Warships and Cargo Ships in Medieval Europe

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It is a commonplace in the history of ship design that during the 16th century Europeans developed two quite different vessel types, one for fighting and one for carrying goods. Each was so specialized that it was not advisable, and in many cases not feasible, to use them interchangeably. Once shipbuilders made the distinction, the two types were subject to separate development. As one work suggests, "One type grew definitely into a mere carrier of merchandise, while the other became a fighting-machine. . . ."[1] The lightly armed Dutch *fluit* (see fig. 1), first built late in the 16th century, is the prime example cited of a cargo ship designed solely for moving goods and ignoring problems of defense. It has been said that "the introduction of the *fluyt* marked the first clear distinction between the functions of the warship and those of the merchant packet."[2]

The implication is that cargo ships and warships were much the same during the middle ages and that ship designers and builders before 1600 were incapable of developing specialized vessels; that they were unsophisticated, blind to the potential for improvement through specialization. In fact that impression is wrong. It ignores both the presence in medieval Europe of a distinct separation between ships for fighting and ships for carrying goods and the variety of designs which existed at all times within those two large categories.

In early medieval Europe there were two distinct types of vessel built

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[1]Hendrik Willem van Loon, *Ships and How They Sailed the Seven Seas, 5000 B.C.–A.D. 1935* (New York, 1935), p. 113. For other similar examples, see T. K. Derry and T. I. Willaims, *A Short History of Technology* (Oxford, 1960), pp. 205, 207–8; J. H. Parry, *The Age of Reconnaissance* (New York, 1963), pp. 82–84; G. P. B. Naish, "Ships and Shipbuilding," in *A History of Technology,* ed. Charles Singer et al. (London, 1957), 3:480–81; Garrett Mattingly, *The Armada* (Boston, 1959), pp. 194–96; and R. and R. C. Anderson, *The Sailing Ship* (London, 1926), p. 135.

[2]J. H. Parry, "Transport and Trade Routes," in *The Cambridge Economic History of Europe* (Cambridge, 1967), 4:213.

FIG. 1.—A convoy of Dutch *fluiten* protected by a warship and a yacht (center). The broad stern and extensive armament of the warship contrasts sharply with the design of the cargo ships. From a painting by an unknown 17th-century Dutch artist now in the Museum of Fine Arts, Budapest (Reproduced from Dénes Pataky and Imre Marjai, *Ships in Art* [Budapest, 1973], no. 29.)

specifically for two quite distinct jobs. The galley, inherited from the Romans, was the warship of the Mediterranean, while the sailing ship was intended for carrying goods. Galleys could be used for moving cargo, but improvements in sailing ships further relegated them exclusively to fighting. This process of differentiation increased through the 13th century. The introduction of the great galley, for example, made light galleys into warships almost completely removed from any commercial function. In northern Europe the same kind of distinction existed between sailing ships for carrying goods and rowed vessels for fighting. Even the addition of sails to rowing barges and other design changes by Scandinavian shipwrights which made that type into a serviceable sailing ship did not eradicate the distinction between the two basic kinds of ship.

What did destroy that distinction were developments in the design of the cog in the 11th and 12th centuries. Here two types were merged into one. More precisely, the cargo ship proved to be the dominant vessel for fighting. Thus, the separation of warships from cargo ships was not a new development but was restored in the course of the 16th century, first by improvements in sailing ships and then by the addition of guns able to sink other ships.

The differentiation of the cargo ship from the warship was not a simple matter of technical change, of builders just deciding to go ahead and build two types of ships. Even if shipwrights could design and build

the two forms of vessel, that by no means insured that they would be used. Throughout the middle ages technical improvements made by shipbuilders, though often incorporated into ships, could not be exploited because of external circumstances.[3] With the differentiation of cargo ship and warship that was especially so. The lightly armed cargo ship could only be used where violence was at a low level or at least where it could be contained by the use of convoys. In general, in the 16th century the channeling and organization of violence by European states made it possible to go ahead with designing and building specialized ship types. European monarchs with greater power over their subjects, approaching or attaining what would later be called absolute monarchy, could more effectively decide when and where violence would occur at sea. These monarchs could not control all of their subjects all of the time, but they still made every effort to contain and direct their violent acts. Attacks, if nothing else, became more predictable. Moreover, the monarchs were interested in increasing their cash income, and a major source of cash was taxes on peaceful trade. They were reluctant to allow indiscriminate warfare on any shippers and took a greater interest than ever before in the promotion of trade. This meant that there was an excellent chance that job-specific cargo ships would be used and that shipwrights were in a better position to build ships.

The European pattern was repeated in the 17th and 18th centuries in American trades. It was then that governments began to stabilize and to direct violence in the Caribbean and along the Atlantic coast of North America. It was precisely that change which made possible the greater use of cargo ships designed exclusively for their job.[4] The lack of order at sea, fighting, and piracy did not act as a constraint on the use of the cog and the carrack, the sailing ships of the 13th through the 15th centuries. Rather, their adoption and widespread use depended in part on the precise fact that they were so defensible. They were so capable as warships that the presence or absence of government control over violence was of only marginal importance.

The insistence on a major breakthrough in specialization of ships around 1600 is wrong, but it is excusable on two counts. First, the claim is valid for northwestern Europe and for the powers that dominated world oceans in the 17th and 18th centuries. The emphasis on the development of the *fluit* and of pinnasses and frigates, warships built

[3]F. C. Lane, "Progrès technologiques et productivité dans les transports maritimes de la fin du Moyen Age au début des Temps modernes," *Revue historique* 510 (1974): 277–302.

[4]G. M. Walton, "Obstacles to Technical Diffusion in Ocean Shipping 1675–1775," *Explorations in Economic History* 8 (Winter 1970–71): 123–40.

solely for fighting, comes from a concentration by scholars on those states and the expansion of European commercial connections over long distances and outside of Europe. Second, the claim is valid over the shorter term of the 14th, 15th, and 16th centuries. Compared with the design of ships during that period, the separation of warship from cargo ship around 1600 was a unique event. It was not unique, however, relative to the level of specialization in design in the much longer period of the entire middle ages. A summary view of just some of the ships built and used in medieval Europe and of some of the adaptations made to improve those vessels clearly demonstrates the ability of shipwrights to exploit the advantages of dividing warships from cargo ships.

The Mediterranean

In the Mediterranean in the early middle ages there was already a long-standing differentiation between ships for fighting and ships intended only for carrying cargo. Southern European vessels are usually divided into long ships, that is with length-to-beam ratios in excess of 6:1, and round ships with a ratio under 4:1 and often well under that figure. In the Roman Empire the only warships were light galleys, called Liburnians, with a high length-to-beam ratio. There were other long ships, galleys, which carried goods. Merchant galleys were of course limited to handling lightweight and valuable items since the cost of carriage was much greater than with round ships. Romans were able to build their navies exclusively of light galleys because they had cleared the Mediterranean of any potential opponents.[5] By the 1st century A.D., Roman builders produced a cargo ship, the large round ship, which was not used in fighting. They produced a warship so well suited to fighting that, in the lighter version, it was unlikely ever to be used for carrying goods. The cargo ship was not highly efficient despite its tremendous size, and it was not easy to handle. Romans used the big ships only on protected and controlled trade routes. The potential created by the distinction was not pursued because the Roman Empire, the political umbrella which made possible specialized designs, declined in strength. This signaled an end to the indirect subsidies to large sailing ships and to the peace which made the small warship effective.

With the decline and the disappearance of the western portion of the Roman Empire, the large sailing ship disappeared. Instead, small coasters typically carried cargoes. Because of challenges to Roman naval superiority in the Mediterranean, the Eastern Roman or

[5]Lionel Casson, *The Ancient Mariners* (London, 1959), pp. 213–36.

Byzantine Empire increased the force of its galleys, among other ways, by making them bigger. The Byzantine navy required and developed a complex organization. The threat of Arab fleets after the middle of the 7th century and then the need to reconquer the strategically important island of Crete in the 10th century led to the development of a large galley which could carry 300 men and more. Arab navies used the same types of ships as did Byzantine naval forces.[6] War fleets were then made up of galleys. These large oared ships which had the generic name "dromon" were also capable of competing as cargo vessels. They were, if anything, more economical to operate than Roman long ships. The smaller size of cargo vessels, though they were easier to handle than Roman round ships, did not offer the same level of competition to oared vessels.[7] Thus the distinction between warship and cargo ship was eroded through the 10th century in the Mediterranean.

The tendency was reversed in the 11th and 12th centuries by a revival in the building of round ships. Shipwrights made them much larger and more reliable than the Byzantine coasters. These cargo ships carried two masts, each with a triangular lateen sail. Using lateen sails made it possible to sail closer to the wind than with square sails. These vessels had the double advantage of being able to carry bulky goods in their holds and lighter goods above the first, but below the main deck. With heavy goods between the two decks the vessels were unstable. The presence of these sailing ships, their increasing numbers, and their capacity for handling lighter goods at a low extra cost made them a direct threat to galleys in the carriage of just that type of cargo. Indeed, the round ships had, by the 13th century come to dominate Mediterranean cargo carriage.[8] At the same time, war fleets were composed almost exclusively of galleys. There were also vessels combining the features of both types, that is, round ships with a small number of oars to give them greater maneuverability. Overwhelmingly, however, their

[6]H. Antoniadis-Bibicou, *Etudes d'histoire maritime de Byzance* (Paris, 1966), pp. 53–117; Ekkehard Eickoff, *Seekrieg und Seepolitik zwischen Islam und Abendland das Mittelmeer unter byzantishcer und arabisher Hegemonie (650–1040)* (Berlin, 1966), pp. 135–50; L. Bréhier, "La Marine de Byzance du VIII[e] au XI[e] siècle," *Byzantion* 19 (1949): 1–16; and Lionel Casson, *Ships and Seamanship in the Ancient World* (Princeton, N.J., 1971), pp. 146–68.

[7]R. H. Dolley, "The Warships of the Later Roman Empire," *Journal of Roman Studies* 38 (1948): 47–53; A. M. Fahmy, *Muslim Sea-Power in the Eastern Mediterranean from the Seventh to the Tenth Century, A.D.* (London, 1950), pp. 116–37; and, Frederick van Doornick, "Byzantium, Mistress of the Sea: 330–641," in *A History of Seafaring Based on Underwater Archaeology,* ed. George Bass (London, 1972), pp. 133–46.

[8]Eugene H. Byrne, *Genoese Shipping in the Twelfth and Thirteenth Centuries* (Cambridge, Mass., 1930), pp. 3–11; and Hilmar C. Krueger, "The Routine of Commerce between Genoa and North-West Africa during the Late Twelfth Century," *Mariner's Mirror* 19 (1933): 430–34.

main source of propulsion was their sails. Therefore the separation of oared vessels from sailing ships was not complete.[9] After all, galleys often sailed most of the way to their destinations. But the distinction between warships and cargo ships by the 13th century was as great as it had been during the 1st and 2d centuries A.D. The crews had to be different, and not just in number. Sailors on a round ship had to have skills which were not required of the rowers, the great majority of men on a galley.

The tendency toward separating fighting ships from cargo carriers, based on Roman practice, was partially checked in the last years of the 13th century. Shipwrights at the government shipbuilding yard in Venice, the Arsenal, developed the great galley. Their goal was to get a more powerful warship by building a bigger galley, giving it more oars, and lowering the length-to-beam ratio. It was to some extent a compromise between the warship and cargo ship, but the great galley turned out to be more effective as a cargo carrier than as a warship. First in carrying pilgrims from Venice to the Holy Land, and then in trade to northern Europe through the Strait of Gibraltar, great galleys in the 14th and 15th centuries were able to partially supplant round ships, which relied exclusively on sails for propulsion. Great galleys were faster than sailing ships and in some cases were effective in moving bulk goods. On the other hand, since they had a lower ratio of crewmen to tonnage shipped than did light oared ships, they offered stiff competition to small commercial galleys. The great galley was in a sense an aberration which, though a significant development in itself, did not change the well-established long-term tendency in the Mediterranean toward the separation of warships from cargo carriers. Great galleys themselves were used for both tasks. By driving smaller rowed ships out of trade, however, they made those vessels into warships and only warships. The arrangement for rowing changed on those lighter galleys by the 13th century. To get more power, a third oarsman was added to each bench, making the warships stronger and faster.[10] It also rendered them almost useless as cargo vessels. They were too fragile, had too small a carrying capacity, and had to make even more frequent and uneconomic stops because of the larger size of the crew.

War galleys changed again with the introduction of artillery.

[9]B. Hagedorn, *Die Entwicklung der wichtigsten Schiffstypen bis ins 19. Jahrhundert* (Berlin, 1914), pp. 37–39; and Anthony Bryer, "Shipping in the Empire of Trebizond," *Mariner's Mirror* 52 (1966): 5–8.

[10]F. C. Lane, *Navires et constructeurs à Venise pendant la Renaissance* (Paris, 1965), pp. 2–24; R. C. Anderson, "Italian Naval Architecture about 1445," *Mariner's Mirror* 2 (1925): 144–45; and Björn Landström, *Sailing Ships* (Garden City, N.Y., 1969), pp. 112–15.

Though guns had already been used in naval battles by 1300, they were not in common use until well into the 15th century. By the early 16th century the result was a galley suited to amphibious operations, to cover landings, or to besiege fortresses along the coast. There was one heavy gun set on the center line of the ship to minimize instability, already a problem in these lightly built vessels. The heavy gun and perhaps one or two lighter guns flanking it were the main offensive weapons of the galley. At that point there was no question at all of using the galley for commercial service. Europeans, at least in the Mediterranean, had developed a distinct type of fighting vessel, this war galley, well before the *fluit* was first built. By the end of the 16th century, the event had lost most of its significance, however, because the galley was a warship of only limited effectiveness (see fig. 2). Except in a dead calm, most sailing ships with guns could destroy opposing galleys. Even in a calm where the oars of the galley gave it an advantage the sailing ship could still fend off the lighter and less heavily armed galley. It mattered little that the warship, the galley, was distinct from the cargo vessel, the sailing round ship. Galleys had been demoted, because of their limited potential as warships, to acting as scouting vessels, as dispatch boats,

FIG. 2.—Destruction of Spanish Mediterranean design galleys off the Flemish coast by Dutch sailing warships, October 3, 1602. From a painting by Hendrick Cornelisz. Vroom now in the Rijksmuseum, Amsterdam. (Reproduced from Dénes Pataky and Imre Marjai, *Ships in Art* [Budapest, 1973], no. 19.)

and as ships to neutralize other galleys in battle. The great galley also became a warship as it was driven out of cargo service in the 16th century. Armed with guns and called a galleass, it appeared in many naval battles. All naval powers in the Mediterranean kept a fleet of galleys if for no other reason than that other states had galleys.[11]

The history of galleys as warships is typically neglected in the discussion of the evolution of ships. Their use was limited to the Mediterranean where weather conditions made it possible to use a long ship with low freeboard and powered by oars. Only in a few other places were conditions similar; for example, in the Caribbean and the Baltic and along the shores of the North Sea and the English Channel.[12] More important in northern Europe was the design of sailing ships.

Northern Europe

After the departure of the Romans from northern Europe, and through the early middle ages, builders there produced a number of different vessel types which were specifically designed for a certain job. One type of sailing ship, probably developed during or before the period of Roman rule by Celtic shipwrights, was obviously meant to carry heavy cargoes and to cross the open sea. The cog was probably descended from this heavy Celtic sailing ship. With its flat bottom and sail, it was well suited to carrying cargo through the shoals of the southern shore of the North Sea and was ideal for landing on the sandbanks of the islands and shores there. Another type, the hulk, was also a sailing ship which may have had a Celtic origin. It was used both on the rivers of the Low Countries and across the North Sea. By the 8th century, then, there were two ship types for carrying goods, neither of which had design features to recommend it as a warship.[13] On the

[11]Lane, *Navires et constructeurs à Venise,* pp. 25–30; and J. F. Guilmartin, "The Early Provision of Artillery Armament on Mediterranean War Galleys," *Mariner's Mirror* 59 (1973): 257–80. On the technical and economic reasons for the importance of galleys in 16th-century Mediterranean warfare, see J. F. Guilmartin, Jr., *Gunpowder and Galleys* (Cambridge, 1974), esp. pp. 264–68.

[12]On a last effort to use galleys in northwestern Europe, see Randal Gray, "Spinola's Galleys in the Narrow Seas, 1599–1603," *Mariner's Mirror* 64 (1978): 71–83. Also, see R. and R. C. Anderson (n. 1 above), pp. 172–78; J. W. Sherborne, "English Barges and Balingers of the Late Fourteenth Century," *Mariner's Mirror* 63 (1977): 109–12; and J. E. G. Bennell, "English Oared Vessels of the Sixteenth Century," ibid., 60 (1974): 9–26

[13]Detlev Ellmers, "Keltischer Schiffbau," *Jahrbuch Römisch-Germanisch Zentralmuseums Mainz* 16 (1969): 73–82, and *Frühmittelalterliche Handelsschiffahrt in Mittel- und Nordeuropa* (Neumünster, 1972), pp. 59–64; Peter Marsden, "Ships of the Roman Period and After in Britain," in *A History of Seafaring Based on Underwater Archaeology,* ed. George Bass (London, 1972), pp. 119–23, and "A Boat of the Roman Period Found at Bruges, Belgium, in 1899, and Related Types," *International Journal of Nautical Archaeology* 5 (1976): 23–55.

other hand, there were rowing barges with no sails which were clearly built to move men. The crew was the cargo. The men pulled the oars, and there was little space for anything other than the crew and a few personal effects. These vessels had high length-to-beam ratios like Mediterranean galleys. Other than carrying migrants, these personnel-carrying vessels were essentially used as warships to get men to the scene of the fighting.[14] The two types with their very different forms of propulsion, manning ratios, and hull forms continued for centuries to exist side by side in northern Europe. Over time each was subjected to improvements in its design.

The Scandinavian ship, developed in the 8th and 9th centuries and used by the Vikings on their voyages of trading and raiding throughout Europe and beyond, is all too often described as a single type. The failure to appreciate differentiation in the design of Viking ships comes from a preoccupation with those vessels excavated in the late 19th and early 20th centuries which were warships. It is true that the Viking ship did develop out of the rowing barge, but even by the 9th century there was already a clear distinction between warships which would in some instances also be used for carrying goods and cargo ships which in some cases would be pressed into service as warships. Construction was similar for both types, as was the method of strengthening the hull. They both carried a single square sail and single balanced side rudder. They both had keels with ribs placed low to give support without sacrificing flexibility, which also made the bottom closer to being flat so the vessels could be easily beached. The differences were still significant, however.

The length-to-beam ratio of warships was from 4.5:1 to 7.2:1; that of cargo ships was from 2.3:1 to 4.9:1. The cargo ship had higher freeboard and a sharp angle between the bottom and the sides. On the warship there was a smoother curve. While the ribs of the cargo ships were fixed to the hull with treenails, on warships they were only lashed to protruding bits of wood left on the interior of the hull planks for that specific purpose. The difference made the warship more flexible and the cargo ship more durable. Only after 1000 did warships change to having permanently fixed ribs. Warships often relied on oars located all along both sides of the ship for propulsion. Cargo ships had few oars, six or eight, and they were placed at the ends of the ship to leave a large open space amidships for cargo. On

[14]H. Åkerlund, *Nydamskeppen en studie i tidig Skandinavisk skeppsbyggnadsknost* (Gothenburg, 1963); and R. L. S. Bruce-Mitford, *The Sutton Hoo Ship Burial* (London, 1968), pp. 40–43. For a general survey of methods of hull construction in early medieval ships, including Viking ships, see Basil Greenhill, *Archaeology of the Boat* (Middletown, Conn., 1976), pp. 174–232.

warships there was a full deck to give rowers a platform for pulling the oars. On cargo ships there were short half decks at either end so that the hold was open in the middle. The high freeboard of cargo ships meant that the oars entered the water at an inefficient angle, but it made little difference since the oars were rarely used, probably only to get in and out of harbor when there was a contrary breeze or to avoid trouble.[15]

By the 11th century differences between the two types of Scandinavian ships became, if anything, more extreme. The relatively long warship was the dominant naval vessel in northern European waters. It was used from the English Channel, in the invasion of England by William the Conqueror, to the Bosporos, in the attacks by Russians on Constantinople. Scandinavian monarchs extended the design of the personnel-carrying type, making it even longer than its predecessors. These dragon-ships, rowing barges with an auxiliary sail, reached lengths of 35 meters and more. Ships that length did lose much of the maneuverability important in naval battles, so typically the long ships were of slightly more than 25 meters. The major purpose of those warships remained the deployment of as many men as possible at the scene of a battle, be it on land or on the water.

The cargo ship also increased in size, and a capacity of 50 tons and lengths of about 25 meters were not uncommon. Such vessels made regular voyages out into the Atlantic to Iceland and Greenland, voyages which warships were not strong enough to make. The Scandinavian cargo ship was the forerunner of the keel, a variation on the basic design built in England and used all along the Atlantic coast of Europe. Keels served to carry cargoes relatively short distances but were also capable of sailing in the open sea. The names of Scandinavian ships reflected the distinction between cargo ships and warships. Both *buza* and *knarr* applied to goods carriers. *Langskip* was the generic term for fighting ships. There were other names used for both types, but in all cases they followed the difference in the design of the two basic types, just as do records of customs collectors. The design of the buss may well have been subject to even further extension, but there is a shortage of precise information on Scandinavian ships from the 12th and 13th centuries. At least it is clear that the buss served as an efficient carrier of heavy and bulk goods across the North

[15]Detlev Ellmers, *Frümittelalterliche Handelsschiffahrt*, pp. 30–45, 118–19. A similar differentiation existed among contemporary Slavic boats from the south shore of the Baltic. Also, see Ole Crumlin-Pedersen, "Kælhngen of kløften," *Handels og søfartsmuseets årbog* (1972): 63–80; A. W. Brøgger and H. Shetelig, *The Viking Ships, Their Ancestry and Evolution* (Oslo, 1971), pp. 79–111; and Olaf Olson and Ole Crumlin-Pedersen, "The Skuldelev Ships (II)," *Acta Archaeologica* 38 (1967): 73–174.

Sea well into the 13th century.[16] The character of the cargoes makes it clear that the busses were not for use as warships. Combined with the reports from sagas on the dragonships, this demonstrates conclusively that northern Europeans in the 11th and 12th centuries did not confuse warships with cargo ships.

The Deep-Sea Cog

The drive toward separation of warships from cargo ships was totally reversed by the development of the deep-sea cog. This type, which began as a coaster, was changed dramatically sometime in the 11th century by the addition of a keel. While shipbuilders did make a major change in the design of the cog, it may well be that they were imitating the use of keels on the highly effective Scandinavian vessels. Whether it was an act of invention or adaptation, the result—the cog with a keel—could survive in the open sea. It retained its single mast with one square sail and was apparently a decent sailing ship. It retained the straight posts and high freeboard of the earlier cog as well as the flat section of the bottom amidships (see fig. 3). The latter gave it an advantage over the keel or buss in having greater carrying capacity for each meter of length. Although it was always tubby with a length-to-beam ratio usually under 3:1, this greater breadth, rather than any increase in length, gave the cog better carrying capacity. The greatest advantage of the cog was that in its new form it could be built bigger and without any great loss of handling qualities. By the late 12th century, shipwrights were building cogs able to move over 300 tons. The average was below that of course, but the maximum and the average had at least quintupled over the preceding 200 years. Beam for cogs was rarely over 9.5 meters, and lengths of 25–30 meters were common, as were tonnages of around 200.

There was no question of oars. The ship was powered entirely by a large square sail, rising to 175 square meters. One or two extra pieces of canvas called bonnets could be temporarily added in good weather along the bottom once the sail had been raised to give a total sail area of as much as 335 square meters.[17] That meant that the cog could be built even bigger. With such high freeboard and rising high in the

[16]A. W. Brøgger and H. Shetelig, pp. 146–62; G. J. Marcus, "The Evolution of the Knörr," *Mariner's Mirror* 41 (1955): 115–22; Ellmers, *Frühmittelalterliche Handelsschiffahrt,* pp. 46–58; N. Bjørgo, "Skipstyper i Norrøne samtidssoger, "*Sjøfartshishtorish årbok* (1965), pp. 7–20; and K. Helle, "Trade and Shipping between Norway and England in the Reign of Hakon Hakonsson (1217–63)," *Sjøfartshistorisk årbok* (1967), pp. 7–34.

[17]Paul Heinsius, *Das Schiff der Hansischen Frühzeit* (Weimar, 1956), pp. 69–93, 139; Ole Crumlin-Pedersen, "Cog-kogge-kaag, træk af en frisisk skibtypes historie," *Handels- og søfartsmuseets årbog* (1965), pp. 81–144; and Ellmers, *Frühmittelalterliche Handelsschiffahrt,* pp. 63–75, 258–59.

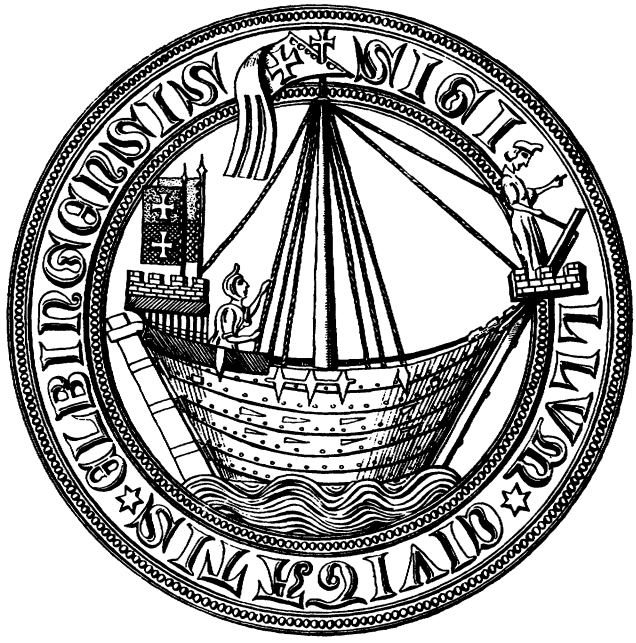

FIG. 3.—A cog from the second seal of Elblag, Poland, from around 1350. (Reproduced from Herbert Ewe, *Schiffe Auf Siegeln* [Bielefeld, 1972], p. 122, no. 42, drawing by Gerda Nützmann.)

water, the cog needed an extremely long side rudder just to reach the water when heeled over. The answer to this problem was to hang the rudder on the straight sternpost of the cog. The rudder did not have to extend below the keel to stay in the water at all times. The adoption of the sternpost rudder by the mid-13th century made cogs easier to handle. This modified and improved cog was easily as efficient as the contemporary buss in carrying goods. It eventually became the dominant cargo type in northern Europe, especially in the long-distance carriage of bulk goods in the North and Baltic Seas. A number of other types remained in use on shorter hauls.

Incidentally, German shipwrights also built in the cog a warship superior to any contemporary type in northern Europe. Because the cog rode so high in the water, its deck was above that of any other vessel. Fighting at sea consisted of hurling missiles at the enemy followed by boarding. Being above the enemy was almost a guarantee of victory. If nothing else, the cog was virtually impregnable to attack except by another cog. To try to overcome the advantage of cogs, Scandinavian longships were fitted with castles, small fighting plat-

forms at the bow and stern which took them up to the height of the cog. Builders simply added castles to cogs to eradicate the gain. Scandinavian monarchs had used a muster system, a naval militia in each district, to raise their fleets of warships. The introduction of cogs forced the abandonment of that system in the course of the 12th and 13th centuries. Longships were no longer worth having, and the kings had to change to a method for supplying and equipping cogs.[18] The cog was not only higher than any other warship, it was also bigger. As cogs grew in size and as the castles became permanent parts built into the ships, those vessels could carry to battle many more soldiers than any potentially competing type. The heavy sail, the short length-to-beam ratio, and the lack of oars made the cog much harder to handle than a Scandinavian warship, although the sternpost rudder was some help. But even though the cog could not be maneuvered easily, its greater size and height made that disadvantage unimportant.

From the 12th, and certainly from the 13th, century, for the first time in northern Europe the cargo ship and the warship were merged into one type. As one scholar has said, "There was in the thirteenth century, and for many hundred years afterwards, no essential difference between the trading ship and the warship."[19] The design of the cog proved to be the best for the long haul of bulk goods and best for warships. The design was not, as it turned out, job specific. Conversion from one task to the other took a matter of minutes. In some cases additional reinforcing might be added to the castles or more cabins created for the soldiers and officers on board to make the cog a better warship. The changes were not necessary, however. Once the standard cargo ship took on troops it became a warship, and the change back to commercial use was just as simple. The crew could and did remain the same since no special skills were needed. Navies turned into fleets of cogs, whose major function was to move manpower in large groups to battles. Governments did not have to maintain war fleets since they could simply rent cogs from merchants and shippers in wartime. The monarchs of northern Europe in some cases did own cogs to be used as warships. They paid for those ships in part by leasing them to commercial shippers, that is, by using their naval vessels as trading ones during peacetime. Battles at sea became land

[18]G. O. Harbitz, "Leidangan og det gamle Norske sainfunn," in G. P. Harbitz, S. Oppegård, and R. Schech, *Den Norske leidangen* (Oslo, 1951), pp. 11–160; and Ole Crumlin-Pedersen, "The Vikings and the Hanseatic Merchants: 900–1450," in *A History of Seafaring Based on Underwater Archaeology*, ed. George Bass (London, 1972), pp. 190–92.

[19]F. W. Brooks *The English Naval Forces, 1199–1272* (Manchester, 1932), p. 27.

battles fought across the decks of the large cogs grappled together. In the 100 Years War between England and France in the 14th century, for example, the navies of both sides were made up largely of cogs, often impressed from merchants.[20]

In the Mediterranean the eradication of the distinction between warships and cargo ships did not occur. The cog had been introduced to southern Europeans, and by the early 14th century shipwrights in the south were building cogs, improving them, and accommodating them to local conditions. In the Mediterranean, however, the cog remained largely a ship for transport, especially of goods. The light breezes of the Mediterranean and the absence of the heavy seas of the Atlantic and northern Europe took away some of the advantages of the cog as a warship. Galley crews were typically larger than those of cogs, and galleys with their oars could always outmaneuver one of the large, clumsy cogs. In light airs the cog could not move, while the galley could sail or row away. That is not to say that cogs were not used in the south as warships. Mediterranean navies began to add them to their fleets soon after they were introduced there, but the numbers were always small, and they were transports rather than fighting ships. The only cases where cogs might have been used for fighting as they were in northern Europe was, for example, in wars between Barcelona and Genoa. In the 14th century, for commercial reasons, both ports had sizable fleets of cogs.[21] In the Mediterranean the cog could not and did not dominate the war galley. The latter remained the typical warship and certainly distinct from cargo carriers.

On the other hand, rowing barges as warships did not completely disappear from northern Europe. Though their use was limited to coastal patrol work and fighting other galleys, monarchs in the north still felt they needed such ships to have a complete naval force. Whether modeled on contemporary Mediterranean galleys or on Viking longships, their number remained small. They could form something of a strike force or be used to defend inland rivers where their maneuverability was a great advantage over large sailing ships in narrow passages. In general, the experiments with oared galley fleets

[20]For example, H. J. Hewitt, *The Black Prince's Expedition of 1355–1357* (Manchester, 1958), pp. 33–39, and *The Organization of War under Edward III, 1338–62* (Manchester, 1966), pp. 77–92.

[21]Lane, *Navires et constructeurs à Venise,* pp. 34–37. Cogs had the added advantage of offering more protection behind their gunwales for men firing a new weapon, the crossbow. Also, see F. C. Lane, "The Crossbow in the Nautical Revolution of the Middle Ages," in *Economy, Society and Government in Medieval Italy,* ed. D. Herlihy, R. S. Lopez, and Vsevolod Slessarev (Kent, 1969), pp. 161–65; and Hagedorn (n. 9 above), pp. 39–42.

failed.[22] Naval superiority in the north depended not on rowed ships but on the large cogs, and the sailing ship was the dominant vessel for all uses in northern Europe by 1400. It was precisely the differentiation of that sailing ship into two types which was the highly regarded technical change of the late 16th century.

The Technology of Differentiation

The first step toward building two distinct types came in improvements in the sailing ship itself. Those improvements formed the greatest single technical advance ever made for wind-powered ships. In the early 15th century builders changed rig to a composite one with both square and lateen sails. Typically there were three masts instead of the previous one or two. The fore- and mainmasts carried one or two square sails each, while the mizzen carried a triangular lateen sail. A relatively small square sail was often slung under the bowsprit to act as a headsail for better control. The rigging as well as construction of the hull required further modification to exploit this invention fully. Shipbuilders made those changes over the following 200 years.[23] The new full-rigged ship was easier to handle than its predecessors. The combination rig gave masters the ability to exploit the divisibility of square sails and to get more power from having a larger sail area. It also gave them the capacity to sail closer to the wind, a feature of lateen sails. Hulls of full-rigged ships were built in the same way as those of Mediterranean ships. Planks were fitted edge to edge, the strength coming from an internal structure of ribs and frames. Repairs were easier and the ship was lighter for each meter of length. Construction was simpler than in the north, where overlapping planking and extensive internal reinforcement was still common.

Overall, the full-rigged ship was more efficient if for no other reason than that it was more reliable, less likely to get into trouble, and better able to get out of trouble. With the lateen sail it was not confined in harbor waiting for just the right winds. Turnaround time was probably decreased. All that was a gain for the cargo ship, but the greater maneuverability had a destabilizing effect on naval use of the sailing ship. Captains were in a better position to run away, to avoid a

[22]M. Oppenheim, *A History of the Administration of the Royal Navy* . . . (London, 1896), pp. 3–8; Antonio de Capmany y de Montpalau, *Memorias historicas sobre la marina y artes de la antiqua ciudad de Barcelona* (Madrid, 1779–92), 3:81–90; Charles de la Roncière, *Histoire de la marine Française* (Paris, 1909–20), 1:399–407; and J. T. Tinniswood, "English Galleys, 1272–1377," *Mariner's Mirror* 35 (1949): 276–315.

[23]R. Morton Nance, "The Ship of the Renaissance," *Mariner's Mirror* 41 (1955): 180–92, 281–98, gives the best summary of the development and modification of the full-rigged ship.

fight. Boarding was more difficult. Naval battles between sailing ships were still fought in the traditional style; however, there was no longer the same guarantee of a battle between opposing naval forces. The sailing skill of the ships' masters became a consideration in naval warfare. Still the full-rigged sailing ship, like its predecessor, the cog, was better than any potentially competitive design as a warship. In fact, the new type even began to erode the advantage enjoyed by the galley as a warship because it was both highly defensible and maneuverable. The multiplication of sails made it possible to build bigger ships, in fact the biggest wooden vessels ever constructed. The largest of full-rigged ships were called carracks. The Portuguese used carracks of up to 2,000 tons to carry goods to India. They were such giants that they were almost impervious to attack. Though they may have been hard to handle, Portuguese carracks were strong enough to dominate any group of smaller vessels.[24] Used in the Mediterranean, the large carracks, though they could not perform all of the functions of galleys, still were of sufficient quality to decrease the value and importance of rowed vessels.

The second and more important step in generating two different types of sailing ships came with the introduction of heavy guns on board. That this was unquestionably the major factor in creating the distinction has long been widely recognized. Heavy guns changed naval warfare from hand-to-hand combat to fighting at a distance, but the change was by no means a rapid one. The guns used on sailing ships in the 14th and 15th centuries were light antipersonnel weapons, no more than missile launchers used like slings or bows from the upperworks of a ship and of no value in a stormy sea. The essential character of fighting remained the same. Large siege guns, on the other hand, had the potential to sink an enemy vessel. The exact date of the introduction of those big pieces is uncertain, but it must have occurred sometime around 1500. The big guns were put in the waist of the ship since the higher decks could not support them. Ports which opened and closed like those already in use for cargo ships made it possible to put the heavy guns down on the lower decks with the ports piercing the hull of the ship. Protected there, the gunpowder and matches were not exposed to the elements and firing was more reliable. In 1513 for the first time in Europe a ship was sunk by the use of gunfire. It was also in the early 16th century that the first battles fought and won entirely with guns took place in the Indian Ocean between Arabs and Portuguese. The firepower of guns gave Portuguese fleets an indomitable advantage.

[24]C. R. Boxer, *The Portuguese Seaborne Empire* (London, 1969), pp. 207–9; and Landström (n. 10 above), pp. 90–95.

It took some time for both shipwrights and ship captains to learn what to do with these heavy guns, partially because the guns themselves were subject to improvement over time.[25] The bronze guns of the 16th century proved surprisingly accurate, while the iron guns used in the 17th century were less so. Navies used the less accurate iron guns because they were cheaper and many more could be deployed. The broadside became the major offensive weapon for the warship, and all navies had to carry heavy guns.[26] Since the pieces, especially the bronze ones, were so heavy that decks had to be reinforced, the design of the ships changed to accommodate the guns. For guns to be carried on the main deck, the width of the ship was made markedly less at deck level than at the waterline. This tumblehome of the sides gave more support to the deck. Unintentionally, it also made boarding more difficult since, even grappled together, two warships with extensive tumble-home would still have their main decks and upperworks far apart. There was no longer the possibility of fighting a running land battle across the decks of two ships.

The warship of the late 16th century with modifications needed for artillery was not likely to be a good cargo ship. It certainly was not an efficient one. The large number of guns took up much of the space below decks, and those guns also needed many men to handle them. Changes made in the hull were matched by changes in the rig to increase maneuverability. These design modifications combined to give such vessels a high ratio of manpower to potential carrying capacity. There was a simultaneous improvement in the design of cargo ships, however, and shipwrights found ways to lower the construction and operation costs of those vessels. The change was most noticeable in the Netherlands, but the process went on in other parts of Europe as well. The rising volume of trade in the 16th century made for an increase in the number of ships and allowed for potentially greater returns from their operation. These profits gave builders more opportunities to experiment with improvements. The greater returns to shipping and the more efficient design of cargo ships made it easier for shippers to sustain charges for fitting out and maintaining convoy ships. Those armed vessels offered the necessary protection which was no longer incorporated into the design of cargo ships. In fact, the

[25]R. and R. C. Anderson (n. 1 above), pp. 127–30; and Carlo M. Cipolla, *European Culture and Overseas Expansion* (Harmondsworth, 1970), pp. 65–70. The latter is in part a reprint of his *Guns and Sails in the Early Phases of European Expansion, 1400–1700* (New York, 1965).

[26]Guilmartin, Jr. (n. 11 above), pp. 268–73; and Peter Padfield, *Guns at Sea: A History of Naval Gunnery* (London, 1973), pp. 19–56. Effective iron artillery was developed in northern Europe at the end of the 16th century.

greater frequency of convoys further released shipwrights from the constraint of building defensibility into their products. At the same time, the market for warships created by the demand for vessels for convoy duty accelerated the process of designing ships purely for fighting.[27] The final result, so often noted, was the distinction of warships and cargo ships in the 17th century.

In the late 15th and in the 16th centuries a number of European governments began the practice of granting subsidies for the construction of more defensible ships. The subsidies were sometimes indirect, but they usually went directly to those buyers of ships who complied with government wishes. The subsidies were either in cash or a rebate on the customs duties on the first voyage, which was almost as good as cash. Governments wanted heavy ships which could carry guns and could be changed into warships quickly. Rather than lay down specific requirements which would be hard to administer, they usually just gave subsidies for the building of comparatively large ships. The interest in supporting privateering had something of the same goal: to keep a stock of functioning powerful ships for the navy with the government not having to pay to build or maintain them. The English government in the reign of Elizabeth I was especially effective in changing the character of the merchant marine through subsidies and the support of certain trades and privateering. The average size of ships increased, and the number of very large ships rose even more rapidly.[28]

The granting of subsidies demonstrated that the difference between warships and cargo ships was not yet complete, even in 1600. It was still possible for shipwrights to build vessels which incorporated sizable carrying capacity along with maneuverability and the ability to carry heavy armament. It was that technical potential which governments sought to exploit. The granting of subsidies also shows that there was already by the late 15th century a distinction between warships and cargo ships and, moreover, that it was great enough for governments to try to slow the process of differentiation. Builders were interested in pursuing the savings to be obtained from designing for a specific task. Their interest was undoubtedly whetted by the demands placed on them by buyers of ships. The shipbuilders of the

[27]On the development of convoys in the Low Countries, see A. Bijl Mz., *De Nederlandse convooidienst (1300–1800)* (The Hague, 1951), pp. 1–48; and R. Degryse, "De konvooieering van de Vlaamsche visschersvloot in de 15de en 16de eeuw," *Bijdragen voor de geschiedenis der Nederlanden* 2 (1948): 1–24.

[28]Lane, *Navire et constructeurs à Venise,* pp. 99–105; Oppenheim, pp. 167–75, 472; de la Ronciére, 1:245; and Ralph Davis, *The Rise of the English Shipping Industry in the Seventeenth and Eighteenth Centuries* (London, 1962), pp. 5–8.

16th century were in exactly the position as shipbuilders working in the years before the development of the cog in northern Europe. Both groups of men found in differentiation potential savings in shipping costs. Governments in the 16th century stepped in to get defensible ships and to stop, or at least deter, the process which led to differentiation. Not incidentally, where governments and their admiralties, which often administered or at least promoted the granting of these subsidies, were weakest, the design of low-cost cargo carriers moved ahead most quickly. For political and historical reasons, the authorities in the Netherlands never had the kind of control over shipbuilders which existed in France, England, Iberia, or even in Scandinavia. It is not surprising that Dutch shipbuilders pursued the possibilities of designing cargo ships earlier and more completely than builders anywhere else in Europe in the 16th century.

Conclusion

The concentration by writers on the history of ship design on northern Europe, on the 16th and 17th centuries, and on the development of the *fluit* unfortunately tends to suggest that the distinction of warships from cargo ships was the result of some long-term development. The concentration tends to suggest that technologists up to that point were not capable, for reasons of incompetence or traditionalism, of building different types of ships for different jobs. In fact the *fluit* only marked a separation of warships from cargo ships for vessels which relied exclusively on sails for power. Its significance is only relevant for the development of ship design during the 15th and 16th centuries and specifically for ships in northern Europe. Certainly the development of the *fluit* by Dutch builders did prove in time to be an important source of increased productivity in European shipping, but that fact does not mean that shipwrights in the middle ages were incapable of making significant contributions to productivity. Medieval shipbuilders were far from being primitives doing just as their fathers had done before them. Quite to the contrary, they had separated the design of warships from that of cargo ships long before 1600 and had continued over the centuries to expand and explore the possibilities created by that distinction. In their drive to find the optimal design for a cargo vessel in the 11th, 12th, and 13th centuries, northern European shipwrights built a cargo vessel which, incidentally, was an excellent warship. They just overshot the mark. This phenomenon is quite common in the history of technical change. No one has ever been able to predict with anything approaching accuracy what the results of a specific improvement might be or how the new device or method will be used. Medieval shipbuilders were in

an even worse position. They had no theory and so could not anticipate with any precision what the effects of even a small change in design on the handling qualities of the ship would be. Technical change has moved at varying paces, pursuing one avenue and then another, attempting to deal with the specific needs of the moment. Technologists often fall short of those goals and sometimes overreach them.

Past emphasis on the crucial changes in ship design around 1600 has the unfortunate side effect of obscuring how specific transport needs were handled in a wide variety of ways by ship designers throughout the middle ages. It also overemphasizes a single event which in itself was a combination of many adjustments and improvements. Techniques used in the middle ages, as in all other periods, depended on more than just contemporary knowledge. Use depended on the potential advantages to be gained by the user. It is now clear that the long-term presence and use of different technologies was a distinguishing feature of medieval Europe. The survival of many traditional methods may have been the result of the incremental nature of technical change with advances being small enough that no single type of hardware or idea was overwhelmingly and obviously better than all others. In shipbuilding, technical change in the middle ages was only rarely a history of major advances. Rather, it was typically a history of the rise to relative dominance of one technique and then another, of adaptation and adjustment of various designs, with no one ever fully disappearing. That dominance often depended not on the quality of the design so much as on economic and political circumstances external to shipbuilding. Through that process medieval shipwrights could and did, in many cases, generate the potential for improvements which were significant and long lasting.