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Hanseatic Cogs and Baltic Trade: Interrelations between Trade Technology and Ecology

Jillian R. Smith
University of Nebraska-Lincoln, jillian.smith@mail.mcgill.ca

HANSEATIC COGS AND BALTIC TRADE: INTERRELATIONS BETWEEN TRADE TECHNOLOGY AND ECOLOGY

by

Jillian R. Smith

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Jillian R. Smith, M.A.

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The Hanseatic League was the major commercial power in northern Europe from the twelfth through the fifteenth centuries. During this time, it grew to encompass the coasts of the North and Baltic Seas and maintained economic influence over key areas on the European continent. From the inception of the Hanseatic League until the mid-fifteenth century, one ship type dominated the inland and overseas trade: the Cog. Cog design remained fairly constant throughout the period in spite of the great geographical variation present within the Hanseatic League. Cogs became increasingly larger throughout the period, requiring a greater amount of oak timber for their construction. The need for timber resources to supply the demand of the shipwrights was a driving force in the expansion of Hanseatic trade eastward into the Baltic States and Russia. Using the framework of Niche Construction Theory, the relationships and interactions between ship design, trade routes and environment will be investigated.

To my graduate school cohort, you've kept me motivated and sane, and to my fiancé Chris, who has always been supportive of my esoteric research interests.

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Chapter 1: Introduction

Trade is an integral part of all historic periods of human history and is therefore one of the most studied topics in the discipline. In archaeology trade is also a common topic of study. Many times these studies focus upon the mechanisms and goods associated with trade in order to more completely understand regional, national, or cultural dynamics. What is not often a stand-alone topic is the trade technology: the vessels of transport, the machinery of loading and unloading, etc. These aspects of trade do appear in both the documentary and the archaeological records and are worthy of study. Ships as trading vessels have received a lot of attention in maritime archaeological contexts, but usually as singular entities with little to no connection to contemporary vessels. Much of the information presented in this paper can be found in greater detail in the following works: Meier (2006), Hocker and Ward (2004), Friel (1995), Gardiner and Unger (1994), Hutchinson (1994), Steffy (1994), Ellmers (1979), and Greenhill (1976).

It is both possible and necessary to connect trading vessels with the mercantile and cultural contexts that aided in their development. Shipwrecks provide a wealth of information regarding not only the ships themselves but can also provide a glimpse into the cargoes carried on various routes. Shipwrecks also show that ships were dynamic and were repaired, retrofitted, and maintained throughout the life of the vessel. Undoubtedly, ships represented a great deal of economic investment, but they were not merely a means of conveying passengers and cargo from one port to another. Ships contained their own microcosms of stratified societies and depending upon the level of salvage associated with a wreck, might illuminate this shipboard society that is largely ignored in the historical record.

Shipwreck studies are certainly interesting, but the ability to connect individual wrecks to each other in either developmental clines or to situate them within a greater societal context is an important direction for the study of these artifacts. There are numerous studies on the macroevolution of ship types, but the individual developments within these types have been done only in few cases such as Blendel (2006), Brøgger and Shetelig (1951), Hornell (1935), and Herreshoff (1891). The importance of these latter kinds of studies is that some of these ship types are not completely eliminated, but are maintained on small, local scales which may show the influence of different cultural or economic factors through time. These connections are important to understand the dynamic nature of the mercantile context in which these ships both operate and continued to operate.

Medieval wrecks are some of the most interesting because of the preponderance of different vessel types corresponding to different regions of Europe. The presence of different ships in certain bodies of water can help to understand the composition of overseas trade relations at that time. However, shipwrecks also give archaeologists clues as to the nature of technical development of the times: how are timbers processed, is it likely that a blast furnace is being used in the manufacture of nails, etc. Though documentary and pictorial evidence may address these issues, analysis of the shipwrecks and their associated parts are some of the most informative avenues in pursuing the research of the development of certain technologies.

Additionally, the medieval period saw the development of joint commercial ventures and the morphology of ships may be instrumental in the understanding of the nature of these ventures, whether purely commercial or militaristic as well. This is certainly the case in northern Germany with the development of the Hanseatic League. Their ships show evidence of the growth in trade and adaptation for militaristic purposes. Analysis of the ships is important to the understanding of the dynamics of the region in the medieval period. Documentary evidence is relatively well represented for the Hanseatic League, but there are a number of questions for which there are no documents to answer or the documents are vague. For example, bills of lading have not been found for Hanseatic vessels, making their precise cargoes more difficult to ascertain. There are numerous accounts of the goods imported on the ships, but the amounts and configurations of cargoes are unknown at this point. Shipwrecks with mostly intact cargoes are invaluable sources of information with regards to this point. Additionally, one of the most often expressed features of the Hanseatic League was its secrecy, but this appears largely due to conflicting accounts of which cities actually retained membership. While the question of exactly who was a member of the Hanseatic League is of interest to historians, archaeological evidence at least has the potential to elucidate participation in Hanseatic trade.

Documentary evidence is very important to questions regarding the economics involved in long distance trade, as the price of goods is affected by a number of factors including transport costs associated with shipping the materials. Costs are perhaps one of the most important factors of trade that is not generally preserved within the archaeological record. The pervasiveness of certain pottery types can be indicative of their relative price and prestige, but does not give precise account of their materials, manufacturing, or transport costs. For these figures, the documentary evidence, such as letters between merchants found in city archives, is imperative. When investigating structural technology such as shipbuilding, the price of materials has a large impact on the commissioners and builders of these structures. The costs of materials will very likely affect the materials chosen for use in construction. Materials cost may also affect the size of the structure or vessel.

Finally, documentary evidence with regards to ships, in the case of formula books and treatises for the construction of optimally sized hulls, may either be non-existent, as they are for the Hanseatic vessels, or incorrect. The documents do not necessarily give an accurate accounting of the adaptations made by the builders during construction, or simply illustrate a theoretical mathematical ideal that is impractical in construction (Castro 2006). In the particular case of ships, it is necessary to have both the actual ships themselves and related documentary sources in order to best understand how and why the ships are constructed the way they are.

During the eleventh through the fifteenth centuries Europe underwent a number of changes from the early medieval period: urban centers were increasing in both size and number, populations generally were rising, and nations were developing (Schildhauer 1985: 16). This was also the period where trade companies began to develop and prosper, gaining rights for members that rivaled those of citizens in the countries they frequented. The most influential of these early trading companies was the Hanseatic League, which operated almost exclusively in the North and Baltic Seas and overland throughout the entirety of the European continent. The influence of this company can still be seen today in this region through the names of various structures and institutions, such as the Hanse Carré in Bremerhaven, the Olde Hansa restaurant in Tallinn, and in the gabled architecture of its cities and *kontors*, such as Lübeck, Bremen, Riga and Tallinn (Figure 1.1, 1.2, 1.3, 1.4). During the medieval period, the Hanseatic League had *kontors* in England, Norway, the Netherlands, Belgium, Denmark, Sweden, Poland, Latvia, Estonia, and Russia that were instrumental to their overseas trade. The presence of these *kontors* reflected the diplomatic prowess of the League's merchants and to their commercial influence.

Figure 1.1: Gabled buildings and the Marienkirche Lübeck, Germany

Figure 1.2: Olde Hansa Restaurant housed in former merchant’s house Tallinn, Estonia

Figure 1.3: Estonian History Museum in former Guild Hall of the Hansa merchants, Tallinn, Estonia

Figure 1.4: Former Hansa merchants Guild Hall Riga, Latvia

In spite of the great expanse of the trading networks established and maintained by the Hanseatic League, the merchants all used ships of the same type of construction collectively known as the Cog. Cogs only appear in areas of Hanseatic control or influence and have a distinctive shape: flat bottom, high sides, straight stem- and sternposts. The vessel form also remains essentially the same throughout the period of its use, the twelfth through the fifteenth centuries, with changes trending towards either the adoption of new technological advances, such as the stern-post rudder, military necessity, or simply general size fluctuations as the distance traveled expanded or contracted.

Cogs did share one important characteristic with other non-Scandinavian medieval vessels: they were constructed wholly out of oak. Oak is a long-lived, slow growing tree that was popular for all manner of construction, but has generally even grains and closed capillaries, making it good shipbuilding material. Oak was used in building construction and winemaking as well as shipbuilding, creating competition amongst various commercial interests for timbers, especially as locally sourced timber became scarcer. As mentioned above, the trend in Europe was towards increasing numbers and sizes of urban centers, and this was particularly the case along the Baltic and North Sea coasts, which were frequented by merchants from throughout the region. The gradual deforestation for construction and fuel spurred the search for plentiful sources of timber. The search for timber resources took merchants inland in the continent and eventually led eastward. The rivers of Europe became incredibly important to the medieval timber trade. They were the paths by which logs were floated to either shipyards or commercial centers and where the logs were processed and then either used in construction on site or loaded for transport to elsewhere.

Figure 1.5: Cog model in Tallinn City Museum, view from stern

Despite the presence and arguable importance of the overland trade to the Hanseatic League, it was the overseas trade that seemed to be the place became most important in the development of trading companies in the periods after the League's decline. The Hanseatic merchants secured monopoly rights in a number of the eastern markets, shutting out any other foreign merchants from operating in these centers. Additionally, in many of the foreign cities, if not Hanseatic strongholds such as Reval (modern Tallinn), the League owned its own depot for the loading and unloading of its cargoes.

Figure 1.6: Cog model in Tallinn City Museum, view from stem

The Hanseatic League was highly influential in the development of later trade companies in England and the Netherlands, as these later companies would try to repeat the same formula for success by securing trade monopolies in specific ports and countries and negotiating for special privileges for their members. In truth, some of these companies began their ascent during the decline of the Hanseatic League, such as the Merchant Adventurers of England. These companies were utilizing the same general strategies as the Hanseatic League but were using a different ship type, the Hulk. The Hulk would eventually replace the Cog as the primary vessel of the Hanseatic League, but the issue is, why did this happen?

To deal with the issue of why Cogs were eventually replaced as the main vessel type for overseas trade by the Hanseatic League, it may be useful to approach it from a technological standpoint. Some aspect of Cog design or construction made it undesirable as a large vessel type after the mid-fifteenth century. In order to understand why the Cog became obsolete, it is important both to trace the development of the ship type throughout its period of dominance and to find a framework in which multiple lines of evidence may be called upon in an analytical fashion. In the case of shipbuilding technology, an evolutionary framework is the most useful, particularly Niche Construction Theory, which melds multiple lines of inheritance and can help shed light on the system that is aiding in the development of the Cog. The use of evolutionary biology frameworks in the study of the development of technology in the archaeological record is very important for the understanding of the dynamics of technical change. Ideas of diffusion are insufficient when discussing traditionally conservative technologies such as shipbuilding. By looking at shipbuilding through the lens of Niche Construction Theory, it may also be possible to see how the use of the ships shaped the culture and the environment in which they were operating. Understanding the dynamic relationships within a system is incredibly important to archaeological studies and analyses in both the prehistoric and historic periods.

Timber usage in Cog construction can be linked to economic fluctuations in the price of timber as it was imported from increasingly farther away. Additionally, the mercantile practices of the Hanseatic League necessitated the expansion of Hanseatic influence into the regions, particularly the Baltic and Russia, which were now supplying timber for use in the western reaches of the Hanseatic sphere.

This paper will present a selection of analyses of Cogs and set out a framework for a technological evolutionary analysis of this vessel form using Niche Construction Theory. In this presentation will be an historical background detailing the expanse and contraction of the Hanseatic League and a preliminary look at the environmental and climatological contexts of the Baltic region in the medieval period.

Figure 1.6: The Holstentor and Salzspeicher Lübeck, Germany

Chapter 2: History of the Hanseatic League

This chapter will provide an overview of the historical context of the time period and geography surrounding the Hanseatic League trade and the development, construction, and transportation methods used. The historical background is drawn largely from the works of Philippe Dollinger (1970) and Johannes Schildhauer (1985).

The Hanseatic League, also referred to as the Hansa or The League in this chapter, was a conglomeration of trading companies and city-affiliated merchants based in various cities around the German States, Central Europe, and the Baltic and North Seas from the twelfth through the seventeenth centuries. The League entered into collective bargaining arrangements with numerous countries in order to secure the optimal trading agreements for the members, thus emulating what would later be termed a "regulated company" (Willan 1956). Comprised of both overland and oversea branches, the Hanseatic League was poised to and did take great advantage of its commercial power to become a leading power in the region. Growing out of German cities in both the German States and the Holy Roman Empire, with a number of cities, such as Hamburg and Lübeck, being given the status of *freie und hansestadt* (free and Hanseatic city), the Hanseatic League had great access to territory without a need for extensive military campaigning to gain more.

Baltic Sea trade was fairly active in the pre-Hansa era, but the main players were not the Germans, they were instead the Scandinavians (Lewis and Runyan 1985: 91, Schildhauer 1985: 13). It was during the pre-Hansa times that the larger trade centers of Birka, Haithabu, and later Schleswig began to develop along the North and Baltic Sea coasts. Haithabu (modern Haddeby) was particularly well positioned on the Schleswig-Holstein isthmus to serve as the point where eastern and western goods and merchants met starting in the ninth century. In addition to these three centers, numerous smaller settlements arose on the southern coast of the Baltic stretching from the modern German state of Mecklenburg across the northern coast of Poland and to modern Kaliningrad. Many of these southern posts would become Hansa centers while the three larger settlements listed above would eventually be overshadowed or rendered obsolete by larger Hanseatic centers such as Lübeck and Hamburg.

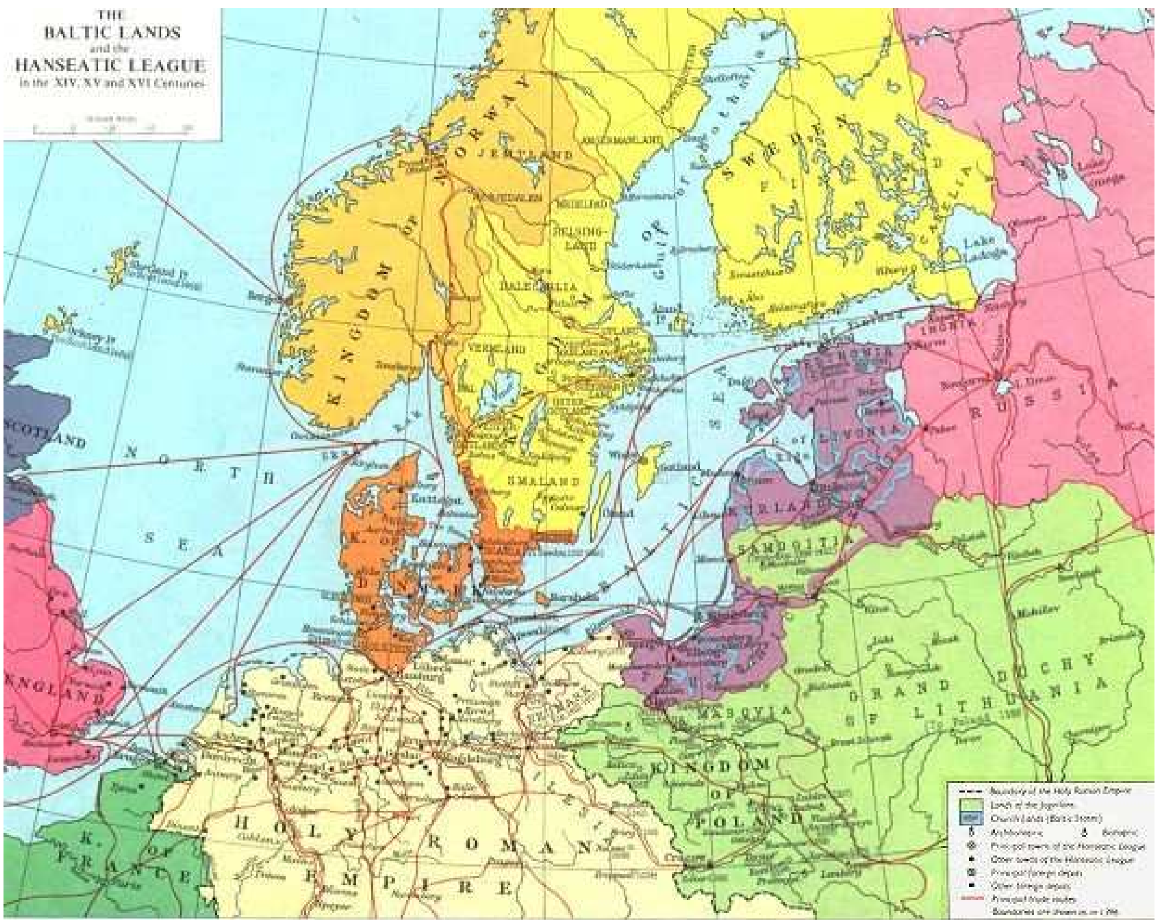

Figure 2.1: Map of the Hanseatic League, cities and trade routes
(www.fordham.edu/halsall/maps/hanse.jpg)

As for the merchants themselves, at this time it was not uncommon for traders to act as a sailor in the crew for a ship that was carrying his goods (Schildhauer 1985: 15). This status was due partially to the nature of commerce, where individual merchants travelled with their goods in order to sell them but were not well enough established to own their own ships. By working as a sailor on the ship as opposed to acting as a passenger, the merchant may also have been able to police his goods. However, there is one additional facet of this practice. There were no protections in place for foreign merchants in the cities and markets at this time (Schildhauer 1985: 16). A merchant's goods could be confiscated at port upon arrival in a foreign port by local authorities without provocation or remuneration. Foreign merchants could be denied the ability to participate in markets if it was thought to be disadvantageous to the locals. This lack of legal protection was a driving force in the conglomeration of merchants first into joint ventures, with a number of merchants sharing passage on a ship, and later into lobbying groups from individual cities in foreign trade centers negotiating rights, privileges, and monopolies to be enjoyed by members.

The trade centers mentioned above also aided in the development of collective interests of merchants and the eventual formation of the Hansa. Additionally, a number of other cities developed at this time and were instrumental in the overland and overseas commerce of pre-Hanseatic northern Europe. The locations of these cities were largely coastal or on rivers where markets and fairs were flourishing. Many of these market towns were established on feudal lands (Schildhauer 1985: 17), but as the size and urbanization of these market towns grew, they began to break free of their original feudal structure and to defend themselves and create civil codes. The development of the medieval city was imperative to that of the Hansa as membership was defined by the city and not by the individual merchant. In Germany, the early market cities began this process of secession in the middle eleventh century with cities west of the Elbe having largely completed the process by the mid-twelfth century (Schildhauer 1985: 17).

Contemporaneous with the German cities' development was the northern French, Flemish, and Rhenish boosting their own market cities on the North Sea towards increased goods manufacture for export, necessitating an increase in infrastructure for transport of these same goods (Schildhauer 1985: 17). In these cities, the dominant industry was cloth weaving and dyeing, but a number of other industries developed along the rivers, particularly the Rhine and the Meuse with various metalworking industries taking hold in Liège and Köln. The regional products were increasingly transported and sold by merchant residents of the major cities in the area, which served to shift the commercial dominance away from those merchants, such as the Frisians, who acted as middlemen for goods. These newly powerful regional merchants would be the ones to band together and form the initial municipal coalitions that would immediately pre-date the Hansa.

Köln's commercial dominance in southern Germany developed quickly, being along the north-south trade axis from the French market fairs to the Mediterranean and being accessible both overland and by ship. This was one of the first German cities to establish trading privileges and rights for its merchants in the major northern European commercial centers of the time including London, Bergen, and others. Among these privileges and rights bequeathed were those by Ethelred II giving protection to the "merchants of the Empire, putting them on an equal footing with the Londoners" (Dollinger 1964: 5) and with Henry II of England allowing Köln merchants to sell Rhine wine in the London market in 1157 and granting them special status to own their own building (Colvin 1971: 10-11, Dollinger 1964: 6, Schildhauer 1985: 17). In particular, the Kölner merchants were granted the right to reside in London in 1130, allowing them to establish a permanent presence in the London marketplace. These privileges granted to the merchants of Köln made membership in this group extremely desirable and brought in membership from neighboring German cities. Additionally, the nature of many of the concessions (exemption from taxes, safe passage of men and goods, etc.) made a good case for the power of collective bargaining for groups of merchants. Many of these concessions granted to the Kölner merchants would be maintained after the city joined the Hanseatic League (Dollinger 1964).

The German cities of the Holy Roman Empire also conducted trade with the Scandinavian countries prior to the inception of and comprising many of the formative relations of the Hanse. Bremen merchants in particular were well ensconced in Scandinavian trade, as both areas were part of the same ecclesiastical province prior to the 1104 founding of the archbishopric of Lund (Dollinger 1964: 12). To the east, Baltic trade prior to Lübeck's founding centered on the Schleswig isthmus, where Frisian, Saxon, Danish, Russian, and Swedish merchants met with Gotlanders in itinerantly occupied villages. The location of this earlier trade is important because of the proximity to the site of what became Lübeck, and may have had a hand in prompting the choice of settlement area for the city. The Gotlanders also established a booming trade with Novgorod at this time, which was to become very important to the Hanseatic League, as Novgorod was the site of one of the first foreign depots (*Kontors*) established by the Hanseatic League at the end of the twelfth century (Dollinger 1964).

Overland trade was also an important feature of The League and the powers that contributed to its founding. It was merchants of Köln who were the most active in this arena, mostly venturing south and east overland. Though there were the beginnings of the great trade power to come, the overall influence of the Germans and the Gotlanders was relatively minor prior to the founding of Lübeck.

After the founding of the city, Lübeck was able to prosper quickly because of the privileges granted to it by Frederick Barbarossa in 1188: supervision of the mint by burgesses of the town, the right to develop the Soest law code, to collect part of the profits from the administration of justice, and to be judged only by the town judge (Dollinger 1964: 22). Later in the history of the city, more privileges were to be granted to its inhabitants and council. There is some mystery as to the reasons and way that the city was founded, as documentary evidence for the contemporary period is non-existent or unclear on the details surrounding the founding. In 1226, Lübeck was granted an imperial charter by Frederick II and became a free imperial city in the Holy Roman Empire. At this time, merchanting was still a primarily individual enterprise, a situation that was to change with the increasing urbanization of Europe and the increasing power of these towns (Dollinger 1964).

At the beginning of The League's ascendance, aside from Lübeck, the most influential towns were the ones that had a long settlement history and were well established politically and commercially, such as Köln and Magdeburg (Dollinger 1964: 13). These cities had thriving ports and river traffic. Dollinger (1964: 13) makes mention of the development and settling of the *wiek*, a fortified merchants' quarter of the town that was expanded as more permanent establishments were set up by merchants within the town. Köln's merchant quarter and marketplace underwent a series of expansions of the walled area from the tenth through the twelfth centuries. The twelfth century also saw the formation of a number of the future member towns of the Hanseatic League. These later towns sometimes were not single towns, but were in effect "multiple towns," where newer suburbs were founded around older towns but were separate municipal entities with their own walls, citizenry, and governing councils (Dollinger 1964). Visby is an interesting example of this multiple city, as there was both a German and a Scandinavian settlement operating contemporaneously, with the Scandinavian section having its own seal different from that of the German (Dollinger 1964: 25).

With the founding of Lübeck came the impetus for German merchants to expand their trade networks eastward into Russia and Livonia. As the merchants pushed eastward, they established new towns and paved the way for German peasant settlers to move into these new towns and suburbs, bringing about the Germanization of the area between the Elbe and the Oder, which had a mixed population of Germans and Slavs (Dollinger 1964: 31). In these instances, of dual populations within a newly founded town, only the Germans were granted citizenship rights, even in cities which were founded in majority Slavic regions, such as Krakow. At the same time, the German merchants were expanding northward into Scandinavia, first with Sweden, and then the rest of the region. Sweden worked for the assimilation of the foreign merchants, instead of the granting of privileges to them that gave the German merchants advantages over the local populations, as was the practice in other countries that The League worked in (Dollinger 1964: 37).

As mentioned above, the merchants of Köln had a relatively significant trade presence in England prior to the inception of The League. During the 13th century the Lübeck merchants began encroaching upon the London trade of the Köln merchants. In 1266/7 the merchants of Hamburg and Lübeck were granted the same privileges as those previously granted to the Köln merchants. 1281 saw the foundation of a federation between the three groups of merchants, and is then referred to as "The German Hansa" in London, and cemented the beginnings of The League as it was to be seen and referred to in later centuries (Dollinger 1964: 40).

When establishing the early trade in the Low Countries, as in the city of Bruges, did not involve the same kind of friction between the merchants of different cities as the forays into London did. It is supposed that in this instance there was little in terms of a territorial conflict as there were few or no privileges previously granted to any of the groups that needed defending (Dollinger 1964: 41). Bruges became an exception to the usual rule of the foreign *Kontors*, in that the German merchants lived with the Flemish population, instead of being segregated into a separate merchants' quarter as they were in other cases (Dollinger 1964: 41). In Flanders, though Köln was geographically closer, it was the merchants of the eastern German cities of Lübeck and Hamburg that were to be principal in the trade with Bruges, being present in the greatest numbers (Dollinger 1964: 42).

The inception of two separate leagues of towns occurred in 1246: one in Westpahlia and the other in Lower Saxony (Dollinger 1964: 45). The first was dedicated to ensuring free access to its markets and providing a united front against aggressors of members of the league, while the second grew out of a protest to Ghent's seizure of all goods of the Saxon merchants. These two leagues of towns were later subsumed by The

League. However, in 1280 the "Wendish towns" of the east, including Lübeck and Hamburg, formed an alliance initially based upon relations between Lübeck and Hamburg starting in 1230. After 1280 and the inception of the Wendish league, the alliance in London, and the below mentioned movement of the *Kontor* from Bruges to Aardenburg, The Hanseatic League began to take the form that would dominate the Baltic and North Seas for the next two centuries.

In the initial consolidation of power at the end of the 13th century, the blockade was the weapon of choice for The League in garnering favorable trade privileges and monopolies (Dollinger 1964: 47-48). In 1280, trade with Bruges was suspended in concert with other foreign merchants due to the citizens of Bruges' trying to lessen the privileges of the foreign merchants. The result of this suspension was the movement of the Flemish *Kontor* from Bruges to Aardenburg. The movement of the *Kontor* became the second-most effective method of ensuring the cooperation of foreign governments in trade with The League. The most effective blockade enacted by The League was against Norway in 1284, which blocked the import of grain into the country sparking a famine and eventually leading to the granting of extensive trade privileges to The League, spelled out in the treaty of 1294 and the lifting of the blockade (Dollinger 1964: 49).

In the first half of the 14th century, The League made steady economical and political gains in all regions where it had gained a foothold. Throughout the Baltic and North Seas regions, cities were expanding, in many cases with the corresponding extension of city walls and increasing foreign populations in the towns. For example, the presence of 160 merchants in the *Peterhof* at Novgorod in the winter of 1336-1337 shows how prosperous trade in this *Kontor* was for The League (Dollinger 1964: 55). England is the country where the most thorough studies of the expansion and trade of The League have been conducted and there are a good number of writings on the subject and as such, discussion in this paper will be left here (Colvin 1971, Lloyd 1991, Lavery 2002).

In 1356, the "Hansa of the Towns," as Dollinger (1964) refers to it, was formed with the backdrop of renewed troubles with Flanders and Bruges in particular. The Hansa of the Towns was the institution of the League that was the most cohesive and influential of all periods of the history of The League. After this date, membership in The League, as discussed below, became more formalized. Prior to 1356, any and all German merchants enjoying The League's privileges abroad were assumed to be members, although the precise procedures for candidacy and membership are unknown at this time for this period (Dollinger 1964: 85). As for the membership of The League, the full extent was never written down, or at least has not been found. (1971: 32) ascribes a certain amount of secrecy in this and with dealings between The League and foreign governments, while Dollinger (1964: 87) cites the lack of a complete list of member cities and the evasiveness that Colvin cites as evidence of secrecy as a well-calculated diplomatic move in negotiating trade privileges after 1356. There are some lists of Hansa towns drawn up for a variety of reasons, but none are wholly consistent in their composition.

The Hanseatic League expanded eastward into Russia and the Baltic regions in the early thirteenth century with trading centers at Riga, Reval (modern Tallinn), and Novgorod among others. The establishment or expansion into these cities and towns created links to inland supplies of grain and timber, in addition to opening new harbors and waters for fishing. Additionally, these eastern ports were the ones serviced by the largest vessels in the Hanseatic fleet (Unger 1980: 167). However, by the end of the fourteenth century, the traffic to Novgorod began to present numerous difficulties with a series of disagreements leading to a suspension of trading activities between the Hanseatic League and the Russians from 1368 to 1371 (Schildhauer 1985: 50). This east-west linkage was deemed too important to their economies to abandon by both sides of the disagreement and in 1392 a treaty was signed renewing old treaty rights for the League in Russia and granting rights to the Russian merchants in Hanse territory that remained in force until the end of the fifteenth century with the closure of the Hanseatic Station in Novgorod (Schildhauer 1980: 50).

The League fell into decline in the latter part of the sixteenth century, and by the seventeenth century it had become an obsolete fixture in the European political and economical landscape. The decline was a result of increasing trade pressure from English trading companies, a series of wars in the fifteenth and sixteenth centuries, and religious tensions brought about by the Reformation. English merchants were pushing eastward and beginning to establish themselves in Hanseatic outposts such as Straslund and Elbing (Schildhauer 1985, Willan 1956). Additionally, beginning with the reign of Richard II, the English monarchs were chipping away at the privileges that the Hanseatic merchants had enjoyed for centuries. English vessel forms, particularly the Hulk, at this time were beginning to replace the Hanseatic form, the Cog, even among Hanseatic merchants. This replacement may be indicative of a shift in influence in the region away from the Hanseatic League and towards different nations entering the region, but more detailed study is necessary to ascertain the nature of this shift.

Continual tension with Scandinavian countries, Denmark in particular, also helped to bring about the decline of The League, as there were frequent conflicts between the Scandinavian powers and The League. With particular regards to Scandinavia, tensions between the different nations in that region tended to affect the League's trading activities. Much of this was due to earlier actions, such as the Norwegian blockade described above, which inextricably linked Scandinavian and Hanseatic mercantile interests.

Goods traded by the League throughout its history included many of the necessities of daily life: salt fish, grain, cloth, wine. Many luxury items from the Far East entered the trade network from Novgorod and the other Russian towns. As the Low Countries and northern Germany were gradually deforested throughout the Middle Ages, the inland timber trade became an important fixture in international trade. Many of the new timber sources for oaks and other hardwoods were in the Baltic regions, such as Poland (Haneca et al. 2005), or from further inland along already traversed rivers, such as areas in the Weser Highlands (Lahn 1992).

Chapter 3: Theoretical Framework

This chapter outlines a theoretical approach to the problem of timber usage in medieval German shipbuilding. It will also present a framework to frame further discussions on the topic of medieval German shipbuilding in particular and shipbuilding in general. There are three main threads that will be discussed: historical archaeology, Niche Construction Theory, and the application of these two perspectives to the development and evolution of medieval German shipbuilding.

Sources of Information on the Cog Tradition

The archaeological record dealt with in this study is largely composed of shipwrecks. These particular vessels have been found, excavated, analyzed, and sometimes reconstructed so that none remain *in situ*. What is of primary importance to the current study is: 1) the analysis of the timber in the ships, 2) the usage of timber for construction or repairs, and 3) the usage of other construction materials in the ships (caulking, nails, etc.). The ships are of primary importance to the analysis and reconstruction of shipbuilding techniques in this context as no textual sources detailing the construction and design of Cogs in the twelfth through the fifteenth centuries.

The documentary evidence dealing with Cogs is largely art historical. Few records survive, but representations of Cogs are seen on Hanseatic town seals in the eleventh century and much of the basis of the identification of Bremen Cog was based upon Heinsius' analysis of these seals (1956). Additionally, there are a number of paintings that detail the loading, docking, and traveling of the ships in harbors. There are a very small number of woodcut depictions of shipbuilding, some of which may be useful in the analysis of this topic. Additionally, there is one extant model from the investigation period on display in the Rotterdam Maritiem Museum. However, no shipbuilding treatises are found for Hanseatic Cogs as there are for caravels, a later ship type, in the sixteenth century. The lack of documentary evidence and a relative preponderance of visual documentation create room for archaeological analysis to create a more complete picture of Hanseatic shipbuilding.

Much of the documentary evidence used in this study concerns the goods carried on the ships more than the ships themselves. Some communications regarding the cargoes of the ships have been found in city archives. Evidence of commissions for the construction of particular ships is not to be found. Thus ownership of ships, at least at time of construction and place of construction may be difficult or impossible to ascertain. However, beginning with the find of the Bremen Cog in the Weser River and the analysis of its timbers and continuing with the excavation and analysis of similar vessels in northern Europe, it is possible to infer that these ships were not constructed in the same location as the materials were harvested, therefore this documents the economic impact of shipbuilding along the southern Baltic and North Sea coasts.

Archaeological evidence for shipbuilding is primarily found in the form of shipwrecks, harbors, and shipyards. Shipyards in the Baltic and North Sea regions can be difficult to find. This is because shipyards were located near the main harbors of the cities, such as the shipyard that built the Bremen Cog. Medieval shipyards have, in many cases, been built over in subsequent centuries as more urban areas have been needed for either residence or for industry. Additionally, many Hanseatic harbor cities along the North and Baltic Seas, such as Bremen, Hamburg, and Lübeck are not located immediately on the coast, but inland along a river allowing for better protection from both the weather and from militaristic incursions by hostile nations. Shipyards may have been located in areas that are now commercial or tourist centers of these cities in modern times, such as is the case in Bremen. Harbors may be problematical at times, especially if they are still in use in the modern times as they must be periodically dredged and likely have had this activity performed multiple times during the course of usage. Dredging can be a boon because it is one of the ways in which many shipwrecks are found in these areas, but the harbor is nowhere near a stable depositional environment and also may have physically changed its boundaries and dimensions multiple times in its history (Van de Moortel 1991, Kliedel and Schnall 1985).

Shipwrecks are possibly the most important and most accessible historical sites and artifacts used in this study. Most of the wrecks used in this study have been found as a result of dredging activities in rivers or in land reclamation efforts in coastal and former inland sea areas throughout the region. Fragmentary wrecks are extremely informative, especially as complete wrecks in these areas are extremely rare to find. The wrecks themselves contain a wealth of information with regards to construction, fashioning, origins, usage, and life history of the vessel. Tool marks on the timbers indicate how they were fashioned from sawn versus hewn, adze-finishing on the ends of the timbers, etc. Additionally, construction marks on the timbers and patches can indicate what kinds of measures were taken to effect repairs either during construction or use. The timbers themselves contain information regarding their place of origin, the environmental conditions of the forests in which they were grown, and what kinds of pressures may have acted upon the ship during construction and use. To date, there have been no Cogs found with full cargoes intact, only partial cargoes or associated finds. The associated artifacts range from construction materials and tools to sailors' or passengers' belongings.

The archaeological evidence is important to the interpretation and understanding of shipbuilding technologies. The historical evidence helps to elaborate and provide context for the ships and the cultural and historical milieu that helped to produce that aspect of the environment that produced them. The technological aspects of shipbuilding are also one of the most visible facets of ships in the archaeological record. The historical archaeological record has many uses for ships in it and there are any number of facets that can be investigated through new and different theoretical frameworks.

Conceptual Tools for Considerations of the Cog Tradition

Niche construction is the process by which an organism alters its environment to impact its evolutionary fitness (Odling-Smee et al. 2003, Sterelny 2005). Niche Construction Theory (NCT) is an idea in evolutionary biology stating that organisms modify the selective pressures acting upon them in their environment through changing the environment and that these changes in the environment are passed along to the next generation of organisms which further changes this environment creating feedback in the ecological system (Odling-Smee et al. 2003). It is the interaction between the organism and the environment that is essential to niche construction in general and the implications of NCT in particular. NCT addresses, or seems to address, the development of specific suites of phenotypes as well as genotypes in certain ecological systems. By taking into account both the biological and the ecological factors interacting with each other; it may be possible to parse out the factors leading to the construction of an organism's particular niche. This particular line of investigation takes into two of lines of inheritance in an evolutionary system, but there are others that may be interacting and NCT allows for these myriad influences and interactions to be investigated and understood as part of the overall system.

Upon delving into the topic, niche construction itself appears to be a fairly intuitive concept that is easily observable in the natural world. Indeed, Odling-Smee et al. include a table in their work with twenty-eight rough examples of niche constructing activities by a variety of organisms (2003: 107-111). These examples may seem obvious, and are likely also traditionally classified as examples of co-evolution, as discussed above, but this earlier classification does not allow for the changes in the overall organismic-environmental system that NCT attempts to address. Co-evolutionary relationships are some of the most obvious examples of niche construction in the natural world and in biology are likely the most promising avenues of study for NCT.

NCT is a theory of triple inheritance: biological, cultural, and ecological (Sterelny 2005). Biological and ecological inheritance are easy to see in biological evolution as these are two facets of research in evolutionary biology. The second aspect, cultural inheritance, is potentially problematic from an evolutionary standpoint and may, in a biological context, have more to do with learning skills needed to effectively modify the environment to suit the organism's needs with regards to all manner of things than with traditional or anthropological definitions of culture. All three lines of inheritance are dynamic and interact with each other within a given ecological and evolutionary system.

The dynamism of this process of niche construction adds feedback into the process of evolution, creating evolutionary cascades (Sterelny 2005) that serve to reinforce adaptations and selections that have been favored by past generations. For example, an adaptation for living in burrows may, in subsequent generations, lead to adaptations regarding claw shape for digging, strength of eyesight and sense of smell, body size and shape, etc (Sterelny 2005: 22). While these cascades are easy to see in the organisms' evolution, cascades should also be looked for in the environments inhabited by the organisms. Niche construction takes into account the actions of the organism upon the environment to maintain optimal living conditions in the evolutionary relationship and development of the species. By examining the effects of the organism on the environment, instead of just the environment on the organism, it is possible to better understand the mechanisms of evolution.

The effects of niche construction and niche constructing behaviors upon both the environment and the organism are observable. What may be less discernable is the precise relationship between these effects beyond their interaction within a feedback system. Though potentially problematic for causal statements, investigations into the relationships between various contextual spheres in evolutionary studies and analyses can benefit from the ideas and framework of NCT. Additionally, investigations into evolutionary relationships can help to illuminate various evolutionary cascades and to help understand the development of various traits in different contexts. The effects of niche construction are important, but the effects can be best used to examine the relationships between these effects and their possible causes.

As a general framework for evolutionary studies, NCT is potentially very useful, especially in fields where it is possible to track changes in variables over time. Archaeological studies of the evolution of certain forms of technology, such as shipbuilding in a given region are areas of research that may benefit from the multi-angle approach adopted by using the NCT framework.

Niche Construction in Archaeology

Archaeological topics could benefit from the application of a NCT framework in their interpretation to enhance the understanding of number of processes and activities because of the triple inheritance lines in the developmental feedback system. A number of researchers have tried to apply NCT to various archaeological topics and interpretation with studies primarily focusing upon the domestication of plants and animals worldwide (Smith 2007) and prehistoric hunter-gatherers (Riede 2008, Riel-Salvatore 2008). These studies have primarily focused on prehistoric populations and events where historical documentation is non-existent and evolutionary principles are more readily applicable to human behavior. However, the use of NCT as a framework for understanding the evolution of technological suites in both prehistoric and historic contexts is a valid and useful utilization of this biological context.

Archaeology is positioned well to utilize NCT. Where evolutionary biology has difficulties identifying cultural factors of inheritance, archaeology is able to present a host of human behaviors affecting selective pressures on both the environments inhabited and other animals within them (Smith 2007, Bleed 2006). In general, the human behavioral element present in archaeology allows for the application of theoretical frameworks that depend upon continual behavioral patterns across generations in their interpretations and analyses. Additionally, it may be more possible within archaeological utilizations of NCT to determine whether the result of an activity is niche construction or a mere effect because while issues of agency may not be easier to resolve, those regarding intentional and unintentional consequence may give rise to a more full interpretation of development.

As stated above, archaeological utilizations of NCT to date have primarily focused on the pre-historic periods. The NCT framework is versatile enough that it can be applied to analyses of historical archaeological topics. The presence of documentary evidence in the historical archaeological context allows for more discussion of the social and cultural milieu in the analysis of the archaeological record and therefore provides insight into the processes by which a particular group is constructing its cultural niche. This is not to say that NCT is appropriate for all historical archaeological analyses, but that there are uses for an NCT framework within historical archaeological study. Issues regarding technology and adaptations of immigrant populations may be avenues of research where this evolutionary framework is most applicable.

Certainly with regards to the evolution of a particular technology in a particular context, NCT is potentially an invaluable tool. As technologies change, the reasons for the change may be difficult to ascertain or simply be multi-faceted and nuanced. Traditionally, the evolution of particular technologies has been attributed to diffusion from outside of a given context. This general framework does not take into account the internal changes in technology to the point where switching from the older to the newer technology is advantageous. NCT allows for changes within a particular context to be understood within that context through multiple variables. This kind of analysis can illuminate specific pressures on a technological system that either forces the adoption of new methods or that maintain older ones. Archaeologically, this can be seen most easily in the archaeological record. Documentarily, these changes can also be seen through a number of sources depending upon the technology and materials involved. This will be discussed in more detail below.

In archaeology, it is sometimes more difficult to ascertain the cause behind the observable effects than in biology. In order to counter this difficulty, the environmental, social and technological aspects of archaeological contexts must be investigated and included in the analysis of the site, artifact or landscape. The difficulties in this kind of analysis arise with the attempts to recreate, even on a theoretical level, past contexts for which fragmentary evidence exists. This necessitates a multi-faceted approach to the analysis of archaeological evidence. NCT provides a useful framework for this analysis and can be used in this fashion with success. Evolutionary effects in the archaeological record are not solely biological or environmental, but can be behavioral or cultural as well. Arguably, higher populations are an effect of increased food resources, but habitation in denser settlements following successful agriculture will create its own cultural evolutionary cascade. I will detail this below in the discussion of how this framework relates to my research.

Niche Construction in Baltic Shipbuilding and Trade

Niche construction allows for the discussion of ecological influences on the extent of trade and the usage of materials in shipbuilding. Additionally, NCT allows me to interpret trade, timber usage, and ecology in a dynamic and possibly causal relationship. While there are many facets involved in the discussion of trade and resource use, this framework is one that has not previously been used in discussing the evolution of shipbuilding techniques. The sources of evidence to be utilized in this study are both documentary and archaeological. Documentary and historical sources largely detail the extent of Hanseatic trade through time and the price and origin of various commodities. The archaeological evidence is largely in the form of shipwrecks and their dendrochronological analysis. The archaeological evidence shows not only the patterns of technological usage, but also sources the materials used in construction much better than general historical or documentary sources.

The Cogs, the ship used by the Hanseatic League for approximately three hundred years, are the system being researched in its niche in the commercial, technological, and economic system of Baltic and North Sea trade. The ships themselves retain a basic form throughout the time period: relatively flat bottom, high-sides, single mast. Later in the period, defensive and sheltering structures are added fore and aft. However, the sizes of the ships vary greatly, with an overall trend of an increase over time in size for the long distance commercial vessels, and therefore the patterns of timber usage during construction will be altered to accommodate a greater need for materials (Unger 1980: 136). Though there is structural variation in Cog form, it is important to note that the largest of the seagoing Cogs were remarkably similar in appearance, shape, and proportions (Hocker 1991: 25).

The architecture of the Cog informs what kinds of harbors and ports can be developed as trade centers develop in new locations. Because of the morphology of the bottom of the hull, Cogs are able to travel on rivers to inland harbors such as those found in Bremen and Lübeck and do not require the coastal harbors that ships with tapered bottoms did. However, Cogs, once beached, were extremely difficult to get back to sea, unlike Keels or other tapered bottom ships, and therefore required docks and mooring points to be constructed in the harbors for the ships. Additionally, the architecture of the Cog reflects its primary function as a commercial shipping vessel. The high sides and flat bottom tend to give Cogs the appearance of a floating box. Cogs also do not appear to have much in the way of above deck shelter for crew and passengers prior to the construction of fore- and aftercastles beginning in the thirteenth century (Ellmers 1985). This might further suggest that the primary function of a Cog was to convey goods and not people despite increased military activities from the thirteenth century forward.

In terms of construction, Cogs were built of oak, which was in high demand for shipbuilding, domestic construction, municipal construction, religious construction, and as a medium for carving or painting within any of these categories, but most often religious. The competing demands for this resource, in some cases with selection of materials being driven by similar criteria, likely impacted timber supply and price, driving the increase in the timber markets on the European continent. The above-mentioned competitions for resources are certainly not the only ones at the time, timber as fuel was also a large competitor in local sources, but those avenues of competition are the ones where dendrochronological and dendroprovenancial evidence can be used to corroborate conclusions reached by similar analyses on Cog timbers.

The extent of trade is a facet to this discussion that is multifold because it was partly affected by the increased demand for and necessity of requiring abroad of raw materials and because it was facilitated by changes in both the structure of the ships and practice of the mariners. In fact, it may be difficult to parse out the extent of trade from discussions of resource utilization as these are very closely interconnected. Along the coasts, where many of the centers of commerce and population are focused, there was a gradual deforestation occurring as arable land was opened up, as urban centers grew in size, and as materials were harvested for construction of homes, ships, and other structures, as well as for fuel. As trade increased, more and bigger ships were needed to carry goods between established trade centers. As resource stress made desirable timber nearby more difficult to obtain, new sources had to be found. New sources of timber were opened up either by pushing further inland along known waterways or by establishing new trade relations and centers with other nations along sea routes.

As new trade markets open and necessary materials come from further away, the costs associated with these materials rise, putting pressure on builders to make maximum use of the resources they purchase. This may mean using timber of poorer quality, not swapping out split planks during construction, or other material conservative methods, including changing how the strakes are joined to minimize waste. With a sufficiently large sample size, these kinds of changes should be visible. With my smaller sample size and limited ability to conduct precise and detailed analysis, I will attempt to discuss likely trends to be more thoroughly investigated in the future with a more complete data set.

It is generally assumed that the price of timber affected the way in which it was utilized during the construction process; mainly that high timber prices cause economical and efficient use of the timber (Van de Moortel 1991: 114). However, evidence for this trend in Hanseatic shipbuilding is fairly good, as repairs were made to split, cracked, and knotty timbers during construction, as discussed below in regards to the Bremen Cog, and dendroprovenance analyses showing differing points of origin for timber used for different purposes within a single ship. In these cases, the trend seems to be that the larger, straighter timbers were preferentially selected for planking and beams, where longer and more uniform pieces were more necessary, came from further inland where forest cover was still quite high. Smaller, less necessarily uniform timbers, such as floor timbers and knees, were found to have been harvested more locally. In the case of the Bremen Cog, most of the timber seems to have been sourced relatively locally to Bremen apart from the larger pieces, which have been sourced to Hesse (Kiedel and Schnall 1985: 27). In this instance, the shifting of the source of raw materials is dependent upon the intended purpose and the internal geometry of the timber in question. In this instance, the actual selection of timbers and their usage is influenced by both the eventual placement and by the costs associated with their purchase. With proper documentary evidence, it is possible to determine shipping and transport costs for a given cargo, as has been done for domestic grain transport in England both overland and oversea (Masschaele 1993). The English example shows that there are many factors that can influence transport costs making overseas domestic transport less expensive than overland domestic transport. The implications of this study for international trade and transport are simply that it may be useful to understand the dynamics of overland and overseas trade in the Middle Ages in order to fully understand the dynamics of trade during this period, especially as the Hanseatic League comprised both overseas and overland arms.

In terms of the purely economic pressures placed upon the construction of Cogs, it is useful to note that there are general proportions of the budget for their construction: forty percent for labor, forty-four percent for timber, ten percent for ironwork (nails, clamps, etc.), and six percent for all of the other finishing materials and tools (Van de Moortel 1991: 113). This budget percentage can help determine the possible cost of construction of individual Cogs at a given time during their usage. By knowing the cost of constructing a new vessel at different points during the history of Cog usage, it will be possible to investigate the patterns of timber usage throughout time as they relate to the cost of the timber. Additionally, it should be possible to compare the price of timber to its point of origin. This latter comparison is extremely important as the general idea is that timber originating farther away from its destination will cost more than timber originating closer. However, this general trend does not account for the cost of local oak timbers being artificially higher due to scarcity. Because of this possibility, it would be necessary to try and determine if there is a price differential in the historical record of timber by source.

Because the Hanseatic League traded in numerous goods, not solely timber, it is important to note that access to a variety of commodities and markets likely drove the expansion of trade more consciously than preferential access to timber sources. Access to and effective monopolies in distant trade centers for commodities were priorities for the Hanseatic League. As the Hanseatic League worked to maintain its dominance in the region, the expanse of their trade needed to grow in order to continue to out-compete new trading powers attempting to enter the region. At the beginning of the fifteenth century, the English and the Dutch begin to make inroads in the Baltic and North Seas, showing cracks in Hanseatic dominance in the region beginning at that time.

There are many accounts of crews fishing and processing their catches on Cogs in period (Klaus and Schnell 1985: 12). It is unclear as to whether the catches were used as part of the marketable cargo or as provisions for the crew. If the first were the more prevalent scenario, then the ability to access fishing grounds in the Baltic and North Seas would push the expansion of sea lanes into areas that may not be as extensively harvested. This particular example may be secondary in consideration to the larger issues regarding the expansion of Hanseatic trade, but it does help illustrate the need for access to supplies of trade goods.

The movement into new geographic markets drove the development of the Cog into new directions. Initially, the expansion eastward into the Baltic States and Russia created a need for larger ships able both to carry more cargo and to remain stable in deep open waters. Later, as the Hanseatic League began to lose its dominance in the region and the Cog began to be replaced by the Hulk, Cog design shifted. In this case, the Cog became smaller, shallower and narrower. The Cog was being adapted to a coastal and inland trade along rivers and canals in northern Europe.

Chapter 4: The Cog: Form, Function, and Technology

This chapter details the Cog; its form, how it was built, and how it changed through time. Using both archaeological and artistic evidence, the basic definition of the Cog form will be presented. I will present approximately ten examples of Cogs primarily from the former Zuiderzee in the Netherlands, and Germany. While there have been at least twenty-one other Cog finds (Hocker 2004: 74), the ones presented are generally the most complete and best documented examples of this ship type. Other examples of Cogs were either scavenged prior to full documentation or are extremely fragmentary and therefore of limited analytical use.

Cog Form and Construction

Cogs are classified in many newer discussions of ship forms as a "bottom-built" vessel (Hocker 2004: 65). A "bottom-built" vessel is one that does not fit neatly into the shell-first/skeleton-first models of construction advocated by earlier researchers. Shell-first construction refers to the method whereby portions of the hull, the shell, are pieced together prior to the insertion of the frames and other internal structural supports, the skeleton. Skeleton-first construction is roughly the opposite, with portions of the structural skeleton being constructed prior to the attachment of the hull planks. In skeleton-first construction, the whole of the skeleton are not constructed and frames and knees are inserted during construction as more of the hull takes shape (Steffy 1994: 280). Bottom-built construction is characterized by a bottom that is constructed differently from the sides (Hocker 2004: 65). There are many examples of these types of vessels in central and northern Europe around inland waters and rivers. The bottoms of these vessels are largely flat, as seen by the Bevaix boat and other boats of the Celtic tradition (Hocker 2004: 66). Cog bottoms are relatively flat, but there is a fair amount of variation, as illustrated below in Figure 4.1.

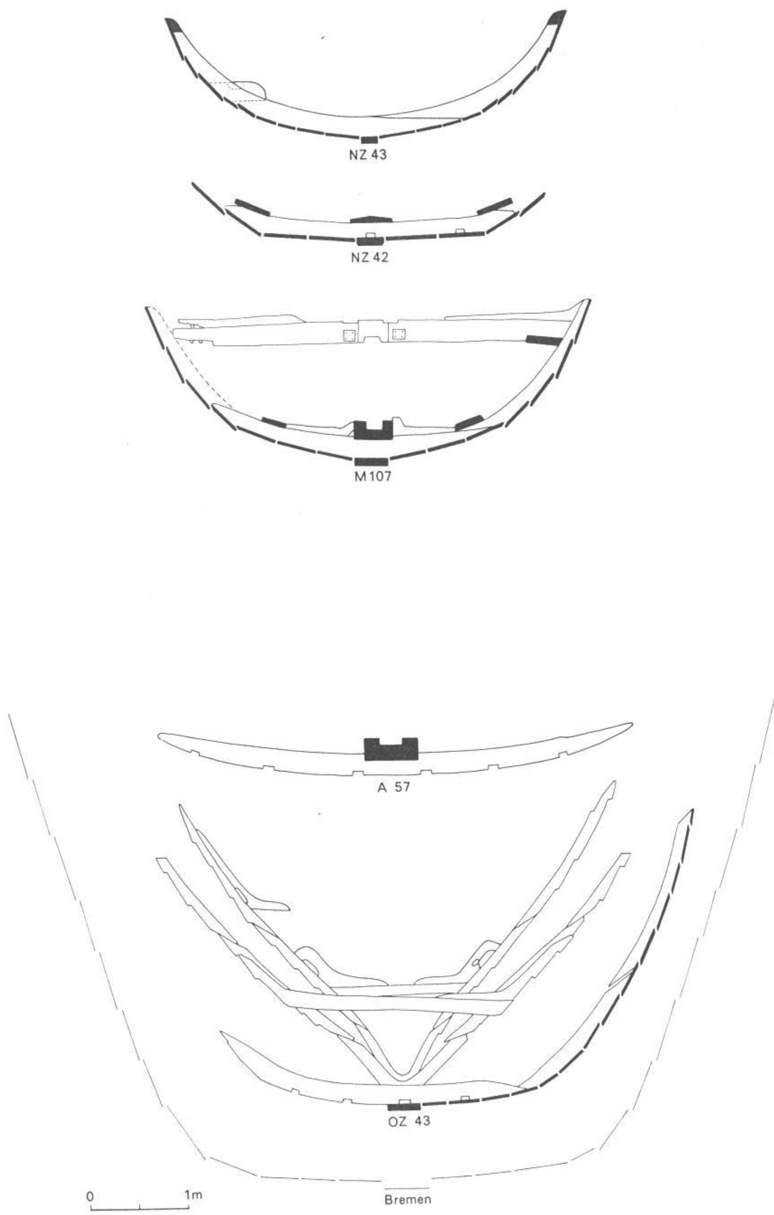

Figure 4.1: Comparative cross-sections of Cog examples (Reinders 1985: 14)

The Cog is a fairly unusual vessel form in the medieval period and was used first and primarily in the German states with similar vessels being seen in the North Sea region in the Netherlands and Belgium. It emerged around CE 1200 and was completely phased out in favor of Hulks by around CE 1450 (Lahn 1992). Ellmers surveyed medieval written sources looking for references to Cogs including: Kuggham, cogscult, Cokingi, and kocho; and found that these references appeared as early as the ninth century (Ellmers 1972). While interesting and certainly worth looking into, none of the archaeological evidence to date has yielded a Cog dating that early, and therefore, in this work, the later starting date for the Cog will be used.

Through trade contacts with the Genoese, Cogs were introduced to the Mediterranean and were modified, but that family of vessels is not the focus of this work. Cogs have relatively flat carvel, or flush-laid, planking switching to lapstrake, or clinker, planking for the high sides at the bilge. The structural elements of Cogs are built from oak, with pine being used on some additions in construction discussed below. In addition to the planking, there are other diagnostic features of Cogs that have led to identification of fragmentary vessels are the fastenings and caulking clamps, or *sintels*. The fastenings are “hooked nails” which were inserted from the outside of the hull; the protruding end on the inside of the hull was then turned 180° and reinserted into the plank (McGraill 1987: 139). The *sintels* are a butterfly-like shape with the “head” and the “tail” being inserted into the planking over the caulking and the “wings” covering it for a short length at the overlap of the side clinker planking. These same *sintels* could also be used on the carvel bottom of the hulls.

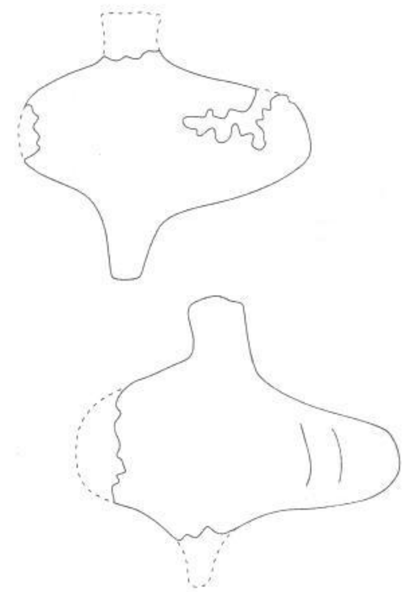

Figure 4.2: Examples of *sintels* from the Almere Cog. (Hocker and Vlierman 1996: 28)

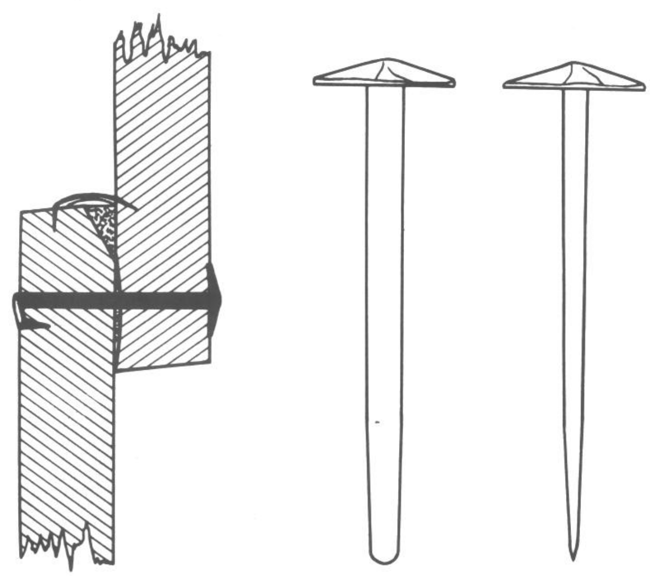

Figure 4.3: Cog planking and caulking (left), Cog nails (right) drawings by W. Lahn. (Ellmers 1960: 60)

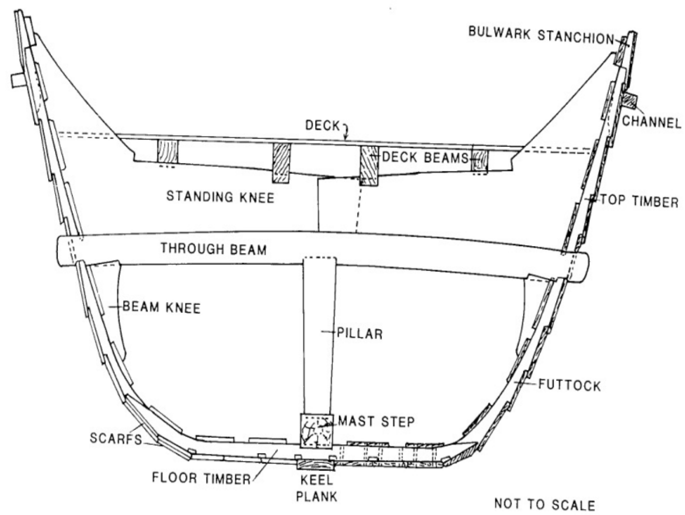

Figure 4.4: Midship Section of the Bremen Cog, 1380 showing hull planking. (Steffy 1994:119).

Representations of Cogs emerged first on coins and city seals in the Baltic region in the ninth century (Ellmers 1985). These early representations show a single-masted ship with three rows of external nails indicating three strakes of clinker-built planking above the water line, and straight stem- and stern-posts. The ships on the seals and coins have square sails and in the beginning of the period are also shown with a side rudder, or steering paddle, which changes to a stern-post rudder later in the period. Towards the end of the thirteenth century, Cogs are shown on some city seals having a superstructure fore, aft, or both atop the main hull that is referred to as the castle. The appearance of the castle may be correlated to the increased use of Cogs in military capacities, as with the Norwegians in the thirteenth century (Ellmers 1985). At this time, castles are not seen on all representations of Cogs, but castles do become more common on Cog representations by the middle of the fourteenth century. As the castle came increasingly into common usage on the vessels, they became locations for captain's and passengers' quarters as well as the location for sanitary services, as seen on the Bremen Cog.

Figure 4.5: City seals of Hanseatic towns (Fliedner 1985: 11)

Cog construction trends were originally traced through city seals and coins prior to the identification of any vessels of that type in the archaeological record. Dr. Paul Heinsius has written extensively upon the iconography of Cogs in his work *Das Schiff der hansischen Frühzeit* (1956) where he identifies the characteristics of Cogs. With the discovery of the Bremen Cog in 1962 it was possible to identify and analyze vessels of this type that had entered the archaeological record. It is important to note that the Bremen Cog is an example of a vessel at the height of the development of the ship type. As will be discussed later, the Bremen Cog was built in 1380 and the widespread supplanting of Cogs by Hulks began by 1400 and was complete by 1450 (Lahn 1992).

Cogs are double-ended crafts, meaning that they have both a stem and a stern. The keel is the spine of the hull and may be in one or two pieces depending upon the size of the craft and cut from a relatively straight timber with little rise fore and aft. Knees, the curved sections of the keel that are scarfed onto the posts, were usually made from naturally forked branches. Additionally, other frames, floor timbers, and knees within the structure of the hull were shaped from similar pieces, indicating that whole trees were used in construction and not simply the straight trunk sections. At least in later Cogs, such as the Bremen Cog, the stem- and stern-posts were double layered with an inner and an outer post. Both were likely fashioned at the same time, but the inner post was needed during laying the keel and fastening the planking during the early construction phases. The outer posts were mounted after the planking was completed (Lahn 1992: 30). For the most part, knowledge of how the planking was laid has been discussed above with regards to switching between carvel and clinker at the bilge. Interestingly, at least on the Bremen Cog, the sintels were spaced at intervals of approximately fifteen to twenty millimeters along the caulking. In all Cogs, large crossbeams were installed towards the top of the hull that spanned the width of the hull and protruded beyond it. This is seen in the iconography and also in the shipwrecks that are complete up to that point in the construction. The crossbeams were fashioned from trunks and it appears that the height and width, though variable, was more important to be consistent than the curvature of the beams (Lahn 1992: 71). The crossbeams were not deck beams and did not directly support the upper deck of the ship.

As mentioned with the iconography, Cogs were single-masted, square-rigged vessels. The mast step, where the mast was seated along the keelson, was the center of gravity of the ship. The location varied depending upon the size of the ship, as is illustrated below in Figure 4.6. The construction of the mast itself tends to be a mystery in many of these ships, as this piece of the ship is not usually recovered, possibly having been scavenged at the time of wreck if the vessel was close to shore.

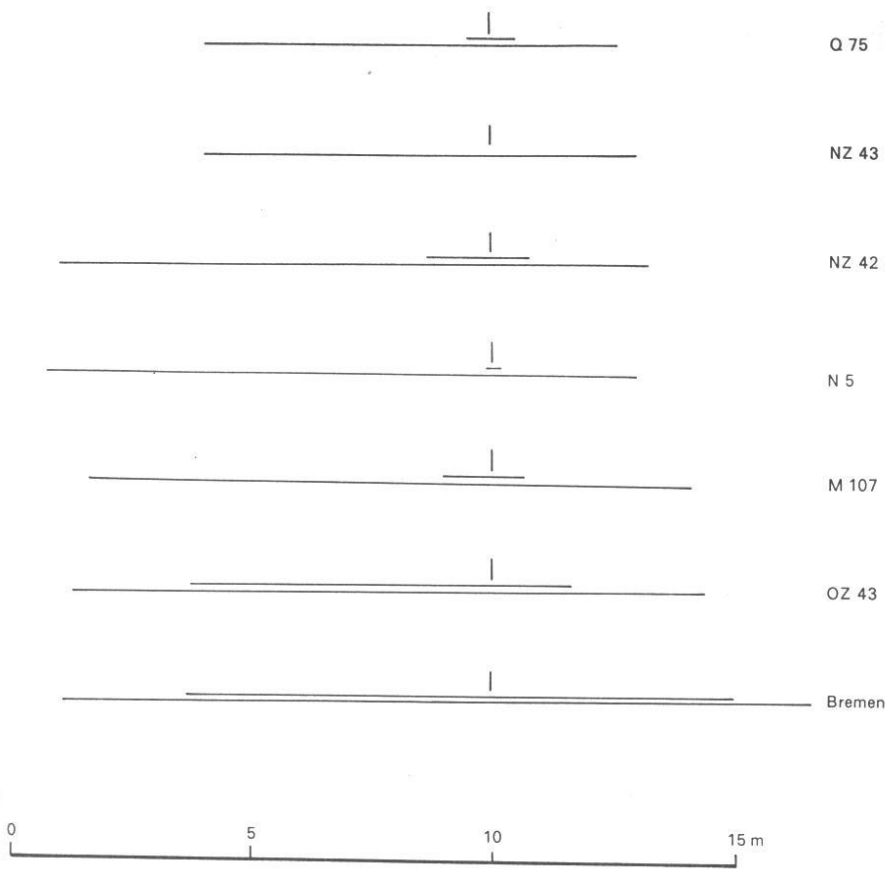

Figure 4.6: Position of Maststep along the keel in different Cog finds. (Reinders 1985: 25)

These basic elements are the main structure of all cogs. The vessel type emerged around 1200 and developed through time until about 1400, when, as mentioned above, it began to be supplanted by Hulks in overseas trade. Descendants of the Hanseatic Cogs were used in inland areas and canals in the Netherlands through the eighteenth century and, apart from the mast step, retained many of the same characteristics scaled down for canal and river use. Variations in Cog form are largely size and curvature of the bottom of the hull, as illustrated above in Figure 4.1.

Examples of Cogs

There are an increasing number of vessels identified as Cogs or Cog-like vessels, which are being treated as Cogs for the purpose of this paper (Hocker 2004) . This paper will highlight the better documented and more thoroughly studied examples of this ship type to investigate the changes in Cogs for the period and to discuss implications of the historical and economic context of their construction. The bulk of these examples are from the Netherlands, particularly from the former Zuiderzee and the IJselmeerpolders as these are locations that have undergone massive dredging and land reclamation projects in the past twenty years and therefore have been the locations of numerous ship finds. Currently, dredging efforts in inland seas, rivers, and harbors have been the primary locations for finding the shipwrecks. This may change as pipelines and other structures are constructed along the seafloor of the Baltic and North Seas. Additionally, early Cogs do not appear in the archaeological record with enough frequency to significantly impact the current analyses of the Cog tradition.

The Bremen Cog

Possibly the best known and most thoroughly studied example of the Cog is the Bremen Cog, discovered in 1962 during dredging operations in the Weser River. This is the first vessel to be definitively classified as a Cog largely thanks to the earlier publication of Paul Heinsius's dissertation 1956 *Das Schiff der hansischen Frühzeit* (Kiedel and Schnall 1985). The wreck itself was very complete, missing: the mast, the stern rudder, the deck timbers of the aftercastle, the very top strakes of the starboard side of the hull and the strakes of the port side of the hull past the fifth strake (Lahn 1992). The rest of the ship was relatively intact with stern rudder gudgeons, capstans, aftercastle structural elements and even a toilet seat intact. There were also some artifacts found associated with the construction of the vessel: a barrel of pitch, a shoe, hammers, an axe, and a turning iron for the planking nails. It is likely that the Bremen Cog never sailed and was lost during construction as the hull is not treated with pitch, there was no ballast discovered with the ship and the sparse associated artifacts do not suggest that they were part of a cargo (Lahn 1992).

The excavation, preservation, and reconstruction of the Bremen Cog have led to a number of insights regarding operation and use. These are detailed in Werner Lahn's 1992 work and will not be discussed in detail here. As mentioned above, the Bremen Cog represents the vessel type at the end of its development because within twenty years of its construction Hulks began to take over the routes that Cogs plied. The Bremen Cog exhibits most of the characteristics seen on the city seals, although it appears to have only an aftercastle and no forecastle. The plank-by-plank analysis of the Cog during reassembly has also been able to help with questions of timber usage and quality that will be discussed in greater detail below.

The timber used on the Bremen Cog itself is interesting, as it generally comes from two different sources and shows a fair bit of variety in quality. Dendrochronological analysis of timbers from the Bremen Cog has yielded an exceptionally precise date of 1380 ± 1 year (Fliedner 1985). This date is that of the timbers, putting the start of construction likely in the spring of that year, although some of the timbers show a date of 1378 (Hoffmann 1985). Construction was likely started within one or two years of the felling of the trees and evidence from timbers of the Bremen Cog, tool marks showing finishing with adzes or axes, has suggested that the timber was green when used in ship construction, allowing for a quick turnaround from felling to construction (Hoffmann 1985). The use of green logs allowed for maximum flexibility when fastening planks and bending the timbers into place during construction. Green timber usage did not completely prevent cracking and splitting of planks and timbers during construction, but this will be discussed below. Dendroprovenencing has placed two origins for different groups of timbers within the Cog. All of the main structural elements of the Cog are oak. Many of the structural components, including the large crossbeams, originated in southern Germany from the Kassel region in the Weser Highlands (Hoffmann 1985). The rest of the wood used in constructing the Cog, such as that for the floor timbers and knees, originated in the lowlands around Bremen (Hoffmann 1985). This is interesting because it appears that there is a cost saving mechanism in play by trying to use local wood for the bulk of the smaller pieces while limiting spending on the more expensive timbers to the pieces that required a certain kind of precision or consistency.

With regards to the quality of the timber used, it appears that there are differences between individual timbers and sections of the ship. The aft section of the keel, which is in three parts, is constructed of poorer quality timber than the other parts (Lahn 1992). This is seen with the absence of a two-sided caulking bevel causing both the inside and the outside of the keel to be caulked. Additionally, on the planking, there are some issues with splitting and knots that required repairs to be made to the Cog during construction, as seen in the figures below. The use of these timbers despite flaws certainly suggests some economic constraints on the part of the builder or commissioner of the Cog, but also suggests that the prices for timber being brought into the towns made discarding usable timber, even if flawed, uneconomical. It appears that wood was efficiently and even intensively used when imported.

NZ 43

This vessel is from lot NZ 43 of the reclaimed Zuiderzee polders in the Netherlands and was excavated in 1979 (Van de Moortel 1991). This particular vessel may be more indicative of a local cog-like vessel instead of a Cog and date much later with a TAQ of 1600, but it is still useful in this discussion because of the geographical importance of the former Zuiderzee as the crossroads of the east-west and north-south shipping routes of the Hanseatic League (Van de Moortel 1991). Within this region there have been at least ten wrecks of various sizes found that date to around the thirteenth and fourteenth centuries that share similar features with the Bremen Cog, among them NZ 43.

The NZ 43 wreck measures approximately 10 m by 4.5 m and the ship was heavily damaged. This vessel was likely a merchant vessel, as its central portion was relatively broad, but no cargo was found associated with it, but brick and ceramic fragments, iron scraps, small cattle bones, a textile fragment and a feather fragment were all found associated with the wreck (Van de Moortel 1991). The ship appears to have sunk due to being stranded on a shallow bank, and was therefore a ship that had seen use, unlike the Bremen Cog (Van de Moortel 1991). In terms of what remains of the ship itself, approximately fifty percent of the planking was found with the port side up to the sheer strake partially in situ and the starboard side more heavily deteriorated. Partial remains of nineteen frames were discovered and the keel plank and hooks were found in situ. The stern was preserved to over 2.25 meters in length, but no sternpost was identified and three deck beams survived, but none of the planking did (Van de Moortel

1991). Despite the damage done to the vessel, the wood itself was generally in good condition.

NZ 43 was constructed of oak, as most vessels in continental Europe were, but there has not been extensive dendrochronological analysis done on the timbers. Additionally, there has not been any dendroprovenencing done on the timbers, but due to the small size of the vessel it may have been constructed of local wood, possibly from the Upper Rhine or Westphalia (Van de Moortel 1991: 33). This possible use of local timber is interesting in light of documentary evidence of the Zuiderzee cities importing substantial amounts of timber from the Baltic and Norwegian areas (Van de Moortel 1991). Because this vessel is on the smaller side, it may be indicative of trends regarding who is building the ship and for what purpose informing the timber usage. Smaller scale vessels requiring fewer long straight timbers may have been able to be constructed more cheaply from local resources while larger scale vessels would require the use of imported timber due to size requirements.

The Almere Cog

The Almere Cog was excavated in 1986 in Almere wijk 13 in the Flevoland Province of the Netherlands (Hocker and Vlierman 1996). The sides of the vessel were preserved to their full height of 5 m with preservation equal on both sides, the ceiling was in place but badly damaged, the rudder and stern post were missing and there was recent damage in the form of two well defined holes through the hull made by digging machines (Hocker and Vlierman 1996). Aside from the damage to the wreck itself, the timbers were generally in good condition for preservation and analysis, the latter of which was performed in 1987. The ship's sinking has been found to have a TPQ of CE 1420 based upon three silver coins found associated with the ship (Hocker and Vlierman 1996). This vessel shows evidence of extensive use throughout its life with numerous repairs in the planking and deterioration of planks prior to its sinking. The ceiling timbers are pine, but the structural elements of the Almere Cog are oak.

It appears that the timbers used in the construction of the Almere Cog are high quality and the builders favored using fewer larger planks in construction as opposed to more smaller ones (Hocker and Vlierman 1996). None of the timbers yielded enough information for a dendrochronological analysis to be completed, so there is no evidence for where the timber from. This presents a problem in investigating trends regarding the use of timber from different geographical regions, but does allow for some general trends to be examined.

Most of the strakes of the sides of the Almere Cog are composed of three planks approximately 4.5 cm thick. Amidships, the planks tend to be between 40 and 50 centimeters wide while the bilge strakes are around 30 – 34 cm wide. The three carvel-laid bottom strakes on each side are approximately 3 cm thick and up to 48 cm wide (Hocker and Vlierman 1996). The relative uniformity of the planks used in the construction may be a primary reason for the use of fewer longer planks: there is potentially less variability than one might expect when using many smaller planks. Relative uniformity in materials appears to be an important selective factor for the timber used, as the crossbeams and other large timber pieces for the Bremen Cog seem to have been similarly chosen for relative uniformity along one or more lines, such as thickness. It may be likely that the larger pieces of the Almere Cog, like the Bremen Cog, were imported from the Baltic region or from further inland and smaller pieces which were not required to be straight or of a certain thickness may have been harvested locally through the coppicing of trees as a cost saving measure (Haneca et al. 2005).

Like NZ 43, the Almere was well-used prior to its sinking. There is substantial evidence of recaulking on the outside of the hull, possibly as repairs once the original caulking lost its water-tightness. Additionally, there are numerous repairs evident on the hull, mostly of cracks and splits. These cracks and splits have all been resealed with caulking, much like the splits during construction on the Bremen Cog. Additionally, there was construction tools found associated with the wreck: a left-squaring axe, an adze, and parts of handsaws (Hocker and Vleirman 1996: 39). The finding of tools on finished and sailed ships suggests that there was some sort of repair kit on board in order to make expedient repairs at sea or at least when away from port.

The structure of the Almere Cog is generally much narrower and flatter than deep water Cogs such as the Bremen Cog, suggesting that the Almere Cog was not intended for open water voyages (Hocker and Vlierman 1996). At 4.20 m at its widest point, the Almere Cog was narrow enough to pass through the canal locks in the *binnenweg*, suggesting that this vessel was used primarily for coastal and inland journeys. This is an interesting development because CE 1400 is when the Hulk starts to supplant the Cog in deep water trade routes, a process which is complete by CE 1450. At this time, large-scale Cog use ceased and these vessels were only employed for specialized functions (Hocker 1991). The Almere Cog likely dates to around CE 1420, placing it within the period that the Hanseatic League was phasing out the Cog. The use of the Almere Cog as a canal boat foreshadows the eventual purpose of descendants of the Cog-building tradition, such as NZ 43. The seemingly easy adaptation of the Cog form to inland usage is important, as the relatively flat bottom of the Cog allowed it to travel inland on rivers to the Hanseatic harbors of Bremen and Lübeck among others. By scaling down the size of the ship and further steepening the sides, the Cog was transformed into a derivative vessel type that remained in use into the sixteenth century in some parts of the Netherlands (Hocker 1991). The adaptation of the Almere Cog to the conditions of Dutch canals is evidence of the Cog form moving into a new niche: inland waterways such as rivers and canals.

The IJsselmeerpolder Wrecks

Another area in the Netherlands, the IJselmeerpolders which includes Almere, has yielded numerous wrecks from 1942 through 1985 during the draining, dredging, and land reclamation projects in the former Zuiderzee (Reinders 1985). Nine of these vessels, including NZ 43, show Cog-like characteristics and similarities to the Bremen Cog. Aside from NZ 43, published reports of the excavation of these ships were not located, and therefore the remaining eight ships will be presented together. Of the eight ships discussed in this section, four were found in the Noordoostpolder and four were found in the Flevoland. Those from the Noordoostpolder were either excavated in the 1940s or not at all, while those from the Flevoland were excavated from 1976 to 1983 (Reinders 1985: 13).

All of these vessels were preliminarily dated to the thirteenth and fourteenth centuries based on a number of characteristics. Initially, one of these IJselmeerpolder wrecks, Q 75 in the Noordoostpolder, had been dated to the twelfth century based on a shell layer above the wreck dating to CE 1200 (Van der Heide 1955). However, upon re-examination of the soil profile, the correct position of the shell layer was determined to be below Q 75, dating the wreck to the first half of the fourteenth century (Reinders 1991). Aside from the soil profile of Q 75 and the dendrochronological analysis of NZ 43, discussed earlier in this chapter, other methods for dating the IJselmeerpolder wrecks have relied primarily upon the associated artifacts: pottery, coins, and clothing (Reinders 1991: 37). This is problematic because the date range for a wreck can easily cover upwards of fifty years, as is the case with the following ships: A 57, OZ 36, NZ 42 (Reinders 1991: 37). Because Cogs are only seen for approximately 250 years, fifty years can span a large amount of development, making precise dating of Cog finds incredibly important.

Trends in Cog Design and Construction

Throughout the two and a half centuries of Cog dominance in the Baltic and North Seas there were a number of trends in the development of the Cog as a ship type. Increasing overseas trade led to the enlargement of the vessel. The development of the stern rudder allowed for easier steering of larger ships. Increased naval military actions led to development of castles on the decks of the ships. And finally, there were the adaptations of the vessel type to more specialized circumstances with its being supplanted in overseas trade by the Hulk, as seen in the example of the Almere Cog.

In spite of the changes, there were numerous constants, such as the exclusive use of oak for structural components of the ships with pine being used for deck timbers and other non-structural elements. If this was affected as a cost saving measure a thorough survey of the city archives of Hansa towns will provide evidence since timber prices are recorded with relative frequency in letters between merchants as found in the Lübeck city archives. In my own research, I found there to be a number of documents detailing the price of timber and presumably the type and origin, but further research is necessary, as is a greater knowledge of German in order to make good use of the archival sources.

A constant in the preparation of the planks used in all the examples of the Cogs was that the planks were sawn instead of split (Crumlin-Pedersen 1983). The difference in sawing versus splitting planks affects the types of wood and quality that can be used. Planks are split on the grain and this process requires mostly straight trunks. Sawing wood does not require the harvested timber to be particularly straight or have an even grain, making poorer quality wood available for construction. In the case of the Bremen Cog, tool marks on the timbers and the crossbeams indicate that while much of it was sawn, specific timbers and beams were finished with adzes (Lahn 1992). The presence of exclusively sawn planking may be a result of either northern continental building practices, in which case more work needs to be done to identify and analyze earlier ship types in the region and a precise chronology for specific woodworking technologies. In some instances, there is evidence that whole trees were not felled, but that the coppicing of oaks in local stands was undertaken, for both the purposes of timber harvest and for acorns to supply fodder for pigs (Haneca et al. 2005). However, these local sources of timber did not produce enough high quality timber for construction, and this was the primary purpose of imported oak timber during the Middle Ages. It appears that Lübeck and Gdansk were the two hubs of the Hanseatic timber trade at least until the middle of the sixteenth century when the eastern hub shifted to Königsberg, Riga, and Courland (Haneca et al. 2005).

Baltic timber of the Middle Ages generally shows elements of high quality that help to determine its origin. These qualities are characterized by wood with narrow tree-ring structure giving it a fine grain that when sawn has great dimensional stability (Haneca et al. 2005). This evidence gives both provenance data and climatological data, as it implies fairly consistent climatological conditions during the trees' growth. Additionally, these timbers have been used, as mentioned above, to create regional oak chronologies which can be used to help date timber remains. The use of these timbers in creating site and regional chronologies is ongoing (Daly 2006, Haneca et al. 2005) and has resulted in some well documented areas such as northern and central Poland.

The differences between the Bremen Cog, the Almere Cog, and NZ 43 show the evolution of the vessel form as it adapted to a new niche: coastal and interior trade. The dimensions of the Bremen Cog would have precluded it from accessing smaller inland ports and it most certainly could not have traveled along the canals in the Low Countries, as it was too wide to fit through the locks. The Almere Cog has a very similar structure as that of the Bremen Cog, but the Almere Cog is narrower and shorter and does not appear to have had any architecture for either a fore- or aftercastle. As mentioned above, the narrowness of the Almere Cog allowed it to travel through the canal locks in the Netherlands to reach the numerous inland harbors that exist there. The Bremen Cog, being slightly larger than average, showed the ultimate in the deep, wide Cogs that dominated the Baltic and North Seas shipping lanes in the medieval period. The Hulk was replacing the Cog in the long distance deep water trade routes. The structure of the Cog, however, was easily adaptable to this coastal and interior trade along the rivers and canals in northern Europe, particularly in the Netherlands. These were already areas where Cog and Hanseatic presence were apparent. The shift from overseas to interior trade is evidence of NCT through the effect of the shipping technology and the economic pressures changing.

Regional geography may have determined Cog size, as it appears the vessels travelling to Danzig (modern Gdansk), Riga, and Reval (modern Tallinn) were more often than not on the larger end of the size spectrum (Unger 1980: 167). These ports were the main export points for surplus grain shipments from Poland and for timber from Poland and Russia and larger vessels would have been able to accommodate bulk shipping more than smaller vessels (Unger 1980: 166). Ships that were intended to make the longer journeys, such a Novgorod to Lisbon, would need to maximize their cargo capacity in order to ensure profitability of voyages, whereas ships intended to travel shorter distances or to remain along the coast these ships would be stopping more often to be off-loaded and re-loaded, allowing number of stops as opposed to volume of cargo to be the determinant of profitability.

The development of the castles on the fore and aft of the main deck coincided with the increase in both militaristic uses of Cogs and the lengthening of the long-distance trade routes. The castles start appearing in CE 1250 and through the period of Cog usage become more integrated into the architectural fabric of the ship as opposed to an addition (Unger 1980). Though the castles were undoubtedly used for various militaristic purposes, they became important as crew and guest quarters on the ships. The conversion of castles into quarters may underline the primary usage of Cogs, which was as commercial vessels and not as warships (Unger 1980). The castles certainly contained small rooms or cabins from 1300 on (Kiedel and Schnall 1985). The loss of the castle on the Almere Cog and NZ 43 suggests that as Hulks took over the major long-distance shipping routes, quarters and military structures were less necessary. This was likely due to the shift in the shipping patterns from overseas to inland routes making the need for these structures obsolete. Here is another example of the adaptation of Cog design being influenced by the economic pressures of the commercial system in which the Cog developed.

Where possible, researchers have applied dendrochronological and dendroprovenance analyses to both date and determine the origin of the timber used for the construction. The apparent trend, which requires more of this work to be done and for the regional databases of oak dendrochronologies to be expanded (Haneca et al. 2005), seems to indicate that smaller pieces of timber were generally found locally while larger pieces originated from further away. In the case of the Bremen Cog, the use of German timber from the Weser Highlands was likely in part due to the relative ease of floating the timbers downstream to Bremen. Ships built in different shipyards may reveal differences in timber origins based upon their own supply networks. In order to test this hypothesis, more ships need to be traced to their shipyards, which is an incredibly difficult task. However, the identification of shipyards archaeologically may reveal evidence of timbers that can be dated and their origins determined, allowing for more knowledge of the lines of supply within the Hanseatic trading system, as has been the case with some English shipyards (Hutchinson 1994).

Chapter 5: Summation and Conclusions

While the extent of the Hanseatic League was extremely visible and dynamic during the thirteenth through sixteenth centuries, the changes in Cog construction are more subtle. The Cog retained much of its original form throughout the period, with modifications made to the structure including stern-post rudders and castles. Where major differences over time are likely to be seen in Cog construction is in the timber usage. These differences can take a number of forms, but the two that appear the most consistent are in the differential usage of imported versus locally sourced timber.

There does appear to be a clear correlation between the size of the Cogs and the distances they were likely to travel. The vessels servicing the easternmost ports tended to be larger than those making shorter journeys, showing a correlation between the size of the vessels and the extent of Hanseatic trade. Between the larger and smaller archaeological examples of Cogs, there are also striking similarities in how timber was used in construction. Fewer, longer planks were used for the sides. Large, somewhat uniform timbers or beams, were fashioned from imported timber, smaller knees and frames being fashioned from relatively locally sourced timbers. This shows a degree of standardization in the shipbuilding industry of the region. If these patterns hold true throughout the ship type in later examples, it may be possible to infer the area where individual ships were constructed. This knowledge can help determine which imported timbers were being used for what. Additionally, along with letters and other documentary evidence, it may be possible to determine how much a ship cost to build at different times and in different ports during the Middle Ages. Understanding precise construction costs for vessels of different sizes may help in understanding the move from Cog to Hulk as the primary ship type used in overseas trade by the Hanseatic League.

However, the one piece of evidence that is missing from this particular section of the investigation is early Cog finds. This is important because the bulk of Cogs found have been dated to the middle or late portion of Hanseatic dominance in the region. In order to better understand the relationship between the timber and its use in construction, early, relatively intact, examples of Cogs need to be found in order to conduct useful comparisons of both cost of materials and use of materials. Additionally, early examples of this ship type will help to understand the later developments and uniformity that is seen throughout the region in the examples that have been found and excavated to date. Earlier Cogs may show variability that is no longer present in later examples showing either an increased adaptation to overseas trade conditions, a standardization of shipbuilding technology and knowledge in the region, or the increasing dominance of the Hanseatic merchants in neighboring areas with similar shipbuilding traditions. All of these ideas are unverifiable without early Cog examples.

In all Cogs, the degree of preservation and the amount of the vessel that is still extant is a variable that is uncontrollable by the archaeologist and is a continual limiting factor in the complete analysis of the vessels. However, through the use of pictorial evidence such as city seals and paintings as well as period models and the remains of the ships themselves, a number of replica ships have been constructed in the Netherlands and Germany including the *Lisa von Lübeck*, the *Ubena von Bremen*, and the *Kampen Kogge*. These ships may be invaluable in their ability to model the timber usage patterns and the timber amounts needed for ships of their size or for the ships that the replicas are based on. The limitations of using the replicas is that it may be difficult to assess the timber usage patterns of smaller ships based on these particular vessels. Additionally, some elements of the replicas are extrapolated from structural elements, such as the aftercastle on the Bremen Cog, which did not remain relatively intact after the loss of the vessel in period. In these cases, these elements may have mistakenly been constructed with too much or too little timber, or in ways that were not common or present in period. In spite of these limitations and in light of the lack of documentary evidence for the total cost of constructing a Cog, these replicas are perhaps the best tool to use for this purpose.

Using the framework of Niche Construction Theory, it is possible to link the development of Cog design with the economic and ecological factors affecting it. The expansion of the Hanseatic trade network throughout this period was fueled by a number of economic factors, including the securing of ample sources of raw materials for its own use and profit. Interactions between the Cog design and the ecological context forced change in the economic context. With the initial expansion of the League into the interior of the continent and the Baltic states, the need to augment the local timber supply is fairly evident. However, the continual expansion into these areas warrants further exploration. Niche Construction Theory may provide the mechanism by which the interactions between the trade patterns, the environment and the ship technology can be better understood in a dynamic fashion. What are necessary in this future discussion are more complete site and regional chronologies of oak tree-ring sequences and regional archaeobotanical studies. These elements would greatly expand the knowledge of the ecological impact of timber harvesting on the localities of harvest. It should be possible to track the patterns of harvest and to see the impact of this on the forest composition of the time. This information is potentially invaluable to understanding the medieval interior and Baltic timber trades in general, and how they affected continental trade patterns in specific. Archaeologically, lumber camps and depots would be important finds, but it is necessary to determine where the timber was being extracted in order to have an idea where such sites may still exist and not have been developed in subsequent years.

Included in the ecology of the region is the climate, and there are few studies that focus on the climate south of Lapland during this period. The climatic patterns during this period may have influenced both the forest composition and the accessibility of certain areas to ships. Again, most of the Hanseatic harbors were somewhat inland along the rivers. Some of these rivers, like the Weser in Germany, are tidal. This means that anything affecting the oceanic tides is going to affect the flow and traffic upon the river. Additionally, general climatic patterns affect the weather and rainfall of different areas and can lead to poor growing years for timber. This begets poor quality timber, excessive rainfall affecting the growth of timber or even the flash floods and the loss of ships during construction or of timber stands too close to riverine areas.

These climatic and ecological conditions remain poorly documented at this time for the Baltic and interior regions of Europe. Understanding them is necessary to the completion and understanding of this aspect of the evolution of both Hanseatic trade and the Cog. While there is work being done by a few researchers to enhance the dendrochronological profiles of the region (Haneca et al. 2005, Daly 2004), the other elements of the climatological analysis are not progressing. It would also be useful in this case to attempt to conduct similar studies in the areas that now contain the medieval

Hanseatic cities in order to attempt to more precisely chart the harvesting of timber resources and the increased agricultural and urban developmental activities of the time. This latter study could have the potential to illuminate the degree of pressure that the Hanseatic League was under to secure foreign timber sources for their own use and could, in concert with the former study, create a much more nuanced understanding of the ecological context surrounding the expansion of Hanseatic trade during the medieval period.

The eventual decline of the Hanseatic League in the commercial milieu of the Baltic and North Sea regions appears to be due mostly to the changing political landscape of the fifteenth and sixteenth centuries (Schildhauer 1985). Additionally, with the advent and adoption of vessel types that could hold much more cargo, the Cog began to decline in its popularity and use in overseas trade. As mentioned above, the comparison of construction costs for different vessel types would be useful in assessing whether or not the political and cargo capacity arenas were the only ones in which the Hanseatic League suffered during its decline.

The work presented here lays the foundation for future research into this topic along the lines listed above: regional ecology and climate, earlier examples of Cogs, and cost-based analyses of construction. Unfortunately, earlier examples of Cogs may be hard to include because we are dependent upon what is found and what is preserved, however, with increased dredging and land reclamation efforts in the Netherlands and other areas in the Low Countries and increased activity surrounding the construction of underwater pipelines in the North and Baltic Seas, the likelihood of such finds in these areas is increased. It is most likely that early Cogs will be found along the coasts and rivers in Germany, Denmark, and the Netherlands. However, these areas have been under constant development and the archaeological record in these places is likely not complete.

With regards to cost analyses, there are a number of limiting factors, some of which were discussed above with regards to the construction of replicas. One major limiting factor encountered during my research was my constraint in utilizing the primary documentary evidence because of my lack of familiarity with the language and handwriting styles of the time. For me to continue this study with regards to cost analysis, I need to become familiar with the historical variants of the language and the calligraphic conventions in medieval Germany. Additionally, knowledge of the historical currency is imperative in any discussion of cost with regards to materials. This is another area where more research may be needed. There are many extant letters and documents in the city archives for the period detailing the price of different kinds of timber from different areas, so there is not a lack of documentary evidence, merely an inability to properly access the information contained therein.

The NCT framework has been useful in the beginnings of this study as a way of both identifying potential avenues of research and influences and as a method to begin understanding the processes that led to the Cog in its most advanced form, evidenced by the Bremen Cog, and to the expansion of the Hanseatic League throughout the Baltic and North Seas regions. This is a framework that can continue to be useful as the further ecological, economic and historical evidences are gathered in continuing studies of this particular trade technology. Additionally, the successful use in applying this framework to the study of trade technology in one sector of medieval Europe shows that this is an appropriate framework for other such studies. It allows for and encourages the inclusion of multiple lines of evidence in the synthesis and analysis of technological advancements in broader social, environmental, or other contexts.

Additionally, this framework has allowed the inclusion of examples of cog-like vessels, such as NZ 43, into the discussion of the evolution of the Cog vessel type. Previously, these examples were not included in the analysis as they fell outside of the general date range for the widespread use of Cogs. These later cog-like vessels show that the Cog vessel form retained functionality in the region and was adapted to use in specialized areas, such as the inland seas and canals of the Netherlands and are still a part of the evolution of this vessel type.

Further work needs to be done to understand the precise dynamics of the different contexts and relationships involved in the evolution of the Cog and the expanse of the Hanseatic League in northern Europe. This work should include investigations into the period after Hanseatic decline as there continue to be developments in the Cog even though it is no longer the dominant ship in the region. The source of timber does appear to have some influence over its use in construction, but it appears that the timber is not originating from as distant as initially thought. The size of the ships does appear to correlate with the expanse of trading activities of the Hanseatic League, but appears to be more reliant upon the distances a particular ship is meant to travel.

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