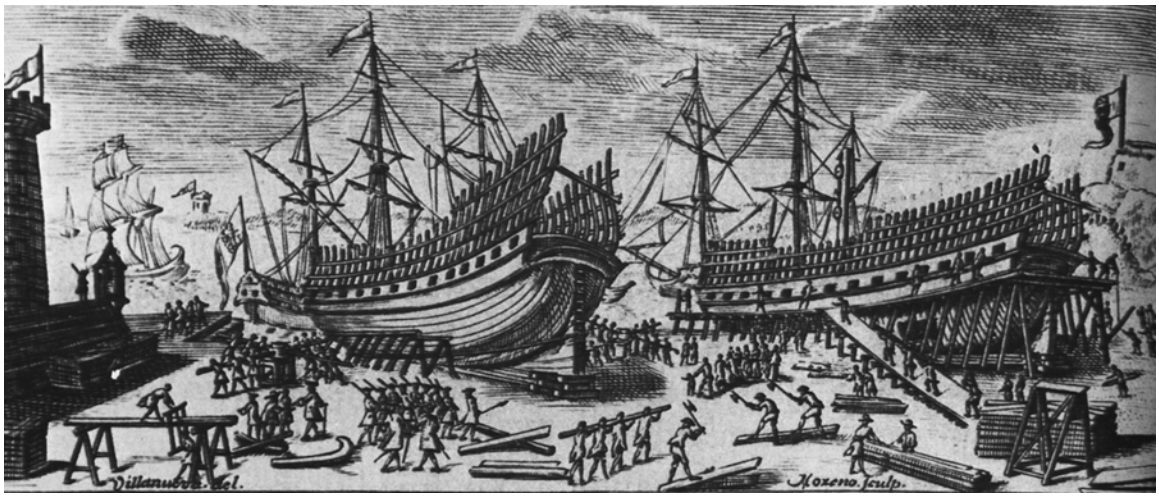
A Plague of Ships:



Spanish Ships and Shipbuilding in the Atlantic Colonies, Sixteenth and Seventeenth Centuries

Chuck Meide

College of William and Mary
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New World Shipbuilding and the Consolidation of Empire, 1490s – 1550s

The First Colonial Ships and the Development of an Inter-Island Trade

The first sailing ship built in the New World resulted from one of its earliest recorded maritime disasters. Having lost three ships to hurricane on his second voyage, Columbus—who had possessed the foresight to bring shipwrights with him to the settlement of Isabela—had the 50-ton caravel *Santa Cruz* constructed from their broken timbers in the summer of 1495. Designed as a sister ship to *Niña* (who had successfully weathered the storm), she was quickly given the appropriate moniker *India* by her Spanish seamen, and safely reached Cádiz a year later on 11 June 1496 (Morrison 1942: 491; Phillips and Phillips 1992: 211).

In Columbus' absence, two more caravels (*caravelas*) were built under the direction of his brother Bartolomé to facilitate communication between the nascent settlements (Haring 1918: 267). But after their construction, there is little if any mention of New World shipbuilding for some time. This does not mean, of course, that vessels weren't being built in the early colonization period. The importance of ships for intra- and inter-island navigation was immediately realized by the first Spanish settlers in the New World, a fact recognized by King Fernando in a 1508 *cédula* granting citizens of Española the right to own ships:

> Also, the said *procuradores* begged Me to grant permission to the towns and settlers on the island to keep caravels, ships, and barks for the trade between towns on the island, as well as for fishing and other necessities that can be met with them; because they say that without them, they cannot live there without great hardship and because it is very difficult to transport things from one region to another due to the forests, the many rivers, and the lack of good roads; and since it is My desire to help and favor the settlers of the island, as was said, I command you to allow them to keep all the barks they may need for the trade of the island, provided these are owned by reliable persons who give bond that they will keep them for the service of the said towns and villages. With regard to the matter of the caravels and larger ships for trading between that island and other regions, I do not command you to allow this until you have informed Me concerning the benefit and utility that could result to the said towns as a result of this, and the regions in which they will be able to trade; therefore I order you [Española's governer] to send Me a report on this matter with your opinion, so that I can have this considered and decided in accord with Our service (Parry and Keith 1984: 387).

Governor Ovando's recommendations must have been favorable, as in 1511 the King decreed that the settlers of San Juan Bautista (present-day Puerto Rico) had the right to trade with neighboring Española as well as directly with Spain; and in 1513 the latter island was granted the authorization to trade with the isthmus of Darién. The growth in

inter-island shipping, not surprisingly, created a need for more vessels, and a *cédula* of December 1516 permitted the inhabitants of Cuba to construct and own vessels for trade with other islands (Haring 1918: 124). While at least some ships were constructed in Havana in that year (Marrero 1975: 73), the king's order was apparently reinforced by another *cédula* two years later which authorized Cuban shipbuilders to build ten vessels, none of which could be over 100 tons burden, for trade and further exploration (Weddle 1985: 115; Haring 1918: 267).

By this time, an increasingly complex network of inter-island exchange—of such items as gold and gold-mining equipment (*bateas*), comestibles, livestock, cotton, and manufactured goods from Spain—had developed between various expanding settlements on Cuba, Española, San Juan, Jamaica, and Santa María del Darién on the mainland of Tierra Firme or South America (Tuner 1998: 64-87). Though there are few references to it or its constructs, a burgeoning local shipbuilding industry was developing alongside this trade.

That some of these early trading vessels were built in the colonies themselves is clear from the extant customs records (*Relaciones de navíos*) of the ports of Santo Domingo and Salvaleón de Higüy (on Española) and Puerto Rico and San Germán (on San Juan Bautista) now housed in the *Archivo General de Indias* in Seville. One such ship, a *carabela latina* named *San Germán*, made at least seven trading voyages between June 1513 and March 1517 (Turner 1998: 354-366). This vessel was constructed during 1512 and the first half of the following year, either in the protected bay of Puerto Rico or at its namesake, the port San Germán (Turner 1998: 356). *San Germán* is thus one of the earliest documented vessels built on the island of San Juan, and indeed anywhere in the New World. She was owned by Miguel Díaz de Aux, a wealthy businessman who had recently been appointed the King's factor in 1512.

We also know the crew of *San Germán*, during her second voyage. Díaz hired an experienced *maestre* named Antonio Catalán (Antón, as he was known, had worked for Diaz before) who with a crew of three *mariners* or able-bodied seamen (including one *calafate* or caulker) and three *grumetes* (apprentice seamen) sailed *San Germán* from Salvaleon to San Germán in August 1513. On a typical venture, such as her maiden voyage over 2 months prior, *San Germán* might carry 100 *cargas* of cassava bread, 31 *arrobas* and 16 *libras* of *tocinos* (salt pork), 54 swine, five horses, three dogs, one load of hammocks, and a single male slave. This diverse cargo was owned by twelve individuals, including the single item—a horse—owned by Díaz (Turner 1998: 357-360).

Ships of the Early Inter-Island Trade: Caravelas, Naos, Navíos, and Barcos

Such mundane cargoes were the building blocks of a new economy, and locally-built caravels like *San Germán* were the workhorses that consolidated it. *Carabelas*, *caravelas*, or caravels were small, fine-lined craft of Portuguese origin, built for seaworthiness rather than cargo capacity and much favored by mariners during the Age of Exploration (Elbl and Phillips 1994: 91-98; Smith 1992: 18-20; 1993: 34-46). They

were shallow-drafted, single- or only partially decked, and usually between less than 50 and 113 tons burthen. Like all Spanish seagoing ships at this time, caravels were constructed by erecting pre-fabricated hull framing onto a keel, upon which flush, edge-joined (carvel) planking was nailed. The first caravels were equipped with triangular or lateen sails and were known as *caravelas latinas*, though their rigs were often altered to display square sails on the main mast (*caravelas redondas*) so as to take advantage of following winds. Lateen-rigged caravels could sail closer to the wind than any other vessel of the era; this rig would have certainly suited *San Germán*'s operations in the Mona Passage and the contrary winds between the Greater Antilles and Tierra Firme. As Spanish maritime activity shifted from exploration to colonization, however, the numbers of caravels in the New World began to decline. Starting in the 1530s caravels were less frequent participants in the *Carrera de las Indias* (Spain's annual convoy to the Caribbean), and they began to be replaced by new types of small, swift vessels such as *pataches* and *bergantines* by mid-century (Elbl and Phillips 1994: 97-98; Smith 1993: 45).

Other merchant vessel types mentioned in the 1512-1517 *Relaciones de navíos* include *naos*., *navíos*, and *barcos.* The first two terms are usually considered to be more or less generic words for "ship," and the latter is often a similarly generalized term for a smaller vessel (cf. Myers 1985; Clayton 1972: 90; Smith 1992: 26). While in the *Relaciones* the three type-names are sometimes used interchangeably to describe particular ships (more so with *nao* and *navío* than with *barco*), there is often enough consistency to suggest that port authorities recognized individual types (Turner 1998: 367). The *nao* was a well-defined type of early 16th century Iberian merchant ship, beamier than caravels and the preferred cargo carriers during the initial colonization period (Smith 1992: 22; 1993: 46-49). Despite this, the Spanish themselves were usually vague in distinguishing between *naos*, *navíos*, and galleons (cf. Smith et al 1995: 10). Additionally, over time the hull shape and nomenclature changed, and by the close of the century there was no recognizable difference between a *nao* and galleon other than their intended function as a merchantman and warship respectively (Myers 1985: 59).

Moya Blanca (1981a: 166) relates that the 16th and 17th centuries the *navío* was similar to and smaller than the *galeoncete* (itself a smaller version of the galleon), measuring between 150 to 238 tons. By the 18th century, *navío* had come to mean a capital warship or ship of the line (*navío de línea*) and was never used like *buque* or *barco* as a generic term for ship (Harbron 1988: xiv). Diego Garcia de Palacio, writing in 1587, uses *navío* in the general sense of a ship, describing twelve distinct types ranging from the *nauio de alto bordo* ("high-sided ship") to the *nauio azorrado* ("sluggish sailor," or one that is improperly weighted and steers poorly) (Garcia de Palacio 1944 [1587]: 149). Clayton (1972: 101, 103) points out that in the Guayacil shipyards *navíos* were distinguished from smaller *barcos* and suggests that the "term *navío* was used for most of the time period under consideration [late 16th to early 18th centuries] to describe a large vessel as opposed to the smaller *barcos*, *fragatas*, *pataches*, and *chinchorros* (a Pacific term for *patache*)." It is probably safe to say that in the 16th and 17th centuries *navío* and *nao* were used as general terms representing medium to large round-hulled, two- or three-masted, square-rigged merchant vessels. Such ships plying the inter-island trade—especially in the first

quarter of the 16th century—would have been smaller rather than larger, but still distinguishable from the smaller class of vessels like those mentioned above. Turner (1998: 378) indicates that one ship, the *Santiago* owned by Alonso López, was consistently labeled a *nao* or *navío* in 1513 but described as a *carabela* in 1516 and later; he suggests that *Santiago* underwent a refit in a Santo Domingo shipyard and had its superstructure reduced for better sailing qualities (which would make it resemble a caravel, whose forecastles were minimal or non-existent).

Barcos (in English, barks), while sometimes used as a generic term for any small watercraft, were also a recognized class of single-masted, square-rigged open coastal fishing, commerce, or exploratory vessels (Smith 1992: 26). The smallest of these were *barco longos*, and had a single square sail and a low freeboard to facilitate rowing. Larger versions known as *barco gavarras* had main- and foretopsails (Manucy 1983: 101). Drake used the term barks to describe the numerous small, 12-15 ton coasting vessels he captured during his 1578-1579 Pacific cruise (Borah 1954: 67). The *barco* illustrated by Smith (1992: 18) is basically double-ended; that is, its sternpost (*codaste*) is curved like its stem (*roda*). Most Iberian ships at this time had straight sternposts, though Garcia de Palacio (1944[1587]: 149) notes a vessel form known as *nauio de dos rodas* which "is one that has the stern like the bow" (i.e., double-ended).

Two early 16th century shipwrecks off the Dominican Republic have been archaeologically investigated and are believed to be participants in the early trade between Española and San Juan Bautista (Turner 1998: 340-354). Unfortunately, the lack of preserved hull remains precludes an identification of their type or if they were actually built in Latin America.

A Vessel of Exploration and Conquest: the Bergantín

At least one other type of vessel, not a trader, was known to have been built on San Juan. This was the *bergantín* (brigantine), which is arguably the first vessel type designed for use in New World waters. One of the duties our friend Miguel Díaz was charged with upon becoming the King's factor in May 1512 was to bring to completion the construction of two *bergantines* whose constituent parts and necessary naval stores had been shipped to San Juan Bautista the year before. Two components in particular, mentioned in inventory records, were prefabricated rudders for the two *bergantines*. Other records indicate Díaz arranged for a shipwright and assistants to build two *bergantines*, as per the King's orders, along with a privately owned lateen-rigged caravel, almost certainly his *San Germán* (Turner 1998: 356).

Bergantines, along with the better-known caravels, played a singular role in the exploration and conquest of Spain's new empire (Turner 2002). Descendants of the Mediterranean rowing galley (*galera*), they were flat-bottomed, partially decked longboats propelled by both sail and oars (Smith 1992: 24; Turner 2002: 1-2). Turner (2002: 3) believes that those built for combat would have been double-ended (*de dos rodas*) for ease of landing troops and supplies and for rapidity of launching from shore.

Generally lightly-built, *bergantines* had one or two lateen-rigged masts, rows of benches with long sweeps for rowers, and generous open space for supplies, ordnance, soldiers, or livestock. Such versatile shallow-drafted galleys, able to operate independently of the wind, were perfect for military expeditions or explorations in coastal waters.

Initially *bergantines* were towed to the New World behind larger caravels and *naos*, but they soon came to be used independently for coastal reconnaissance (Smith 1992: 25). They also came to be built locally, often on the fringe of empire by sailor-soldier-carpenters turned impromptu shipwrights. The thirteen vessels that Hernando Cortés had made in 1520-1521 for the successful assault on the Aztec capital Tenochtitlán were *bergantines*, and their construction (with the aid of substantial Indian labor) was described in some detail by Bernal Díaz del Castillo:

> [Cortés] also gave orders that timber should be cut for the building of thirteen launches [*bergantines*] so that we could return to Mexico again, for we knew for certain that we could never master the lake without launches, nor carry on war, or enter that great city another time by the causeways, without great risk to our lives.
>
> He who was the expert to cut the wood and make the model and the measurement, and give instructions how the launches were to be fast sailors and of light draught for their special purpose, and the one who built them, was Martin López, who certainly, besides being a good sailor in all the wars, served His Majesty very well in this matter of the launches and working at them like a strong man . . . [he] made such speed in cutting the wood with the great assistance rendered him by the Indians, that he had the whole of it cut within a few days, and each beam marked for the position for which it was intended to occupy, after the manner that the master carpenters and boat builders have of marking it. He was also assisted by another good soldier named Ándrez Nuñez, and an old carpenter who was lame from a wound, called Ramírez the elder.
>
> Then Cortés sent to Villa Rica for much of the iron and the bolts of the ships which we had destroyed, and for anchors, sails and rigging and for cables and tow and all the other material for building ships, and he ordered all the blacksmiths to come, and one Hernando de Aguilar who was half a blacksmith and helped in the forging. . . . He brought everything, even to the cauldrons for melting the pitch, and all the things that they had taken out of the ships, and transported them with the help of more than a thousand Indians, for all the towns of those provinces were enemies of the Mexicans, and at once gave men to carry the loads. Then as we had no pitch with which to caulk the launches, and the Indians did not know how to extract it, Cortés ordered four sailors who understood the work to go and make pitch in some fine pine woods near Huexotzingo. (1956: 336-337).
>
> . . . [A]nd all came in the charge of Martin López who was the Master carpenter who cut the timber and gave the model and dimensions for the boards. . . (1956: 353).

> From that time forward the greatest dispatch was used in building the 13 launches. Martin López was the Master builder, aided by other Spaniards and two blacksmiths with their forges, and some Indian carpenters; and all worked with the greatest speed until the launches were put together, and they only needed to be caulked, and their masts, rigging, and sails to be set up. . . (1956: 354)
>
> Cortés examined the sloops which were already built and had their rigging, sails, and oars in place, and spare oars for each sloop. . . . Cortés also divided among them all the boat guns and falconets we possessed and the powder he thought they would need (1956: 391-392).

Each *bergantín* carried twelve crossbowmen and musketeers, twelve rowers, one captain, one gunner or artilleryman. After the lake battle Cortés later wrote King Carlos I and told him that the *bergantines* "were the key of the whole war, and it was on the water that a decision would be come to . . . we dashed into the midst of them and broke up numberless canoes and killed and drowned many of our enemies" (31 May 1521, cited in Díaz del Castillo 1956: 403).

Bergantines were the preferred attack craft during the Carib wars. They were also extensively utilized—often in conjunction with deeper-drafted caravels—for exploratory missions during the expansion of colonial territory. For example, *bergantines* were used during the reconnaissance and attempted conquest of Florida by Ponce de León (who had one named *San Cristobal*) in 1513, by Pánfilo Narváez in 1528 (who arrived with one small *bergantín*), and by Hernando de Soto, who arrived with two, one of which had been built in Havana, in 1539; the survivors of his failed expedition would built seven more on the Mississippi in order to make it back to New Spain (Smith 1992: 23, 25; Weddle 1985: 214, 221-222). It was a *bergantín* deployed from St. Augustine by Pedro Menéndez de Avilés that discovered the passage between the Marquesas and Dry Tortugas, which would become the standard route for the *Carrera de las Indias* convoys returning to Spain (Lyon 1976: 147).

On the other hand, *bergantines* were poorly-suited for trade or cargo-carrying. There is only one recorded example of a *bergantín* being used in the San Juan-Española circuit (Turner 2002: 4). Its cargo of oranges could have been transported in a partially- or undecked vessel without sustaining water-damage like other commodities. The use of a *bergantín* in the Mona Passage, however, is a testament to the seaworthiness of this vessel type.

The Nascent Industry of Colonial Shipbuilding

As seen in the 1512-1517 *Relaciones de navíos* of San Juan and Española, small-scale *astilleros* or shipyards tended to spring into existence wherever there were profits to be made from maritime trade. Usually this was through individual contracts between independent shipbuilders and private individuals, or government representatives. A wealthy businessman might contact a shipwright who would agree to construct a vessel

according to the terms and deadlines specified in a detailed contract (Turner 1998: 103). Alternatively, shipwrights might undertake of their own initiative the construction of a vessel, in order to sell the final product or accept a contract with a buyer before the ship's completion.

One example of such a contract was drawn up in Cuanavaca in New Spain in 1531 (Navarrete et al 1843: 416-419, as cited by Turner 1998: 103). In early November of that year, Hernando Cortés agreed to buy two vessels already under construction by a shipwright named Juan Rodriguez de Villafuerte, in an *astillero* near Acapulco. The contract stipulated that the two *navíos* would be completed by Christmas day of that same year. There was a hefty penalty to be paid of 1000 *castellanos*, or two-thirds of the total price, if Rodriguez could not deliver the ships by the agreed deadline.

As the Atlantic empire expanded, the development of local shipbuilding industries became increasingly important to the exploration and consolidation of Spain's new territories, and over the century various laws were passed to promote it. One such edict was given by Carlos I in 1545, directing colonial governors to encourage Native American cultivation of hemp and flax, which was necessary for making cordage (Haring 1918: 124). In general, the shipbuilding industry in the Caribbean was slower to develop than that on the Pacific coast. This can probably be explained by the fact that there were frequently ships available for purchase in the Atlantic colonies which had made the cross-oceanic voyage from Spain, while in the Pacific all ships plying the coastal trade had to be built from scratch. Shipbuilding centers on the Pacific coast included Guayaquil (Quito's port, in Ecuador), El Realjo (Nicaragua), Iztapa (Guatemala), Panama City, and Hutualco and later Acapulco on the west coast of New Spain (cf. Moya Blanca 1981a: 152; Clayton 1972; Radell and Parsons 1971; Borah 1954: 23-26; Hazlett 2002: 12-15; MacLeod 1984a: 345). On the Atlantic side, significant yards included those established at Havana and elsewhere on Cuba, Maracaibo, Veracruz, Campeche, along with the smaller *astilleros* of Jamaica, Santo Domingo, San Germán, Puerto Rico, and along the north coast of Tierra Firme (Moya Blanca 1981a: 152; MacLeod 1984a: 345).

It is likely that many of these shipyards relied on *ecomienda*-type Indian labor for much of the unskilled work, though the degree to which this was true (especially in the smaller yards) is not known. Scheina (1972) has emphasized the role of massive Indian labor in the construction of early colonial ships. He pointed out that Vasco Núñez de Balboa utilized as many as 2000 natives to carry materials to the Pacific coast in order to construct four *bergantines*, and that Cortés commanded 40,000 to dig a canal for the launching of his *bergantines* (1972: 197-198, 195). Typically Indians were used for burden-carrying, timber-hewing, and other manual labor, while *peninsulares* or *criollos* conducted the necessary skilled labor. It is likely that Scheina, who blames the "decline of maritime construction" after the 16th century on the lack of available Indian labor, overemphasizes its importance; for one thing, colonial shipbuilding thrived in the first few decades of the succeeding century, and the native populations of the Caribbean had already been decimated by that point. It certainly may be the case, however, that free Indian labor helped offset costs such as the importation of iron fasteners and fittings that were unavailable in the New World.

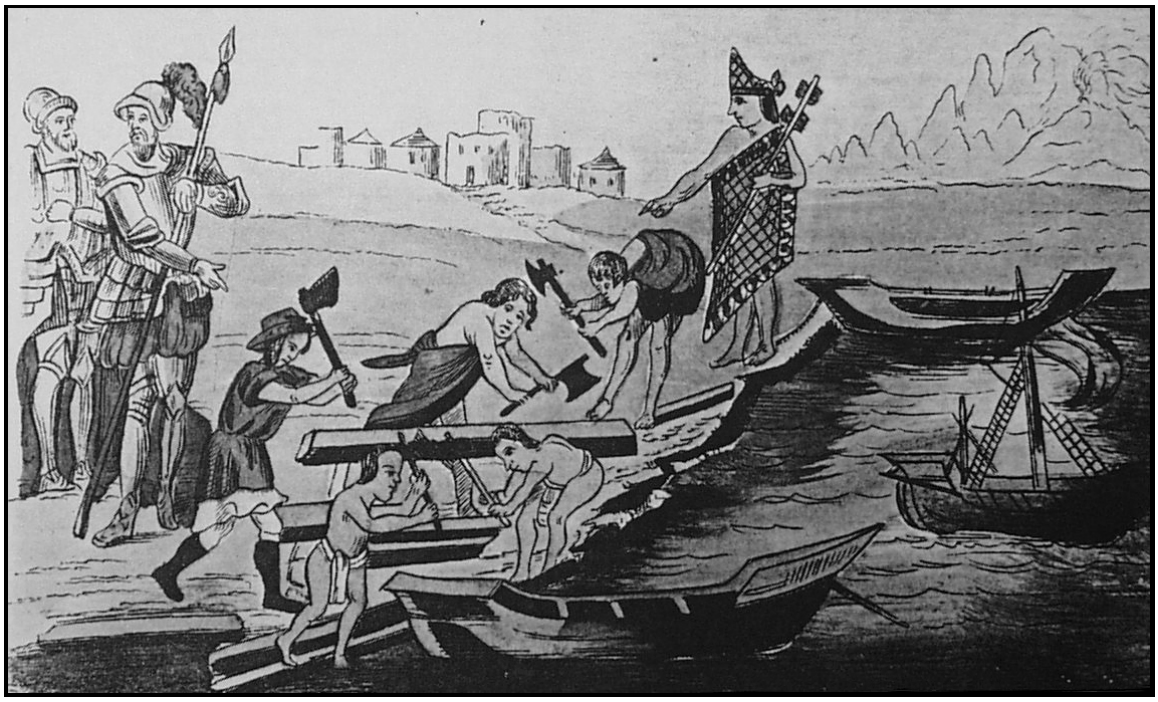

Figure 1. Indians used as laborers for shipbuilding in early 16th century New Spain. (Scheina 1972: plate 10)

The use of African slaves also supplemented and in some places replaced Indian labor, though again the extent of their role in colonial shipbuilding is unclear. It is known that in the province of San Salvador in the 1550s officials requested African slaves for (among other things) shipbuilding and dock work (Fiehrer 1979: 40). In 1670 a Genovese bank firm was granted slave importation rights by the Crown in return for their guaranteed production of a set annual tonnage, though this system apparently had little success (Haring 1918: 270; Scheina 1972: 202). As late as the 1770s, unskilled and semi-skilled slave labor accounted for 25% of the total work force in Havana's royal shipyards, a factor which helped keep construction costs lower than in Spain (Harbron 1988: 60-61).

Through the 1520s, most of Spain's shipping was concentrated in the islands of the Caribbean. After this period, however, focus shifted to the mainland, towards ports such as Cartagena and Nombre de Dios, and especially to New Spain and its main port of Vera Cruz (Parry 1972: 118-119). This shift was also evident in the colonial shipbuilding industry, as it became more and more clear that the Empire was to be founded on Peruvian and Mexican silver output. While Havana would remain a major maritime port and shipbuilding center—primarily because of its role as the last staging point for *flotas* departing home for Spain—shipbuilding in Mexico developed rapidly as it became one of Spain's premier colonies.

The shipyards of Veracruz and Campeche were turning out a wide variety of vessels by the middle of the 16th century. The range of sizes and types is illustrated by the vessels built in Veracruz and utilized for Tristan de Luna's failed 1559 attempt to found a colony at present-day Pensacola Bay, Florida. Six 100-ton *barcos* were purposely built for this endeavor in 1558, though only three—*San Luís*, *La Salvadora*, and *Corpus Christi*—actually ended up sailing with Luna's fleet the following year. According to a letter from the Viceroy to the King they were designed to carry 100 men and four pieces of artillery (Velasco to Felipe, 30 September 1558, as cited in Priestly 1928, 2: 257-261). A *fragata* whose name is lost to history was also built in Veracruz, possibly in the same shipyard (Scott-Ireton 1998: 69).

The largest ship in the expedition which was launched in Veracruz was the fleet's *almiranta* (vice-flagship), the newly-built galleon *San Juan de Ulúa*. It returned to New Spain after dropping off the colonists, and later served as a relief vessel after Luna's expedition was struck by a disastrous hurricane. The remaining six ships (*naos*, *navíos*, a caravel, and a galleon) participating in the colonization fleet were either purchased and of unknown origins or members of the incoming 1558 New Spain *flota*, presumably built in Spain (Smith et al 1995: 10-12). One of Luna's larger *naos* or galleons was discovered and archaeologically excavated in the 1990s, and its hull was found to have a mix of Old and New World timber species. This suggests that the ship, which was quite old at the time of sinking, was built in Spain but subjected to a rebuild or substantial repairs in a New World shipyard, possibly Veracruz or—as is tentatively suggested by ballast stone analysis—Havana (Smith et al 1998: 64, 70).

Design Influences from a New World, 1550 – 1600

Introduction of the Galleon

Galleons, or *galeones*, were developed in the middle of the 16th century and would soon become the workhorses of the *Carrera de las Indias* lifeline between Spain and her colonies. Essentially similar to transport *naos*, though more heavily armed, they constituted a new hull type designed for transatlantic speed, seaworthiness, cargo capacity, and defense (Elbl and Philips 1994: 98-114; Philips 1986: 40-46; Philips 1993: 230-234; Smith 1992: 27-28). Representative of Italian, Spanish, and Portuguese shipbuilding traditions, the *galeón* combined the cargo capacity of round *naos*, the swift waterlines of oared galleys, and the advantageous rigging configuration of maneuverable caravels to become the most advanced sailing vessels of the 16th and early 17th centuries (Smith 1992: 27).

One of their most characteristic features was a strongly reinforced hull which allowed hard and continuous service on the open ocean, as well as for fighting as a ship of war (Elbl and Philips 1994: 99). This was especially true for those participating in the *Carrera de las Indias*, which were built with thicker hull members to withstand numerous transatlantic crossings and the more frequent careening required in tropical waters (Serrano Mangas 1992: 15). Galleons featured characteristic beaks below their bowsprits, a throwback to the ram of medieval war galleys. In addition, their forecastles were shortened and situated aft of the stem, and were thus much lower than their stern superstructure, giving them what Carla Rahn Philips has called "a distinctive, low-slung crescent profile" (Elbl and Philips 1994: 101).

The aftermost portion of the galleon hull, like those of caravels, ended in a square transom or flat stern, designed for speed. Galleons also had increased length for speed, though compromises were made to allow for cargo capacity by retaining a somewhat wide hull. Thus the typical galleon might have a 1:3.5 length-to-breadth ratio, compared with the traditional "as, dos, tres" proportions of merchant *naos* (signifying a keel of twice the breadth, and length of three times the breadth, or 1:3) (Elbl and Philips 1994: 101; Philips 1993: 230). In contrast, the classic Mediterranean galley—designed solely for speed—might have a length to beam ratio as high as 1:6 or 1:8 (Phillips 1987a: 72).

The average galleon of the second half of the 16th century was around 350 *toneladas*, though some registered in the Basque province of Guipúzcoa in the 1570s were as large as 700 tons (Philips 1993: 231). One notable example, the *Capitana Real* (also built in Guipúzcoa, in 1595) was 1500 tons (Moya Blanco 1981: 152). This singular exception notwithstanding, Haring states that relatively few galleons over the size of 500 tons made the Atlantic crossing, and both war and trade ships in the *Carrera* were limited to a displacement of 550 tons by a 1628 *cédula* (1918: 263). The classic armed galleon had two decks loaded with cannon, along with a half-deck, quarterdeck, and poop deck which

might also carry artillery. It was this heavy armament, rather than size, that truly distinguished the galleon from similarly evolving merchant *naos*, and unarmed galleons were usually referred to by that name. True merchant *naos* were similar to galleons in most respects, and though they lacked heavy internal bracing, this might be added in order to re-classify one as a galleon (Philips 1986: 45).

The same galleon might serve as a warship, merchant ship, or even whale ship during her career, and might be described as both a *galeón* and a *nao* even in the same document (Philips 1993: 231). Accordingly, it should be understood that Spain did not use her transatlantic or *Carrera de las Indias* galleons as dedicated warships; their design was specialized to only a certain degree and allowed for versatility in function, so that these guardians of the merchant *flotas* were themselves cargo carriers. Without exception, outgoing and incoming galleons carried both legal and illegal mercantile cargos (Philips 1986: 45). As they were invariably the best-armed, the King's galleons carried his share of the incoming treasure from the New World.

It is not clear if galleons were constructed in the New World for the *Carrera de las Indias* before the 1590s, though, as demonstrated above, vessels known as *galeones* were built in New Spain as early as 1558. The galleon was designed with the particular features of the Atlantic passage in mind, and by the first decade of the 17th century an increasing number of galleons were designed and constructed on the far side of the Atlantic in the colonies themselves.

Design Contributions from New Spain: García de Palacio and the Instrucción náutica

That the first—and arguably the most influential—comprehensive shipbuilding treatise was produced in New Spain is a testament to Mexico's influence on late 16th century Spanish shipbuilding in general. This remarkable book, *Instrucción náutica*, was written and published by Dr. Diego García de Palacio in Mexico City in 1587 (García 1944; 1988). García, the *alcalde* of New Spain and a member of the King's Council of War, provided detailed information on almost every aspect of contemporary maritime technology (Fernández Duro 1996, 1: 133; García 1988: v). It includes discussions of hull and rigging designs, ship construction, sailmaking, ships' officers and crews, and the types of vessels built and used in colonial waters.

Like other early nautical writers, García was particularly concerned with the ideal dimensions and proportions of the five fundamental measures on the ocean-going vessel: beam or breadth (*manga*), keel (*quilla*), length (*eslora*), floor (*plan*), and depth (*puntal*) (cf. Philips 1987b; 1987a: 70-73). Written as a response to the demands of Spain's Indies trade, the treatise's extended title—"Nautical Instruction for the Good Use and Management of Ships, Their Design, and Conduct in Accordance with the Latitude of Mexico—suggests that the ship designs discussed are the ones that were put into practice in New Spain's *astilleros*.

García (1944: 90b-98a), discusses in detail his ideal proportions for two ships in particular: a merchant *nao* of 400 *toneladas* (which is "enough burden and a good size for a ship, whether for war or trade"), and a smaller *nao* of 150 *toneladas* (Figures 2 and 3). The sheer view (side profile) of the larger ship features no superstructure in the bow or stern. The illustrated profile of the 150 ton *nao,* on the other hand, displays a prominent beak, a low forecastle placed abaft the stem as well as a quarterdeck or raised superstructure in the stern. It thus resembles the low-slung crescent profile typical of the galleon, and may represent a small galleon or *galeoncete*. The latter vessel also has a much greater length to beam ratio; it was undoubtedly a much faster vessel, probably used for patrolling or escort missions as opposed to cargo-carrying.

The dimensions and proportions of García's 400-ton *nao* (with the depth dimension corrected as per Philips 1987b) are rather close to the traditional "as, dos, tres" proportions of merchant *naos* mentioned above. The figures are not too dissimilar, though, to those that would be mandated in the 1607, 1613, and 1618 regulations for similarly-sized ships plying the Indies trade (see Table 1). The 0.48 depth to beam ratio in particular is quite close to those which would be required by the later *ordenanzas*. The most salient difference in García's proportions and those of later transatlantic vessels was the trend of lengthening the hull, reflected in the increasing ratio of keel to beam (Philips 1987b: 295).

García (1944: 91b-92a) also provides useful information on the variety of smaller vessels constructed and used throughout the various colonial waters:

> [I]t is fitting that you give, for greater clarity, another demonstration of a ship [*navío*] of less burden, showing its measurements and design [this probably refers to the 150-ton *nao* discussed above] and what those used in the Windward Islands and Tierra Firme and the coasts of New Spain, Panama, and Peru ought to have . . . [this request is made by a hypothetical Viscayan, and the following answer is supplied by a similarly fictional Montañes]
>
> It is necessary to build ships that are to serve between the Windward Islands and Tierra Firme in proportion to the depth of hold, beam, and floor, and although they will exceed few in length, they are not to have more than a sixth part of the widest beam at the floor, and a third of the widest beam for the depth in hold, without the upperworks, because these vessels must ordinarily make their voyages by the bowline, as the trade-winds almost always blow in these parts. The main-mast will be of the same magnitude as the keel, the main-yard twice the beam, and the fore-mast in proportion. These are called *fragatas* [frigates], and most commonly, and properly, they do not, or ought not to, exceed fifty *toneladas*.
>
> The ships [*navíos*] that are used on the [Gulf] coast of New Spain, from Cozumel to Panico, considering the ports and coasts most generally have very shallow water, a beam-wind from the North, and very shallow anchorages, are made with the floor equal to one-half of the widest beam

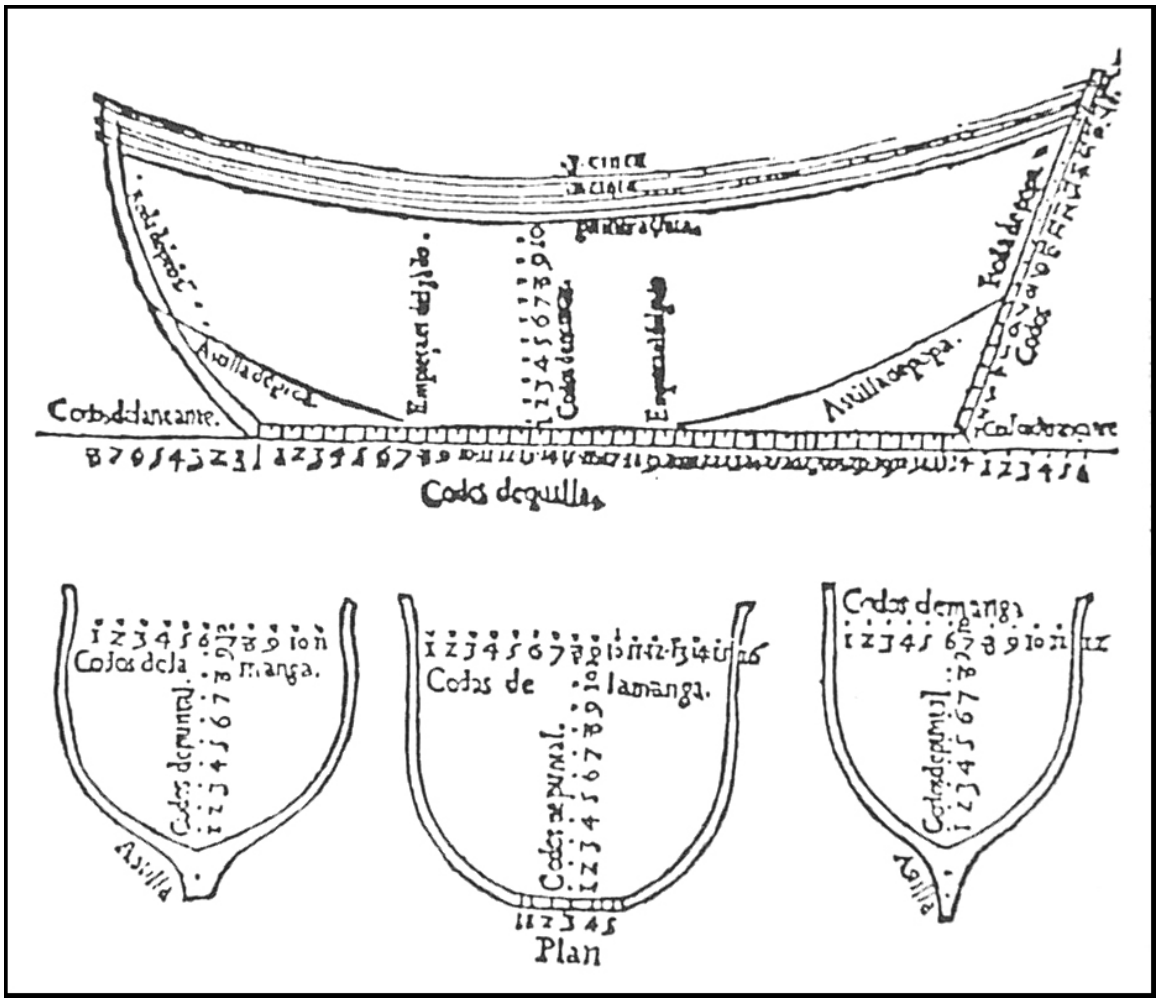

Figure 2. García de Palacio's *nao* of 400 *toneladas*, from the *Instrucción náutica* published in Mexico City, 1587. Longitudinal or sheer profile is above (note the flush profile or lack of raised superstructure); below are hull sections at the bow, midships or master frame, and stern. The dimensions of this ship are listed in Table 1. From García 1944 [1587]: 93-94.

and the depth of hold two-thirds, because they would continuously be shipwrecked, otherwise. They are of fifty *toneladas*, and are called *barcas del trato* [trading-boats], and the masting is like that of the aforesaid *fragatas*. Ships [*navíos*] of 50 to 100 *toneladas* are used on the coasts of Peru, Nicaragua, and in the trade with the Yçalcos (land that is in Guatemala) [Izalcos in present-day San Salvador], and on the Southern Ocean and South Sea [Pacific]. They are built with the floor a fourth of the widest beam, the depth a half, much sharpness in the stern and bow deadrising, and a good lateral resistance, because they always sail close-hauled, and thus, they sail well to the windward, though badly running before the wind. Notwithstanding, in building ships, there are no true calculations for some, as they ask for them according to their form, for

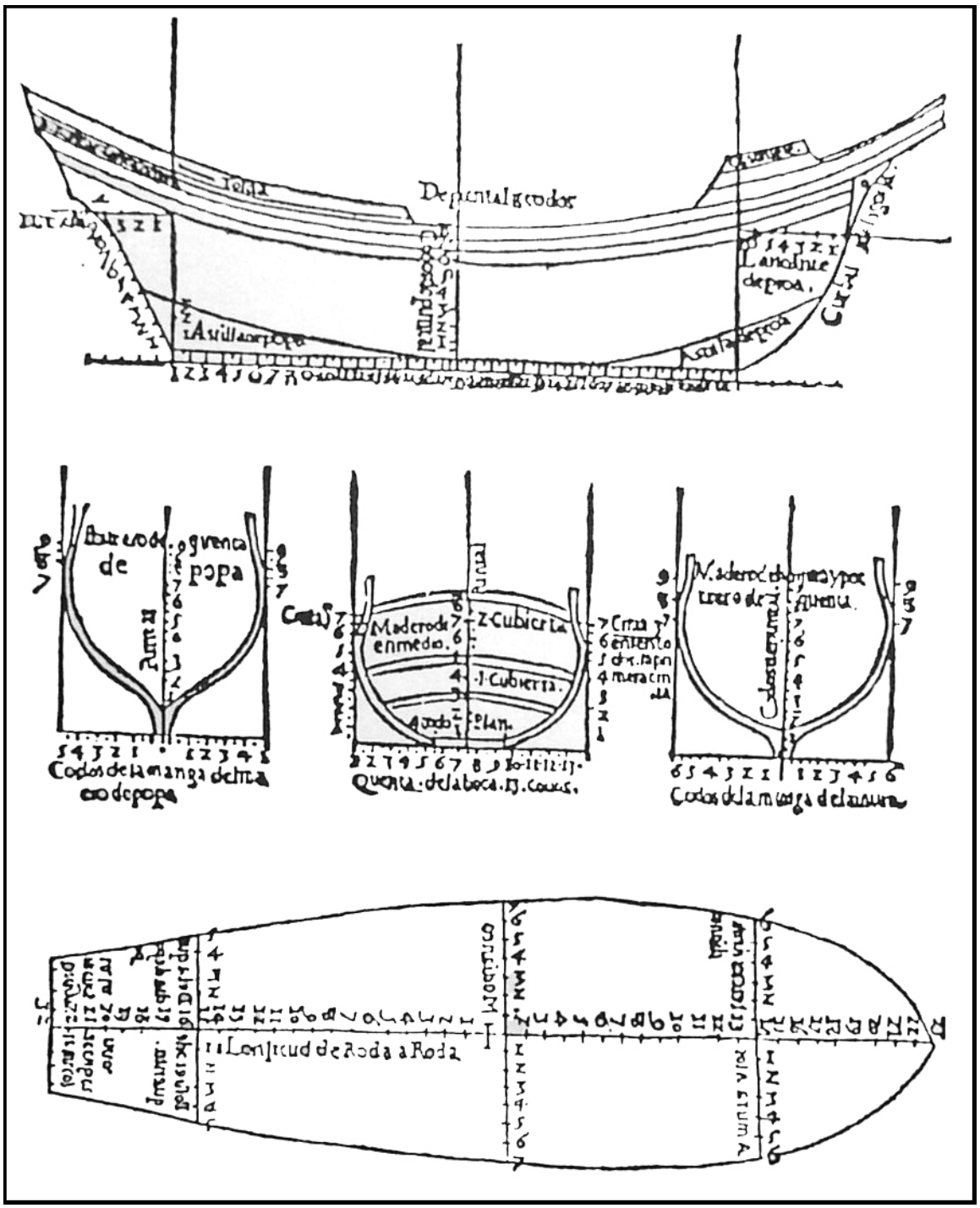

Figure 3. García de Palacio's *galeoncete*-like ship (*nao)* of 150 *toneladas*, from the *Instrucción náutica* published in Mexico City, 1587. Top: Longitudinal or sheer profile (compare with the *fragata* in Figure 4). Middle: Hull sections at the stern, midships or master frame, and bow. Bottom: Plan view of lower deck (note some of its labels are printed backwards). From García 1944 [1587]: 96-97.

> different navigations: wanting more floor, more of less of keel, or beam, and according to their cost, requirements, or places where they have need of them.

García's 50-ton *fragatas* are smaller than those built in Havana by Juan de Tejada around 1600 (Otero Lana 1991) which are discussed in the following section. They are similarly smaller than García's 150-ton *galeoncete*-like ship (which bears a rather striking resemblance to Tejada's *fragatas*). The depth to breadth ratio (0.33) of García's *fragatas* is closer to that of his 150-ton ship (0.37), however (see Table 2).

The *barcas del trato* are slightly deeper in relation to their width, displaying a 0.67 depth to breadth ratio. Like García's *fragatas*, they also displace about 50 tons, and they must have therefore been comparatively shorter (tonnage is usually derived by a formula incorporating length, breadth, and depth) and certainly slower. Their floors of 1/2 the beam, compared the that of the *fragatas* of 1/6 the beam, meant that the *barcas del trato* were three times wider at the bottommost part of their hold, or considerably less V-shaped than the finer-lined *fragatas*. The floor to beam ratio of the *barca del trato* is virtually identical to that prescribed by the 1618 ordinances for ships in the Indies trade, a reflection of their shared goal of increased cargo capacity. It is unfortunate that García does not provide any of the five standard dimensions for his *fragatas*, *barcos de trata*, and Pacific *navíos*, which would have allowed a much more meaningful comparison between these and other contemporary designs. Regardless, the variety of ship designs presented in *Instrucción náutica*, and the passage quoted above in particular, suggest that New World shipbuilders were quite sophisticated in adapting hull designs according to intended function and local environmental conditions.

Design Contributions from Havana: the Galeoncete *and* Fragata

Innovative designs were also coming out of Havana shipyards in the second half of the 16th century. What was probably the first New World design to directly affect shipbuilding in Spain was created by Pedro Menéndez de Avilés, the *adelantado* of Florida. Menéndez may himself have been influenced by Don Alvaro de Bazán, who from 1540 experimented with the combined use of sails and oars to produce "galleons of new invention," the galleas or *galeaza* (Philips 1993: 231). While the oars—and vessel type—were eventually abandoned, the galleas was an important step in the evolution of the galleon.

Whether he was inspired by Bazán or not, Menéndez also saw the usefulness of a strong-hulled yet swift ship that could be propelled by either wind or rowers. In the latter half of the 1560s he constructed twelve of these which embodied a significantly lengthened keel in relation to beam. Designed and built in Havana shipyards, they were called "*galleones agalerados con remos*" or, by Menéndez himself, *galeoncetes* (Marrero 1975, 2: 73; Haring 1918: 265). Impressed with their reported sailing ability and seaworthiness, Felipe II ordered Menéndez to build eight *galeoncetes* of the Havana design in Viscaya

Table 1. Comparative dimensions and proportions for selected idealized and actual transatlantic vessels, late sixteenth and early seventeenth centuries

		García's *400-ton nao*	**1607 *ordenanza***	**1613 *ordenanza***	**1618 *ordenanza***	***N.S. de Atocha***
Year		1587	1607	1613	1618	1616-1620
Toneladas	as in document	400	567.88	539.25	530	550 and 600
	merchant formula	397.81	498.75	530.59	476	546
	warship formula	453.50	568.58	604.87	542.64	622.66
Beam or Breadth (*manga*)	*codos*	16	16	17	17	17.5
	meters	9.04	9.04	9.61	9.61	9.89
	feet	29.66	29.66	31.51	31.51	32.44
Keel length (quilla)	*codos*	34	42	46	44	46
	meters	19.21	23.73	25.99	24.86	25.99
	feet	63.02	77.85	85.27	81.56	85.27
Length (at lower deck) (*esloria*)	*codos*	51.33	57	58.75	56	58.75
	meters	29.00	32.21	33.19	31.64	33.19
	feet	95.15	105.66	108.90	103.81	108.90
Depth of Hold (*puntal*)	*codos*	7.75	8.75	8.5	8	8.5
	meters	4.38	4.94	4.80	4.52	4.80
	feet	14.37	16.22	15.76	14.83	15.76
Breadth of Floor (*plan*)	*codos*				8.5	8.5
	meters				4.80	4.80
	feet				15.76	15.76
Keel to Beam		2.13	2.63	2.71	2.59	2.63
Depth to Beam		0.48	0.55	0.50	0.47	0.49
Length to Beam		3.21	3.56	3.46	3.29	3.36
Floor to Beam					0.50	0.49
Reference		Garcia 1944; Philips 1987a: 87	Philips 1987a: 83	Philips 1987a: 83	AGM Caja Fuerte 134	AGI CT 4895; Marrero 1975: 84-91

Notes:

- One *codo* (cubit) is equivalent to 0.565 meter. Feet are standard English measure, or 0.3048 meter.
- Depth of hold figures from García's treatise have been adjusted to correspond to the standard Spanish definition of this dimension (see Philips 1987b).
- The 1607, 1613, and 1618 regulations issued by Felipe III represent ideal (not necessarily real) dimensions, as does García's *nao* of 400 tons. *Nuestra Señora de Atocha*, on the other hand, was an actual ship built in Havana between 1616 and 1620 by master shipwright Alanso Ferrera. The *ordenanzas* were supposed to apply to all ships, whether merchantmen or warships, built in the New World or Old, participating in the *Carrera de las Indias* (Philips 1993: 233-234; 1986: 28-32)
- The two tonnage formulas were the standard ones used by the Spanish to determine *toneladas* for merchant ships and warships (the latter calculation produced a tonnage about 14% greater for the same ship). The actual formulas, whose results do not always correspond well with the tonnage reported in the primary sources, are provided in Philips 1987a: 73-75. Note the Vizcaya *tonel macho* is a different measure than the *tonelada*, which was the standard tonnage unit used in the Indies trade in Seville and the New World. The two reported tonnages for *Atocha* are based on discrepancies in different documents in the *Archivo General de Indias*. This was not uncommon, considering the two separate formulas could produce varying results for the same ship.

Table 2. Comparative dimensions and proportions for selected idealized and actual smaller vessels in colonial waters, late sixteenth and early seventeenth centuries

		García's 150-ton vessel	**Tejada's *fragatas*** (Havana)	**Menéndez' *galizabras / galeoncetes***	**García's *fragatas***	**García's *barcas de trato***	**García's Pacific *navíos***
Year		1587	c.1600	1568	1587	1587	1587
Toneladas	as in document	150		"about 200"	50		
	merchant formula	152.19	334.69				
	warship formula	173.50	381.54				
Beam or Breadth (*manga*)	*codos*	12	14				
	meters	6.78	7.91				
	feet	22.24	25.95				
Keel length (*quilla*)	*codos*	34	38				
	meters	19.21	21.47				
	feet	63.02	70.44				
Length (at lower deck) (*esloria*)	*codos*	45	51				
	meters	25.43	28.82				
	feet	83.42	94.54				
Depth of Hold (*puntal*)	*codos*	4.5	7.5				
	meters	2.54	4.24				
	feet	8.34	13.90				
Breadth of Floor (*plan*)	*codos*						
	meters						
	feet						
Keel to Beam		2.83	2.71	2.5			
Depth to Beam		0.37	0.54		0.33	0.67	0.50
Length to Beam		3.74	3.64	3.7			
Floor to Beam					0.17	0.50	0.25
Reference		Garcia 1944; Philips 1987a	AGS MPD 42, 70; Otero Lana 1991	AGI PR leg. 260, no. 2, ramo 34 as cited in Philips 1993: 231	Garcia 1944: 91b-92a	Garcia 1944: 92a	Garcia 1944: 92a

(Fernández Duro 1895-1903, 1: 184). A memorandum dated 17 December 1575 provides the measurements of these vessels, which are referred to as *galizabras* (AGI PR 1575). They had a keel to beam ratio of about 2.5 and length to beam of nearly 3.7, dimensions approaching García's 150-ton vessel and later *fragatas* built in Havana (see Table 2).

Philips (1993: 231) notes that the Viscayan-built *galizabras* handled poorly, and thus "must be qualified as an interesting failure rather than a success." Regardless, because of this design Menéndez is traditionally credited with starting the trend of lengthening the Atlantic sailing vessel, a feature important to the ongoing evolution of the galleon and, as Haring (1918: 265) points out, the 17th and 18th century frigate.

A Havana design which would prove of more lasting influence was the *fragata*. Descendants of Menendez' earlier design, *fragatas* built in Havana were among several smaller types designed for anti-corsair patrols and to serve as auxiliaries for the *Carrera de las Indias flotas*. The most important of these various designs was the creation of *maestre de campo* Juan de Tejada during the final decade of the 16th century. His *fragatas* were so successful that their production at Havana has been credited with the city's transformation into the preeminent shipbuilding center in the Indies (Marrero 1975, 2: 73).

This *fragata* was a transitional vessel different from those known by that name which had been built before and after this period. The traditional *fragata* was a variant of the Mediterranean galley which was undecked and equipped with six to twelve benches for one-manned oars and one or two lateen-rigged masts (Smith 1992: 26). These were used well after the time of Lepanto, and during the initial phase of exploration in the New World. A few extant shipbuilder's contracts in the *Archivo General de Simancas* indicate the oared *fragata* was built in Spanish yards as late as 1639 (Otero Lana 1991: 87).

But those built by Tejada in Havana's *astilleros* were of a different design, closer to Menéndez' *galeoncete* than to the *bergantín*-like oared *fragata*. Due to the paucity of information provided by García, it is difficult to understand how similar his 50-ton *fragatas* fit into this evolutionary sequence, though Otero Lana (1991: 89-91) believes they were related. The Havana *fragatas* were not propelled by oars, and instead were probably three masted and square-rigged, foreshadowing the more sophisticated rig of their distinguished descendant, the 18th century frigate. Like their descendants, *fragatas* had a single continuous gundeck.

A ca. 1600 illustration exists of one of the Tejada *fragatas* (AGS MPD 42, 70; published in Otero Lana 1991: 90). Unlike its smaller ancestors, the *fragata* depicted in this illustration (Figure 4) is well-armed, bearing cannons both at the bow (for pursuing enemies) and in a broadside row. Its profile is similar in shape to that of a galleon, though with a considerably lowered superstructure for increased maneuverability in contrary winds. This has lead Otero Lana (1991: 93) to remark that "it is reminiscent of a *galeoncete* with low lines and with well-balanced proportions . . . " The illustrated profile actually bears a striking resemblance to that of García de Palacio's 150-ton vessel,

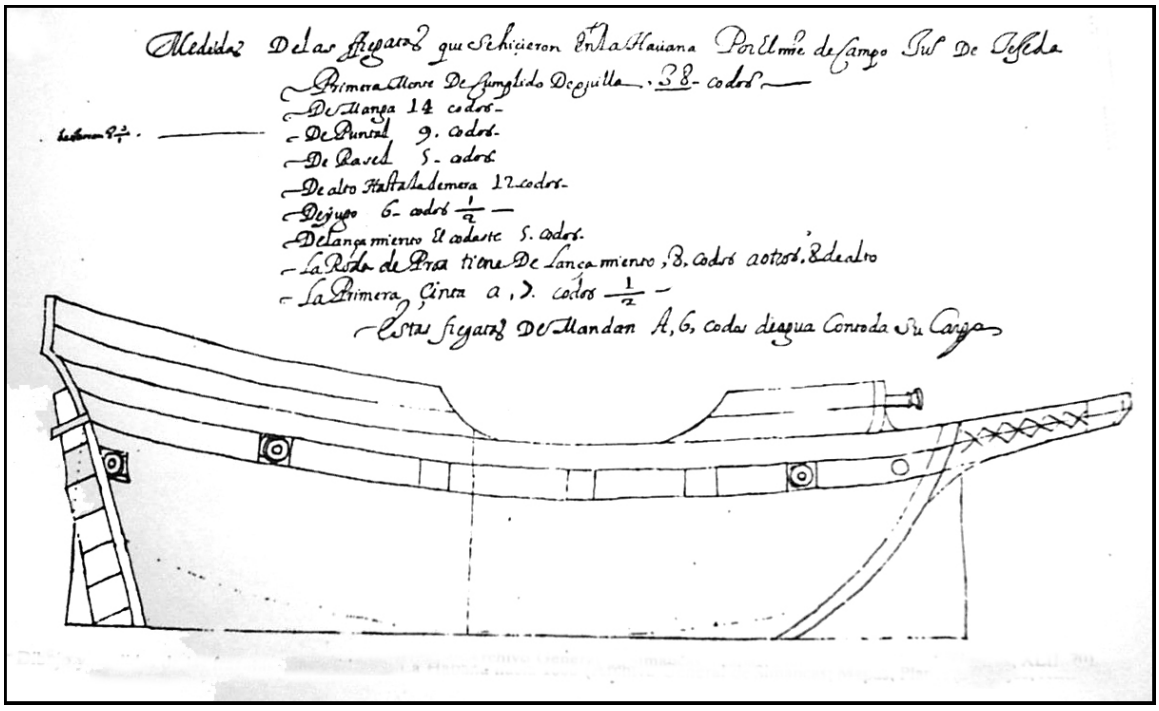

Figure 4. Depiction and principle dimensions of a *fragata* built under the direction of Juan de Tejada in Havana, ca. 1600. *Archivo General Simancas; Mapas, Planos y Dibujos* 42, 70; published in Otero Lana 1991: 90

though the latter ship has a pronounced upswept bow (see Figure 3). Table 2 facilitates a comparison of the two vessels' principle dimensions and proportions.

Contemporary maritime experts were certainly impressed with Havana's *fragatas*. In an 17 October 1606 letter to Felipe III, the Duke of Medina Sidonia wrote:

> The better ships that I have known, or have seen sailed, were the *fragatas* that were built in Havana by the *maestre de campo* Juan de Tejada, which measurements I have; and now I have one official that made one of them, and the best, named *Santa Ana* of 180 *toneladas*; and in every way they were marvelous ships and the sail was extremely so, so that it couldn't be improved (AGS GA 1606 as cited by Otero Lana 1991: 91).

He emphasized their success in mitigating piracy in Cuban waters and, noting the lack of similar light cruisers in the navy, went on to suggest that the Crown build six Havana-style *fragatas* in Sanlúcar or Gibralter to supply the Armada of the Ocean Sea and the Tierra Firme *flota*. In a second letter drafted by his secretary, the Duke added in his own hand:

> Neither the Armada nor the squadrons can be effective without light vessels to see the corsairs, in catching or punishing or hurting them; that is the only means for them [the corsairs] to quit this activity; and thus these *fragatas*, for what I am seeing and the voyages many have completed and the brief ones to the Indies, they [the *fragatas*] were the best ones to accomplish this service (22 October, AGS GA 1606; as cited by Otero Lana 1991: 91).

While the King apparently authorized the experimental construction of two 200-ton *fragatas*, there is no trace in the documentary record of their subsequent careers (Otero Lana 1991: 93). It is clear from these letters and the drawing that the Havana *fragatas* of the last decade of the 16th century were fast, maneuverable, and yet sturdier and better armed than their forbears; a design that was obviously suited for hunting the pirates which were the scourge of Spain's Atlantic colonies. It is also noteworthy that, along with the Menéndez' *galeoncete*, this vessel is one of the earliest examples of a colonial ship design becoming recognized as worthy of imitation in European shipyards. Colonial Spanish shipwrights deserve credit for having engineered a fundamental advance in the early evolution of what was undoubtedly the most important naval vessel of the 18th and early 19th centuries other than the ship-of-the-line itself: the frigate. The success of the *fragata* at the dawn of the 17th century would, along with García de Palacio's *Instrucción náutica*, help focus Spain's attention towards the potential of shipbuilding in her colonies, precisely at the moment that her domestic shipbuilding industry was in decline.

Criollo Galleons for the *Carrera de las Indias*, 1600-1700

Spain's Shipbuilding Crisis and the Cuban Solution

By the turn of the century, the Havana shipyards were actively producing an increasing amount and variety of vessels, from *fragatas* for coastal defense to 300 to 500-ton merchant *naos* and *navíos* for use in the *Carrera de las Indias*. After a 1589 shipbuilding contract with the crown, at least 15 Havana-built ships were plying the *Carrera* in the last decade of the 16th century; they were possibly the earliest colonial ships to do so (Fuente et al 1996: 108). Havana's yards were so busy at this time that she has been labeled by modern scholars "the chief shipbuilding centre of the West Indies" and the "Vizcaya de las Indias" (Haring 1918: 268; Pierre Chaunu as quoted in Marrero 1975, 2: 73). Her maritime importance was also recognized by contemporaries, who referred to the city as "the best port in the World," "the key . . . to the New World," and the "throat" of the Indies (Fuente et al 1996: 95).

Ironically, this period of New World productivity coincided with a decline in the domestic shipbuilding industry back in Spain. Actually, the lowest point in domestic output had occurred somewhat earlier, around 1575, when Escalante de Mendoza wrote in his *Itinerario de navigación* "I believe the business is now decayed, because they [Viscayan shipwrights] have made it a matter of profits . . . sometimes [building] weak ships not having regard for the qualities they should possess" (as cited in Usher 1932: 192). The industry was in such a slump that the rules giving native-built ships preferences in the Indies trade had to be lifted for a few years in the 1580s. While it is true that the industry achieved a major rebound in that decade (despite the debacle of the Great Armada), it is clear that Spanish shipbuilding remained more or less in a state of crisis through the end of the century, and into the next (Usher 1932: 193-194; Philips 1986: 22).

Letters from officials such as the *contador* of Cuba, Pedro de Arana, confirm a critical shortage of ships needed for the defense of Spain's overseas possessions in the face of increasing challenges to her claims of monopoly in the New World:

> Spain has never had a time of greater necessity for good, strong, and numerous ships than that which exists now, as it can be noticed; and in the *Carrera de las Indias*, Your Majesty doesn't have in the trade and commerce an ordinary armada that can resist and attack the corsairs in order to prevent them from robbing and [illegally] trading, because they have become powerful masters of navigation and [illicit] commerce . . . each year they take, steal, sack, and burn . . . (Arana to King Felipe III, 19 February 1600, as cited in Herrera 1975, 2: 73).

The situation was even worse three years later, when officials feared there weren't even enough seaworthy vessels at hand to make up the *flota* for the following year:

> The general Don Luis de Córdoba wrote . . . that although the galleons that carry the silver have been modified as best possible . . . they are old, and they have made many trips, and they won't e able to return for another trip, and the ones that came on the most recent passage are not in good shape, and there are no ships to bring silver next year . . . (*El Consejo de Indias* to King Felipe III, 25 March 1603, as cited in Herrera 1975, 2: 73).

The problems that Spain's depressed shipbuilding industry created for both imperial defense and the critical annual infusion of New World treasure are clear. The exact reasons behind the slump are less so, however. While many have placed the blame on intense foreign competition spurred by Dutch technological advancement (cf. Usher 1932: 195-6), it seems more likely that the unprecedented rates of inflation during the latter half of the 16th century were the fundamental cause. One early 17th century writer, Tomé Cano, noted that the cost of ship construction had more than tripled between the first half of the 16th century and the start of the 17th (Philips 1986: 23). The increasing scarcity of raw materials in Europe, particularly timber, constituted one of the major costs.

Timber, of course, was anything but scarce in Spain's overseas empire, and many saw the thriving industry in Havana as a logical solution to the problem. This justification, along with the quality of tropical hardwoods, was the one stressed by Arana when he tried to convince King Felipe III to authorize a major shipbuilding program in Cuba: "[The] commodities and advantages of the woods that are the best ones of the world in this island, particularly for this effect, because a ship built with these ones lasts more than two *naos* [that have been] built with wood from other places, and in the careenages there is an advantage of much money . . ." (19 February 1600, as cited in Marrero 1975, 2: 73). Back in Spain, the *Consejo* apparently agreed with this assessment, recommending to the King

> to build some galleons . . . because there is good woods in Havana, and an abundance of it, and a good master [the renowned Francisco Gutiérrez Navarrete, who had built the *fragatas* under Tejada]; there could be built some *galeoncetes*, sending from here the measurements and fasteners and cordage and trees, creating a better price and making them last longer than the ones here [in Spain] . . .
>
> . . . in Havana, because of the quality of the wood, because there would be ships for many years, and with the same cost of building one here one could be built there, taking from here the equipment in two *filibotes* [Dutch-style *fluits* or flyboats (storeships)] that go there [to Havana], and to take advantage of the trees for the new galleons (Marrero 1975, 2: 74).

One problem that was noted by the *Consejo* was that "only wood is available there . . . and everything else has to be sent from Spain" (Marrero 1975, 2: 74). It was true that

most necessary materials other than timber—hemp, oakum, and other cordage, tools, sailcloth, iron fasteners and fittings, pitch, tar, and other naval stores—all had to be imported (Serrano Mangas 1992: 71). But while constituting an increased expense, none of these were as bulky and therefore as costly to transport as timber. The *Consejo* estimated the total cost to build a galleon in Havana to be between 7,833 and 8,333 *ducados* (Marrero 1975, 2: 75).

This correspondence led to an *asiento* with General Juan de Borja Enríquez, who left Seville in 1608 to build seven galleons in Havana for the Windward Fleet (Marrero 1975, 2: 76). The *asiento* was a shipbuilding contract whereby an individual or group of individuals agreed to construct a specified number of ships to certain specifications within a certain amount of time for an agreed price (Serrano Mangas 1992: 3). When an *asiento* was in effect, the shipyard would be considered a *real astillero*; once completed (or abandoned) the yard would revert to private status (Clayton 1976: 238). The *asentista* (contractor) enjoyed many of the same special privileges and exemptions that royal officials did. While the direct construction of ships by the crown had resulted in excellent vessels in the late 16th century, the practice had proven to be prohibitively expensive. Private contracting, which was cheaper and shifted both risk and hassle to the *asentista*, became the preferred method of constructing royal ships in the 17th century (Philips 1986: 27). The Borja *asiento* resulted in the first of many privately-contracted galleons that would come out of Havana's shipyards.

"To discuss naval construction in Spanish America in the first half of the 17th century," writes Fernando Serrano Mangas, "is to talk about the shipyard in Havana" (1992: 72). This is a valid statement. While other American *astilleros* occasionally launched large ships, such as the two built in Veracruz in 1620 for the Royal Armada (González Echegaray 1981: 295), Havana was catapulted to a preeminent position in New World shipbuilding which it would retain through the end of the colonial period. At least seven different shipyards were operating in Havana in the 1578-1610 period (Fuente et al 1996: 108). Between 1612 and 1648 these *astilleros* produced at least 21 galleons for the transatlantic trade, or some 60% of all the galleons built in Spain's American colonies (Serrano Mangas 1992: 73).

Table 3 is a compilation of all known vessels participating in the *Carrera de las Indias* that were built in Havana between 1594 and 1636, the port's most productive years. This list, which is based on the Chaunus' (1956, 4-5) monumental analysis of the *Archivo General de Indias Legajos de Contratación*, includes a total of 57 ships comprising a total of 20,880 *toneladas*. These are made up of 18 galleons, 33 *naos*, 4 *navíos*, one 110-ton *filibote*, and a single 70-ton *patache*. The 18 galleons, comprising a total of 10,850 *toneladas*, are rather large, averaging around 600 *toneladas*. The *naos* had a much greater range of sizes, from 70 to 680 tons (almost all were greater than 150, however, with an average size of 275). Their aggregate tonnage was 9,100. The ships classified as *navíos* ranged in size from 100 to 300 tons, averaging 187.5. *Patache* was a general term for a smaller vessel, usually ranging from 80 to 150 tons, and frequently served as *flota* tenders or dispatch vessels (Moya Blanco 1981: 166). Despite the low numbers of such

Table 3. *Carrera de las Indias* vessels constructed in Havana between 1590 and 1636, according to the *Archivo General de Indias, Legajos de Contratación* (adapted from Marrero 1975, 2: 91)

Vessel Name	Type	Tons	Years	Comments
Nuestra Señora del Rosario	*Nao*	500	1596-1602	In all cases, the two years refer to the first and last time the ship is mentioned in the AGI *Contratación* records as a participant in the *Carrera de las Indias*.
N.S. del Rosario	*Nao biscaina*	300	1596-1601	
N.S. de la Concepción	*Nao*	180	1590	
N.S. de la Encarnación	*Navío*	300	1595-1606	
Los Tres Reyes	*Nao*	120	1594-1601	
N.S. del Valle	*Nao*	160	1599-1601	
San Francisco	*Nao*	200	1601-1612	
El Espíritu Santo	Galleon *biscaina*	400	1601-1610	
San Juan Bautista	*Nao*	200	1601-1605	
N.S. del Valle	*Nao*	300	1603-1605	
N.S. de los Remedios	*Nao*	140	1607-1608	Built in Cuba, but specified if in a Havana shipyard or elsewhere on the island
El Espíritu Santo	*Nao*	350	1607-1610	
N.S. del Rosario y San Salvador	*Nao*	650	1607-1612	Built for the governor Pedro de Valés
San Lorenzo	*Nao*	280	1604-1611	
N.S. de los Dolores	*Nao*	300	1608	Completed her third voyage by 1608.
N.S. de la Encarnación	*Nao*	70	1609-1610	
N.S. de Atocha	Galleon	650	1610-1628	This is the first of 7 galleons built by a 1608 *asiento* with Juan de Borja Enriquez. They became part of the *Armada de Guardia de las Indias*; *Atocha* served as *Capitana* (Marrero 1975,2: 82)
N.S. del Pilar de Zaragoza	Galleon	640	1610-1623	Built in 1610 by Borja; made 18 Atlantic crossings, broken up in Veracruz in 1623 (MacLeod 1984a: 345)
N.S. de la Vittoria	Galleon	630	1610-1628	Borja *asiento*
N.S. de los Remedios	Galleon	600	1610-1617	Borja *asiento*
N.S. de los Peligros	Galleon	600	1610-1612	Borja *asiento*
N.S. del Rosario	Galleon	600	1611-1621	Borja *asiento.* This ship was destroyed by fire at Veracruz.
La Caridad	*Nao*	350	1613	
N.S. de la Asunción	*Nao*	250	1613-1624	

Table 3. *Carrera de las Indias* ships built in Havana 1590-1636 (continued)				
Vessel Name	**Type**	**Tons**	**Years**	**Comments**
N.S. del Rosario	*Patache*	70	1614-1621	*Pataches* are small (less than 150 tons) and typically used as tenders or dispatch vessels
La Caridad	*Nao*	350	1614	
San Lorenzo	*Nao*	280	1615	
N.S. del Buenviaje	*Nao*	150	1616	Owned by Pedro Caballo; used as a slave ship on a 1616 voyage from Africa to Tierra Firme
N.S. de Atocha y San Francisco	*Nao*	150	1618-1621	
N.S. del Rosario y San Francisco	*Nao*	150	1619-1621	
N.S. del Rosario	Galleon	600	1619-1623	*Avería asiento* with Alonso Ferrera
Santa Ana la Real	Galleon	600	1619-1628	*Avería asiento* with Alonso Ferrera
La Candelaria	Galleon	650	1619-1630	*Avería asiento* with Alonso Ferrera
San Francisco de Paula	Galleon	600	1620	
San Francisco del Buen Jesus	Galleon	600	1620	
N.S. de la Candelaria	Galleon	600	1620-1635	
N.S. de Atocha	Galleon	600 or 550	1620-1623	Built by Alonso Ferrera, *Atocha* wrecked in the 1622 *flota* disaster off the Florida Keys. She has been worked by modern salvers and her hull remains recorded by archaeologists (Moore 1995). This is the *Atocha* listed in Table 2.
N.S. de la Candelaria	*Nao*	250	1621-1625	
Santa Cruz	*Navío*	100	1621-1622	
El Juncal	*Nao*	600	1621	
El Rosario	*Felibote*	110	1621-1622	Variant of the Dutch *fluit*, related to the *urca*, usually round-sterned (Olesa Muñido 1981:136).
San Blas	*Navío*	150	1622-1630	
San Antonio o La Cubana	*Nao*	360	1623-1624	
San Juan	Galleon	600	1624-1625	Burned in Seville in 1625.
N.S. de la Concepción	Galleon	680	1624-1633	
N.S. de las Aguas Santas	*Nao*	200	1625-1630	
Santa Ana María	*Nao*	200	1628-1631	
N.S. de Regla	*Nao*	80	1628	
N.S. de la Concepción	Galleon	600	1629	
Santa Teresa	Galleon	600	1629	
La Limpia Concepción	*Nao criolla*	200	1631	
San Marcos	*Nao*	250	1633	
N.S. del Rosario y San Josefe	*Navío*	200	1633	
N.S. de la Concepción	*Nao*	250	1633	
San Marcos	*Nao*	250	1634	
Santa Teresa de Jesús	*Nao*	680	1635	

Table 3. *Carrera de las Indias* ships built in Havana 1590-1636 (continued)				
Vessel Name	**Type**	**Tons**	**Years**	**Comments**
N.S. de la Candelaria	*Nao*	350	1636	
TOTAL VESSELS	**57**	**20880**		
TOTAL NAOS	**33**	**9100**		
TOTAL GALLEONS	**18**	**10850**		
TOTAL NAVÍOS	**4**	**750**		
TOTAL PATACHES	**1**	**70**		
TOTAL FELIBOTES	**1**	**110**		

small vessels represented in the *Contratación* records, it is certain that Havana's yards continued to build them in significant numbers during this period of expansion.

The *galeones criollos* soon gained a reputation for being stronger and more durable than European-made ships, and became the preferred ships for the Armada (Serrano Mangas 1992: 71). Numerous testimonials as to the superior quality of Havana's ships exist in the archival record. In September of 1621 the (undoubtedly biased) "people of San Cristobal de La Habana" stressed their ships were "the best ones that navigate in the *Carrera de las Indias*," pointing out they were consistently chosen to serve as *Capitanas* and *Almirantes* by *flota* officials. Likewise, in a statement taken from a 8 September 1638 *Junta*, the Count of Castrillo declared "they were the strongest for the silver trade and navigation to the Indies" (Serrano Mangas 1992: 72). The longevity of the ships themselves was a widely recognized testament to their excellent construction. The Havana-built *Nuestra Señora del Pilar de Zaragoza*, for example, made 18 Atlantic crossings between 1610 and 1623, an impressive career by any standard (MacLeod 1984a: 345). These qualities may explain why Havana's shipyards remained busy despite the increased overall construction costs due to the necessity of importing metal fasteners, tools, and other manufactured supplies. Philips (1986: 79) suggests it was actually cheaper to make ships in Spain: the price for a galleon built in Havana in 1617-19 was 47.3 *ducados* per *tonelada*, as opposed to as little as 30 *ducados* per *tonelada* in Vizcaya in the late 1620s[1].

Meanwhile, back in Spain, there were efforts underway by the crown to exercise tighter control over shipbuilding in an effort to revive the flagging industry. In addition to issuing *asientos* both at home and abroad, a major part of the effort to improve and regulate ship construction were the 1607, 1613, and 1618 *ordenanzas* of Felipe III's reign (Philips 1986: 28). Influenced by the ideas of García de Palacio and others, the regulations were designed to foment uniformity, quality, public debate among ship designers, and the incorporation of scientific innovations into ship design. A noticeable effect were longer, narrower hulls and decreased superstructures in ships built

[1] Though Philips does point out that other expenses would have raised the final price per ton. She also explains that the Vizcayan *asentista* in question was purposely underbidding, and thus losing profits, in order to gain the favor of the King.

domestically or overseas (Philips 1986: 29; see also Table 1 for a comparison of various dimensions and proportions required by the three ordinances). This trend improved speed, sailing qualities, and effectiveness in battle. While some have argued that strict regulation further stagnated the industry (cf. Clayton 1976: 243), Philips (1986: 33) argues the system was a beneficial "compromise of theory, tradition, and the needs of the Indies trade" which did seem to help bolster domestic shipbuilding.

As the industry began to re-assert itself in Spain, numbers of colonial-built ships in the Seville trade started to decline. Serrango Mangas (1992: 71) reports that between 1618 and 1648, at least 35 galleons, each of about 600 tons, were built in Caribbean ports for the *Carrera de las Indias*. Almost two-thirds of these were constructed in Havana. Of the total 35 *criollo* galleons, 25 were built before 1625, while only ten were produced after that date. The opposite situation was the case in Spain. Forty-two galleons were built in the same period in Viscaya and Cantabria. Of these, only 15 were constructed before 1630, and a full 27 were produced over the next two decades. These figures reflect the degree to which Spain had to rely on New World shipbuilding during the first three decades of the 17th century, and the subsequent recovery (temporary or otherwise) in the domestic shipbuilding industry after that point.

In June 1638, a royal *cédula* granted to shipbuilders of Havana, Campeche, Puerto Rico, Jamaica, and Santo Domingo all the privileges granted to Spanish yards. Ten years later, similar privileges were extended to all America (Haring 1918: 268). It is not certain why this was necessary, occurring as it did well after the Havana shipbuilding boom, though it may have been an attempt to bolster an industry that had begun to sag in the colonies. Serrano Mangas (1992: 73) believes that after 1630 the predominance of Cantabrian shipbuilding, through a monopoly of *asientos*, "broke the growing industry of building large ships in America." He notes that between 1630 and 1648 there is only one confirmed launching of a galleon of large tonnage in Havana.

It is difficult to reconcile this statement with those of other historians, however. Parry, for example, reports that "shipbuilding in Spain was a dying industry" and that in 1650 "a little more than a third [of all ships in the *Carrera*], including many of the warships, were American-built" (1966: 249). Likewise, MacLeod (1984a: 345) writes "by 1650 Spain built less than a third of its Indies fleets, while Holland and the West Indies supplied more than a third each. The lowest period for Spanish shipbuilding was the 1650s and 1660s." Clayton (1976: 246) gives Havana's shipyards even more credit, stating that the city "had grown into a most prosperous shipbuilding port that was supplying over fifty per cent of the vessels employed in the *carrera* by the second half of the seventeenth century." Marrero may shed some light on the issue:

> In the Armada and *Flota* that arrived in Seville in 1633, there were seven ships originating in Havana, and of those the *Nuestra Señora del Rosario y San Josefe*, of 200 tons, was new, but Chaunu thinks that others were also new and he adds that with the Armada or *Flota* the number of ships built in Indian shipyards contributed to the growth of returning tonnage (1975,2: 92).

It thus may be that Havana and the other New World shipyards continued to turn out significant numbers of ships that were simply smaller. The 200-ton *navío* mentioned by Marrero certainly cannot compare to the 600-ton galleons that had been built during the two previous decades, and he is apparently correct in pointing out that such great ships were produced with much less frequency after the first third of the century. Regardless, colonial shipbuilding, primarily in Havana *astilleros*, must have continued to provide an important supplement to the diminishing products of domestic yards and to an increasing number of foreign ships in the *Carrera* through the end of the 17th century.

New World Timber Resources and Construction Practices

As mentioned previously, new species of tropical hardwoods were the most important resource for shipbuilding in the New World. In the tropical conditions of Spain's Caribbean empire, seamen found that "the strain of the heat destroys in a short time the *navíos* built with other types of woods from outside . . . even with oak from Vizcaya" (Arana to King Felipe III, 19 February 1600, as cited in Herrera 1975, 2: 73). But certain species of trees encountered in the new empire were discovered to be superb for shipbuilding, and these "incorruptible woods" were highly praised by contemporary shipbuilders and officials (Marquis de Varinas to King Carlos II, 15 July 1691, as cited in Serrano Mangas 1992: 72). Tropical hardwoods such as mahogany were dense, durable, and rot-resistant, and were used by Spanish shipwrights as early as the first half of the 16th century (Record and Hess 1943: 368). On the other hand, conifers such as pine and cypress—which were harvested in Florida's wilderness on the northern fringe of the empire—were prized for mainmasts, topmasts, and spars (Hunter 2000).

A variety of these new species might be used by a New World shipbuilder, who would seek timbers with characteristics most suited for the various hull members that made up a sailing ship (Miller 2000: 18). The framework of the vessel, for example, was made up of the keel, floors and futtocks (collectively, the frames), and stem and sternpost. The most important aspect for these timbers was strength, with durability being of secondary concern. Planking, however, should be both strong and durable, and to a certain degree flexible as well. New World shipbuilders had at their disposal a greater diversity of wood species than the traditional European shipwright could even imagine. Additionally, the abundance of large trees allowed the *criollo* shipwright more options than were available in timber-starved Europe.

Despite what was written about the qualities of various woods for shipbuilding, attempts to reconcile colonial nomenclature with the proper terms of modern taxidermy can be a difficult endeavor. For example, the term "mahogany" has been applied to nearly 200 trees in 35 families, despite the fact that there are only three true species of mahogany (Miller 2000: 236). Serrano Mangas relates that Spanish colonial shipwrights usually used *sabicu*, "a very rigid wood that demanded great effort to work," for the framing members. The rest of the hull might use various types of mahogany, "preferably *capá* and *maría*" (1992: 72).

Sabicu is probably the same wood as *sapucaia*, which was used by Portuguese shipwrights in Brazil for keels, frames, and other large timbers. Miller (2000: 250) relates that *sapucaia* was so hard that axes were known to ring like bells during felling, if they did not break outright.

A number of wrecked ships originating in the Spanish New World have been discovered and archaeologically excavated, providing direct evidence of what woods were actually used. The Caballo Blanco wreck, believed to be a Spanish New World vessel built in the second half of the 18th century and lost near the Mona Passage, was found to have used *Busieraceae* sp. and *Pithecellobium* sp., both tropical hardwoods, for hull planking (Turner 1998: 350). *Nuestra Señora de Atocha*, built in Havana between 1616 and 1620 and lost in the Florida Keys in 1622, was made up of two different tropical hardwood species. Her floors (lowermost section of the frames) were crafted of *Swietenia mahogani*, a variant of mahogany. Two of the floors were anomalous, identified as *Tabebuia* sp. Moore (1995: 3) suggested that this might be the result of a temporary mahogany shortage, or else simply a particular shipbuilding practice whose purpose is no longer known. *Atocha*'s ceiling planking, placed along the upper surface of the floors in the hold, was also of this wood. All of her futtocks (upper portions of the frames) and outer hull planking were likewise constructed from *Tabebuia* sp., known in the Spanish Caribbean as *roble* ("oak"). Despite this name, *Tabebuia* sp. is not related to oak at all, bearing a closer resemblance to cedar (Moore 1995: 3).

A third sunken vessel, the Santa Rosa Island Shipwreck off Pensacola, Florida, is believed to be the remains of *Nuestra Se*Ż*ora del Rosario y Santiago Apostol*, a 450-ton, 42-gun *fragata* built at Veracruz in 1695 (Hunter 2001). Wood samples were taken from a variety of her hull members, revealing the ship was constructed exclusively of two New World hardwoods, Spanish cedar (*Cedrela* sp.) and mahogany (*Swietenia* sp.) (Hunter 2001: 68-69). The main segment of the keel was fashioned from a single log of Honduran mahogany (*Swietenia macrophylla*), a species that grows only along the eastern seaboard of the Yucatan and Central America, in the vicinity of both Campeche and Veracruz' shipyards (2001: 81-82). Framing members were composed of both mahogany and cedar, while the stem, keelson, deck stanchions, pump well components, ceiling and hull planking were all hewn from mahogany (*Swietenia* sp.) (Hunter 2001: 85-108).

One construction feature observed on the Santa Rosa Island wreck that has not been observed on Old World shipwrecks was the use of a massive, one-piece foremast step timber. European shipwrights would normally use multi-component assemblies for each of the mast steps. Hunter (2002: 97, 112) speculates that this exemplifies one of the well-known advantages of New World shipwrights; namely, that the readily available sources of timber would allow for large hull components to be hewn from a single, massive piece of wood. This would have not only allowed for a stronger ship, but also used less iron fasteners, which were considerably more expensive in the colonies. A similar practice was observed by the crew of the English frigate *Dolphin* making port at Rio de Janeiro in 1764. Witnessing the ongoing construction of the 64-gun *São Sebastião*, they were

astonished to see the enormous sternpost was fashioned from a single Brazilian cedar (Miller 2000: 18).

Another intriguing characteristic of this shipwreck is that its hull appears to have been fastened entirely with iron fittings. Contemporary Old World shipwrights would typically have used a combination of both iron fasteners (spikes) and wooden treenails (dowels) to attach, for example, the hull planking to the exterior surface of the frames. The wooden fasteners were traditionally favored because they tended to swell when wet, creating a more water-tight seal. The lack of treenails is significant because of the greatly increased cost of iron fittings in the New World, and the abundance of inexpensive wood suitable for making treenails. This feature becomes all the more mysterious when it is realized that the hull of the *Nuestra Señora de Atocha* also appears to be fastened entirely with iron fittings—even though her builder Alonso Ferrera's *asiento* specifically stated: "Once the frames have been set up, they must be mortised, nailed, and joined with three small bolts to the futtocks; between nail and nail, a treenail of dry wood for better fortification" (AGI CT 1616). David D. Moore, the archaeologist who has analyzed *Atocha*'s hull, speculated the meaning of this apparent discrepancy:

> This of course raises some very interesting questions as to Ferrera's shipbuilding credibility. Was this obvious breach of contract purely a fraudulent practice on his part, or a situation inherent with New World naval architecture and ship construction practices? Evidence is beginning to suggest actual fraud, particularly in view of the fact that the *Atocha* was one year late when finally launched. It appears that Ferrera was simply cutting corners and in fact, was charged with delivering an inferior vessel when the *Atocha* was forced to return to Havana with a leaking bow and broken mainmast shortly after she began her maiden voyage in 1620 (Moore 1995: 6)

Leaky bows and broken mast notwithstanding, it appears that Moore's first supposition may not have been the correct one. Hunter (2001: 79) believes that the Santa Rosa Island vessel's builder may have purposely eschewed treenails because of a shipbuilding practice described in Jovo Baptista Levanha's early 17th century treatise *Livro Primeiro de Architectura Naval*. Levanha stated that iron fasteners were preferred over treenails for ships sailing in tropical waters because they were less susceptible to attack from teredo worms and other marine borers. Alonso Ferrera, a contemporary of Levanha's, may have been subscribing to a distinctly colonial shipbuilding practice. The fact that a hull fastened entirely with iron would be more rather than less expensive to assemble, and that Ferrera appears to have used thicker hull planks and more floor timbers than called for in the contract (cf. Moore 1995: 3, 5) suggests that he may have actually been attempting to build a vessel beyond the required specifications.

Operation of a Criollo *Shipyard at Close of the Seventeenth Century*

While Clayton has provided a detailed overview of shipyard operations in Spain (1976: 238) and in Guayaquil (1972: 24-57; 1980: 19-41), there is little published information on the characteristics, organization, and activities of the *astilleros* of the Atlantic colonies, especially the lesser known ones.

A series of documents related to shipping and shipbuilding recently discovered in the *Archivo General de la Nación, Fondo Reales Cédulas Originales* in Mexico City have been acquired and translated by R. Wayne Childers of the University of West Florida (AGN 1701-1702). One of these, from volume 30, *expediente* 48, *legajo* 196, is a copy of a detailed letter written on 8 April 1701 to King Felipe V by Captain don Francisco Arias de Vivero, the *vecino* of New Veracruz in New Spain. Don Francisco was attempting to convince the king of the benefits of establishing a new and substantial shipyard at a site 40 leagues south of Veracruz, on the River of Guasacoalco. Like many officials writing their king, his point of view is clearly biased, but this does not render the document any less useful. Vivero's description of what actions were needed to transform Guasacoalco into a viable shipbuilding center gives us a clear understanding of what characteristics, resources, organizational structure, and labor system were required for the operation of an idealized shipyard in the late 17th or early 18th century. His criticism of other known shipyards, certainly affected by a bias towards his proposed shipbuilding site, nonetheless provides details on contemporary shipyards elsewhere in the Caribbean, details which for all but Havana are sorely lacking in the literature.

Vivero begins by justifying the need for a capable new shipyard in the New World. He states he is

> well informed of the desires that Spain has for the construction of ships for its Armadas and merchant trade of the Indies and how stripped the Spanish forests are, which is the reason that the few [ships] that are built have such little durability that even before they can be used, they are already rejected as unusable. Further, that at various times, it has been discussed that there are shipbuilding sites in the Indies that because of how costly they are and the lack of means and of subjects that would be encouraged to employ themselves in this occupation and the other reasons that the Council [has dismissed their use].

Vivero then lays out the reasons that Guasacoalco is so well-suited for the crown's needs that it should replace all others to become the major shipyard of the New World empire. He believes that at least four to six vessels, as large as 70-gun ships, could be built there every year; and that even larger ones could be started there and then towed "to San Juan de Ulua [Veracruz' main harbor] to be finished." In addition to constructing new vessels for both the crown and private citizens, the proposed shipyard would also be responsible for the careening, maintenance, and repair of vessels of the New Spain *flota* making call at the nearby port of Veracruz.

Vivero then outlines three criteria that are probably the most important for the location of any shipyard (cf. Scheina 1972: 195). The first of these is a suitable site that is both safe and has water access with the necessary depth to construct large ships. The River of Guasacoalco "is large, holds a lot of water and on its bar at low tide, there are 28 to 30 *palmos* of water [5.9 to 6.3 meters, or 17.8 to 19.1 feet] capable of having ships of the stated port [70-gun ship] with 2 decks, a quarterdeck and a forecastle depart over it."

The second criteria is easy access to forests with wood suitable for shipbuilding:

> The river has a great abundance of timbers. The greater part of them are cedars, seasoned and old, ordinary ones and big ones: *Havies*, Mulberry trees, *Zapateras Amarillas*, *Ocujes* and other types of wood, all of them the most precious types for shipbuilding and without excessive toil can be conveyed to the camp or shipyard which would be selected. This shall be on the river away from the coast about eight leagues more or less.

The final requirement was labor. Like the Mexican *astilleros* of almost two centuries prior, the proposed yard at Guasacoalco would rely heavily on Indian labor: "There are Indians in this jurisdiction that when paid the ordinary daily wages, can assist during the times that they would be needed for cutting timbers, to drag them and bring them down [to the water] and other mechanical exercises which will be done by Spaniards or Negroes with a greater amount of daily wages."

Vivero proceeds to discuss what must be done in order to start a viable shipyard on the site. Of primary importance is to establish a garrison of soldiers in order protect the *astillero* from pirate attacks. The fear of pirates, who, because of the sparse population along the river, have periodically "been able . . . to enter it and make meat, get firewood and water, robbing some unprotected pueblos during the summers" is the primary reason that "there have never been any [ships] built in this place." One of the benefits of establishing a shipbuilding operation here, Vivero adds, is that the camp "which shall soon be a populous pueblo, necessarily must evidently be of 300 persons" would discourage future incursions. He believes that a garrison of 25 soldiers and a reserve officer would be sufficient to keep the camp secure and "serve as defense for whatever incident." Included among them should be "eight or nine artillerymen with their master gunner, 200 flintlock muskets and the munitions that correspond to them for the defense of the said camp which must have, as stated above, 300 men."

The shipbuilding camp will first require the construction of a number of necessary buildings.

> A camp must be formed with houses of wood and roofed with straw as are those of most of the pueblos of this America. [There must be] warehouses for the materiel, blacksmith shops, houses and bowers [*ramadas*] for the skilled workers and peons and seamen. Once it is set up there is plenty of room, they will be building them at their own expense for their greatest convenience for this occupation.

The initial phase of shipbuilding will, as previously mentioned, require paid Indian labor and take over a year before the actual construction of any ships can begin:

> There are Indians (who ordinarily are paid 2 *reales* a day, and 2 ½ *reales* per day if they bring their own food, which is usual for these people). Further, for the woodcutting, conveyance of them to the shipyard for this and starting to hew out timbers. This must occupy the first year so that in the second they can lay down two or three keels and the following one in the future, four, five, and six every year the same so that cutting timbers never stops . . .

Vivero adds that while "the first of anything are most costly," the process will become much less expensive once the facilities are in place and the shipyard operational for a few years.

Vivero also provides us with an idea of the numbers, variety, and availability of craftsmen necessary for a large New World shipyard. The Guasacoalco yard "will create many skilled jobs for carpenters [*carptinteros*], caulkers [*calafates*], many woodsmen and seamen." While some of these were readily available in the New World, a number of the more specialized professionals would have to be sent from Spain or elsewhere in Europe. These include

> two master carpenters, shipbuilders not craftsmen [*mechanicos*] (of which there is no shortage), two or four skilled workmen for the trailboard sculptures [*esculturas vichas*] and adornment of poops. There are none of these [sculptors] in America and for this there are good Flemmings or Frenchmen or Dutchmen as the most experienced.
>
> The other skilled workmen and caulkers are not lacking around here and at the first report of these constructions, there will be more than enough discovered without the many that will show up while the said constructions are ongoing.

While timber and certain other raw materials were plentiful in colonial Spanish America, iron for fasteners, tackle, and hull fittings was not. A brittle, low-grade iron was produced in New Spain, and while this could be used in some minor fittings, the majority of iron hardware needed in colonial *astilleros* had to be imported at great cost from Spain or elsewhere in Europe (Clayton 1980: 33, 88). This was also the case for the proposed shipyard at Guasacoalco.

> For the greatest speed and the least expense, Your Majesty must send from Spain, the nails [*calvazon*], bolts [*perneria*], *gobernaduras*[2], chains [*cadenaje*], grommets [*anillas*], forelock keys [*chavetas*], all made in

[2] This term remains untranslated and its definition is unknown. It may have to do with iron fittings related to steering tackle (*gobernar*, to steer a ship or obey the helm).

> Vizcaya and for the tackle [*aparejos*], rigging, cables, canvas, lead sheets, and the rest that will be found in the memorial at the end of this proposal.

Vivero suggests that ships that are to be removed from the crown's service should be sent to the New World in order to be "broken up and stripped [of] materiel, masts and spars and nails" for use in shipbuilding This would be more cost effective than selling the hulks in Spain, where they would fetch little profits. They could also be used to transport the largest varieties of spars and masts from Europe. While the pines and cypress for such materials were available "from the Bay of Santa María de Galve" (present-day Pensacola Bay, Florida), the harsh environment, labor problems, and hostile Indian attacks made their harvesting prohibitively difficult (Hunter 2000: 17). Additionally, according to Vivero, those "specimens [which] have been brought [were] of little size . . . [there being] no larger ones."

On the other hand, there was a suitable local source for cordage:

> This river has a tree that is called *majagua* in great abundance, from whose bark ropes, hawsers, and cables can be made for the use of the constructions which shall excuse the expense of the many ropes and hemp rigging that they consume since with the seamen that shall assist said constructions and a master ropemaker of which thre is no lack here, as much as is necessary can be made for this use *hasta los tables* which the ships shall use up while they are in this river, reserving those of hemp for the ports.

Vivero also explains the manner in which the proposed yard should be organized and administrated. At the apex of the shipyard's organization

> Your Majesty must place a general superintendent with the greatest authority over all the administration of said constructions with the license that they are with both Royal military and ordinary jurisdiction who is recognized as the superior inasmuch as to those who live (and work) in the said camp and shipyard . . . [the general superintendent should answer directly] to the Viceroy of New Spain and [must] maintain his presence in the camp or shipyard except for those times when he might have to go to Veracruz to deliver ships or to finish up some of them.

He suggests that the future superintendent should also be granted the position of *Alcaldia Mayor* of Guasacoalco and Agualulco (the province in which the proposed shipyard site is located), in order to prevent political rivalry between the two positions.

There must also be

> one paymaster who is charged with the money and he must pay this by drafts from the superintendent with a letter of payment from whoever receives money from Your Majesty not only for their daily wages and

> salaries but also of the rest of the items that shall be purchased for this effect. Further, this one must also give his accounts to whoever Your Majesty would order him to which will prevent the multiplicity of ministers and salaries which usually are found for each thing of Your Majesty's service.

For quality control and "to have an accounting and relation of everything, Your Majesty shall order that there is an inspector accountant that shall approve of everything that is done. This would not be a position that can be omitted nor can the rest that Your Majesty should wish to be there."

He stresses the importance of ensuring "that the work never stops because of lack of . . . sufficient money in the coffers of Veracruz", suggesting that money should be sent monthly to the shipbuilding camp. Available cash will be necessary, Vivero explains, for the expedient payment of required materials, along with other constant expenses of the yard (salaries are presumably one of these expenses). To keep track of the money flow, the Superintendent will periodically send to the Viceroy of New Spain detailed accounts of the progress of ongoing construction projects.

Vivero estimated that, if his cost-cutting recommendations were followed, it would require 40,000 pesos to build one of the aforementioned 70-gun ships, including "its perfectly finished hull with its launch and boat (*bote*) and gun carriages (*cureñaje*)." This is an extremely low and probably unrealistic estimate, considering that in Campeche—"where construction is the cheapest of all America"—a *Capitana* and *patache* currently on the stocks were contracted at a price of 1000 pesos per *codo*, or 55,000 and 45,000 pesos respectively.

In his concluding remarks, Vivero includes a brief list of other shipyards operating in the Indies, and their "inconveniences," so as not to "ignore the many places in which ships have been built and so that it does not appear that ignorance or passion is the reason [for his promotion of the Guasacoalco project]." This provides very interesting, albeit somewhat biased, commentary on the locations and limitations of the major Caribbean shipyards at the turn of the 18th century.

The yards of Campeche, "where constructions are frequent" and the least expensive, were having increasing problems with access to timber resources. According to Vivero, this was due to deforestation related to long-term shipbuilding, and the increased difficulty in finding and transporting adequate timber created significant delays. Additionally, Vivero states that due to shallow water conditions a large ship built in Campeche must be launched after completion of the first deck, and towed "more than a league to sea in order to finish it, at the mercy of the winds and enemies who can carry it off or burn it."

Vivero characterizes Honduras as having abundant forest resources and numerous shipyards, but points out two significant drawbacks. Resources other than wood were scarce, necessitating their costly import, and there is no suitable "sheltered spot" anywhere along the coast there.

Even Vivero cannot disparage the great shipyards of Havana, though he does note similar deforestation problems based on the longevity of the industry there. "The timbers are already very distant. They must be conveyed from far away in vessels and rafts and many of these are lost . . ." He does note the abundance of good timber in Matanzas. He describes Cuba (presumably another port on the island) as being able to "do everything," but with too little water depth for the entry and departure of large ships.

Other island ports with shipyards, notably Santo Domingo, faced the same problems of water depth and access for large ships. Puerto Rico, on the other hand, had a good harbor as well as abundant "timbers but it does not have more nor are there dockyards, tar, turpentine nor any other thing. Everything is needed to be taken there from outside."

Vivero mentions three shipbuilding ports in Tierra Firme: Cartagena, Maracaibo, and Caracas. The first of these, Cartagena, has a tradition of building "ships of good tonnage," but was plagued by deforestation and other challenges: "The timbers come from very far away and with difficulty as has been experienced in the careening that was given to the galleons of the Conde de Sauzedilla." Maracaibo frequently had "a shallow bar" built up at its entrance, preventing large ships from leaving "and in the meantime the shipworms eat up the bottoms." Finally, Vivero is entirely critical of the port of Caracas, where "[n]othing is possible . . . because to careen even one *fragata* cannot be done."

Despite the persuasive argument, the King never authorized the establishment of a new shipyard at Guasacoalco. But at the close of the 17th century, Spain's flagging New World shipbuilding industry was finally at a turning point. After a serious decline which bottomed out in the 1670s and 1680s (MacLeod 1984a: 345), the efforts of men like Francisco Arias de Vivero would herald a new era of colonial shipbuilding. Under the maritime Bourbon reforms of the following century, Havana's yards would again put out large vessels in the same numbers as she had in the first three decades of the 17th century. Spain would go further than any other major power in the development of her overseas shipbuilding facilities, making Havana without question the most advanced shipbuilding center anywhere in the world outside of Europe, with at least 74 *navíos de línea* or ships-of-the-line built there in the 18th century (Lavery 1989: 284; Harbron 1988: 51-75). The pride of Havana's *astilleros* was the 144-gun flagship *Santísima Trinidad*, launched in 1769 and widely regarded as the most powerful sailing warship ever afloat. In the face of the final demise of the *Carrera de las Indias* in 1789, and the subsequent fragmentation of her empire, Spain's long-celebrated tradition of glory on the high seas would thrive a bit longer, exemplified through the ships made in her last great colonial possession.

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