618

Notes

Only the articles referring directly to ship design and shipbuilding are presented in this partial translation done by the author for the Naval History Symposium 2009.

Ship dimensions were specified for *Navíos* of fourteen beams, using the same format as the one included here as an example.

To preserve the full meaning of shipbuilding language, not always possible in a word-to-word translation for ships of the 16th and 17th centuries, the original *Spanish* terms are used in the text and their meaning explained in the Vocabulary included at the end.

Spanish syntax of the 17th century has been maintained wherever possible, as it departs from the established language used by contemporary writers like Cervantes or Quevedo.

5. For Navío of thirteen cubits in breadth. Will have 251 toneladas

Floor, six cubits and one half.

Depth, six cubits, at the widest, and the deck at six and one half.

Keel, thirty six cubits.

Length, forty five cubits.

Rake forward, six cubits.

Rake aft, three cubits.

Rising aft, four cubits and one third, and the third part of these risings forward.

Transom, six cubits and three quarters

Shall have thirty one *Orengas de cuenta* (main floors), with the Master one.

Rise of Floor, three quarters of a cubit, distributed in three equal parts: two of dead rise at the middle *Orenga*, and the other one third distributed into as many equal parts as is the number of *Orengas de cuenta* she has, from the second *Orenga* in the middle Forward and Aft.

Jova, three quarters of a cubit, distributed in equal parts, into the *Orengas* that are forward from the second in the middle; and half of this *Jova*, distributed into the *Orengas* that are aft from the seventh one.

Sheer at the Deck, half a cubit forward, and one aft

Sheer at the Wales, one cubit and one half aft and two forward

She has to have a Flush Bridge at three cubits above the main Deck, and two Breaks at the same Bridge, one forward, and another aft, one cubit and one half high each, and another Break at the Halfdeck aft, and the Rowlock at the same Brake of the Halfdeck. For the Helm man to see the Head of the *Nao*: and the Forecastle at three cubits height, from the Break, and the same three cubits height the Castle aft.

The Bitt is to be like the English, aft of the Break, and one cubit gap, till the cross piece that clings to the two *telas* (bitt posts).

The Hawse holes are to be underneath the Castle, as high as possible.

The Counter sternpost at the *Zapato* (sole piece) has to be one third of a cubit wide, and diminish by thirds, to end at the Helm port.

The Fashion pieces are to be round like the *Genol* (first futtock).

Note: The *Ordenanzas* specified a Flush Bridge to connect Halfdeck and Forecastle, thus becoming a second deck. This Bridge is no to be confused with the one that was added to complete a third deck and was officially prohibited.

15. And We order that all the *Navíos* to be fabricated from now on in all our Kingdoms and Lordships be in accordance with these *Ordenanzas* without exceeding one point; and be advised that it should be served with the same *Grúa* of the foot of the *Genol* that it would serve for the first *Orenga* at the middle, in the whole first *Ornizón* Aft, and Forward, and the same is to be used for the Fashion pieces, without changing for another *Grúa* in any way, except that in the Stem will need six or eight *Espaldones* that this *Grúa* cannot serve for them, and for the rest of the timbers if it serves for the first *Ornizón*, and this way the *Navíos* will come out round, with much Hold, and perfected in accordance with the count of the *Ordenanzas*.

16. And they are not to have any Sheer in the Breaks Aft, nor Forward, Port nor Starboard, nor the Decks arched, but everything squared, leveled, for the guns to run better, and she has to be planked at the Breaks, up to the gun ports, filled with chocks, instead of *Escoperadas*, fitted, nailed and caulked, opening scuppers in the Breaks, to send the water out.

17. And it is advised, that in any case it should be looked for wrong timber that serves half as *Branque* and half as Keel, since this is stronger, and avoid that there is any scarp in the Rising Forward, because having it, the *Navíos* are not watertight, as the experience in many has proven.

18. If it be offered in all sort of *Navíos*, that because the weight of the timbers, and the ground of the shipyards being soft, the Braedth would open something more than the measures that belong to them up to the amount of one cubit, by that be not understood that the good fabric has been exceeded, or altered, but the *Ordenanzas* have been complied with, not being in the measures referred above, except for the Breadth, for this often occurs for the weight of the timbers, and the grounds of the shipyards being soft, where it is force to consent the shores although much care is used with them.

19. Considering the great damage that the people in our *Armadas* receive, getting ill from lack of water, and the expenses incurred, and the delay in getting ready, with ordinary casks, it is necessary to have *Pipotes*, each one of the capacity of six water casks, and the staves, and bottoms are to be two inches thick, and in each head of *Pipote* five iron rings thick as a little finger, and three fingers wide each ring, carrying in the bottom of the hold of the Galleon as many as it can, buried in the ballast, and on top the rest of the casks for wine, and water, for with these *Pipotes* the Hold is more unhindered to take a shot inside when they would fight, and there will be no risk with the rolling of the Galleon to get loose, and break, as ordinarily happens with the casks, and there will be no lack of water at any time, and with this it will not be necessary to make new casks every year: and in time of hibernation, taking out the bottom from a head, putting fire, and wiping them well, put the sails inside, without *Relingas*, and they will be saved from being eaten by mice. These *Pipotes* are to be three cubits long each one, which is in accordance with the spacing of the Hold Beams, and having drunk the water of one *Pipote* it is refilled with salt water, and with this the *Navío* will be at her level, and will not be unstowed like now, that because in the ordinary casks the staves are thin, the casks that are stacked above, open the one underneath, with which the water lacks, and the *Navío* gets unstowed, which are damages of great consideration.

GENERAL RULE TO ARM ALL THE NAVÍOS

20. Having set the Keel, which has to have butt joints, and having rised the Stem and Stern posts, and with shores Forward and Aft, it is to be taken one string as long as the Length of the Navío being armed, and ply it at the middle: and then ply it again at the middle to take the fourth part of the Length, which is to be put at the Rake of the Stem, and where it ends, over the Keel, one cubit forward, the last *Orenga* is to be put, and in the same way, it is to be put the fourth part at the Rake of the Stern post: and where it ends over the Keel, two cubits forward, it is to be put the other last *Orenga*; in the distance from *Orenga* to *Orenga* have to be distributed the Main Floors.

21. For the *Navíos* to end up full in all their thirds, and with good proportion, with respect to their Breadth, it is necessary that the aftmost *Orengas* have the width of half the Floor, and something more, and besides this, that the Forward *Orenga* at the *Mura* be one cubit less, than the Breadth, and the last *Orenga* at the *Quadra*, two cubits less, than the Breadth; and to know how much the last *Orengas* have to be bigger than half the Floor, it is to be taken the measure that has the *Grúa* of the Floor, which is the half of the whole Floor, at the Master Frame, from the point of *Escoa* to the Keel, and this distance be divided into five equal parts, and one of these parts will be divided into other five equal parts, and the amount of one fifth of these parts, is what the *Orengas* have to be bigger than half the Floor at the *Grúa*, what is important for a navío with more *Buque*: and for what rises the Rise of Floor, it is convenient that the *Orengas* open, not only as much as half the Floor, but that be added that little more, because with this, and with what is given as *Jova* Forward, more than Aft (which is always doubled) the *Orenga* forward at the *Mura* will come out as said, with one cubit less of Breadth than at the middle, and with the *Jova* that is given to the *Orenga* Aft (which is half of the one Forward), the *Orenga* Aft at the *Quadra* will result with two cubits less of Breadth than the middle, and making the whole side with the same *Grúa* the *Navío*, or Galleon, will come out with the said qualities.

22. For the *Navío* to come out good sailing, and buoyant, and not open-mouthed, nor walled up, nor rolling much, it is convenient that the Bridge closes as much as it opened from the Beams, which will be three cubits and a half from the Deck, and from the Bridge up has to straighten the Toptimber a little, in order to have more *Plaza de Armas*.

23. The Fashion pieces have to open the Transom half the Breadth, and one fourth of a cubit more, and two cubits down, or two cubits and a half, have to open one fourth of a cubit more than at the Transom, for the Stern to be more round, and with more support, for when the *Nao* falls she has where to shore.

All said Galleons, *Navíos* and *Pataches* have to be fabricated with the following strength.

24. After arming the Frames, or *Orengas*, that should be scored, well nailed, and riveted with the feet of *Genoles*, will populate the Keel with them after having put the *Maestras*, or *Armaderas*, and having leveled the main Floors, and shored at the *Escoa*, will be filled at the heads with the feet of *Genoles*, and *Piques*, which are to be hooked, and nailed with three small bolts with rivet each one, to be riveted at the scarpes, which fillers will have to be layed orderly one by one, from the middle Forward, and from the middle Aft, so that they can be nailed to one another, and hooked, and from there upwards all the Futtocks, and *Aposturage* is to be the same way hooked, and nailed to one another, for the sides to be strong, and there is no way for the Futtocks to play, and in this way the Floor, and Sides will be strongly joined, and much care is to be put in this because this is the foundation of the whole fabric.

- 25.** From the second *Ornizón* (which are the feet of *Genoles*) upwards, it has to be procured to look for long timbers, that get to cross until they reach the heads of the *Orengas*, as much as possible: and likewise that the same timbers reach to the second *Ornizón*, as much as they can.
- 26.** The scarphs of the feet of *Genoles*, with the *Varengas*, or Floors, that have to be as long as they can, so that they cross more over the Floor, and that they make good dovetailing.
- 27.** That they must have two rows of *Singlas* at the heads of the *Varengas*, and at the feet of *Genoles*, all scored, and fitted, so that the heads don't play, which is the key of the fabrics.
- 28.** The Keelson has to be well scored with the *Varengas* and stitched skipping one timber, with iron bolts, the Keel scattered with the Keelson.
- 29.** The Floor, and the *Piques de Proa a Popa*, have to be filled with lime, sand, rubble of small pebbles, between Frame and Frame, and on top of them have to be laid the planks of the *Granel* Forward and Aft, until they get to the *Singlas* at the heads of the *Varengas*: and above this *Singla* has to go one plank well fitted, that will serve as *Alboala*, and in it the *Escoperada* of the *Granel*, and on top of that will go the *Taquetes* of the Maststep scored, and clinched on the same planks of the *Granel*, to reach to the *Singla* that goes on the heads of the *Genoles*, with its tooth in the same *Singla*.
- 30.** The *Alboalas* must go skipping one plank, from down upwards, with its *Alboala* under every *Lierna*, or Clamp.
- 31.** The Clamps must be half a cubit wide, and one fourth thick, fitted, and scored to one another, with *Esgaravote*.
- 32.** The *Navíos* under nineteen cubits in Breadth don't have to have more than one level of Hold Beams, at the height of half the Depth, and they have to be placed carefully so that the Clamps take the scarphs of the Futtocks, if possible, and they have to have three *Curvatones* at each head, one above the Beam, and two on the Aft and Forward sides; but the *Navíos* of twenty cubits in Breadth and more, will have two levels of Hold Beams, and for this the Depth has to be divided in three equal parts, and at the height of each one they have to be settled, such that they are equally distant, ones from the Floor, and the others from the Deck, and also between them.
- 33.** The Counterclamp is to be one fourth of a cubit square, fitted like the Clamp.
- 34.** The main Deck must have four Beams at the mouth of the Hatch and athwart the Mast, one third of a cubit wide, and one third sided, because of the Partners of the Main Mast.
- 35.** The Carlings of the Decks are to be laid vertical, leveled with the Beams, sitting at one third of a cubit from one another with dovetail, well nailed, which are to have one third of a cubit height, and the width of five in a cubit.

36. The Waterways must be of very good timber, and wide in accordance with the size of the navío, grooved, and fitted with dovetail like the Carlings to the Clamp, and cross nailed, from outside to inside, and from up down, and over the Waterway must not have more than one plank for the *Escoperadura*.

37. The *Cuerdas, or Eslorias* of the main Deck, and the Bridge are to be sided, to reach below the Carlings to hook up to the middle, and over the Deck others that fit with the lower ones, and for this it will be good that they be one third of a cubit high, and one fifth of a cubit wide, like the Carlings, and over the Beams must go two other rows of *Cuerdas, or Eslorias*, clinched to the Beams over the *Entremiche*, and these are to be square, of one fourth of a cubit.

38. The *Corvatonos* have to go skipping three Carlings, and each one has to have five iron bolts scattered.

39. The Carlings of the Bridge must be one third of a cubit height, and the width of six in a cubit, sitting at one third of a cubit from one another, like the ones of the main Deck, with their *Corvatonos* and *Entremiches* hooked with the Carlings, and *Corvatonos*, skipping three Carlings or less, the same as the ones at the Deck, with their Waterways grooved, hooked, with their dovetail, and nailed like the rest, and with four Beams, in the way of the main Deck, and neither more nor less the *Eslorias, or Cuerdas*.

40. The *Navíos* of fifteen cubits in Breadth and more, will have six pillars at each side, four forward of the Mast, and two Aft, from the heads of the Hold Beams to the *Cuerdas* which are under the Bridge, hooked up, and down, and at the main Deck, and with two *Corbatones* at each head, at the side, and below the Bridge two more, hooked against them, and with iron bolts, and scattered.

41. The Stern has to be curved properly up to the Transom, and the timber of the *Cintón*, to fill the angle of the Rising, has to be good, and wide, to reach up and down the *Puercas*, and Breasthooks at the Stem, as usual, with their *Corbatones* at the *Puercas*.

42. The Gun Ports must have their *Batidero* one cubit above the Deck, and each one has to be one cubit and one fourth squared.

43. The Chain Wales must be like the Portuguese

44. The *Corbatón* at the Cutwater, which is below the mother of the *Espolón*, must have two males fitted in the Stem, and from there down the Cutwater, and Counter Stem, down to the Keel, with its joints of *Entremiches*, and males at the Stem, and the Cutwater the widest that can be found.

45. The *Espolón* must be three fifths of the Breadth in length, from the Stem outwards.

46. The Helm port has to go under the Break of the Halfdeck, and at the same Break the Rowlock, and the Galleries over the Break of the Halfdeck, and underneath will play all her artillery.

47. She has to have another Counter Stern post on the inside, over the *Puercas*, fitted to the Stern post.

48. Forward she has to have Counter Stem at the inside, and in it should be nailed the outer planks, so that all the heads are fitted on to the same Stem, and to this end should be sought the strongest timber that can be found, so that the planks reach from side to side to be nailed on it.

49. The Bitt is to be like the English, strengthened with its *Corbatones* on the Aft side, at the main Deck, and at the upper one on the Forward side, hooked by the Carlings.

50. The Clamps of the Quarterdeck, and Forecastle have to be of the thickness of five in a cubit, and one third of a cubit wide.

51. The Carlings of the Quarterdeck, and Forecastle have to be one fourth of a cubit high, and the width of six in a cubit.

52. The first Wale has to go one cubit below the main Deck, and the second one at the heads of the Carlings, across the Clamp, so that the water of the Scuppers flows above the Wale, and the third one above the Gun Ports, which amounts to two cubits and a half above the main Deck.

53. The *Navíos* from seventeen cubits in Breadth up must have the planking from the second Wale down of five in a cubit; and from the second Wale up, of six, seven and eight, thinning the wood up as much as they can: the planking of the Deck has to be of six in a cubit.

54. The *Navíos* of fifteen, and sixteen cubits in Breadth must have planking of six in a cubit, up to the second Wale, and from there up is to be of seven, eight, and nine in a cubit, thinning the wood the higher the more: and the planking of the Deck is to be of eight in a cubit.

55. The *Navíos* of thirteen, and fourteen cubits in Breadth must have the planking of seven in a cubit, up to the second Wale, and from there upwards of eight, nine and ten, thinning the wood, as said, the higher the more proportionally: the planking of the Deck must be of eight in a cubit.

56. The *Navíos* of eleven, and twelve cubits in Breadth must have planking of eight in a cubit, up to the second Wale, and from there up of nine, and ten, thinning the wood proportionally, the higher the more: and the same is to be understood for the strengthening: the planking of the Deck of nine in a cubit.

57. The *Navíos* of eight, nine, and ten cubits in Breadth must have planking of nine in a cubit, up to the second Wale, and from there up of ten in a cubit, thinning the wood, the higher the more: and the planking of the Deck is to be of ten in a cubit.

58. The planking of the Bridge, Quarterdeck, and of the Forecastle must be of pine, and if possible, be from Flanders, because it is lighter, and from there up the planking also of pine, for not being heavy up that causes rolling: which planking must be in accordance to the burthen of the *Nao*, as has been said above.

- 59.** The planking from the Bridge up is to be planked, clincked like the Flemish, because it is less costly, and more watertight.
- 60.** The thickness of all the planking said is understood to be after being hewed.
- 61.** The first, and second Wale must be double, so that the two together make two thirds of a cubit wide, and one third thick, chiseled on the upper and lower parts, so that they are drowned, and Wale and plank be all one, that there be in the Wale proper two fingers at each part, up, and down, so that it is more watertight in the battering of the water.
- 62.** The *Navíos* of thirteen cubits in Breadth and down must be strengthened in proportion to their burthen.
- 63.** For the whole work to be fixed it is convenient that the material be dry, and the timber be cut in the waning moon of August, December, January, and February, and at no other time, and if it were possible, to be cut from noon to the night.
- 64.** The Rudder must have the thickness of the width of the Counter Stern post, and two fingers more, and in the outer face, two and a half times the thickness of the inner part: the width will be proportioned to the burthen of the *Nao*, and the length that be required: and in all the *Naos* a mould of the Rudder she has will be kept to be able to make another one by it, in case it breaks, or is missing due to another cause.
- 65.** The Capstans must be placed on the Bridge.
- 66.** The Maststep of the Main Mast is to be placed in the middle of the length of the Keel.
- 67.** The Maststep of the Fore Mast is to be placed in the middle of the Rake of the Stem.
- 68.** The Maststep of the Bowsprit is to be fixed on the main Deck.
- 69.** In the *Navíos* of fifteen cubits in Breadth and up, if they would like to put Galleries, they should be at the Break of the Halfdeck, and they are to be small, not to go out more than the vault above, and at the sides, two thirds of a cubit.
- 70.** The Futtocks are to be distributed in the manner that the Carlings, where they can pass to hook, with their dovetail, to the Wales, be done so; and where they cannot, they have to pass between the *Genoles*, supposed there are two Wales, that are to join on the outside, and make a plank that can be caulked, and the Carlings hooked, as it is said, to get to the side planking: and not only there is to be a dovetail in the Wales, but also in the Clamp, for in this manner it is going to be with the strength that can be imagined: and in the Castles the heads of the Carlings have to pass out of the Wales, at the side, for the strength that is intended, hooked with dovetail, if possible, in the Wales, and if not, in the Clamp.
- 71.** The *Vagaras* at the Aft Rising, under the *Brazales*, are not to meet the tooth of the Stern post, but the whole thickness of the Stern post, so that the Stern comes out more round with respect to the *Calimas*.

Vocabulary adopted in this translation

Alboala	Plank on the futtocks as inner shell
Alcázar	Half deck
Aletas	Fashion pieces
Aposturage	The members of a frame above the Floor
Árbol Mayor	Main mast
Árbol Trinquete	Fore mast
Armaderas	First Floors on the Keel, used as guide
Arrufada	With a Sheer
Arrufadura	Sheer
(A)travesaño	Cross piece
Astilla Muerta	Dead rise; Rising
Baos Vacíos	Hold-beams
Barraganete	Top timber
Batidero	Gun port sill
Bauprés	Bowsprit
Bitá (Vita)	Bitt
Branque	The round timber of the Stem
Brazales de Popa	Fashion pieces
Buzardas	Breast hooks
Cabrestante	Capstan
Calimas	Pieces with much curvature (at the ends)
Caña del Timón	Tiller
Carlinga	Step of a Mast
Castillo (de Proa)	Forecastle
Cintas	Wales
Cintón	A thicker or wider Wale
Codaste	Stern post
Contrabranque	Inner Stem; Apron
Contracodaste	Counter sternpost (inner or back)
Corredores	Gallery (stern corridor)
Cubierta	Deck
Cuerda o Eslora	Deck Stringer (binding Baos and Carlings)
Curvatonés	Small knees
Desarrumarse	To get loose (the hull structure)
Desembarazada	Unhindered (the hold)
Durmiente	Clamp
Encolamiento	Joint with dovetail
Entremiches	Timber pieces between two beam heads or timbers
Escoa	Shoring point at the Wronghead
Escobenes	Hawse-holes
Escoperada	Plank scored to cover the timber heads and space between
Escoperadura	The fitting of a Escoperada
Escotilla	Hatch
Eslora	Length (of deck); deck stringer (Cuerda)
Esgaravote	A tool to mark adzing lines in timber
Espaldones	Reverse timbers at the bows
Espolón	Beak head
Fogonadura	Partners (of a mast)

Genol	First futtock
Grael	Planking on the floors; hold bottom ceiling
Grúa	Mould to shape the timbers
Jova	Widening of the frame mould up
Lanzamiento	Rake, end projection beyond the Keel
Latas	Carlings
Lemera	Helm port
Ligazón	Each futtock or part of a frame
Madero de cuenta	Account timber (main floors)
Maestra	Master frame (midship frame or timber)
Manga	Breadth (of beam)
Molinete	Rowle (rowlock of the Whipstaff)
Muerta	The Dead rise; the rising at Midship
Mura	Section at Length / 4 from the Stem
Nao	General name for a round ship or vessel
Navío	Vessel, then smaller than a gallion
Orenga	Floor timber; also a frame
Ornizón	The timbers of a level, e.g. floors
Pipote	A big cask
Piques	“V” shaped frames w/o Floor; crotches
Plan	Floor width between points of “escoa”; hold floor
Plaza de Armas	Clear deck space at the Waist
Popa	Aft
Portas (artillería)	Gun ports
Proa	Forward
Puente corrida	Flush deck from Alcázar to Castillo
Puercas	Lower transoms
Quadra	Section at Length /4 from the Stern post
Quebrado	Break (of deck)
Quilla	Keel
Rasel	Rising at the ends, forward and aft
Redel	Balance-frame
Relinga	Bolt-rope
Roda	Stem (as a wheel)
Singla	Girder (binding the floors and futtocks)
Tajamar	Cut-water
Taquetes	Small cleats
Telas	Bitt-pins
Timonero	Helm man
Tolda	Quarter deck
Trancanil	Waterways
Vágaras	Ribbands
Vita (Bita)	Bitt
Yugo	Transom
Zapato	Sole (of the Rudder)

Notes

¹ Fernández González, F: El Galeón Español, Investigación y Ciencia, nº 191, pp. 58-63, 1992, also in: Le Galion Espagnol, Pour La Science, num.182, Dec.1992, pp.90-101. Edited also in Historia de la Técnica, Prensa Científica. Barcelona, 1994. pp.80-89 and Le Galion Espagnol (Ch.6; pp.51-61), Les Bateaux; des trières aux voiles de course, Bibliotheque Pour La Science. Paris. 1999

² MNM, CN, XXII, doc.76, f.296-302, in Casado Soto, JL: Los barcos españoles del siglo XVI y la Gran Armada de 1588.

³ AGS, GA, leg.117, nº98

⁴ AGS, GA, leg.144, nº113; leg.146, nº83

⁵ AGS, GA, leg.111, nº166

⁶ AGS, GA, leg.248; leg.250, nº356; leg.251, nº232; leg.252, nº159.

⁷ AGS, GA, leg.250, nº308 and nº356)

⁸ Cano, Tomé: Arte para fabricar, fortificar y aparejar naos de guerra y merchante, Tenerife, 1611. The *joba* consisted in an increase of the volume of the hold achieved by pivoting the frame mould on its foot, at the head of the floor, which increased the breadth at deck. This solution maintained the futtocks mould unchanged. The amount of *joba* was measured at the hold beams or about half depth of the foremost and aftmost main frames and diminished linearly to midship. However, the instrument used to apply the *joba* was unknown to us until we found it depicted in Gaztañeta's manuscript of 1688. (Note 15)

⁹ Lavanha, J.B: Livro Primeiro de Architectura Naval. Manuscript, RAH, Madrid. First edition published by Academia de Marinha, Lisboa, 1996.

¹⁰ Ley xxv. Que en el arquear, y medir los navíos se guarde la forma que por esta ley se manda (1614). Don Felipe III en Ventosilla, 19 de Octubre de 1613. En Madrid a 30 de Junio de 1614. Ordenanza de la Casa. This Rule of Tonnage was in force for all Spanish vessels until 1742. The general rule was based on the proportions and shapes specified in the *Ordenanzas* and the tonnage was calculated using the formula:

Volume in cubic royal cubits = Beam x Depth x (Keel + Length) / 4

Tonnage = Volume / 8, in *toneles machos*.

The Breadth was increased by the (Floor – Breadth / 2) / 2, for floors not equal to Breadth / 2.

Alternatively the Volume was = (3/4 Breadth + 1/2 Floor) x 1/2 Depth x 1/2 (Keel + Length).

3% was added for each half cubit of height of the Deck below the Breadth, and deducted if above.

Other corrections were applied for the difference in the shape of the Deck and the Floors with respect to the *Ordenanzas* that was calculated in terms of volume by simple geometry. It assumed the stem to be one circular arc, and all sections shaped with one single mould, of one circular arc only.

¹¹ Serrano Mangas, F: Función y evolución del del galeón en la Carrera de Indias. Mapfre, 1992.

¹² Veitia y Linage, J: Norte de Contratación de las Indias Occidentales. Facsimil of Madrid ed.1672, Instituto de Estudios Fiscales, Madrid, 1981. Libro II, cap. 14, nº 10.

¹³ Veitia y Linage, J: Informe sobre si los navíos han de tener tres cubiertas para servir en la Armada de Indias, in Serrano Mangas, Op.cit.

¹⁴ A letter of the King to the Count of Aguilar dated 29 March 1685 ordered that for Armada ships the single circle should be substituted by an oval or double circle of radius Breadth/3, imitating the shape of Dutch vessels. The first ship built with the oval was the *Santísima Trinidad*, Almiranta del Mar Océano, launched at Colindres in 1692, right after the Capitana.

By then, Antonio Garrote, experienced sea captain had written in Sevilla a *Recopilación para la Nueva Fábrica de Baxeles Españoles*, Manuscript 1691, BNM. In this unpublished work Garrote specified six classes of ships and gave dimension and scantlings for more than 270 items of every ship, either merchant

or for armada, as a proposal for a new *Ordenanza*. However, as it had happened with Lavanha, his work was superseded by Gaztañeta's idea to distinguish merchant from combat ships from their design.

¹⁵ Fernández-González, F, Apestegui, C and Miguélez, F: *Arte de Fabricar Reales: A critical, technical study of the manuscript by D. Antonio de Gaztañeta (1688)*. Lunwerg Editores. Barcelona. 1992. This work proved that shipbuilding techniques used in Spain had remained unchanged since mid sixteenth century, with the exception of the *joba*.

¹⁶ Gaztañeta Iturribálzaga, A:

Medidas arregladas a la construcción de un bajel de guerra de sesenta codos de quilla, in a memorial of Bernardo Tinajero (1713) to the King: *De lo que se ha de observar, y regla con que se ha de hacer la fábrica de diez bajeles y dos pataches que S.M. ha resuelto se construyan en el puerto de La Habana*.

Proporciones de las medidas más esenciales para la fábrica de navíos y fragatas de guerra, que puedan montar desde 80 cañones hasta 100, con la explicación de la construcción de la barenga maestra, plano y perfil particular de un navío de 70 cañones, con los largos, gruesos y anchos de los materiales, escrito de orden del Rey, Madrid, en el año de 1720.

AGS = Archivo General de Simancas

GA = Guerra Antigua

MNM = Museo Naval de Madrid

RAH = Real Academia de la Historia (Madrid)

BNM = Biblioteca Nacional, Madrid