

**THE DEVELOPMENT OF A BOTTOM-BASED
SHIPBUILDING TRADITION IN
NORTHWESTERN EUROPE AND THE NEW WORLD**

A Dissertation

by

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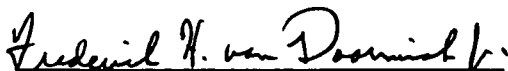
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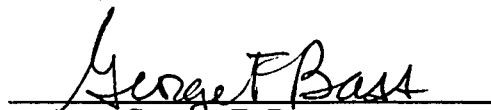
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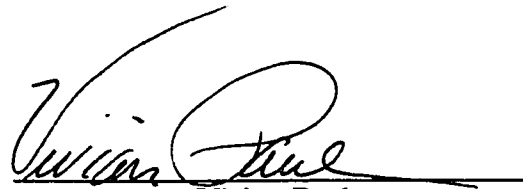
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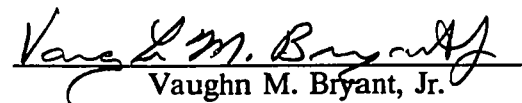
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ABSTRACT

**The Development of a Bottom-Based Shipbuilding Tradition
in Northwestern Europe and the New World. (December 1991)**

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Ship classification based on construction has traditionally divided boats into two major families: shell-built, in which the exterior skin of planking or other material is the primary component, and skeleton-built, in which internal framing is dominant. A large number of vessels, largely flat-bottomed and confined to inland and coastal waters, do not fit neatly into either category. They appear to mix both shell and skeleton concepts, or employ methods that do not seem to be either. These vessels belong in a distinct, third family: bottom-built construction, in which the bottom of the vessel is the primary component.

Most of the excavated, northwestern European vessels of the Roman period, which have been previously identified as members of a native "Celtic" tradition, are bottom-built craft. The distinguishing feature of this tradition is a heavy, flat bottom of straight planks, temporarily fastened together as the first stage of construction. After the bottom has been shaped, the temporary fastenings are replaced by heavy floor timbers and the sides completed.

In the Middle Ages, this tradition produced cogs, the dominant seagoing ships of the twelfth through fourteenth centuries, as well as a variety of related inland craft. Careful examination of an early fifteenth-century cog from the reclaimed land of the Zuiderzee, Almere Wijk 13, reveals details of the construction process and structural thought involved in cog construction. Despite the abandonment of lapstrake planking in favor of carvel in the fifteenth century, Dutch shipwrights continued to build even large seagoing ships in a bottom-based manner and were thus able to take quick advantage of the economic benefits of the new technology. A late sixteenth-century ferry from the Zuiderzee, Oost Flevoland B 71, demonstrates the manner in which bottom-based construction was adapted to carvel construction, as well as the limitations it imposed.

A brief look at shipbuilding traditions in the New World shows that bottom-based concepts were transported to the English colonies, and that native bottom-based methods may have been merged with European skeleton methods to produce hybrid vessels.

v

For Vinnie

It always was

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Protracted research on a graduate assistant's salary is just about impossible, especially when it requires repeated trips to and lengthy stays in foreign lands. For financial support, I would like to thank the International Association for the Exchange of Students for Technical Experience (IAESTE), which sponsored research in the Netherlands during the summers of 1988 and 1989; the South Carolina Institute of Archeology and Anthropology (SCIAA), which financed the recording of the Brown's Ferry vessel in October of 1990; the Institute of Nautical Archaeology (INA) for numerous airplane tickets since 1986; and the Master and Fellows of Magdalene College, Cambridge for a grant to cover research expenses in the Netherlands in March, 1989. The last year of research and writing has been supported by a Dissertation Award from the College of Liberal Arts, Texas A&M University, for which I am most grateful. My family have also kept me solvent (or nearly so) over the last several years, when expenses exceeded incomes, and I especially wish to thank my late grandmother, Lavinia Grady, who covered most of the cost of a year of research at the University of Cambridge.

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Museum, has always been forthcoming with permission to conduct research on and publish wrecks excavated by the Museum. Dr. Reinder Reinders, the former director of the Museum, has been especially supportive over the years. Dr. Caes Paul has graciously provided access to the plan and model collections of the Rijksmuseum Nederlands Scheepvaartmuseum in Amsterdam on several occasions.

In the spring of 1990, I was asked to complete the study of the Brown's Ferry vessel. This project came at the last minute, after the rest of the research for the dissertation was done, but with the willing help of Jon Leader and Harold Fortune, of the Conservation Laboratory of SCIAA, recording of the primary structure was completed in time to include it in this work. The staff of the Underwater Division were also helpful, and I am particularly grateful for the administrative wizardry of Steve Smith - archaeology needs more like him.

Quite a few of my professors and others have offered advice and criticism as I have developed the ideas contained in this volume. At the University of Cambridge, Geoffrey Scammell and Peter Spufford provided useful advice and an introduction to a wider field of view. Patrice Pomey and Lucien Basch offered helpful criticism during the International Symposium on Boat and Ship Archaeology (ISBSA) in 1988, and Béat Arnold participated in much productive and fanciful brainstorming over numerous *bolletjes* of de Koninck. At Texas A&M, Dr. Frederick van Doorninck, Jr. and Dr. George Bass have been both challenging and supportive, and have offered useful career advice along the way. Dr. Vivian Paul provided a break from rotten bits of wood with an invitation to the Narbonne

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TABLE OF CONTENTS

CHAPTER	Page
I INTRODUCTION	1
II THE ROMAN ERA	29
Cultural and Historical Background	29
Watercraft	36
The "Celtic" Tradition	59
III THE EARLY MIDDLE AGES	75
IV THE LATER MIDDLE AGES AND COGS	91
Historical Background	91
Cogs	101
Almere Wijk 13: A Fifteenth-Century Cog	127
V THE LAPSTRAKE-CARVEL TRANSITION AND DUTCH SHIPBUILDING	153
Historical Background	153
The Lapstrake-Carvel Transition.	160
Dutch Carvel Construction	174
Oost Flevoland B 71: A Late Sixteenth-Century <i>Karveel</i>	181
VI EPILOGUE: THE NEW WORLD	220
The Transfer of Culture	220
North American Bottom-Based Watercraft	223
The Brown's Ferry Vessel	227
VII CONCLUSIONS AND PROBLEMS	249
BIBLIOGRAPHY	263
APPENDIX I: A SHORT HISTORY OF THE ZUIDERZEE, THE ZUIDERZEE PROJECT, AND THE MUSEUM VOOR SCHEEPSARCHEOLOGIE	285
APPENDIX II: GLOSSARY	293

VITA	315

LIST OF TABLES

Table	Page
1. Almere Wijk 13 Hull Coefficients	136
2. Oost Flevoland B 71 Hull Coefficients	187

LIST OF FIGURES

Figure	Page
1. Map of Roman Era ship and boat finds in northwestern Europe	42
2. Site plan of the bow area of the Blackfriars excavation .	44
3. Sections of the Blackfriars and Bruges vessels . .	45
4. Schematic section of Zwammerdam barge 2 . . .	52
5. Bottom planking of the Bevaix boat, with plugged, temporary fastening holes indicated	56
6. Ship representations on early medieval coins . . .	85
7. Map of cog finds and related vessels in northern Europe .	105
8. Almere Wijk 13 site during excavation	127
9. Almere Wijk 13 stern area after removal of frames . .	128
10. Almere Wijk 13 stem and hook details, port side . .	137
11. Almere Wijk 13 construction section amidships and at sailbeam	138
12. Almere Wijk 13 caulking detail	140
13. Almere Wijk 13 repair to port strake 7 at rosebolt . .	145
14. Oost Flevoland B 71 after excavation	181
15. Oost Flevoland B 71 being raised from the excavation pit .	182
16. Oost Flevoland B 71 construction section amidships and at sailbeam	191
17. Oost Flevoland B 71 <i>spijkerpennen</i> detail, strakes 2 and 3 .	214

Figure	Page
18. Map of South Carolina, showing the location of Brown's Ferry	228
19. Brown's Ferry Vessel construction section amidships, from aft	233

LIST OF PLANS

Plan	Page
I. Almere Wijk 13 Conventional Hull Lines (to upper, inboard edges of strakes)	131
II. Almere Wijk 13 Planking Lines	132
III. Almere Wijk 13 Longitudinal Construction Section	133
IV. Almere Wijk 13 Exterior Profile	134
V. Almere Wijk 13 Deck and Framing Plan	135
VI. Almere Wijk 13 Planking Expansion	139
VII. Oost Flevoland B 71 Hull Lines (to inside of plank)	186
VIII. Oost Flevoland B 71 Longitudinal Construction Section	188
IX. Oost Flevoland B 71 Exterior Profile	189
X. Oost Flevoland B 71 Deck Plan	190
XI. Oost Flevoland B 71 Planking Expansion	195
XII. Oost Flevoland B 71 Framing Schematic	200
XIII. Brown's Ferry Vessel Preliminary Hull Lines (to inside of plank)	231
XIV. Brown's Ferry Vessel Construction Sketch	232

CHAPTER I

INTRODUCTION

The study of ship remains begins with the recording of seemingly trivial details: the thickness of a plank, the numbers and sizes of nails, the direction of an adze stroke, the color and texture of stains in half-rotten bits of wood. If my brother, who "works for a living," saw one of my timber catalogues, he would be certain that William Proxmire's Golden Fleece award was richly deserved. In fact, some of those details and measurements are trivial. The problem is that you can't tell which ones until long after the recording is finished. Those tool marks and stains, grain patterns and botched repairs, are the voices of the people who owned, built, and sailed the vessels archaeologists excavate and ship specialists study. Their voices can tell us who they were and why they built their boats and ships the way they did. The great temptation in archaeological ship studies is to concentrate on the technical specifics of joinery and assembly sequences and ignore broader social and economic conditions. While the minutiae are vital to the reconstruction of ship remains, a purely technological approach puts shipbuilding in a vacuum, where voices do not carry.

One of the things those voices can tell us is how people of the past thought about the products they made and used (including boats), how they organized their

This dissertation follows the format of the *Nautical Archaeology Series* of monographs published by Texas A&M University Press.

perceptions of the physical world. While it is impossible to know the thoughts of another person, especially one dead for hundreds or thousands of years, I believe that basic patterns or concepts can be recognized in a wide variety of boatbuilding traditions otherwise segregated into discrete regional or chronological units. A better understanding of the conceptual approaches taken by boatbuilders should in turn illuminate not only the relationships between technically similar but culturally or chronologically separate methods of construction, but also specific choices of shape, material, and structure.

Classification, the ordering of non-identical objects on the basis of stylistic or conceptual relationships, is a primary tool of archaeology, from the field to the highest realms of theory and interpretation. Ceramics, shoes, pipes, bottles, almost anything that appears in the archaeological record in sufficient quantity and variety, can be grouped on the basis of observable similarities into typologies and assigned type numbers or similar designations. Temporary typologies are often devised in the field to organize large quantities of objects for which "official" classifications have not yet been produced. These may be nothing more than a simple division into arbitrary groups by size or color, or they may become more complex if based on form or a combination of features. All depend on the observation of distinct physical characteristics and the matching of those items that share a specific group of diagnostic features.

At a higher level, artifacts from a group of sites or from several stratigraphic levels may be grouped for comparison or to develop a chronological series. Such a typology has uses beyond the simple organization of data. It may aid in the

dating of another layer or site, or the interpretation of cultural influence. An examination of the evolution of individual types is a common form of archaeological analysis, and often provides insights into the function of objects and their place in the culture that produced them.

Even this sort of classification must be based on features observed by the archaeologist and thus may be highly arbitrary, with little or no relevance to cultural context. Some archaeologists have suggested that typology should be based on distinctions that would have been important to the original manufacturer and user.¹ Such a grouping would be ideal for interpretation, but it is the result of analysis rather than a tool, and hardly practical at the field level. Furthermore, concepts of similarity and dissimilarity are highly idiosyncratic, so there might not be such a thing as a cultural norm. If archaeologists attempting to impose a completely rational, if subjective, typology on a group of artifacts cannot agree on which criteria are significant and which objects belong together, why should they expect people of the past, who probably did not feel a burning need to order things in their world so minutely, to be any less vague or inconsistent? Still, responsible interpretation of artifacts must involve some analysis of their place in the parent culture, and this in turn depends on how the makers and users viewed their world and the objects in it. In some fashion, the objects reflect and incorporate those views. Even if it is impossible to reconstruct such intangible aspects of culture, their existence should be kept in mind. They make our

¹ I. Rouse, "The Classification of Artifacts in Archaeology," *American Antiquity* 25 (1960): 313-323.

understanding of the past more human, not just a sterile statistical analysis of "scientifically" derived data.

Watercraft, like any other artifact, can be classified in a sometimes bewildering variety of ways. Traditionally, they have been grouped by the type of buoyancy and primary building material.² The first category is normally divided into rafts (which derive buoyancy from the reserve floatation of materials less dense than water), floats (closed, hollow vessels that displace water and support individuals or a working platform above the water), and boats (open, hollow vessels that displace water and carry loads inside the hull). The most common materials before the introduction of iron and steel in the nineteenth century were reeds, skins, bark, and wood, with some use of ceramic pots in certain regions.³ This is a useful, if obvious, grouping, but sometimes too simple. Not all bark boats or wood rafts are the same.

Those interested in the use of watercraft often group vessels by function. Richard Steffy divides watercraft into four major groups: cargo carriers (which includes passenger vessels), warships, fishing craft, and utility craft. The last is a catch-all for a wide variety of special-purpose vessels, such as tugboats, lifeboats, crane barges, etc.⁴ Often, the intended function of a vessel will have considerable influence on its design and construction, but in many periods the lines between

² S. McGrail, *Ancient Boats in NW Europe: The Archaeology of Water Transport to AD 1500*, p. 4.

³ *Ibid.*, pp. 4-7; B. Greenhill, *Archaeology of the Boat: A New Introductory Study*, pp. 91-96.

⁴ J.R. Steffy, pers. comm.

merchant and fishing vessels, cargo and warships are blurred or nonexistent. In addition, smaller craft are often built for a wide range of uses and thus their design can be rather generic. Still, such classification is essential for the understanding of the use of watercraft and the evolution of broadly-defined vessel types.

Since the late eighteenth century, sailing vessels have been identified by rig: ships, barks, brigs, schooners, sloops, cutters, etc. At sea, this was a handy method of identification and rough estimation of size, as sails could be seen at quite a distance, even if the hull was below the horizon ("hull down"). Before then, when there was somewhat less variety in the rig of seagoing vessels, they were distinguished by hull type. Thus Chapman, in his *Architectura Navalis Mercatoria* of 1768,⁵ listed frigates, cats, hoys, galliots, pinnaces, etc. Warships of the same period, and into the mid-nineteenth century, were classified or "rated" by the number of guns carried. In organized construction programs, ship types could also be identified by the design or specifications to which a group of similar vessels were built. In the Royal Navy, vessels were sometimes built to an "Establishment," a group of specifications set down in a certain year, or to a design often named for the first vessel built to it.⁶

Modern warships are still grouped by size and armament or design; thus

⁵ F.H. of Chapman, *Architectura Navalis Mercatoria*.

⁶ B. Lavery, *The Ship of the Line I*, passim. Naval Institute Press, in their *Anatomy of the Ship* series, publish excellent studies of individual Royal Navy classes; each volume is titled for the type vessel, such as B. Lavery, *The 74-Gun Ship Bellona*.

"*Aegis*-class frigate" denotes a moderate-sized vessel armed with guided missiles and a complex electronic fire control system built to a specific design first used for U.S.S. *Aegis*. Since the containerization revolution, merchant vessels are readily identified not only by the type of cargo they carry but also by the way they carry it: oil tankers, break-bulk freighters, RO/RO's (roll on/roll off), containerships, etc. Merchantmen may also be divided into liners and tramps, depending on whether they operate on fixed routes or not.

Anthropologists are sometimes interested in the regional or cultural origins of watercraft. Can a particular vessel type be tied to a distinct cultural group (as cogs are strongly, although not exclusively, related to the Low German-speaking people of northern Germany and the Low Countries), or do different vessel types used by a certain group of people have anything in common that might be a result of a common cultural background? Bronze Age ship studies in the Mediterranean are traditionally based on such classification; one reads of Egyptian shipbuilding, Syro-Canaanite ships, Minoan ships, etc. This is partly due to the nature of the evidence, which is long on text and representation and short on hull remains, but also due to regional specializations in Bronze Age archaeology as a whole. Unfortunately, ships are the ultimate form of portable (and thus transferrable) technology in pre-industrial societies, so shipbuilding methods do not always observe cultural or geographical boundaries.

In northern Europe, a dominant trend in ship archaeology has been the attempt to relate excavated material to vessel types mentioned in historical

sources. This requires not only the classification of hulls, but the reconciliation of classification schemes imposed by archaeologists with the more flexible, imperfectly understood typologies of past cultures. At least one ship archaeologist, Thijs Maarleveld, feels that this approach is pointless, as long as archaeological typologies are too rigid and fail to take into account the contextual variation of historical ship types.⁷ Maarleveld's position is perhaps extreme, but emphasizes the dangers of confusing classification with reality, which is considerably more messy. Essentially, this is another manifestation of the inherent conflict between imposed typology and contemporary perceptions of difference and similarity.

Others interested in the origins of boats may divide them by their roots, which are generally thought to be rafts, bark boats, skin boats, or dugouts.⁸ The origins of boatbuilding are sufficiently obscure and the descendants of different roots sufficiently similar that classification on the basis of origins is often vague at best, except for fairly primitive craft. Not going back as far, Ole Crumlin-Pedersen has identified four archetypes, based on form and construction, from which he believes almost all northern European craft are descended: the round-bottomed clinker vessel (Nordic ships), the flat-bottomed vessel with stem, sternpost, and flush bottom planking (cogs), the flat-bottomed vessel with square ends and vertical sides (punts or barges), and the rockered hull with long, parallel strakes

⁷ T.J. Maarleveld, "Classificeren van schepen. Nut en risico's, theorie en praktijk," in *Bouwtraditie en Scheepstype*, ed. H.R. Reinders, pp. 99-101.

⁸ Greenhill, *Archaeology of the Boat*, pp. 91-153. The roots of boatbuilding are a prominent theme in J. Hornell, *Water Transport*.

but without a true keel (hulks). In different periods, each of these archetypes was developed to become an ocean-going cargo carrier in northern Europe.⁹ The last of these has been discounted somewhat by recent archaeological finds and re-interpretation of the Utrecht vessel,¹⁰ once thought to be a hulk predecessor,¹¹ but otherwise they do identify the dominant shipbuilding traditions of northern Europe before the widespread adoption of carvel construction.

Crumlin-Pedersen's archetypes reflect a common form of classification, based on construction methods. In northern Europe, the dominant class (normally called a "tradition") of the early Middle Ages is clinker construction, a shell-based technique in which overlapping planks are rivetted to each other. Ships of the classical Mediterranean are divided between those which have the planking edge-joined by pegged mortise-and-tenon joints (the majority of excavated hulls) and those which have the planks held together by pegged ligatures.¹² Sometimes construction types are named for the vessels built with them, as in "cog construction" or "carvel-built." These traditions are defined by observed and/or deduced

⁹ O. Crumlin-Pedersen, *From Viking Ships to Hanseatic Cogs*, pp. 6-9.

¹⁰ R. Vlek, *The Mediaeval Utrecht Boat: The History and Evaluation of One of the First Nautical Archaeological Excavations and Reconstructions in The Low Countries*, pp. 139-146.

¹¹ For example, see Greenhill, *Archaeology of the Boat*, p. 285, who is less dogmatic than most.

¹² The latter have only recently emerged as a distinct group with the excavation of several sixth- and fifth-century BC hulls off Italy and a mixed mortise-and-tenon/ligature Ma'agan Michael wreck off Israel. See P. Pomey, "L'épave de Bon-Porté et les bateaux cousus de Méditerranée," *MM* 67 (1981): 225-243; J.P. Rosloff, "Analysis of the Phoenician (?) Shipwreck at Ma'agan Michael, Israel," in *Proceedings of the 1991 Society for Historical Archaeology Conference on Historical and Underwater Archaeology* (in press); M. Bound, "Early Observations on the Construction of the Pre-Classical Wreck at Campese Bay, Island of Giglio: Clues to the Vessel's Nationality," in *Sewn Plank Boats*, eds. S. McGrail and E. Kentley, pp. 49-65.

physical characteristics and are quite similar in use to conventional artifact typologies, with the same advantages and dangers. It is not uncommon for construction traditions to be linked to regional or cultural distinctions; thus Greco-Roman mortise-and-tenon construction, or Nordic shipbuilding, which is virtually synonymous with a particular variety of clinker construction.

To return to the idea of a typology based on distinctions perceived by the original manufacturers and users, is it possible to identify the basic, common concepts behind different styles of construction practiced all over the world? To a certain extent, this is a sort of "psycho-archaeology," which seeks to reconstruct not just the ships and boats, but also the ideas and thought processes that produced them. In truth, this is the goal of much anthropological archaeology, although it is often hidden behind complex jargon and theory. An entire branch of technological history is devoted to the realm of ideas: how they are expressed, how they are exchanged, how they are adopted.

Technology, like art, is the physical expression of an abstract concept. Ships and paintings both begin as ideas that must be realized through the application of tools and materials available to the craftsman or artist. Success or failure depends on the quality of the concept as well as the ability of the conceiver to translate that idea into physical substance, either with his own hands or through the accurate communication of his idea to other, more skilled hands. The major difference between the two is which end of the process is considered more important. The shipwright is judged more by the physical qualities of his product and his craftsmanship, while the artist is praised for the idea, not just the clarity

with which he expresses it.

The same idea can be expressed in many different ways. Artists separated by media and millennia are often very close in spirit - compare the lion hunting reliefs of Assyria to some of Fredric Remington's action-filled western scenes, or a Roman mortise-and-tenon joined hull to a fiberglass hull. While there is no limit to imagination and the generation of new ideas, the range of expression is somewhat limited, or at least guided, in each case by the available materials and techniques, by the cultural background of the craftsman or artist, as much as by conscious choice. Welded steel, commonly used in both sculpture and shipbuilding today, opens possibilities to sculptors and shipwrights inconceivable before the nineteenth century. Cultural background provides the artisan with an established set of conventions for expressing ideas. Classical and biblical allegory was a popular genre in Renaissance art, because a wide range of themes and emotions could be communicated through the stories and characters with which any educated observer should have been familiar. The meaning or "message" of such paintings is less accessible to us today, as we are not as readily familiar with the symbology, the "vocabulary," of Renaissance culture. Technologically, the cultural background might be thought of as tradition, the conventional methods for building things. When new ideas develop, their application may be limited by the lack of new forms of expression, the tendency to think of new ideas in old, traditional terms.¹³ Northern Europeans were exposed to carvel-built Mediterra-

¹³ N. Rosenberg, "Factors Affecting the Diffusion of Technology," *Explorations in Economic History* 10 (1972): 6.

nean vessels for nearly two hundred years before they adopted the technology, but even then, the new idea was expressed in traditional terms by the first shipbuilders north of the Channel to embrace it, the Dutch.¹⁴

It is also possible for divergent ideas to find similar expression. Often this is a result of the limiting or levelling nature of cultural background and technology. Where the range of expression has been pared down to a relatively small number of conventions, as in medieval art, it is hardly surprising that concepts converge and overlap. Disagreements over the interpretation of works of art, even among experts, are the modern result. The same is true of shipbuilding. Because the materials and tools of shipbuilding, as well as the basic requirements of shipping, changed little between the Bronze Age and the Industrial Revolution, boats from different periods and regions often bear more than superficial resemblance to each other. In the finished product, there is very little to distinguish a Gallo-Roman vessel such as the Blackfriars ship from a modern carvel-built vessel, even though the two are built on vastly different principles.

Ship scholars have, for many years now, observed a conceptual difference which divides boats and ships into two major families, conventionally called "shell" and "skeleton" construction.¹⁵ While not all agree on exactly how the difference should be defined, there is a general intuitive appreciation that in some vessels,

¹⁴ See Chapter V.

¹⁵ These terms and the conceptual basis for them were coined by O. Hasslöf, "Wrecks, Archives and Living Tradition: Topical Problems in Marine-Historical Research," *MM* 49 (1963): 163-164.

the exterior planking (shell) is of primary importance, in others the internal framework (skeleton) dominates. As I propose a revision of this division, some discussion of its history and definition is in order.

For centuries the maritime tradesmen of northern Europe have been aware of a difference between the lapstrake (or clinker)¹⁶ craft of Scandinavia (as well as other parts of the north) and the smooth-skinned (or carvel) vessels of the rest of Europe. The difference was immediately apparent to the eye but represented more than variations in surface texture or planking methods. The two types of construction were based on assembly techniques that were the reverse of each other. Clinker ships and boats were built by laying up the planking first and inserting the frames afterwards, while carvel ships had their planks bent around and fastened directly to pre-erected frames. The clinker/carvel distinction became the basis for both a conceptual and a practical division of watercraft; already in the sixteenth century, barely a hundred years after carvel construction had been introduced to the North, it was considered a lower, less prestigious form of shipbuilding in the Low Countries. Indeed, guild regulations sometimes indicate that it was the only type of shipbuilding work available to non-guildmembers.¹⁷

James Hornell, whose wide-ranging work on water transport is the basis for

¹⁶ Strictly interpreted, "clinker" only refers to overlapped planks joined with "clinker" (derived from the same root as "clenched") nails, which are essentially rivets, nails driven through both planks and headed or peened over a rove or burr. Other fastenings may be used to accomplish the same task: double-clenched (sometimes called "twice-bent") nails and wooden pegs have both been used in northern Europe. "Lapstrake" is a more generic term, which denotes only overlapped planking, however it is fastened, or even if it is not fastened together at all.

¹⁷ The early sixteenth-century guild regulations of Veere and Arnemuiden both make such provisions; R.W. Unger, *Dutch Shipbuilding before 1800: Ships and Guilds*, pp. 124, 131.

much of the later development of ship studies and maritime ethnology, was quite aware of the clinker/carvel distinction and explained it in detail.¹⁸ He identified the diagnostic features of carvel construction that differentiated it from clinker building, with an emphasis on the assembly sequence and the arrangement of planks (either edge-to-edge or overlapping). While he sometimes related boatbuilding techniques from other parts of the world to these two European methods, he did not apply the distinction generally.

Since the divide was so clear in northern Europe and shipbuilding methods elsewhere in the West more homogeneous, it is not surprising that a general shell/skeleton distinction was first postulated by a Scandinavian ethnologist, Olof Hasslöf. In 1963 he described conceptual differences between the two approaches, gave them the names still in use, and related them to the old clinker/carvel distinction.¹⁹ More importantly, he suggested that these concepts had wider application and might prove a useful tool for the study of watercraft from other cultures.²⁰ In short, he defined two distinctly different, but potentially universal, ways of thinking about boats: either as a "watertight shell" or a "waterproofed

¹⁸ Hornell, *Water Transport*, pp. 189, 193-94.

¹⁹ Hasslöf, *MM* 49 (1963): 163-4. Note that the 1988 International Symposium on Boat and Ship Archaeology in Amsterdam had as its theme "The Transition from Clinker to Carvel." These terms are still widely used in northern Europe, while scholars working on Mediterranean material are more consistent in their use of "shell" and "skeleton."

²⁰ Ibid. and O. Hasslöf, "Main Principles in the Technology of Ship-Building," in *Ships and Shipyards, Sailors and Fishermen: Introduction to Maritime Ethnology*, eds. O. Hasslöf, H. Henningsen, and A. E. Christensen, pp. 27-60.

frame."²¹

Hasslöf based his classification on one aspect of the expression of this idea, the sequence of construction. In general, this has been the direction followed by other scholars and has led to the common use of the terms "shell-first" and "frame-first." The discovery of well-preserved, ancient hull remains on the bottom of the Mediterranean and the observation that these must have been built shell-first led to the application of Hasslöf's ideas to ancient Mediterranean ships.²² In 1972, Lucien Basch addressed the shell/skeleton divide and its relevance to Mediterranean shipbuilding.²³ He added a corollary to the basic idea in the form of a classification of frames by function. In a shell hull, the frames perform a secondary, supporting role and are thus "passive." In a skeleton hull, the frames determine the shape of the hull, so they are "active."²⁴ The stress on the importance of the shell or skeleton in determining the shape of the hull has remained a primary aspect of the shell/skeleton distinction. Basch also noted some dangers posed by an oversimplified division and attempted to set some standards by which a true shell hull could be identified. While Basch's article set the tone for a trend in which the emphasis was on the observable characteristics of shell

²¹ McGrail, *Ancient Boats in NW Europe*, p. 5.

²² The Nemi barges of the first century AD provided the first clear indication to scholars that ancient Mediterranean hulls were extensively edge-joined, although earlier finds had suggested the possibility; G. Ucelli, *Le Navi di Nemi*. See also L. Casson, *Ships and Seamanship in the Ancient World*, pp. 201-216 and L. Basch, "Ancient Wrecks and the Archaeology of Ships," *IJNA* 1 (1972): 12-14.

²³ Basch, *IJNA* 1 (1972): 1-48.

²⁴ *Ibid.*, pp. 15-16.

construction, he was clearly aware of the conceptual origins of those characteristics and how technical limitations might obscure them.²⁵

Basil Greenhill was the first to break with the emphasis on sequence of construction. In 1976 he accepted the shell/skeleton division, but was adamant that the fundamental distinguishing feature was not the order of assembly but whether or not the exterior planking was edge-joined and was thus an integrated shell.²⁶ He did note that shell-built hulls were normally assembled shell-first, but that it was also possible to build a non-edge-joined hull in the same order.²⁷ Hasslöf had observed the same thing, but considered it a special case.²⁸ In general, Greenhill was interested less in design than in structural thought. His idea has the advantage that while it is not always possible to determine construction sequence, it is possible to tell if the planks are joined to each other.²⁹

The general emphasis on construction sequence and the knowledge that later Mediterranean hulls were built frame-first led naturally to an interest in the transition from shell to skeleton construction. The fundamental aspects of this transition were largely defined by the remains of a seventh-century hull excavated at Yassiada, Turkey in the early 1960s. This ship, the first sea-going Mediterra-

²⁵ Ibid., pp. 23-9, 34-5.

²⁶ Greenhill, *Archaeology of the Boat*, pp. 60-3.

²⁷ Ibid., pp. 65-6.

²⁸ Hasslöf, *MM* 49 (1963): 166 and supra n. 20, pp. 51-53. The example he cited was a Zuiderzee yawl built shell-first by temporarily fastening the planks together with short cleats nailed over the seams until frames were inserted. See Chapter V, below.

²⁹ Greenhill, *Archaeology of the Boat*, p. 66.

nean hull to be studied and reconstructed systematically,³⁰ was built in a mixture of shell and skeleton methods.³¹ Since then, there has often been an emphasis on finding the "first" skeleton-first hull, with claims for the eleventh century AD,³² seventh century AD,³³ fourth or fifth century AD,³⁴ and third century AD.³⁵ As Richard Steffy's work on the Serçe Limanı hull has shown, even that eleventh-century vessel was only partially built frame-first.³⁶ His emphasis on understanding the nature of and reasons for the transition is the more fruitful avenue of research.

The complexity of the shell/skeleton transition in the Mediterranean reflects

³⁰ The hull remains of the Grand Congloué shipwreck(s) formed the basis of a general study of ancient Mediterranean shipbuilding published by Fernand Benoit in 1961 (*Fouilles sous-marines: L'épave du Grand Congloué*), but of the hulls he discussed, only the Nemi barges had been recorded in detail and studied critically (Ucelli, *Le Navi di Nemi*). Van Doorninck's careful recording of the Yassıada hull remains, fragment by fragment, and subsequent reconstruction work marks the beginning of systematic hull research as an integral part of Mediterranean nautical archaeology. F.H. van Doorninck, Jr., "The Seventh-Century Byzantine Shipwreck at Yassı Ada: Some Contributions to the History of Naval Architecture" (Ph.D. diss., University of Pennsylvania, 1967) and "The Hull Remains," in *Yassı Ada I: A Seventh-Century Byzantine Shipwreck*, G.F. Bass and F.H. van Doorninck, pp. 32-64.

³¹ Van Doorninck, "The Hull Remains," and J.R. Steffy, "Reconstructing the Hull," in Bass and van Doorninck, *supra* n. 30, pp. 65-86.

³² J.R. Steffy, "The Reconstruction of the 11th Century Serçe Liman Vessel: A Preliminary Report," *IJNA* 11 (1982): 26-34.

³³ M.-P. Jezegou, "Éléments de construction sur couples observés sur une épave du haut Moyen-Age découverte à Fos-sur-mer (Bouches-du-Rhône)," *VI Congreso Internacional de Arqueología Submarina, Cartagena 1982*, pp. 355-356.

³⁴ F.H. van Doorninck, Jr., "The 4th Century Wreck at Yassı Ada. An Interim Report on the Hull," *IJNA* 5 (1976): 126-127; van Doorninck notes that the entire hull is not shell-first, but that the midship half-frame may have been erected after only three strakes had been laid up.

³⁵ J.-M. Gassend and J.-P. Cuomo, "Un acquis récent des recherches d'architecture navale: La 'construction alternée' des navires antiques," *VI Congreso Internacional de Arqueología Submarina, Cartagena 1982*, pp. 343-350.

³⁶ Steffy, *IJNA* 11 (1982): 32-33.

the basic complexity of the division itself. Oversimplification obscures several important aspects of the transition from shell to skeleton, both in the Mediterranean and elsewhere in the world. The basic division is quite useful, as it distinguishes between two fundamentally different ways of thinking about boatbuilding, but there is more than one facet to the conceptual side of the process. I believe that shipbuilding can be divided into three main areas: design, assembly sequence, and structural philosophy.³⁷ The first and second are self-explanatory, but the last requires clarification. Structural philosophy is the way in which the shipwright intends the component timbers of the hull to distribute the different working stresses his vessel can be expected to encounter. For example, he may choose thick, edge-joined planking with light internal reinforcement, thus relying on the shell for the majority of the vessel's strength. Or he may build a heavily-framed hull with light, non-edge-joined planking and so depend more on the skeleton. Few plank-built hulls rely entirely on shell or skeleton,³⁸ but instead the two complement each other in an integrated system. Even in modern carvel-built hulls with relatively light planking, an important amount of strength and stiffness resides in the skin.

³⁷ Sean McGrail noted that the "shell sequence" or "skeleton sequence" determined three important characteristics of the craft produced: how the shape was obtained, where the structural strength lay, and how the vessel was made watertight. Still, McGrail is not considering a broad shell or skeleton concept, but concentrating on the order of assembly, on the assumption that all else follows from this choice; *The Ship: Rafts, Boats and Ships From Prehistoric Times to the Medieval Era*, p. 43.

³⁸ The exception usually cited is the Middle Kingdom Egyptian boats from Dashur: they appear to have had no frames and no structural timbers other than planking, tenons, and beams. See C.W. Haldane, "The Dashur Boats" (M.A. thesis, Texas A&M University, 1984).

While design at its most basic level is neither shell- nor skeleton-based (hull form, while sometimes limited by construction methods, is essentially an abstract thing), in practice it is closely tied to the sequence of assembly. The shape of a shell-first hull is determined by the planks, but a frame-first hull requires, by definition, that the skeleton be designed before it is erected. In transitional hulls, where bits of shell alternate with bits of skeleton in the construction sequence, the design may follow in similar fashion. Even in largely frame-first hulls, planking (or battens, a lightweight substitute for planking) is often used to determine the shapes of frames between the pre-erected frames and in awkward areas, such as the extreme bow and stern. The eleventh-century Serçe Limanı ship is normally considered the first "skeleton-first" seagoing ship from the Mediterranean, since there is no evidence of edge-joinery in the planking and good evidence for the pre-erection of at least some frames amidships,³⁹ but the shapes of frames fore and aft of the central ten frames (and possibly some of those ten) were determined by several key strakes hung early in the construction process.⁴⁰

Even though design and building sequence are normally rather closely related, there are exceptions - it is possible to build a hull shell-first over a set of pre-erected temporary frames, called moulds - but structural philosophy is not necessarily tied to the other two aspects of the concept. It is possible for a hull

³⁹ Steffy, *JNA* 11 (1982): 32-33.

⁴⁰ Ibid. and J.R. Steffy, "The Mediterranean Shell to Skeleton Transition: A Northwest European Parallel?" *Proceedings of the Fifth International Symposium on Boat and Ship Archaeology, Amsterdam 1988* (in press), n.p.

to be built shell-first, yet rely on the frames for much or most of its strength. Later Greco-Roman hulls were edge-joined, but the small, loose, widely-spaced mortise-and-tenon joints had ceased to offer much strength to the hull, while frames had grown heavier and more closely spaced. It is less likely for a hull to be built frame-first but rely on the shell for strength, as pre-erected frames get in the way of efficient edge-joinery, but the above-mentioned example of a shell built over moulds could be interpreted as a form of this combination. There is also the example of the fourth- or fifth-century ship at Yassiada, which was edge-joined (if only with small, loosely fitted mortise-and-tenon joints) but may have had a central master frame erected shortly after planking began.

One of the reasons the distinction was first made in northern Europe is the clear-cut difference between Nordic clinker vessels, which are shell-built in all three aspects, and other European vessels, which have been largely skeletal for the last two centuries or so. It is in some ways unfortunate that the division was applied with such vigor to other areas and other traditions. Some types of shipbuilding do not fit into this classification without coercion, and forcing them into one group or the other hinders rather than helps interpretation. As an alternative, most of the transitional hulls from the Mediterranean have been classified as "mixed", partly due to the jumbling of structure with construction sequence, but also because they do indeed represent a mixture of shell and skeleton ideas.⁴¹

⁴¹ *"La construction mixte"* is a phrase found in many French studies of late Roman and early medieval ships and shipbuilding.

Both Basch and Greenhill have noted that a significant number of vessels, including central and northern European craft, stand at least partly outside the shell/skeleton system. These vessels, mostly confined to inland waters, are characterized by flat bottoms often constructed differently than the sides.⁴² Basch observes that "The very form of these ships imposes a peculiar method of construction, at least in the early stages. It derives neither from the 'shell' nor the 'skeleton' technique."⁴³ This "peculiar" system consists of laying up the bottom planks on trestling of some sort and then fastening them together with heavy "beams" (he is reluctant to call them floor timbers).⁴⁴ He believes that the initial construction of flat-bottomed boats is "common of *necessity*"⁴⁵ (his emphasis), but that the flat form may derive from any of several sources. Among archaeological remains, Basch identifies the Blackfriars vessel as "typical of keel-less, flat bottomed boats that are neither 'skeleton' nor 'shell' technique,"⁴⁶ and observes that some Zuiderzee vessels of the seventeenth to nineteenth centuries have similar framing.⁴⁷

Greenhill describes a technique from the Peshawar Valley of Pakistan in

⁴² Basch, *IJNA* 1 (1972): 17-18; Greenhill, *Archaeology of the Boat*, pp. 68-70.

⁴³ Basch, *IJNA* 1 (1982): 17.

⁴⁴ *Ibid.*, p. 18. He cites examples from the Vistula, Adriatic, Danube, and Portuguese coast.

⁴⁵ *Ibid.*

⁴⁶ *Ibid.*, p. 41. He also notes that the bottom planks of some vessels, such as seventeenth-century Dutch ships and some modern Vietnamese boats, are set up before the frames.

⁴⁷ *Ibid.*, p. 43. The evidence he cites was reported by G.D.H. van der Heide, "Archeological Investigations on New Land. The Excavation of Wrecked Ships in the Zuyder Zee Territory," *Antiquity and Survival* 3 (1955): 243-250.

which the floor timbers are set upside-down on trestling and the keel and bottom planks nailed directly to them. After the bottom is trimmed to shape, it is turned right-side-up and the posts and futtocks added. The remaining planks are then bent around and nailed to the futtocks. Greenhill believes that a similar method may have been used in the flat-bottomed boats of northwestern Europe, such as those found at Blackfriars, Zwammerdam, Bevaix, Yverdon, and in the Zuider-zee.⁴⁸

Other scholars have also considered flat-bottomed boats as a separate class, but typically they consider such craft either irrelevant to the more important shell/skeleton question, or see them as a special type of mixed construction. With a bit of pressure, the boats described by Basch could be seen as a non-edge-joined type of shell-first building. The Peshawar Valley boats could as easily be interpreted as a two-stage variation on skeletal construction.

I believe Basch is on the right track, that there is a group of (mostly) flat-bottomed boats that stand outside the shell/skeleton conceptual divide, but not that they are a special case or secondary group, or that they are limited to strictly flat-bottomed vessels. Instead, I believe they are the products of a separate and distinct concept, a different way of thinking about boatbuilding. The essential idea in this alternate philosophy is the choice of the bottom of the hull, rather than the shell or skeleton, as the principal component. In its purest form, the bottom would determine the shape of the hull, be the first element assembled, and be of

⁴⁸ Greenhill, *Archaeology of the Boat*, pp. 68-70.

distinctly different construction than the sides. As with the shell and skeleton families, partial or hybrid forms should also exist, in which the bottom dominates only in certain aspects, such as design or assembly sequence. In line with the other two philosophies, I propose that vessels in the new, third group should be called "bottom-built" or "bottom-based."⁴⁹ Bottom-built vessels often incorporate features that could be interpreted as "shell" or "skeleton" in origin, but there is a consistent approach to the mixture that indicates a clearly defined and independent concept, rather than an arbitrary combination of attributes. In addition to watertight shells and waterproofed frames, there are also bottoms with raised sides.

As with shell and skeleton concepts, bottom-based design and construction can be expressed in many ways, but several features are more or less common to bottom-built vessels, and others may be clear indications of a bottom-based concept. It is most often, but not exclusively, expressed in flat-bottomed vessels. The connection here is logical, although not necessarily inescapable. Flat bottoms, by their nature, often meet the sides in a hard bilge or chine. The abrupt transition strongly suggests, if not requires, a structural difference between bottom and side. The concept may be expressed in vessels that are not strictly flat-bottomed, but have keels, softer bilges, and deadrise; such hulls are usually the

⁴⁹ The choice of names was the subject of a long and often fanciful conversation with B  at Arnold in a tavern in Amsterdam in September of 1988. "Bottom-built" was eventually chosen for simplicity, parallelism with shell- and skeleton-built, and the relative ease and accuracy with which it can be translated into French (*construction sur fond*) and German (*bodengebaur*). I thank M. Arnold for his advice, creativity, and half the de Koninck.

descendants of flat-bottomed ancestors.

Flat bottoms may not always be bottom-built. The bottom may indeed be a separate structure, but not the primary element of construction. Numerous types, such as a large family of North American small craft described as "flatties" or "sharpies", are based on sides with chine timbers.⁵⁰ In these craft, the sides determine the overall shape of the hull and are the primary structural element. The bottom is a skin of transverse planks nailed onto the chines and lower edges of the sides late in the process of construction. Similar craft are built today on the upper Danube.⁵¹ Greenhill describes a flat-bottomed type from the Pakistan Indus in which bottom and sides are constructed concurrently but separately, then joined.⁵² Should these be called "side-built?" I think I will leave that for someone else's dissertation.

The concept is expressed in construction as well as form. Flat bottoms are easily built as a separate unit, independent of posts and sides. In many cases, the bottom may be built in an entirely different manner than the sides, both in terms of structural philosophy and in construction sequence. The sequence described by Basch, in which the bottom planks are laid up on trestling of some sort and then fastened together by heavy "beams," floors, or cleats, is common among the

⁵⁰ Greenhill, *Archaeology of the Boat*, pp. 34-37; H.I. Chapelle, "The Migrations of an American Boat Type," in *Contributions from the Museum of History and Technology*, pp. 133-154. See also H.I. Chapelle, *American Small Sailing Craft: Their Design, Development, and Construction*, pp. 100-133.

⁵¹ J. Sarrazin, pers. comm.

⁵² Greenhill, *Archaeology of the Boat*, pp. 67-68 and Figs. 22-23.

bottom-built boats of Europe. In many cases, the bottom planks are temporarily fastened together until permanent framing is added. The bottom planks themselves may be heavier than the rest of the planking, especially in the absence of a keel, although bottom-based construction is not incompatible with keels or keelplanks. In contrast to the unusual assembly of the bottom, the sides of bottom-built vessels are normally constructed in the tradition prevailing among non-bottom-built vessels of the area. Thus medieval northern European bottom-built vessels normally had lapstrake sides, but these were replaced by carvel sides in the Renaissance.

Bottom-based design may be more difficult to detect, although "bottom-first" construction does imply it to a certain degree. With a completely flat bottom, overall hull shape is primarily determined by bottom shape. In many flat-bottomed boats, the bottom is built as a panel from straight planks. After temporary assembly of the panel, a "boat-shaped" bottom is cut out of it, sometimes with little regard for the exact orientation of the planks.

The geographical range of bottom-built craft is as great as that of shell- and skeleton-built vessels, which is to say worldwide. Flat-bottomed vessels, many if not most of which are bottom-based, are found on all inhabited continents, either as the result of independent development or diffusion. The vast majority of these are found on inland waters. This is hardly surprising, as flat bottoms offer certain advantages in such conditions, but are poorly suited to the open sea.

Flat bottoms have an advantage in capacity where beam and draft are limited (as in shallow waters or narrow canals and locks); even seagoing vessels

with otherwise "round" bottoms but a need for large capacity or displacement often have a narrow to moderate flat section either side of the keel. Flat bottoms also work well where vessels must take the ground to load and unload.⁵³ On the other hand, a flat bottom wide and long enough to offer a significant advantage in capacity leads to performance problems in open water. Such vessels pound badly in a chop, which is hard on both vessel and contents, and suffer stability problems at extreme angles of heel. Stability may also be adversely affected by the free surface effect of bilge water, which is exaggerated in flat-bottomed hulls.⁵⁴ The absence of a keel may reduce directional stability in vessels with low length-to-beam ratios. A commonly-cited fault of flat bottoms, that they do little to resist leeway and thus make poor sailers, is not caused so much by hull shape, but by the shallow draft of most such craft. Less draft means less lateral area. The slab sides of many flat-bottomed vessels should resist leeway quite effectively if sufficiently immersed, but devices such as centerboards and leeboards are often added to improve weatherliness and other sailing qualities.

A wide, flat bottom requires a hard bilge, or even a chine between bottom and side. This is no handicap in calm water, but stress is concentrated at abrupt transitions in shape or structure. In the harsh conditions of the open sea, where all vessels flex, twist, and "work" under the changing forces of wind and wave, hard

⁵³ For example, the barges of the Thames and Medway; E.J. March, *Spritsail Barges of the Thames and Medway*.

⁵⁴ J. Coates, "Safe Carrying Capacity of the Hypothetical Reconstruction," in *The Brigg "Raft" and Her Prehistoric Environment*, ed. S. McGrail, pp. 263-5.

bilges are prone to leakage and require extra reinforcement to prevent broken frames. Where flat bottoms have gone to sea, they have tended not to be as wide as those on inland craft, and some effort has been made to soften the bilge.

In the following pages, I would like to examine the bottom-based concept as it developed in a particular region. A large number of vessels which fit into this philosophy have been excavated in northwestern Europe. Mostly flat-bottomed and from inland waters, many of them have been grouped together as much because of their difference from the clinker craft of Scandinavia and Britain as because of some general similarities in construction.⁵⁵ Besides sharing specific features of joinery, fastening, caulking, etc., the vessels display a clear relationship in both concept and expression, and descendants of the medieval varieties are still in use in Europe and areas settled by Europeans.

A few terms need to be defined before going on. I have concentrated on a particular geographic region generally identified as northwestern Europe. This includes western Germany, the Low Countries, northern France, and the British Isles, but not Scandinavia. Northern Europe includes Scandinavia with the northwest. "Germany" also presents some geographic problems. Medieval north Germany is sometimes understood to encompass the entire Low German-speaking area from Flanders to Livonia (modern Estonia). The inclusion of the Baltic coast is quite reasonable, in light of heavy German colonization of the region from the

⁵⁵ As Martin de Weerd asks in his typically elliptical manner, "Type consistency by sharing absent characteristics?" M.D. de Weerd, "Ships of the Roman Period at Zwammerdam/Nigrum Pullum, Germania Inferior," in *Roman Shipping and Trade: Britain and the Rhine Provinces*, eds. J. duP. Taylor and H. Cleere, p. 20.

twelfth century on, but the inclusion of the Low Countries may be jarring to the modern mind. In fact, the distinction between German and Dutch is relatively recent; the medieval line was drawn between Germany and Holland, which is only the western part of the modern Netherlands. Even then, the distinction was more political and economic than ethnic. Many of the towns of what is now the eastern Netherlands (in the provinces of Groningen, Overijssel, and Gelderland) were members of the Hanse and thus considered German. In the interest of clarity and convenience, "the Netherlands" and "Dutch" refer either to the modern country or the area occupied by it, with specific counties/provinces indicated where necessary or possible. "Germany" must, unfortunately remain a fairly nebulous term, as it still is - does Germany stop at the Oder, or should it continue into Poland, where large numbers of ethnic Germans lived until forcibly relocated after World War II? Indeed, most national terms such as "France" or "Spain" are only well-defined in modern times. Prior to the nineteenth century, most of Europe was a patchwork of smaller, semi-autonomous principalities under greater or lesser central control. The exception is England, a cohesive, relatively unified state from before the Norman conquest.

Shipbuilding terminology often seems mystifying, if not downright silly, to those from other backgrounds. Must it be called a treenail, when it is really just a peg? Why sided and moulded instead of the more straightforward wide and thick? Why ceiling instead of interior planking? The answer is actually rather lame: because those are the names of things. Unfortunately, nautical terms are not even regionally consistent, much less standardized throughout the English-

speaking world. An alternative might be a standardized, neutral set of descriptive terms, such as those proposed by Eric McKee,⁵⁶ but this is too cumbersome for easy use. I have relied on the (New England) terminology I learned as an apprentice shipwright, but this is usually in agreement with traditional published references, such as Falconer's eighteenth-century dictionary of nautical and shipbuilding terms.⁵⁷ To save trips to the dictionary, a glossary of nautical terms is included here as Appendix II. A greater problem is posed by foreign (mostly Dutch) names for timbers peculiar to foreign shipbuilding traditions. I have attempted to supply functional English equivalents, but sometimes there are none, so literal translations or made-up words have been the only alternative, although descriptions are also provided.

⁵⁶ J.E.G. McKee, "A Glossary of Boat Archaeology Terms," in *Sources and Techniques in Boat Archaeology*, ed. S. McGrail, pp. 9-13. This was a very general approach to the problem, but does not seem to have borne fruit before McKee's untimely death.

⁵⁷ W. Falconer, *An Universal Dictionary of the Marine*.

CHAPTER II

THE ROMAN ERA

Cultural and Historical Background

With the extension of Roman control to the North Sea and Britain in the first centuries BC and AD came drastic changes to the economic structure of northwestern Europe and a significant increase in the demand for water transport. Before the Romans, the area was home to a large number of tribal groups subsisting on a mixture of agriculture, herding, and hunting, with agriculture less common among the tribes of northern Britain and east of the Rhine. Those tribes to the west, more or less in modern-day France and Belgium, were called Gauls by their Roman conquerors. Like the Britons (the inhabitants of southern Britain), the Helvetiae (the people of Switzerland), and the inhabitants of much of southern Germany, the Gauls are today generally identified as Celts. Many of these tribes were socially quite advanced, coining money and trading for luxuries, especially wine, from the Roman Mediterranean.

Caesar, as governor of Gallia Cisalpina and Illyricum (northwestern Italy), began his famous conquest of northern Gaul in 58 BC. Within eight years he had extended Roman control to the North Sea and begun the slower process of establishing Roman administration in the conquered lands. His acquisitions were constituted as three provinces, known as the Three Gauls, by Augustus in 27 BC: Gallia Lugdunensis (central and northwestern France), Aquitania (western

France), and Gallia Belgica (Belgium, northeastern France, and the lands along the west bank of the Rhine). Lugdunum (Lyon) was chosen as the central administrative center for the Three Gauls, partly because of its location on the Rhône, the primary route of communication and transport from the Mediterranean northward.

The spread of Roman culture was encouraged by the founding of colonies, towns of transplanted Roman citizens. Many of the citizens were, in fact, army veterans, who not only provided an example to the locals of the advantages of Roman citizenship, but were also capable of playing a defensive role. Gallia Narbonensis (southern France) and the Spanish provinces were the oldest and most Romanized of the territories outside Italy, but the combination of military force and political and economic incentives succeeded in creating a strong Gallo-Roman (or Gallic) culture in much of the Three Gauls.

Caesar continued across the Channel to Britain in 55 and 54 BC, but did not establish a permanent foothold on the island. After another century and the pacification of Gaul, Claudius was able to launch an assault in AD 43. Claudius's campaign began a gradual process of subjugation of the British tribes, but Rome never conquered the entire island. Successful campaigns in Scotland in the mid-first century (under Agricola¹) and the early third century (under the emperor Septimius Severus) were both closely followed by the abandonment of Scottish acquisitions. Frequent depredations and barbarian assaults prevented Roman

¹ The subject of a well-known biography by his son-in-law, Tacitus.

armies from establishing stable frontiers until well into the second century. Revolts within the area of nominal Roman control, such as that of the Iceni under their queen Boudicca during Nero's reign, were also a problem. Eventually, just as some semblance of stability had been achieved, the southern and eastern coasts began to suffer the attacks of Germanic raiders from the base of the Danish peninsula. Roman armies and fleets managed to keep the invaders at bay, and even after the withdrawal of Roman forces early in the fifth century, the Romanized natives scored some victories; however, by the sixth century, the Angles, Saxons, and Jutes were firmly planted on British shores and wasted little time in wiping out most vestiges of Roman society.

The Romans considered the tribes of the dense woodlands to the east of the Rhine culturally distinct from the Gauls and called them Germans, although those east of the Upper Rhine were more Celtic until Germanic incursions late in the pre-Roman period. The Germans were less socially advanced and even fiercer fighters than the Gauls, but they shared many cultural similarities. While Gaul was completely subjugated and a significant portion of Britain was eventually brought under Roman control, the German frontier was never completely pacified. Originally, the west bank of the Rhine had marked the effective border of Gallia Belgica as well as the cultural boundary between Gauls and Germans, at least in Roman eyes. In reality, Celts had crossed the Upper Rhine and begun to settle the Black Forest in the first century BC. In contrast, the inhabitants of Belgica were the least Celtic of the Gauls, with strong Germanic influence. While the Gauls had been relatively amenable to the imposition of Roman authority, the

Germans were less sophisticated culturally (and thus more difficult to convert to the town-based society of a province) and more warlike, as well as more effective military opponents. They posed an appreciable threat to the new provinces west of the Rhine. This threat was met by a series of offensives between 25 BC and AD 9, as Roman forces attempted to take imperial authority farther east and establish a secure frontier on the northeastern edge of the Empire. Several of these offensives penetrated quite deeply into Germany: Drusus reached the Weser in 11 BC, and the Elbe two years later. Forts were established on the far side of the Rhine and an attempt made to consolidate gains, but Roman forces were unable to hold the new territory for long. The annihilation of three legions under Quintilius Varus in AD 9 marked the end of serious Roman efforts to conquer Germany until an unsuccessful expedition under Domitian, and the legions retreated to the Middle and Upper Rhine.

Following the campaigns of Drusus, Rome claimed a substantial territory as the province of Germania, although a clear border was not established. With the defeat of Varus and the retreat to the Rhine, this province ceased to exist. The area continued to be heavily militarized and was the site of punitive campaigns against the German tribes of the area, as well as the scene of a number of ugly mutinies and rebellions. Under Domitian, the Rhineland was formally constituted as a pair of provinces carved out of Gallia Belgica: Germania Inferior (Lower Germany, a strip along the Lower Rhine with a bulge into Flanders) with its capital at Colonia Claudia Ara Agrippinensium (Cologne) and Germania Superior (Upper Germany, the upper Rhineland, Helvetia, and modern Alsace and

Lorraine) with its capital at Mogontiacum (Mainz). These two provinces were effectively separated by the southern end of Belgica, the land around Augusta Treverorum (Trier).

The two Germanies were heavily garrisoned, with up to ten legions at times, but the principal threat came along the Lower Rhine. This was countered both by the offensives and punitive expeditions of the first century, but also by the establishment of client states, such as that of the Frisii at the mouth of the Rhine. This state did not remain loyal for long, and eventually the northern end of the frontier was protected by a series of permanent legionary fortresses and other defensive works running down the river to the coast. Beginning in the 90s AD, many of these were rebuilt in stone. Defense was also provided by regular patrols along the river, with a fleet, the *Classis Germanica*, headquartered at Colonia Agrippina and supplemented by boats attached to army units.² From Mogontiacum south, where Roman conquest in the 70s and 80s had been assisted by the migration of Celtic Gauls back into the Black Forest, the frontier lay east of the river. After Domitian's campaigns of 83-5, a formal land frontier, the *limes*, was set up with earthworks and guard towers. The German *limes* was pushed further east and extended in the second century to meet up with the Raetian *limes* north of the Danube.

² O. Höckmann, "Römische Schiffsverbände auf dem Ober- und Mittelrhein und die Verteidigung der Rheingrenze in der Spätantike," *Jahrbuch des Römisch-Germanischen Zentralmuseums Mainz* 33 (1986): 369-416.

Throughout the northwestern provinces, natives were incorporated in the administrative structure and encouraged to adopt Roman culture. By demonstrating their Romanization through the construction of temples and monuments in Roman style and the adoption of Roman habits of dress and behavior, locals could attract the notice of imperial officials. While a few provincial and local officials received enough recognition for their accomplishments to achieve senatorial rank or other status in Rome, most were relegated to a secondary level of prestige in the Empire. In contrast, the northwestern provinces, especially Britain and Germany, provided excellent opportunities for advancement in the military. The provinces had large garrisons and were sufficiently distant from Rome for commanders to build strong power bases through military victories and the cultivation of personal loyalty. More than one general went on from a northwestern post to greater things, including the Principate, and the Rhine garrisons frequently played a decisive role in the success or failure of claims to the purple.

The army also provided the driving engine of the economy in the northwestern provinces. The large number of troops stationed along the Rhine and in Britain required food, wine, and manufactured goods from both the Mediterranean and indigenous industries. In addition to the army, the Romanization of the provinces insured a healthy demand for Mediterranean goods, as well as the wine that Greek and Roman merchants had sold to the Gauls since before the conquest. The northwestern provinces provided some raw materials to the Mediterranean, such as British lead, and produced and traded their own manufactures, such as woolens, glass, and pottery. Gallic Samian ware enjoyed

especially wide popularity in the Empire, and has been found on archaeological sites from Spain to Palestine and the Black Sea. The rebuilding of many forts in stone from the late first century required substantial local quarrying in many locations, but the forts near the mouth of the Rhine had to have stone brought in from upriver.³

The Romans wasted no time in establishing a system of roads in the northwest, but Gaul, Germany, and Britain were also exceptionally well provided with navigable rivers: the Rhine, Moselle, Rhône, Garonne, Seine, Loire, and Thames are only the largest. For the transport of bulk goods and the large quantities of manufactures in demand, the sea offered the most efficient route, but river traffic was still vastly less expensive than moving goods by land.⁴ The rivers also had the advantage of providing direct access to the large garrisons on the German frontier. Within the river system, the most important route was the north-south axis along the Rhône, Saône, Moselle, and Rhine, by which goods could be moved from the Mediterranean to the North Sea. As the Rhineland was also a dominant market, it could not help but become a major highway once reasonable security of the waterway could be assured. Other routes by the Aude and Garonne to the Atlantic coast of Aquitania and along the Mediterranean and Channel coasts of Gaul were instrumental in the economic development of the

³ There is essentially no building stone in the alluvial plains at the mouths of the Rhine, just broad expanses of fertile soil and mud.

⁴ R. Duncan-Jones, *The Economy of the Roman Empire: Quantitative Studies*, pp. 366-9 calculates from the Price Edict of Diocletian the relative costs of transport by sea, river, and road at a ratio of 1:4.9:28, which is approximately equal to ratios in eighteenth-century England.

areas outside the principal military theaters. Many of the major towns of the northwestern provinces and all of its important commercial centers were coastal or riverine ports, such as Arelate (Arles) at the mouth of the Rhône, Lugdunum at the confluence of Rhône and Saône, Augusta Treverorum on the Moselle, Mogontiacum at the confluence of Rhine and Main, Colonia Agrippina on the Rhine, and Londinium (London) on the Thames.

Watercraft

With this need for water transport, it is hardly surprising that the remains of a number of Roman-era river and coastal craft have been discovered in northwestern Europe. In addition to the vessels, there is some textual and iconographic evidence for the variety and nature of watercraft of the period. The best contemporary written description of a northern vessel actually dates to pre-Roman times. This, of course, is Julius Caesar's account of the ships of the Veneti, a Celtic people of Normandy and Brittany.

This account forms the basis of much of the interpretation of the excavated vessels, all of which post-date it. As with much of Caesar's *Commentaries*, the description is straightforward and fairly detailed:

Carinae aliquanto planiores quam nostrarum navium, quo facilius vada ac decassum aestus excipere possent: prorae admodum erectae atque item puppes, ad magnitudinem fluctuum tempestatumque accommodatae: naves totae factae ex robore ad quamvis vim et contumeliam perferendam; transtra ex pedalibus in altitudinem trabibus, confixa clavis ferreis digiti pollicis crassitudine; ... pelles pro velis alutaeque tenuiter confectae. ... Cum his navibus nostrae classi

*eiusmodi congressus erat, et una celeritate et pulso remorum praestaret ... Neque enim iis nostrae rostro nocere poterant - tanta in iis erat firmitudo - neque propter altitudinem facile telum adigebatur, et eadem de causa minus commode copulis continebantur.*⁵

This can be translated as follows:

Their bottoms are flatter than those of our ships, so that they are easily able to withstand shoal waters and in particular the receding tide; the bows are very high,⁶ as are the sterns, suitable for great waves and storms; the ships, built completely of oak, withstood attack and abuse; beams of timbers a foot high [thick], fastened together with iron nails the thickness of a thumb; ... skins and soft leather for sails, carefully assembled;... Our fleets fought with these ships, and each showed speed and power of oars... Indeed, our rams were not able to damage them, so great was their strength, nor could the spear be driven home easily, due to their height, nor could they be grappled, for lack of suitable cord.

The only passage that provides any real trouble is *transtra ex pedaliibus in altitudinem trabibus*. *Transtra* can be rendered literally as the plural of *transtrum*, beam or transom, but it also carries the nautical meaning of "deck."⁷ Most scholars have chosen the literal meaning, and ship historians have taken this to mean the heavy floor timbers seen in several of the wrecks of the period,⁸ but Martin de Weerd prefers the nautical usage. In addition to the philological evidence, de Weerd argues that *transtra* must mean "deck" since Caesar could not

⁵ Julius Caesar, *Commentarii de Bello Gallico*, III.13f.

⁶ *Erectae* may also be translated "upright," suggesting a stem closer to the vertical than was common among Roman ships; contemporary Roman merchantmen other than those built with ram-like, cutwater bows, had a fair amount of rake to the stem. Compare the Portus relief: L. Basch, *La musée imaginaire de la marine antique*, pp. 463-467 and Figs. 1038, 1043. "High" or "lofty" is the more common reading of this passage.

⁷ M.D. de Weerd, "A Landlubber's View of Shipbuilding Procedure in the Celtic Barges of Zwammerdam, the Netherlands," in *Local Boats*, ed. O.L. Filgueiras, p. 42.

⁸ E.g. P. Marsden, "A Boat of the Roman Period Found at Bruges, Belgium, in 1899, and Related Types," *JNA* 5 (1976): 53.

have seen below the deck to the frames, as he did not succeed in boarding the ships of the Veneti.⁹ De Weerd then translates *trabibus* (dative of *trabs*) as "beam," so that the entire phrase means a "deck of beams a foot thick." He further requires that *confixa clavis ferreis* mean that the beams were fastened to each other by heavy nails, based on a literal interpretation of *confixa* (participle of *configere*).¹⁰ I am afraid that he cannot have his cake and eat it too; if Caesar could not see below the deck, how could he tell that the deck was made of such thick beams? Or that they were nailed to each other? *Confixa* does not have to mean "joined together;" it is equally acceptable to translate it more loosely as "fastened." Not only is a deck of foot-thick beams laid side by side unnecessary, it is structurally impractical for ships of small to moderate size, and the weight of the timber would create potentially serious stability problems. If *transtra* must be translated as "deck," the entire passage might read "decks above beams a foot thick, fastened with iron nails," but this requires a less common interpretation of *ex* as "above." I see no reason to throw out the traditional translation in favor of de Weerd's more tortured reading.

Other textual evidence is much less specific, but does suggest that flat-bottomed boats were widely used in the shallow waters around the mouth of the Rhine and on campaigns into the marshy lands of the modern Netherlands. For his second invasion of Britain in 54 BC, Caesar had hybrid vessels built. These

⁹ De Weerd, *supra* n. 7, p. 42.

¹⁰ *Ibid.*

combined the speed of his own Roman vessels with the shallow draft and ability to take the ground of the local transports.¹¹ Germanicus, in AD 16, had a large fleet built for a campaign in northern Germany. Some of these quickly-built vessels were short and beamy to take the rough seas, others were flat bottomed to take the ground safely, and the rest had rudders at both ends so that they could change direction quickly in the rivers.¹² Specific information on construction is extremely limited, but Pliny did note that in Belgica, boats were caulked with crushed, sticky reeds driven into the seams.¹³

The iconographic evidence comes primarily from the Rhineland, much of it in the form of tombstone reliefs.¹⁴ Many of these representations show ships of recognizably Mediterranean form, such as the bireme/wine carrier from Neumagen.¹⁵ Craft of (presumably) native form are best known from the monument of Blussus, a Rhine shipper buried at Mainz in the mid-first century,¹⁶ and a

¹¹ Caesar, *De Bello Gallico* V.1.

¹² Tacitus, *Annals*, II.5.

¹³ "...ubi lignosiore induruit callo sicut in Belgis, contusa et interiecta navium commissuris feruminat textus glutino tenacior rimisque explendis fidelior pice." *Natural History*, XVI.158.

¹⁴ This evidence has been collected by D. Ellmers, "Keltischer Schiffbau," *Jahrbuch des Römisch-Germanischen Zentralmuseums Mainz* 16 (1969): 73-121. Ellmers's "Shipping on the Rhine during the Roman Period: The Pictorial Evidence," in *Roman Shipping and Trade: Britain and the Rhine Provinces*, eds. J. duP. Taylor and H. Cleere, pp. 1-14 is more accessible and concentrates only on the representations.

¹⁵ Now in the Römisch-Germanisches Zentralmuseum in Mainz, this stone sculpture has been published in many works on Rhine shipping of the Roman period. A detailed description of the sculpture can be found in E. Fölzer, "Ein Neumagener Schiff neu ergänzt," *Bonner Jahrbücher* 120 (1911): 236-250.

¹⁶ First published by F. Behn, "Römische Schiffe in Deutschland," *Altertümer unserer heidnischen Vorzeit* 5 (1911): 418 and Pl. 71. More accessible is Ellmers, *supra* n. 15, p. 4, Fig. 5, although a more complete discussion is found in Ellmers, *Jahrbuch des Römisch-Germanischen*

mosaic pavement at Bad Kreuznach, which shows a curious sailing vessel, as well as a Mediterranean-style oared warship.¹⁷ Blussus's vessel has a high stern, two pair of oars, and a short forward mast, possibly for towing. Rudders or steering oars are depicted at both ends, recalling the vessels built by Germanicus. The stern rudder appears to be mounted at the centerline of the vessel, while the bow rudder is slung over the represented (starboard) side. Ellmers sees this as a precursor to the Oberländer, a type of high-sterned drifting vessel common on the Rhine in the Middle Ages.¹⁸

The Bad Kreuznach vessel has as its most distinctive characteristics a somewhat open bow and a brown sail with scallops out of the edges. The projecting open bow is not typical of Mediterranean vessels, and Ellmers believes it is derived from a type of open-bowed dugout that is represented in a gold model from an early La Tène burial near Hallein.¹⁹ The color of the sail suggests that it is made of a different material than the white sail of the warship in the same relief, but the scalloped edges are more enigmatic. Clarification is provided by a relief fragment from Junkerath in the Eifel, which shows a sail with a similar

Zentralmuseums Mainz 16 (1969): 85-86.

¹⁷ Discovered in 1966 and reported in the *Mainzer Zeitschrift* 63/64 (1968/69): 196ff. with illustration. See also O. Guthmann, *Bad Kreuznach und Umgebung in römischer Zeit*, p. 44, and Ellmers, *Jahrbuch des Römisch-Germanischen Zentralmuseums Mainz* 16 (1969): 79-82, Fig. 4 and Pl. 16.1.

¹⁸ Ellmers, *supra* n. 14, p. 3.

¹⁹ Ellmers, *Jahrbuch des Römisch-Germanischen Zentralmuseums Mainz* 16 (1969): and *supra* n. 14, pp. 1-2, Fig. 1.

scalloped edge and horizontal battens, somewhat in the manner of a Chinese junk.²⁰ Other representations typically show smaller craft loaded with barrels and propelled by a variety of means.²¹

While the textual references and iconographic material provide some indications of the general characteristics of northern European craft, it is the vessels themselves that provide the only reliable evidence of construction methods in the period. A number of wrecks have been excavated in the former Roman provinces of Gaul, Germany, and Britain, but all but one of these are from inland sites (Fig. 1). The construction of seagoing ships in the region remains largely unknown, although there is some evidence that it may not have differed greatly from that of some of the inland vessels. These vessels fall into clear groups, usually named for type vessels, based on configuration, shape, and construction.

The Blackfriars vessel

Work near the Blackfriars Bridge in London in 1962 exposed the port bow of a moderately large oak vessel.²² After excavation in 1962 and 1963, this was

²⁰ Behn, *Altertümer unserer heidnischen Vorzeit* 5 (1911): 417 and Pl. 71, no. 1337; Ellmers, *Jahrbuch des Römisch-Germanischen Zentralmuseums Mainz* 16 (1969): 81 and Pl. 16.2.

²¹ Ellmers, *supra* n. 14, Figs. 9, 10, 13, 15.

²² Since 1962, the remains of at least three other vessels, all of medieval or later date, have been found in the vicinity of the bridge; the Roman wreck is thus officially Blackfriars I. See P. Marsden, "Blackfriars Wreck III. A Preliminary Note," *IJNA* 1 (1972): 130-32. The essential reference for Blackfriars I is P. Marsden, *A Ship of the Roman Period from Blackfriars in the City of London*.

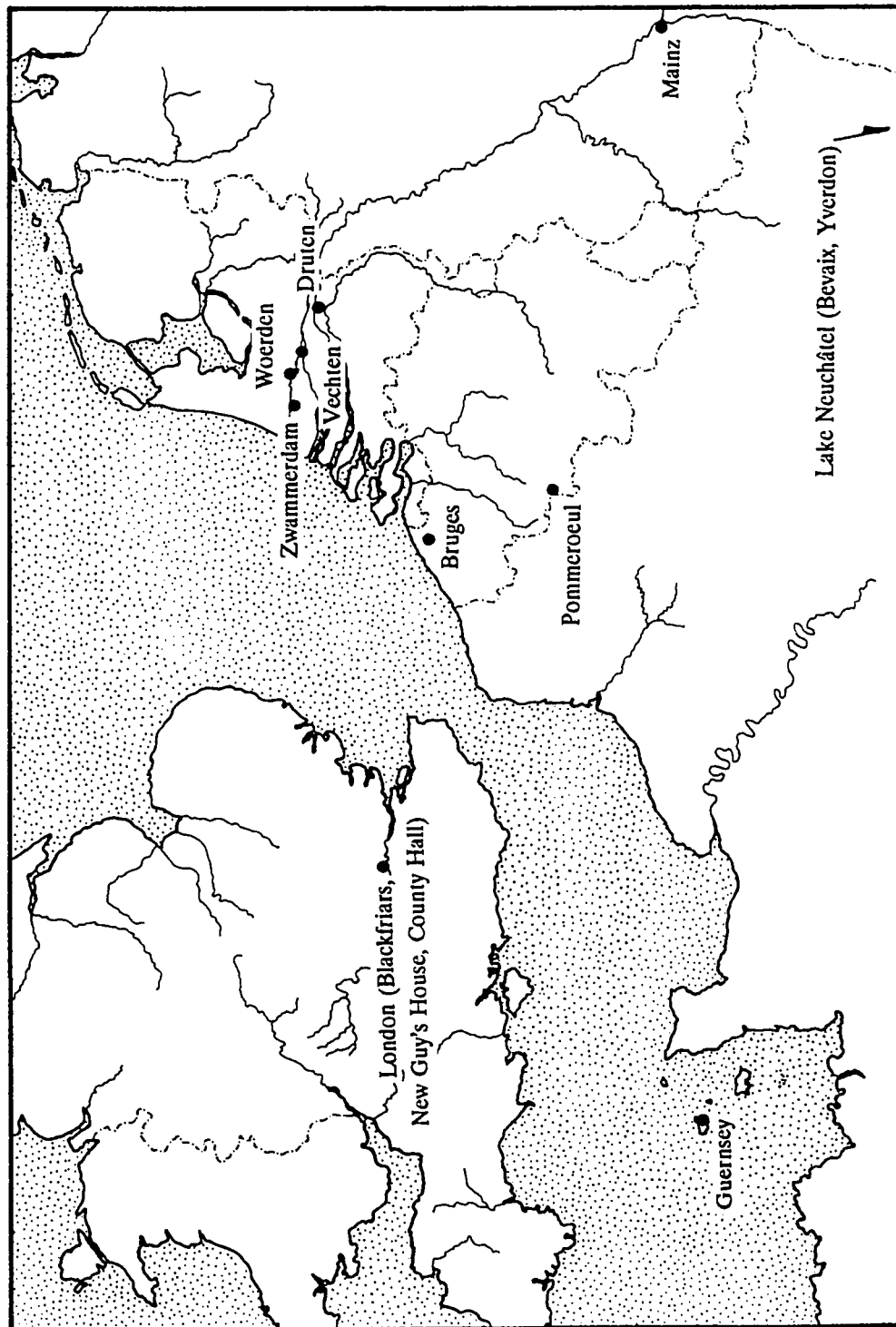


Figure 1. Map of Roman Era ship and boat finds in northwestern Europe.

revealed to be a cargo vessel of the second century AD loaded with Kentish ragstone, commonly used for building in Roman London. Only the bow and a small part of the stern could be excavated and studied in detail. At the bow, preservation was limited to the central and port areas of the bottom and a collapsed section of the port side. As reconstructed, the ship was between 15 and 17 m long, approximately 6.7 m in beam, and at least 1 m deep. Peter Marsden calculates its capacity as 92 tons, but the calculation is based on a registered tonnage formula that is not applicable to vessels of these proportions.²³ As far as can be determined, the vessel was intended primarily for inland transport, but the Kentish origin of the cargo would have required travel in the Thames estuary at the mouth of the Medway. Marine borers in the wood remains confirmed that the vessel had been exposed to water more saline than occurs in the London stretch of the Thames.²⁴

The most obvious structural features of the Blackfriars ship are the flat bottom and heavy frames (Figs. 2, 3a-d). There is no keel, but a pair of heavy central planks, each 7.5 cm thick and 66 cm wide. The stem, sided 30 cm and moulded 15 cm, rises at a low angle from the bottom. The heel of the stem is not fastened directly to the central strakes, but is fitted into a slot approximately 90 cm long between the ends of the central planks and fastened to several floors. The sternpost, sided only 15 cm, is presumably attached in the same manner. The

²³ Marsden, *Ship of the Roman Period from Blackfriars*, p. 28.

²⁴ *Ibid.*, p. 38.

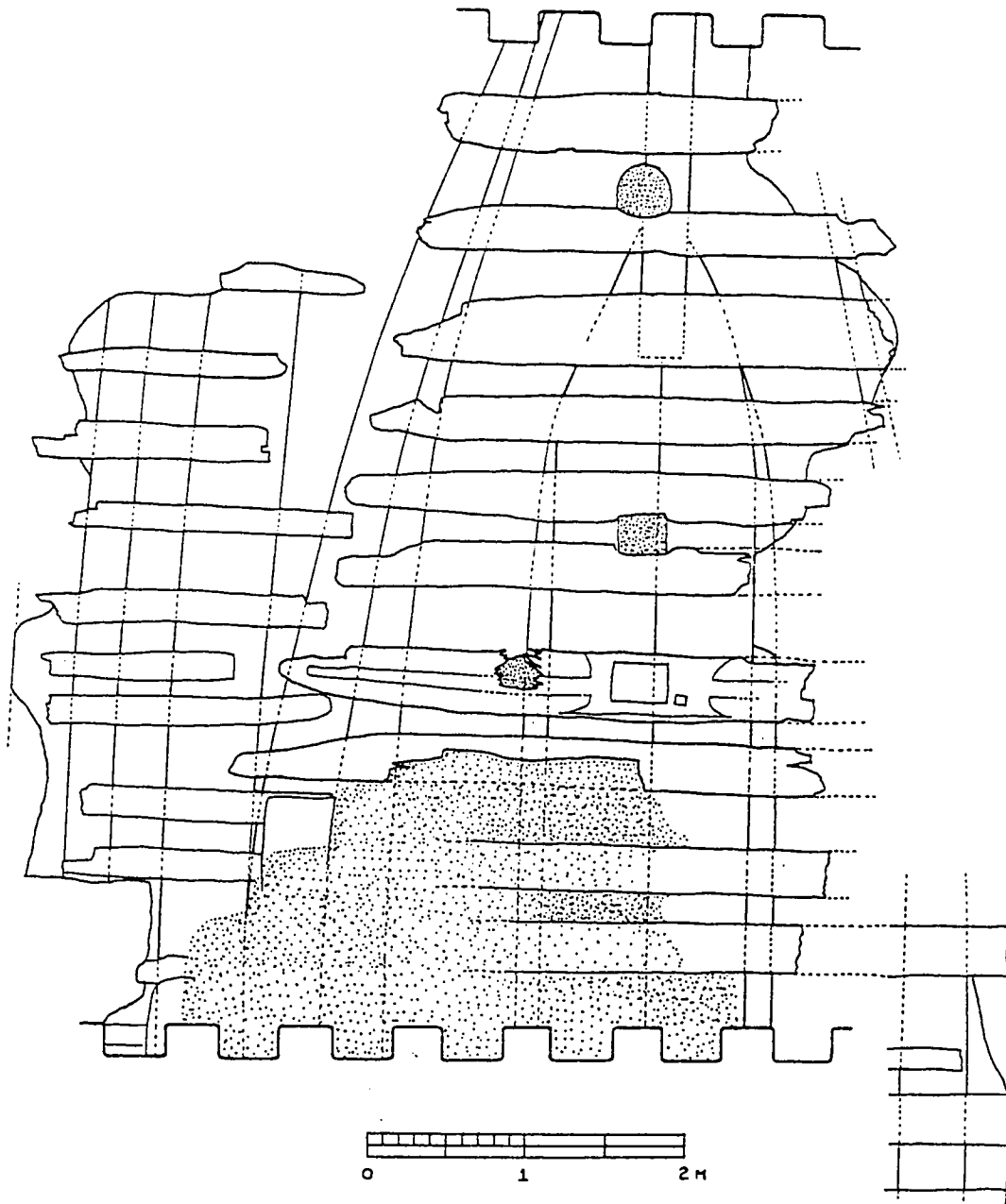


Figure 2. Site plan of the bow area of the Blackfriars excavation (Drawing author, after P. Marsden).

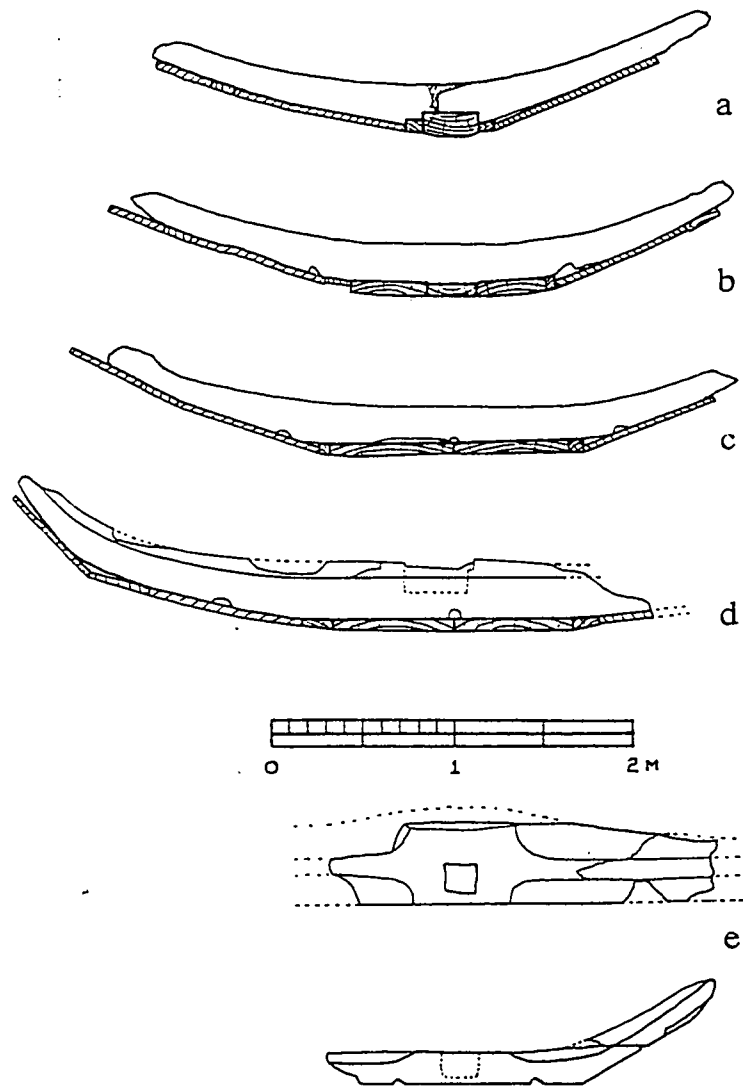


Figure 3. Sections of the Blackfriars and Bruges vessels. a-d. Blackfriars vessel at frames 2, 3, 4, and 7, respectively; e. Bruges vessel maststep floor timber (Drawing author, after Marsden).

transition between the heavier bottom planks and the rest of the planking, which is 5 cm thick, is made by a narrow strake 7.5 cm thick on its inboard edge and 5 cm outboard. As these and the central strakes are more or less straight, with parallel sides, they are cut off at an angle at the bow to allow the first thinner strake to reach the stem.

In the excavated section, there is some deadrise in the third strake, but this decreases toward amidships. A narrow fourth strake meets the fifth at an increasing angle toward amidships. Marsden refers to the angle as a chine, which was observed quite far aft, but disappears towards the bow.²⁵ At its tightest, the included angle is still 145°. The overall impression is less that of a hard chine, as seen in some flat-bottomed boats with slab sides, than of slightly angular seams necessitated by the wide, thin planks used in the hull. The same sort of angular sections can be seen on other northern European craft that used wide planks, such as cogs. In that context, the fifth strake of the Blackfriars vessel could be interpreted as a bilge strake, which forms the transition between a relatively flat bottom and the side. A number of plugged holes, 1 to 2.5 cm in diameter, "were noted in some of the strakes."²⁶ Caulking was of crushed hazel twigs forced into the seams, recalling Pliny's description of Belgian caulking.

The planks are fastened directly to a large number of heavy, closely set frames by iron nails driven through treenails from the outside and double-clenched

²⁵ Ibid, p. 13.

²⁶ Ibid.

into the tops of the frames. Double-clenched nails are also used to hold the hood ends of the third strake to rabbets in the stem. The frames consist of separate, heavy floors with lighter, free futtocks between. Oddly, the recorded shapes of the floors do not conform to the angular interior surface of the fourth and fifth strakes. The overlap of floor and futtock is relatively small and confined to the fifth strake, although the site plan suggests that the floors toward amidships reach higher up the sides (Fig. 3d). Floors are typically sided 30 cm and moulded 22 cm with upper ends somewhat reduced in both dimensions, but the first, third, and seventh from the bow are wider, sided up to 40 cm, and the first and seventh are also thicker. Marsden believes that the first is larger because it is the first such timber in the bow and the third larger because it covers the join between stem and central bottom strakes.²⁷ The seventh timber is not only heavier, but contains the maststep mortise, a cavity 34 cm wide, 25 cm long (fore to aft), and 12.5 cm deep. This has a raised surround, into the after edge of which is cut a ledge for the forward end of the 2.5-cm ceiling. Running out from the surround to the port end of the floor is a central ridge 9 cm higher than the rest of the floor; remains of a similar ridge were found on the damaged starboard extremity of the timber. The purpose of these ridges is unknown. Futtocks are sided 16.5 to 20 cm and moulded 12.5 cm.

Marsden believes that the vessel was assembled by laying out the bottom planks up to the fourth strake and then placing the floors on top. The first floor

²⁷ Ibid., p. 15.

in the bow had to have been inserted after the third strake was laid up, because the hood end nails are clenched over the inside of the stem beneath the floor. After the floors had been fastened in place, the fifth strakes were attached. With the bilge strake in place, the lower ends of the futtocks could be fastened and the side planks added.²⁸ This seems perfectly logical to me, but I would add that the small, plugged holes in the bottom planks are probably left from temporary fastenings to hold the bottom together until the floors could be added.

Boat remains similar to those from Blackfriars have been excavated in Bruges in 1899,²⁹ and in the harbor of the Channel Island of Guernsey in the 1980s.³⁰ No detailed information is yet available on the Guernsey wreck, but it does suggest the seaworthiness of Blackfriars-style construction. Until the Guernsey wreck is better known, the Bruges boat remains the most informative parallel for the Blackfriars remains. Only a sampling of timbers, dated to the second century AD, has been preserved. They include a floor timber with maststep mortise and raised ridges, a matching partner/thwart, a piece of the stem or sternpost with rabbets, and even remains of a mast, as well as other frame

²⁸ Ibid., pp. 22-23.

²⁹ Marsden, *IJNA* 5 (1976) is the definitive study of these remains, but they have been published several other times, in varying reconstructions. The earliest is the excavator's report, including drawings of the timbers: E. Jonckheere, *L'origine de la côte de Flandre et le bateau de Bruges*. See also M.A. Nagelmakers, "Le bateau de Bruges," *Academie van Marine van Belgie, Mededelingen* 8 (1954): 193-204 for a good descriptive account of the remains before Marsden surveyed them in 1973. The timbers have also been studied by O. Crumlin-Pedersen, "Cog-Kogge-Kaag, Træk af en Frisisk Skibstypes Historie," *Handels- og Søfartsmuseets på Kronborg, Årbog* (1965): 99.

³⁰ This wreck remains unpublished, aside from a notice in the *Observer* newspaper of 7 April, 1985. I thank Jon Adams and Adrian Barak, who excavated and raised the remains under the direction of Margaret Rule, for what little information I have on this important find.

fragments and a steering oar. Where comparable timbers from the Blackfriars vessel survive, the similarities are striking. Both present evidence of double-clenched nails driven through treenails to fasten flush-laid planks³¹ to frames, free futtocks, and the distinctive maststep/floor (Fig. 3e), although the Bruges remains are clearly from a smaller boat (1.4 m across the bottom flat at the maststep rather than 2.5 m). In the Bruges boat, the angular meeting of bottom and side is more pronounced, with about 35° of deadrise at the maststep frame.

An unusual vessel, possibly a hybrid of Blackfriars-style construction and Mediterranean shipbuilding, was discovered on the building site of New Guy's House in London in 1958.³² The remains were not completely excavated, but they show some similarities to the Blackfriars hull. The double-clenched nails, flat bottom, and caulking of hazel twigs were all present, but certain differences were also observed. The planking was much lighter, only 2.5 cm thick, despite a similar overall length, and the frames were both lighter and more widely spaced - sided 11.5 cm and moulded 7.5 cm, with a room and space of about 65 cm. In the bow, hood ends were simply nailed into the rabbets rather than double-clench nailed, and floors alternated with half frames. In shape, the bottom was flat amidships, but the bilges were quite soft. Marsden suggests that the vessel was a river barge,

³¹ Crumlin-Pedersen, *Handels- og Søfartsmuseets på Kronborg, Årbog* (1965): 99, had suggested, based on a notch in one edge of the maststep floor that the sides of the Bruges boat were of reverse clinker construction, but Marsden, *IJNA* 5 (1976): 36-37 and Fig. 17, has shown that this was not the case.

³² P. Marsden, "A Boat of the Roman Period Discovered on the Site of New Guy's House, Bermondsey, 1958," *Transactions of the London and Middlesex Archaeological Society* 21 (1965): 118-131. The wreck is also briefly described in Marsden, *Ship of the Roman Period from Blackfriars*, pp. 31-33 and Fig. 14.

and considers it an example of a different type than the Blackfriars and Bruges hulls.³³

Rhine Barges

Another distinctive type of vessel is represented by a series of medium to large barges from the Rhine. These are generally identified as the Zwammerdam type, after the most impressive examples, from a site near the mouth of the Old Rhine. These are characterized by flat, straight bottoms with vertical sides and blunt or square ends. Three examples of the type were found at Zwammerdam,³⁴ but others are known from elsewhere on the Lower Rhine and its tributaries, as well as a pair from the Middle Rhine. Barges have been excavated

³³ Marsden, *IJNA* 5 (1976): 49.

³⁴ The bibliography on these vessels is quite extensive, with titles in three languages, but the sources themselves are curiously uninformative. The initial publication, M.D. de Weerd and J.K. Haalebos, "Schepen voor het opscheppen," *Spiegel Historiael* 8 (1973): 386-397 is a short popular article, as is M.D. de Weerd, "Schepen in de Romeinse tijd naar Zwammerdam (ZH)," *Westerheem* 25 (1976): 129-37. M.D. de Weerd, "Römerzeitliche Transportschiffe und Einbäume aus Nigrum Pullum/Zwammerdam (Z.-H.)," in *Studien zu den Militärgrenzen Roms* 2, pp. 187-198 and Plates 13-19 provides more descriptive detail and several photographs but no drawings other than schematic sections of the three types found at the site. M.D. de Weerd, "Ships of the Roman Period at Zwammerdam/Nigrum Pullum, Germania Inferior," in *Roman Shipping and Trade: Britain and the Rhine Provinces*, eds. J. duP. Taylor and H. Cleere, pp. 15-30 is essentially an abridged English translation of "Römerzeitliche Transportschiffe" with fewer photographs. M.D. de Weerd, "Matvoering in pedes monetales en andere nieuwigheden bij de bouw van de z.g. Keltische rijnen van Zwammerdam," in *Raakvlakken tussen Scheepsarcheologie, Maritieme Geschiedenis en Scheepsbouwkunde*, ed. H.R. Reinders, pp. 15-23 and "Zwammerdam-Utrecht-Flevoland: Schemata en maten voor het plaatsen van leggers en wrangen in Romeinse en Middeleeuwse boten," in *Scheepsarcheologie: Prioriteiten en Lopend Onderzoek*, eds. H.R. Reinders and O. Oosting, pp. 59-78 both concern the use of Roman units of measurement in the spacing of frames in the Zwammerdam vessels. M.D. de Weerd, "Schepen voor Zwammerdam" (Ph.D. diss., Amsterdam, 1988) is supposed to be a definitive study, but is also largely concerned with Roman units of measurement and framing sequences, but does provide more hard information on vessel construction. De Weerd, *supra* n. 8, is actually a preliminary version of a later article (see below) on the non-native, Roman roots of the Zwammerdam type, but it does provide a schematic plan of the bottom of one of the barges.

at Druten,³⁵ Kapel Avezaath,³⁶ Woerden,³⁷ all in the Netherlands, at Pommeroeul (two examples)³⁸ in Belgium, and at Mainz (two examples, like the Zwammerdam vessels, associated with a fortress).³⁹ All date to the middle or late Empire. A detailed description of the Zwammerdam vessels should serve to illustrate the basic features of the type.

During excavations along the riverfront of the Roman fort of Nigrum Pullum, the fourth such installation from the mouth of the Old Rhine, the remains of six vessels and a loose section of planking were found along the shoreline. The loose planking (sometimes referred to as vessel 2a) is edge-fastened with regularly-spaced pegged mortise-and-tenon joints. Two of the vessels (finds 1 and 5) are simple, round-bottomed dugouts of oak with decks. A third (Zwammerdam 3) is a flat-bottomed oak dugout with frames and fir washstrakes, fastened lapstrake fashion to the lower hull. The other three vessels are planked oak barges ranging in length from 20.25 to 34 m. In each, the bottom is composed of six or seven straight strakes, 8 to 10 cm thick and up to 85 cm wide, flush laid but non-edge-

³⁵ R.A. Hulst and L. Th. Lehmann, "The Roman Barge of Druten," *Berichten van de Rijksdienst voor het Oudheidkundig Bodemonderzoek* 24 (1974): 7-25 and L.Th. Lehmann, "The Flat-Bottomed Roman Boat from Druten, Netherlands," *IJNA* 7 (1978): 259-267.

³⁶ L.P. Louwe Kooijmans, "Een onderzoek en een opgraving," *Studium Generale* 14.11 (1968): 6-7.

³⁷ J.K. Haalebos, "Een Romeins schip te Woerden," in *Raakvlakken tussen Scheepsarcheologie, Maritieme Geschiedenis en Scheepsbouwkunde*, ed. H.R. Reinders, pp. 25-28.

³⁸ G. de Boe and F. Hubert, "Binnenhafen und Schiffe der Römerzeit von Pommeroeul in Hennegau (Belgien)," *Archäologisches Korrespondenzblatt* 6.3 (1976): 227-234 and G. de Boe, "Roman Boats from a Small River Harbour at Pommeroeul, Belgium," in *Roman Shipping and Trade: Britain and the Rhine Provinces*, eds. J. duP. Taylor and H. Cleere, pp. 22-30.

³⁹ G. Rupprecht, *Die Mainzer Römerschiffe*, pp. 166-172.

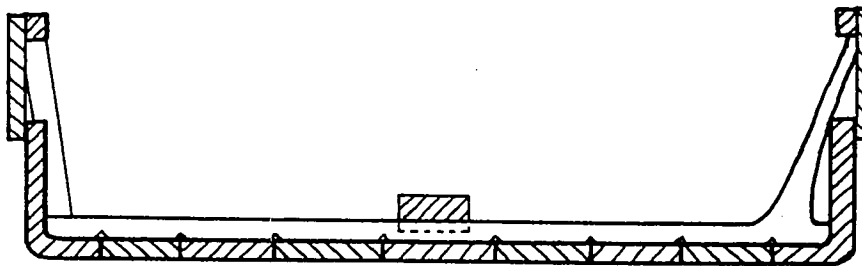


Figure 4. Schematic section of Zwammerdam barge 2 (Drawing author, after de Weerd).

fastened between a pair of L-sectioned bilge strakes (sometimes called chine girders)⁴⁰ up to 85 cm high, carved from very large logs (Fig. 4). Low, vertical sides were built up by the addition of one strake above the bilge strake. In the largest barges, vessels 2 and 4, side strakes are attached lapstrake fashion with clenched iron nails. In Zwammerdam 6, the side strake is flush laid and edge-fastened to the bilge strake by oblique nails and a few pegged mortise-and-tenon

⁴⁰ D. Ellmers, "Punt, Barge or Pram - Is There One Tradition or Several?" in *Aspects of Maritime Archaeology and Ethnography*, ed. S. McGrail, p. 155.

joints. Each vessel is fitted with a large number of frames. In vessel 4, more than ninety frames are arranged in pairs. Each frame consists of a straight section that acts as a floor with a branch at one end. In each pair, the branches are set on alternate sides. In vessels 2 and 6, the frames are similarly branched and alternated, as they are in the extended dugout Zwammerdam 3, but they are single and evenly spaced rather than paired. In vessel 2, the floors have separate straight futtocks, stepped in slots or mortises in the upper surface of the floors, at the unbranched ends. In all three, the planks are fastened to the frames by "partly-clenched"⁴¹ iron nails and some treenails, and the heads of the frames are enclosed by a notched inwale. Some of the nails in the bottom planking appear to be driven from above.⁴² All have steps for masts or towing bitts one quarter of the length abaft the prow. In vessels 4 and 6, the step is a mortise in a heavy floor, as in the Blackfriars vessel. In Zwammerdam 2, the step is cut into a long central stringer.

While all three barges are rectangular in section, different treatments are employed at the ends. Vessel 6, which the excavator claims shows an exceptionally high standard of craftsmanship,⁴³ has iron-reinforced, square ends slightly narrower than midships with the bottom rising toward both ends. The central portions of barges 2 and 4 are straight but taper slightly toward the stern. At

⁴¹ De Weerd, *supra* n. 34 ("Ships of the Roman Period at Zwammerdam"), p. 17.

⁴² *Ibid.*, Figs. 22, 23.

⁴³ *Ibid.*, p. 17.

either end of the straight portion, where the bilge strake is scarfed, the sides turn in and run straight to pointed ends.

It is believed that the Zwammerdam barges were used as stone carriers to supply the construction of the legionary forts along the lower Rhine. The caulking material in the seams and the stone used in the forts is believed to come from upriver, as does some of the softwood used in the dugouts.⁴⁴ De Weerd has noted that the unit of measurement used in the construction of the barges is a common Roman unit, the *pes monetalis*.⁴⁵

The other vessels are generally similar to the Zwammerdam barges, although paired frames are more common than single, evenly spaced frames. The Pommeroeul barges are two of five vessels found on the river Haine, a tributary of the Scheldt . One vessel was too badly damaged to be identified; two others were extended dugouts. Of the barges, one was essentially similar to Zwammerdam 4, with a cabin at the preserved end and a cross-ribbed gangway, but the L-sectioned bilge strakes were smoothed out into curved, "spoon-shaped"⁴⁶ ends at the preserved end of the vessel. The excavator notes that the double-clenched nails fastening planks to frames were driven from both inside and outside.⁴⁷ The second barge was less well preserved, but de Boe notes that the bottom planks

⁴⁴ Ibid., p. 16.

⁴⁵ De Weerd, *supra* n. 34. Virtually all of the publications deal with the Roman foot to a greater or lesser degree.

⁴⁶ De Boe, *supra* n. 38, p. 27.

⁴⁷ Ibid.

were "nailed to each other."⁴⁸ Unfortunately, he does not illustrate or further explain this interesting feature. The Druten barge displays no notable differences from the essential features of the Zwammerdam type, except for tapering rather than parallel sides, nor do the cursorily-published remains from Woerden and Mainz. These vessels do show that the type was in use over much of the Rhine, probably for the transport of bulk goods, especially building stone.

The Boats of Lake Neuchâtel

Often classed with the Rhine barges and certainly of a related type are two vessels found in Lake Neuchâtel, at Bevaix⁴⁹ and Yverdon.⁵⁰ Of these, the Bevaix boat is much better preserved. Its remains were excavated between 1970 and 1973. As reconstructed, it is 19.4 m long, 2.9 m in beam, and only 0.9 m high amidships. Like the Zwammerdam vessels, it consists of a flat bottom of flush-laid, non-edge-joined planks flanked by L-sectioned bilge strakes and vertical sides. The frames are paired, alternating L-shaped timbers attached to the planks with

⁴⁸ Ibid., p. 29.

⁴⁹ Summarized, with the Yverdon boat, in B. Arnold, "Gallo-Roman Boat Finds in Switzerland," in *Roman Shipping and Trade: Britain and the Rhine Provinces*, eds. J. duP. Taylor and H. Cleere, pp. 31-35. Originally published by M. Egloff, "La barque de Bevaix, épave gallo-romaine du lac de Neuchâtel," *Helvetica Archaeologica* 19/20 (1974): 82-91. A more detailed report is available in B. Arnold, "La barque gallo-romaine de la Baie de Bevaix," *CahArchSub* 3 (1974): 133-150. B. Arnold, "The Gallo-Roman Boat from the Bay of Bevaix, Lake Neuchâtel, Switzerland," *IJNA* 4 (1975): 123-126 is an English summary of "La barque gallo-romaine."

⁵⁰ D. Weidmann and G. Kaenel, "La barque romaine d'Yverdon," *Helvetica Archaeologica* 19/20 (1974): 66-81; see also Arnold, *supra* n. 50 ("Gallo-Roman Boat Finds in Switzerland").

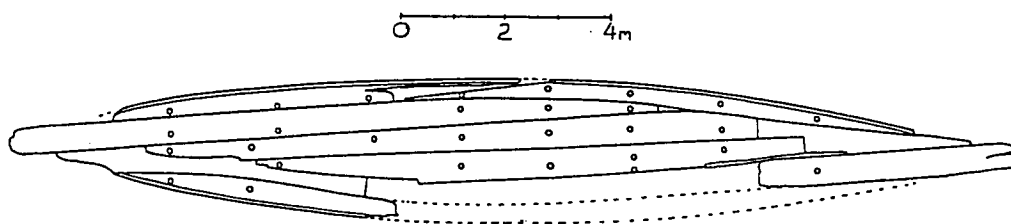


Figure 5. Bottom planking of the Bevaix boat, with plugged, temporary fastening holes indicated (Drawing author, after Arnold).

double-clenched iron nails driven from both inside and outside. A mast or bitt was stepped in a mortise in an oversized, single frame one quarter of the length aft from the prow. Where the vessel differs is in shape and the arrangement of the bottom planks. The bottom is lanceolate in shape, rather than rectangular with pointed ends, and the ends are formed by the rising, projecting ends of the bottom planking. The planks do not run parallel to the axis of the vessel, but are skewed and staggered so that they lie approximately parallel to one side or the other. In this way, four planks, each slightly over half the overall length of the boat, can form most of the bottom without scarfs. One more plank at each end fills out the rest of the bottom. Most interesting are seven rows of plugged holes across the bottom planks (Fig. 5). Béat Arnold believes that these are the remains of

temporary fastenings used to hold the bottom planks and bilge strakes together until the frames were inserted.⁵¹

Much less remained of the Yverdon boat, but it was originally slightly larger than the Bevaix boat and had broader ends. The bottom planking was arranged more conventionally, but rather than cut a lanceolate shape out of straight planks, the outboard planks of the bottom parallel the sides, with a shorter, tapered plank in the center. The surviving end of the vessel is not complete, but the joinery of the extremity suggests to Arnold a higher stern reminiscent of the boat on Blussus's tombstone.⁵² Both vessels are reconstructed with long steering sweeps mounted in notches on the centerline.

Mainz Patrol Boats

Small groups of long, narrow boats have been found on both the Rhine and Danube. Those on the Rhine were discovered at Mainz in 1981 and date to the late fourth century.⁵³ They are characterized by shallow keels, round bottoms of

⁵¹ Arnold originally suggested that these held vertical bars that were lashed together (supra n. 49, p. 34), but now suggests, on the basis of ethnographic parallels, that the holes were once occupied by nails or treenails that fastened the bottom planks down to the trestling on which they were assembled (Paper presented at 1988 International Symposium on Boat and Ship Archaeology in Amsterdam, in press).

⁵² Arnold, supra n. 49, p. 35.

⁵³ Rupprecht, *Die Mainzer Römerschiffe* is the primary source on the excavations. Most studies of the boats themselves have been carried out by Olaf Höckmann: "Rheinschiffe aus der Zeit Ammians: Neue Funde in Mainz," *Antike Welt* 13.3 (1982): 40-47; "Spätrömische Schiffsfunde in Mainz," *Archäologisches Korrespondenzblatt* 12 (1982): 231-250; "Zur Bauweise, Funktion und Typologie der Mainzer Schiffe," in *Die Mainzer Römerschiffe*, pp. 44-77; "'Keltisch' oder 'römisch'? Bemerkungen zur Typgenese der spätrömischen Ruderschiffe von Mainz," *Jahrbuch des Römisch-Germanischen Zentralmuseums Mainz* 30 (1983): 403-434; supra n. 2, pp. 389-396; and "Late Roman River Craft from Mainz, Germany," in *Local Boats*, ed. O.L. Filgueiras, pp. 23-34.

thin, flush-laid, non-edge-joined planks, and frames consisting of broad, flat floors and short, free futtocks. All were primarily propelled by oars but also carried single masts stepped fairly far forward. The steps are mortises cut in a raised sections of oversized floors, nearly identical to the one from the Bevaix vessel. Four of these vessels are similar enough in size (19.5 to 20 m long, 2.7 m in beam) and construction that they are considered members of a standardized class of fast patrol vessel, possibly attached to the army stationed at Mainz (Mogontiacum) rather than the *Classis Germanica*.⁵⁴ They were originally reconstructed with simple raking stems, but Höckmann now believes that they had cutwater bows or "false rams."⁵⁵ Little information is available on the finds from Oberstimm, on the Danube, as only sections were seen in test trenches, but these are built in the Mediterranean tradition, with pegged mortise-and-tenon joints.⁵⁶

Contemporary Mediterranean and Nordic Craft

All of the vessels described above differ markedly from contemporary craft in the Mediterranean and Scandinavia. Craft built in the Mediterranean manner have been found in northern Europe, translated into oak,⁵⁷ but they are compar-

⁵⁴ Höckmann, *supra* n. 53 ("Late Roman River Craft"), pp. 23-25.

⁵⁵ *Ibid.*, pp. 29, 31, and 24, Fig. 1.1.

⁵⁶ O. Höckmann, "Roman Danube Vessels from Oberstimm, Germany," in *Tropis II: 2nd International Symposium on Ship Construction in Antiquity*, ed. H. Tzalas, pp. 215-24.

⁵⁷ At County Hall in London, in 1910: P. Mærdsen, "The County Hall Ship," *Transactions of the London and Middlesex Archaeological Society* 21.2 (1965): 109-117 and "The County Hall Ship, London," *IJNA* 3 (1974): 55-65; and at Vechten, the Netherlands, in the 1890s: Fz. S. Muller, "Verslag van een opgravingen van Romeinsche oudheden te Vechten gedaan op kosten van het Provinciaal Utrechts Genootschap van Kunsten en Wetenschappen in de jaren 1892-1894," *Verslag*

atively rare. Certain aspects of construction and seafaring may be the result of Roman influence, such as the double-clenched nails, which are common on Mediterranean craft for fastening frames and planking together.⁵⁸

The basic features of the Scandinavian clinker tradition were defined by the end of the Roman period as well. These are: thin lapstrake planking fastened together by iron rivets ("clinker nails"); a flanged keel or keelplank to which the garboards are rivetted; light, widely spaced frames that define the distance between rowing positions; and a heavy sheer strake. All of these features can be seen in the oak ship from Nydam, which dates to the end of the Roman period.⁵⁹

The "Celtic" Tradition

As noted above, the boats of northwestern Roman Europe have often been grouped together as much because they lack the distinctive diagnostic characteristics of both Mediterranean mortise-and-tenon construction and Scandinavian clinker construction as for any shared characteristics. There is an intuitive sense that somehow these vessels belong together, but defining a clear tradition has been

van het verhandelde in de Algemeene Vergadering van het Provinciaal Utrechts Genootschap van Kunsten en Wetenschappen, gehouden den 25 Juni 1895 (Utrecht, 1895): 129-142 and 160-161, Pl. IV, V. Recall also the mortise-and-tenon joined planking from Zwammerdam (above).

⁵⁸ See, for example, J.R. Steffy, "The Kyrenia Ship: An Interim Report on its Hull Construction," *AJA* 89 (1985): 91, 93. Marsden noted the similarity soon after the excavation of the Blackfriars ship; Marsden, *Ship of the Roman Period from Blackfriars*, p. 29.

⁵⁹ On the general development of Nordic shipbuilding, A. W. Brøgger and H. Shetelig, *The Viking Ships: Their Ancestry and Evolution* remains the best introduction, especially to the earlier material. On the Nydam ship, H. Åkerlund, *Nydamskeppen* is the most recent, thorough study, incorporating the work of the original excavator, Engelhardt, and the reconstruction by Johannessen in the 1920s.

difficult. Detlev Ellmers and Peter Marsden were the first to try, in the late 1960s and early 1970s. Both saw in the Blackfriars ship the vessels that Caesar described - flat bottomed, with stout oak construction, heavy beams (here interpreted as the floor timbers) and large, iron nails.⁶⁰ From there, both went on to define a "Celtic" or "celtic"⁶¹ shipbuilding tradition. The name was chosen partly because the excavated examples come from the area occupied by Celtic peoples, more or less, and partly to distinguish the designated vessels from Mediterranean and Nordic ships. Marsden dealt primarily with hull remains and defined four eponymous primary types derived from a native, pre-Roman tradition: Blackfriars, New Guy's House, Zwammerdam (including the Swiss lake boats), and Utrecht (named for a medieval example).⁶² The thread knitting these types together was their obvious difference from Mediterranean and Nordic construction, but Marsden noted that most were inland craft with broad, flat bottoms.⁶³ He also suggested that the typically crude construction of these vessels, better suited to smaller craft, was a result of hurried expansion of smaller native vessels to fill the Roman demand for tonnage.⁶⁴

⁶⁰ Marsden, *Ship of the Roman Period from Blackfriars*, pp. 34-35; Ellmers, *Jahrbuch des Römisch-Germanischen Zentralmuseums Mainz* 16 (1969): 76-77.

⁶¹ Most scholars prefer lower case, as a definite and exclusive connection between these vessels and Celtic culture cannot be demonstrated. See P. Marsden, "Celtic Ships of Europe," in *Sources and Techniques in Boat Archaeology*, ed. S. McGrail, p. 283.

⁶² Marsden, *IJNA* 5 (1976): 43-49.

⁶³ Marsden, *supra* n. 61, p. 282.

⁶⁴ *Ibid.*, p. 287.

Ellmers, writing before the excavation of the Zwammerdam or Swiss vessels, was the first to call these boats "Celtic." He defined a similar broad tradition with specific types or subdivisions, but based his typology on representations, models, and modern ethnographic parallels in addition to the (then limited) archaeological evidence.⁶⁵ Within his Celtic⁶⁶ tradition, Ellmers named several regional sub-traditions, such as "Gallo-Rhenish" and "Alpen-Rhenish," defined by general distinctions in basic hull form. Several of his types are based heavily on modern small craft, such as the Rhenish *Nachen* and *Kahn*, and attested only by representational evidence in the Celtic and Roman periods.⁶⁷ In general, Ellmers's typology is not as widely used as Marsden's, but he was the first to suggest that the excavated vessels were enlarged, Romanized versions of native prototypes.⁶⁸ Arne Emil Christensen has grouped the "Celtic" vessels in two broad categories: plank boats with hard chines, thus combining Marsden's Blackfriars and Zwammerdam types, and boats of the "holck" type, combining the Utrecht and New Guy's House types. As Christensen admitted, the division is based largely on general similarities in hull shape rather than construction and may be oversimplified.⁶⁹

⁶⁵ Ellmers, *Jahrbuch des Römisch-Germanischen Zentralmuseums Mainz* 16 (1969).

⁶⁶ Ellmers ties the shipbuilding tradition explicitly to the Celtic culture, so an upper case C is in order.

⁶⁷ Ellmers, *Jahrbuch des Römisch-Germanischen Zentralmuseums Mainz* 16 (1969): 87-91.

⁶⁸ D. Ellmers, "Rheinschiffe der Römerzeit," *Beiträge zur Rheinkunde* 25 (1973): 36.

⁶⁹ A.E. Christensen, "Ancient Boatbuilding - A Provisional Classification," in *Sources and Techniques in Boat Archaeology*, ed. S. McGrail, p. 274.

Certain structural features do seem to occur in most of the types, except for the Mainz patrol boats, which are not normally associated with the others. The most obvious structural similarities are seen in the heavy bottom planks, angular join of bottom to side (except for the New Guy's House boat), double-clenched nails, and a heavy floor that acts as maststep. Many of these features appear, individually or in combination, in later northern European craft.

In the late 1970s, many scholars abandoned "celtic" in favor of the culturally neutral "continental" as a name for this tradition.⁷⁰ This has its own problems, as, strictly speaking, it should exclude the boats of the British Isles. Regardless of the name applied to the tradition, until recently there had been no suggestion that the Roman-era craft of northwestern Europe, with the exception of the County Hall and Vechten boats, were anything but native in origin. As Martin de Weerd noted in 1978, "*Provincial* Roman shipbuilding is a Romanization of local pre-Roman traditions: the construction is native in origin, but the size is in fact Roman."⁷¹

De Weerd's work on the Zwammerdam vessels has concentrated on demonstrating that they were built using a Roman unit of measurement, the *pes monetalis* of 0.296 m, although his evidence has been recently discounted, convincingly I believe, by B  at Arnold on methodological grounds.⁷² Since 1978,

⁷⁰ De Weerd, *supra* n. 34 ("Ships of the Roman Period at Zwammerdam"), p. 15.

⁷¹ *Ibid.*, p. 16.

⁷² B. Arnold, "Some Objections to the Link Between Gallo-Roman Boats and the Roman Foot (*pes monetalis*)," *IJNA* 19 (1990): 273-277.

he has come to believe that the Zwammerdam vessels, as well as the other ships and boats normally identified as celtic or continental, are not simply romanized native craft but purely Roman vessels transplanted to northwestern Europe.⁷³ Essentially, he offers no direct evidence of Roman influence, other than the *pes monetalis*, but seeks to disassociate the vessels from a pre-Roman, native shipbuilding tradition, if such existed. He notes that none of the vessels date to before the Roman conquest,⁷⁴ and that they do not conform to Caesar's description, as Marsden and Ellmers believe. He discounts Caesar largely on the basis of the phrase *transtra ex pedalibus...* discussed above, and claims that the only feature of Caesar's description that can be observed in the excavated vessels is a general heaviness of construction.⁷⁵ Nailing was a common fastening technique in both Mediterranean and Celtic woodworking, so it cannot be treated as culturally distinctive.⁷⁶ Finally, he notes that the L-sectioned chine girders are not the conceptual descendant of a split dugout (as had been suggested by Ellmers)⁷⁷ but a purely Roman invention to suit the conditions of northern

⁷³ De Weerd, *supra* n. 8, *passim*; a more refined argument is offered in "Sind keltische Schiffe römisch?," *Jahrbuch des Römisch-Germanischen Zentralmuseums Mainz* 34 (1987), but this was not available to me.

⁷⁴ De Weerd, *supra* n. 7, p. 42.

⁷⁵ *Ibid.*, p. 43.

⁷⁶ *Ibid.*

⁷⁷ Ellmers, *supra* n. 40, p. 155.

European waterways and harbors, for the expected typological sequence of dugout-split dugout-planked boat is not reflected in the evidence.⁷⁸

In way of positive evidence for Roman origins, he offers the Laibach (Ljubljana) boat, a sewn, flat-bottomed vessel excavated in what is now Yugoslavia (Slovenia) in 1890.⁷⁹ This vessel is of uncertain age, but predates the Roman acquisition of the region. The ends were not preserved, but the midships area has a flat bottom and straight, outward sloping sides connected by a narrow bilge plank of curved section. The planks are sewn together with battens over the seams and under the stitches. The framing consists of alternating straight floors and angular side frames, all of which are notched over the seam battens and fastened to the planking by treenails. Longitudinal reinforcement was added by a series of stringers over the floors; these were both nailed and treenailed.

De Weerd cites the Ljubljana boat and similar craft discovered in Italy as evidence of a Mediterranean tradition of flat-bottomed, straight-sided inland craft, and sees a relationship between this vessel and Zwammerdam 2, which had treenails in addition to nails fastening the floors to the planks, and notches in the frames over the plank seams (the other two barges are different). In the case of the later barge, the seam battens have gone but the form of the frame is retained. In addition, the framing has been altered to replace the transverse stiffening

⁷⁸ De Weerd, *supra* n. 7, p. 47.

⁷⁹ Originally published in A. Millner, "Ein Schiff im Laibacher Moore," *Argo, Zeitschrift für krainische Landeskunde* 1 (1892): 1-7 and "Addendum," *Argo, Zeitschrift für krainische Landeskunde* 5 (1896). More frequently cited (and accessible) is G. Salemke, "Die Ausgrabung eines Binnensee-Transportschiffes: Schiffsarchäologie von 1890 aus Laibach, Österreich (jetzt Ljubljana in Jugoslaviën)," *Das Logbuch* 9 (1973): 1, 21-24.

formerly provided by the sewing.⁸⁰ Both vessels have carved bilge strakes, but they serve different functions. The narrow curved strake in the Laibach boat connected the bottom and sides, but offered no other structural advantages. The heavy chine girders of the Zwammerdam vessels provide longitudinal strength and stiffness to their hulls, as well as greater transverse strength at the turn of the bilge.⁸¹ According to de Weerd, they were developed by the Romans to accommodate the inward pressure of the water, as right-angle chine girders might be stronger than obtuse-angled ones, and to allow heavily-laden boats to approach river quays.⁸²

I cannot agree with de Weerd's suggestion that the Roman-era craft of northwestern Europe are Mediterranean in origin, that an existing native tradition of boatbuilding was obliterated rather than adapted. Aside from problems with de Weerd's interpretation of the evidence, such an approach is distinctly non-Roman in attitude. While Rome was fairly insistent about spreading Roman government and culture, she was also a consummate syncretist. Her willingness to combine native religions and cultures with her own is a hallmark of Roman rule throughout the Empire. Thus Greek was never replaced by Latin in the East, foreign gods were included in the Pantheon, either directly or through identification with traditional Roman deities, and purely Italian forms of art and architecture were never transplanted much beyond the Alps. Even in the military, which

⁸⁰ De Weerd, *supra* n. 7, pp. 44, 47.

⁸¹ *Ibid.*

⁸² *Ibid.*, p. 47.

achieved a degree of standardization most impressive for a pre-industrial culture, fortification and other aspects of military technology were adapted to fit prevailing conditions and often borrowed from native traditions. One of the strengths of the early Empire was knowing how much Romanization was enough. In the matter of watercraft, Caesar himself was the first to note the advantageous qualities of the native vessels. More importantly, he wasted little time in adopting those aspects of native craft that could give him parity or an edge over the foe.⁸³

On a specific level, de Weerd divorces the excavated craft from Caesar's description too hastily. Even if *transtra ex pedalibus...* refers to the deck rather than the floors, there is no reason that the ships of the Veneti must be vastly different from the Blackfriars vessel. The heavy oak construction and thick nails are still present. The posts are not sufficiently preserved to determine their height or uprightness above the waterline, nor can any useful information be determined about the deck. If *transtra* does indeed mean "floors," then the applicability to the Blackfriars vessel would be hard to deny. The problem lies not just in the ships, but in Caesar's experience - the parts of the Veneti ships he is most likely to have described are not the parts most likely to have survived. That the finds date to after the Roman conquest is hardly surprising - the dramatic increase in the demand for water transport after the mid-first century AD should be reflected in the archaeological record.

⁸³ Caesar, *De Bello Gallico*, V.1.

The relevance of the Ljubljana boat is questionable. In the first place, it is not demonstrably "Roman," or even Mediterranean. It predates the Roman occupation of the region, and was found on a tributary of the Danube, rather than a river flowing into the Adriatic. While it is true that the discovery of other sewn river vessels in the region suggests the existence of a distinct tradition, there is no evidence for its widespread adoption outside Illyricum and Dacia. On the Tiber, where conditions necessitated shallow, burdensome craft to move bulk goods, such as grain and stone, upriver from Ostia, Zwammerdam-style craft were not adopted. Instead, shoal vessels with flat floors and keels, built in the mortise-and-tenon tradition common to the Mediterranean were used. Excavated examples of such craft have been found at the mouth of the Tiber, at Fiumicino.⁸⁴ Even on the Sea of Galilee, a backwater if ever there was one, an excavated vessel of the Roman period was still built in a recognizable, if crude, mortise-and-tenon style.⁸⁵ As the County Hall and Vechten vessels show, Mediterranean shipbuilding technology was imported into northern Europe, but it is less common than a non-edge-joined method exemplified by the so-called "celtic" vessels. It may well be that the oak of the North was poorly suited to mortise-and-tenon construction, and that a local alternative was preferred.

Even if the tradition represented by the Ljubljana vessel can be shown to be Roman/Mediterranean, there is at best a superficial resemblance between it

⁸⁴ O. Testaguzza, *Portus: Illustrazione dei Porti di Claudio e Traiano e della Città di Porto a Fiumicino*, pp. 129-146.

⁸⁵ J.R. Steffy, "The Boat: A Preliminary Study of its Construction," in *The Excavations of an Ancient Boat in the Sea of Galilee (Lake Kinneret)*, S. Wachsmann, pp. 29-48.

and the Zwammerdam vessels. As Basch noted, all flat-bottomed vessels do not come from the same roots.⁸⁶ De Weerd notes three similarities: treenails fastening frames to planks, notches in the underside of the floors that correspond to the plank seams, and carved bilge strakes/chine girders. He does not specifically mention the flat bottom, but it is sufficiently obvious. He then must explain the significant differences between the vessels: the absence of edge-to-edge fastenings in most of the Zwammerdam vessels (a major conceptual discrepancy), the dissimilar framing systems, the predominance of iron fastenings rather than treenails in the Zwammerdam barges, and the different form and function of the bilge strakes/chine girders. He portrays most of the differences as advances, but it seems odd that it took Mediterranean shipbuilders another two or three centuries to begin to give up edge fastenings and then in a manner suggesting an entirely different approach to planking and framing than is seen in the northwestern vessels. The change in framing, from Ljubljana to Zwammerdam, is in fact a step down rather than up. The thin branches on the ends of the Zwammerdam floors and the separate side futtocks provide relatively little transverse strength to the sides; the chine girders are much more important here. If the Romans had imposed their own building methods, why did they abandon the evenly-spaced, alternating floors and half-frames common in Mediterranean ships from the fourth century BC to the seventh century AD in favor of a system not seen on any

⁸⁶ L. Basch, "Ancient Wrecks and the Archaeology of Ships," *IJNA* 1 (1972): 18.

Mediterranean wreck before the eleventh century AD.⁸⁷ As will be seen below, paired floors with knee-ends at alternate sides remain a tradition in medieval craft of northern Europe, but are not seen in medieval Italian vessels, such as those found at Contarina and Logonovo.⁸⁸ Where Mediterranean planking methods were imported into the north, the framing system was included, so why abandon it in the barges?

I agree with de Weerd that the chine girder does not seem to be a straightforward development of the split dugout, and his suggestion that this was a Roman answer to the problems of hull stiffness in long, narrow, shallow barges is entirely reasonable, as long as one does not put too much emphasis on who came up with the idea. The use of double-clenched nails may also be a result of Roman influence, but independent invention cannot be ruled out - the technology is hardly complex or mysterious. The use of Roman units of measurement is interesting but by itself does not constitute proof of a wholly Roman method of shipbuilding. In the end, I believe that Ellmers was essentially correct - the Zwammerdam and Blackfriars craft are native types enlarged to meet Roman needs. Some improvements, such as the chine girders, may have been necessary in craft expanded beyond the "natural" size range of the type, but the basic features are indigenous.

⁸⁷ In the Serçe Limanı vessel, the floor timbers are L-shaped and alternate sides. J.R. Steffy, "The Reconstruction of the 11th Century Serçe Limanı Vessel," *JNA* 11 (1982): 21-23.

⁸⁸ M. Bonino, "Lateen-Rigged Medieval Ships. New Evidence from Wrecks in the Po Delta (Italy) and Notes on Pictorial and Other Documents," *JNA* 7 (1978): 13-17. Both vessels are distinguished by symmetrical floor timbers.

What then is this native tradition? A variety of hull forms and apparent construction methods are represented, although all but the Mainz and Oberstimm patrol craft have either completely flat bottoms or a central bottom flat in an otherwise rounded hull. I suggest that the Blackfriars, Zwammerdam/Bevaix, and probably the New Guy's House types are all products of an indigenous, bottom-based tradition of shipbuilding. All share a bottom made up of relatively straight, heavy planks that is easily distinguished from the sides, either by form or construction.

In the Blackfriars vessel, the bottom consists of the two central strakes and the tapered transition strake on either side. These are shaped to form a bottom with relatively straight edges amidships and tapered ends. The ends of the transition strakes were cut off short of the posts by the third strakes, which sweep in to meet the post rabbets. Conceptually, the bottom is a flat panel made up of four straight boards, out of which the tapered final shape was then cut. The odd, plugged holes in these planks may be the remains of temporary fastenings used to hold this "panel" together until it was shaped and the floors added. The sides may well have been built by bending planks around the ends of the floors, up to the fifth strake. In contrast to the Zwammerdam barges, the sides do not meet the bottom at as sharp an angle. The decreasing deadrise of the third strake toward midships hints that the bottom flat (the straight part of the floor, rather than just the central four strakes) may have been wider than the "structural" bottom. The "roundness" of the hull negates some advantages of the flat bottom, namely increased capacity for limited beam and draft and simplicity of construction, so one

must ask why the builder chose this configuration. As Caesar noted, not only did the ships of the Veneti survive shoal waters, but they could take the ground safely.⁸⁹ A flat bottom with a central "runner" of heavier planks seems ideal for such use, and grounding remained a common method of loading and unloading vessels in the tidal reaches of the Thames and Medway into this century. An interesting parallel may be seen in the eighteenth-century Brown's Ferry vessel discussed below (Chapter VI).

The Bevaix boat offers the clearest example of a bottom-based tradition of boatbuilding. The arrangement of the bottom planks and the rows of plugged holes in them are strong evidence that the bottom was assembled plank-first and fastened together temporarily, until frames could be added. The chine girders complete the bottom and form the sides; the vessel is not just bottom-built, but almost bottom-only. The bottom planking of the Yverdon boat is more conventionally arranged, about a central axis, but it still makes up a flat panel out of which the bottom is shaped.

The Zwammerdam vessels, as well as the other barges of Germania, are essentially similar to the Bevaix and Yverdon boats in all respects. The barges are somewhat more crudely shaped, with long straight portions amidships, but this shows even more clearly how the bottom is a separate structure, a panel of straight planks cut to shape. The sides of the Zwammerdam barges demonstrate the variation in side construction that is often a diagnostic feature of bottom-built

⁸⁹ Caesar, *De Bello Gallico*, III.13.

construction. Two of the barges, vessels 2 and 4, have a single side plank lapstrake fastened to the upper, outboard edge of the chine girders (the same method can be seen in the extended dugout, vessel 3), but the side planks of vessel 6 are laid flush to the upper edge of the chine girders and edge-fastened to them by oblique nails and a few Mediterranean-style mortise-and-tenon joints. Different framing patterns are also possible, with both single and paired frames represented. Unfortunately, there is no direct evidence yet published that the bottom planks were laid up and temporarily fastened together before the floors were added.⁹⁰ It does seem more efficient to shape the frames to fit the chine girders than the other way round, but modern ideas of what is easier or harder do not always apply to ancient craftsmanship.

It is difficult to determine if the chine girders should be considered part of the bottom, or part of the side. If the Blackfriars vessel is taken as conceptually similar, part of the bottom flat amidships is formed by the lowest side plank. On the other hand, if certain later northern European bottom-built vessels are in the same mold, the bottom-built portion of the ship continues up around the turn of the bilge. If, as de Weerd has suggested, they are a Roman innovation, they may represent a blurring of the line between bottom-built and true shell-built craft. It

⁹⁰ Nor is such evidence likely to be published until after the vessels come out of conservation. De Weerd works only from drawings at scale 1:20, and these were done before Dutch archaeologists were aware of the presence of temporary fasteners in excavated craft - see below, Chapters IV and V.

should be noted that although they survive into the Middle Ages, their use is restricted to the box-section craft identified as prams by Ellmers and others.⁹¹

The New Guy's House and Mainz rowed vessels remain oddballs. The former was simply not sufficiently excavated to determine the necessary details of construction, but a few clues are available. The round bilges may or may not be significant, as the Blackfriars vessel may have relatively soft bilges in the same area. The framing in the bow, where floors alternate with the stumps of half-frames meeting over or near the keel, suggests a Mediterranean influence. As the Blackfriars and Zwammerdam/Bevaix types show, several different framing patterns were in use among the bottom-built craft, but alternating floors and half-frames do not appear to be among them.

The Mainz patrol boats are most peculiar. They are clearly round-bottomed, with keelplanks but no apparent distinction in shape or structure between bottom and side. They are not Mediterranean craft, at least not in the mortise-and-tenon fashion considered typical of Mediterranean shipbuilding of the period, nor do they fit in with the bottom-built vessels described above. Ellmers has published at least one representation of a low, oared boat from a Roman Rhine context,⁹² and this may depict vessels similar to the Mainz boats. Perhaps they are a native type, a "war canoe," adapted to fit Roman needs. Their late date coincides with a period when native troops were in increasing use along the

⁹¹ D. Ellmers, *Frühmittelalterliche Handelsschifffahrt in Mittel- und Nordeuropa*, pp. 95-110.

⁹² Ellmers, *supra* n. 14, p. 9, Fig. 13. Ellmers identifies it as an Anglo-Saxon warship.

frontier. In any case, the possibility that they were built frame-first cannot be ignored. Perhaps further study of the hull remains will yield better insight.

While a strong tradition of bottom-built ships and boats can be identified among the excavated wrecks from Roman northern Europe, some problems of interpretation remain. The principal question centers on the cultural origin of this tradition: can this style of boatbuilding be tied directly to the indigenous peoples of pre-Roman northern Europe? These people were primarily Celtic, at least in the area governed by Rome, and there does seem to be some correspondence between the ships described by Caesar and the Blackfriars ship. In addition, the Mainz patrol boats indicate the existence of a separate boatbuilding tradition, possibly originating in Germanic culture. If a Celtic affiliation can be demonstrated, it is interesting to note that the tradition reached its highest level of development among medieval Germanic peoples along the coast of the North Sea.

CHAPTER III

THE EARLY MIDDLE AGES

The Roman Era in northwestern Europe "officially" ended in 486, with the defeat of the last significant Gallo-Roman warlord by the Franks, but steady encroachment by Germanic invaders and a succession of rebellions by Roman generals and their troops had begun to break down the political stability and economic health of Roman Gaul and Germany long before. From the late third century, it became increasingly difficult to maintain the authority of Roman civil administration and social institutions. From the fourth century, frontier security depended increasingly on a policy of "Germanification," the settling of German troops and their dependents within the borders of the Empire. Eventually, the combination of external pressure and interior decay proved too much, as a succession of Germanic peoples poured across the Rhine and into the West in the fifth century. Pockets of Romanized culture survived, but Rome ceased to have any real influence in the affairs of Britain, Gaul, and Germany early in the fifth century. The invaders carved new kingdoms out of the old Roman dioceses. Angles, Saxons, and Jutes divided Britain into a host of small states that merged and fought with each other for nearly four centuries. Periodically, one king would exert enough influence over his neighbors to be recognized as *bretwalda*, the high king or, literally, "ruler of Britain." Eventually, a series of strong rulers emerged in the Saxon kingdom of Wessex. They succeeded in uniting most of southern

Britain into more or less one state by the ninth century, but, just as their Roman predecessors, they could not subdue the Welsh or the Scots.

In northern France and Germany, the Franks had little trouble wiping out Gallo-Roman resistance and Germanic competition. Merovingian kings, the successors of Childeric and Clovis, concentrated their efforts in the area that is now France, which was divided between the Neustrian and Austrasian kingdoms, and left the lands east of the Rhine to other tribes even less civilized than themselves. They took over some (largely cosmetic) aspects of late Roman administration and established ties with the Mediterranean world, but spent much of their time warring with the Burgundian and Visigothic states to the south. Their line was eventually replaced on the throne by that of Charles Martel, the former Mayor of the Palace, in the first half of the eighth century. His Carolingian successors, especially Charles the Great (Charlemagne), pushed the borders of Frankish territory south to Italy, east into Germany, and successfully opposed the northward expansion of Islam from Spain. Charlemagne also began a long and difficult association between German kings and the Papacy. The division of the Frankish empire among his three grandsons in 843 set the stage for much of later European history: French and German kings fighting over the eastern half of the Rhineland.

Both England and the Frankish kingdom were well on the way to some form of political unity in the late eighth century when a new group of invaders struck. Unlike previous barbarian hordes, these men did not come from the east and they did not at first come to occupy the land or settle. They came from the

north and preyed on the wealth of their southern neighbors. The Vikings were Danes and Norwegians who began raiding coastal settlements in England and the Frankish lands in the 790s. Their tactics depended initially on speed, ferocity, and the avoidance of pitched battles with seasoned troops. The raids grew in frequency and size as the ninth century progressed, until the Norsemen were able to sack Paris in 845 and winter over in France through much of the 840s. The immediate effect was widespread destabilization, especially near the coastal areas controlled by the invaders. The Franks under Charlemagne and his son, Louis the Pious, had managed to hold off the major assaults, but the breakup of the Carolingian Empire after Louis's death in 840 left France unable to mount effective resistance.

In a second wave of attacks beginning in the later ninth century, Danes and Norwegians began to settle in northeastern England, Ireland, and northern France. English forces were unable to dislodge them and were forced to accept a permanent Norse presence, the Danelaw. In the early eleventh century, renewed Danish expansion put a Viking king, Canute the Great, on the English throne. His son, Hardicanute, succeeded him but marked the end of the Danish dynasty, although the Norse were not permanently ejected from England until 1066, when Harald Godwinson defeated the last Viking army at Stamford Bridge, only weeks before his own defeat by William's Normans, themselves the descendants of Norse settlers in northern France.

The marshy lands to the north of the mouth of the Rhine and around the Flevomeer, a freshwater lake that later became the Zuiderzee,¹ had been occupied in Roman times by the Batavi and the Frisii, Germanic tribes who eked a marginal existence from fishing and herding. The Batavi had proved a perennial problem to the Romans, but the Frisii had been briefly employed as a client buffer state early in the Roman administration of the Rhine frontier. They later rebelled, and were never really subdued. The inhospitable country which they inhabited no doubt contributed to a lack of Roman enthusiasm for campaigns in the area. The Frisians retained an independent spirit throughout the Middle Ages and into the present. They occasionally acknowledged Frankish kings, but had their own rulers until finally conquered by Charles Martel in the 730s and were serious competition for Frankish merchants. Even today, they maintain their own language (so that Friesland is the only Dutch province with bilingual road signs) and a strong sense that they are an independent nation allied with the surrounding country. Although somewhat isolated in their waterlogged land, the Frisians turned outward in the early Middle Ages, voyaging westward to France, eastward to Denmark, and from there to the Baltic, where they established settlements as far north as Sweden.

With political fragmentation and the withdrawal or defeat of Roman troops came economic collapse. The decline of the towns and departure of the army removed the most important markets for both staples and luxury goods. At the same time, the ensuing insecurity of roads and waterways must have discouraged

¹ The development of the Flevo Lacus (Flevomeer) into the Zuiderzee is described in Appendix I.

travel and rendered long-distance commerce extremely risky. Trade in cheap bulk goods is exceptionally vulnerable to perturbations of market and political instability. Such goods can only be traded profitably at a distance if transportation and other costs are kept to a bare minimum. Other factors being equal, larger vessels are more efficient and tend to be favored in bulk trades, but they depend to a greater degree than smaller vessels on reliable sources, steady demand, and secure, free routes. Roman control and the institutions that maintained it had provided the necessary conditions for bulk trades to develop, most noticeably in the shipment of staples and building materials, and consequently a demand for large ships and barges, such as *Zwammerdam 4*. With political control distributed among a large number of petty kings and warlords, each extracting tolls from traffic through his realm and each posing a risk to merchants, goods, and vessels, bulk trades rapidly become economically impractical.

Where risk is greater, there is often a tendency to distribute the risk by breaking one shipment up into several smaller shipments and to own several smaller vessels rather than one large one. While division reduces losses due to theft, piracy, etc., it is less efficient and effectively increases the cost of transportation. Risk itself increases cost, even where risk has not been quantified in the form of insurance. Shippers and merchants must charge enough to cover incidental losses and hedge against possible catastrophic loss. The general trend under such conditions is an overall decline in the volume of long-distance travel and commerce, as well as a reduction in vessel size.

This is not to suggest that the economy of northwestern Europe ground to a halt. Merovingian merchants maintained some contacts beyond the regional level, and rulers certainly had access to foreign products, as the variety of goods buried in the seventh-century ship grave at Sutton Hoo attests.² Individual town markets had largely ceased to exist with the end of Roman control and did not begin to revive until the tenth century. Instead, regional emporia served as the focus of smaller-scale, long-distance exchange. Trade across the North Sea to Britain did not cease, as excavations at the early medieval port of Hamwih (Southampton) show.³ Excavations have also shown the development of major emporia at Dorestad (the Netherlands),⁴ and Haithabu (at the base of the Danish peninsula)⁵ in the eighth and ninth centuries, with minor markets elsewhere in northwestern Europe.⁶ With trade reduced in volume and largely restricted to

² R. Bruce-Mitford, *The Sutton Hoo Ship-Burial*, is the definitive study of the ship and grave goods. The grave, thought to be that of the East Anglian *bretwalda* Rædwald, contained Byzantine silver plate, a Coptic bowl, Merovingian gold coins, Swedish armor, etc. as well as Anglo-Saxon luxuries.

³ R. Hodges, *The Hamwih Pottery - The Local and Imported Wares from Thirty Years Excavations in Middle Saxon Southampton and Their European Context*, deals primarily with the pottery, but also provides an introduction to the excavation and discusses the evidence for the structure of trade across the Channel in the Anglo-Saxon Period.

⁴ W.A. van Es and W.J.S. Verwers, *Excavations at Dorestad 1. The Harbour: Hoogstraat 1*, is the first scholarly synthesis of the Dorestad excavations.

⁵ H. Jankuhn, *Haithabu. Ein Handelsplatz der Wikingerzeit*, although originally written in the 1930s, has been continuously updated (through eight editions to 1986) and offers a masterful summary of both the excavated material and the historical background to the development of the site.

⁶ Recent thinking on the development of North Sea trade in the early Middle Ages is reflected in R. Hodges, "North Sea Trade before the Vikings," in *Archaeological Approaches to Medieval Europe*, ed. K. Biddick, pp. 193-201. See also R. Hodges and D. Whitehouse, *Mohammed, Charlemagne and the Origins of Europe: Archaeology and the Pirenne Thesis*, pp. 77-122.

regional routes, the demand for water transport should have shifted largely to local riverine and coastal craft, with some seagoing ships, many of which seem to have been operated by Frisians.

Richard Hodges believes that the small size of watercraft available to merchants in this period also limited trade, or at least reflected its small scale.⁷ After examining the few archaeological examples of watercraft from the early Middle Ages, he concludes that these are typical of long-distance vessels and thus prove that trade cannot have been anything but minimal, as all of the vessels are rowed, with only small, auxiliary sails. Shippers had to wait until the tenth century for keels strong enough to carry large sails and bottoms deep enough to make seagoing commerce economically feasible.⁸ Unfortunately, few if any of the vessels examined (the Graveney, Utrecht, and Äskekärr finds) can be shown to be typical deepwater merchantmen. The Graveney boat,⁹ a small, heavily-built clinker vessel from Kent, is considered suitable (although not comfortable) for seagoing commerce and was probably propelled by sail,¹⁰ but there is no way to

⁷ Hodges, *supra* n. 6, p. 196; more fully developed in R. Hodges, "Frisians and Franks: Argonauts of the Dark Ages," *Archaeology* 37.1 (Jan/Feb, 1984): 31.

⁸ Hodges, *Archaeology* 37.1 (Jan./Feb., 1984): 31.

⁹ V. Fenwick (ed.), *The Graveney Boat: a Tenth-Century Find from Kent*, is an exhaustive study of all aspects of the Graveney vessel and its environment, although the interpretation of the vessel itself relies too heavily on attribute analysis.

¹⁰ V. Fenwick, "Geographical and Historical Background," pp. 173-175 and E. Corlett, "Appreciation of the Lines," pp. 305-307 in *The Graveney Boat: A Tenth-Century Find from Kent*, ed. V. Fenwick. Corlett notes that while the boat is quite capable in a seaway and "extravagant" if only a river barge (p. 307), it was probably a wet sailer in rough water, necessitating a cover or dodger over the cargo. Could this be better interpreted as a coastal rather than seagoing vessel?

tell if it is typical. The Sutton Hoo ship,¹¹ of earlier date, is considerably larger; although not intended as a cargo carrier, it does demonstrate the existence of larger craft in Anglo-Saxon England. The Utrecht vessel, a large dugout with raised sides, has been redated to the early eleventh century.¹² Even if earlier, it is clearly a river vessel, with its low freeboard, shallow draft, and round bottom. The Äskekärr vessel,¹³ of typical Nordic construction, is too poorly preserved to determine its function or propulsion characteristics, although a small maststep was found. In the absence of an identifiable deepwater cargo carrier that can be accepted as typical, these vessels by themselves tell us nothing of the size or scope of early medieval trade. In any case, it is more likely that vessel size was limited by the volume of trade rather than determined it. In the Roman period, northwestern European shipwrights had built quite large vessels; if this technology was "lost," it was through lack of need. Once demand for tonnage increased, vessel size increased accordingly.

Northern European trade and the economy in general had definitely begun to recover by the late eighth century. Gold had gone out of circulation, but a strong silver coinage had been successfully established by Charlemagne.¹⁴ The

¹¹ A.C. Evans and R. Bruce-Mitford, "The Ship," in *The Sutton Hoo Ship-Burial I*, R. Bruce-Mitford, pp. 345-435.

¹² R. Vlek, *The Mediaeval Utrecht Boat: The History and Evaluation of One of the First Nautical Archaeological Excavations and Reconstructions in the Low Countries*, p. 67.

¹³ D. Ellmers, *Frühmittelalterliche Handelsschiffahrt in Mittel- und Nordeuropa*, pp. 314-315.

¹⁴ This was based on the *denier* (penny), of which there were 240 in a *libra* (pound) of silver. This currency system survived in Europe, in various forms, until the United Kingdom switched to New Pence (100 to the pound) after 1970. The last northern European gold coins were minted

first Holy Roman Emperor also pressed Constantinople for favorable trading privileges for Frankish merchants, suggesting the existence of some sort of long-distance commerce. Dorestad experienced its greatest prosperity in the late eighth and early ninth centuries, and Haithabu, where the overland journey between the North and Baltic Seas was shortest, began to flourish soon after.¹⁵ There is ample evidence for long-distance voyages, especially by Frisian merchants, who established colonies in the Baltic.¹⁶ The Rhine remained a major highway from north to south, and east-west traffic passed from Denmark along the Frisian coast, behind the barrier islands guarding the Waddenzee. The Vikings disrupted the recovering economy somewhat, but did not destroy it. As many scholars have noted, the Norse came not just to steal from the rich, but to trade with them. The Swedes were especially successful, establishing strong trading links across the Baltic, along the Russian rivers, all the way to the Black Sea and Byzantium.

It is unfortunate that we know so little of the watercraft of this period. Nordic vessels are well represented, but there are no excavated examples of the Frisian ships so instrumental in the establishment of long-distance trading contacts. The Sutton Hoo and Graveney vessels indicate that a clinker boatbuilding tradition seen earlier in the Nydam vessels and certainly related to Viking/Nordic boatbuild-

in the 670s, by which time silver deniers had begun to appear. On the transition from gold to silver currency and the monetary reforms of the Carolingians, see P. Spufford, *Money and its Use in Medieval Europe*, pp. 17-36.

¹⁵ Hodges, *supra* n. 6, p. 195.

¹⁶ D. Jellema, "Frisian Trade in the Dark Ages," *Speculum* 30 (1955): 15-33.

ing had been imported into Britain by the invading Anglo-Saxons,¹⁷ but what of native British boatbuilding, or its Roman-influenced descendants? The Anglo-Saxons were quite effective in eradicating most aspects of Roman and native British culture, but did that include long-standing craft traditions as well? Certainly, the general decline in the level of trade and number of ships means that there are fewer ships to find, but surely some await discovery in the Rhine and the inhospitable waters of the Waddenzee.

Until then, most of the evidence for non-Scandinavian ships and shipping is textual and philological. In Anglo-Saxon Britain, the most commonly mentioned boat type (where a specific word, rather than the ubiquitous Latin *navis*, is used) is the keel (Latin *ciula*, from Anglo-Saxon *ceol*).¹⁸ Fliedner has noted that the two most important deepwater ship types of the later Middle Ages, the cog and hulk, are both attested before 1000,¹⁹ although what sorts of vessels these terms describe is difficult to say.

¹⁷ D. Goodburn, "Do We Have Evidence of a Saxon Boatbuilding Tradition?" *JNA* 15 (1986): 39-47; V. Fenwick, "Structural Evidence for the Origin of the Ship and Comparison with other Early N. European Ship-Finds," in *The Graveney Boat: A Tenth-Century Find from Kent*, pp. 193-264.

¹⁸ Ellmers, *Frühmittelalterliche Handelsschifffahrt*, pp. 47-58 on the keel type generally.

¹⁹ S. Fliedner, "'Kogge' und 'Hulk': Ein Beitrag zur Schiffstypengeschichte," in *Die Bremer Hanse-Kogge: Ein Schlüssel zur Schifffahrtsgeschichte*, H. Abel et al., p. 42 gives 948 as the earliest reference to cogs, in the word *cogsculd* (literally, "cog-obligation"), a military duty or tribute owed Emperor Otto the Great by the Bishop of Utrecht. Ellmers, *Frühmittelalterliche Handelsschifffahrt*, p. 71 notes a reference of 867 to a people newly called "Cokingi" in the *Annales Bertiniani* ("*incolae, qui Cokingi novo nomine dicuntur*"). These people expelled the Danish prince Rorik from Frisia. Ellmers would like them to be named for the vessels they used to do this. Fliedner, *supra*, p. 54, finds the first reference to hulks in English toll records of foreign vessels from the reign of Æthelred II (991-1002).

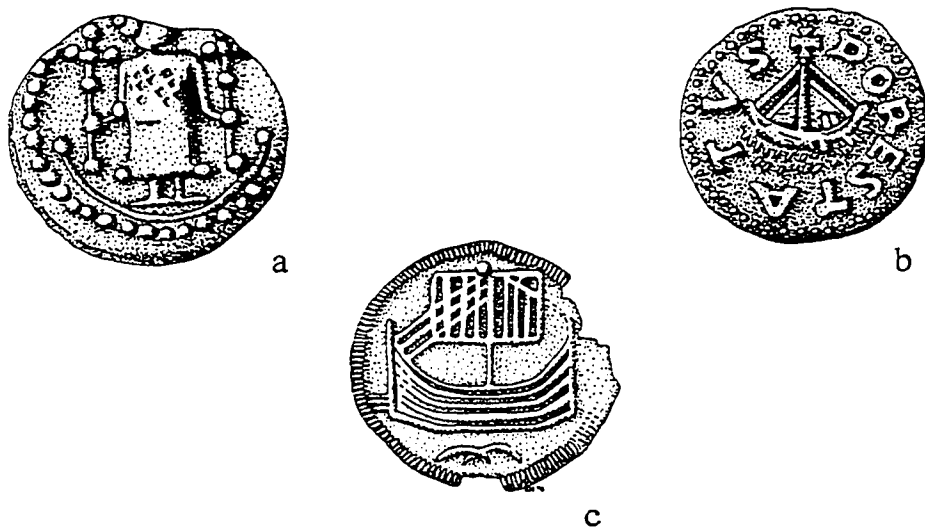


Figure 6. Ship representations on early medieval coins. a. Saxon *sceatta*; b. Dorestad *denier*; c. Baltic coin possibly minted at Haithabu (Drawing E. Titford).

Representational evidence is also slim, with most of the discussion centered on some very schematic depictions on coins. These include crescentic hulls on Saxon *sceattas* of the seventh century (Fig. 6a),²⁰ and similar vessels with single masts, quarter rudders, and oars on Carolingian *deniers* minted at Dorestad and Quentovic (Fig. 6b).²¹ Vessels with straight or kinked bottoms, straight, vertical posts and single, square sails are shown on later silver coins attributed to Birka or

²⁰ Ellmers, *Frühmittelalterliche Handelsschifffahrt*, p. 43, Fig. 28.

²¹ *Ibid.*, p. 56, Fig. 39a-d shows four representative Dorestad issues of Charlemagne and Louis the Pious. Quentovic issues are similar, but slightly later and rarer; one is illustrated in Bruce-Mitford, *The Sutton Hoo Ship-Burial*, p. 423, Fig. 321a. I thank Peter Spufford and the Fitzwilliam Museum, Cambridge, for the opportunity to examine an example of the Dorestad issues in detail.

Haithabu (Fig. 6c).²² Ellmers believes that the Saxon coins show keels, the Dorestad and Quentovic coins show hulks, and that the Haithabu ships are cogs.²³ There is no reason that this cannot be so, as the appropriate ships could have reached the required ports/mints: the Saxons used keels; hulks (whatever they were) may have been able to reach Dorestad, which was a major international port; and Frisians, who are thought by many to have "invented" the cog, were probably very strongly represented at Haithabu. The difficulties lie in the representations themselves. They are all far too schematic and stylized to offer much real help in the identification of ship types. The ship of the *sceattas* is no more than a single curved line with a dot at each end, parallel to the border, below a standing man. There is nothing inherent in the representation that specifically identifies it as a boat. The Dorestad/Quentovic representations are composed of two or three curved lines for the hull, one (or no) vertical for the mast, one to three lines (stays?) fore and aft of the mast, a series of short strokes below the hull for oars, and various methods for representing the quarter rudder. These are extremely generic pictographs barely a centimeter across; they convey the idea of "ship," but little more. They cannot be compared with the extremely

²² Ellmers, *Frühmittelalterliche Handelsschiffahrt*, p. 56, Fig. 39e-h. Ellmers believes these to have been minted in Haithabu as imitations of contemporary and earlier Dorestad coins, but with a vessel representation more relevant to Haithabu traffic: *Ibid.*, pp. 71-72. His argument depends on the identification of the ship representation: because the coins show cogs instead of Viking ships, they cannot have been minted at Birka (Sweden, where they were formerly attributed) before the establishment of the *Kugghamn* ("cogharbor"), but they must have been minted where cogs were important. Haithabu, because of its Frisian connections and the similarity of the reverse device to houses in Trelleborg (South Scandinavia), is the logical choice.

²³ *Ibid.*, pp. 48, 59, 71-3.

detailed cog and hulk representations from late medieval city seals of Germany, France and England.

The Haithabu coins are similar in layout to the Dorestad/Quentovic coins, but the ships are noticeably different; the sails are raised and the hulls are definitely not crescentic, although lines that seem to represent planking are curved upward toward the ends. Because later cogs had straight (although not vertical) posts and single square sails, Ellmers sees in these coins the earliest representations of the cog type, even claiming that the kinked bottom on some of the coins represents the slight angle between keelplank and hook (an angular intermediate timber between keelplank and post) observed on some cogs of the High Middle Ages and interpreting the number of represented strakes literally.²⁴ I cannot accept this without reservation, as the Frisians were not the only seafarers to frequent Haithabu; archaeology suggests a strong Scandinavian presence as well.²⁵ The territory itself is Danish/Wendish, and the earliest detailed seal representations from the Baltic side of the base of the Danish peninsula, the city seals of Lübeck from 1224 to 1280, do not show cogs but a more Scandinavian or Slavic vessel with curved posts.²⁶ As with the Dorestad and Saxon coins, the

²⁴ Ibid., p. 69; D. Ellmers, "The History of the Cog as a Ship Type," in *The Hanse Cog of 1380*, eds. K.-P. Kiedel and U. Schnall, p. 62.

²⁵ Jankuhn, *Haithabu*, p. 126 notes that the presence of Frisians in Haithabu cannot be proven archaeologically or from textual evidence before the tenth century, although it is highly likely. The only boat remains found to date in Haithabu harbor are of a Nordic vessel: O. Crumlin-Pedersen, *Das Haithabuschiff*, pp. 28-29.

²⁶ These representations will be discussed in more detail below. Ellmers, *supra* n. 24, p. 63, Illus. 58, although Ellmers believes it shows a cog.

stylized nature of the representations themselves argues against too detailed an interpretation.

The lack of concrete evidence about non-Scandinavian shipbuilding presents an undeniable problem for any argument that a bottom-built tradition of shipbuilding has survived in northwestern Europe since before the Roman conquest. The existence of a tradition can be clearly demonstrated for the Roman era and for the High Middle Ages onward, but the early Middle Ages remain a vacuum until more and better evidence can be produced. It is perhaps reassuring that the cog can be traced back to the tenth century in written records, but there is no certainty that early medieval cogs were built in the same manner as Hanseatic versions, although there is also no good reason to presume that they were not. It is also reassuring that the principal product of this tradition in both Roman and later times was inland and coastal craft, those types least vulnerable to political and economic disturbance.

If the distinctive feature of a bottom-built tradition is a conceptual difference between bottom and side, it might be suggested that some larger Viking ships could be interpreted as bottom-built. In these vessels, the bottom of the ship ends at a heavy, wedge-sectioned or moulded strake called the *meginhufr*. The heads of the floor timbers are fastened to this strake, and none of the upper frame components extend down to it, so that the sides are virtually independent of the bottom. In some of the earlier vessels, such as those from

Gokstad,²⁷ Oseberg,²⁸ and Tune,²⁹ the distinction between bottom and side is further emphasized by changes in fastenings; the floor timbers are lashed to raised cleats on the inner surface of the planking, while the upper frame components are nailed or treenailed in place.

Such an interpretation is valid only superficially, as it ignores the essential features of Nordic shipbuilding in favor of certain quirks of its later development. Clinker boats and ships are, first and foremost, shell-built in a relatively pure sense, with a continuous structure of overlapping, edge-joined planking assembled before the insertion of framing. Earlier and smaller Nordic craft, such as the Nydam and Kvalsund³⁰ vessels, have a simpler structure, with ribs instead of complex frames. These ribs reach the sheerstrake, which is a heavier plank of wedge or moulded section. Lateral stiffness and rowing perches are provided by thwarts slotted over the heads of ribs. Later Viking craft may be seen as an extension of this basic structure upwards, as none of the original features were initially abandoned. The floor timbers in later vessels are still, essentially, ribs that reach upward to a heavier, wedge-sectioned or moulded strake. Thwarts are still

²⁷ N. Nicolaysen, *Langskibet fra Gokstad ved Sandefjord/The Viking Ship from Gokstad*, is the excavator's comprehensive report and remains the best source on the ship and burial. W. Dammann, *Das Gokstadsschiff und seine Boote*, is intended primarily for model builders, but provides an excellent summary of the principle construction features and a complete, detailed set of drawings of the hull.

²⁸ A.W. Brøgger, H. Falk, and H. Shetelig, *Osebergfundet*.

²⁹ The Tune vessel is less extensively published than other Scandinavian boat finds, largely due to its poor preservation and early date of excavation, but some useful information on construction can be found in A.W. Brøgger and H. Shetelig, *The Viking Ships: Their Ancestry and Evolution*, pp. 104-107.

³⁰ H. Shetelig and Fr. Johannessen, *Kvalsundfundet*.

slotted over the heads of the ribs, even if they are too low in the hull to be useful as seats for oarsmen. Above this, the sides are constructed of more clinker planks reinforced by standing knees fastened to the upper surface of the thwarts and short, free futtocks (sometimes called "side frames"). In some vessels, the thwart/knee combination may be repeated at several levels. This peculiar system of framing was retained until well into the late Middle Ages, but the strong distinction between lower and upper structure had begun to disappear by the end of the Viking Period; the eleventh- or twelfth-century Skuldelev vessels have no *meginhufar* and in at least one of the ships, the free futtocks extend downward to overlap the ribs/floor timbers.³¹

³¹ O. Olsen and O. Crumlin-Pedersen, "The Skuldelev Ships (II)," *Acta Archaeologica* 38 (1967): 116-117 and Fig. 34.

CHAPTER IV

THE LATER MIDDLE AGES AND COGS

Historical Background

The last significant invasion in northwestern Europe until 1944 came in 1066, with the Norman Conquest of England. Pity the vanquished, Harald Godwinson, who had only just succeeded in throwing out the previous horde of invaders, the Danes. William set about the business of administering (and exploiting) his new acquisitions in a very modern way: he commissioned a survey of the island's land, population, tax history, and resources in 1086. In many ways, that survey and its product, the Domesday Book, are important symbols of the future. Europe was passing out of a period in which arms and prayer ruled into an age in which money talked. All members of society were increasingly concerned with cost and with income. Rulers could no longer depend entirely on force for power; they too had to worry about the cost of arming and maintaining their troops.¹ They had to devise practical means of raising revenue, as the European economy became increasingly monetary and unclaimed land harder to find. The growth of economic influence was an almost inescapable result of a general increase in prosperity and disposable income.

The cause of economic growth after about 1000 is difficult to ascribe to any

¹ The growing importance of economic factors in the development of military technology from the beginning of the eleventh century is the central theme of W.H. McNeill, *The Pursuit of Power: Technology, Armed Force, and Society since A.D. 1000*. On the Middle Ages, see pp. 63-116, esp. pp. 102-16.

one factor. Lynn White, one of the first historians to relate technological advances to economic and political developments, believed that agricultural advancements of the eighth, ninth, and tenth centuries increased productivity sufficiently to provide landowners with usable surplus and thus a source of monetary income.² A moderate increase in political stability did not hurt, nor did the growth in population. Both allowed waste land to come under cultivation and provided inhabitants for the growing towns and cities. The beginnings of urbanization, whether cause or effect of economic growth, provided markets for agricultural surplus and centers for manufacturing and commerce.³ The bureaucratization of government and the Church also provided markets for luxury goods and a focus for aristocratic spending.

If the causes of prosperity can only be surmised, the results are easy to observe in both the historical and archaeological record. Issues of coinage increased to meet the demand for currency.⁴ Major building campaigns in stone began on cathedrals, churches, and palaces throughout the northwest after about 1000. Governments instituted rational bookkeeping systems for recording income and expenditures. Towns grew and new towns were founded. The first hints of the growth of a middle class, men not tied to the land or receiving the fruits of peasant labor, but earning a decent income from manual trades or commerce, can

² First suggested in L. White, "Technology and Invention in the Middle Ages," *Speculum* 15 (1940): 151-153.

³ See R. Hodges, *Dark Age Economics: The Origins of Towns and Trade AD 600-1000*, for an archaeological view of the origins of medieval towns.

⁴ P. Spufford, *Money and Its Use in Medieval Europe*, pp. 74-131.

be seen in larger towns.

Most important, in terms of its consequences for shipping and shipbuilding, was the settlement of the East. Civilized, Christian Germany had consisted of a relatively narrow strip of land between the Rhine and the Elbe, approximately what was West Germany until 1990. Charlemagne and his successors had conquered some of this, conducting campaigns against the Slavs in the East, but it is surprising how little the frontier of "Western Civilization" had advanced since Roman times. Beginning in the eleventh century, serious efforts at German colonization of the Slavic lands got underway. Progress was most rapid in the north, along the Baltic coast in what became Saxony, Poland, and Prussia. Towns were established as administrative and cultural centers, with a layer of German elites imposed on the existing Slavic population. As more settlers arrived, along with missionaries, the countryside became increasingly German.

In Prussia, the process of colonization was somewhat more brutal, as the Teutonic Knights conducted a crusade against the pagan peoples of what is now Poland and the Baltic Republics. Eventually, the Grand Master of the Order ruled a broad swath of the Slavic east from his castle at Marienburg. Towns were established, as in the areas closer to the German homeland, but the Knights were able to exercise centralized political power (until their destruction in the fifteenth century) unknown in the rest of northern Germany.

Germany stands apart from the rest of northwestern Europe in that the general political trend is away from central government. Non-Danish England had been effectively unified before the Norman Conquest, with the Danelaw and

Wales coming under English control in the later Middle Ages, and French kings, whose power did not extend far beyond the Île de France by the eleventh century, steadily chipped away at the power of the great dukes who controlled most of the country. Germany began to splinter with the division of the Carolingian Empire among Charlemagne's grandsons and did not reverse the trend toward smaller and smaller political units until Napoleon imposed a rationalized regional administration in the nineteenth century. Strict primogeniture was uncommon, so an increasing assortment of dukes, counts, margraves, and barons squabbled over increasingly smaller bits of land. To complicate matters, powerful bishops and archbishops did not have to divide up their lands at death and managed to acquire an impressive, although discontinuous, share of the German countryside through bequests. Towns could also be granted independent status by the Emperor. By the fourteenth century, there were over three hundred different political units in the region generally identified as Germany. The effective result was that municipal governments were largely left to themselves and exercised the most useful local power in the absence of strong princes.

Nominal overall suzerainty was vested in the emperor, elected by the most powerful princes from among themselves and confirmed by the pope. Strong emperors were not uncommon, but their actual influence varied considerably within the Empire, being strongest in their own hereditary lands. During the twelfth and thirteenth centuries, a preoccupation with Italian and papal affairs weakened the emperor's power in Germany. In the fifteenth century, control of the throne passed to the Habsburg family, who did not relinquish it until the

dissolution of the (Austro-Hungarian) Empire in the aftermath of World War I. The Habsburgs succeeded in adding vast tracts of territory, including Spain, to their dominions, but imperial power faded after the sixteenth century.

In France, real power was in the hands of regional rulers, such as the dukes of Normandy and Anjou, with a largely independent Angevin state flourishing in Aquitaine until the late twelfth century. Royal influence was extended by strong kings such as Philip Augustus and Louis IX, but the grip of the aristocracy was not completely broken until the seventeenth century, under Louis XIII and XIV. Complicating royal attempts to attain overall dominion were English campaigns on French soil. When the Normans invaded Britain, they did not relinquish their possessions in France, but ruled a combined Anglo-Norman kingdom until 1204, when the barons were forced to choose between their English and French possessions. Intermarriage between William the Conqueror's line and the French royal family also provided English kings with potential claims to the French throne. Between 1337 and 1453, intermittent warfare in France occupied both sides and discouraged the development of strong national economies. In the end, the English won the great battles, even taking King Jean II of France prisoner at Poitiers, but could not win the Hundred Years War. By the end of the fifteenth century, the English had abandoned all French lands acquired in the campaigns of the Black Prince and Henry V except for the area immediately around Calais, which they held until the middle of the sixteenth century. Besides demonstrating English power on French soil, Calais was employed as the principle commercial center for the export of English goods, primarily wool.

The Low Countries, a group of principalities stuck between the northern ends of France and the Empire, were relatively independent and consequently were often engaged in playing rival French, English, and German factions against each other for political and economic advantage. Until the end of the fourteenth century, this group was dominated by the county of Flanders, which was the economic and industrial center of northwestern Europe. Flanders earned this position by virtue of its location, at the confluence of the major trade routes, and because of the growth of the woolen cloth industry, centered around Bruges and Ghent. Flanders was often linked with the southern county of Artois and exerted some influence over the combined counties of Holland and Zeeland to the north.

In the late fourteenth century, the Valois dukes of Burgundy began to acquire these counties, perhaps with the intention of establishing their own Burgundian kingdom, a border state between France and the Empire with the economic clout to compete with the great powers of Europe.⁵ Under Philip the Fair, who added Holland, Zeeland, and Hainault after the civil war of 1417-28, and his son, Charles the Bold (or Rash, depending on your translator and point of view), Burgundy incorporated most of the southern Netherlands into a semi-independent state begun by Philip's father, John the Fearless, in northeastern France. Eventually, much of this territory passed to the Habsburg duke (later emperor) Maximilian through his marriage to Charles's daughter, Mary. Aside

⁵ Richard Vaughan has produced an exhaustive collection of works on the Valois dukes and their territorial ambitions. In addition to eponymous individual works on John the Fearless, Philip the Fair, and Charles the Bold, a summary volume, *Valois Burgundy*, is also available.

from simplifying administration and consolidating the coinage, the growth of Burgundy gave the merchants of the Dutch counties, particularly those in Holland and Zeeland, a strong political backer in their efforts to acquire favorable trading privileges in the rest of northern Europe.

Trading privileges were the essential tool of economic politics in medieval Europe. Charlemagne had attempted to acquire favorable tariffs and duties for Frankish merchants in the Byzantine Empire, and one of the primary reasons for the economic prosperity of Venice was her effectiveness in securing such privileges. Without such privileges, which were essentially legal rights granted foreign merchants and reductions in the fees charged them, the merchants of one country could not compete effectively for the distribution of the goods of another. At the same time, princes wielded trading privileges as a powerful political weapon. Normally, such privileges were reciprocal agreements of fixed duration negotiated between political rulers.

The merchants of northern Germany should have been at a severe commercial disadvantage, as they had no princes with any real power behind them, but they had something just as useful: exclusive access to the produce and markets of the German Baltic. Beginning in the thirteenth century, after German settlement of the Slavic East had progressed sufficiently to allow commerce to develop, the merchants of northern Germany began to represent themselves in negotiations for trading privileges with the princes of the West. They banded together into loose commercial organizations, called *Hansen*. Because of their

effective monopoly on Baltic trade, which supplied valuable bulk commodities, such as Prussian grain and timber, Russian wax, and Swedish herring, to western Europe and opened potential markets for Flemish cloth, French and Rhenish wine, and other western manufactures, they were able to obtain concessions for "the German merchants," as they referred to themselves. By the thirteenth century, these organizations had become *the* Hanse, which represented all German merchants abroad.⁶ In return, the merchants had to abide by certain policies set by the Hanse at general meetings. Eventually, the organization was based on participating towns, which stretched from Harderwijk and Kampen on the eastern shore of the Zuiderzee to Reval (modern Tallinn, in Estonia) on the Russian frontier.

From the beginning, Lübeck was the most influential of the Hanse towns, and its merchants tried to set policy for the entire group. Founded in 1189, the town owed its dominance to position. Goods entering and leaving the Baltic did not pass through the straight between Denmark and Sweden/Norway, (called the Sound or the Skaw in English and Øresund by the Danes who controlled it) until late in the thirteenth century, but were shipped overland between Lübeck on the Baltic and Hamburg on the North Sea. Because of this stranglehold, Lübeck and,

⁶ P. Dollinger, *The German Hanse* (English translation of *La Hanse*) is the standard general work on the history of the Hanse. Specific aspects of the Hanse are covered in an enormous number of specialized works. Hanse research has been an area of intensive study in Germany since the nineteenth century, when large numbers of relevant documents were sought out in archives all over Europe and published in the *Hansisches Urkundenbuch*. Proceedings of the *Hansetage*, the general meetings of Hanse representatives to decide political and economic matters and work out internal disputes, have been published in *Hanse Recesse*. *Hansische Geschichtsblätter* is the journal of Hanse studies, and there are a number of Hanse monograph series.

to a lesser extent, Hamburg could set Hanse policy to their own advantage, often to the disadvantage of other Hanse merchants, especially those in Prussia.

The Hanse, once sufficiently institutionalized to admit subdivision, was divided into regional thirds (eventually, there were four sections, still called "thirds"). The Westphalian third, centered on Cologne, was primarily concerned with traffic up and down the Rhine. The Wendish third, controlled by Lübeck, was the heart of the Hanse and depended more on the exchange of the products of other regions, although Hamburg was a major exporter of beer, especially to the Low Countries. The Livonian (Prussian) third, commercially based at Danzig (modern Gdansk, Poland), was partly under the control of the Teutonic Knights, the only effective political force in the region; the Grand Master of the Order was the only political ruler to be an official member of the Hanse. The Livonian third produced raw materials (timber) and grain, and controlled the flow of Russian goods, such as furs and wax.

Abroad, the Hanse established commercial headquarters, called *kontore*, in London (the Steelyard), Bruges in Flanders, Bergen in Norway, and Novgorod in Russia. In addition, substantial colonies of German merchants were set up in Stockholm and on the island of Gotland, at Visby. Within the *kontore*, they were normally able to govern themselves and assure the security of their goods from confiscation, two important privileges rarely extended to foreigners. The *kontore* also sometimes served as exclusive outlets for German goods, in a staple system similar to that employed by England to control the wool trade.

While not really a political organization, the Hanse was able to muster considerable political and military power to protect its economic health. A Hanse blockade of Bruges in 1358 forced concessions from the count of Flanders, and in the late 1360s, Hanse ships and troops defeated Denmark in a full-scale war. In 1439 the Hanse again went to war, against the Hollanders, but lost. Although foreign influence was considerable, internal discipline was difficult to maintain. There were no permanent officers until the sixteenth century, nor was it ever certain which towns were members and which were not. The organization was based on shared economic interest, and when regional interests began to diverge, decline could not be far behind.

The shippers and merchants of Holland emerged as the most serious threat to Hanse monopolies in the late fourteenth century and by 1441 had effectively broken the Hanse's exclusive control of Baltic trade, the backbone of Hanseatic prosperity.⁷ Hollanders pioneered commercial navigation of the Sound in the thirteenth century, thus bypassing the Lübeck-Hamburg bottleneck, and by the fourteenth century began dealing directly with Prussian farmers and timber cutters, rather than buying at town markets such as Danzig. By eliminating the Hanse middleman, Dutch merchants could pay producers a higher price than they were getting from German merchants and still charge less in the markets of Holland,

⁷ The Holland-Hanse conflict is one of the most significant economic developments of the fifteenth century, and so has been studied in depth. An early, formative work on the subject is E. Daenell, "Holland und die Hanse im 15. Jahrhundert," *Hansische Geschichtsblätter* 9 (1903): 3-41. More recent, with a comprehensive bibliography and Marxist slant, is K. Spading, *Holland und die Hanse im 15. Jahrhundert*.

Zeeland, and Flanders. Holland fishermen benefitted from the shift of the herring shoals from the Baltic to the North Sea around 1400, and after the inclusion of Holland in Burgundy, could generally rely on the support of the Duke in trade disputes regarding privileges in Flanders, the heart of Western commerce.

From the beginning of the fifteenth century, countering Hollander competition became a primary focus of Lübeck-led Hanse policy. They were denied access to Baltic markets, prohibited from purchasing Hanse-built ships, and Hanse merchants were discouraged, if not prevented, from entering into partnerships with Hollanders. The policy failed, largely because it was not in the interest of the Hollanders' chief trading partners, the Prussian producers and merchants. In the treaty ending the Holland-Hanse war of 1438-41, the Hollanders formally obtained trading rights in the Baltic. By 1497, the first year for which toll records for the Sound are available, over 55% (455 out of 795) of the ships passing into and out of the Baltic were from Holland.⁸

Cogs

Until the fifteenth century, cogs formed the backbone of the Hanseatic and Hollander fleets but do not seem to have been widely used outside the German and Dutch regions of northern Europe, except for some spillover into Denmark and Sweden. English deepwater ships were mostly keels and hulks, and

⁸ N.E. Bang (ed.), *Tabeller over Skibsfart og Varetransport gennem Øresund 1497-1660* I, p. 2. In all, Dutch ships accounted for 567 of the 795 ships reported in 1497. The Dutch share of traffic continued to grow throughout the sixteenth and seventeenth centuries, as later records show.

Scandinavian shippers sailed in large, clinker-built hulls ultimately derived from Viking transports. The Nordic hulls are outside the scope of the current work; suffice it to say that they were enlarged versions of Viking *knarrs*, with the framing consisting of several levels of beams and standing knees above small floors. At the largest, these approached and may have equalled the size of contemporary cogs.⁹ There is little agreement on precisely what a hulk was, except that it had a flat bottom (or flat floors), curved stem (and sternpost before the development of the sternpost rudder in the late twelfth century), lapstrake planking, and castles at both ends.¹⁰

The nature of the hulk is one of the great unanswered questions of northern European ship studies. Aside from the evidence provided by a few seals, mostly from England and post-1400 Hanseatic towns, and some textual sources, competing theories on hulks are based on relatively little, but often go into surprising detail. Thus Basil Greenhill suggests that hulks did not have a true stem but a central plank, that strakes did not end on this central strake but were arranged parallel to it, and that the planking was built in reverse-clinker fashion.¹¹ A possible solution to the hulk problem is provided by a late fifteenth-century wreck excavated near Dronten, East Flevoland, the Netherlands,

⁹ Partial remains of an extremely large vessel were found incorporated into buildings in the Hanse *kontor* town of Bryggen (modern Bergen, Norway): A.E. Christensen, "Boat finds from Bryggen," in *The Bryggen Papers*, pp. 178-192.

¹⁰ See K.-F. Olechnowitz, *Der Schiffbau der hansischen Spätzeit*, pp. 7-8 and n. 14 for a summary of hulk arguments up to the late 1950s; a different viewpoint is provided in P. Heinsius, *Das Schiff der hansischen Frühzeit*, pp. 213-235.

¹¹ B. Greenhill, *Archaeology of the Boat: A New Introductory Study*, pp. 283-285.

between 1986 and 1988 by the Museum voor Scheepsarcheologie of Ketelhaven. This vessel is extremely large (over 30 m long, with a broad, deep midsection), completely clinker planked (with both rivets and wedged treenails fastening the bottom planks together), flat-floored, with curved stem and straight sternpost. The vessel, designated U 34 by the Museum, is considered a possible hulk by the excavators, Reinders and Oosting.¹² In contrast, the cog is a clear example of bottom-based shipbuilding, with many conceptual and technical similarities to Roman bottom-built craft.

For many years, the study of cogs was based entirely on textual and representational evidence. Shipping documents of the thirteenth through fifteenth centuries showed the range of sizes in which cogs were built and their dominant position in Hanseatic fleets, and many of the Hanse towns logically chose cogs as the central motif in their official seals.¹³ A near-contemporaneous written account describing one of these seals specifically states that the vessel depicted is a cog, in case there was any doubt.¹⁴ Many of the seals display impressive detail, but their accuracy could not be proven until 1962, when a large medieval vessel

¹² H.R. Reinders and R. Oosting, "Mittelalterliche Schiffsfunde in den IJsselmeerpoldern," in *Ländliche und städtische Küstensiedlungen im ersten und zweiten Jahrtausend*, pp. 113-118.

¹³ B. Hagedorn, *Die Entwicklung der wichtigsten Schiffstypen bis ins 19. Jahrhundert*, pp. 10-24 was the first to examine this material systematically. The seals have been collected by several authors; the best is H. Ewe, *Schiffe auf Siegeln*. Heinsius, *Das Schiff der hansischen Frühzeit*, although archaeologically out of date, remains the best comprehensive study of the non-archaeological material.

¹⁴ The seal in question is from Stralsund, ca. 1329, the description from 1485. See R.A. Hulst, "Iconographische aspecten van de 'Kogge'," in *Raakvlakken tussen Scheepsarcheologie, Maritieme Geschiedenis en Scheepsbouwkunde*, ed. H.R. Reinders, p. 50.

was discovered in the Weser river just below Bremen.¹⁵ The remains, surprisingly complete, were immediately identified as those of a cog, based on their startling similarity to the vessels on later Hanseatic town seals. While the Bremen ship was not the first excavated vessel to be correctly identified as a cog,¹⁶ it was the first to be widely known and quickly resulted in the complete rethinking of cog development. Since then, numerous examples of cogs and vessels built in a similar manner have been excavated or identified from older excavations. At present, the number of finds stands at a minimum of fifteen by my count (Fig. 7), with ten from the reclaimed Zuiderzee in the Netherlands,¹⁷ three from Denmark,¹⁸ the

¹⁵ The discovery of the Bremen cog was reported in a number of journals in 1963 e.g. S. Fliedner, "Der Fund einer Kogge bei Bremen im Oktober, 1962," *Mededelingen van de Nederlandse Vereniging voor Zeegeschiedenis* 7 (1963): 8-16. An account of the excavation is provided in Rosemarie Pohl-Weber, "Fund und Bergung der Bremer Kogge," in *Die Bremer Hanse-Kogge*, H. Abel et al., pp. 15-37. Other chapters in Abel et al. discuss conservation, geology of the site, and the etymology of the words "cog" and "hulk." On the ship itself, publication is minimal, although a comprehensive report on the hull is expected in the early 1990s. At present, the best source for construction is K.-P. Kiedel and U. Schnall (eds.), *The Hanse Cog of 1380*. This is a short (80 pp.) guide to several aspects of the vessel and supersedes an earlier museum guide: S. Fliedner and M. Pohl-Weber, *The Cog of Bremen*. D. Ellmers, "The Cog of Bremen and Related Boats," in *The Archaeology of Medieval Ships and Harbours in Northern Europe*, ed. S. McGrail, pp. 1-16 concentrates primarily on modern ethnographic parallels for certain perceived features of the Bremen cog. A replica has recently been built in the Rathje shipyard in Kiel, Germany; see W. Dammann, "Die Bremer Kogge in Kiel," *Das Logbuch* 25.3 (1989): 95-98 and V. Westphal, "Die Bremer Kogge in Kiel," *Das Logbuch* 27.1 (1991): 18-21.

¹⁶ That honor belongs to IJsselmeerpolders find M 107, excavated in 1944 and published in 1945; P.J.R. Modderman, *Over de Wording en de Beteekenis van het Zuiderzeegebied*. Unfortunately, the publication was a rather obscure wartime issue and not widely circulated.

¹⁷ Nine of these are summarized in H.R. Reinders, *Cog Finds from the IJsselmeerpolders*. Of these, several have been treated individually or as part of comparative studies. Find M 107, the first to be excavated, was described by Modderman, *Over de Wording en de Beteekenis van het Zuiderzeegebied*; N 5, a small vessel, is covered in R. Reinders, H. van Veen, K. Vlierman, and P.B. Zwiers, *Drie Schepen uit de Late Middeleeuwen*, pp. 7-16; A 57, the bottom of a very large cog, is described by R. Oosting, "De opgraving van het vlak van een kogge bij Rutten," in *Raakvlakken tussen Scheepsarcheologie, Maritieme Geschiedenis en Scheepsbouwkunde*, ed. H.R. Reinders, pp. 57-63 and A.D. Vos, *Een Bijzonder Grote Kogge in de Noordoostpolder, het Onderzoek van een Scheepswrak op Kavel A 57*; OZ 36, a deep cog similar to but smaller than the Bremen vessel, is described by A.F.T. Luns, *De constructie van scheepswrak OZ 36 in Zuidelijk Flevoland*; NZ 43,

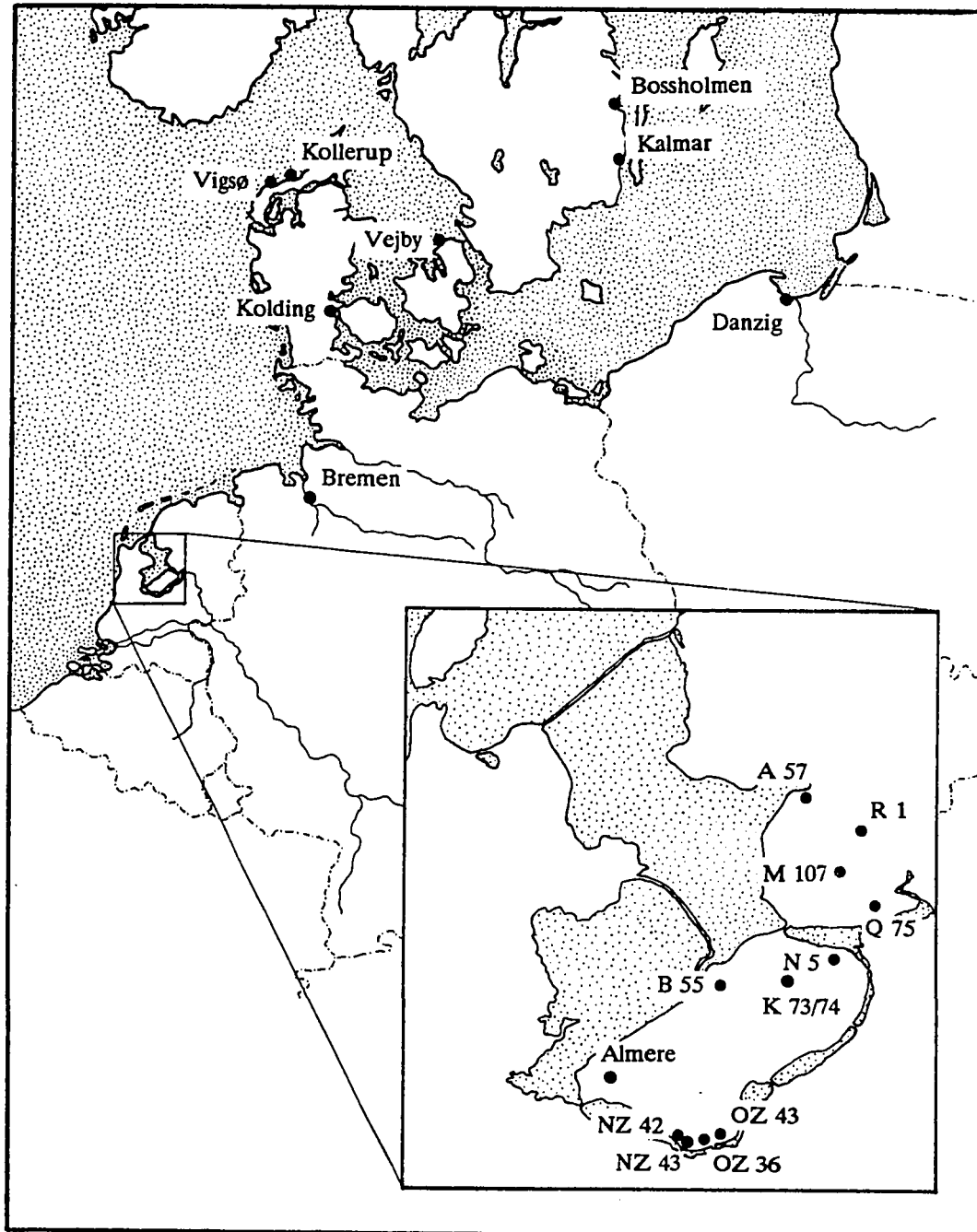


Figure 7. Map of cog finds and related vessels in northern Europe (Drawing E. Titford).

Bremen cog, and one from Sweden.¹⁹ In addition, rudder hardware from a medieval wreck at Vigsø, Denmark is thought to have come from a cog,²⁰ although it is impossible to identify a vessel type by such hardware when nearly all vessels of the period carried essentially similar sternpost rudders. A plank fragment found in the medieval levels of Bergen, Norway is probably from a cog.²¹ Boat find II from the medieval and post-medieval harbor of Kalmar, Sweden is dated to the fourteenth century and often identified as a cog, or a Nordic vessel strongly influenced by cogs.²² Ellmers identifies a boat found in Gdansk in the nineteenth century as a cog, despite its all-clinker construction.²³

a small, cog-like vessel, has been studied in detail by A.M. van de Moortel, "A Cog-Like Vessel from the Netherlands" (M.A. thesis, Texas A&M University, 1987), with a synopsis of the same title in *Underwater Archaeology Proceedings from the Society for Historical Archaeology Conference, Reno, Nevada, 1988*, ed. J.P. Delgado. The tenth cog, excavated at Almere Wijk 13, is briefly described by F.M. Hocker, "Cogge en Coggeschip: Late Trends in Cog Development," in *Bouwtraditie en Scheepstype*, ed. H.R. Reinders, pp. 25-32; a more complete account appears in this chapter, below.

¹⁸ Summarized by O. Crumlin-Pedersen, "Danish Cog Finds," in *The Archaeology of Medieval Ships and Harbours in Northern Europe*, ed. S. McGrail, pp. 17-34. The Kollerup cog is also treated individually by P.K. Andersen, *Kollerupkoggen*, and a brief report on the Kolding cog, investigated in 1943, was published by a naval architect; K.E. Hansen, "Kolding Skibet. Foreøbig Meddelelse om Fund af Middelalderskib," *Handels- og Søfartsmuseet på Kronborg, Årbog* (1944): 119-129.

¹⁹ At present, only preliminary reports on the excavation and recording of the Bossholmen/Oskarshamn vessel have appeared, as the project is still under way: C.O. Cederlund, "The Oskarshamn Cog. Part I: Development of Investigations and Current Research," *IJNA* 19 (1990): 193-206 and J. Adams, "The Oskarshamn Cog. Part II: Excavation, Underwater Recording and Salvage," *IJNA* 19 (1990): 207-220.

²⁰ Crumlin-Pedersen, *supra* n. 18, pp. 22 and 23, Fig. 2.6.

²¹ Christensen, *supra* n. 9, pp. 95, 100-101, 111 (Fig. 6-18), 203; fragment no. 90513.

²² H. Åkerlund, *Fartygsfynden i den Fornä Hamnen i Kalmar*, pp. 51-54 and Plans 10 and 11.

²³ D. Ellmers, *Frühmittelalterliche Handelsschiffahrt in Mittel- und Nordeuropa*, pp. 74, 303, and 67, Fig. 45.

A votive model dated to the early fifteenth century from a church in Ebersdorf, Germany has been identified as a cog,²⁴ but as Reinders and Oosting have shown, the model actually shares very few construction features with the excavated cogs and probably represents something closer to the hulk tradition.²⁵

As noted in the previous chapter, cogs are attested in written sources as early as the ninth century. The word itself is derived from an Old German word for a mollusk and suggests a bowl-like or rounded form.²⁶ The origins of the ship type described by this word are less certain, although consensus at the moment favors a Frisian background.²⁷ Hagedorn, who wrote the first major study of the development of shipbuilding in northern Europe, believed that the cog was a German invention,²⁸ while his contemporary Vogel supported a Frisian origin.²⁹ Most arguments since then have been in one of these two camps,

²⁴ W. Steusloff, "Das Ebersdorfer Koggenmodell von 1400," *Deutsches Schifffahrtsarchiv* 6 (1983): 189-207; reported by A.E. Christensen, "A Medieval Ship Model," *IJNA* 16 (1987): 69-70.

²⁵ The Ebersdorf model is completely clinker built, with a curved stem, rabbeted keel and completely rabbeted posts. As discussed below, all of these features are the opposite of what have been found in excavated vessel remains; Reinders and Oosting, *supra* n. 12, p. 116.

²⁶ S. Fliedner, "'Kogge' und 'Hulk': Ein Beitrag zur Schiffstypengeschichte," in *Die Bremer Hanse-Kogge: Ein Schlüssel zur Schifffahrtsgeschichte*, H. Abel et al., pp. 40-42.

²⁷ Olechnowitz, *Der Schiffbau der hansischen Spätzeit*, pp. 7-8, n. 12 provides a good summary of older theories on the origins of the cog.

²⁸ Hagedorn, *Die Entwicklung der wichtigsten Schiffstypen*, pp. 22-23. Hagedorn believed the cog too deep a vessel for the Frisian coast, so it could not have originated there, although he admitted that the name is derived from a Frisian word.

²⁹ W. Vogel, *Geschichte der deutschen Seeschifffahrt I: Von der Urzeit bis zum Ende des 15. Jahrhunderts*, p. 93, n. 4.

although a third possibility, a Scandinavian origin, has been suggested.³⁰ Since the discovery of archaeological examples, the Scandinavian idea has been largely discredited, as the construction is clearly different, although Ron Hulst continues to believe in a south Scandinavian role in the development of the cog.³¹ Heinsius proposed a lower Saxon origin based on inter-farm craft developed by Baltic traders.³² He also identified in the representational evidence several regional and late transitional forms.³³

The argument for Frisian origins is largely reasoned from geographic and historical premises rather than supported by direct evidence. The trickiest part of the main east-west trade route in northern Europe, along which Baltic and German goods had to travel, was not in the Baltic but in the North Sea, between the base of Jutland and the river mouths of the Rhine and Scheldt. The route did not lead through the North Sea itself, but through the Waddenzee behind the Frisian barrier islands. The shallow waters of this sound required shoal-draft vessels with flat bottoms to take the ground. In contrast, Scandinavian vessels of the period were deeper, with round or V-bottoms. Archaeological evidence for the pre-German boatbuilding of the southern Baltic coast is limited, but it strongly

³⁰ A. Bugge, "Besprechung von H. Hagedorn: Die Entwicklung der wichtigsten Schiffstypen bis ins 15. Jahrhundert. Berlin 1915," *Zeitschrift des Vereins für Hamburgische Geschichte* 19 (1917): 109-110. See also H. Kuhn, "Besprechung zu P. Heinsius: Das Schiff der hansischen Frühzeit," *Hansische Geschichtsblätter* 75 (1957): 101.

³¹ R.A. Hulst, "Item van den Kogge," in *Bouwtraditie en Scheepstype*, ed. H.R. Reinders, pp. 17-18.

³² Heinsius, *Das Schiff der hansischen Frühzeit*, pp. 213-215.

³³ *Ibid.*, pp. 58-62.

suggests a dominant tradition similar to Nordic shipbuilding but depending less on iron fastenings and more on wooden pegs to hold the planks together.³⁴ As the Frisians were the predominant long-distance seafarers and traders of the ninth and tenth centuries, it stands to reason that their ships would form the majority of the merchant fleet engaged in east-west trade to their German, Dutch, and Scandinavian neighbors. If the Haithabu coins and their ship representations must be considered here, they may show the existence, although not the nationality, of a boat type with single square sail and straight, upright posts, characteristics reminiscent of later cogs.

Regardless of origins, a distinct vessel type can be identified in representations and the archaeological record by the late thirteenth century. The dominant visual characteristics of this type are straight, raking posts, lapstrake side planking, and a single square sail, all of which can usually be observed in the seals. The earliest of these is from Elbing, dating to 1242. Ellmers, following Heinsius, claims that the representations on the earliest seals of Lübeck, dating to at least 1224, also show cogs,³⁵ but these in fact show a vessel with curved posts sporting animal-head finials and a *firrer*, a sort of steering paddle, instead of a sternpost rudder. In the earliest versions, the curvature of the posts is quite pronounced. There is a report from 1328 that the Lübeck seal showed a "*cogko sive liburna*,"³⁶

³⁴ Ellmers, *Frühmittelalterliche Handelsschifffahrt*, pp. 88-89.

³⁵ Ibid., p. 70; Heinsius, *Das Schiff der hansischen Frühzeit*, p. 66.

³⁶ Heinsius, *Das Schiff der hansischen Frühzeit*, p. 56.

but the thirteenth-century depictions are so different from the other "cog seals" that the identification is difficult to credit. The vessel looks more like a Scandinavian or Slavic vessel.³⁷ The remainder of the cog seals, which come from as far west as Harderwijk on the Zuiderzee, are in contrast rather consistent.

As the underwater portion of the hull could not be seen in detail in these representations, scholars logically concluded that the entire hull was clinker-built, in a manner similar to Nordic watercraft. In fact, all medieval vessels of northern Europe were presumed to be clinker built, as there was no widely known evidence to the contrary. The idea of clinker Middle Ages followed by a carvel Renaissance remains the central theme of northern European ship studies.³⁸

Study of the archaeological material has revealed a distinct and consistent set of diagnostic construction features that are common to the fifteen cogs. The hull remains have also shown that the seals were often extremely accurate, even down to fine detail and proportions in some cases, but that the bottom construction is substantially different than previously thought. The characteristics that currently define the type are:³⁹

1. A keel plank, rather than a keel, without rabbets or fastenings to the garboards.

³⁷ Hulst, *supra* n. 14, p. 49 states flatly that it not a cog, as it cannot have a flat bottom.

³⁸ The theme of the 1988 International Symposium on Boat and Ship Archaeology was "The Transition from Clinker to Carvel."

³⁹ Most of these are discussed by Reinders, who first suggested a comprehensive set of diagnostic structural features in *Cog Finds from the IJsselmeerpolders*, pp. 13-22.

2. Knees, called hooks, that are scarfed to the posts and keelplank as intermediate timbers and form the angular transition from the keelplank to the posts. Rabbets for the hood ends of the garboards are normally cut into the hooks.

3. Straight, raking posts (the stem rakes more than the sternpost) with rabbets for the hood ends of the lowest strakes (often, but not always, the same strakes that are flush-laid). The hooding ends of the upper strakes are fayed to bevels on the outboard faces of the posts. Later vessels normally have a false stem protecting the forward faces of the stem and hook and the thin, bevelled edges of the upper hooding ends. Some later vessels also have a false sternpost.

4. Bottom strakes flush-laid, edge-to-edge rather than lapstrake, over the central part of the hull. Towards the ends, these planks become lapstrake. Later cogs tend to have fewer flush strakes, which stop below the bilge, but never less than three. Earlier vessels sometimes have the flush strakes continuing up around the turn of the bilge.⁴⁰

⁴⁰ The Kollerup cog and IJsselmeerpolders NZ 42 are good examples.

5. Remaining planking lapstrake, fastened with double-clenched iron nails driven in from the outside. Where conversion has been noted, the planking is normally sawn. In both bottom and side planking, planks within a strake are joined by flat scarfs fastened together with double-clenched nails driven from both inside and outside.

6. Caulking by tarred moss or hair (moss in the German and Dutch examples, hair in some of the Scandinavian cogs) covered by thin wooden laths and held in place by closely-spaced flattened iron staples, called *sintels*. The flush planking is caulked from the outside, but the lapstrake planking is normally caulked from the inside, where a bevel is cut on the upper, outer edge of the lower plank in each seam. The sintels themselves develop over time, sprouting ears that extend along the seam. In later vessels, the sintels are frequently spaced so closely (on 5 to 6 cm centers) that the ears touch.⁴¹

7. Frames are straight or alternating knee-ended floors amidships and V- or Y-shaped floors at the ends. Futtocks rest on top of the floors. Both floors and futtocks are joggled over the

⁴¹ K. Vlierman and L. van Dijk, *Sintels*.

lapstrake planking.

8. A sternpost rudder, mounted with iron pintles and gudgeons.

9. A single mast. Formerly, this was thought to set a square sail, but there is the possibility that later, inland variants set a spritsail - see below. A single example, IJsselmeerpolders NZ 43, had some sort of bipod arrangement.⁴²

Within these structural limits, there is wide variation in size and form, as well as some differences in construction. The Bremen cog, because it was "first," and because it was immediately identifiable as a cog from the seals, is usually considered the type specimen. As deepwater cogs go, it is on the small side of average at 24 m long, with a capacity of 40 lasts⁴³ (about 120 m³, which is about 80 metric tons of rye⁴⁴). A cog bottom excavated in the Netherlands is somewhat

⁴² Van de Moortel, "A Cog-Like Vessel from the Netherlands," pp. 144-152.

⁴³ This is the most recent estimate; D. Ellmers, "Frisian and Hanseatic Merchants Sailed the Cog," in *The North Sea. A Highway of Economic and Cultural Exchange*, eds. A. Bang-Andersen, B. Greenhill., and E.H. Grude, p. 79. Previously, Ellmers, *Frühmittelalterliche Handelsschifffahrt*, p. 257 gave a capacity of 130 deadweight tons, or about 65 lasts of grain.

⁴⁴ Cog sizes were expressed in lasts, the common grain measure of northern Europe, as grain was the principle bulk cargo shipped by the Hanse. Lasts varied from town to town and from grain to grain (a wheat last was not the same size as a rye last), but generally ranged either side of 3 m³. For example, the rye last of Lübeck in 1400 was 3.024 m³, while the ship last of Danzig was 3.105 m³. The weight of grain in such a volume depended on a number of factors, such as humidity, how tightly packed the grain was, etc., but modern rye is calculated for shipment at 0.727 tons/m³, giving a value around 2.2 tons/last. Two tons per last is an approximation commonly used

larger than that of the Bremen cog, but preservation is insufficient to determine capacity.⁴⁵ Medieval documents show that Hanseatic cogs exceeded 100 lasts by the 1240s,⁴⁶ and cogs of 150 lasts were known in the fifteenth century.⁴⁷ Ships of over 100 lasts regularly visited Livonia in the later fourteenth century, as the toll records of Reval show.⁴⁸ At the other end of the scale are inland vessels found in the Netherlands. The smallest of these, NZ 43, is just under twelve meters long and carries a little over nine tons at maximum draft.⁴⁹

In shape, the Bremen cog and several others identified as deepwater vessels,⁵⁰ have flat floors a little over half the total breadth of the hull, straight, high, outward sloping sides and moderately hard bilges. In contrast, IJsselmeerpolders finds M 107 and NZ 43 have more rounded bottoms, low sides, and no discernable bilges. M 107 actually has a small amount of deadrise amidships. It is tempting to say that they are too fine and graceful to be "true" cogs. All

by ship scholars. See P. Heinsius, *Das Schiff der hansischen Frühzeit*, pp. 82-84.

⁴⁵ IJsselmeerpolders find A 57. See Oosting, *supra* n. 17.

⁴⁶ Based on a letter of the Grand Master of the Teutonic Order of 1421, quoted by Heinsius, *Das Schiff der hansischen Frühzeit*, pp. 88-89.

⁴⁷ Vogel, *Geschichte der deutschen Seeschifffahrt*, p. 435.

⁴⁸ W. Stieda (ed.), *Revaler Zollbücher und Quittungen des 14. Jahrhunderts*, p. 41, nos. 909, 939; 43, nos. 950, 975. See also Heinsius, *Das Schiff der hansischen Frühzeit*, pp. 88-89.

⁴⁹ Van de Moortel, "A Cog-Like Vessel from the Netherlands," pp. 37, 183. Calculation of deadweight capacity is based on displacement of 17.8 tons at a moulded draft of 0.93 m, with ship weight calculated at 8.130 tons. Draft is based on a chosen freeboard of 0.20 m, which I believe is too small for an open hull in Zuiderzee conditions. A draft of 0.60-0.70 m makes more sense, and so actual displacement and deadweight capacity should decrease significantly.

⁵⁰ IJsselmeerpolders A 57 and OZ 43.

excavated cogs have hollow sections at the ends, as well as slight to moderate hollow in the lower waterlines. This has sometimes been interpreted as a conscious choice by shipbuilders to improve the hydrodynamics of their vessels, to give them more speed and ease in a seaway.⁵¹ Whether deliberate or not, hollow ends are an unavoidable consequence of the combination of relatively full midsections with angular keel/post joins. The garboards must twist in a short distance from horizontal (or nearly so) to vertical, while the fullness of the rest of the hull is carried up and over the ends of the garboards.

One cog has been reconstructed with curved rather than straight posts. Van de Moortel shows IJsselmeerpolders find NZ 43 with a flaring, "clipper" bow and convex sternpost. This results in a rabbet along the entire length of the stem and the inconvenience of only two sets of pintles and gudgeons for the rudder. Her reconstruction of the posts is based almost entirely on the recorded shapes of two loose timbers not specifically identified as endposts during excavation, as no hood ends above the garboards were preserved, except for the forward end of one sheerstrake. She was able to place these timbers because of distinctive nailing patterns and characteristic trapezoidal sections. She finds support for curved stems in the iconography, with at least six seals showing stems with some

⁵¹ See, for example, van de Moortel, "A Cog-Like Vessel from the Netherlands," p. 243, in which she states that all cogs have tubby midsections combined with fine ends, and were thus designed for both maximum capacity and good sailing qualities. R.W. Unger, *The Ship in the Medieval Economy, 600-1600*, p. 138 even goes so far as to say that cogs were better sailers than Viking *knarrs*, if slower (whatever that means).

curvature,⁵² although only the second Damme seal of 1309 shows flare anywhere near as dramatic as van de Moortel has reconstructed; in the others, it is a matter of interpretation of line drawings of sealings. At the stern, van de Moortel cites four seals as evidence,⁵³ but the sternpost itself is only visible in three.⁵⁴ Where it can be seen, the curvature is again so slight that it is more an optical effect caused by shadow from the planking, which stands in higher relief. In one of the seals, from Harderwijk, three sets of pintles and gudgeons are shown, a number incompatible with a curved sternpost. In many ways, NZ 43 is the least "cog-like" of the excavated vessels in this building tradition, but I find it difficult to accept this aspect of the reconstruction. The preserved portions of the posts do indeed appear to be curved, but the recorded shapes reflect distorted and badly eroded timbers. The absence of rabbets in the lower part of the stem, when rabbets were recorded in the forward hook, suggests the poor state of preservation of this timber. If a straight stem is used, the preserved sheerstrake that now lands in a rabbet toward the after edge of the stem would end on the forward face of the stem, in traditional cog fashion, with no significant change in the shape of the bow planking. In the stern, little of the original scantling or surface remains, as a

⁵² She cites the seals of Harderwijk (1263), Vlaardingen (1312), Damme (1309), Kiel (1365), Stralsund (1301), and Nykøbing (1556); van de Moortel, "A Cog-Like Vessel from the Netherlands," p. 63.

⁵³ Harderwijk (1263) and Damme (1309) again, plus Staveren (1369) and Kiel (1365); *ibid.*, p. 66.

⁵⁴ The planking obscures the sternpost proper on the Staveren seal; only the rudder is actually visible.

section of the timber shows.⁵⁵ A better clue to the original shape of the timber is the straight line of planking nails that disappears where the eroded surface curves away.

Structural differences among the excavated cogs are most noticeable in the timbers for supporting the mast. Maststeps range from mortises in heavy floors (Kollerup and IJsselmeerpolders N 5) to short longitudinal timbers notched over a few floors (IJsselmeerpolders M 107 and NZ 42) to full-length or nearly full-length keelsons with enlarged central sections (Bremen, IJsselmeerpolders OZ 36 and OZ 43). NZ 43 presents a peculiar arrangement, in which a pair of heavy blocks with sockets were fastened to the frames on opposite sides of the boat, presumably for a bipod arrangement.⁵⁶

Differences also occur in the transverse support of the upper sides. Several of the deeper cogs, such as Bremen, Kolding, and IJsselmeerpolders find OZ 36, have throughbeams notched over and into a strake approximately halfway up the side.⁵⁷ The ends of throughbeams are also seen in some of the seals.⁵⁸ Most of the smaller cogs have simpler arrangements.

Other variations may be traced to "foreign" influence. Two of the Danish cogs, Kollerup and Kolding, had heavy stringers against the inner surface of the

⁵⁵ Van de Moortel, "A Cog-Like Vessel from the Netherlands," p. 67, Fig. 37.

⁵⁶ Van de Moortel proposes two possible solutions: a bipod mast and a pole mast on a bipod-mounted tabernacle; *ibid.*, pp. 144-152.

⁵⁷ The exact location of the Kolding throughbeam is uncertain, as it was a loose find. Crumlin-Pedersen, *supra* n. 18, p. 21, Fig. 2.3.

⁵⁸ For example, Harderwijk (1263), Damme (1309), Stralsund (1329), etc.

lowest lapstrake plank.⁵⁹ This is reminiscent of the heavy stringers of similar section fastened to the inner surface of the planking of some of the Skuldelev Viking ships.⁶⁰

With a relatively large sample of vessels, spanning nearly two centuries, it has been possible to identify some evolutionary trends in cog construction. As noted above, the number of flush strakes decreases over time to an average of three or four on the later vessels, and false posts appear in the fourteenth century, in both the seals and the excavated vessels. Other chronological developments have been suggested. Crumlin-Pedersen, on the basis of the Danish cogs, suggested that maststeps evolved from heavy floors to full-length keelsons and that the position of the mast moved aft from the bow toward the midpoint of the hull.⁶¹ As Reinders showed in his survey of the IJsselmeerpolders finds, neither notion holds true: a long maststep/proto-keelson can be seen in the thirteenth-century A 57 hull, and M 107, dated towards the end of the fourteenth century, has the mast stepped relatively far forward in a short block.⁶² In fact, most of the IJsselmeerpolders hulls have masts set toward the bow.

With such wide variations in size and form, is it possible to characterize all of these vessels as cogs, or are only the large, deepwater examples, such as the

⁵⁹ Crumlin-Pedersen, *supra* n. 18, p. 31, Fig. 2.12.

⁶⁰ O. Olsen and O. Crumlin-Pedersen, "The Skuldelev Ships (II)," *Acta Archaeologica* 38 (1967): 73-174. See also Hulst, *supra* n. 31, pp. 17-18.

⁶¹ Crumlin-Pedersen, *supra* n. 18, p. 30.

⁶² Reinders, *Cog Finds from the IJsselmeerpolders*, pp. 23, 25 and Fig. 14.

Bremen ship, "true" cogs? Should we be referring to cogs and "cog-like vessels," as Reinders once suggested?⁶³ Or is a broader approach appropriate for archaeology? Here the problem is one of "psycho-archaeology," trying to figure out what was considered diagnostic by the vessels' contemporaries. It is clear that a distinct building tradition is represented by these craft, but is that what identified a ship type to thirteenth- and fourteenth-century seafarers? Or were cogs only one type of vessel built in this manner? Did "cog" refer to function (deepwater merchantman) as well as construction or general configuration?

Until the end of the fourteenth century, cogs could be distinguished from other cargo carriers intended for open water, such as hulks and Nordic ships. The most obvious difference to us is in hull form, as cogs, hulks, and traditional Scandinavian vessels were essentially similar in other immediately obvious features, such as rig and lapstrake topsides. Only cogs seem to have carried the straight, raking stem and relatively flat sheer.⁶⁴ The structural differences are either fairly fine detail (double-clenched nails rather than rivets; moss, lath, and sintels instead of luting) or confined to the bottom, which is not easily visible to those outside the shipyard. As the dominant visible features (straight posts, lapstrake sides, straight sheer, single mast) are common to all the representations and the excavated examples (excepting the strange and wonderful bipod mast of NZ 43, which does

⁶³ *Ibid.*, p. 31.

⁶⁴ Although a medieval Nordic vessel excavated at Kyholm, Denmark, carried a heavy stem carved to give a straight leading edge ahead of a conventional, curved, Scandinavian rabbet; O. Crumlin-Pedersen, L. Nymark, C. Christiansen *et al.*, "Kyholm 78: A Joint Archaeological-Geological Investigation around a 13th Century Wreck at Kyholm, Samsø, Denmark," *IJNA* 9 (1980): 198-199.

have a representational parallel in a seal from Kuinre), I see no reason why all cannot be considered cogs, as all are immediately recognizable as such. Contemporary and slightly later (early fifteenth century) accounts indicate that not all cogs were huge vessels; some were quite small and travelled on inland waters.⁶⁵ If a stricter definition is adopted, based on the shared structural characteristics seen in the Bremen, IJsselmeerpolders, and Danish cogs, the Kalmar II and Danzig vessels will have to be excluded, as they are clinker-built throughout.

The later development of cogs is largely ignored by ship scholars, as cogs were superseded as the dominant deepwater carrier in the first half of the fifteenth century by hulks. The transition was not immediate, and there was some confusion of terminology early in the century, with some vessels identified as a cog in one place and a hulk in another.⁶⁶ Still, ship historians give the overall impression that early on the morning of 1 January, 1401, cogs disappeared from the waters of the Baltic and North Seas. In fact they appear in the historical record into the early sixteenth century, and ship types with at least their names derived from the old Hanseatic trader continued into the nineteenth century in Denmark and the

⁶⁵ Toll records from Iersekerood, the southern terminus of the inland waterway from the Zuiderzee to the Scheldt, and from Kampen, at the mouth of the IJssel river, testify to the use of cogs on inland waterways. See W.S. Unger (ed.), *De Tol van Iersekerood*, nos. 13, 47 and H.J. Smit (ed.), "Het Kamper pondtolregister van 1439-1441," *Economisch-Historisch Jaarboek* 5 (1919): 209-295.

⁶⁶ Heinsius, *Das Schiff der hansischen Frühzeit*, p. 214.

Netherlands.⁶⁷

Cogs were phased out of long-distance bulk trades by about 1450, but they hung on in a variety of economic niches.⁶⁸ The shippers of Zeeland seemed especially fond of the type and used small and medium-sized versions for transporting coal from northern England.⁶⁹ Cogs and *coggeschepen* (literally "cogships") appear throughout the fifteenth century in inland toll records from the *binnenweg*, the inland waterway between the Zuiderzee and the rich cities of Flanders.⁷⁰ The *binnenweg* was important as a sheltered route for Dutch and Hanseatic goods, with heavy traffic along the rivers, lakes, and canals that made it up. Vessel size was limited by the locks along the way to breadths under six meters or so.

Several scholars have observed features shared by cogs and some vessels of Roman northwestern Europe. Crumlin-Pedersen noted the similarity of early cog maststeps (mortises in heavy floors, as in the Kollerup cog) to the steps found in the Blackfriars, Bruges, and Bevaix vessels, suggesting that "the early Hanseatic cogs were modelled on principles, which have been called Celtic, and which were

⁶⁷ O. Crumlin-Pedersen, "Cog-Kogge-Kaag: Træk af en Frisisk Skibstypes Historie." *Handels- og Søfartsmuseets på Kronborg, Årbog* (1965): 81-144. Dutch *kagen* were distinguished by, among other things, straight, raking posts at both ends. I. de Groot and R. Vorstman, *Sailing Ships: Prints by the Dutch Masters from the Sixteenth to the Nineteenth Century*, no. 83, a print by Reiner Nooms, shows a Frisian *kaag* of the seventeenth century.

⁶⁸ The later development of the cog type is discussed in greater detail in Hocker, *supra* n. 17.

⁶⁹ H.J. Smit (ed.), *Bronnen tot de Geschiedenis van den Handel met Engeland, Schotland en Ierland: Tweede Deel 1485-1585: 1 (1485-1558)*, no. 265; Z.W. Sneller and W.S. Unger (eds.), *Bronnen tot de Geschiedenis van den Handel met Frankrijk: Eerste Deel 753-1585*, nos. 226, 294.

⁷⁰ F. Ketner, "Amsterdam en de binnenvaart door Holland in de 15e eeuw," *Bijdragen voor Vaderlandsche Geschiedenis en Oudheidkunde*, 8th series, 4 (1943): 169-200.

most likely developed by the Frisians into sea-going vessels."⁷¹ Greenhill sees a resemblance in form to the Blackfriars/Bruges tradition,⁷² and implies without explicitly stating a similarity to the Zwammerdam/Bevaix type in the joinery of the bottom.⁷³ McGrail suggests that cogs and the "Romano-Celtic" vessels may both belong to a hybrid form of skeleton construction.⁷⁴ Béat Arnold has noted the similarity of caulking systems in the Bevaix and Yverdon boats to systems used later in northwestern Europe.⁷⁵

In the most thorough discussion of the relationship between cogs and "celtic" craft, Detlev Ellmers maintains that the cog represents the apex of development of an old shipbuilding tradition in northwestern Europe, and that "all the shipbuilding techniques typical of the later cog can be found amongst the Frisians in the Rhine estuary shortly after the birth of Christ,"⁷⁶ by which he means that the Bruges vessel represents the ancestor of the cog type.⁷⁷ From the Early Middle Ages, he cites double-clenched nails from Hamburg, a "cog shipyard"

⁷¹ Crumlin-Pedersen, *supra* n. 18, p. 30.

⁷² Greenhill, *Archaeology of the Boat*, p. 259.

⁷³ *Ibid.*, p. 70.

⁷⁴ S. McGrail, *Ancient Boats of NW Europe: The Archaeology of Water Transport to AD 1500*, p. 9.

⁷⁵ B. Arnold, "Some Remarks on Caulking in Celtic Boat Construction and its Evolution in Areas Lying Northwest of the Alpine Arc," *IJNA* 6 (1977): 296-297.

⁷⁶ D. Ellmers, "The History of the Cog as a Ship Type," in *The Hanse Cog of 1380*, eds. K.-P. Kiedel and U. Schnall, p. 61.

⁷⁷ Ellmers, *Frühmittelalterliche Handelsschifffahrt*, pp. 63-64.

at Wilhelmshaven,⁷⁸ and the Haithabu coins, as well as place-names, as evidence of the continuous use and development of the cog.⁷⁹ His argument presumes, to a large degree, that all flat-bottomed boats (such as those that used the slipway at Wilhelmshaven) and all vessels built with double-clenched nails were cogs or at least in the direct line of descent from the Bruges boat. He even goes so far as to say that double-clenched nails and sintels alone can identify a cog, even if the wood has rotted away.⁸⁰ This is not, in fact, the case, as a pair of river vessels from the Zuiderzee show. IJsselmeerpolders finds B 55 and K 73/74 both have flat, flush-planked bottoms and lapstrake sides, with double-clenched nails used for plank-to-plank fastening and sintels holding the caulking in place, but neither is a cog.⁸¹ They are the product of the same bottom-based philosophy of construction, but lack keelplanks, hooks, and the distinctive rabbet construction of "true" cogs. I believe Ellmers applies the term indiscriminately, including a wide variety of related, flat-bottomed craft but making no attempt to determine or observe a valid historical definition of "cog." He is, in reality, describing a broader tradition of which cogs were only a part.

It is difficult to deny some sort of relationship between cogs and the bottom-built vessels of Roman Gaul, Germany, and Britain, particularly the Black-

⁷⁸ This is actually a seventh-century slipway with parallel runners leading down into the water, apparently for a flat-bottom vessel. *Ibid.*, pp. 144 and 130, Fig. 103.

⁷⁹ *Ibid.*, pp. 64-72; Ellmers, *supra* n. 76, pp. 60-63.

⁸⁰ Ellmers, *supra* n. 76, p. 60.

⁸¹ Reinders, van Veen, Vlierman and Zwiers, *Drie Schepen uit de Late Middeleeuwen*, pp. 17-42.

friars/Bruges type. General configuration, flat bottom, double-clinched nails, caulking, non-edge-joined bottom planking, and some maststeps are all similar. Many of these features are simply the results of the fundamental, bottom-based concept behind both the Bremen cog and the Blackfriars ship. The cog as a type illustrates the evolution of the expression of an essentially static concept, and shows that the concept does not limit hull shape to strictly flat-bottomed forms.

As with other bottom-built craft, the sides of cogs are constructed in a different manner than the bottom. The lapstrake side planking may be the result of Scandinavian influence, but it is interesting that German and Dutch shipbuilders then retained the fastenings and caulking of "celtic" vessels, rather than adopting the rivets and luting of Nordic clinker construction. The flush bottom planking is an obvious clue to the bottom-based concept, but it is not the only clue, nor is it inherently definitive. As the bottom planks are overlapped and edge-fastened at the ends, it is possible that the flush arrangement amidships was chosen for functional reasons, as a deliberate adaptation of an all-lapstrake, shell-built ancestor. Flush planking could be more suitable to shallow waters where occasional grounding was a fact of life or where vessels took the ground to unload. Such abuse might rapidly wear away the edges and fastenings of a lapstrake bottom.⁸² The evolutionary trend from many flush bottom strakes to only a few suggests that this is not an alteration of an all-lapstrake hull, but the reverse, the

⁸² I thank James Coggeshall for suggesting this to me. I must admit that in my concentration on the conceptual and structural aspects of this project, I sometimes neglected more important functional requirements.

gradual "clinkerization" of an all-flush ancestor. The earliest cogs have the lowest few strakes flush-laid all the way to the hood ends,⁸³ another indication that the type is developed from a flush-planked prototype. The question might be why flush planking was not completely eliminated eventually, with the same functional reasoning as above serving as an answer.

The order of assembly also reflects a bottom-based concept. As with the Bevaix and Blackfriars vessels, traces remain in at least some cogs of temporary fastenings used to hold the bottom planking together until the floors could be inserted. In IJsselmeerpolders find N 5, small laths were found still nailed across the seams of the bottom planks.⁸⁴ In A 57 and NZ 43, small, square, tapered wooden pegs were found in the bottom planks. These occurred in groups, either as a pair straddling a plank seam or a line of several pegs across two planks.⁸⁵ These have been identified as what later Dutch sources call *spijkerpennen* or the diminutive *spijkerpennetjes* (literally, "nailpegs"), small bungs to fill holes left by the removal of nails. Their arrangement is probably the result of short cleats nailed across the seams to hold the planks together, as was common in later Zuiderzee shipbuilding (see below, chapter VI).⁸⁶ The hood end nails and short lapstrake

⁸³ Crumlin-Pedersen, *supra* n. 18, p. 30 (the Kollerup cog); Reinders, *Cog Finds from the IJsselmeerpolders*, p. 16 (OZ 43).

⁸⁴ Reinders, van Veen, Vlierman, and Zwiers, *Drie Schepen uit de Late Middeleeuwen*, p. 11.

⁸⁵ Oosting, *supra* n. 17, pp. 59-60; van de Moortel, "A Cog-Like Vessel from the Netherlands," p. 110.

⁸⁶ Oosting, *supra* n. 17, p. 60; van de Moortel, "A Cog-Like Vessel from the Netherlands," pp. 110-114.

sections at the ends of the bottom planks also helped to hold the bottom together until floors could be inserted. Overlapping and edge-fastening at the ends is probably an aid in shaping the hull where twist and curvature are most extreme and the planks hardest to hold together at desired angles. Werner Lahn, who directed the re-assembly of the Bremen cog, was impressed with how easily the planks went together amidships, requiring nothing more than flat beams under the hull to support them, but that more help (meaning force) was needed at the ends of the strakes.⁸⁷

The development of the keelplank can be seen as an improvement from "celtic" construction. In addition to providing a central runner or skid on the outside of the bottom, it offered a stronger point of attachment for the posts than the slot in the bottom seen in the Blackfriars ship. Another major advance is in hull shape. None of the excavated cogs has a truly flat bottom. Even where the hull is flat amidships, deadrise increases steadily and smoothly toward the ends as the garboards twist up into the post rabbets. Few cogs have the chine seen in the Bruges boat⁸⁸ and none have the right-angle join between vertical sides and flat bottom of the Zwammerdam barges.

⁸⁷ W. Lahn, "From Laying the Keel to Launching the Cog: Cog Building Around 1380," in *The Hanse Cog of 1380*, eds. K.-P. Kiedel and U. Schnall, pp. 54, 56.

⁸⁸ Of course, because most cogs were built with relatively wide planks, the hull sections are not smooth curves but a series of flats. I consider a chine a seam where the angle between planks is decidedly more pronounced than in the other seams. Those cogs that do have it frequently show it in the seam between the outboard two flush strakes in a bottom of three or four flush strakes. See IJsselmeerpolders find NZ 42 (Reinders, *Cog Finds from the IJsselmeerpolders*, p. 14, Fig. 4.). Van de Moortel's claim that NZ 43 has a "slight chine of 15°" ("A Cog-Like Vessel from the Netherlands," p. 81) is a misuse of the term.

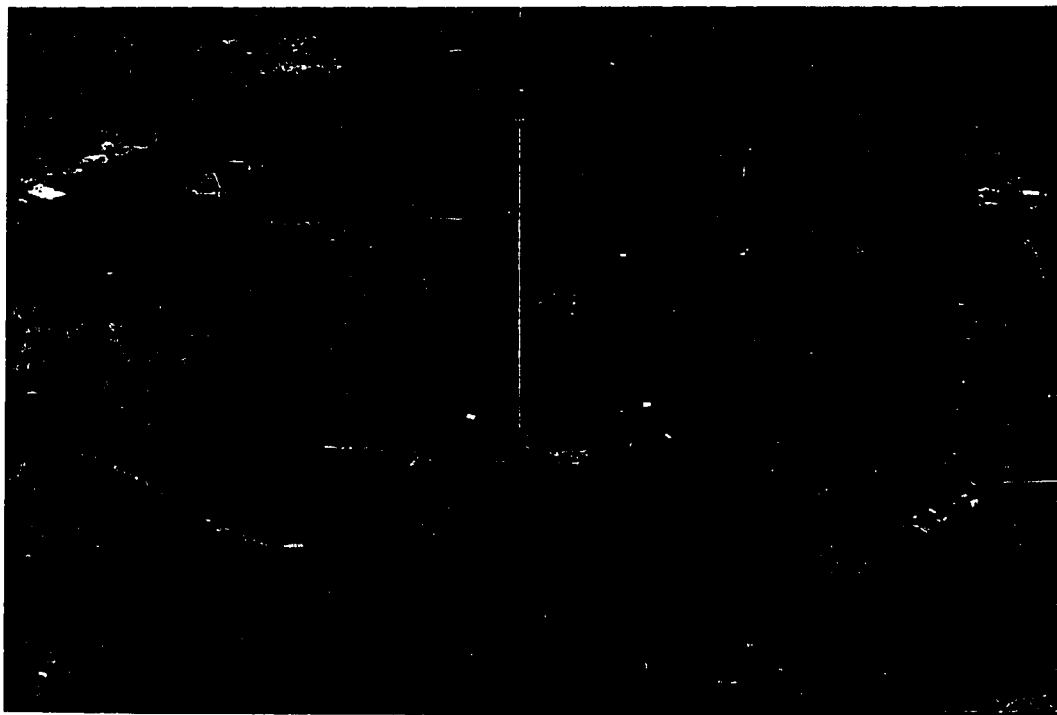


Figure 8. Almere Wijk 13 site during excavation (Photo RIJP).

Almere Wijk 13: A Fifteenth-Century Cog

A vessel excavated in the new town of Almere, the Netherlands, in April of 1986 illustrates many of the features discussed above.⁸⁹ The remains were discovered during ditching operations; aside from a 2 m trench cut completely through the stern, the vessel is very well preserved, although flattened (Fig. 8).

⁸⁹ The vessel was excavated by the staff of the Museum voor Scheepsarcheologie, Ketelhaven, and recorded between June and August of 1988 by Texas A&M Nautical Archaeology Program graduate students Mike Fitzgerald, Bob Neyland, and Sam Mark, under the direction of the author. Recording was funded by the International Association for the Exchange of Students for Technical Experience (IAESTE) and the Institute of Nautical Archaeology (INA), with materials provided by the Museum voor Scheepsarcheologie.

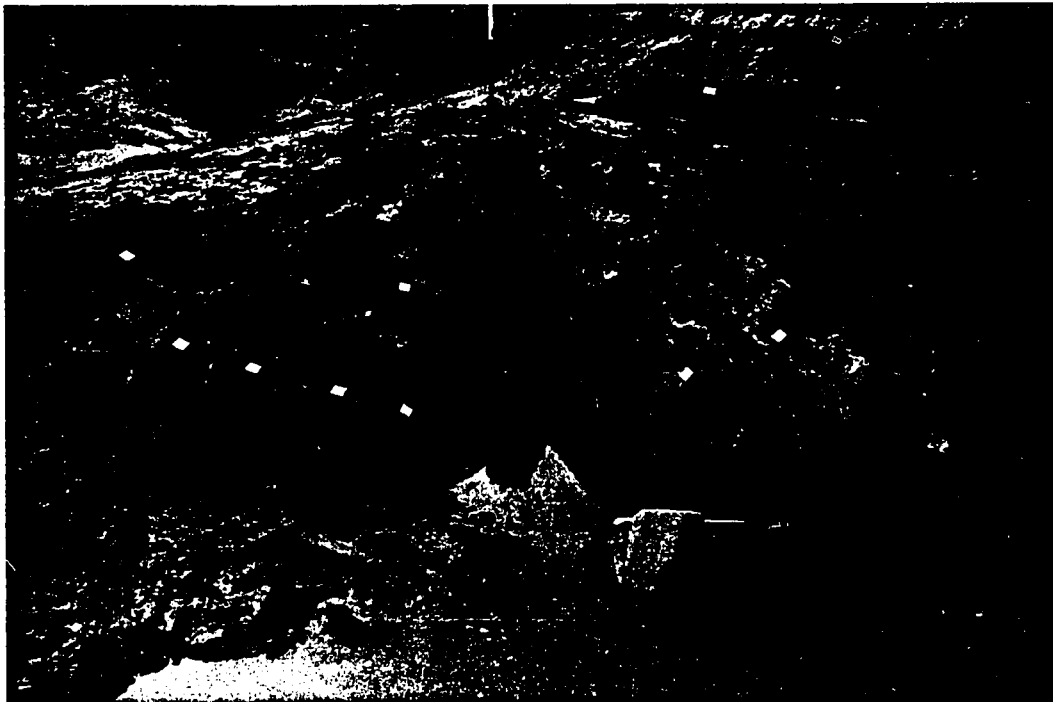


Figure 9. Almere Wijk 13 stern area after removal of frames (Photo RIJP).

Both sides survive, partially detached from the bottom, to their full height amidships. At the bow, the hood ends of the bottom strakes are intact, but the upper hood ends lay above the "rot line." Fortunately, the upper end of the stem was broken off, probably by ice or a passing vessel, and survived, so the stem and false stem are virtually complete. At the stern, there was no sign of the sternpost during excavation, but the hood ends of all but the upper two strakes were still in place (Fig. 9). Much of the deck structure had collapsed into the hold, but no beams were completely preserved.

No significant cargo remains were found, but fragments suggested the

possibility that a past cargo had been brick, a common Zuiderzee commodity. Most of the skeleton of an adult male human was recovered, along with a wooden clapper of the type lepers were required to carry in the medieval Netherlands.⁹⁰ The sinking has been dated to between 1422 and 1433,⁹¹ but extensive wear and repairs indicate that the vessel is somewhat older.

Dimensions

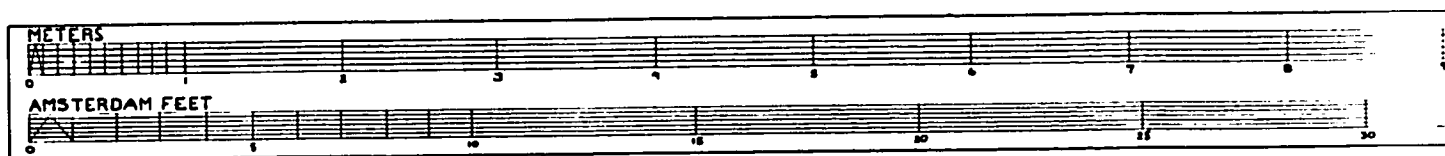
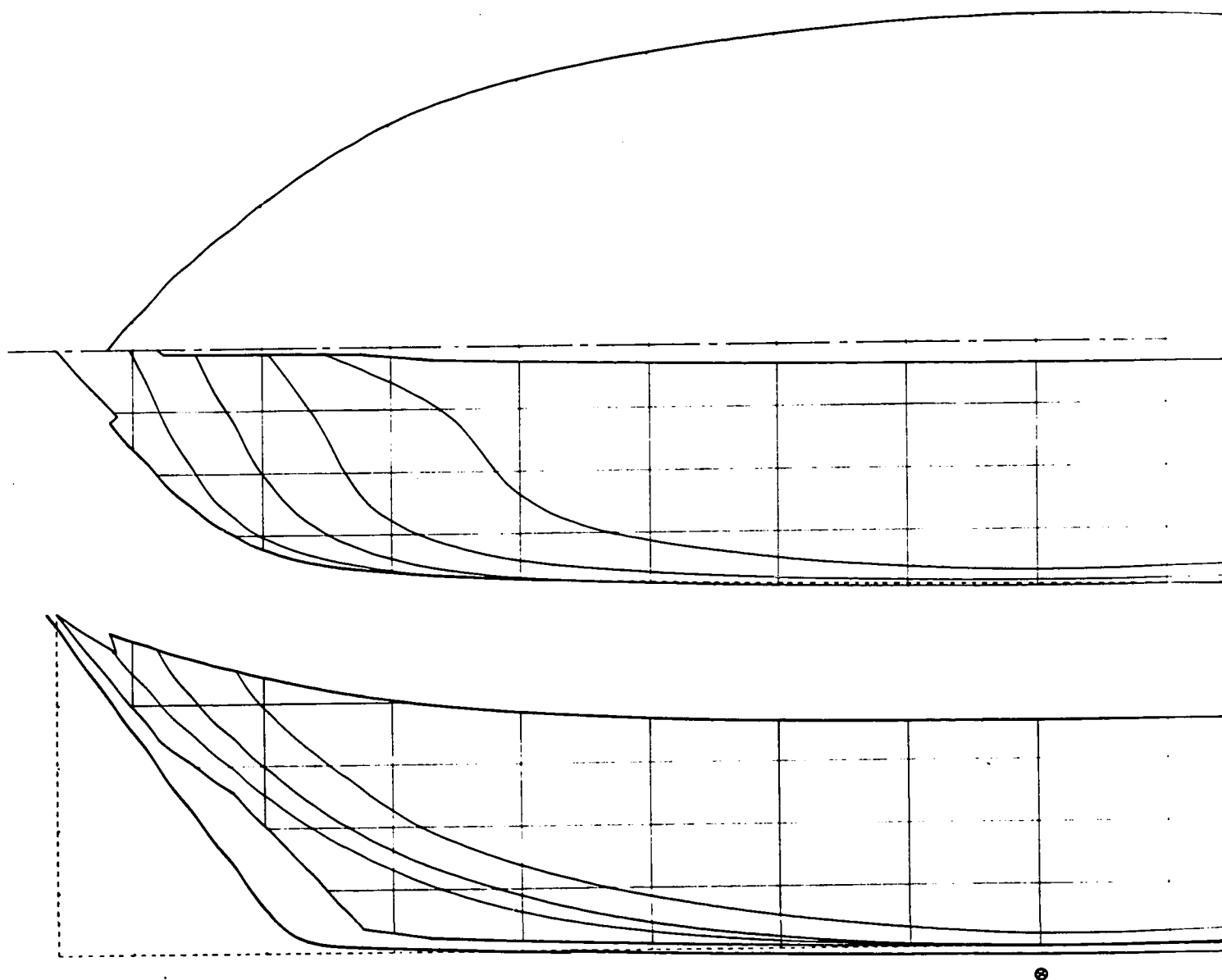
As reconstructed, the Almere cog is 15.95 m long overall (not including the missing rudder, which should add some length), with a moulded beam of 3.96 m and extreme beam of 4.20 m. At its lowest point, the top of the caprail stands 1.93 m above the bottom of the keelplank. Depth in hold, from the underside of the beams to the top of the ceiling, is 1.70 m. Loaded draft is unknown, but no doubt varied. Maximum draft probably did not exceed 1.16 m, as this is the height at which the chainwale is mounted. At this draft, displacement in fresh water is 39.5 tons. Ship weight is estimated at 15 tons, giving a maximum deadweight capacity of 24.5 tons. At the 2 tons/last approximation discussed above, this comes to 12 lasts or so.

⁹⁰ It would be most poignant if the clapper belonged to the dead man, but it was not found in association with the skeleton.

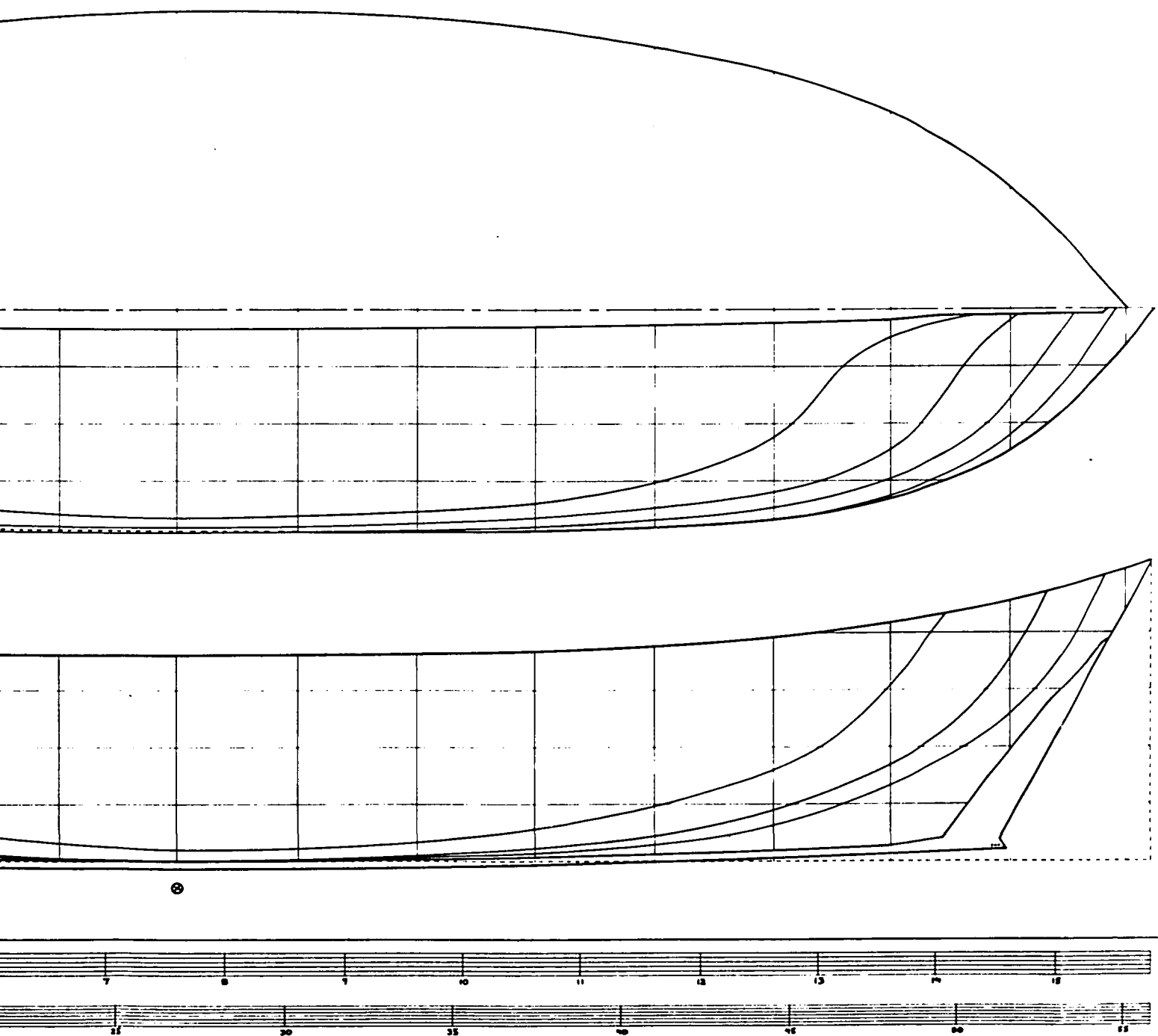
⁹¹ Dating is by coins, several of which were found. These range in date between 1416 and 1422. A handy *terminus ante quem* is provided by Philip of Burgundy's currency reorganization of 1433, in which nearly all circulating money in the southern Netherlands was replaced with a new, unified coinage: see P. Spufford, *Monetary Problems and Policies in the Burgundian Netherlands 1433-1496*, pp. 1-7.

Hull Form

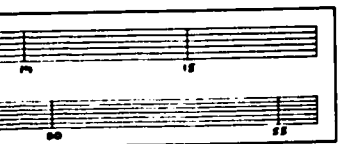
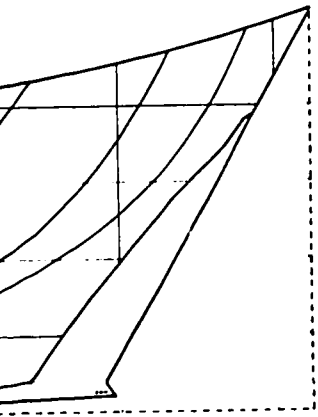
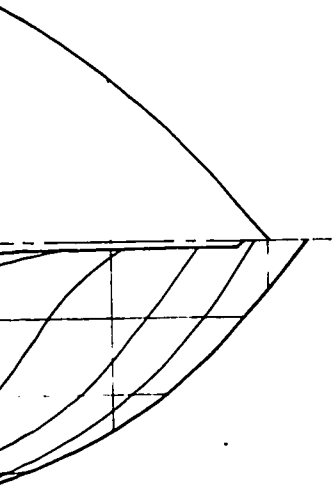
The lines drawings (Plans I, II) show a relatively narrow, shallow hull with extremely full sections. The bottom flat is wide in comparison to other cogs, especially those like the Bremen cog, and the sides nearly vertical, with some tumblehome in the sheerstrake. Consequently the bilges are relatively hard, although they are eased somewhat by the deadrise of the outermost flush strake. The full sections are carried very far forward and aft, so that the sides are nearly straight over most of their length. The stem rakes considerably; the face of the stem proper stands at an angle of 131° to the line of the keel, or 50° to the horizontal. The result is an extremely full bow with an exaggerated hollow low down in the entrance, where the garboard must run into the angular join of post and keel. A similar, if less extreme, shape is seen in the stern, although the reconstruction is less reliable here due to the damage done by the ditching machinery that first exposed the wreck. The sternpost rakes less (as is typical of cogs), at 61° to the horizontal, and the run is easier than the entrance. Hulls fuller at the bow than stern are characteristic of the inland craft of northwestern Europe. In this reconstruction, the keelplank is slightly rockered (12 cm over 11 m), but I am beginning to think a flat keel more likely; another reconstruction will be necessary to test this. Distortion of the planking after sinking makes it difficult to tell with certainty. Flattening the keel should make the diagonal a bit fairer in the bow, but will not cause major alterations of the basic shape. Hull coefficients (not including the external areas of stem, false stem, and sternpost) are given in Table 1.



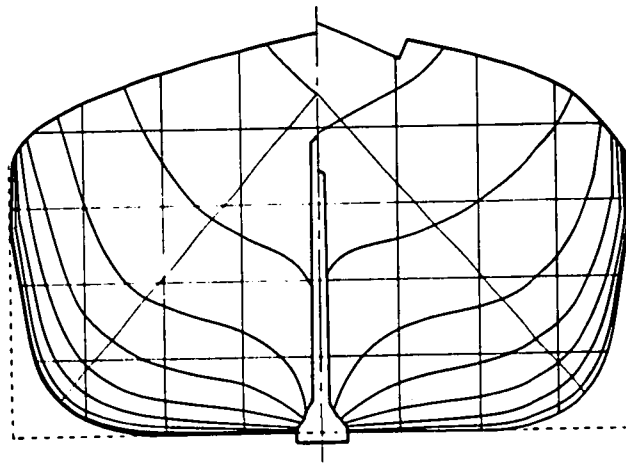
PLAN I. Almere Wijk
As in all other drawings

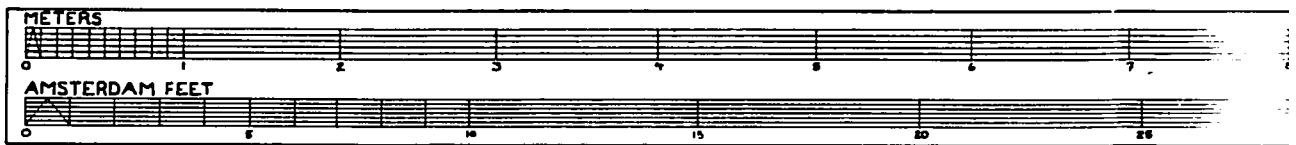
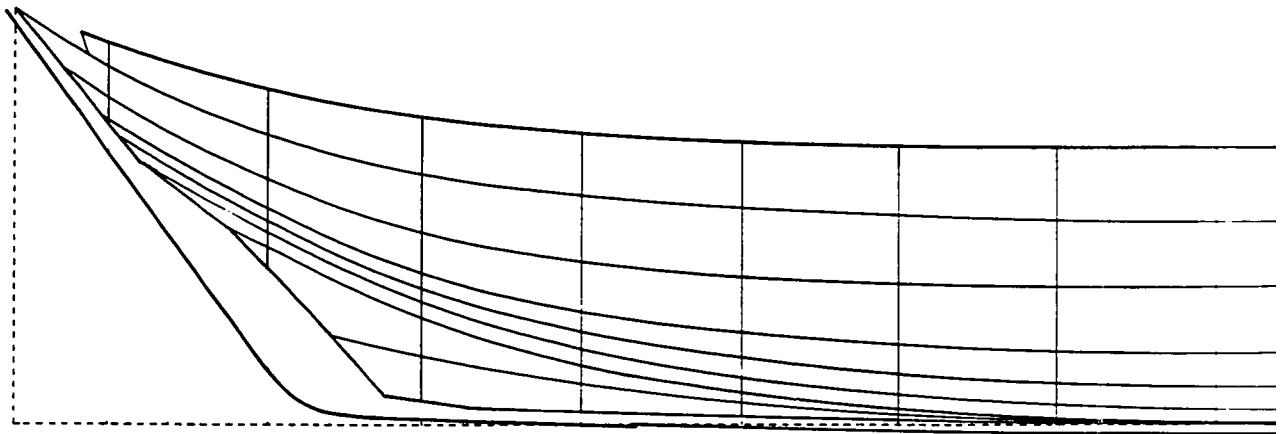
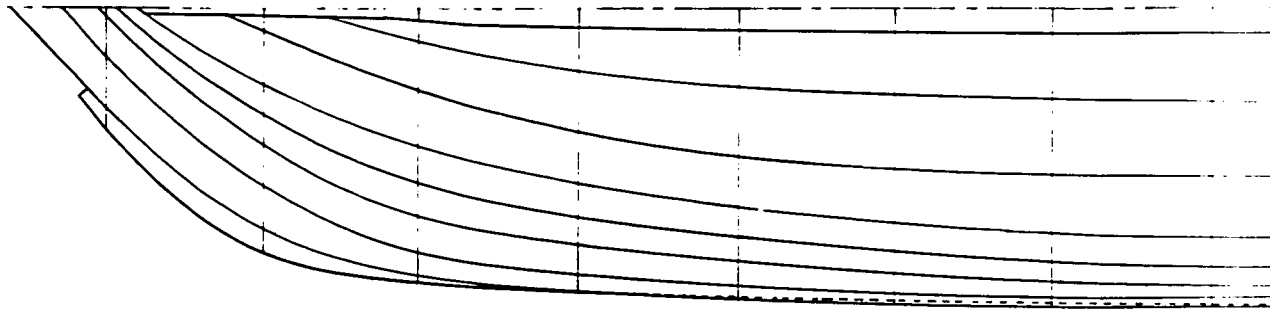


PLAN I. Almere Wijk 13 Conventional Hull Lines (to upper, inboard edges of strakes).
 As in all other drawings of this hull, the port side is represented.

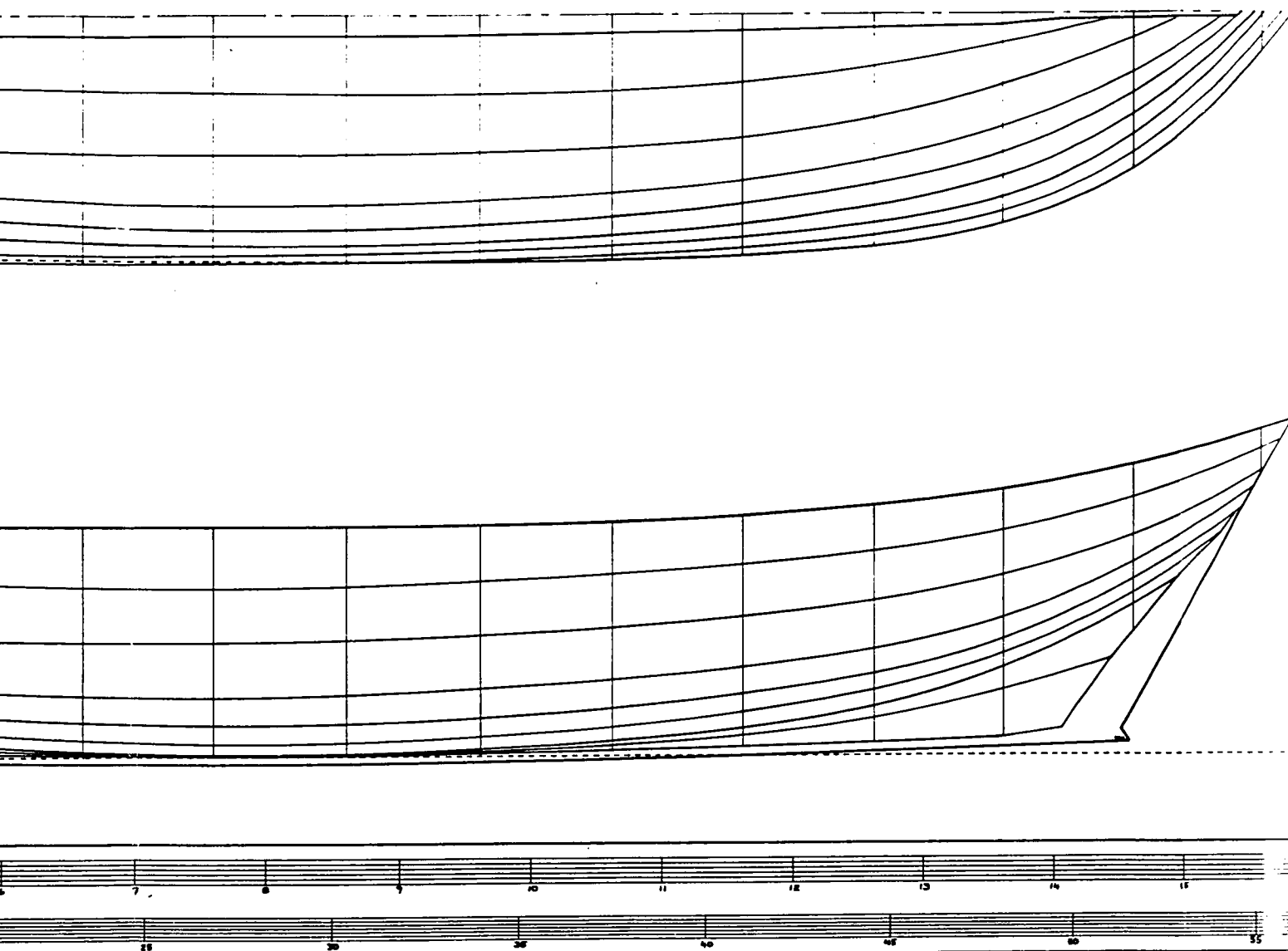


strakes).

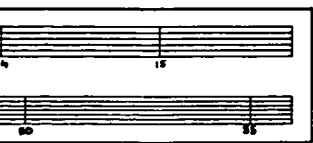
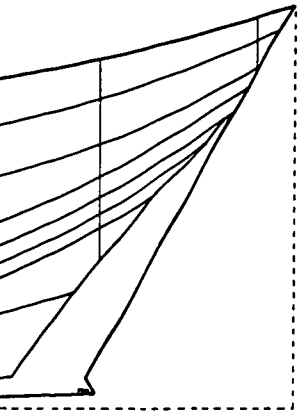
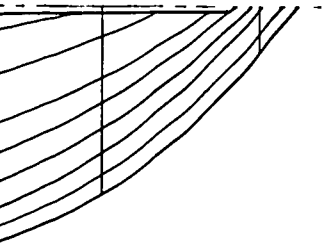




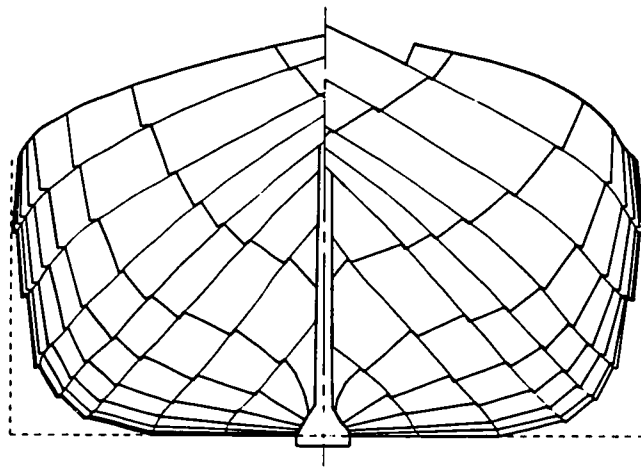
PLAN II.
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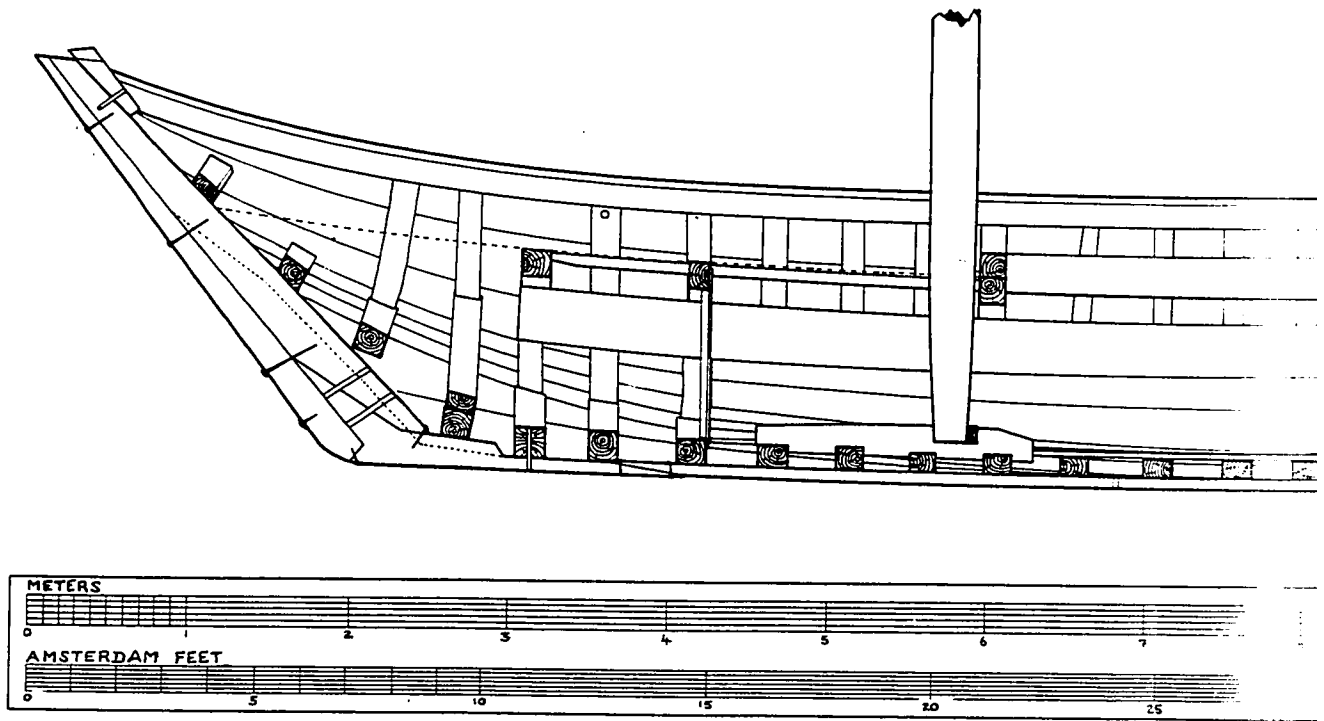


PLAN II. Almere Wijk 13 Planking Lines. Longitudinal sweeps represent the upper, inboard edges of strakes.

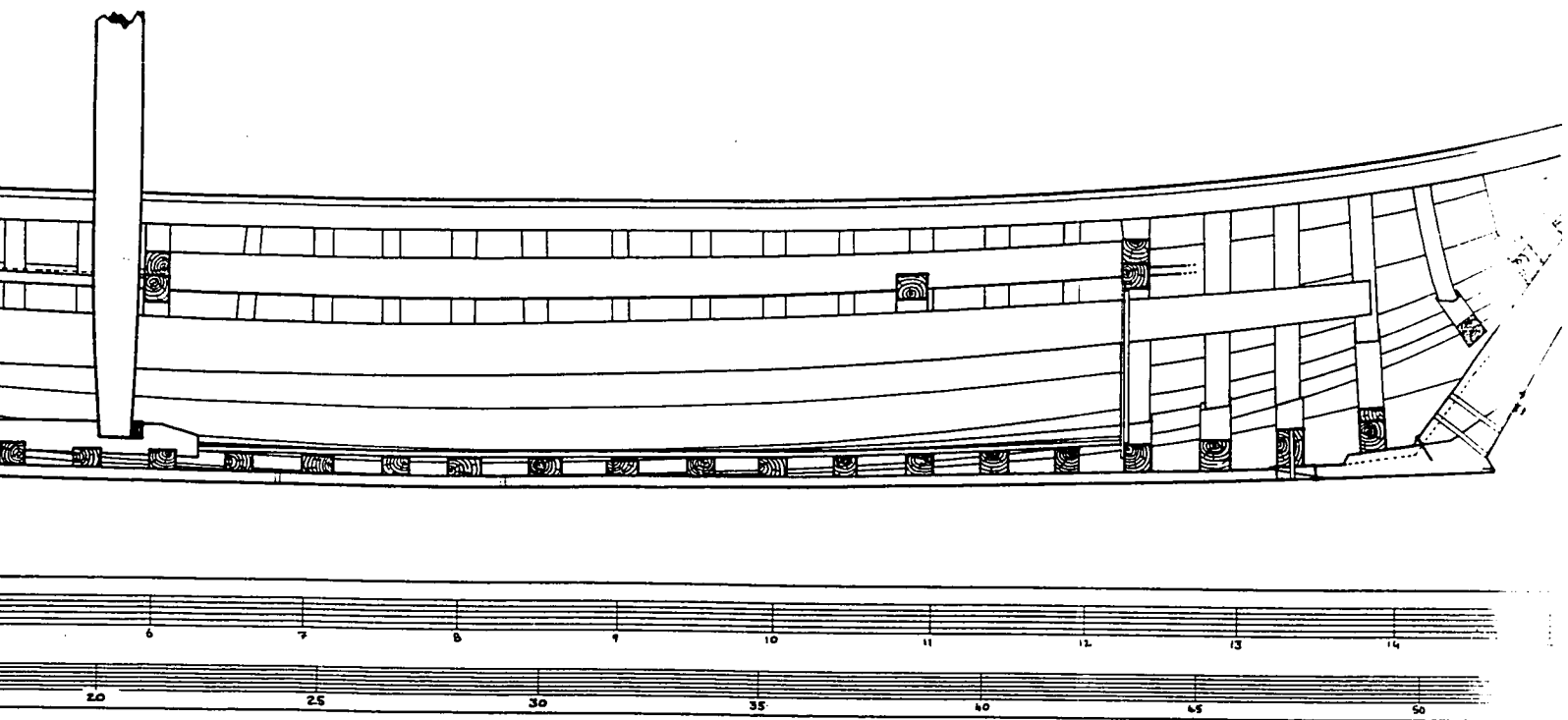


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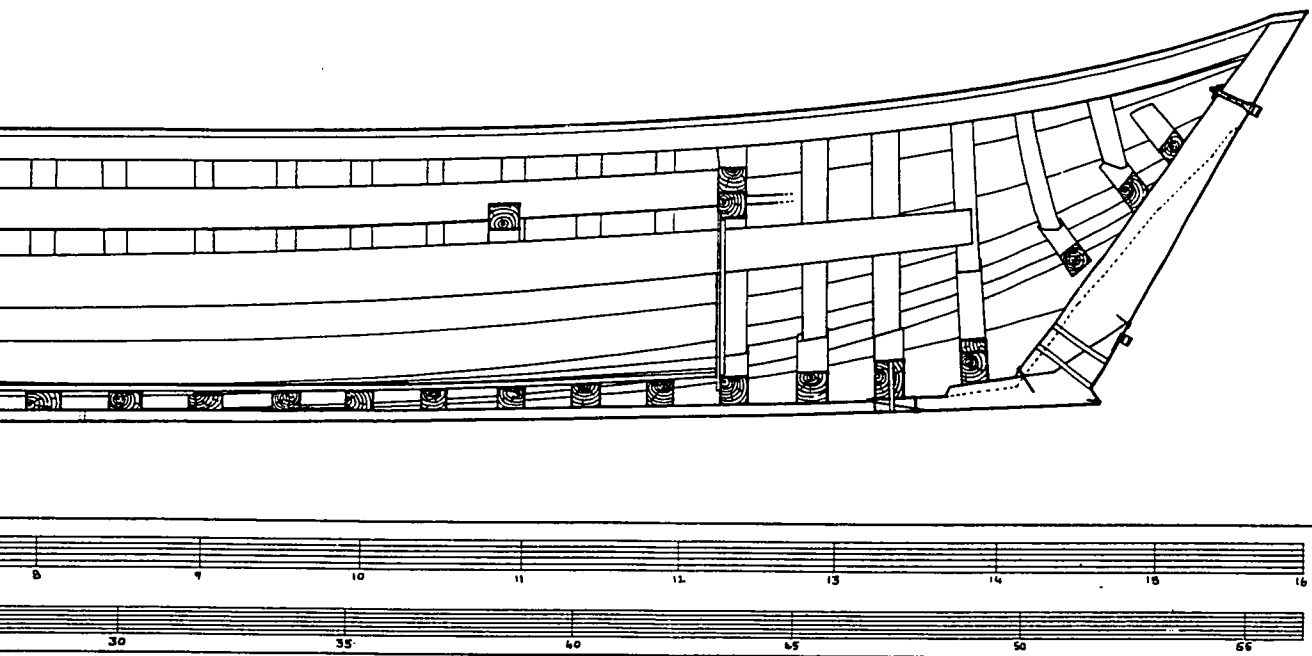




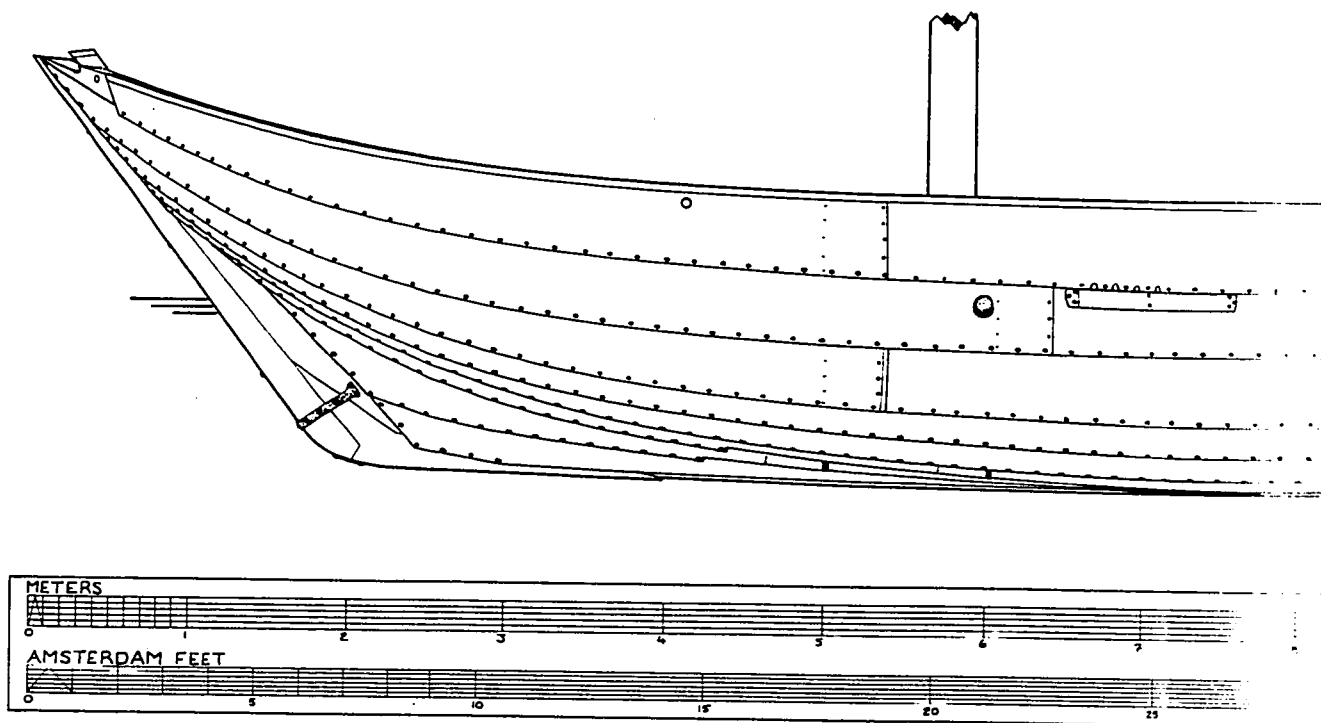
PLAN III. Almere Wijk 13 Longitudinal Cor
exact arrangement of the stern framing are la



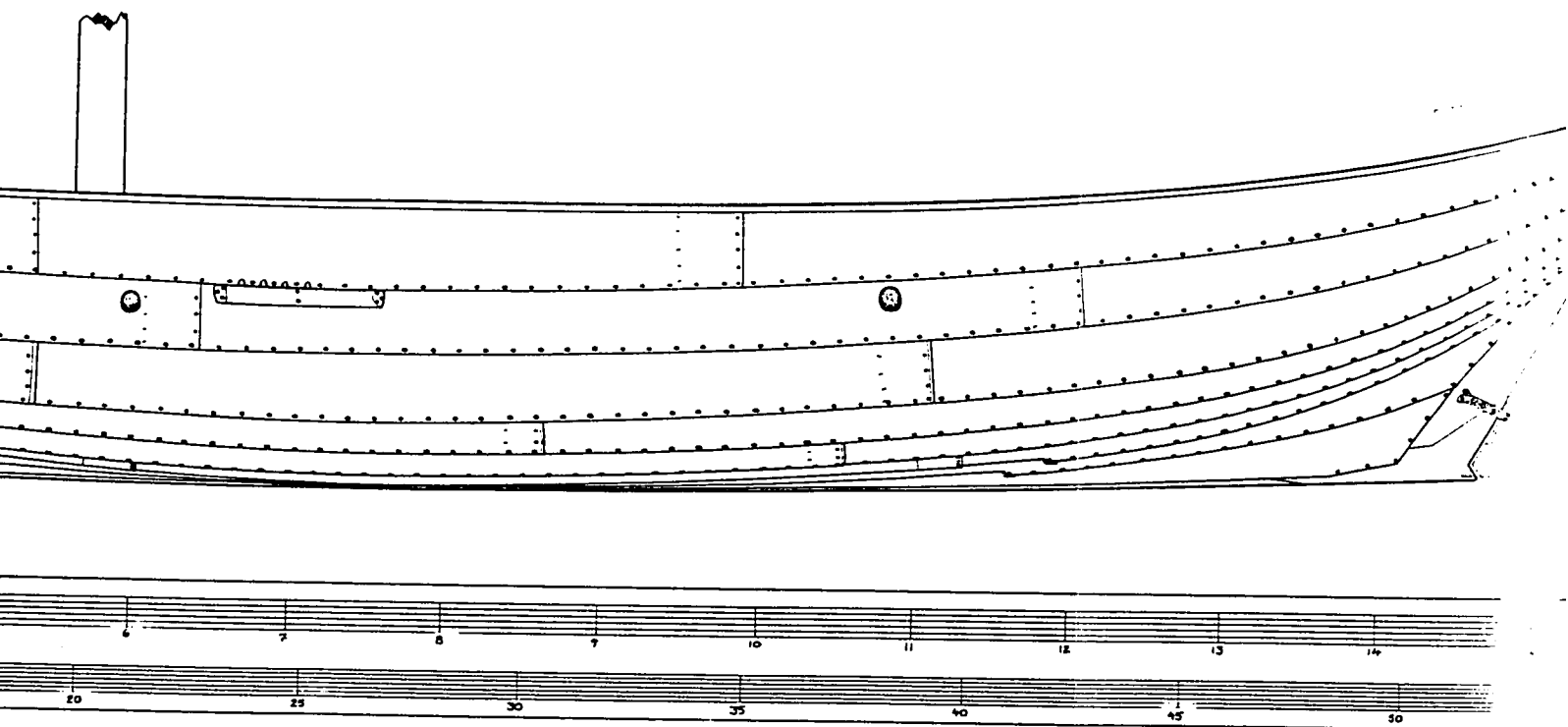
I. Almere Wijk 13 Longitudinal Construction Section. Deck structures and the arrangement of the stern framing are largely conjectural.



Construction Section. Deck structures and the
re largely conjectural.



PLAN IV. Almere Wijk



PLAN IV. Almere Wijk 13 Exterior Profile.

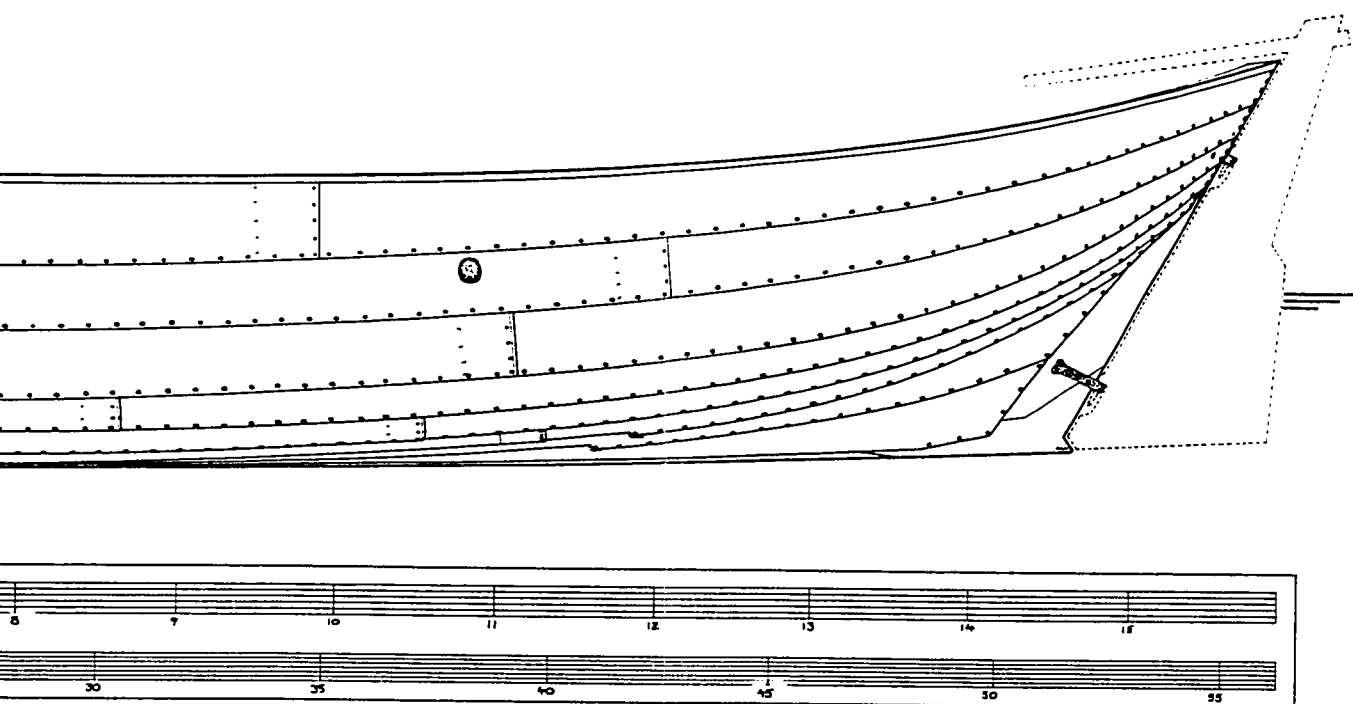
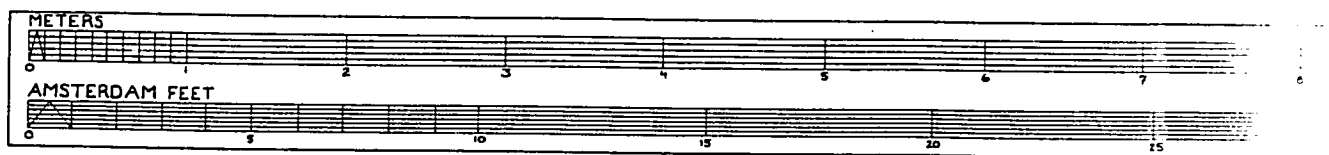
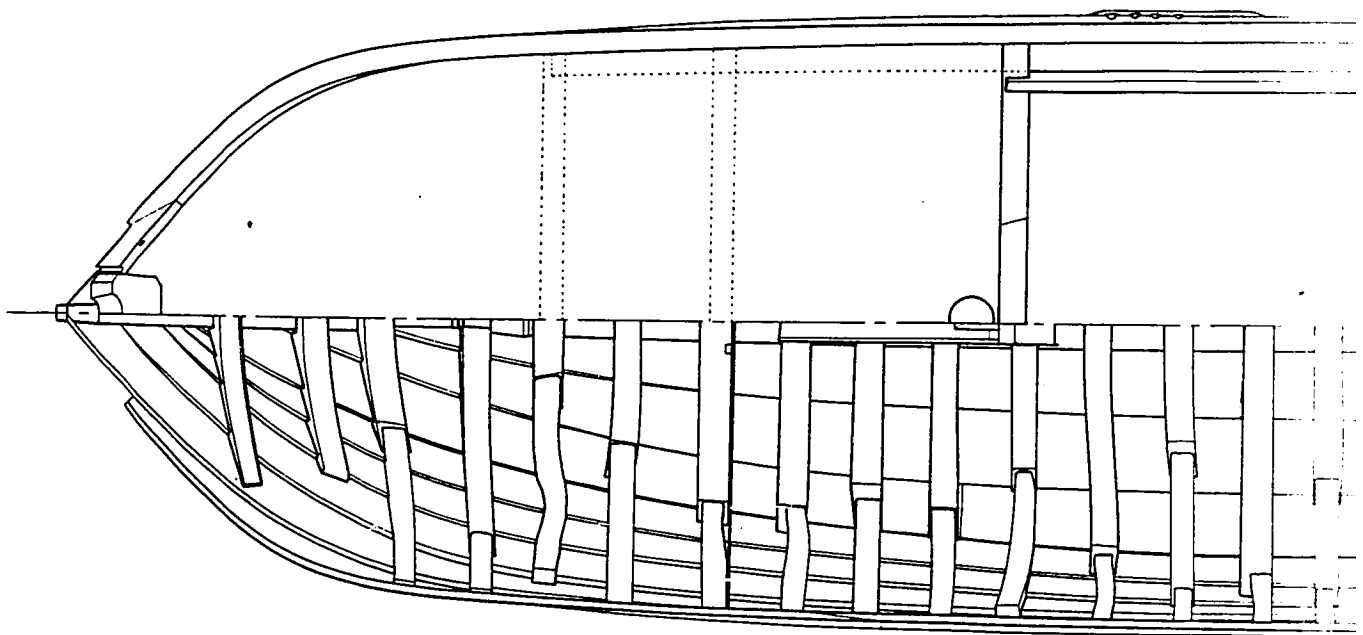
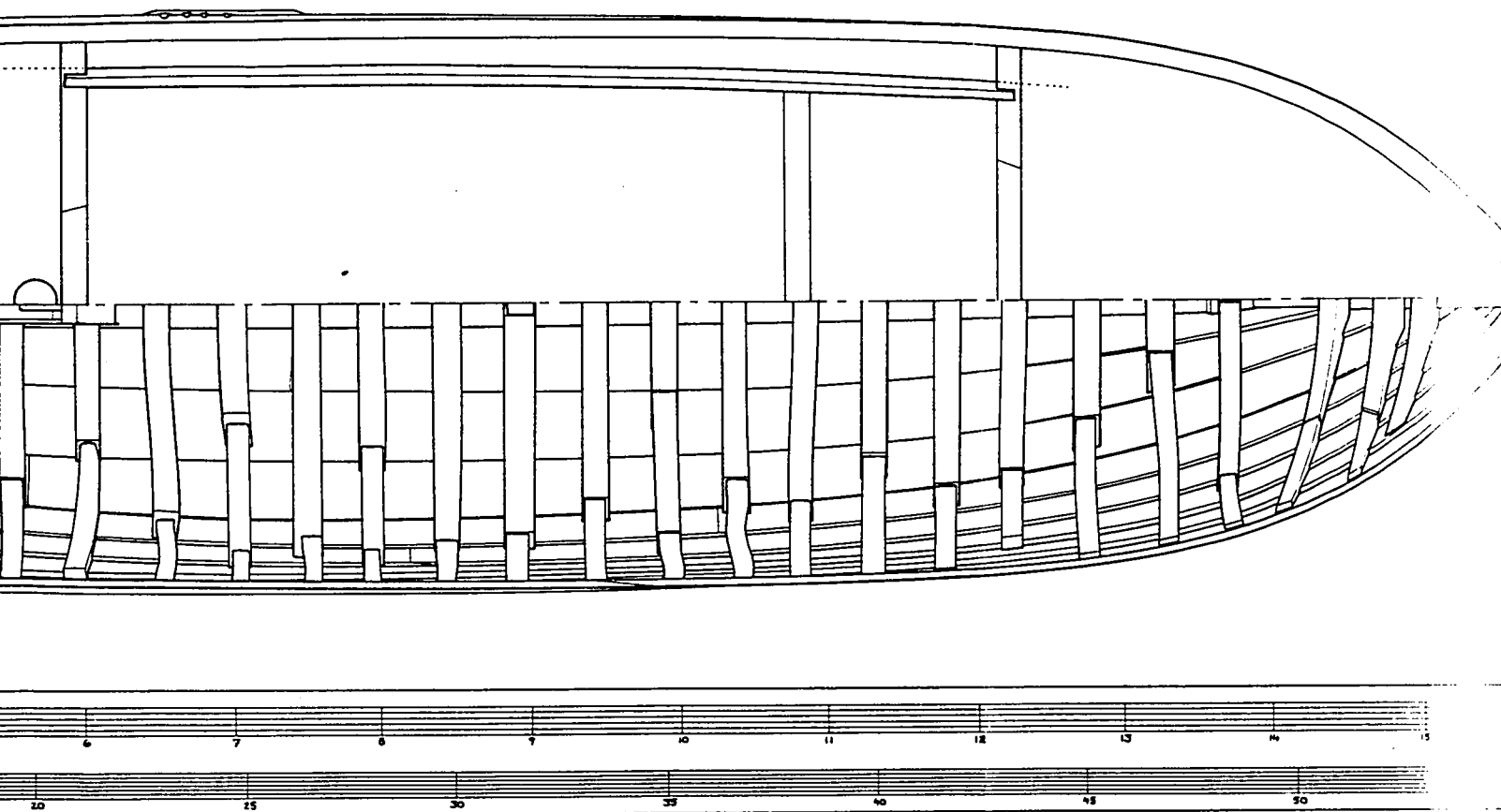


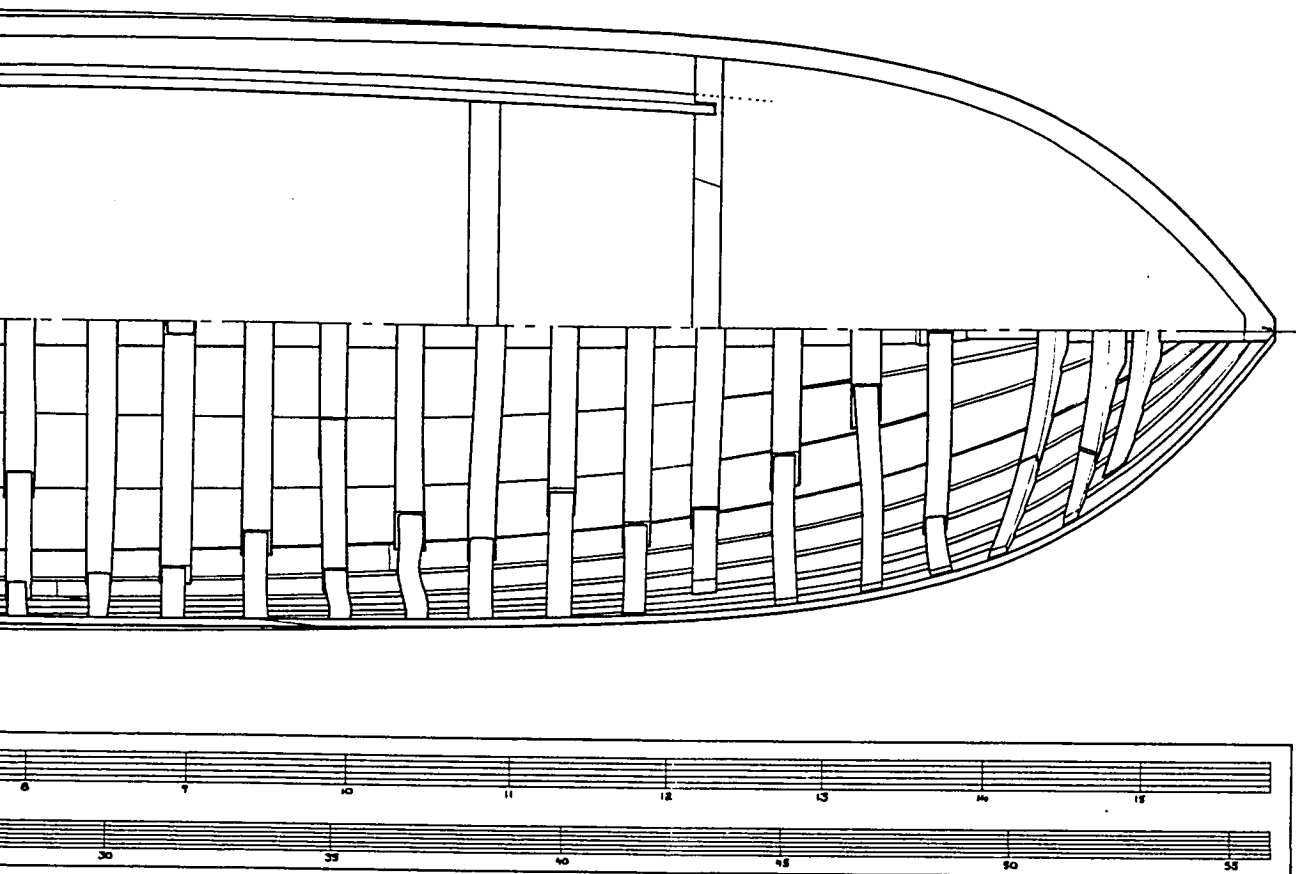
Figure 13 Exterior Profile.



PLAN V. Almere Wijk 13



PLAN V. Almere Wijk 13 Deck and Framing Plan.



13 Deck and Framing Plan.

Table 1. Almere Wijk 13 Hull Coefficients.

Block Coefficient (C_B):	0.66
Midships Coefficient (C_M):	0.96
Prismatic Coefficient (C_P):	0.69
Waterplane Coefficient (C_{WP}):	0.85

Structural Components

Despite the late date, the construction (Plans III-V) is squarely in the cog tradition, with all the diagnostic elements present. All structural timbers are of oak, with an unidentified and poorly-preserved softwood used for some of the ceiling over the bottom. The backbone is formed by a keelplank 9.94 m long, 32 cm wide amidships, and 6.5 cm thick, scarfed and fastened to the hooks with double-clenched nails driven from both inside and outside. The forehook is longer (2.11 m on the bottom flat) and higher (0.68 m above the bottom surface) than the one at the stern. Straight posts are scarfed to the hooks and fastened in place by wedged, through-treenails. The stem (Fig. 10) is 3.40 m long, moulded 31 cm at its widest point (at the upper tip of the hook) and tapers to 14 cm at the upper end. The post is sided 18 cm on the after edge at the bottom and 13.5 cm at the top, with a forward face sided 11 cm. Rabbets for the lowest three strakes are cut into the sides of the hook and post. The remaining strakes are nailed onto a changing bevel on the forward face of the post. The lateral area of the stem is increased and the upper hood ends protected by a false stem nailed to the face of the stem. This timber tapers from a lower end moulded 22 cm and sided 11 cm

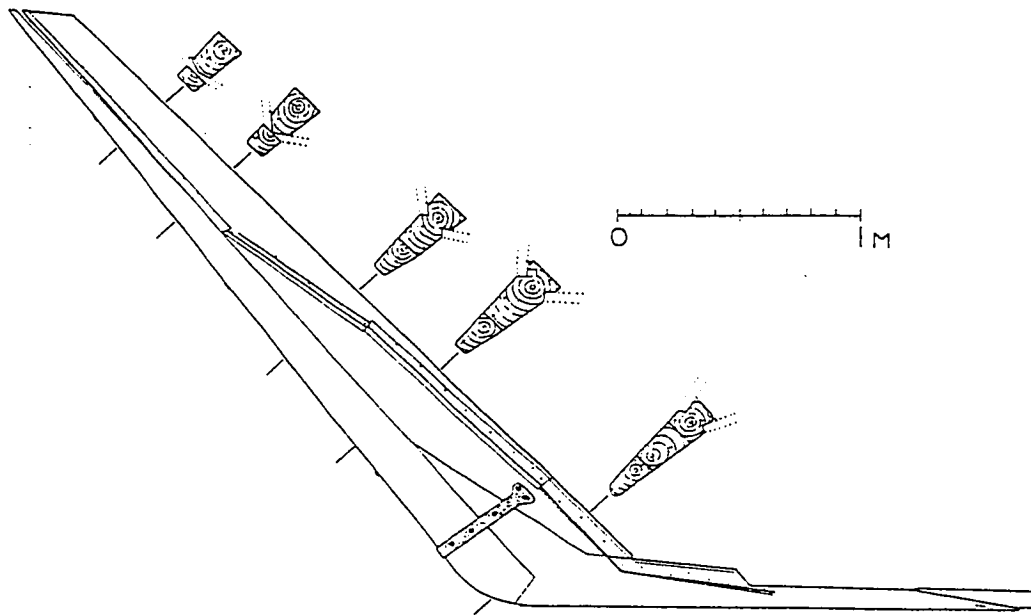


Figure 10. Almere Wijk 13 stem and hook details, port side. Note the angular run of the rabbet for the lower three strakes and the changing face bevel for the upper hooding ends.

to an upper end moulded 4 cm and sided 11 cm. The lower ends of the stem and false stem are clamped fore and aft of the upper end of the hook by an iron strap wrapped around the forward edge of the false stem and nailed to all three timbers.

In the stern, nothing remains of the post, but some details can be reconstructed from the preserved hook and hood ends. The hook itself is only 1.44 m long and 0.53 m high. The height of the post is unknown, but the lower end was moulded about 40 cm at the upper end of the hook and sided about 15 cm at the forward edge. The after edge was sided 10 cm at the upper tip of the

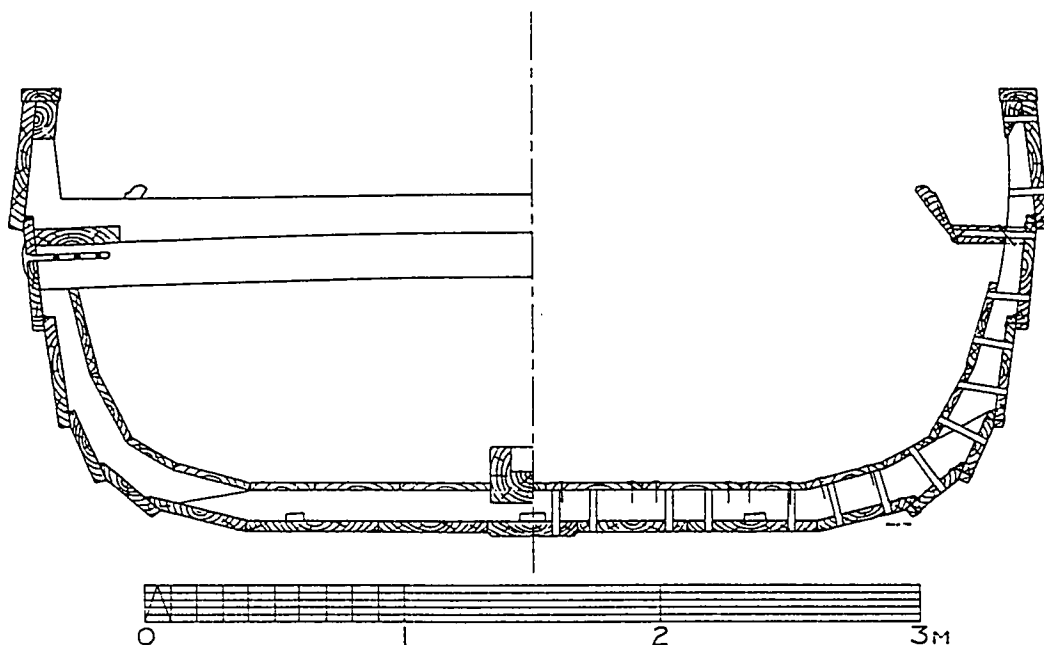
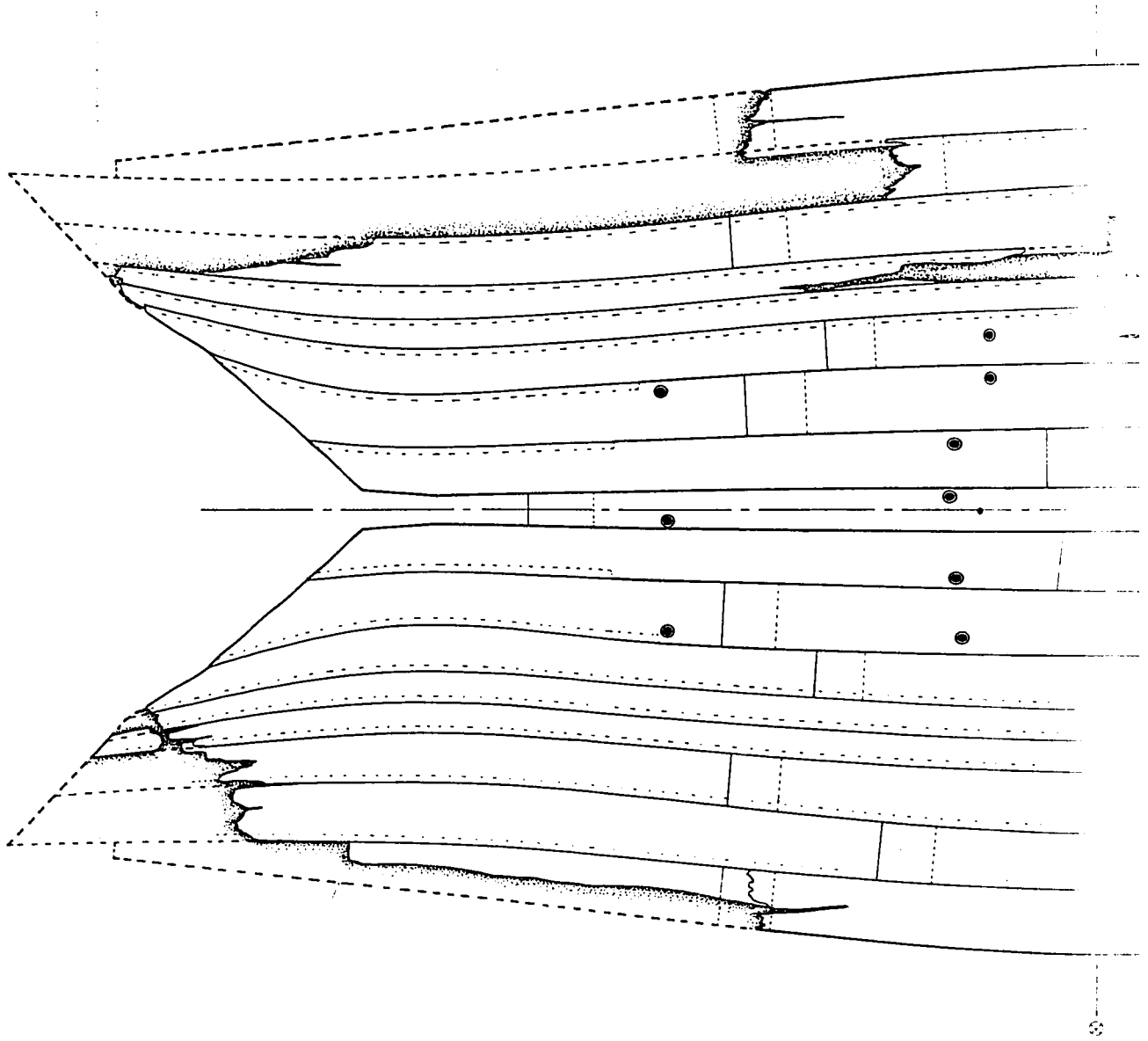


Figure 11. Almere Wijk 13 construction section amidships and at sailbeam.

hook. The lower four strakes were let into rabbets in the post (note that in the bow, only three strakes are let into rabbets), with the remainder scabbed onto the bevelled after face. There is no trace of a false sternpost. A carved hollow in the after face of the hook seems to be relief for a rudder pintle, suggesting there was not originally a rudderpost.

The planking consists of eight strakes on either side (Fig 11 and Plan VI). The lower seven of these were originally about 4.5 cm thick, but wear of the bottom and bilge strakes has reduced this to little more than 3 cm in many places. The sheerstrake is 5.3-5.7 cm thick. All are plain (tangentially or flitch) sawn and hung with the heart side inboard. The lowest three strakes are flush-laid amidships and lapstrake at the ends. The remaining planking is completely



PLAN VI. Almere Wijk 13 Planking Expansion
temporary fastening holes plugged with treenails

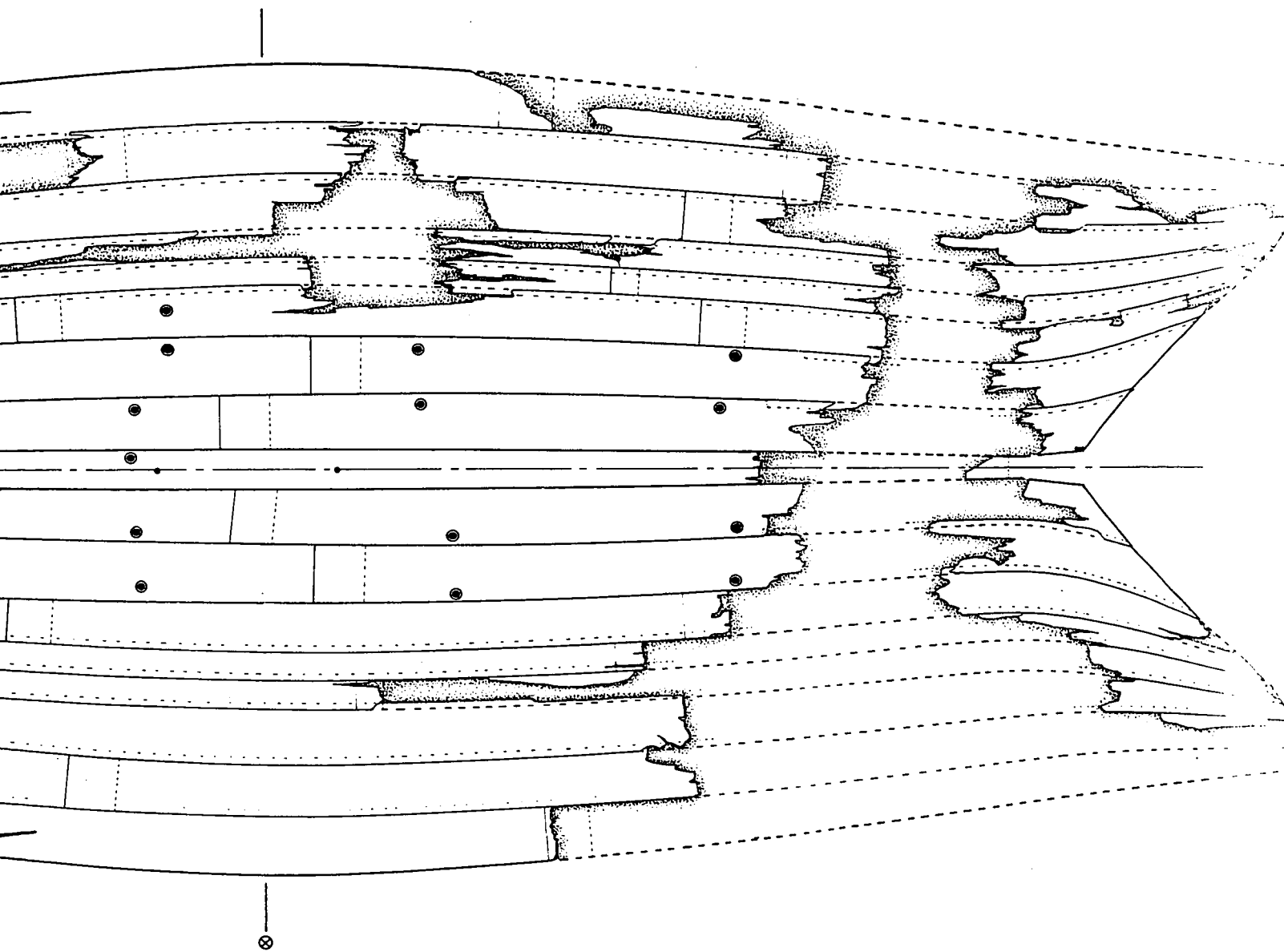


Figure 13 Planking Expansion. The bullseyes denote the location of
holes plugged with treenails.

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expansion. The bullseyes denote the location of green nails.

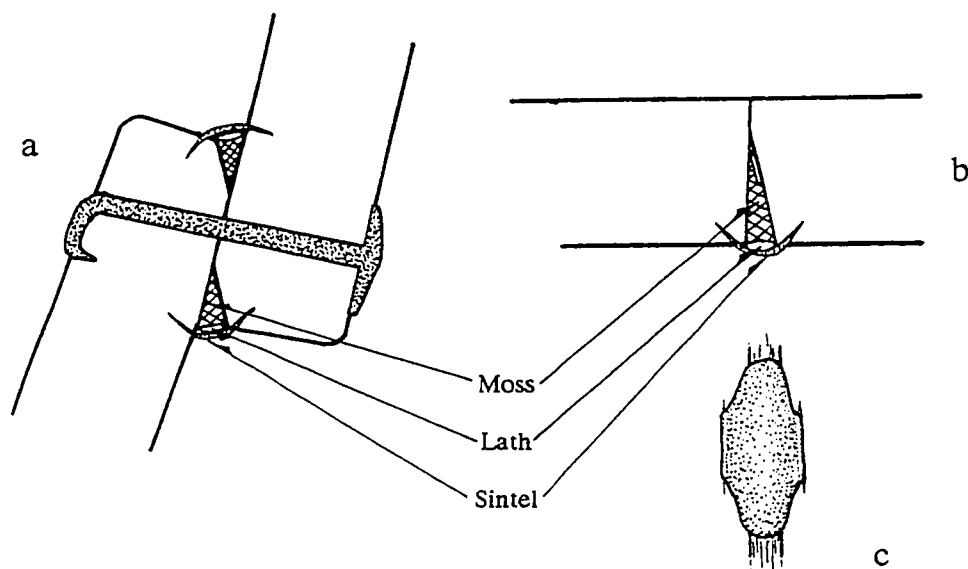


Figure 12. Almere Wijk 13 caulking detail. a. lapstrake. b. carvel. c. sintel.

lapstrake. All of the overlapped planking is fastened together with double-clenched iron nails, driven in from the outside, 15 to 18 cm apart. The fourth and fifth strakes form the turn of the bilge and are considerably narrower than the rest (30 to 34 cm wide versus 40 to 50 cm amidships). The sheerstrake is the widest, exceeding 55 cm amidships. The garboards and bilge strakes are each made of two planks, flat-scarfed and clench-nailed together, but the other strakes are each made of three planks.

Caulking is by moss, lath, and sintels (Fig. 12). An odd detail is very narrow, thin strips of wood laid into the bottom seams along one side of the caulking. In contrast to most of the other cogs, the lapstrake seams of the Almere vessel are caulked both inside and out, except for the seam at the lower edge of

the sheerstrake, which would have been out of the water in most circumstances. At least 6,000 long-eared sintels were used. Several seams have been recaulked, as evidenced by superfluous sintel holes and scraping damage.

Framing is simple, with 22 floor timbers (the Bremen cog, a much larger vessel, had only 27 timbers)⁹² treenailed to the keelplank, two pair of half-frames (one on top of either hook), and three more floor timbers⁹³ across (but not fastened to) either post, for a total of 30 frames (Plan V). Of these, all but the forward- and aftermost post floors have a futtock on each side. In some cases, an intermediate bilge knee is added between a floor and its futtock, but these may be repairs. The floor timbers are heavy and regular in shape and spacing. At the keel, they vary from 15 to 21 cm sided. Amidships they are moulded 13 cm, but this increases toward the ends as the deadrise increases. Typically, one arm is longer than the other and extends up past the bilge to the sixth strake. The long arms alternate sides along the boat, in a manner reminiscent of the single-framed Zwammerdam-type barges. The futtocks are less regular in size and shape, but are typically sided less than their respective floors and moulded less than 8 cm over some of the upper plank overlaps. The frames are fitted to the planking: flat over the flush planks and joggled over the lapstrake planks. Treenails 2.3 to 2.7 cm in diameter originally held the frames to the planking, with two treenails per plank at each frame on the bottom and side strakes and one treenail per

⁹² Lahn, *supra* n. 87, p. 57.

⁹³ These might seem to be breasthooks, but Dutch shipwrights call them by the same name, *liggers*, as the floor timbers across the keel and use them instead of cant frames.

plank through the bilge strakes. Many of the treenails, especially in the ends of the vessel, are cross-wedged.

The heads of the futtocks are protected by an inwale (*randgaard*), a stringer 15 cm wide and 7 to 8 cm thick treenailed to the inner surface of the sheerstrake, flush with its upper edge. The feathered ends of the futtocks are captured in beveled notches on the underside of the inwale and transfixed by treenails passing through plank, frame, and inwale. The forward end of the inwale is a heavy block that completely replaces the forward end of the sheerstrake and acts as a chock and bolster for anchor lines. A caprail (now missing) 12 to 13 cm wide and approximately 5 cm thick was fastened to the upper edge of the inwale by widely-spaced treenails.

The heel of the (single) mast rested in a short (1.77 m long) timber notched over and treenailed to (but not completely through) four floor timbers forward of amidships. At its heaviest, just abaft the mortise, the maststep is sided 34 cm and moulded 23 cm. The mast heel was wedged in place by a block that rested in a notch over the after part of the mortise. The maststep had been removed and refastened at least once in the vessel's life. In its final position, it does not sit directly above the centerline of the keelplank, but slightly skewed and about 5 cm to starboard. At deck level, a heavy beam with standing knees just abaft the mast acts as a partner. In later Dutch craft, this assembly is called the "sailbeam" (*zeilbalk*). Of the mast and rigging nothing remains, but the location of the step strongly suggests the use of a sprit rig.

Internal longitudinal strength is provided by gangways (*gangboorden*) 7.5 cm thick and up to 28 cm wide, notched over the frames and treenailed through them to the inner surface of the seventh strake. These are single timbers at least 9 m long, which extend over the straighter portion of the sides. They lie on top of and are treenailed to beams along their length. Between the sailbeam and a similar beam aft, the inboard edge of each gangway is bevelled to fit the lower, thinner edge of a wedge-sectioned timber (*denneboom*), which acts as a coaming around the large, central hatch. If this timber is similar to those on later vessels, it supported the lower edges of the arched panels of a barrel-vaulted hatch cover.

The hold appears to have been completely ceiled with 3 cm boards. Most of those over the bottom (*buikdenning*) were of pine and were nailed in place.⁹⁴ Ceiling along the sides (*wegering*) is of oak. Both bottom and side ceiling, except for the uppermost strake, end just short of the twenty-fourth frame, at the bulkhead marking the forward end of the hold. The after ends continued into the damaged area. The uppermost ceiling strake is thicker, at 4.5 cm, and extends forward to the twenty-sixth frame. The beams of the foredeck, and presumably the afterdeck, rest on the upper edge of this strake, which foreshadows the broad, thin shelf clamps of later *Zuiderzee* vessels.

Little intelligible remains of the deck survive, but the locations of several key beams can be deduced. The sailbeam has already been mentioned. It and another, similar beam at the after end of the hatch are essentially double beams.

⁹⁴ None of this could be recovered, as it was in such poor condition; it was recorded in place before being removed.

In each, a continuous lower beam rests on the upper edges of the uppermost ceiling strakes and the truncated upper ends of a frame. A rider is constructed above this from a pair of standing knees (which are notched over the gangways) and a central filler, all of which are treenailed to the lower beam. The knees are treenailed to the sides and inwales, as if they were the upper ends of the truncated futtocks, in a manner reminiscent of the *biti*-knee combination seen in Nordic vessels. The whole forms a strong transverse structure; combined with the gangways, they reinforce the potentially weak area of the hatch. The location of the after double beam is uncertain, as it must lie in the part of the hull destroyed by the ditching machine. As reconstructed, it rests on the seventh frame from the stern.

Between the double beams is an intermediate single beam, just forward of the tenth frame from aft. This is not stiffened by knees, but the gangways are lightly notched over it. Like the sailbeam, it is fastened to the seventh strake directly by a heavy bolt at either end. These *rozebouten* (literally "rosebolts," from the large heads) are short (30 to 35 cm) iron bolts 2.5 cm in diameter with flattened inboard ends and large, mushroom-shaped heads 16-18 cm in diameter. The inboard end of each is pierced with three holes. The bolts are placed along the forward or after face of a beam and then nailed to the surface of the beam. Apparently, this was an attempt to get some of the structural qualities of through-

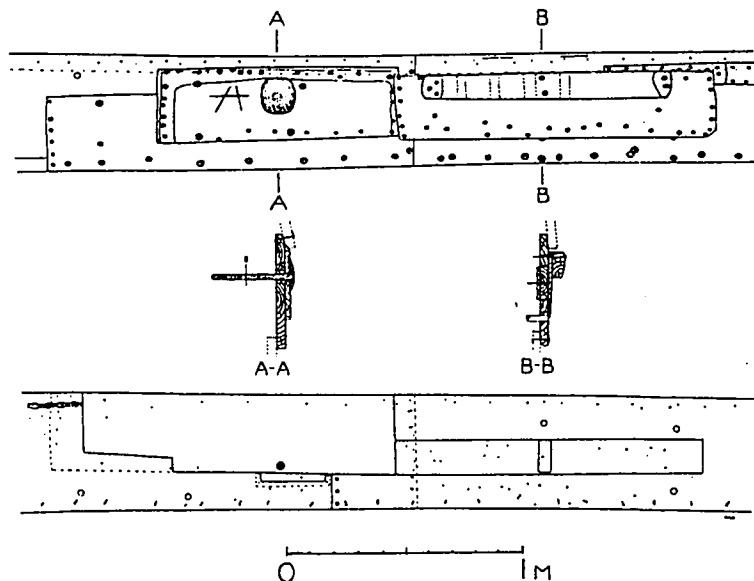


Figure 13. Almere Wijk 13 repair to port strake 7 at rosebolt.

beams without the extra width and clutter of protruding beam-ends.⁹⁵ In practice, the idea was not particularly successful. Three of the bolt locations are preserved, but both of the sailbeam bolts had been moved or replaced as they wore or damaged the planking. On the port side, the seventh strake had shattered around the bolt, requiring extensive repairs and a pad on the outside (Fig. 13).

⁹⁵ Unger, *The Ship in the Medieval Economy*, p. 147, states that protruding beam ends were needed by northern ships as fenders to keep them off quays and wharfs, since wales were not used until later. Clearly Unger has never worked on real vessels - protruding fixtures are a headache at the quay, as they are prone to catching on top of or under shore structures and other vessels moored alongside, with potentially disastrous consequences. The problem is especially worrisome in harbors with a moderate to large range of tide, as is found in many northern European ports. Examination of several of the more detailed seals (such as the 1329 seal of Stralsund) show wedge-shaped blocks forward of the beam ends. These blocks have been found on a fifteenth-century clinker-built vessel excavated at Aber Wrac'h, Brittany. They are farings, to guide lines, etc. over the beam ends, so that they will not foul. M. l'Hour and E. Veyrat, "A Mid-15th Century Clinker Boat Off the North Coast of France, the Aber Wrac'h I Wreck: A Preliminary Report," *JNA* 18 (1989): 288.

Two other beam locations can be determined, both in the bow. One lay above the twenty-fourth frame, and had a bulkhead fastened to its after face; the lower edge of the bulkhead was nailed to the after face of the twenty-fourth frame. A second beam rested atop the truncated ends of frame 26 and supported the forward ends of the gangway. Other beams must have been placed in the stern, but poor preservation does not reveal their location. Details of the deck itself also remain unknown, but later craft that are quite similar in basic configuration and beam location have a long foredeck extending from the stem aft to the sailbeam and a small afterdeck abaft the double beam at the after end of the hatch. There should also be a pair of hatches in the foredeck: one just forward of the mast, into the hold, and another, smaller hatch forward of the hold bulkhead, into the forepeak.

Most of the interior of the hull is devoted to the hold, from the bulkhead at frame 24 aft to somewhere in the damaged area. A badly-damaged beam fragment from this area appears to be part of the double beam; it has a rabbet with nails along its lower edge, indicating the presence of a bulkhead at the after end of the hatch. If the beam is located at frame 7, the total length of the hold is 8 m. Access is by the central hatch, 6.15 m long, 3.08 m wide at the forward end and 2.84 m wide aft. The use of neither the bow nor stern compartment can be determined from structure or small finds, but later vessels arranged this way typically use the forepeak for living space and the stern compartment for the storage of ship's gear and bosun's stores.

Function

The shape and size of this vessel strongly suggest that it was not primarily intended for open water. It is the narrowest (for its length) and most flat-bottomed of the excavated cogs (although the Kollerup cog comes close), especially in comparison with the examples considered late, inland vessels (IJsselmeerpolders finds M 107 and NZ 43). The strange rosebolts and narrow beam suggest a concern for keeping width and projecting obstructions to a minimum, while the hull shape is clearly an attempt to cram as much capacity into the given dimensions as possible. The find location is in the southern end of the Zuiderzee, not far from Amsterdam and Muiden, the entrances to the *binnenweg*. The Almere cog is narrow enough, at 4.20 m, to pass the narrowest of the locks on the sixteenth-century *binnenweg*, the Donkere Sluis in Gouda, and there is no logical reason to suppose a wider lock in the fifteenth century. Other oddly-proportioned, flat-bottomed craft are known from the medieval Zuiderzee,⁹⁶ but are considered misplaced river craft. Taken all together, along with textual evidence for the appearance of cogs on the *binnenweg* throughout the fifteenth century, I believe the Almere cog (or *coggeschip*, to use the fifteenth-century term) was, at least originally, a *binnenvaarder*, or canal boat.

⁹⁶ For example, IJsselmeerpolders finds K 73/74 and M 55, both dated to the late fifteenth century, are long, narrow hulls considered best suited to riverine and canal travel; Reinders, van Veen, Vlierman, and Zwiers, *Drie Schepen uit de Late Middeleeuwen*, pp. 29, 40, 50.

Construction

The Almere cog's bottom-based heritage can be seen not only in the typical cog features of flush bottom and lapstrake sides, etc., but in the construction sequence. As has been noted above, temporary fastening of non-edge-fastened, flush bottom planking before the insertion of floors seems to be a common feature of northwestern European bottom-built vessels in the Roman and medieval periods. The Almere cog is no exception. Plugged, treenail-sized holes occur in groups across seams in several places in the bottom strakes (Plan VI).⁹⁷ Some of these holes are under frames but do not correspond to holes in the frames. Their grouping suggests that during assembly, the bottom was held together by long cleats or trestles at four points along the length of the hull. The forward and aftermost cleats were located at the ends of the flush seams, just before the bottom planks turned to lapstrake. The other two were evenly spaced between these. This does not seem like much reinforcement, but the flat bottom requires little twist or edge-set of the planks in their flush portions. At the ends, where twist and stress are greater, the planks overlap and are clench-nailed together.

Two plugged holes in the keelplank (visible in Plan III), one forward of

⁹⁷ The function of these holes only revealed themselves after all the recording had been finished and a comprehensive planking plan drawn. During recording, we were consciously looking for *spijkerpennen*, as had been seen in cogs N 5 and NZ 43, but not one was observed. For some time, we considered the possibility that the hull had been built partially frame-first, as there was some evidence that the scarf fastenings in the garboards had been countersunk under frame 17, the midships frame, as if the plank was fitted to an existing frame. Inspection of the lapstrake seams under the ends of frame 17 showed double-clenched nails, eliminating the possibility that the frame was pre-erected. The countersunk scarf nails remain puzzling - did the shipwright know that a frame was going there? There is no mark in the keelplank to indicate a designated midships point.

frame 15 and the other forward of frame 18, are rather enigmatic. They are not drain plugs, as they are cut off flush inside and out and nailed into their holes with three toenails each. They may be the remains of pegs to hold the keelplank down on the ways, but they are close to and evenly spaced either side of the midships frame (frame 17), rather than evenly spaced between the ends of the keelplank. Could they be the traces of fastening for a pair of temporary sleepers to assure a transverse flat amidships?

Cogs are not the only bottom-built vessels in northwestern medieval Europe. A wide range of flat-bottomed craft from inland sites exhibit either distinct bottom structures or strong similarities to other bottom-built vessels. The tradition is particularly strong in the Netherlands. IJsselmeerpolders finds K 73/74 and B 55 are mentioned above, as an indication that some cog features appear in other, possibly related types. Neither vessel has a keel, and in both the slab sides meet the bottom at a hard chine. K 73/74 has simple framing: each frame is a floor with a knee on one end matched with a knee-ended futtock. The floors are arranged so that the knee-ends alternate sides, as in the Almere cog and the Zwammerdam-type barges. The framing of B 55 is based on this system, but in between each pair of frames is a narrower cleat that spans only the bottom planking. K 73/74 is interesting in that its bottom planking becomes lapstrake toward the ends of the hull. Both hulls lack hooks; the posts are simply nailed to the upper surface of the central bottom plank.

Outside the Netherlands, flat-bottomed barges are not uncommon. Many of these have lapstrake or clinker sides combined with flush, keel-less bottoms.

Comparanda include several late medieval barges from Antwerp⁹⁸ and a river-boat from Elbing (Germany).⁹⁹ The latter still has the L-sectioned bilge strakes seen in the Roman barges. The boats and barges typically grouped under the heading of prams, such as the finds at Falsterbo (Sweden)¹⁰⁰ and Treiden (Latvia)¹⁰¹ attest the wide distribution of essentially similar, simple craft. The Treiden pram has a double bottom, but both, along with the Elbing boat, have bottoms made up of a panel of straight planks out of which is cut a pointed final shape. Both also carry the traditional barge framing system of alternating knee-ended floors and short futtocks. The two Dutch vessels, K 73/74 and B 55, might also fit into the pram category.

While these vernacular craft demonstrate the continuity of simple expressions of the bottom-based concept, cogs show an increasing sophistication in form and structure. The later, inland examples, such as M 107 and NZ 43, have moved away from the perfectly flat bottoms and slab sides of cruder bottom-built boats and are almost graceful. The Almere cog, in contrast, points the way forward to the general shape and configuration of Dutch inland merchantmen and ferries of the next four centuries. Full, bluff bows, easier sterns and full sections carried far out to the ends can be seen in the *karveel* of the seventeenth century

⁹⁸ Ellmers, *Frühmittelalterliche Handelsschiffahrt*, pp. 284-287 and Figs. 181, 182.

⁹⁹ B. Ehrlich and E. Steegmann, *Elbinger Jahrbuch* 3 (1923): 152ff and Plates 5 and 6; reported in Ellmers, *Frühmittelalterliche Handelsschiffahrt*, pp. 96, 109, 306, and 104, Fig. 79.

¹⁰⁰ Ellmers, *Frühmittelalterliche Handelsschiffahrt*, pp. 316 and 104, Fig. 77.

¹⁰¹ *Ibid.*, pp. 314, 104, Fig. 78, and p. 313, Fig. 190.

and its descendant, the *tjalk* of the eighteenth through twentieth century. The basic layout of long foredeck, large hatch, and small afterdeck are almost as long-lived. Even some of the specific structural features are carried on; the *gangboord-denneboom* assembly can still be seen in steel on modern Rhine barges.

Cog construction was no less important to the development of big ships in northwestern Europe, particularly in the Netherlands. Cogs were replaced as the dominant deepwater carrier in the fifteenth century, but they did not disappear entirely. Their replacement, the hulk, was probably all-lapstrake,¹⁰² but a major change in northern European shipbuilding was coming. When "carvel" construction was introduced to the North in the early fifteenth century, cog builders were best able to take immediate advantage of the economic benefits of the new system.

Cogs reflect a gradual trend away from "pure" bottom-based construction. The bottom is still a separate element in the design and assembly processes, but the finished hull is structurally more homogeneous, although not yet completely so. Where the bottoms of Roman barges are essentially distinct platforms to which sides are attached, the more rounded hull form of the cog results in smoother structural transitions between bottom and sides. At the ends of the hull, where even the bottom planks are lapstrake, no distinction is apparent. Even amidships, a cog is structurally a mix of shell and skeleton, with a greater reliance on skeleton in the bottom. When later shipbuilders in this tradition abandon

¹⁰² If U 34 from the IJsselmeerpolders is indeed a hulk.

lapstrake planking altogether, there is structurally no difference between a bottom-built hull and a modern skeletal-built hull.

CHAPTER V

THE LAPSTRAKE-CARVEL TRANSITION

AND DUTCH SHIPBUILDING

Historical Background

The end of the fifteenth century and beginning of the sixteenth saw major political upheaval in several important areas of northwestern Europe. In 1485, Henry Tudor succeeded in bringing more than a generation of English dynastic squabbling to an end. Through vicious suppression or elimination of rivals to their somewhat tenuous claim to the throne, Henry VII and his heirs enforced a welcome political stability in their realm. With the kingdom re-unified, sovereigns were able to exert some foreign influence based more on economic than factional motives on behalf of English merchants, who had taken a back seat to German and, more recently, Dutch merchants in the previous century.

At about the same time, the Burgundian state constructed by Philip the Fair and his son Charles disintegrated. Charles had eventually pushed the French king too far, and was defeated on the battlefield, ending his dream of an independent Burgundian kingdom. At his death in 1477, his lands passed to his daughter Mary and her husband, the Habsburg duke and future emperor Maximilian. Flanders responded by revolting, and the ensuing military campaigns to reassert control led to widespread economic disruption, fluctuating prices, and rampant inflation in the Low Countries. By 1485 Flanders had been subdued, but economic stability did

not return to the region until the turn of the century. The Burgundian state had been divided between France and the Empire on Mary's death in 1482, with the Low Countries going to the Habsburgs and eventually passing to the emperor Charles V, whose holdings included most of western continental Europe, except for France and parts of Italy. When Charles's empire was divided at his death, the Low Countries were included in the dominions of the kings of Spain.

In northern Germany, discontent with the Roman administration of the Church had been rising throughout the late Middle Ages. Secular authorities resented the imposition of papal power, and a succession of reform movements advocated a less worldly, more responsive clergy. In the second decade of the sixteenth century, both secular and spiritual discontent exploded in response to the publication of the writings of Martin Luther. The north German princes rapidly threw off the yoke of papal fealty, and the Reformation spread to Scandinavia, the Low Countries, France, and Switzerland, with various branches arising from the teaching of other reformist theologians, such as Calvin and Zwingli. Henry VIII proclaimed himself head of an independent English church, largely for political reasons, but retained the theology and liturgy of Roman Catholicism.

Rome responded with penalties for the heretics and rewards for the loyal in a Counter-Reformation that also addressed some of the complaints that had caused the breach. Early Reformist gains were reversed, particularly in southern Germany, Poland, and France, but the enmity aroused by competing spiritual ideas, especially between princes and their subjects, became a major political force in the later sixteenth century. The Spanish rulers of the Low Countries fought a

series of military campaigns to reassert Catholic and Habsburg rule, and even attempted to invade Protestant England in 1588. The Dutch, who eventually won independence from Spanish kings in the early seventeenth century, were split between Reformists in the north and Catholics in the south. Catholic-Protestant antipathy continued to run high, with each side persecuting the other until the carnage of the Thirty Years War dragged most European nations to the brink of disaster between 1618 and 1648.

In general, the economic health of northwestern Europe had been improving since a low point reached at the beginning of the fifteenth century. Gold coinage had been reintroduced prior to the Black Death, but silver had started to dry up toward the end of the fourteenth century. A serious bullion shortage had occurred around 1410 and lasted long enough to ruin bankers and merchants caught in the ensuing credit crunch. A series of bad harvests throughout the fourteenth and into the early fifteenth century contributed to the decline, as did recurring outbreaks of plague. Recovery was slowed in the mid-fifteenth century by another silver shortage, more serious than the first, but the damage was not combined with other problems as it had been earlier in the century. The shortage was perhaps more trouble to Hanseatic merchants than others, as the Hanse did not permit the use of credit.

The discovery of the New World at the end of the fifteenth century was overshadowed, in economic consequences for parts of northern Europe, by the nearly-simultaneous penetration of the Indian Ocean by de Gama. While later English imperial history is intimately entwined with the development of North

American colonies, the English took little immediate interest in Atlantic ventures, other than Elizabethan plundering of Spanish fleets and possessions. The Dutch, on the other hand, followed the Spanish and Portuguese into the Far East, where they were able to establish trading stations and a foothold for future control of the importation of Far Eastern luxuries into northern Europe.

At home, Holland shippers dominated the major east-west routes, carrying French salt and Flemish cloth to the Baltic for grain, timber, furs, and wax. The Hanse was of less and less importance as the fifteenth century wore on, and by the sixteenth century it had little effect on the structure and course of trade in Germany, although it continued to exist well into the seventeenth century. Divisions of interest within it had been the seed of its demise, but external developments had passed it by. The Hollanders, who had flourished at Hanse expense, had a geographic advantage similar to that earlier enjoyed by Lübeck and Hamburg: Holland sat at the nexus of northern European trade, where the great east-west and north-south routes met, at the mouth of the Rhine. Burgundian consolidation in the fifteenth century gave Dutch shippers both political backing and preferential access to the products and markets of Flanders, the richest and most "industrialized" area of the northwest. The Hollanders, who had no real products or resources of their own, with the exception of cheese, concentrated on developing their skills and organization as middlemen and carriers.

Within the Netherlands, economic and political dominance had shifted northward and westward at the end of the Middle Ages. Bruges, the center of the medieval cloth industry, the source of Flemish prosperity, had declined in favor of

Antwerp. Partly this was the result of geography - the river Zwin, which allowed access to Bruges, had silted up, leaving Antwerp more accessible - but it was also a result of changes in the textile industry and the regional economy. Other areas, such as Holland and England, had developed their own cloth industries, and Amsterdam had grown since the early fifteenth century as an entrepot for foreign goods and a transshipment point for goods bound westward to Flanders.

The rise of Amsterdam coincided with the decline of the eastern Dutch towns, such as Kampen, Zwolle, Deventer, and Zutphen. The eastern towns, many of which had been members of the Hanse, had dominated medieval Dutch trade. Most were on the IJssel, one of the mouths of the Rhine, and thus connected to the Westphalian towns of the Rhineland. Kampen, at the mouth of the IJssel, had a relatively clear channel to the Marsdiep and the Vlie, the inlets into the Zuiderzee, and was an important deepwater port.¹ When Hollanders and the Hanse went to war in the 1430s, Holland goods and ships bound for Germany had to go through Kampen, which was not yet an official Hanse member and did not observe the Hanseatic blockade of Holland. The Kampenaars took advantage of the increased traffic and mollified their Hanseatic neighbors somewhat by establishing a toll on Holland, Zeeland, and West Friesland goods and ships.² After the war, Kampen remained an entrepot for Overijssel and the eastern Dutch

¹ F. Petri, "Die Stellung der Südersee- und IJsselstädte im Flandrisch-Hansischen Raum," *Hansische Geschichtsblätter* 79 (1961): 49-53.

² The records from this toll, which lasted from 1439 until peace broke out in 1441, survive and offer an interesting picture of Dutch commerce, although little specific information on ships. See H.J. Smit (ed.), "Het Kamper pondtolregister van 1439-1441," *Economisch-Historisch Jaarboek* 5 (1919): 209-295.

hinterland, as well as a terminus for the land and river route from Munster, but international traffic increasingly favored Amsterdam.³

Amsterdam owed its growing importance at least partly to geography, as it was located at one end of the *binnenweg* between the Zuiderzee and Flanders. It was also an important distribution center for Hanse products, particularly Hamburg beer in the fourteenth century, serving the hinterland of Holland through the inland waterways as well as Zuiderzee towns. Amsterdammers established favorable trading relations with the other towns of Holland, particularly those on the *binnenweg*, such as Haarlem, Gouda, Spaarndam, and Leiden, and eventually assumed a leadership role in economic matters.⁴ Although shippers from Amsterdam accounted for only a part of Holland shipping abroad, Amsterdam itself was the principal port on the Zuiderzee, despite its location at the southern end of the sea. A channel to the Marsdiep and Vlie had to be dredged and marked for larger vessels, along with a similar channel from Kampen. Originally Kampen and Amsterdam had shared responsibility for channel maintenance, but in 1463 the two towns agreed that Kampen would do the work if Amsterdam would pay a fixed annual amount.⁵ This agreement was renewed (at increasing annual amounts) until 1527, when Amsterdam took over complete responsibility for the channels.

³ W. Jappe Alberts, "Overijssel und die benachbarten Territorien in ihren wirtschaftlichen Verflechtungen im 14. und 15. Jahrhundert," *Rheinische Vierteljahrsblätter* 24 (1959): 54-56.

⁴ F. Ketner, *Handel en Scheepvaart van Amsterdam in de Vijftiende Eeuw*, is an excellent introduction to the rise of Amsterdam as a commercial and shipping center in the late Middle Ages.

⁵ *Register Charters en Beschieden Kampen* I, no. 675. See Ketner, *Handel en Scheepvaart van Amsterdam*, p. 109.

The money for maintenance was raised through a tariff, the *paalgeld*, charged on goods landed by those other than Amsterdam and Kampen shippers.⁶

Despite the channels, the largest ships of the fifteenth century had difficulty reaching Zuiderzee ports. Most of these were Prussian vessels transporting bulk goods. In fact, when the Hanse was considering relocating the Bruges *kontor* in 1451, Prussian delegates to the Diet requested that Amsterdam, Deventer, or Utrecht not be chosen, as the harbors were not accessible to the larger Prussian ships.⁷ These ships could only land at the deeper ports of the Wielingen, such as Antwerp, Bergen op Zoom, and Middelburg.⁸

The long-distance commerce centered on Amsterdam required not only an extensive network of waterways and a large fleet of vessels to move goods south to Flanders, but it also stimulated the growth of the domestic economy of the Netherlands, thus encouraging the development of waterborne traffic to and from other Zuiderzee towns and up the rivers to the hinterland. Large numbers of small and medium-sized craft were built to carry goods and people to and from Amsterdam and along the shores of the Zuiderzee. Over the course of the sixteenth century, this traffic developed into a network of regular, scheduled ferries between Amsterdam and the other towns around the Zuiderzee. These *beurtscheepen* sailed regular routes, typically between Amsterdam and one other town, on

⁶ Ketner, *Handel en Scheepvaart van Amsterdam*, pp. 107-111.

⁷ *Hanse Recesse* II.3 nos. 693, 710; II.4 nos. 3, 5, 6, 50, 51, 52.

⁸ See Ketner, *Handel en Scheepvaart van Amsterdam*, p. 112 for discussion of this debate. In the end, Deventer was chosen as *Kontor*, with the Prussians agreeing to send smaller ships through the Zuiderzee and the larger ones to the Wielingen.

fixed schedules. Inland, on the canals and rivers, similar services operated, sometimes in barges (*trekschuiten*) pulled by men or animals on towpaths, sometimes in sailed vessels similar to *Zuiderzee* craft.

The Lapstrake-Carvel Transition

Among deepwater ships, the fifteenth century saw major changes in size, type, propulsion, and construction. These changes, taken together with developments in navigation, produced ocean-going ships radically different from medieval craft. Evolutionary improvements occurred thereafter until the nineteenth century, when the industrial revolution replaced wood and wind with iron and steam, but the basic pattern had been set by 1525 or so. The full-rigged ship marked the transition from medieval to modern seafaring.

Despite the generally worsening economy of the fourteenth century, an increase in ship size can be detected in the documentary evidence of customs and toll records of the later fourteenth century. As discussed above, cogs had already reached impressive size by the end of the thirteenth century, but became even larger toward the end of the fourteenth. This growth accelerated after 1400, producing ships of 150⁹ and even 200¹⁰ lasts by the second quarter of the fifteenth century. Ship size continued to increase until the early sixteenth century,

⁹ W. Vogel, *Geschichte der deutschen Seeschifffahrt I: Von der Urzeit bis zum Ende des 15. Jahrhunderts*, p. 433.

¹⁰ For example, of the 23 Prussian ships seized by Hollanders off France in 1438, several were over 200 lasts, with the largest carrying 225 lasts of salt; H.A. Poelman (ed.), *Bronnen tot de Geschiedenis van den Oostzeehandel: Eerste Deel 1122-1499 I*, no. 2205.

when a plateau was reached around 600 tons. Warships were even bigger; in the first quarter of the fifteenth century, Henry V of England built a number of immense ships, some over 1000 tons, for his campaigns against the French.¹¹ The burnt remains of one of these, the *Gracedieu* of 1418, lie in the Hamble River near Bursledon, and have been investigated at low water.¹² An account from a Florentine galley captain who toured the giant ship in 1430 indicates an original length of 56 m and a capacity in excess of 1,500 English tons.¹³ No larger English ship was built until 1682.

At the same time that size was increasing, the dominant ship type in northern Europe, the cog, was being replaced in bulk trades by the hulk. Until the mid-fourteenth century, hulks had been regularly mentioned in customs and toll records, but much less frequently than cogs. They also appear to have been generally smaller. From the 1380s, hulks become both larger and more common in the historical record. Around 1400, hulks and cogs are about even in size and frequency, but there are several cases in which the same vessel is called both cog and hulk in the records, possibly indicating some mixture of diagnostic features. By 1450 or so, cogs seem to have disappeared almost completely from long-

¹¹ W.J.C. Turner, "The Building of the *Gracedieu*, *Valentine* and *Falconer* at Southampton, 1416-1420," *MM* 40 (1954): 55-72 and "The Building of the *Holy Ghost of the Tower*, 1414-1416, and Her Subsequent History," *MM* 40 (1954): 270-281; L.G. Carr Laughton, "The Great Ship of 1419," *MM* 9 (1923): 83-87.

¹² R.C. Anderson, "The Bursledon Ship," *MM* 20 (1934): 158-170.

¹³ M.W. Prynne, "The Dimensions of the *Grace Dieu* (1418)," *MM* 63 (1977): 6-7. The dimensions reported by Luca di Maso degli Albizzi were: length on deck of 92 braccia, beam of 50 braccia, and capacity of 3,000 to 3,300 *botte*. Prynne (p. 7) notes that the beam must be wrong.

distance, bulk trades.¹⁴ The reason for the change is difficult to determine, but the concurrent rapid growth in ship size suggests that it was impractical to build cogs larger than about 150 lasts, either for structural or economic reasons, while the hulk type could be enlarged beyond this limit. Unfortunately, knowledge of the hulk is limited, so it is not possible to say why hulks could be enlarged and cogs could not. If IJsselmeerpolders find U 34 is, in fact, a hulk, the primary structural differences between cogs and hulks are in the backbone and planking. U 34 has a true keel joined directly to a heavy, curved stem and straight sternpost, instead of the keelplank, hooks, and straight stem of the cog. The planking of U 34 is heavier than that of the Bremen cog on the bottom, but thinner on the sides and completely lapstrake. The bottom planking is fastened together with rivets and wooden pegs, while the sides are only clinkered.¹⁵

At the same time, a major innovation in propulsion was introduced. Since ancient times, northern European vessels had been propelled either by oars or a single square sail. The square sail rig was mechanically simple, efficient,¹⁶ and easy to manage on the small to medium-sized craft of the medieval north, but could not be infinitely enlarged to suit increasingly bigger ships. Larger sails mean longer spars and greater weight, all of which is concentrated at a single point.

¹⁴ S. Flidner, "Kogge' und 'Hulk': Ein Beitrag zur Schiffstypengeschichte," in *Die Bremer Hanse-Kogge: Ein Schlüssel zur Schiffahrtsgeschichte*, H. Abel et al., p. 67.

¹⁵ H.R. Reinders and R. Oosting, "Mittelalterliche Schiffsfunde in den IJsselmeerpoldern," in *Ländliche und städtische Küstensiedlungen im ersten und zweiten Jahrtausend*, pp. 114-118.

¹⁶ T. Gillmer, "The Capability of the Single Square Sail Rig - A Technical Assessment," in *The Archaeology of Medieval Ships and Harbours in Northern Europe*, ed. S. McGrail, pp. 167-182.

Eventually, the size of the sail is limited by the men and machinery available to raise, lower, and trim it. If sail size is limited, ship size is also limited. The solution was to increase total sail area by breaking it up into several smaller sails set on more than one mast. The precise date of this innovation is unknown, but four-masters are seen in representations by the 1430s.¹⁷

The final innovation was somewhat later than the others, but no less important in the development of the modern sailing ship. Toward the middle of the fifteenth century, northern European shipbuilders began to abandon lapstrake construction in favor of flush-laid, non-edge-joined planking. The first vessel built in this manner in Holland or Zeeland was launched in Zierikzee (Zeeland) in 1459, according to a sixteenth-century chronicle,¹⁸ but another had been built at Sluis, near Brussels, in 1439 for Philip the Fair.¹⁹ The transition was not immediate or evenly adopted throughout the North. English warships at the beginning of the sixteenth century were still clinker-built, but were being converted or rebuilt in the new style soon after. A large ship discovered at Woolwich in 1912 and believed to be the *Sovereign*, built in 1488 and rebuilt in 1509/10, was originally of lapstrake construction, but was converted to carvel planking. The conversion required the partial fairing of joggled frames and the insertion of shims and fillers

¹⁷ This is a decorated tile depicting Flemish ships, found in the Carmelite cloister and church of St. Mary, Helsingør, Denmark; J. van Beylen, *Schepen van de Nederlanden: Van de Late Middeleeuwen tot het Einde van de 17e Eeuw*, pp. 3-4 and n. 4.

¹⁸ J. Reygersbergh, *Dye Cronycke van Zeelandt*, p. 190.

¹⁹ Van Beylen, *Schepen van de Nederlanden*, p. 7.

in the deepest notches to form a fair planking surface.²⁰ Another approach can be seen in a late sixteenth-century vessel from Massilinn, Estonia. This vessel had been clinker-built around 1555, but was later given a second layer of planking arranged to present a smooth exterior.²¹ In contrast to the rest of northern Europe, many Norwegian shipwrights managed to ignore the new technology until the twentieth century and the introduction of diesel engines and their attendant vibration forced the abandonment of clinker construction for large craft.

The new type of planking was not a local invention, but a Mediterranean technology imported via Portugal, Bordeaux, and Brittany. Flush-planked Mediterranean vessels had been seen in northern waters since at least 1295, when Venetian galleys began visiting Flemish ports for woolen cloth, but the direct stimulus seems to have come from French and Portuguese ships, particularly Breton salt carriers. Only a few Italian ships visited the north each year, and then only at a few important ports, while French and Iberian ships were a more common presence in the large and small ports of Flanders and England. With the growth of the long-distance salt trade from the Bay of Borgneuf in the later fourteenth and early fifteenth centuries, the exposure to Breton shipbuilding was

²⁰ R.C. Anderson, "The Story of the Woolwich Ship," *MM* 45 (1959): 94-99 on the history of the discovery and controversy surrounding the ship's age and identity. W. Salisbury, "The Woolwich Ship," *MM* 47 (1961): 81-90 presents the recorded structural information and identifies the ship as *Sovereign*, although not with certainty. Salisbury observed the traces of the conversion from lapstrake to carvel and suggested that the peculiar treatment of the frames may have been an attempt to preserve the shape of a good sailer, as *Sovereign* was known to be. M. Rule, *The Mary Rose: The Excavation and Raising of Henry VIII's Flagship*, p. 21 notes evidence of similar conversion in at least one area of the side of *Mary Rose*, built in 1509 and heavily rebuilt in 1536.

²¹ V. Mäss, pers. comm.

increasingly intense. The vessel launched in Zierikzee in 1459 had been built by Breton shipwrights, while Philip's ship of 1439 had been built by imported Portuguese craftsmen. Even after northern shipwrights began to adopt the technology, Dutch shippers continued to purchase Breton ships.²²

The new type of planking was named for the Portuguese ships that had brought it to northern France. These *caravelas* were derived from coastal fishing craft and had been developed into excellent ocean-going craft, popular with Iberian explorers as well as merchants. Breton *caravelles* could be distinguished from the other ships in northern ports, cogs and hulks, by their flush topside planking.²³ Thus "carvel" planking was the kind seen on the Breton and Portuguese ships. Eventually, Dutch and German shipwrights built their own caravels (*karveel*, *kraweel*, etc.), but these were not direct copies of the Atlantic types, merely vessels built with flush planking throughout.²⁴

The new technology was primarily applied to larger ships at first, but toll records from the southern terminus of the *binnenweg* record *karveels* with Dutch skippers by the 1480s.²⁵ In contrast, the archaeological remains lag behind the

²² For example, see Z.W. Sneller and W.S. Unger (eds.), *Bronnen tot de Geschiedenis van den Handel met Frankrijk: Eerste Deel 753-1585*, nos. 292 and 296, reporting sales of Breton *karveels* to shippers from Zeeland and Utrecht in 1476.

²³ Where Breton ships are mentioned in fifteenth-century Dutch sources, they are almost always called caravels (*carveel*, *karveel*, *carvelle*, *caravelle*, etc.) - see *ibid.*, nos. 281, 285, 287, 288, 289, 292, 296, 308, 353. In contrast, caravels appear only rarely before the end of the fifteenth century in documents dealing with Baltic trade; cogs and hulks are the rule; see Poelman, *Bronnen tot de Geschiedenis van den Oostzeehandel*.

²⁴ B. Hagedorn, *Die Entwicklung der wichtigsten Schiffstypen bis ins 19. Jahrhundert*, pp. 56-57; R.C. Anderson, "'Carvel' and 'Caravel,'" *MM* 18 (1932): 189.

²⁵ W.S. Unger (ed.), *De Tol van Iersekeroord*, p. 295.

documentary evidence. The earliest extant carvel hull in northern Europe is the *Mary Rose*, sunk in 1545, although, as mentioned above, it appears to have been at least partially rebuilt carvel from an original clinker structure, unless the examined area was built using re-used frames.²⁶ The Cattewater wreck is approximately contemporary and carvel built, but its origins are not certain.²⁷ The oldest extant carvel hull that is definitely of northern origin and carvel built from the start is a fishing vessel, a *waterschip*, of the 1570s, excavated in the IJsselmeerpolders.²⁸ Vessels of this type from earlier in the sixteenth century are lapstrake.²⁹ The large merchantman from the IJsselmeerpolders thought to be a hulk dates to the late fifteenth century and is completely lapstrake.³⁰ The continued commercial prominence of the hulk, a lapstrake type, into the early sixteenth century suggests that the advantages of carvel construction were not immediately exploited on a large scale, or that economic conditions in the Baltic, where hulks continued to dominate, blunted the impact of the new technology.

The most obvious benefits of carvel building are economic: reduced capital costs as a result of less material and labor used in construction. Unger believes

²⁶ The possibility is noted by Rule, *The Mary Rose*, p. 22.

²⁷ M. Redknap, *The Cattewater Wreck: The Investigation of an Armed Vessel of the Early Sixteenth Century*, pp. 95-100.

²⁸ H.R. Reinders, H. van Veen, K. Vlierman, and P.B. Zwiers, *Het Wrak van een 16e Eeuws Visserschip in Flevoland*.

²⁹ A.F.L. van Holk, *De Constructie van Twee Waterschepen, Gevonden op Kavel NZ 74*. A lapstrake *waterschip* is also known from the seventeenth century; R.A. Hulst and R. Vlek, "Drie Waterschepen Gevonden op de Kavels P 33, P 40, en R 13 in de Noordoostpolder", pp. 2, 5-10.

³⁰ Reinders and Oosting, *supra* n. 15, p. 115.

that the primary savings are in timber, due to the elimination of plank overlaps.³¹ Strictly speaking, this is true, as slightly less board footage is needed to cover the same hull, but I think the savings are less dramatic than Unger suggests. For a typical cog, overlap width is a tenth to a sixth of plank width, but rarely is more than two thirds of the planking lapstrake. As a specific example, in the Almere cog, the elimination of overlaps would decrease the total mass of the planking about 12%, but any one plank is only 5 cm narrower. The great width of the strakes in this vessel implies little pressure to conserve timber.

In addition, a decrease in structural reliance on one major component (the shell) is normally matched by an increase in reliance on another (the skeleton), so that the elimination of the overlaps (and thus their edge-fastenings) should require more framework, either in the form of bigger internal timbers and/or more internal timbers. In fact, Dutch shipwrights did not alter the scantlings of frames after the adoption of carvel planking, but did increase their number in some cases. For example, the room and space³² in the Almere cog is a fairly regular 47 cm or so, but the *karveel* B 71 (discussed in detail below), which is only slightly longer, has a room and space of 37 cm for frames of the same scantling, resulting in an increase of frame mass of around 27%. In this case, the difference may reflect a greater reliance on framing in the later hull, or it may only be that the *karveel* was intended for the rougher conditions of the Zuiderzee rather than the *binnenweg*

³¹ R.W. Unger, *The Ship in the Medieval Economy 600-1600*, p. 225.

³² The total distance from the forward edge of one frame to the forward edge of the next.

and so was more heavily framed. On the other hand, frame scantling and spacing in *waterschepen*, a round-bottomed type of fishing vessel, did not change with the adoption of carvel planking in the fifteenth century.

In late medieval Holland, the cheapest form in which to buy timber was as *wagenschot*, or roughly finished planks; the most expensive was *kromhout*, or compass timber, the naturally-curved balks from which frames and knees were cut.³³ This is hardly surprising, as the cost of transporting Baltic timber to western markets could approach 80% of the initial cost in Prussia, or 44% of the total cost of timber and transportation.³⁴ Straight lengths stow more efficiently and cost less to ship per unit. Thus overall, there may actually be an increase in timber cost as a result of adopting carvel planking, as the savings in planking may be exceeded by the increase in framing.

The foregoing is an interesting mathematical exercise, but probably does not reflect much in the way of structural reality. Waste in the conversion of log to plank stock cannot be determined, although it can be assumed that slightly narrower planks require slightly narrower stock. A more significant factor may be

³³ This information can be derived from a number of sources, but three are particularly helpful: toll records from the *binnenweg* (Unger, *De Tol van Iersekeroord*) and building records from Bruges and the cathedral of Utrecht; J.-P. Sosson, *Les travaux publics de la ville de Bruges XIVe-XVe siècles: Les matériaux, les hommes*, and N.B. Tenhaeff (ed.), *Bronnen tot de Bouwgeschiedenis van den Dom te Utrecht: Tweede Deel 1 (Rekeningen 1395-1480)*. The last is a potentially rich source for prices and economic trends of a wide variety of materials and commodities: building materials and supplies, wages, transport costs, food, even boats. Unfortunately, access to the information is hindered by the bewildering variety of accounting standards, or "moneys of account," and coinage in use both before and after Philip the Fair's monetary reforms of 1433.

³⁴ P. Dollinger, *The German Hanse*, p. 157. The specific figures are: freight for timber from Danzig to Bruges in the early fifteenth century was equivalent to 79% of the original purchase price in Danzig.

the reduction in structural strength expected from the planking. If the planking becomes more of a watertight skin than a structural component, then long, straight, wide runs of planking stock are not required, and cheaper, lower quality stock can be selected. If maximum savings were being realized from cheaper planking, carvel hulls should display short, narrow planks, perhaps no longer arranged in continuous strakes but in an irregular pattern intended to take advantage of available stock. Thinner planks might also be in order. In reality, Dutch shipwrights continued to use wide, long planking stock of similar thickness in continuous strakes. Only much later did Dutch shipbuilding start to employ stealers, drop strakes, and other irregular forms of planking. Partly this was the result of the availability of cheap timber,³⁵ and partly it was necessitated by the peculiar manner in which the Dutch built carvel ships until well into modern times (see below).

The primary economic savings were not in timber, but in iron and labor. By eliminating the overlaps, all of those double-clenched nails were eliminated as well. Even in a small cog such as the Almere vessel, approximately 1,100 planking nails represent over 30 kg of iron, an expensive material. Perhaps more importantly, they represent 1,100 pilot holes that must be drilled and a similar number of fastenings that must be driven and clenched. By changing to carvel construction, all of this work is eliminated, although at the potential penalty of more frames to cut and fasten. How the labor balances out is difficult to say, as

³⁵ As Unger himself notes: "Dutch Design Specialization and Building Methods in the Seventeenth Century," in *Post-Medieval Boat and Ship Archaeology*, ed. C.O. Cederlund, p. 153.

it would depend on whether water power was available to cut framing stock. From my own experience building and repairing both carvel and lapstrake hulls, I can say that a large portion of the time taken to plank a lapstrake hull is devoted to drilling, driving, and clenching the nails in the overlaps. Once lapstrake planking was abandoned, Dutch shipwrights were particularly sparing in their use of iron, using it only at hood ends and scarf tips.

Carvel planking has other advantages. It is somewhat simpler to repair, and it allows a wider range of hull shapes than edge-fastened planking. Harder bilges (even chines) are possible, as are rapid changes in hull girth. Edge-joined planking prevents the former, as the fastenings cannot accommodate extreme angles between strakes, and discourages the latter, as it requires non-continuous strakes (stealers, etc.). Edge-joined hulls can be built with non-continuous strakes (a square-tuck or transom stern, as is found in many types of modern lapstrake small craft, often requires a stealer or two at the hollow below the buttocks), but construction is generally simpler without them.

It is often said that lapstrake construction places a technological limit on vessel size, and that carvel ships can be built bigger.³⁶ The evidence normally cited in support of this idea is largely circumstantial. Since vessel size was increasing rapidly in the fifteenth century, and carvel construction was also introduced in the fifteenth century, it seems reasonable that the two developments

³⁶ For example, B. Greenhill, *Archaeology of the Boat: A New Introductory Study*, p. 72; K.-F. Olechnowitz, *Der Schiffbau der hansischen Spätzeit*, p. 9; Unger, *The Ship in the Medieval Economy*, p. 225, etc.

are related. This relationship is then pushed farther toward cause-and-effect with the suggestion or claim that the adoption of carvel construction was a response to the demand for larger ships; thus, it must have been impossible to build clinker ships large enough. The *Gracedieu*, one of Henry V's giant warships, is believed to confirm this hypothesis. It was built in a complex, multi-layered form of clinker construction and is widely considered a failure, as it was never put into service. Many scholars then assume that failure was a result of the construction, thus clinker building must have been inadequate for a vessel this size or any large ship.

The above argument is flawed by poor reasoning and a none-too-careful examination of chronological developments. It is quite easy to demonstrate that the largest merchant vessels had exceeded 200 lasts (400 metric tons deadweight capacity) well before carvel construction was widely adopted,³⁷ and clinker types, particularly the hulk, continued to increase in size throughout the fifteenth century. As for the *Gracedieu*, it was not particularly successful as a warship (it spent most of its life in ordinary, tied up in the Hamble River), but there is no indication that the failure was due to construction. It is entirely possible that the ship was too large for available propulsion systems i.e. it predates the widespread use of multiple masts. In any case, it does demonstrate that clinker construction does not place a technological limit on size - the *Gracedieu* is far larger than any merchant ship, clinker or carvel, mentioned before the eighteenth century.

³⁷ The Prussian salt ships seized by a Hollander fleet off Brest in 1438 must have been composed entirely of lapstrake ships (the sources normally called them hulks), yet the largest of these carried 225 lasts; Poelman, *Bronnen tot de Geschiedenis van den Oostzeehandel*, no. 2205 is a formal account of the losses, listing ship owner, size, cargo, and value.

The real limit is probably not technological but economic. Carvel construction does not make big ships possible, it makes them cheaper to build and thus economically practical. A huge clinker vessel such as the *Gracedieu* was technically possible, but only a government bent on foreign conquest could tolerate the cost. The same rules apply in other periods - ship size today is not determined by technical limits, but by economic and geographical circumstances.

One of the indirect advantages of carvel construction also presents an immediate disadvantage. The elimination of edge fastenings places a greater emphasis on internal timbering and renders a frame-first assembly sequence easier. Frame-first assembly requires some technique for determining the shapes of the frames. Methods range from the extremely simple use of a midships mould and longitudinal battens, from which frame shapes are taken (essentially duplicating the planking in temporary form) to modern naval architecture, in which frame shapes are derived from a two-dimensional plan of the hull. All of these have significant advantages, not the least of which is a rational approach to ship development. By recording the shape of the hull, either in plan or as a set of moulds, good hulls can be "saved" for reproduction and bad hulls avoided. Specific alterations can be proposed and tested, and numbers of similar or identical vessels can be built in different places. Once design methods are developed to the point where the important component timbers can be shaped from plans, frame-first carvel construction is also more efficient in its use of materials and labor.

The disadvantage is that such methods must be developed; they are not

self-evident in the ships they produce. Carvel planking by itself does not readily suggest specific methods for designing hulls, but there must be something to which the planking can be fastened. Mediterranean shipwrights, who had been exploring the possibilities of predetermined hull forms since the late Roman period, had already evolved rational systems for designing, recording and transmitting the vital shapes of ship hulls by the fifteenth century.³⁸ By the Renaissance, many of these depended on the process of whole moulding, in which a single fundamental sectional shape, which formed the midships bend, was altered by specific (if secret) mathematical formulae in breadth (narrowing) and height above the keel (rising) for use at other points in the hull. Later northern naval architecture was also heavily based on whole molding. It is quite possible that the shipwrights who introduced carvel planking also transmitted southern building methods, but there is no concrete evidence of whole molding in the North until the 1580s, when Mathew Baker, an Elizabethan master shipwright, began a lavishly illustrated

³⁸ The fourth- or fifth-century Yassiada vessel probably had a pair of half-frames erected amidships early in the construction process; F.H. van Doorninck, Jr., "The 4th Century Wreck at Yassi Ada. An Interim Report on the Hull," *IJNA* 5 (1976): 126-127. Careful analysis of the framing of the eleventh-century Serce Limani vessel suggests the use of simple proportional systems for the determination of deadrise at key points in the hull and the outward slope of the sides; J.R. Steffy, "The Mediterranean Shell to Skeleton Transition: A Northwest European Parallel?" in *Proceedings of the Fifth International Symposium on Boat and Ship Archaeology*, eds. H.R. Reinders and C. Paul, n.p. At least two short treatises on ship design were written in fifteenth-century Venice: the so-called *Fabrica di Galere* of ca. 1410 (MS, Magliabecchian Library, Venice) and a notebook by the merchant Giorgio Timbotta after 1447, which includes a partial copy of a treatise by someone else (Cottonian MSS, British Museum; Titus, A. 26, f. 2-60). Part of the former was published and translated in A. Jal, *Archéologie Navale* II, pp. 1-106 with recent revisions and additions by S. Bellabarba, "The Square Rigged Ship of the *Fabrica di Galere* Manuscript," *MM* 74 (1988): 113-130, 225-240. The latter, commonly known as the "Timbotta manuscript," was published and translated by R.C. Anderson, "Italian Naval Architecture about 1445," *MM* 11 (1925): 135-154.

treatise on ship design.³⁹ The methods he described are very much in the conceptual tradition of fifteenth- and sixteenth-century Italian ship design, although specific hull shapes differ. The tone of Baker's manuscript indicates that he was describing accepted methods rather than radically new ideas, so whole moulding must have been introduced relatively early in the sixteenth century, if not before.

Dutch Carvel Construction

Dutch shipwrights circumvented the need for "scientific" design methods by developing a unique form of carvel construction. Essentially, they continued to build cogs, but eliminated the overlaps. Bottom and bilge planking was assembled first and temporarily fastened together by small cleats nailed across the seams, as had been done on some cogs. Shaping was accomplished with shores, props, clamps, and other forms of mechanical support and persuasion. Once the bottom planking was assembled, floors were inserted and fastened in place. As the floors were installed, the cleats were removed and the nail holes plugged with small, square wooden pegs, called *spijkerpennen*. With the bottom framed, the lower ends of free futtocks were fastened to the bottom planking. The standing futtocks could then be planked in the conventional carvel manner.

³⁹ The manuscript, which includes early seventeenth-century material by Baker's successor John Wells, is generally known as *Fragments of Ancient English Shipwrigthry*. It was never published, but found its way into the library of Samuel Pepys, secretary of the Navy Board in the late seventeenth century. At his death, Pepys bequeathed a carefully-chosen and meticulously catalogued selection of his books to his alma mater, Magdalene College, Cambridge. The Baker/Wells manuscript (Pepys Library no. 2820) was among these books. Unfortunately, no transcription or facsimile edition has been produced, despite common citation and frequent reproduction of certain of the more elaborate illustrations.

Illustrations of this sort of construction can be seen in seventeenth-century prints, such as a series on the building, sailing, and breaking up of a large armed ship by Sieuwert van der Meulen.⁴⁰ Nicolaes Witsen, in his 1671 treatise on shipbuilding and navigation (revised for the second edition of 1690), described the method in detail. After the keel and posts were erected, the planks of the bottom were laid up and temporarily held in place by clamps, chains, and wooden cleats nailed across the seams. When the outboard edge of the bottom was reached, the midship floor timber was fastened in place across the *hals* ("neck," or widest part of the bottom) and its first futtocks erected. Thereafter, the bilge was planked. Once the bilge had been rounded, the rest of the floors and first futtocks could be added, and the sheerstrake run along the tops of the futtocks. With the sheerstrake in place, the rest of the sides could be planked.⁴¹ This sort of construction was practiced in the northern Netherlands. To the south, shipbuilding methods were similar to those in England and France, where a set of key frames followed the erection of the keel and posts. After the key frames were erected, the sheerstrake was hung to establish the shape of the upper hull. This method is described by Witsen's contemporary, Cornelius van Yk, himself a professional

⁴⁰ I. De Groot and R. Vorstman, *Sailing Ships: Prints by the Dutch Masters from the Sixteenth to the Nineteenth Century*, nos. 138-153. No. 139, the second in the series, titled "*Het Schip werd begonnen met boeijen en optimmeren*" ("The ship is begun with clamping and planking"), shows the keel, stem, sternpost and transom erected, and the first few strakes of the bottom laid up and held together with *boeijtangen* and *klampen* (planking tongs and cross-cleats).

⁴¹ N. Witsen, *Architectura Navalis et Regimen Nauticum, ofte Aaloude en Hedendaagse Scheeps-Bouw en Bestier*, pp. 164-175 (2nd ed.).

shipbuilder from the south.⁴² The two methods produce hulls with similar topsides, but the bottom-based system of the north results in an angular bilge.⁴³ The angle is the result of the planking method; the use of tongs (*boeijtang*) to hold the bottom planks in alignment enforces a flat bottom from keel to bilge, where the bilge plank must be set at an angle to make the transition to the side. Van Yk was aware of this method, and considered it bad practice.⁴⁴

The northern method is attested by other sources. A Frenchman named Arnould, who toured English and Dutch shipyards on the orders of Admiral Colbert in 1670 reported that shipwrights in Holland did not get out frames until the first ten or twelve strakes had been laid up, and adjusted the shape of the hull as they went along, by eye. The shape was determined by specified planking widths and adjusted by bracing the assembled planking up or down to fair lines.⁴⁵ Archaeological remains have also revealed evidence of this method. Several seventeenth-century vessels excavated from the reclaimed land of the old Zuiderzee have planking marked with large numbers of *spijkerpennen* arranged in

⁴² C. van Yk, *De Nederlandsche Scheeps-Bouw-Konst Open Gestelt*, pp. 52-103.

⁴³ A.J. Hoving, "A 17th-Century Dutch 134-foot *pinas*, Part 1: A Reconstruction after *Aaloude en Hedendaagse Scheepsbouw en Bestier* by Nicolaes Witsen 1671," *IJNA* 17 (1988): 217. Hoving was the first to compare critically the building methods described by Witsen and van Yk and note the differences in shape they produce.

⁴⁴ Van Yk, *De Nederlandsche Scheeps-Bouw-Konst Open Gestelt*, p. 70. See also Hoving, *IJNA* 17 (1988): 217.

⁴⁵ Published in H. Colenbrander, *Bescheiden uit Vreemde Archieven* 2, p. 10. Quoted by O. Hasslöf, "Main Principles in the Technology of Ship-Building," in *Ships and Shipyards, Sailors and Fishermen*, eds. O. Hasslöf, H. Henningsen, and A.E. Christensen, pp. 59-60, who also reproduces Arnould's drawing of an English or French hull in frame and a Dutch hull "in plank" (p. 60, Fig. 20). The original manuscript and drawing are in the Bibliothèque Nationale, Paris.

rows across the seams of the bottom and bilges. The most impressive of these in size is a 30 m *pinas*, IJsselmeerpolders find E 81.⁴⁶ Sea-going ships were also built this way, as several early seventeenth-century VOC ships⁴⁷ and the *Wasa*⁴⁸ show.

Several of the VOC ships, all dating to before 1650 or so, have two layers of planking.⁴⁹ The layers are of approximately equal thickness, but the fastenings show that the inner layer was the first assembled and that the outer layer was added after the frames had been installed. This peculiar arrangement may be a solution to one of the problems with assembling free-standing planking: stabilizing the planks before framing is inserted. The thicker the planking, the greater the force required to bend it to shape and hold it there. With a rigid, pre-erected framework, heavy planking can be bent around and clamped to the frames. Jacks,

⁴⁶ Currently on display in the Museum voor Scheepsarcheologie, Ketelhaven.

⁴⁷ A.D. Vos, "De replica van een VOC-retourschip te Lelystad: de *Batavia*?" in *Bouwtraditie en Scheepstype*, ed. H.R. Reinders, pp. 48-55 and "Scheepsbouw in de zeventiende eeuwse Republiek. Huid eerst of skelet eerst?" in *Scheepsarcheologie: Prioriteiten en Lopend Onderzoek*, eds. H.R. Reinders and O. Oosting, pp. 79-88.

⁴⁸ The *Wasa* was built by Swedish and Dutch shipwrights under the direction of a Dutch master shipwright, Henrik Hybertsson, with the assistance of other Dutch shipwrights, and displays features of form and construction consistent with Dutch practice; C.O. Cederlund, "Shipbuilding in the 17th and 18th Centuries: The *Wasa* as a Product of Dutch Shipbuilding," in *The North Sea. A Highway of Economic and Cultural Exchange*, eds. A. Bang-Anderson, B. Greenhill, and E.H. Grude, pp. 167-178. The *spijkerpennen* can be easily observed in the conserved planking of the ship, on display at the Wasawarvet in Stockholm.

⁴⁹ Vos, *supra* n. 47 ("De Replica van een VOC-Retourschip te Lelystad: de *Batavia*?). The wrecks he identifies are the VOC ships *Batavia* and *Mauritius*, and Scheurrak SO 1, a late-sixteenth-century ship excavated in the Waddenzee. On the *Batavia*, see J.N. Green, "The VOC Ship *Batavia* Wrecked in 1629 on the Houtman Abrolhos, Western Australia," *IJNA* 4 (1975): 43-63 and "The Planking-First Construction of the VOC Ship *Batavia*," in *Proceedings of the Fifth International Symposium on Boat and Ship Archaeology*, eds. H.R. Reinders and C. Paul, n.p. On *Mauritius*, see M. l'Hour et al., *Le Mauritius. La mémoire engloutie*.

screws, levers, wedges, and other devices can be applied, using the frames as a point of attachment, base, or fulcrum. Without frames, planking must be bent on itself, "in thin air." Even though clamps and shores, as well as the cleats tying one plank to another, can exert a fair amount of force, they are not as firm a foundation as rigid frames. A thinner initial layer of planking can be shaped more easily, then reinforced with a second layer after the hull is framed. A surprisingly similar system can be seen in large Mediterranean hulls of the last two centuries BC. These ships have a thicker, primary layer of planking assembled shell-first and fastened edge-to-edge with mortise-and-tenon joints. After framing is inserted, a secondary layer of planks, also mortise-and-tenon joined (but less extensively), is fastened through the primary layer to the frames.⁵⁰ Double planking seems to have been abandoned by mid-century. Neither Witsen nor van Yk mentions it. Towards the end of the century, Dutch shipbuilders also began to move away from plank-first bottoms and build conventional framed hulls, at least in large, sea-going ships.⁵¹ Smaller, inland vessels continued to be built in the older manner, in some cases until wooden shipbuilding was abandoned altogether.⁵²

This bottom-first style of construction had several advantages. It required no major modifications in the way Dutch shipwrights approached shipbuilding,

⁵⁰ The Madrague de Giens vessel is an excellent example of this process. A. Tchernia, P. Pomey, and A. Hesnard, *L'épave romaine de la Madrague de Giens (Var) (Campagnes 1972-1975)*, pp. 75-80.

⁵¹ Hoving, *IJNA* 17 (1988): 216.

⁵² Hasslöf, *supra* n. 45, p. 52, Fig. 16 shows a photograph of a twentieth-century Dutch yawl completely planked, with the surface of the boat covered with cleats. See also pp. 53, 59-60.

other than the frame-first assembly of the sides. The "difficult" parts of the hull, the bottom and bilges, were still built in a manner nearly identical to that in use since at least the thirteenth century on cogs.⁵³ After the bilge was rounded, the important limits of the hull had been defined and the construction of the sides was relatively simple. It also avoided the necessity for pre-determination of the frames, a potential problem. It allowed Dutch shipbuilders to skip much of the experimentation normally associated with the adoption of a new technology and take immediate advantage of the economic benefits of carvel planking.

The price paid for the head start was a certain amount of technical complacency. With no immediate need to develop more sophisticated design methods, Dutch shipbuilders eventually lagged behind their English and French counterparts. Throughout the sixteenth and seventeenth centuries, the Dutch were shipbuilders for most of northern Europe, exporting finished vessels and labor to other nations. Their ships were seaworthy, capacious, and inexpensive, partly due to superior management of the supply of imported timber. Once English and French shipwrights had solved the problems inherent in whole-moulded design methods, towards the end of the seventeenth century,⁵⁴ they replaced the Dutch

⁵³ Unger, *supra* n. 35, p. 159, notes that previous cog experience was helpful, but does not believe it was a significant factor in the growth of the Dutch shipbuilding industry.

⁵⁴ Whole moulding works well over the main body of the ship, where longitudinal curves are relatively flat, but it cannot accurately predict shapes at the extremes of bow and stern. As the shipwright approached the ends of the hull, he had to alter the "planned" shape of each frame a little bit more to make the lines come out fair. Even so, whole-moulded hulls are often characterized by exaggerated hollows in the forefoot and skeg. The solution was to augment the rising and narrowing lines of whole moulding, which indicated how much the basic sectional shape should be raised and narrowed at different points along the hull. New longitudinal lines, called waterlines and bow-buttock lines, were introduced. These were true projections of horizontal and

as the dominant shipbuilders of Europe.⁵⁵

The bottom-first ships produced by the Dutch are perhaps the ultimate expression of the bottom-based concept seen in the Roman ships and barges of northwestern Europe. Large, sea-going ships that travelled the globe for the *Vereinigde Oostindische Compagnie* and a variety of inland craft were built for a wide range of conditions by large and small yards throughout the northern Netherlands. For over a century, Dutch-built ships dominated the carrying trade in the region.

Paradoxically, these ships had moved far enough away from their bottom-based ancestors that the finished product bears no overt evidence of the original concept, except for the *spijkerpennen* and the angular bilge. Structurally, there is no difference between bottom and side, and the primary strength member throughout the hull is the framework. As in their cog predecessors, and as Arnould's observations attest, the bottom-based concept is expressed primarily in design and assembly sequence. Unlike cogs, Dutch carvel ships retain no structural expression of the concept.

vertical sections through the length of the ship, and allowed the builder to loft the end frames directly, without major corrections. On the development of whole-moulding and the various solutions to the problems it presents, see B. Lavery, *The Ship of the Line II: Design, Construction and Fittings*, pp. 7-27.

⁵⁵ R.W. Unger, *Dutch Shipbuilding before 1800: Ships and Guilds*, pp. 111-115.

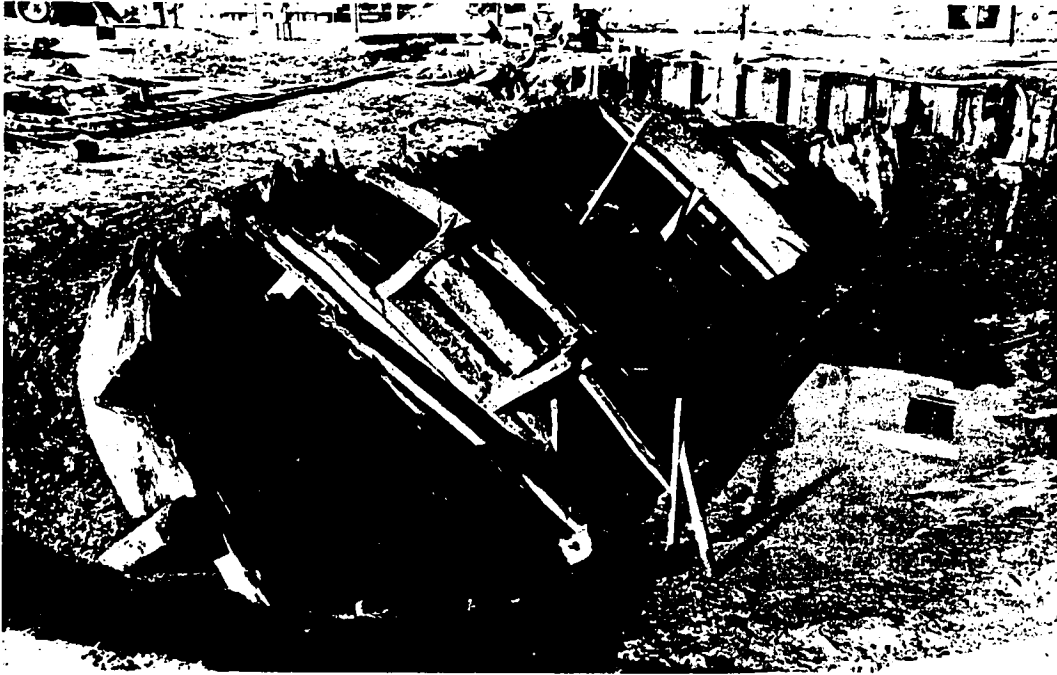


Figure 14. Oost Flevoland B 71 after excavation (Photo RIJP).

Oost Flevoland B 71: A Late Sixteenth-Century *Karveel*

IJsselmeerpolders find B 71, an inland vessel of the late sixteenth or early seventeenth century, illustrates both the heritage of Dutch carvel vessels and the trend away from it. The vessel was discovered in August of 1980, during construction of a canal in the city of Lelystad, East Flevoland (Fig. 16).⁵⁶ The interior of the hull was excavated during the fall of that year. In the spring of 1981, the largely intact remains of the hull were raised by constructing a reinforced steel

⁵⁶ H.R. Reinders, "The Excavation and Salvage of a 16th Century 'Beurtschip'," *IJNA* 12 (1983): 336-338. Early results of the hull research are available in F.M. Hocker, "The Lelystad *Beurtschip*: Preliminary Report on the Hull Construction," in *Scheepsarcheologie: Prioriteiten en Lopend Onderzoek*, eds. H.R. Reinders and R. Oosting, pp. 89-94.

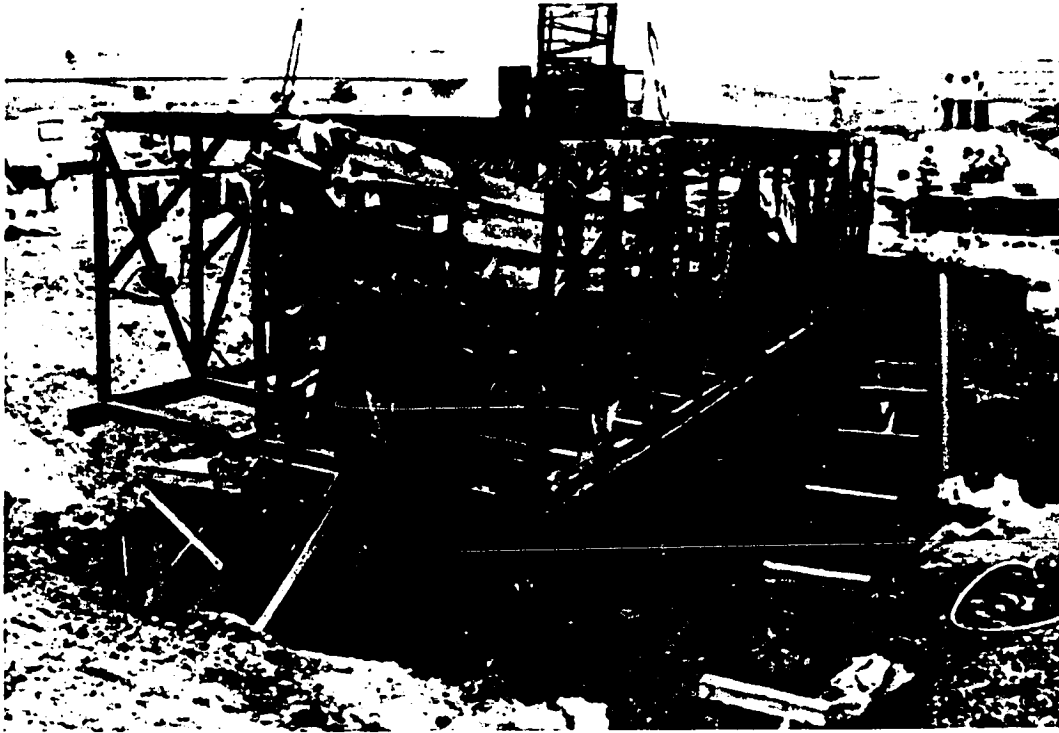


Figure 15. Oost Flevoland B 71 being raised from the excavation pit (Photo RIJP).

cage around the vessel, then righting and lifting the cage (Fig. 15). Vessel and cage were transported by low loader to an RIJP⁵⁷ storage facility in nearby Lelystadhaven, where the remains were conserved by controlled air drying. The results of the treatment were not as positive as had been hoped; there was substantial shrinkage and distortion of all timbers, and much of the loose timber and bottom ceiling deteriorated badly. Some components, such as pumps and bulkheads, were removed and conserved in polyethylene glycol (PEG). The intact

⁵⁷ Rijksdienst voor de IJsselmeerpolders, the government authority responsible for all phases of the draining and development of the old Zuiderzee. The Ketelhaven museum is part of the Wetenschappelijke Afdeling (scientific division) of the RIJP. See Appendix I on the Zuiderzee Project.

structure and most loose timbers remain at the RIJP warehouse.

The hull was partially recorded during excavation. Transverse sections of the interior, deck plans, and a number of detail drawings were made by the Ketelhaven staff, under the direction of P.B. Zwiers. Semi-measured site plans were drawn by K. Vlierman, and an overall site view was produced by stereo photogrammetry. After raising, exterior transverse sections were taken. In 1986, I travelled to Lelystad and spent two months completing the recording of the hull.⁵⁸ This included another set of exterior sections (to assess distortion), detailed recording of the planking, and the measuring and photography of many individual features.

The excavated remains, while damaged and distorted, were remarkably complete. The vessel lay in the ground at a 45° list to starboard, with the bottom, starboard side, and most of the deck intact and structurally coherent. Most of the port side had broken off as a single, large panel, possibly as a result of contact with another ship, and collapsed into the hold. Loose timbers from the port side of the decks lay on top of and inside the wreckage. The rudder was found detached and reversed, leaning against the intact area of the port quarter. Missing were the mast and sprit, forward windlass, hatch covers, and leeboards. After the port side was broken off, the ends of the hull hogged downward and to starboard into scour pits. The topsides and posts were pushed over to starboard, in effect

⁵⁸ My work was funded by an assistantship from the Nautical Archaeology Program of the Department of Anthropology, Texas A&M University, with travel expenses paid by the Institute of Nautical Archaeology. The Museum voor Scheepsarcheologie provided facilities and materials, as well as occasional muscle power.

giving the hull a more graceful shape than it originally had. The loss of the port side also caused the deck to sag.

Little cargo was found in the hull: a bolt of cloth, a barrel of scrap pewter, and a crate of eggs (187 still unbroken!) were the principal items, but broken fragments of other containers were found, as well as salvors' tools. Large numbers of personal possessions, including mowers' tools, a pair of citterns (wire-stringed musical instruments similar to mandolins), and at least thirty pairs of leather shoes and boots were found in the forepeak and below the remains of a small passenger cabin aft. The strange mix of contents, as well as the vessel type, have led to the conclusion that the B 71 was a *beurtschip*, one of the scheduled ferries operating between Amsterdam and another Zuiderzee town.⁵⁹ Circumstantial evidence suggests that this particular vessel stopped at Zwolle, near Kampen at the mouth of the IJssel River. The sinking is dated to the 1620s by coins, but extensive repairs indicate that the vessel itself is considerably older. Certainly it was built before 1600, perhaps as early as the 1580s, based on a (rather subjective) evaluation of the wear and tear.

Dimensions

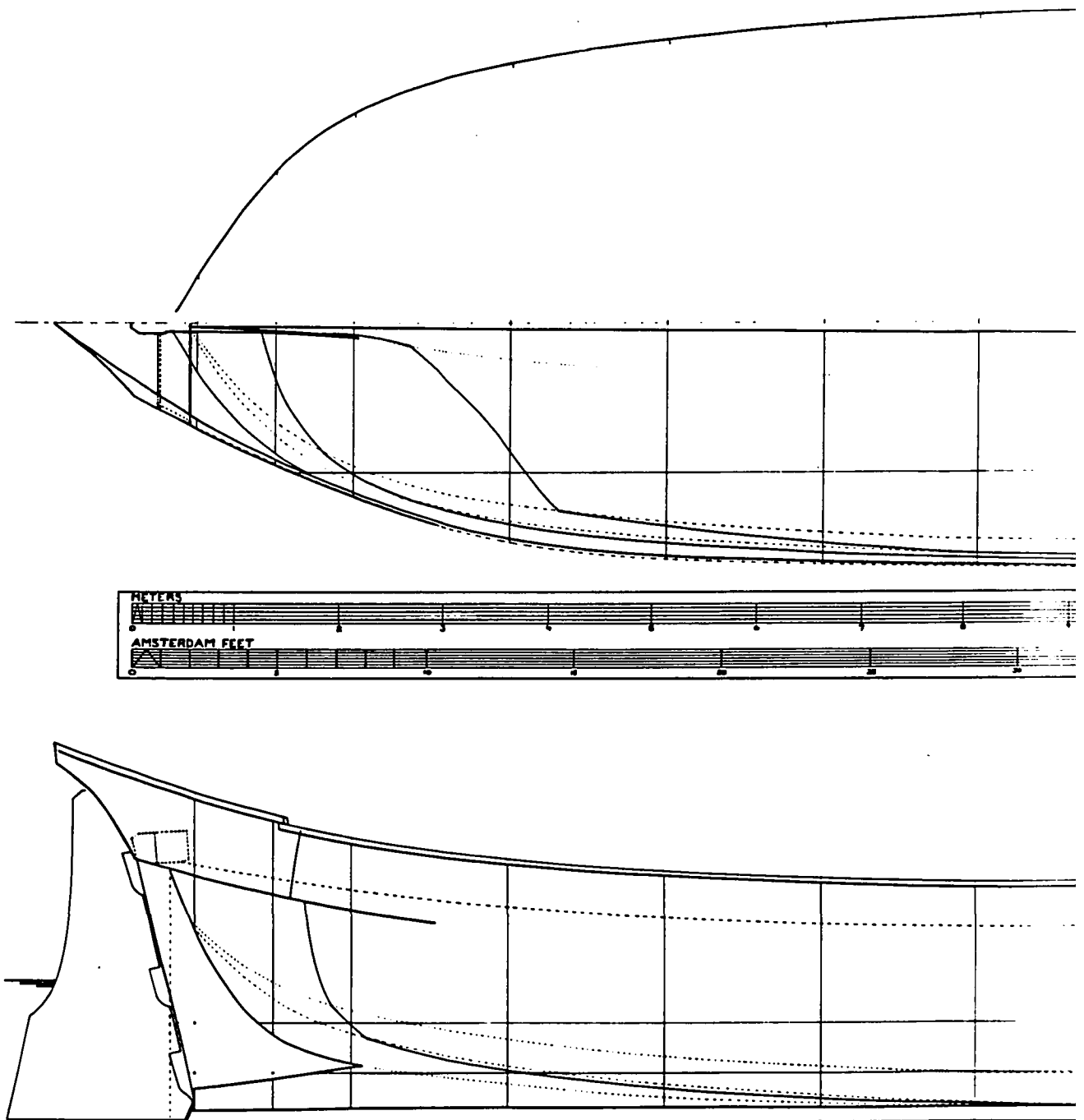
As reconstructed, the Lelystad *beurtschip* is 18.25 m long overall, including the rudder, but only 16.35 m between perpendiculars. The moulded beam is

⁵⁹ Reinders, *IJNA* 12 (1983): 337.

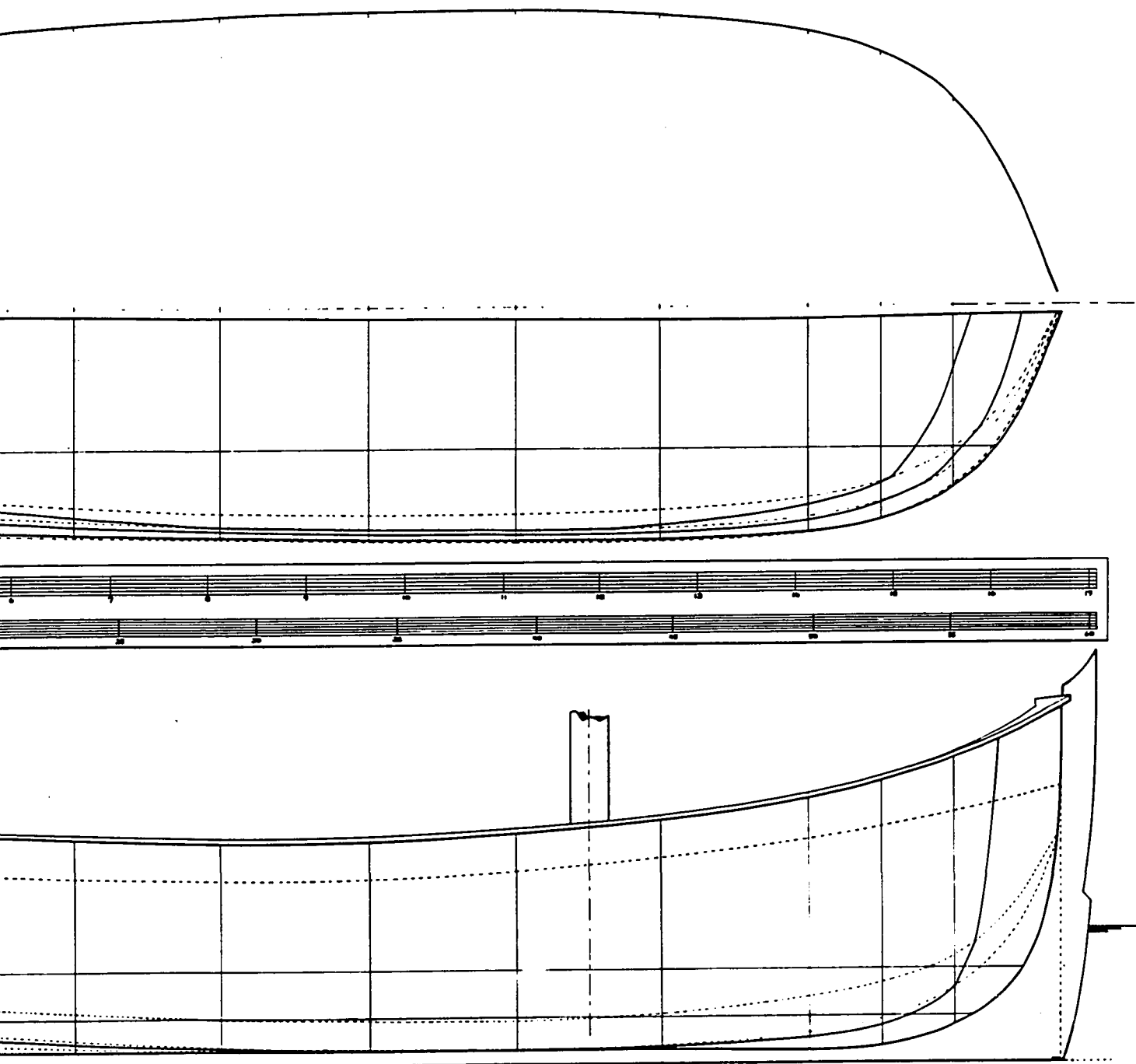
4.96 m, the extreme beam 5.50 m. At its lowest point the top of the caprail is 2.41 m above the bottom of the keel. Draft marks cut into the starboard side of the stem and sternpost indicate that the maximum original draft was five Amsterdam feet (1.42 m), later increased to six feet (1.60 m). At five feet, the displacement in salt water is 78 metric tons; at six feet, the displacement is 90 tons. Ship weight is estimated at about 30 tons, giving a deadweight capacity of 48 to 60 tons. Hold volume is 72 m³ (approximately 24 lasts) to the underside of the beams, but extra space is available under the arched covers over the large central hatch.

Hull Form

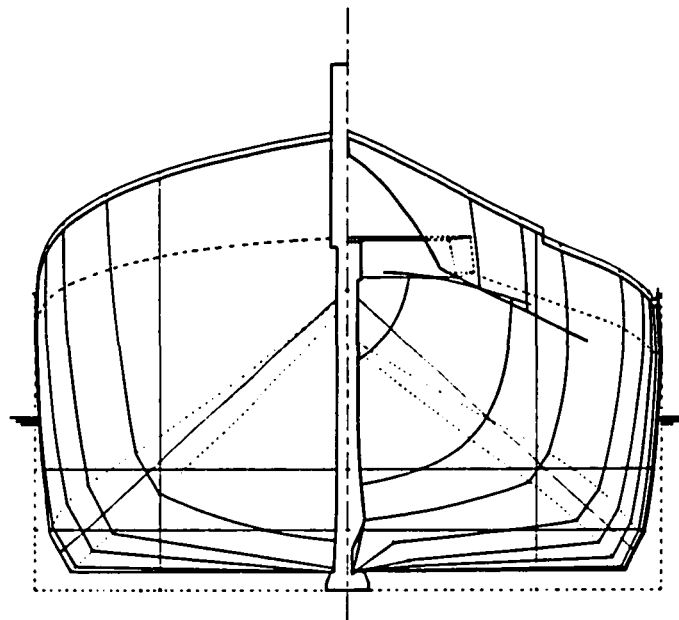
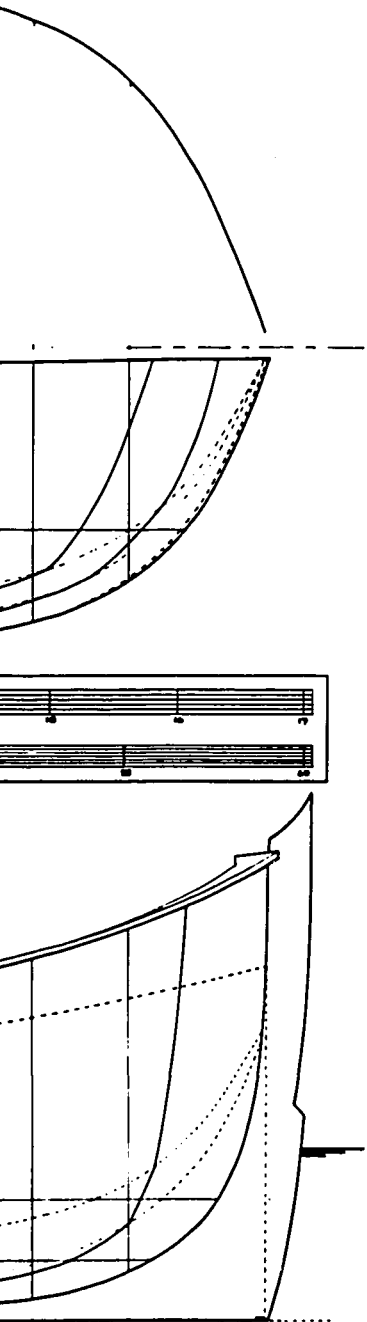
The shape betrays the cog ancestry of the hull (Plan VII). A wide, flat bottom is carried very far forward, with only a slight increase in deadrise, into a bluff bow with curved stem; there is no hollow in the entrance, as the bottom planks curve upward into the stem rabbet, but do not twist. The bottom develops a bit more deadrise aft, with an easier run, but the garboard twists to the vertical, creating an angular hollow in the after sections. Over most of the hull, the sides meet the bottom in a hard chine that approaches a right angle amidships. The sides themselves are gently curved, with slight tumblehome in the bulwarks. At the stern, the lower hull planking turns into the sternpost rabbet, but above the deck, the bulwarks separate from the lower hull and project beyond the sternpost, enclosing the head of the rudder in a "pink" stern. Coefficients and ratios are presented in Table 2. Note that the midships and waterplane coefficients are



PLAN VII. Oost Flc
starboard side.



PLAN VII. Oost Flevoland B 71 Hull Lines (to inside of plank). All drawings are of the starboard side.



Drawings are of the

nearly identical to those of the cog *Almere Wijk 13*, but that the block and prismatic coefficients are noticeably greater, suggesting fuller ends.

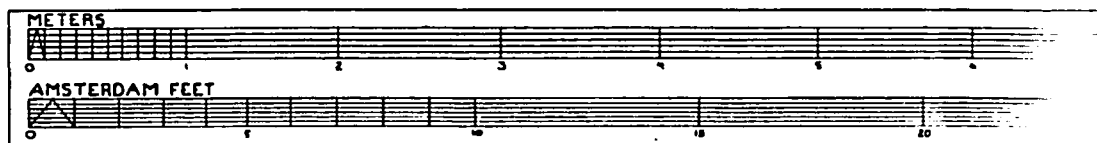
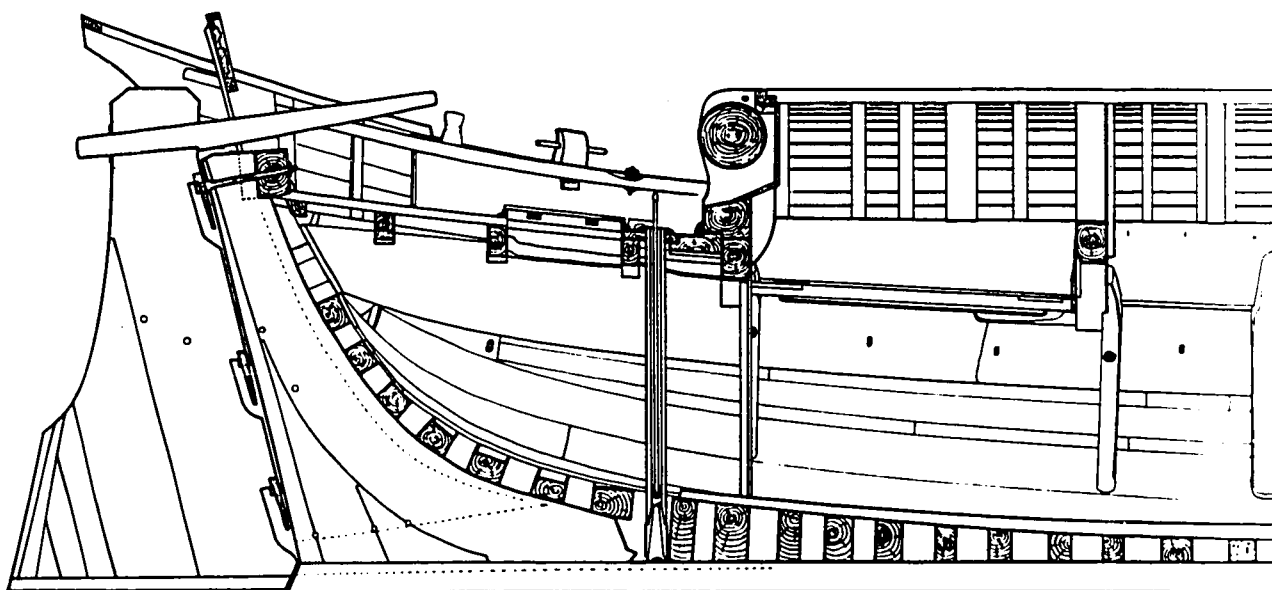
Table 2. Oost Flevoland B 71 Hull Coefficients.

Block Coefficient (C_B):	0.73
Midships Coefficient (C_M):	0.96
Prismatic Coefficient (C_P):	0.75
Waterplane Coefficient (C_{WP}):	0.87

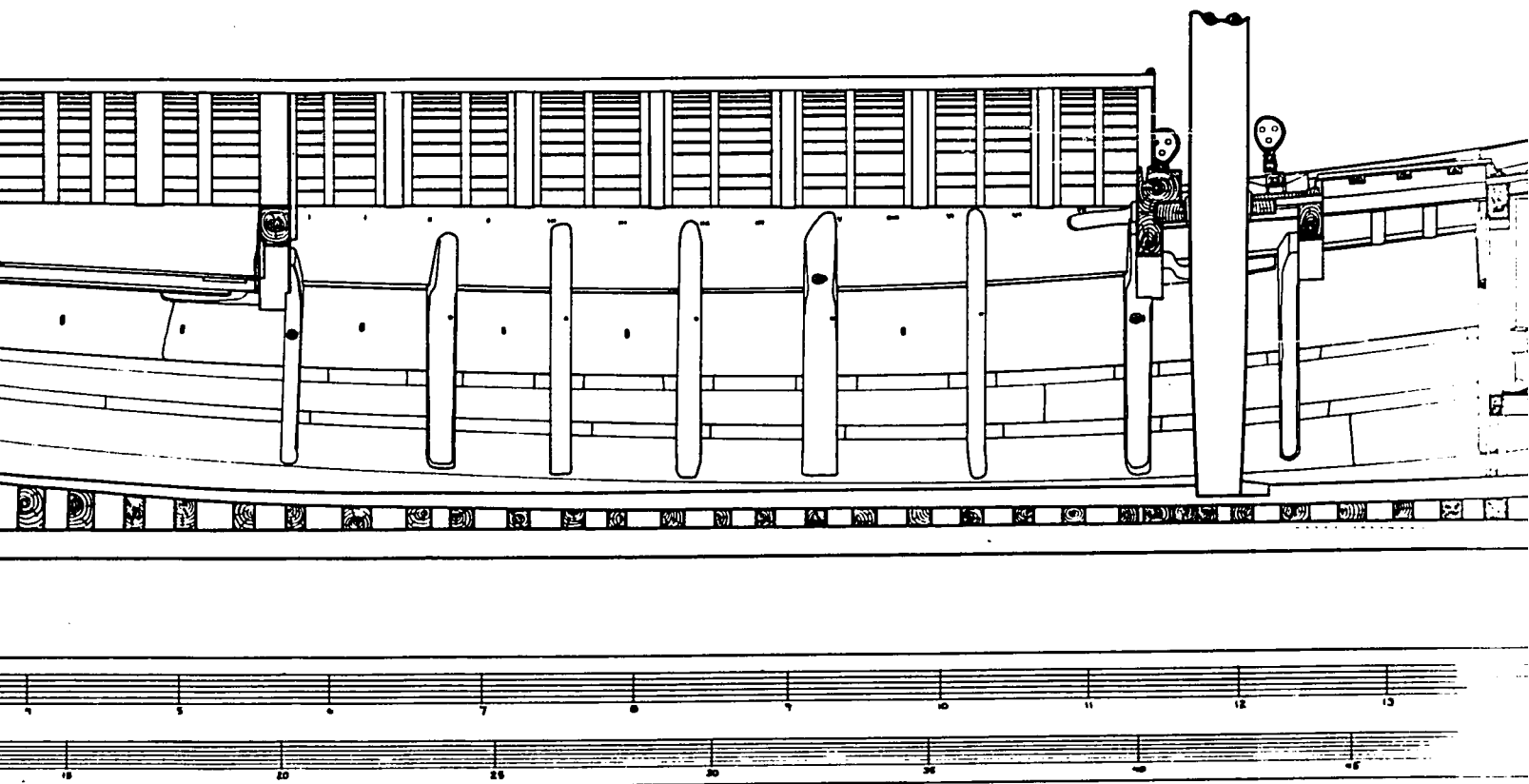
Structural Components (Plans VIII-X)

The hull is built almost entirely of oak (*Quercus spp.*), with some softwood used in repairs to the ceiling and in non-structural bulkheads and panelling. The majority of fasteners are oak treenails, with iron spikes in certain applications. Iron hardware is also used to hang the rudder and leeboards.

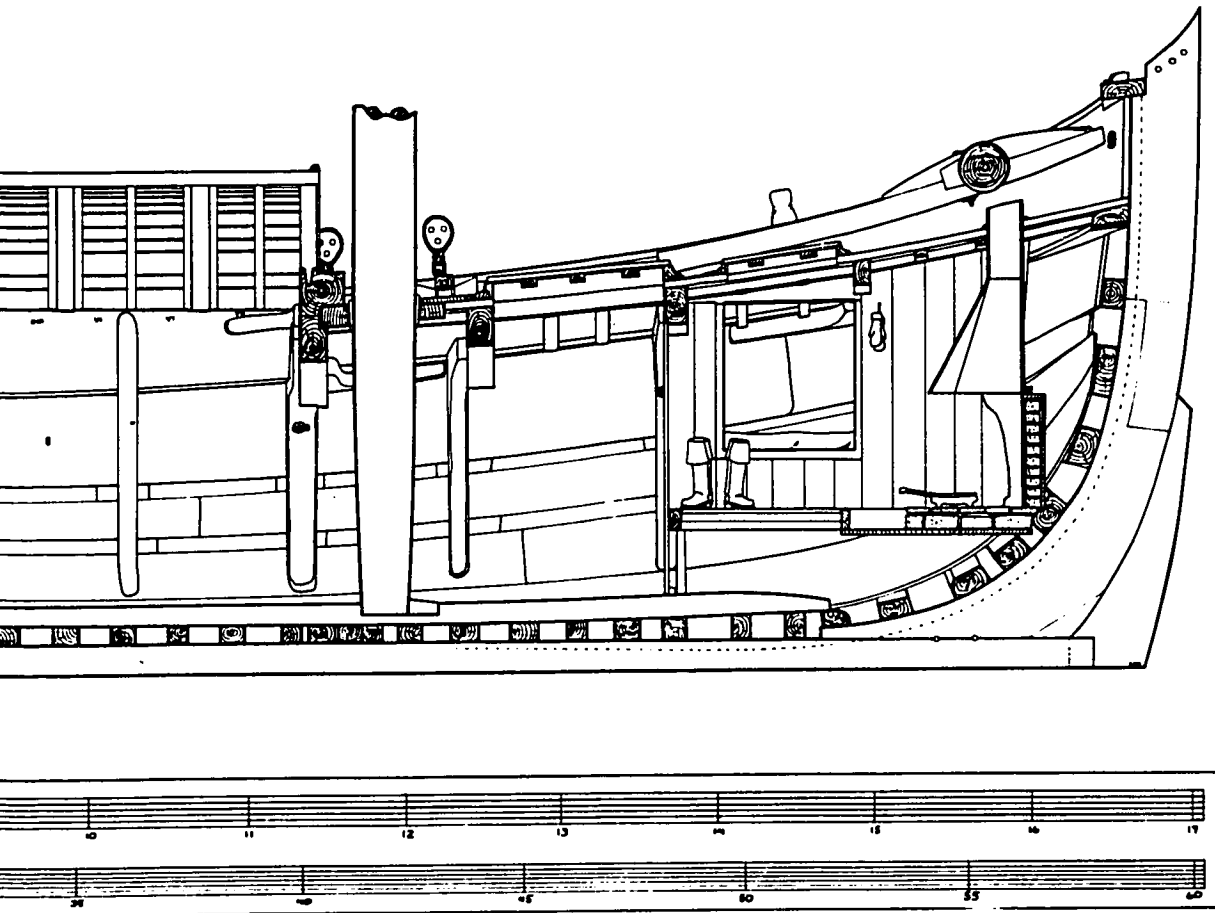
The keel is a single timber 15.85 m long, sided 34 cm and moulded 20 cm amidships. It tapers in width toward both ends. The moulded depth was originally constant over the entire length, but extensive wear at the stern has reduced this to 16 cm aft. Wear at the bow, although less severe, has reduced the moulded depth to 18 cm at the forward extremity. The lower edges are also worn and



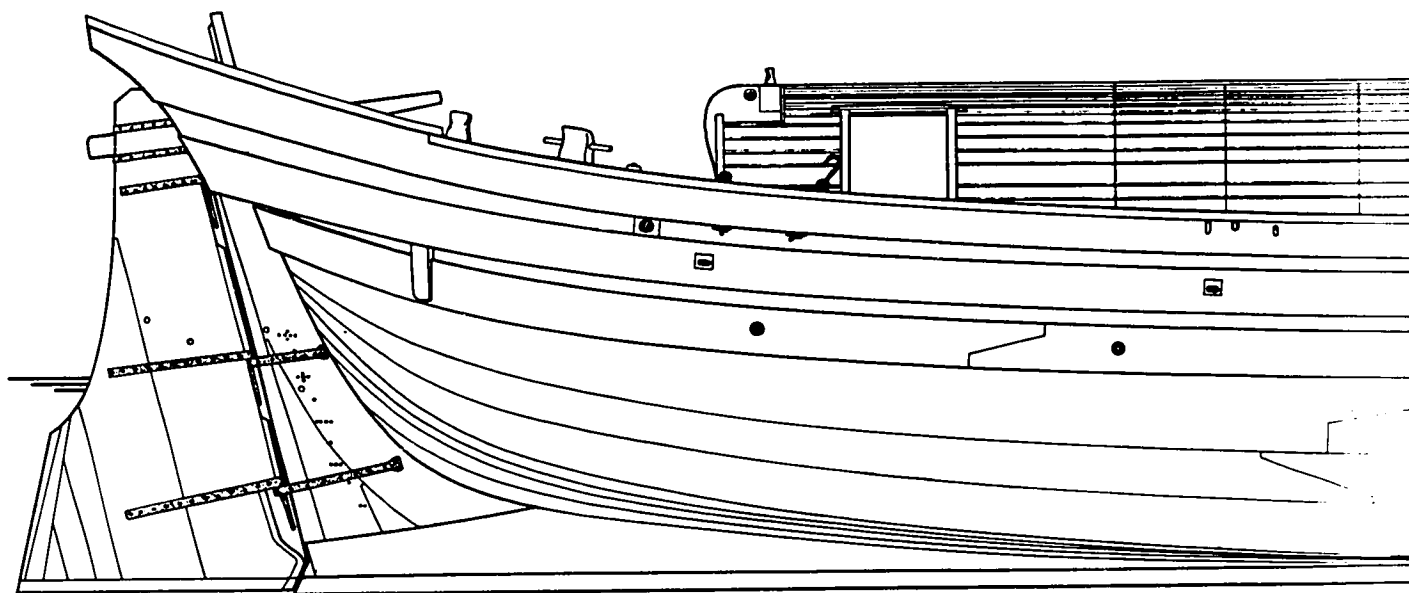
PLAN VIII. Oost F



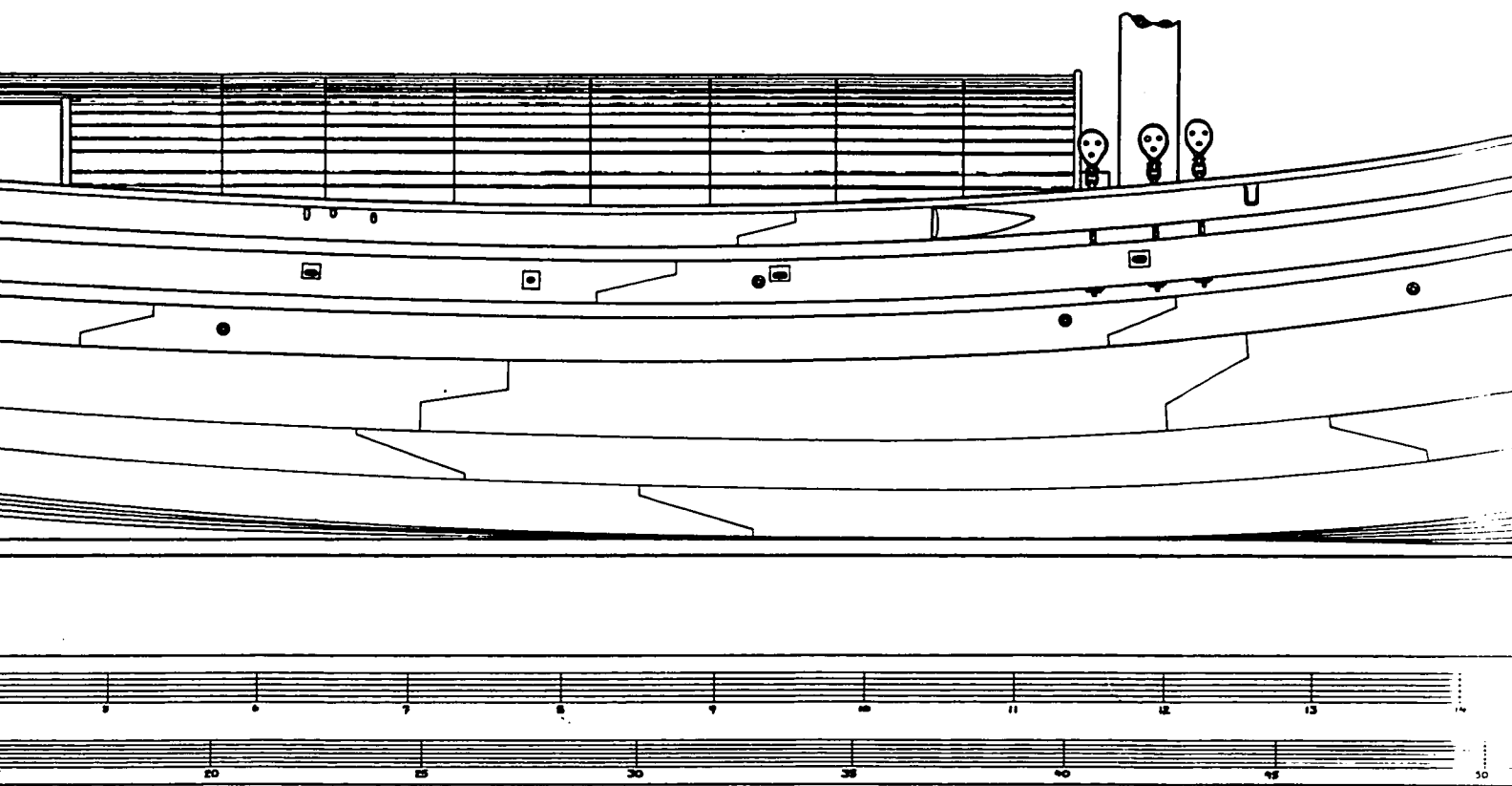
PLAN VIII. Oost Flevoland B 71 Longitudinal Construction Section.



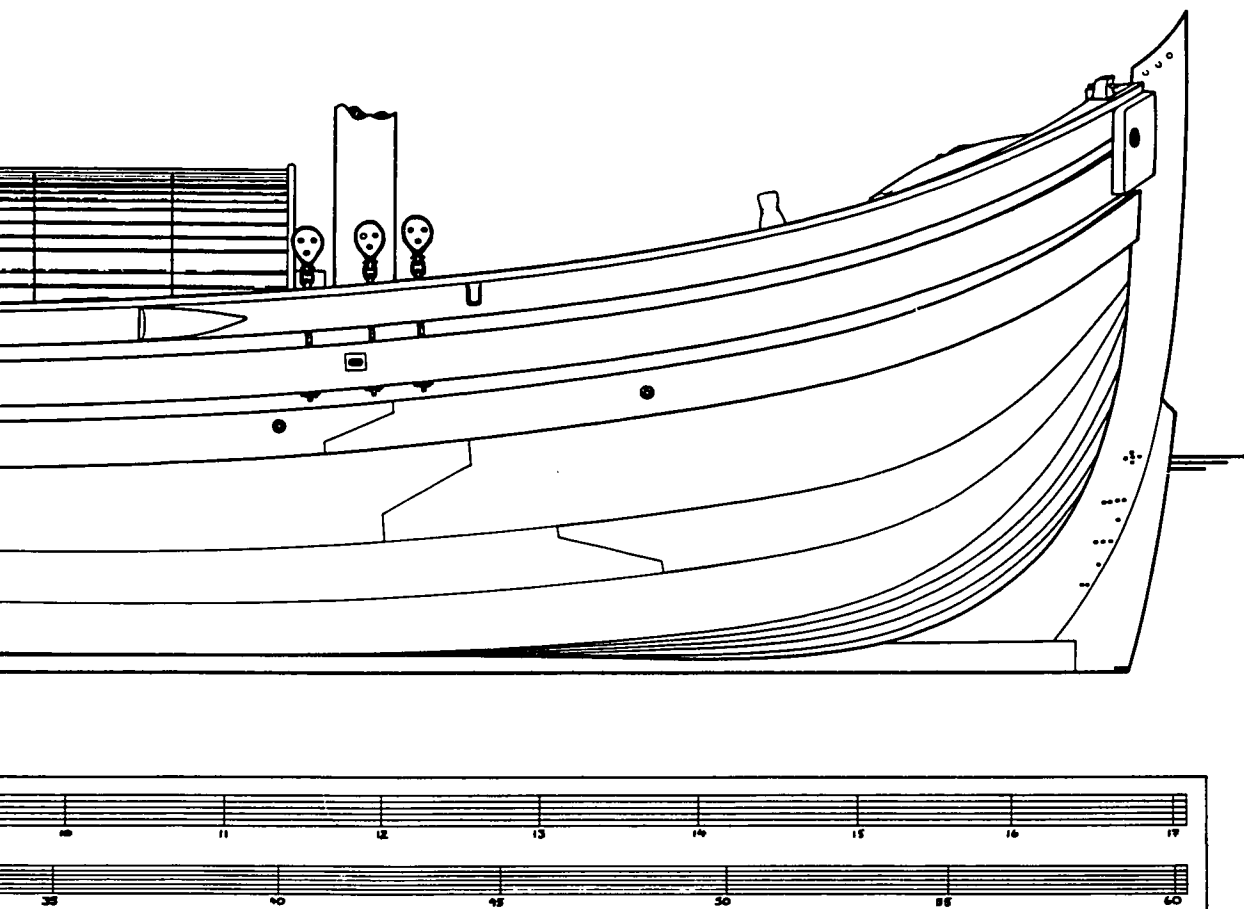
Construction Section.



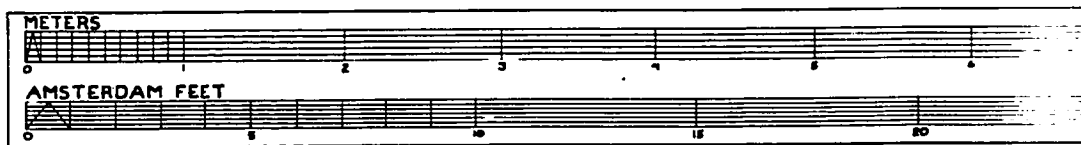
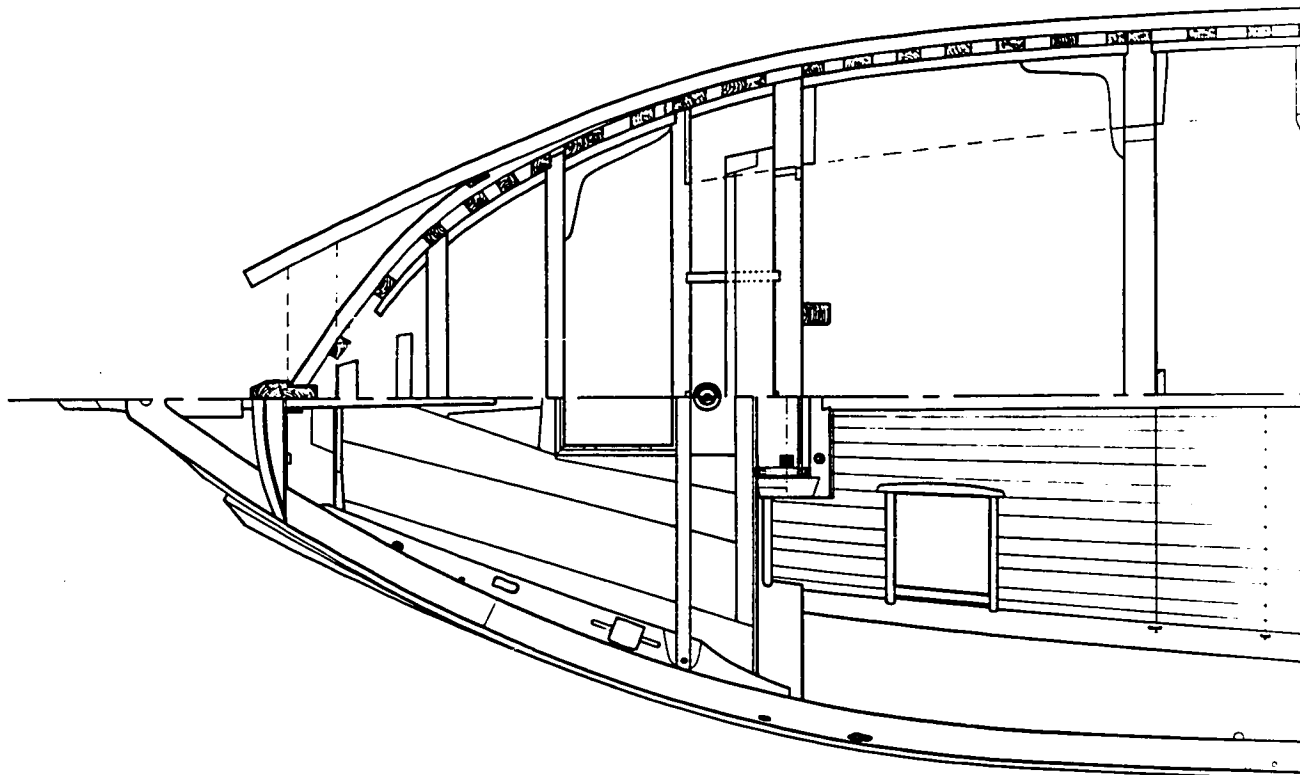
PLAN IX. Oost Fl



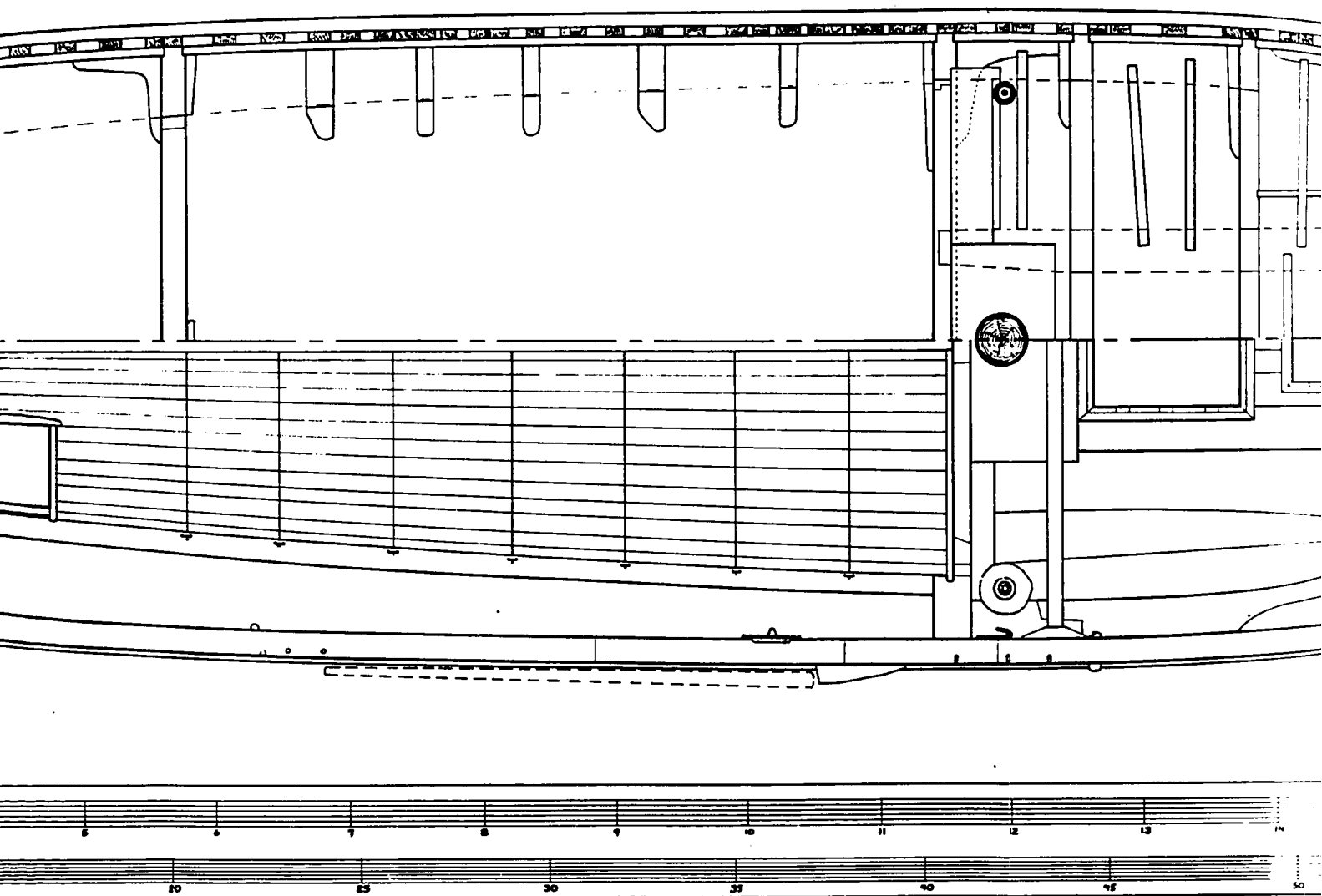
PLAN IX. Oost Flevoland B 71 Exterior Profile.



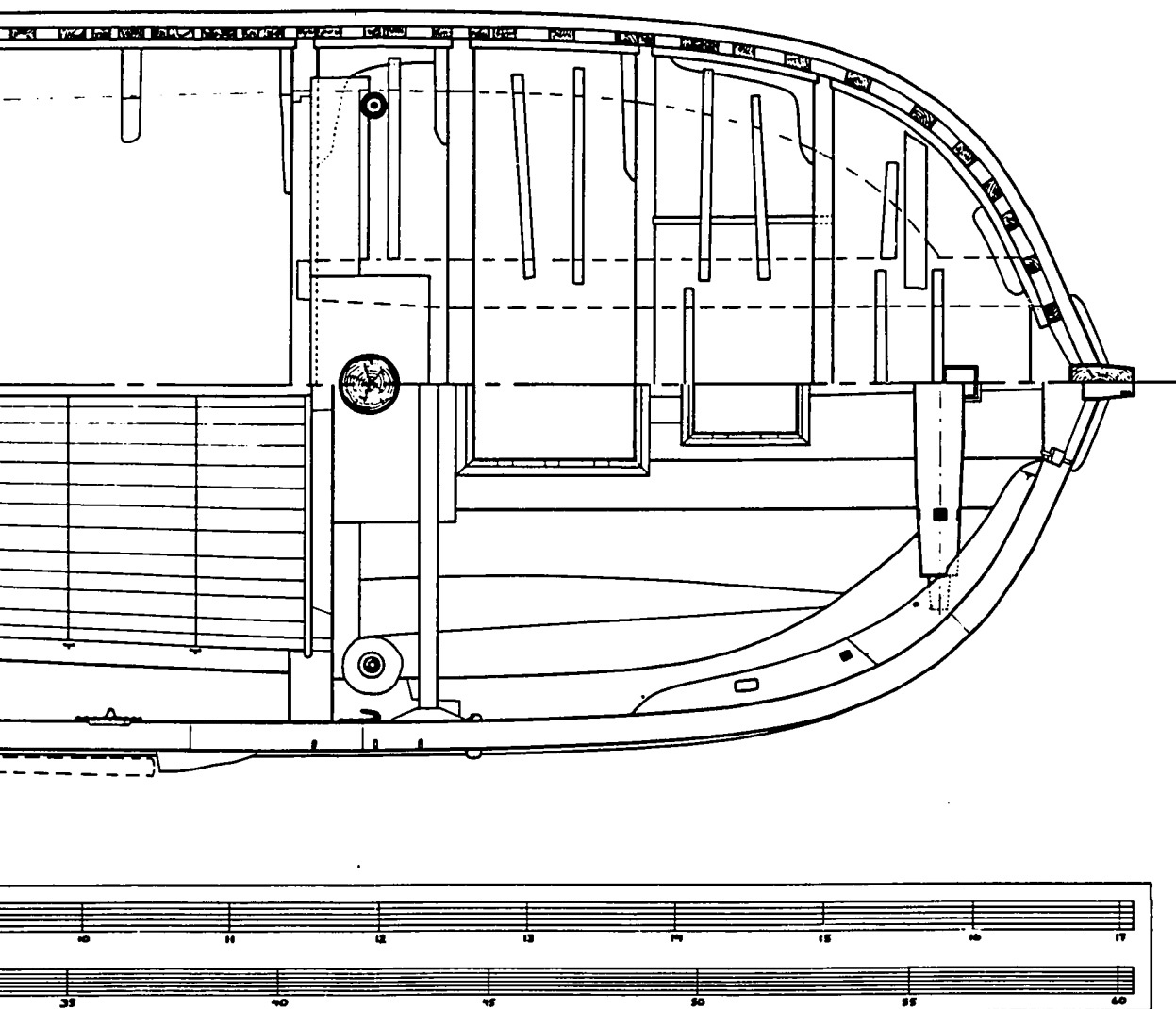
profile.



PLAN



PLAN X. Oost Flevoland B 71 Deck Plan.



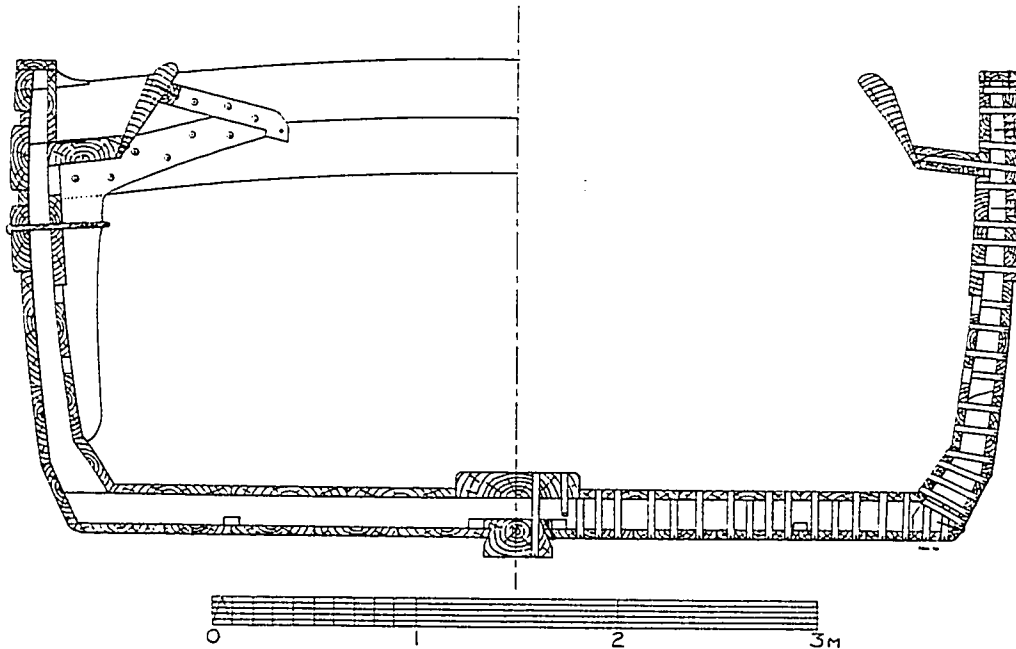


Figure 16. Oost Flevoland B 71 construction section amidships and at sailbeam.

rounded, sometimes extensively.

The keel is rabbeted over most of its length. Amidships, the rabbet is a triangular groove approximately 9 cm high and 5 cm deep (Fig. 16). The upper plane of the rabbet is horizontal and lies 5 cm below the upper surface of the keel. The rabbet continues to the after end of the keel, where it turns to the vertical. The after end of the keel forms a small skeg to protect the heel of the rudder. At the forward end, the rabbet curves upward onto the stem and the keel continues forward to the lower end of the gripe (*loefbijter*).

Aside from the fastenings connecting the posts, frames, and garboards to

the keel, there are two large (diameter 5.5 cm) horizontal plugs in the starboard rabbet. These are finished flush with the rabbet surface.

The stem, as found, was made of three timbers, but may have been only two timbers originally. The lower stem is a heavy curved timber fastened directly to the upper surface of the keel with treenails and scarfed to the upper stem. The third piece is little more than a small filler at the forefoot, behind the added gripe. The stem (as reconstructed) rises 4.15 m above the keel with a foot 1.58 m along the keel. It is sided 24 to 25 cm at the after edge and tapers to 14 to 15 cm at the leading edge. Its maximum moulded depth is 61 cm, but is only 9 cm at the after end. The upper and lower stem were fastened together by a vertical scarf that began 1.40 m above the keel. The scarf lies entirely forward of the rabbet, and thus seems to be a repair. Little of this scarf remains, so details of its configuration and fastenings are unclear. The third piece, which is rather irregular in shape, fills out the stem at its deepest point, where the original timber was probably of insufficient scantling. The stem is fastened to the keel by four centerline treenails, 3.5 cm in diameter.

Originally, a separate gripe (*loefbijter*) was fitted to the forward face of the stem. It was vertically scarfed to the end of the keel and treenailed to the forward face of the stem. Although the timber itself does not survive, the fastenings show that it was at least 1.7 m high and moulded at least 15 cm. Contemporary and later iconography and models indicate that the gripe ended not far above the load

waterline.

The rabbet runs onto the stem from the keel and continues upward over the preserved length of the stem. The rabbet continues to be a triangular groove at the lower extremity of the stem, but becomes shallower and rectangular as it approaches the upright portion. If the stem was fashioned in a similar manner to the sternpost, only the thinner planking would have lain in rabbets; the wales would have been fayed and scabbed onto the sides of the stem, without rabbets.

As reconstructed, there are three transverse holes in the head of the stem for the lanyard of the forestay. The three-hole deadeye from the lower end of the forestay was recovered, and contemporary representations typically show the forestay attached to the head of the stem by a lanyard passing through a deadeye seized in the end of the forestay and a corresponding number of holes in the stem.

The stem-keel join was bedded in a layer of tarred moss or felt, as were most fayed joints in the hull. The penetration of water was further discouraged by two transverse stopwaters 2 cm in diameter, located forward of the rabbet.

The sternpost is formed by four timbers fastened to each other and the aftermost 2.08 m of the upper surface of the keel. The sternpost proper is a single, heavy, naturally-curved timber rising 3.70 m above the keel. It is sided 24 cm at its widest and moulded 41 cm at its deepest, but varies little in either dimension. The foot of the post is treenailed directly to the top of the keel.

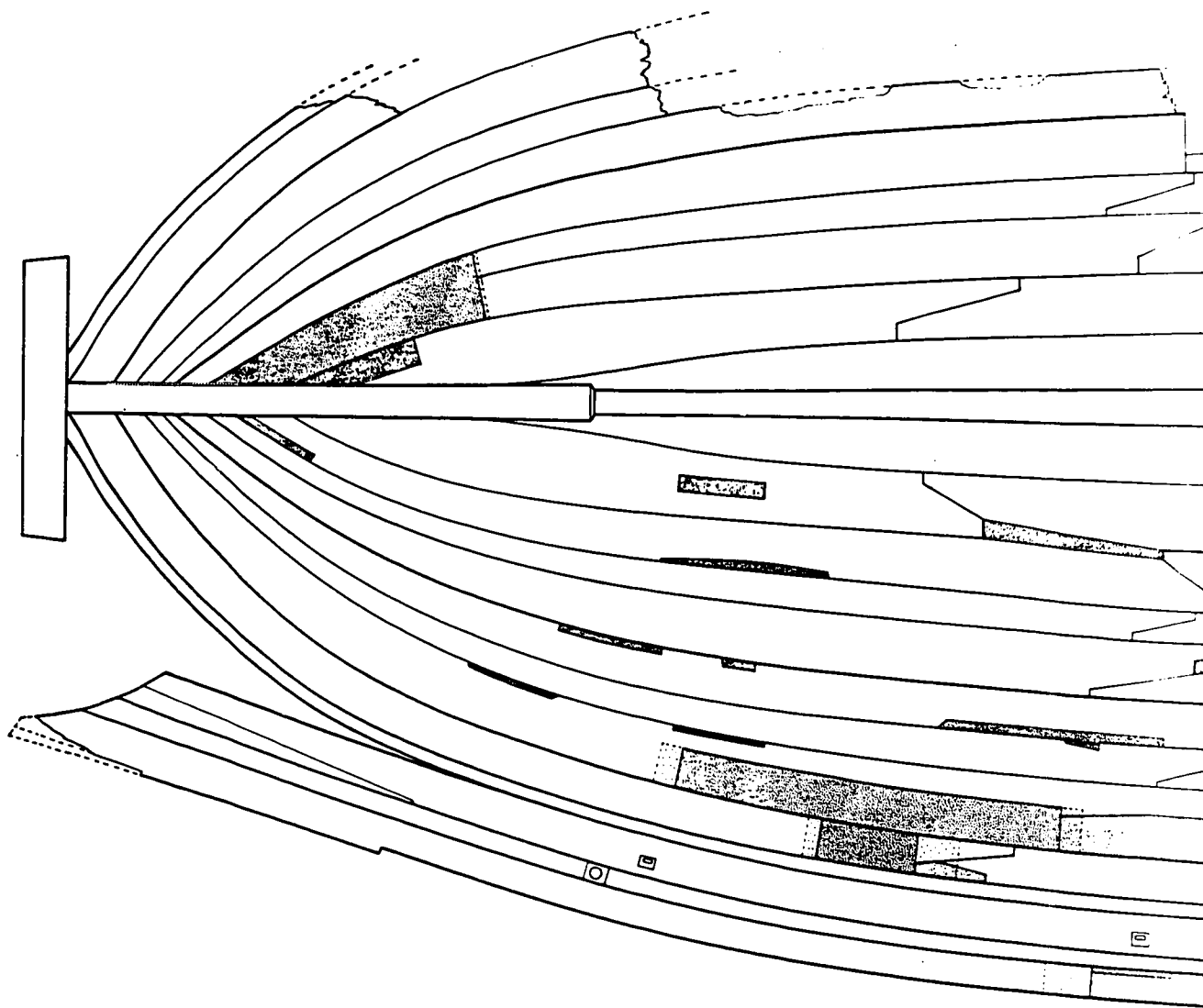
A light rudderpost is fastened to the after face of the head of the sternpost and the end of the keel. The triangular space between the sternpost and

rudderpost is filled with two chocks. The chocks are treenailed to the after face of the sternpost, while the rudderpost is nailed and treenailed to the after face of the post and after chock. Stopwaters are placed between all of the component timbers, and the entire assembly is fastened to the top of the keel by five treenails. The whole forms a massive structure and contributes a substantial amount of lateral area to the hull.

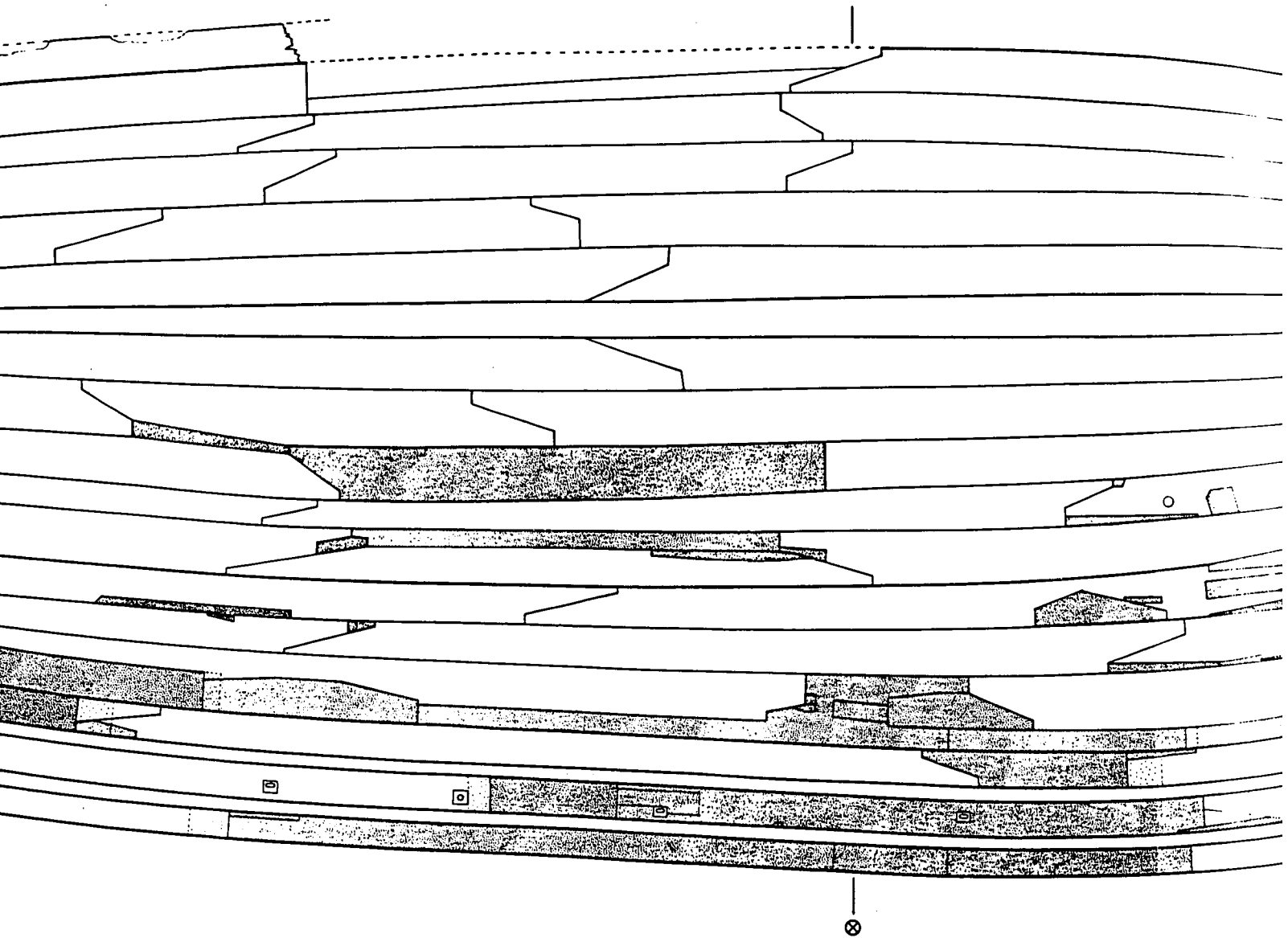
A wide, shallow rabbet is cut into the side of the assembly for the vertical end of the garboard, which runs out to the after end of the keel. A triangular rabbet for the second through eighth strakes continues from the upper edge of the garboard. The rabbet stops at the lower edge of the first wale, which is fayed and scabbed to the side of the post. The forward face of the head of the post is stepped and cut down on the sides to fit a notch in the after face of the afterbeam (*hekbalk*).

The rudder was hung from the sternpost on three sets of iron pintles and gudgeons. Each of the two lower gudgeons consists of a ring welded into a bend in a strap 6 cm wide with flared ends. The strap is spiked to the sides of the post. The upper gudgeon (now missing) was an eye formed in the outboard end of the forelock bolt used to fasten the *hekbalk* to the sternpost.

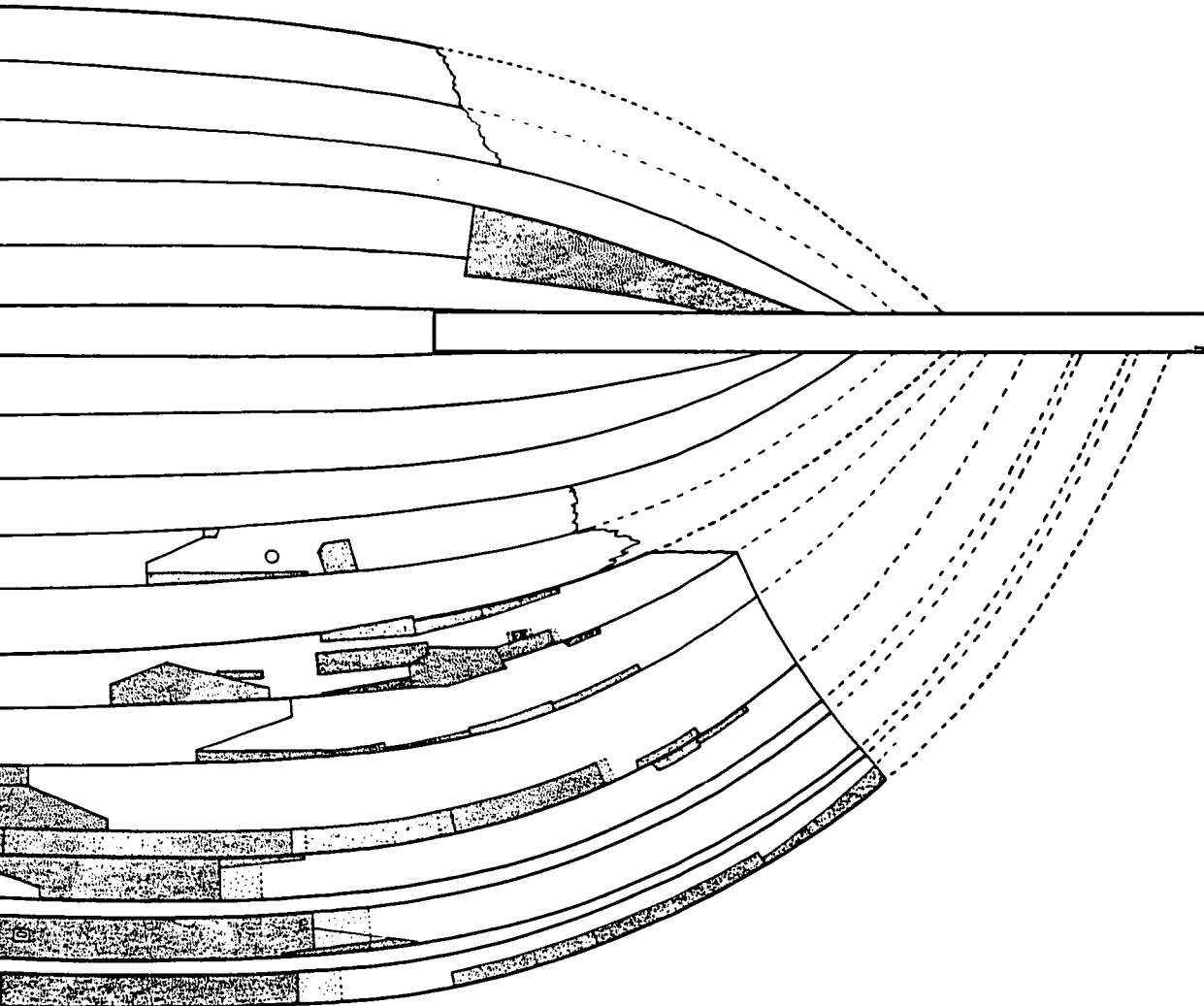
Eight strakes on either side below the wales can be subdivided into three areas: bottom, bilge, and side planking (Plan XI). There are no stealers or drop strakes. All planks, of plainsawn oak, were originally just over 5 cm thick, but



**PLAN XI. Oost F
to scale.**



PLAN XI. Oost Flevoland B 71 Planking Expansion. Shaded areas represent repairs. Not to scale.



t repairs. Not

wear and damage over the long working life of B 71 have reduced this in the bottom planks somewhat, although much less so than in the Almere cog. Planks are treenailed to the frames, with iron spikes used at the hood ends, scarf tips, and along the inner edge of the garboard. Repairs are also normally fastened with spikes unless particularly extensive. The bottom and bilge strakes are marked inside and out with numerous small (ca. 0.5 cm across), square, tapered, oak pegs. Similar pegs can be found on the sides of the stem and sternpost.

The predominately flat bottom is made up of five strakes. The first, second, third, and fifth strakes are relatively wide, exceeding 36 cm over most of their length (the widest is strake 2, at 52 cm). The fourth is somewhat narrower, except at the bow. Each plank is fastened to each frame by one or two blind treenails and several more treenails that also fasten the ceiling. The treenails average 3 cm in diameter and are wedged on the outside with square central plugs (*deutels*), on the inside with plain cross wedges (*arken*). The garboard is made up of two planks, but the other bottom strakes consist of three planks each. Planks originally met in simple, nibbed scarfs at least as long as the width of the plank. Some of these scarfs have been partially obliterated by extensive planking repairs (see below), but the tips were originally fastened to the frames with two nails each.

The garboard is fastened to the underside of the keel rabbet with iron nails spaced 12 to 16 cm apart and small, unwedged treenails 1.8 cm in diameter in the central part of the hull. These little pegs are irregularly spaced, but some attempt seems to have been made to set one after every third nail. At its after end, the

garboard does not follow the curve of the sternpost but twists to the vertical and continues straight aft, where it is nailed to the continuing keel rabbet and the sides of the sternpost assembly. The after tip of the garboard is protected by a small cap, nailed in place. At the sternpost, the second strake continues into the curved sternpost rabbet. Over the last two meters or so of the garboard/second strake seam, the upper edge of the garboard acts as a secondary rabbet, with a pronounced bevel and nails driven from inside through the garboard and into the inboard edge of the second strake. A drain plug, 7.5 cm in diameter, is wedged into the fourth strake on each side forward of amidships.

A single bilge strake meets the fifth strake at a steep angle, 115° degrees amidships. The bilge strake is up to 44 cm wide and originally made up of two planks. In addition to the treenails fastening it to the frames, its lower edge is nailed at irregular intervals (30 to 70 cm) through the outboard edge of the fifth strake and into the frames.

Two strakes form the sides below the wales. The seventh strake is 42 cm at its widest and composed of three planks. The eighth strake is the widest in the vessel, exceeding 50 cm over most of its length and reaching a maximum of 65 cm as originally hung. Curiously, the width is divided into three approximately equal segments by two longitudinal lines graved in the surface. These lines are even graved in the repairs that have replaced much of the original timber, and some repairs are made so that their edges follow the lines. A similar graved line can be observed in the after end of the fifth strake. Graved lines in the planking have

been found on other Zuiderzee craft of the seventeenth century.⁶⁰

The topsides of B 71 are strengthened by three wales separated by narrow (generally less than 10 cm wide) planks 5 cm thick (Fig. 16 and Plan XI). The two lower wales are 10 cm thick and 34 cm wide, while the uppermost wale is only 8 cm thick and 22 cm wide. The only hood ends to survive are those at the after end of the lowest wale; these are scabbed onto the sides of the sternpost. I presume the hood ends at the bow were treated similarly. The two upper wales continue aft of the sternpost in a "pink" stern partially enclosing the head of the rudder. The after tips of the port and starboard third wale probably joined in some manner, but damage to the extremities prevents a definite reconstruction.

Each wale was originally composed of three pieces meeting in scarfs similar to those in the planking, but most of these, especially in the third (upper) wale, have been obliterated by repairs. The wales are fastened to the frames by treenails similar to those in the planking. The scarf tips and after hood end of the first wale are fastened with iron spikes. Presumably, the forward hood ends were also nailed to the stem.

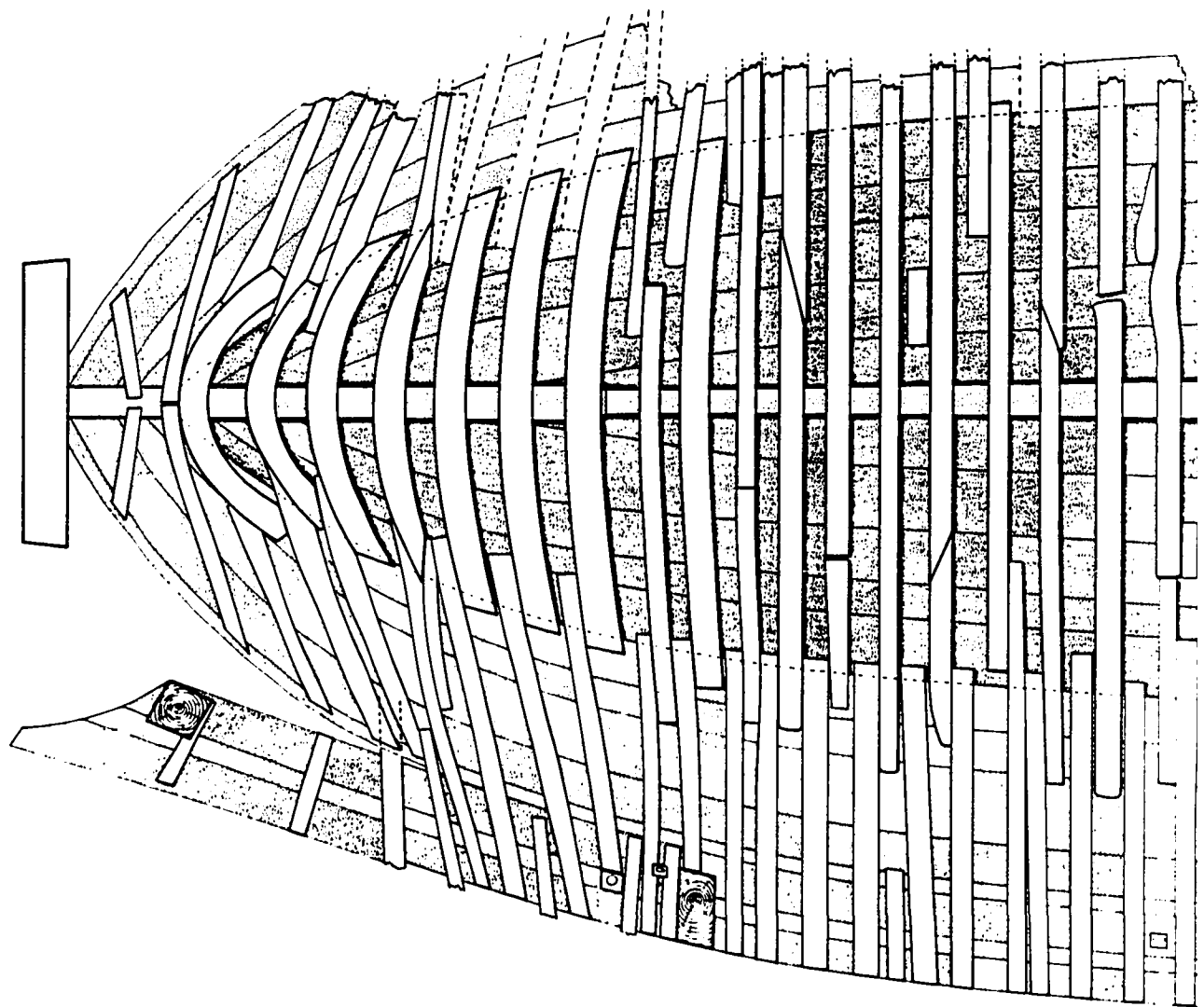
Hawseholes 8 cm in diameter were cut into the spacer plank between the upper and middle wales on either side of the stem and reinforced by heavy oak plates 55 cm long, 55 cm high, and 6 cm thick fastened over the two upper wales

⁶⁰ For example, a late-seventeenth-century *ventjager*, or fish market-boat similar to a modern *botter*, excavated in 1986 near Swifterbant, East Flevoland, and now undergoing conservation while on display at the Museum voor Scheepsarcheologie.

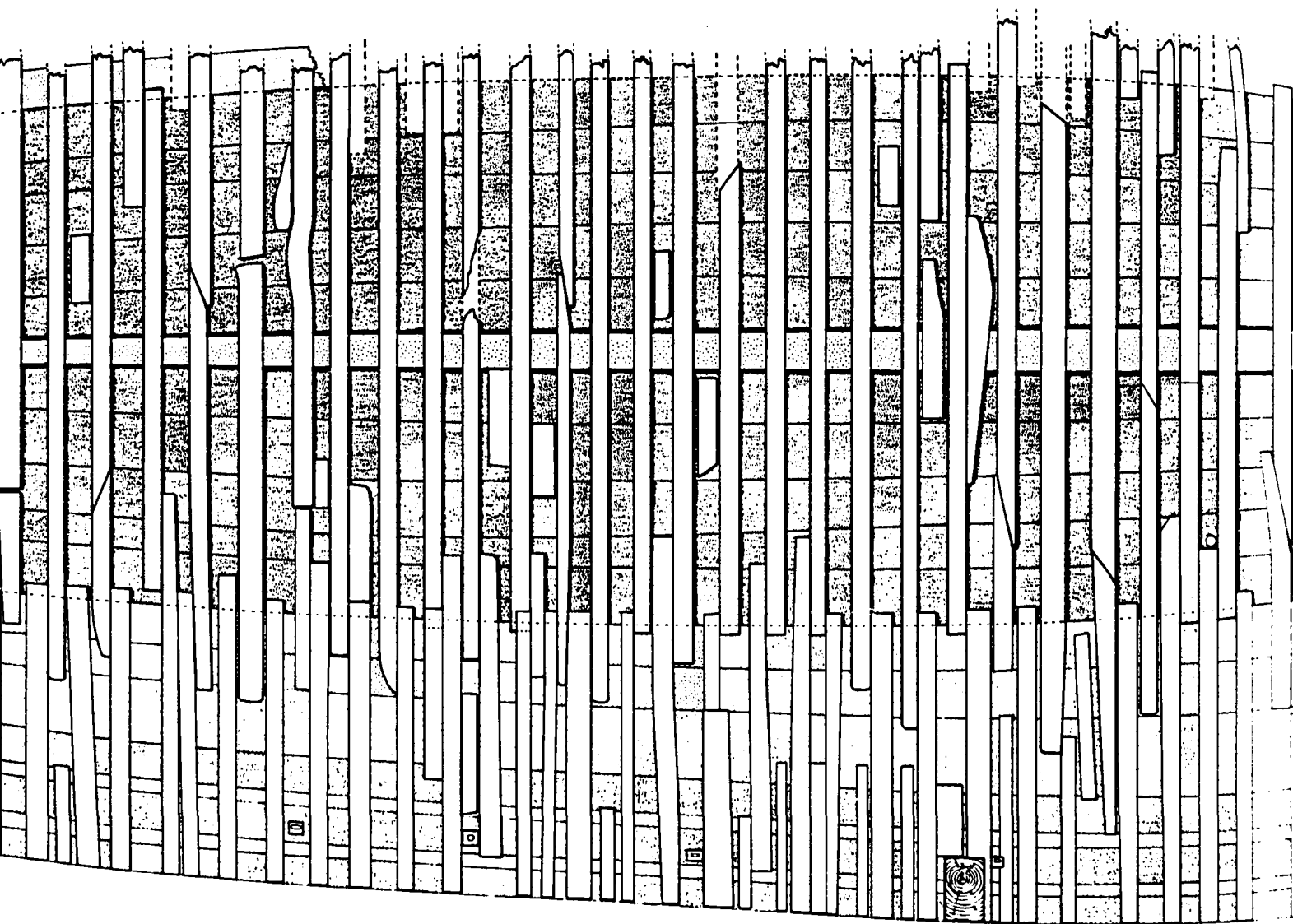
and against the stem.

Forty-nine frames provide the hull with transverse strength (Fig. 16 and Plan XII). Thirty-four of these rest on the keel, with eight crossing the stem and seven crossing the sternpost. Each frame is composed of a floor timber (*legger* or *ligger* today, although Witsen called them *zitters*) and two futtocks (*oplangers*), with a few frames reinforced by additional futtocks. In addition, there are several free bulwark stanchions/top timbers behind the wales, especially around the leeboard hangers, and a few short butt blocks and sisters in the bottom.

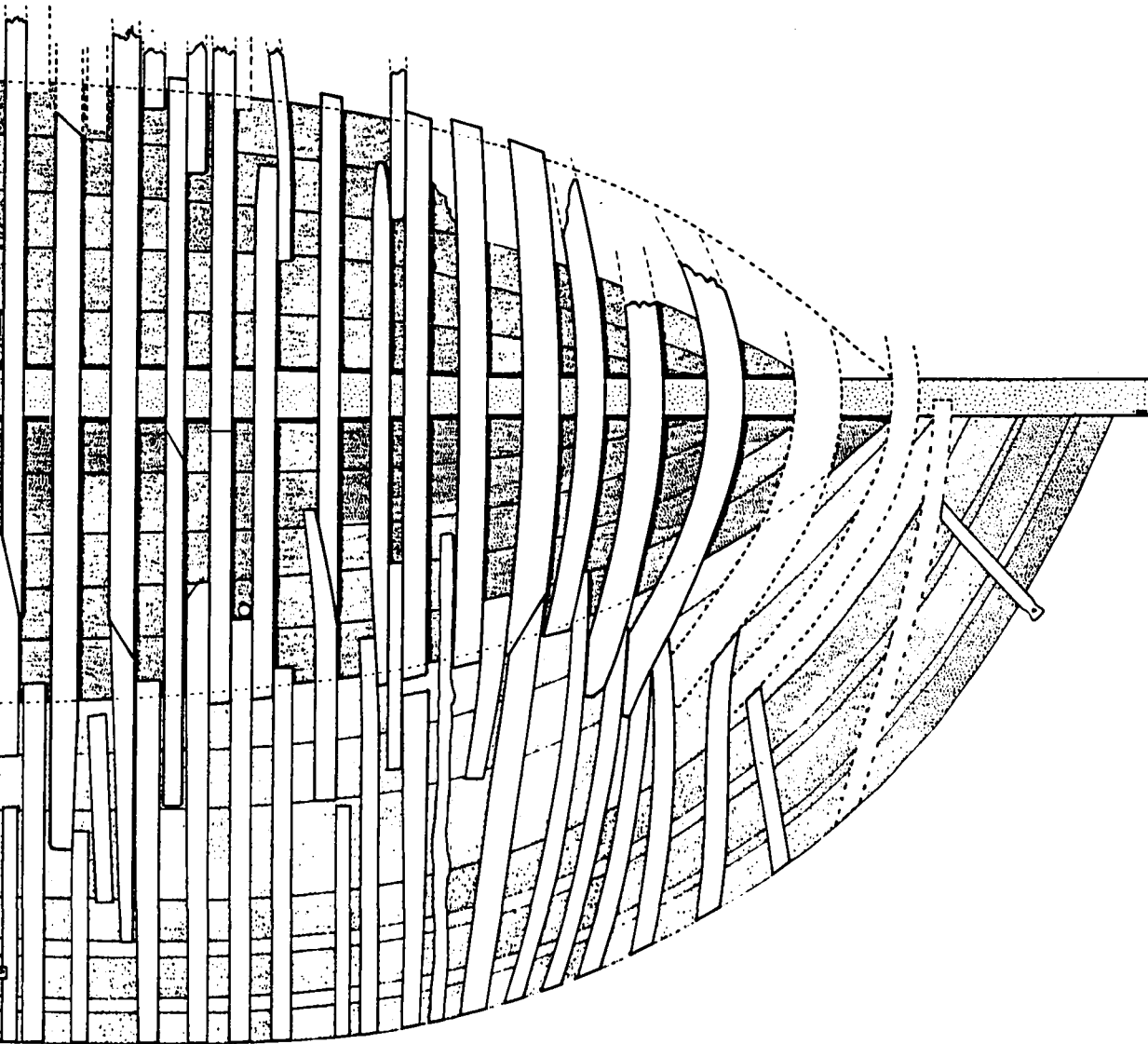
The keel floor timbers are sided 11 to 20 cm, with most between 15 and 18 cm. They are moulded 13.5 to 14.5 cm over most of the bottom, but as they are notched over the projecting upper surface of the keel, the moulded depth over the keel varies from 9 cm amidships to 37.5 cm aft; the rising bottom and twisting garboards necessitate deep, "T-shaped" floors aft. The after floor timbers are not vertical to the keel, but lean forward slightly. The futtocks are sided 10 to 20 cm, with most between 12 and 16 cm, and taper from a moulded depth of 15 cm behind strake six to 6 cm at the heads, under the caprail. The joinery between floors and futtocks is not normally visible, but there is ample evidence, both from prevalent Dutch shipbuilding traditions and observable features in B 71 that futtocks are placed before or abaft floor timbers and are not fastened to them. A few futtocks, usually in addition to the normal framing, rest on top of the ends of floors. The framing pattern is extremely irregular, but floor timbers over the



PLAN XII. Of
darkest, the wal



PLAN XII. Oost Flevoland B 71 Framing Schematic. The bottom planks are shaded darkest, the wales lightest. Not to scale.



s are shaded

keel usually have one long arm and one short arm. The short arm ends over the bottom or continues straight out to the turn of the bilge and butts against the inside of the sixth strake; the long arm incorporates a knee that rises onto the seventh and sometimes the eighth strake. There appears to have been some attempt to alternate long arms to port and starboard, as is typical with this sort of framing, but the pattern is not consistent throughout the hull.

The frames that cross the posts are of a type peculiar to Dutch shipbuilding. These timbers might seem to be similar to English and American breasthooks and transoms due to their location and orientation, but Dutch shipbuilders consider them floor timbers and use them instead of cant frames. The normal sequence of frames is simply carried up the inner faces of the posts, square to the post surface. The futtocks are canted slightly, and some floor timbers, normally those higher up, may have two pairs of futtocks.

The keel floor timbers are each fastened to the keel by two treenails 3.5 cm in diameter, square-wedged inside and out. The post floor timbers are not fastened to the stem or sternpost, except for a toenail in one of the sternpost floors. All floors are notched over the projecting interior keel. These notches are 16 to 20 cm wider than the keel and posts and form limber passages to either side of the keel. Other limber holes are cut in the keel floors over strakes 3 or 4.

In the stern, a single, heavy stanchion on either side supports the bulwarks where they leave the curve of the first wale. The heel of this stanchion is visible from outboard (see Plan IX), as it is notched over and fastened to the exterior surface of the lower wale.

The keelson was originally a single timber 12.00 m long, sided 70 cm and moulded 12 cm amidships, tapering to 26 cm sided and 6 cm moulded aft and 58 cm sided and 10 cm moulded forward. It lies directly on top of all the keel floors and is fastened at each frame with three or four treenails. The central one or two treenails, 3.5 cm in diameter, pass through keelson, floor, and keel and are wedged inside and out. The two outboard treenails, 3.0 cm in diameter, are driven through keelson, floor, and garboards and wedged. A maststep mortise 50 cm long, 25 to 26 cm wide, and 7 cm deep is cut directly into the keelson just forward of amidships. The maststep is supported from below by two short blocks between the normal frames and reinforced laterally by a pair of quarter-round bolsters 1.56 m long, sided 16 to 17 cm, and moulded the same as the keelson. These are treenailed in place. Both ends of the keelson are now damaged, and a large chunk of the upper surface was replaced during the working life of the vessel simply by cutting down the keelson in an offending area aft. The after end of the keelson may originally have run onto the lowest sternpost floor, but this portion appears to have been removed to provide a pump sump aft of the last keel floor when the after pump was fitted (see below). These alterations to the keelson weakened it considerably and no doubt contributed to the noticeable hogging aft.

The interior of the hull is completely ceiled with 5 cm-thick boards. Dutch ship terminology distinguishes between the ceiling over the bottom of the hull (*buikkenning*) and that over the sides (*wegering*), but there does not appear to be

any functional difference between the two. Both are fastened to the hull by treenails (the same treenails that fasten the exterior planking, in most cases) and are of the same thickness. The planks of the *buikdenning* are wider and end in butts (if not single lengths), rather than the flat scarfs of the *wegering*. The *buikdenning* seems to have consisted originally of two extremely wide (at least up to 85 cm, possibly as wide as 90 cm) strakes on each side of the keelson, possibly with removable limber boards between. These planks have been so extensively repaired that the exact original configuration is difficult to determine. Some of the repairs were made with pine boards only lightly nailed in place.

The *wegering* is in much better condition, as it suffered less abuse during the working life of the vessel. There are two strakes on each side. The lower strake meets the outboard *buikdenning* edge at a steep angle and is separated from the upper strake by an air strake. Another air strake separates the upper *weger* from the clamp (see below). Each air strake consists of a series of short, removable sections wedged in place.

The clamp (*balkweger*) is only slightly thicker than the ceiling (6 to 6.5 cm rather than 5), but very wide (up to 69 cm). It is made of three sections joined by simple flat scarfs and is fastened to the frames by treenails passing through the frames and exterior planking. The upper edge is notched to receive the ends of deck beams forward and aft and fits flush against the underside of the gangway. The after end continues all the way to the sternpost; the forward end is missing.

Six iron eyebolts protrude from the clamp in the hold. These probably served to secure cargo.

The large, central hatchway is flanked by heavy gangways (*gangboorden*) that extend past the rider beams at either end of the hatch. These gangways, 10.10 m long, 10 to 12 cm thick and 30 to 60 cm wide, are through-fastened to the frames and middle wale by treenails 3.0 cm in diameter and also by a forelock bolt in the waist of the vessel. The inboard edge is bevelled to fit the inward-sloping coaming (*denneboom*) in the way of the hatch, but the edges beyond the hatch are finished square. The upper surface is gradually cut down toward the outboard edge so that a raised lip 2 cm high and 5 cm wide is left standing beneath the lower edge of the bulwark planking. Beneath the rider beams at the ends of the hatch the gangway retains its full thickness. At its ends, the gangway is shaped to fit the adjoining deck timbers. The inboard ends of five wooden scuppers are let into the upper surface of each gangway. Three of these are in the waist, with one at the after edge of the foredeck and one at the forward edge of the afterdeck.

The hatchway is further strengthened transversely by three heavy beams: the *zeilbalk* at the forward end, the *lierbalk* at the after end, and the *ruimbalk* about 2 m forward of the *lierbalk*. A fourth beam, the afterbeam (*hekbalk*), is found at the after end of the afterdeck.

The beams at the ends of the hatch are actually double beams, consisting

of a heavy deck beam with a massive rider beam above. In each case, the lower beam is sided less than the rider (17 cm at the *lierbalk*, 20 cm at the *zeilbalk*) and moulded 28.5 cm, with the gangways and adjoining deck timbers let into its upper surface. The ends of the lower beam are cut down into tenons that rest in deep notches in the clamp. The rider beam for each is much heavier, sided and moulded 30 cm outboard of the coaming (*denneboom*), and treenailed to the lower beam. The very ends of the rider beams sweep upward slightly to match the height of the bulwarks, so the maximum moulded depth is 37 cm, but extra depth and sweep are made up by a small, separate piece.

The forward double beam supports the mast partner as well as the deck, and carries the stanchion for the hatch ridgepole in a mortise on the centerline. Between this mortise and the coaming, the forward two-thirds of the upper surface are cut down 2 cm or so to form a seat for the lower edge of the bulkhead that forms the forward end of the hatch cover. The after faces of lower and rider beams, which are set flush, are mortised to take the forward end of the wedge-sectioned coaming. The upper edge of the coaming continues over the top of the rider beam. The kingplanks, transverse waterways, and mast partner block are all let into the upper surface of the lower beam and clamped in place by the rider. The beam is attached to the hull and reinforced by hanging knees notched over the after face of the lower beam, lodging knees against the forward face of the lower beam, and a small lodging knee between the upper beam and the coaming. The inboard end of this knee is hooked over the upper end of the hanging knee.

All knees are fastened to the beams by treenails and nails, to the rest of the hull by treenails.

The after double beam carries a windlass (*lier*) in a pair of heavy bitts, and is thus called the "windlass beam" (*lierbalk*). It is essentially similar in configuration to the *zeilbalk*, with cuttings for the gangways, coamings, and transverse waterway in the lower beam. The upper surface of the rider beam is also cut down over its after two-thirds between the windlass and the coamings for the bulkhead that closes off the after end of the hanging cabin. The lower ends of the aftermost cabin roof rafters sit in shallow sockets in the rider beam. The windlass bitts are let into the upper surface of the rider beam and extend down the forward face of the composite beam to near the lower edge. A rabbet 2 cm high and deep is cut into the lower, forward edge of the lower beam. Shallow mortises cut into the lower surface of the beam behind the rabbet are directly above similar mortises in the bottom ceiling. The mortises probably carried stanchions that supported the light bulkhead originally nailed to the beam rabbet. Other mortises took the after ends of two light carlings that carried the loose sole of the hanging passenger cabin. The beam is fastened to the hull by hanging knees notched over the forward face of the lower beam.

The middle beam (*ruimbalk*) is a single timber, sided 19 cm and moulded 24 cm at the centerline. The gangways and coaming are let into the upper surface of the strongly crowned beam, and the join between beam and coaming is strengthened by a long, low chock fastened to the upper surface of the beam and

the inboard surface of the coaming on either side. The light, forward bulkhead of the hanging cabin was originally nailed into a rabbet in the forward, upper edge of the beam, while the forward ends of the cabin sole carlings were suspended from the after face of the beam by iron strap hangers. A light rabbet is cut into the lower forward edge, a deep rabbet 1.27 m long was cut into the lower after edge at the center, and a pair of opposed pintle-and-gudgeon style hinges were attached to the after face of the beam just outboard of this rabbet. The purpose of the rabbets and hinges remains unclear, but the deep rabbet and hinges could be the remains of a swinging door allowing access to the hold. There may also have been a light hold bulkhead at this beam. A plank crutch for the after end of the hatch cover ridgepole is nailed to the forward face of the beam. The ends of the beam rest in notches in the clamp and are attached to the hull by hanging knees notched over the forward face and lodging knees on the after face.

The afterbeam (*hekbalk*) is a square timber sided and moulded 30 cm. It is notched over the forward face of the head of the sternpost and fastened to it by an iron forelock bolt that also serves as the uppermost rudder gudgeon. The lower, forward edge is bevelled to take the after ends of the deck planks, which are nailed to the underside of the beam. The middle wales are treenailed to the ends of the beam; small braces nailed to the after face of the beam also connect the beam to the wales. The upper surface of the beam is slightly cut down in the way of the tiller. The bulwarks are attached to the beam by thin standing knees notched over the forward face of the beam and nailed and treenailed to beam and

wales. Two small notches, 7 cm long and 3 cm deep, in the upper, after edge may have housed the lower ends of stanchions or braces to support a *hakboord*, a decorative plaque between and above the bulwarks.

The foredeck, 5.20 m long from the forward face of the *zeilbalk* to the inboard face of the stem, covers the fo’c’sle and the forward part of the hold (Plan X). A centerline hatch 1.12 m square, just forward of the mast, provides access to the forward end of the hold. A second centerline hatch 74 cm square reaches the fo’c’sle. Each hatch is surrounded by simple, L-sectioned coamings with mitered corners nailed to the deck. The side coamings of each are notched for the cleats of hatch covers. Just abaft the stem, the vent for the fo’c’sle hearth pierces the deck. The vent is partially obscured by the anchor windlass, set in the heavy pinrails fastened to the forward bulwarks. Between the hold hatch and the mast, a wooden horse for the forestaysail sheet is set in pyramidal bulwark rests. Two bilge pumps are set in the after, outboard corners of the deck, surrounded by broad, circular bolsters.

The deck structure is based on both transverse and longitudinal members. Three beams (not including the *zeilbalk*) provide the major transverse support. The forwardmost is sided 12 cm and moulded 18 cm; the others are sided 15 and 17 cm and moulded 24 cm. Their cut-down ends rest in notches in the clamp. The forwardmost is braced by lodging knees against its after face; the others have hanging knees aft. In addition to the beams, a series of lateral and central ledges

reinforce the deck and frame deck openings. These secondary members average 7.5 cm square. Their ends are half-lapped under and nailed to the underside of the primary longitudinal members. The longitudinal timbers consist of two heavy king planks, 8.5 cm thick, which pass to either side of the hold hatch, and margin planks 7.5 cm thick. The king planks rest in notches in the lower *zeilbalk* and are notched into the upper surfaces of the beams and clamps forward. The king planks carry the mast partner, a solid block of oak 1.50 m wide, 40 cm long, and 6.5 cm thick, let into their upper surfaces. The space between the heavy planks is filled by irregular deck planks 5 cm thick. The after ends of the deck planks rest in a rabbet cut in the forward edge of transverse waterways clamped between the lower and rider beams of the *zeilbalk*.

The afterdeck is a simpler affair than the foredeck, 2.68 m long with no real longitudinal structural members. A single hatch, 74 cm square, gives access to a small compartment below. L-sectioned coamings with mitered corners are nailed directly to the deck to keep water out of the hatch. A single, centerline pump passes through a partner block between the hatch and the *lierbalk*. A wooden horse for the main sheet is bolted to depressions in the top of bulwark pinrails.

Three beams, sided 12 cm and moulded 18 cm, carry the irregular, 5-cm-thick planking. A transverse waterway 12.5 cm thick is clamped between the lower and rider beams of the *lierbalk* and is rabbeted to receive the forward ends of the deck planks. The waterway is connected to the first beam by two short carlings.

Originally, a third, centerline carling was also present, but was removed in order to install the after pump.

The bulwarks are completely planked on the interior with 5 cm oak, except at the very after end. The bulwark planking stops where the upper wales leave the hull to form the pink stern. A caprail 5 cm thick and 18 cm wide runs the full length of the vessel. At the stem, the inboard portion of the rails is replaced by the ends of a small breasthook, 90 cm long, sided 10 cm and moulded up to 28.5 cm at the throat. This is treenailed to the inboard surface of the upper wale. Small bitts, carved from the projecting upper ends of top timbers, pierce the rails at the outboard ends of the breasthook. At the stern, the main rail stops at the end of the bulwark planking, where there is a step in the upper edge of the wale. A short length of rail starts on top of the main rail and runs to the end of the vessel.

Heavy pinrails are through-treenailed to the bulwarks fore and aft. The forward pinrails, 3.32 m long, up to 16 cm thick and 26 cm wide, have carved bearings for the anchor windlass. Cap timbers make up the upper half of the windlass bearings, with a removable chock behind the ends of the windlass. The forward pinrails also carry small bits and holes, possibly for belaying pins. The after pinrails are also treenailed to the interior face of the bulwarks, but their forward ends are spiked into notches cut in the upswept ends of the *lierbalk*. Each after pinrail, 3.24 m long, 10 cm thick, and up to 21 cm wide, carries a large bollard

with belaying pin (possibly for trimming and belaying the leeboard tackle), a smaller bitt, and other holes with rope wear marks, as well as the end of the main sheet horse.

The main hatch, 7.90 m long, 3.54 m wide at the forward end, and 2.44 m wide aft, covers most of the hold. It is protected by high, wedge-sectioned coamings (*dennebomen*) and an arched cover of removable, clinker panels. Either coaming is a single timber, 8.02 m long, 46 to 60 cm wide, and 11 cm thick at its upper edge. Its lower edge is heavily nailed to the inboard edge of the gangway, and the ends are housed in mortises in the *zeilbalk* and *lierbalk*. The coamings and gangways are supported by five heavy hanging knees on each side. Each knee reaches the turn of the bilge at its lower end, runs up the underside of the gangway and inboard surface of the coaming, and is fastened in place by treenails through the hull and gangway and nails into the coaming. The upper edge of the coaming is rounded, with a rabbet cut into the outboard face just below the upper edge. Wide, shallow mortises are cut at regular intervals into the rabbet. Originally, the hatchway forward of the *ruimbalk* was covered by seven removable panels on each side of a central ridgepole. Each panel, 65 to 86 cm wide, was constructed of a dozen or so clinker-fastened planks nailed to three cleats. The upper ends of the cleats rested on the ridgepole, while the lower ends sat in mortises in the upper edge of the *denneboom*. At the seams between panels, rafters acted as gutters to carry rain and spray down to drain holes in the coaming.

The hatch covers could be lashed to iron staples just above the drain exits in the outboard surface of the coaming. Since the hatchway widens forward, the panels are not interchangeable. Consequently, hatches and their proper locations are numbered I to VII, from the stern forward, with numbers scribed into the inboard face of the coaming.

Between the *lierbalk* and *ruimbalk*, the hatch is covered by a permanent clinker roof nailed to fixed rafters (the house carpenter's terminology is consistent with the Dutch terms for these components - the cover itself is called a *roeffje*, "little roof"). The roof, with a central ridgepole, covered a low passenger cabin suspended above the after part of the hold. Access was through a small companionway in the starboard side of the roof. The after ends of the roof planks were quite vulnerable to wear and damage from the lines leading to the windlass built into the after bulkhead of the cabin; to protect these ends, a smooth guard was nailed over them.

The forward bulkhead of the cabin was nailed into rabbets in the after edges of the ridgepole crutch and forward edge of the *ruimbalk*. The after bulkhead was largely formed by the windlass. A thin pine panel, with two pentagonal lights cut through it, is nailed to the forward faces of the windlass bitts. To either side of the windlass, small triangular spaces between the bitts, *lierbalk*, and aftermost rafters are lightly panelled. The sole of the cabin was made of fixed boards on the sides and a removable panel between the two longitudinal sole

beams.

A small living space for the vessel's crew was located in the forepeak. A vertically-planked bulkhead at the after face of the second foredeck beam separates the fo'c'sle from the hold. The forepeak could be reached from the deck via a hatch, or from the hold through a door in the bulkhead. Inside the forepeak, partially enclosed berths on either side flanked a central tiled hearth with smoke hood and chimney. The hearth was set in a sole raised 65 cm above the bottom ceiling, giving maximum headroom of only 1.65 m beneath the deck planking.

The sole is built on a simple framework of a single transverse beam at the after edge of the sole (this beam also supports the fo'c'sle bulkhead) and a pair of longitudinal beams 66 cm apart. Midway along their length, the longitudinal beams are separated by a short stud of similar dimension to the beams. The area between the beams and forward of the stud has a bottom nailed to the underside of the beams and stud. The box thus formed contains the ceramic elements of the hearth - a layer of bricks covered with a layer of glazed terra cotta tile. The vertical firewall was made up of twenty polychrome, tin-glazed earthenware tiles, each 13.5 cm square. The exact manner in which these tiles were supported is unknown. Smoke was guided out the deck vent by a wooden hood, but this structure did not survive and its nature remains conjectural.

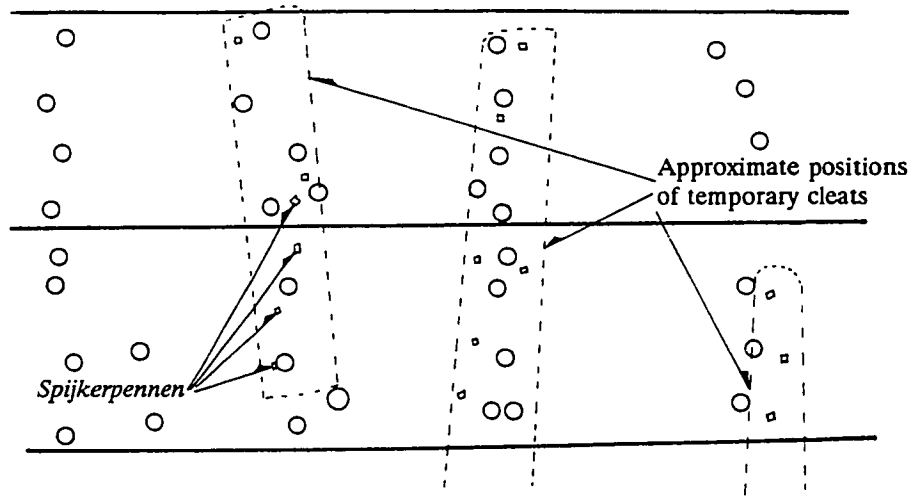


Figure 17. Oost Flevoland B 71 *spijkerpennen* detail, strakes 2 and 3.

Construction

After the erection of the keel and posts, the bottom and bilge planking was laid up and temporarily stabilized by clamps, shores, and cleats nailed across the seams. Once the hull reached the outboard edge of the bottom, one or a few floors were lightly fastened in place and strakes 6 and 7 laid up with the help of cleats. At this point, the rest of the floors and futtocks could be inserted. Cleats and clamps in the way of the frames were removed and the nail holes filled with *spijkerpennen*. These pegs can still be seen in lines across the seams (Fig. 17); they show that cleats typically spanned only two planks and were fastened to each plank by two to four nails. Cleats were also used at the hood ends (thus the *spijkerpennen* on the posts). Unfortunately for the archaeologist, the cleat pattern is often obscured by repairs, not only because they remove evidence of the original

construction, but because cleats (which left *spijkerpennen* behind) were also used to hold larger repairs in place during fastening.

After all of the floors were inserted, the keelson and bottom ceiling were laid down and through-fastened to floors and planking. A test of ceiling and exterior planking treenails⁶¹ shows that most exterior planking treenails are also ceiling fasteners. Whether the builders followed Witsen's sequence and attached the sheerstrake (the upper wale) next is impossible to say, as much of the wale has been replaced.

With the futtocks in place, and possibly one wale, the remainder of the planking, wales, ceiling, and clamps could then be fastened directly to the standing frames without cleats, and there are, in fact, no *spijkerpennen* above the bilge strake, except at the hood ends. After planking was complete, but before the ceiling and clamps had been installed, the floors over the posts were cut to fit the planking and fastened in place.

Once the hull was complete, the deck and hatch structure could be added. The construction of these features is straightforward, and could be accomplished quite rapidly after the primary hull structure was in place. The most important timbers are the gangways, which add considerable longitudinal strength and stiffness to the hull where it would otherwise be rather weak, due to the large

⁶¹ Bob Neyland and I went over all of the accessible areas of the bottom, tapping lightly on treenails with a mallet. One person taps from above or below, while the other feels treenail ends for vibration, indicating continuity. The method seems rather violent, but with dried, sound oak and a light touch, no damage is done. The alternative is destructive sampling - sectioning, coring, etc.

hatch opening.

Repairs

The exterior planking and ceiling have both been extensively repaired, to the extent that the original planking arrangement can be difficult to determine (Plan XI). Repairs range from extra nails to tighten up loose seams to the replacement of substantial lengths of planking. Small or limited defects in grain or surface were easily corrected by removing the offending area and replacing it with a graving piece (or "dutchman" in American terminology). In several locations, where extreme bending of the planks had caused short grain in the plainsawn timber to lift, tar was forced under the lifted grain and the projecting ends fastened back down with numerous iron tacks.

Where sections of plank were simply replaced, there was still an obvious attempt to preserve as much of the original plank as possible. Most of these repairs are along the seams, where rot is most common. In one 2.5 m long area of the starboard bilge strake, where it bends sharply in toward the stem, thirteen different repairs have replaced parts of the strake, but a narrow bit of the original plank, no more than 6 cm wide, survives to connect the full widths forward and abaft the repaired area. Where the wales were damaged, new sections were let in with long, nibbed scarfs. Perhaps significantly, several wales were repaired in this way on the quarters, at approximately the same position as a similar repair in the keelson. The consequent loss of longitudinal integrity probably contributed to the abrupt hogging aft.

In the cold, brackish to salty waters of the Zuiderzee, both rot and teredo are inhibited. The extensive repairs thus suggest a long working life for B 71, as does the wear at the ends of the keel. The primitive mounting arrangement for the leeboards also indicate a construction date earlier than the 1620s. It is quite likely that B 71 was actually built at the end of the previous century, and not inconceivable that the vessel was as much as 40 years old at the time it sank.

The B 71 is a member of the broad class of inland vessels called *karveels* in contemporary documents. These are distinguished primarily by their carvel planking (thus the name), but also seem to have been full-bodied hulls with relatively flat bottoms. *Karveels* are attested from the late fifteenth century to the seventeenth on both the Zuiderzee and the *binnenweg*. Maritime art of the period shows medium-sized vessels identical in configuration to B 71 and identifies them in a variety of ways.⁶² Such vessels are often functionally identified as *veerschepen*, ferries. The hull type, if more specific than *karveel*, is either *wijdschip* (wide ship) or *smalschip* (narrow ship). Witsen illustrates and describes a *wijdschip* and notes the diagnostic criteria.⁶³ Essentially, a *wijdschip* is a *karveel* too broad to pass through the Donkere Sluis in Gouda i.e. broader than 16 feet 6 inches Amsterdam measure (4.68 m). Typical dimensions for a *wijdschip* of Witsen's day

⁶² De Groot and Vorstman, *Sailing Ships*, nos. 14, 15, 18 (in which the boats are identified as "*Karviel-Schepen*"), 37, 49, 53 ("*Veerschip*"), 64, 80 ("*smalschip*").

⁶³ Witsen, *Architectura Navalis*, p. 189, and illustration of a "*wijt of over-zees Veer-schip*" following p. 178.

were 70 (Amsterdam)⁶⁴ feet long and 20 feet in beam.⁶⁵ The B 71 is of earlier date but similar proportions, at 63 feet long with a beam of 19 feet. As Witsen's illustration shows, deck layout is virtually identical, down to the relationship of hatches and the presence of sheet horses fore and aft. Witsen's depiction differs in the underbody - there is no indication of the garboard which turns to the vertical and continues aft over the skeg, as is seen in B 71. The construction is not unique to B 71: a disassociated sternpost in the Ketelhaven Museum shows similar features.⁶⁶

The *karveel* is the ancestor of a number of later Dutch inland vessels, including the *tjalk*, which replaced the *karveel* as the dominant Zuiderzee cargo carrier of the eighteenth and nineteenth centuries.⁶⁷ *Wijdschepen* like B 71 are the direct ancestors of the *hektjalk*, a longer, narrower vessel that eliminated the peculiar garboard construction but kept most other features, including the *hekbalk*, pink stern, and arched hatch covers. The direct predecessor of the *karveel* itself is less clear, but the similarities in shape, construction, and configuration between the Almere cog and B 71 cannot be ignored. Significant differences in stern and sternpost shapes and framing systems argue against a direct conversion from one to the other, but the intervening two centuries provide ample room for develop-

⁶⁴ 1 Amsterdam foot = 0.2831 m.

⁶⁵ Witsen, *Architectura Navalis*, p. 189.

⁶⁶ The provenience of this timber is uncertain, other than it comes from the reclaimed land.

⁶⁷ E.W. Petrejus, *Oude Zeilschepen en hun Modellen: Binnenschepen, Jachten en Visserschepen*, p. 17. *Tjalks* are mentioned in the second edition of Witsen, *Architectura Navalis* (1690), p. 189, but not in the first (1671).

ment. A possible link is provided by IJsselmeerpolders find GZ 13, a mid-sixteenth-century wreck surveyed but not fully excavated by the Museum voor Scheepsarcheologie. Trenches at bow, stern, and amidships revealed a carvel bottom with clinker sides and hatch construction identical to that of both the Almere cog and B 71.⁶⁸ It is hoped that future excavation of this vessel will provide a better understanding of the transition from cog to carvel construction.

⁶⁸ H.R. Reinders, pers. comm.

CHAPTER VI

EPILOGUE: THE NEW WORLD

The Transfer of Culture

When European colonists moved out to the New World, they did their best to take their culture with them. Architecture, dress, material possessions; all reflected the places from which people had come. Even where primitive living conditions or limited resources discouraged the maintenance of old cultural traditions, efforts were made to adapt available materials to traditional forms. In some cases, this meant the importation of architectural raw materials from the mother country. Social structure and other intangible aspects of culture proved more difficult to maintain. A full cross-section of society was not imported to the colonies, as there was no immediate need for ruling elites to be represented in strength. In those English colonies established as business ventures or as refuges for religious groups, there was even less need for an aristocratic presence. In the absence of traditional rulers, the growth of a democratic spirit is hardly surprising. At the bottom of the social hierarchy, the introduction of African slaves to the New World not only altered the organization of labor and economic hierarchy, but sowed the seeds for social conflict that flared into war in the nineteenth century and continues to haunt us today.

As the colonies were concentrated on the Atlantic coast of North America and only accessible by sea from the mother country, settlers quite logically brought

shipbuilding skills with them. The indigenous population, who relied largely on bark boats and dugouts for inland transport, had little to offer in the way of seagoing ships. The first vessel built in the English New World was a pinnacle of 30 tons, *Virginia*, built in 1607 in what is now Maine and used by discouraged colonists to escape the inhospitable conditions of the Maine coast. Other early vessels built in the New World were the products of shipwrecked crews in need of a way onward or home. In 1609-10, the crew and passengers of the ship *Sea Venture*, wrecked on the east end of Bermuda by a storm, built two vessels, *Deliverance* and *Patience*, from the salvaged remains of their ship and native cedar and completed their passage to Jamestown.¹ The first vessels built in large numbers in the New World were probably small craft and coasters,² but by the mid-eighteenth century, American yards were producing seagoing ships of substantial size and had begun to develop their own vessel types.³ The best

¹ J.R. Steffy, "The Thirteen Colonies: English Settlers and Seafarers," in *Ships and Shipwrecks of the Americas: A History Based on Underwater Archaeology*, ed. G.F. Bass, pp. 111-115. The remains of *Sea Venture* have been investigated by divers since their discovery by Edmund Downing in 1959. Since 1981, the site has been excavated under the archaeological direction of Jon Adams by the *Sea Venture* Trust. See A.J. Wingood, "Sea Venture. An Interim Report on an Early 17th Century Shipwreck Lost in 1609," *IJNA* 11 (1982): 333-347 and J Adams, "Sea Venture: A Second Interim Report - Part 1," *IJNA* 14 (1985): 275-299.

² The work of the naval architect/historian W.A. Baker has shed much light on small and coasting craft of the seventeenth century; e.g. W.A. Baker, *The Mayflower and Other Colonial Vessels*.

³ H.I. Chapelle, *The History of American Sailing Ships*, pp. 4-43. J.A. Goldenberg, *Shipbuilding in Colonial America*, remains the most comprehensive study of early American shipbuilding, especially from an economic or social point of view.

known of these are the sharp schooners that found use as pilot and messenger boats, as well as smugglers.⁴

The techniques employed by colonial shipwrights were those they had brought over from Europe, although the abundance of easily-accessible timber eventually led to a less conservative use of materials.⁵ Small craft were often built in traditional ways as well, as the small, late seventeenth- or early eighteenth-century clinker boat from Lyon's Creek, Maryland shows.⁶ A small carvel vessel of similar date, excavated at Hart's Cove on the Piscataqua River, in Maine, is built in fairly typical northern European fashion, with single-sawn frames on a conventional keel.⁷

The New World also saw the infusion of new technology and the mixing of older European traditions. Builders of small craft did not limit themselves to European techniques, but appropriated many aspects of Native American boatbuilding, especially on the frontier. Traders and trappers on the rivers of the Old Northwest depended on bark canoes, but enlarged them to impressive cargo

⁴ These schooners, mostly built on and around Chesapeake Bay, were known for their speed and weatherliness, although not their durability; H.I. Chapelle, *The Baltimore Clipper: Its Origin and Development* and *The Search for Speed under Sail 1700-1855*, pp. 142-145.

⁵ English shipwrights were forced to make composites of many small pieces due to the limited supply of good shipbuilding timber. American builders tended to use large barks and long lengths, limited only by the mechanical requirements for handling and moving such massive timbers.

⁶ The badly damaged remains of this little boat were sent by the excavator, Ralph Eshelman, to Texas A&M for study. They were recorded by Nautical Archaeology Program graduate students as part of a class in ship research and reconstruction techniques in the spring of 1988. Subsequently, the hull has the subject of R.S. Neyland, "The Lyons Creek Boat Remains" (M.A. thesis, Texas A&M University, 1990).

⁷ W. Riess, pers. comm.

carriers. Dugout and log-based construction remained in use in New England well into the nineteenth century,⁸ and in the southern colonies and the states that succeeded them until the twentieth century.⁹ Several prominent boat types on Chesapeake Bay, such as bugeyes and, oddly enough, log canoes, which look like conventional plank-built boats, are actually based on three to nine logs bolted together and hollowed out. Later bugeyes were built on frames and were called "frame bugeyes."¹⁰

North American Bottom-Based Watercraft

Along with the better-known clinker and carvel traditions of boatbuilding, bottom-based methods were also carried to the New World. These typically flat-bottomed boats and barges were particularly suited to the coasts and rivers, which formed the principal highways of early settlements. Almost all of the North American bottom-based boats I have been able to identify are characterized by flat, keelless bottoms assembled as panels and then cut to shape. Posts and floors are fastened to the upper surface of the bottom, as are the lower arms of L-

⁸ The New Haven sharpie, a type of long, narrow oystering boat, may be derived from a dugout prototype; H.I. Chapelle, "The Migrations of an American Boat Type," in *Contributions from the Museum of History and Technology*, p. 136. Two Fair Haven oyster-tonging dugouts are in the collection of Mystic Seaport Museum; M. Bray, *Mystic Seaport Museum Watercraft*, p. 202. The sharpie is one of the "side-built" vessels referred to in the Introduction: the bottom is a series of transverse planks nailed to the lower edges of the sides, which are constructed first. An intermediate stage in the development of this type is represented by dugouts cut completely through and cross-planked on the bottom; H.I. Chapelle, *American Small Sailing Craft: Their Design, Development, and Construction*, p. 104.

⁹ R. Fleetwood, *Tidecraft: An Introductory Look at the Boats of Lower South Carolina, Georgia, and Northeastern Florida: 1650-1950*, pp. 178-182.

¹⁰ M.V. Brewington, *Chesapeake Bay Log Canoes and Bugeyes*.

shaped futtocks. Side planking, frequently thinner than the bottom planking, meets the bottom at a hard chine. Common terminology calls the first side plank the garboard, and the bevel on the outer edge of the bottom the rabbet. These vessels are bottom-based in the purest sense; the bottom is not only the basis of design and the first part constructed, but also structurally distinct, with heavier planking and massive floors.

Examples of this style of construction are best known in New England, probably due to more extensive study of the watercraft of this region, but not confined to the Northeast. Larger vessels built in this manner are often called gundalows, such as the Piscataqua River gundalows of the nineteenth and early twentieth centuries.¹¹ During the War of Independence, gundalows were rapidly built for use as gunboats by both sides on Lake Champlain.¹²

One such vessel, the gunboat *Philadelphia*, part of Benedict Arnold's fleet, was sunk in the Battle of Valcour Island in 1776 and raised in the 1930s. Examination of this vessel has shown that it was heavily built (probably to support the weight of three heavy guns) but mixed traditional bottom-based methods with joinery more appropriate to house carpentry.¹³ Notable details include the free-

¹¹ H.I. Chappelle, *The National Watercraft Collection*, pp. 55, 103-104. The bottoms and sides of these vessels were built of hewn logs, edge-bolted together. A working reconstruction now takes tourists up and down the river from a base in Portsmouth, New Hampshire.

¹² H.I. Chappelle, *The History of the American Sailing Navy*, pp. 105-111.

¹³ *Ibid.*, pp. 107-111. A full set of detailed reconstruction plans were produced by Howard Hoffman and are available from the Armed Forces Division of the National Museum of American History, Smithsonian Institution, which houses the vessel. I thank Philip Lundeberg, former curator of Naval History, for permission to examine the vessel in 1984. A replica was built in Basin Harbor, Vermont between 1988 and 1991 by the Lake Champlain Maritime Museum.

standing futtocks, which are L-shaped knees fastened to the bottom between the floor timbers but set square to the curve of the side, like cant frames, rather than perpendicular to the centerline, and the flat sides. The floors are massive barks set close together, as are some of the beams beneath the gundeck forward. There is no keel, only a flat bottom of wide, thick planks. The wreck of a sailing canal boat near Burlington, Vermont hints that this type of construction continued in use on Lake Champlain until late in the nineteenth century.¹⁴ In many ways, these vessels resemble traditional English flat-bottomed craft, such as the barges of the Thames and Medway.¹⁵

This construction method did not die out in large vessels until the twentieth century. Goelettes, motor-driven cargo vessels of the St. Lawrence, were built this way until the last, *Jean Richard*, was launched in the 1950s. The sternpost had to be modified to accommodate the shaft log and an overhanging counter, so the vessel looks like a conventional carvel ship above the water, but construction is based on a flat bottom assembled as a panel on temporary trestling.¹⁶

Conceptually similar construction is used in a large class of small craft, called dories. These have a transversely flat, longitudinally rockered bottom held together by cross cleats and floors, with clinker sides and a narrow, triangular

¹⁴ J. Cozzi, pers. comm. The North Beach wreck appears to have a flat bottom, freestanding L-shaped futtocks at the ends, and edge-fastened "scow" sides.

¹⁵ E.J. March, *Spritsail Barges of the Thames and Medway*.

¹⁶ B. Greenhill, *Archaeology of the Boat: A New Introductory Study*, p. 278.

transom sometimes called a "tombstone".¹⁷ The simplest forms, seen in the Grand Banks fishing dory and the bateaux of the St. Lawrence basin, have flared, flat sides whose lower edges are simply nailed to the outboard edge of the bottom.¹⁸ More refined variants, such as the Swampscot dory, have a narrow bottom, often made of a single plank, to which more rounded clinker sides are fastened. Such craft mirror the medieval trend away from strictly flat-bottomed, "pure" bottom-based vessels to types incorporating other technologies. Partly this is the result of growing technical skill, but also a conscious desire to avoid some of the more significant disadvantages of flat-bottomed, hard-chined craft.

Almost all of the bottom-based vessels in North America are descended from English, French, or Native traditions. I can find no evidence of the transportation of Dutch carvel construction to the New World. This is hardly surprising, as Dutch colonization of North America was limited and short-lived, but a careful survey of the Hudson River, the center of seventeenth-century New Holland, might reveal the remains of Dutch-style inland craft that must have been built and used there. If a fledgling shipbuilding industry did get established, it does

¹⁷ The best general study is J. Gardner, *The Dory Book*. Although he concentrates on how to build different variants of the basic type, Gardner also reflects on the European ancestors of the type. E. Rieth, "Le doris côtier de Saint-Pierre et Miquelon: mode de conception et procédés de construction," in *Actes du colloque international sur les traditions maritimes au Québec (Québec, 10-12 October 1984)*, pp. 386-409 and "Essai d'analyse d'une parenté technologique: Warys et doris de pêche côtière de Saint-Pierre et Miquelon," in *Local Boats*, ed. O.L. Filgueiras, pp. 119-140, examine a particular group of dory variants, the large powered vessels of the French islands off Canada and their eighteenth- and nineteenth-century antecedents.

¹⁸ Examples of the bateau have been excavated in Quebec, Lake George, and Alexandria (Virginia); K.J. Crisman, "Struggle for a Continent: Naval Battles of the French and Indian Wars," in *Ships and Shipwrecks of the Americas: A History Based on Underwater Archaeology*, pp. 130-138.

not appear to have had much influence on later North American shipbuilding. The simpler, flat-bottomed English approach to bottom-based construction is much more widespread.

The Brown's Ferry Vessel

Of the North American bottom-based boats known from historical or archaeological evidence, the most sophisticated is a moderate-sized mid-eighteenth-century vessel found in the Black River, near Georgetown, South Carolina (Fig. 18).¹⁹ This boat, excavated at Brown's Ferry in 1976 by the South Carolina Institute for Archeology and Anthropology (SCIAA), was raised and conserved in Columbia. Preliminary recording was carried out by Richard Steffy in difficult conditions before conservation in polyethylene glycol. After conservation was completed, the vessel was recorded in detail by SCIAA staff under my direction in the autumn of 1990.²⁰

The vessel's last cargo was bricks, with an estimated weight of 25 tons. A small but odd variety of other artifacts was associated with the hull, including an

¹⁹ A.B. Albright and J.R. Steffy, "The Brown's Ferry Vessel, South Carolina," *IJNA* 8 (1979): 121-142; J.R. Steffy, "Preliminary Report: Hull Construction Features of the Brown's Ferry Vessel," *Notebook of the Institute of Archeology and Anthropology, University of South Carolina* 10 (1979): 1-29.

²⁰ This work was funded by SCIAA and the University of South Carolina, with my travel paid by the Institute of Nautical Archaeology. Recording was done primarily by myself, Jon Leader, conservator for SCIAA, and Harold Fortune, conservation assistant. Help was also provided by the staff of the Underwater Division of SCIAA, headed by Christopher Amer.

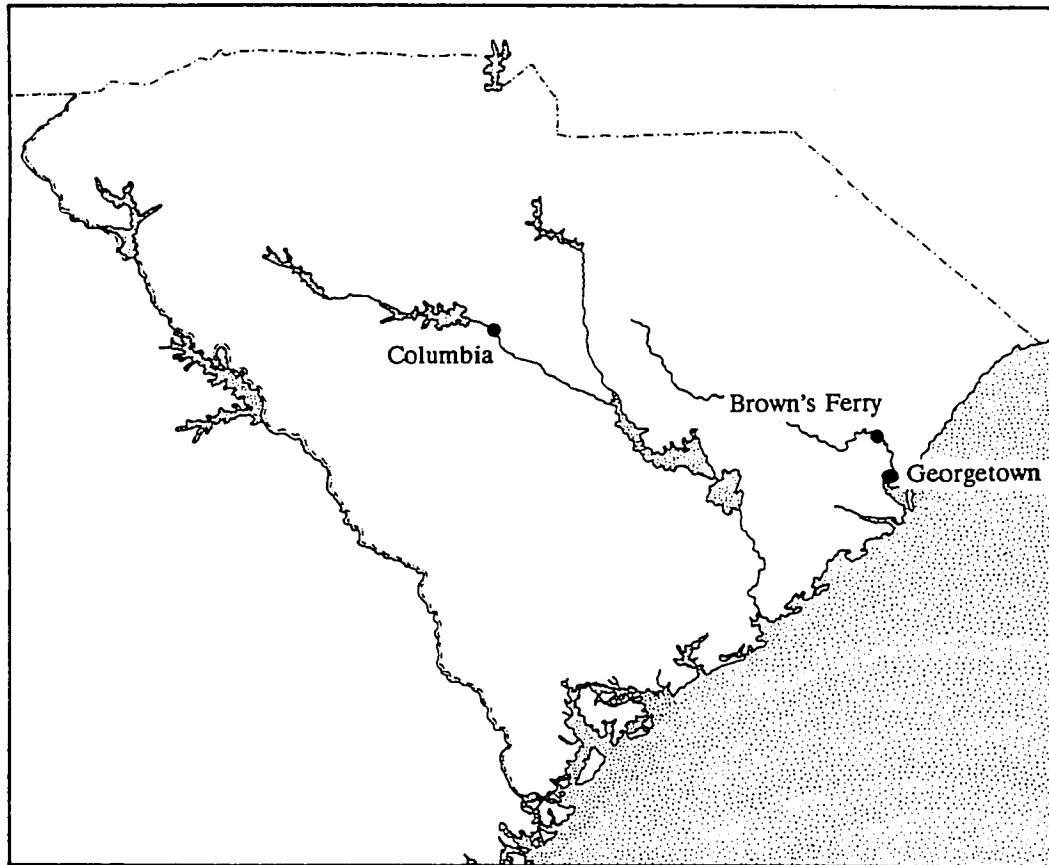


Figure 18. Map of South Carolina, showing the location of Brown's Ferry (Drawing E. Titford).

improved Davis quadrant (a deepwater navigator's tool).²¹ Small finds in the vessel date it to the middle of the eighteenth century, but the sample is very small, with no "hard" dates, as might be produced by coins. Dendrochronology of the hull timbers was attempted, but the softwood is too soft to produce a usable sample and the hardwood, live oak, is not currently datable by this method.

²¹ The exact provenience of this item, found by Hampton Shuping, the sport diver who discovered the wreck, remains uncertain, but its date is consistent with the other artifacts more definitely associated with the vessel.

Preservation

Preservation of the hull is, in general, very good. While no remnants of decks or other superstructure survive, the bottom is complete and much of the starboard side survives to the wale at the sheer. The port side is also well-preserved, although a strake lower. The lower part of the stem survives, attached to the bottom, but all that remains of the sternpost is the horizontal portion of the inner post.

The bottom and much of the port side were still coherent when discovered, but the starboard side above the fourth strake had broken loose and lay separately on the bottom, as did a long section of the sheer wale with attached rail fragments. In addition, several loose timbers were found at the stern. Extensive gribble damage was noted on the exterior surfaces of the bottom and lower side planking, as well as on both sides of many of the detached starboard planks.

At excavation, the iron fastenings were heavily corroded, but many still had metallic cores and held timbers together. PEG treatment, while effective in preserving many organic materials, is notably hard on iron, and the iron fastenings deteriorated further during conservation, many failing.

The conservation treatment was extremely effective on the softwood (pine and cypress) components of the vessel - indeed, the bottom was still "watertight" and several inches of PEG had to be bailed out of the hull after draining the tank. Unfortunately, the treatment had little apparent effect on the live oak timbers. Many of these may have begun to distort before PEG treatment began, but all

emerged from conservation twisted, checked, and distorted, although most are mechanically sound with hard surfaces.

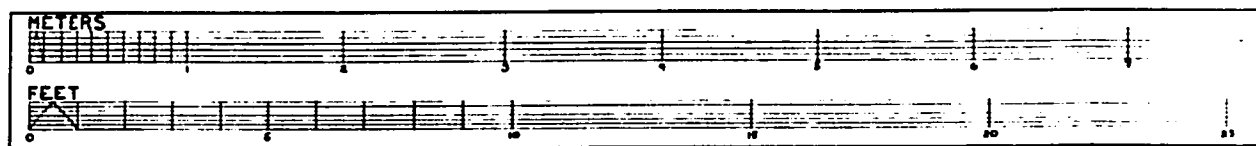
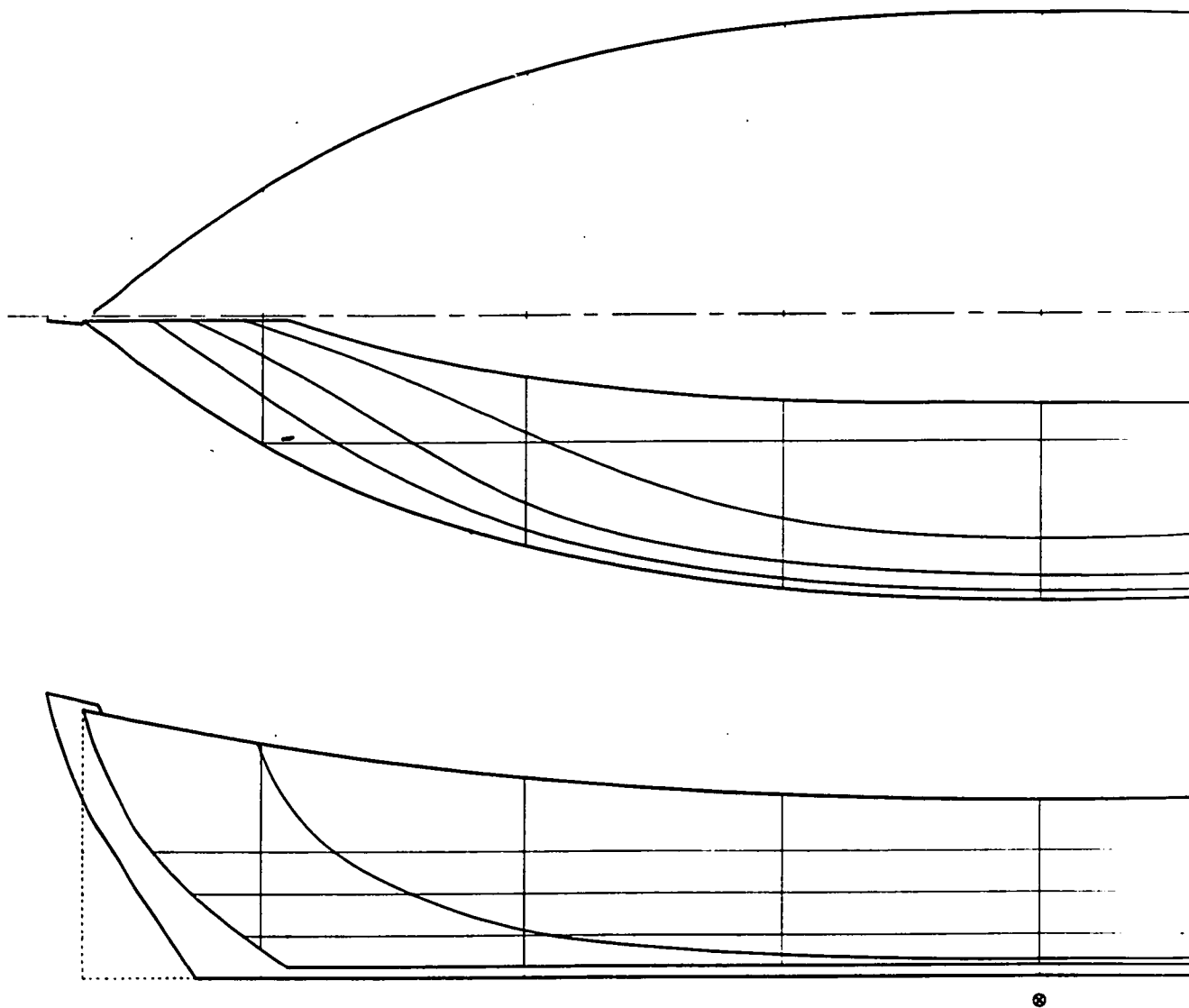
Hull Form

The hull is surprisingly graceful for a brick carrier (Plan XIII). The midsection, despite the flat bottom, has relatively soft bilges that fair into the bottom rather than stand at an angle. Toward the ends, as deadrise increases, a chine develops, but the soft bilge is carried higher and narrowed, leaving pronounced hollows in the forefoot and skeg. Entrance and run are long and fine, with noticeable hollow low down. The rake of the bow is moderate, with reasonable fullness above the water. The square tuck stern ends in a narrow transom. An earlier reconstruction was double-ended, but the long, straight length of preserved wale reaches almost to the sternpost, and the location of key frames suggests little difficulty in bending the planking in to the stern, so a transom is the more logical choice.

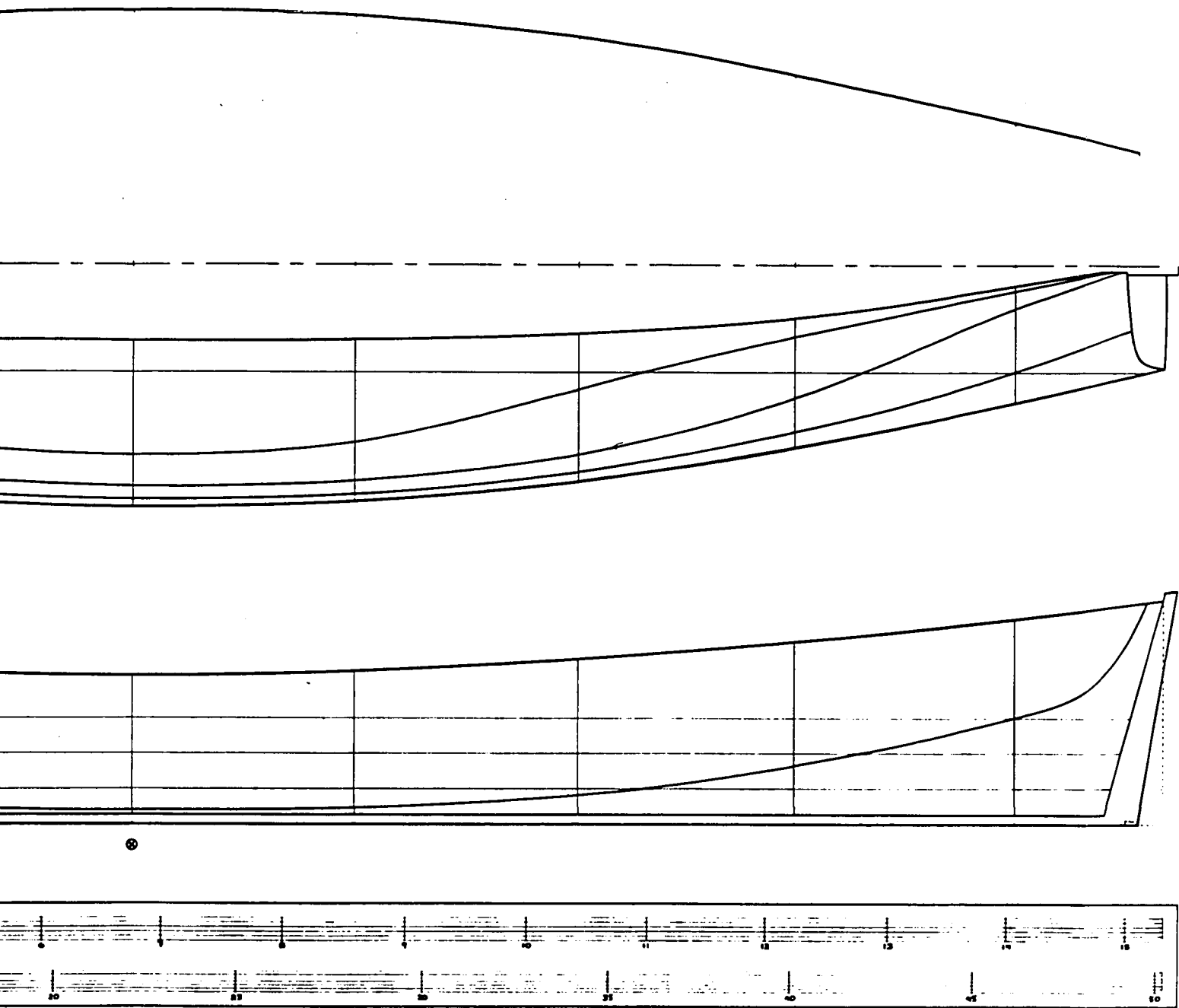
Structural Components

The hull is built primarily of yellow pine planking, with live oak posts and frames and cypress keelson and wales. Fastenings are of iron (both nails and bolts) with treenails of softwood (cypress? pine?).

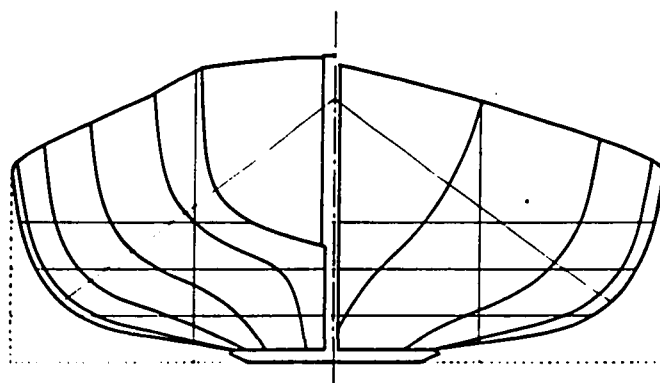
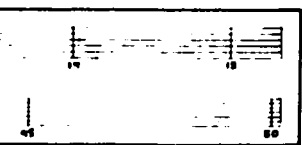
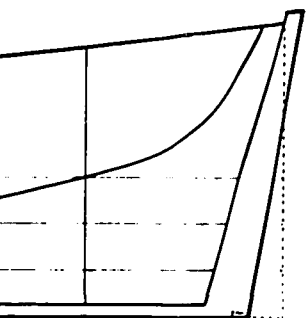
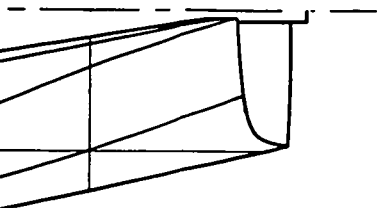
Instead of a keel, the backbone of the vessel is formed by a separate, flat bottom to which the posts and frames are attached (Plan XIV and Fig. 19). Originally ca. 46 feet 9 inches (14.25 m) long (45 feet 3 inches [13.79 m] survive),

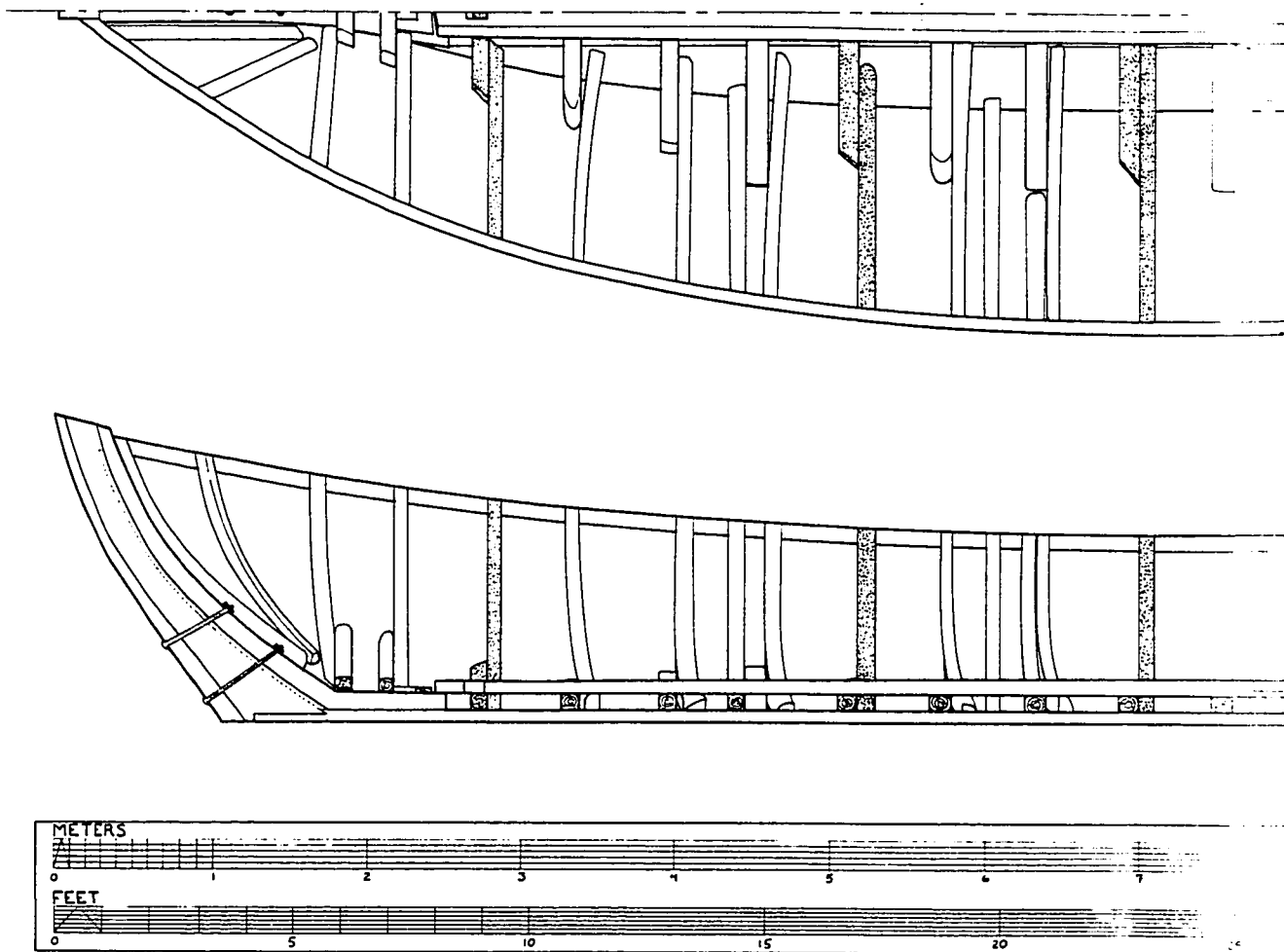


PLAN XIII.
drawings of

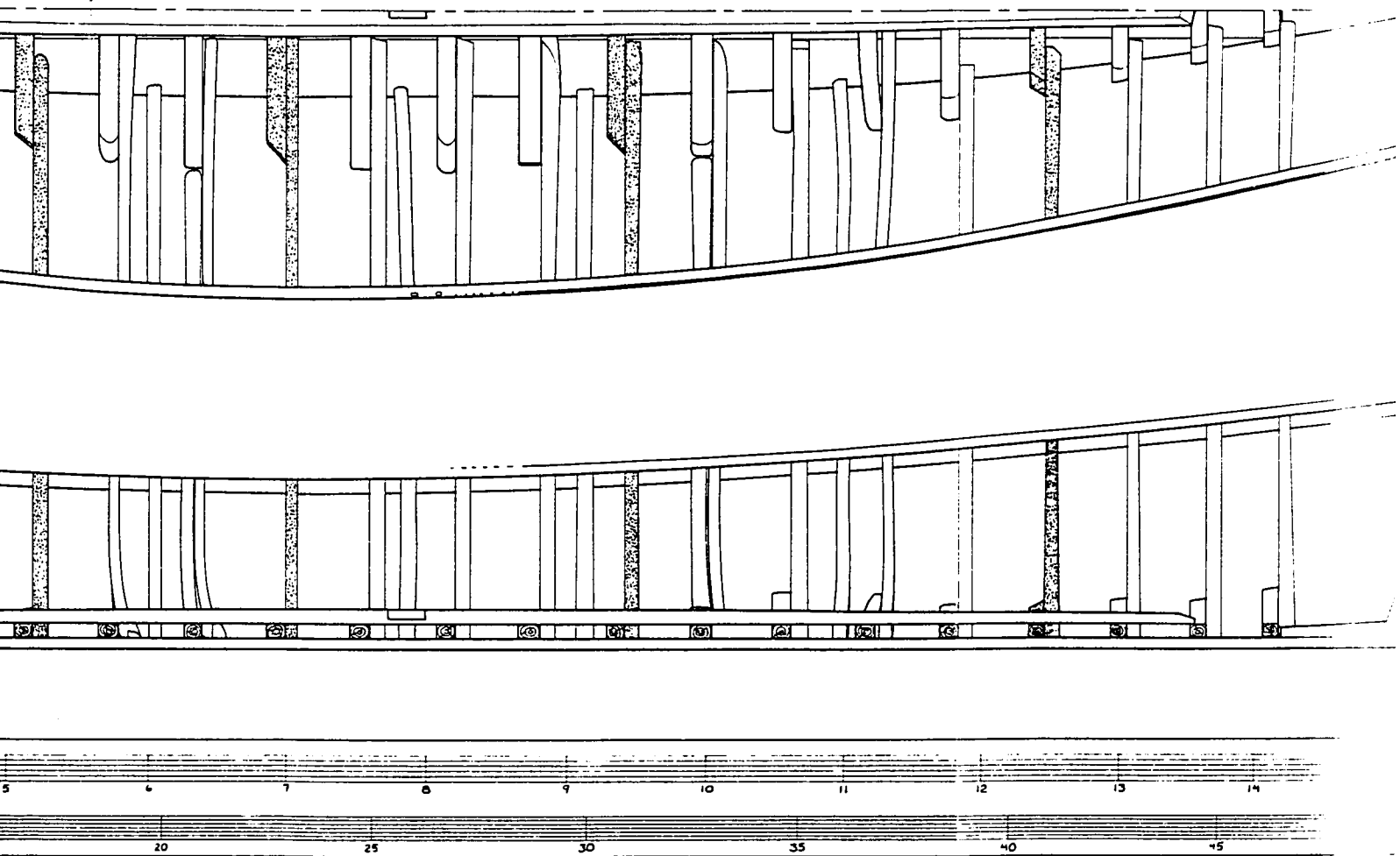


PLAN XIII. Brown's Ferry Vessel Preliminary Hull Lines (to inside of plank). All drawings of the port side.

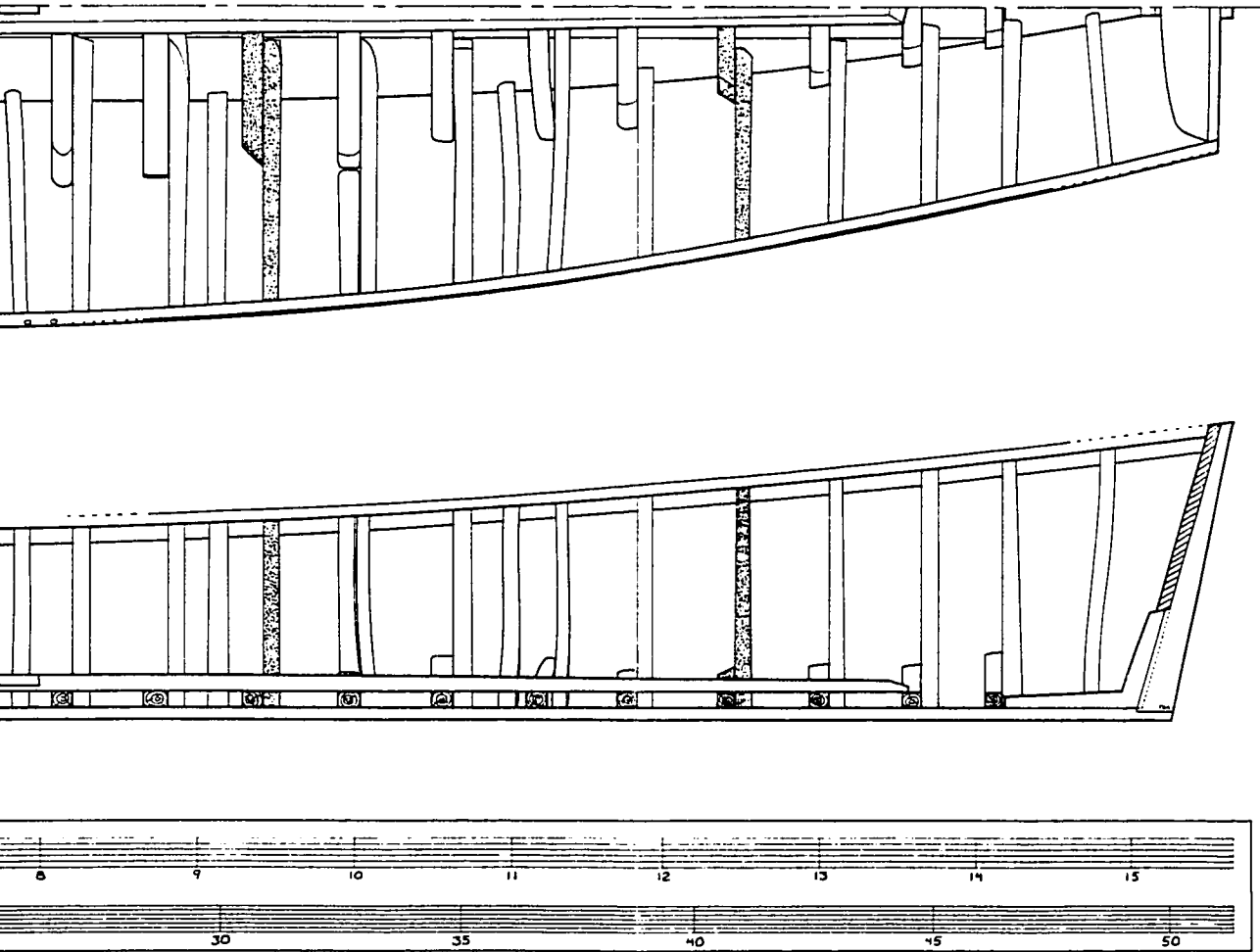




**PLAN XIV. Brown's Ferry Vessel Constructed
futtocks fastened to the floor timbers.**



V. Brown's Ferry Vessel Construction Sketch. The shaded frames have the
fastened to the floor timbers.



uction Sketch. The shaded frames have the

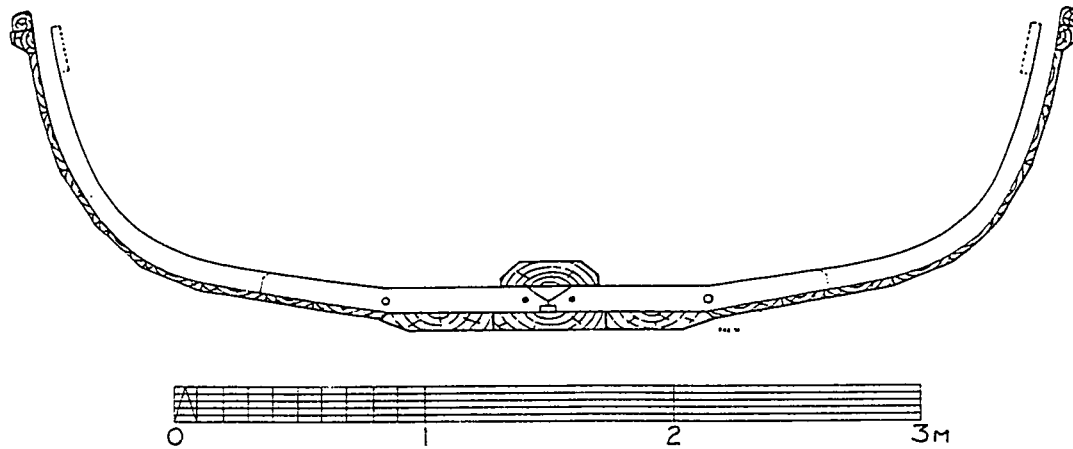


Figure 19. Brown's Ferry Vessel construction section amidships, from aft.

it tapers in width from a maximum of 53.5 inches (1.34 m) amidships to 5.25 inches (13 cm) at the stem rabbet. Forward of the stem rabbet, the bottom continues in a "tongue" under the stem. The thickness is cut down by 0.75 inch (2 cm) under the stem, so that the after end of the stem abuts an acute shoulder or stop in the bottom plank. A bevel 1.25 inches (3.2 cm) wide runs along the outboard edge of the upper surface to form a rabbet for the side planking. The angle of the bevel varies from 43° degrees below horizontal amidships to about 20° degrees at the ends. The outboard edge of the lower surface is also bevelled, from 20° degrees above horizontal amidships to nearly 90 degrees at the ends. The lower bevel is no longer crisp, but heavily rounded over the entire bottom.

The bottom is formed of three heavy, straight planks 3-3.5 inches (7.6-

8.9 cm) thick laid side by side. These must have been laid on some sort of trestling during construction, as the lower surface is flush, but there is noticeable unevenness on the upper surface (over much of the forward half of the center/port seam, the port plank surface is 0.25-0.5 inches (0.6-1.3 cm) higher than the center plank surface). The port and starboard planks also taper in thickness from the inboard toward the outboard edge, in some places more than 0.5 inch (1.2 cm). The central plank runs the full length of the bottom and tapers slightly in width, from a maximum of 18.75 inches (47.5 cm) at the bow to 16.75 inches (42.5 cm) at the stern. The taper is quite even and straight. The port bottom plank is 39 feet 1 inch (11.91 m) long and 18 inches (45.5 cm) wide amidships. It ends just forward of the after end of the apron forward and just short of the inner sternpost aft. The starboard plank, originally 38 feet 11 inches (11.86 m) long and up to 17.75 inches (45 cm) wide, ends at slightly different places fore and aft, but is essentially similar to the port plank. The bottom is extremely symmetrical about a center line, but the axis does not coincide with the centerline of the central plank (thus the port and starboard bottom planks do not end symmetrically).

Steffy noted small (0.75 inch/2.0 cm diameter), horizontal dowels in the seams of the bottom planks and suggested that these were used to align the bottom planks during construction.²² These could not be found during thorough probing of the bottom seams in 1990, but quite a few small pebbles of about the same size were detected jammed in the seams.

²² Steffy, *supra* n. 19, p. 5.

The entire bottom surface of these planks is heavily worn and gribble-eaten. At the after end, where the structure had obviously been exposed to river currents for some time, the bottom and associated timbers were badly eroded, with original surface and scantlings preserved only at nails.

While little of the stern survives, it appears that the sternpost structure was essentially similar to that at the bow. The stem is composed of three pieces, all of live oak: the stem proper, a false stem or gripe, and the apron. The stem is a deep, narrow timber of trapezoidal section with a rabbet cut into the after edge. At its deepest, it is sided 5.25 inches (13 cm) and moulded 14.5 inches (37 cm). At the limit of preservation, 3 feet 7.5 inches (1.105 m) above bottom, the stem is sided 3.25 inches (8 cm) and moulded 6.5 inches (17 cm). The after face is curved gently, while the surviving portion of the forward face appears to be straight and sided 3 inches (7.5 cm) at the base, tapering towards the upper end (shrinkage and distortion have altered the shape and dimensions of this timber substantially - fortunately, it was recorded carefully in 1977). The flat foot of the stem is treenailed directly to the upper surface of the bottom plank, and its after end is captured under a forward-sloping shoulder or stop in the bottom. In addition to the shafts of nails in the 1.25-inch (3 cm) wide and deep rabbet, there are a number of small, square or squarish wooden pegs on both sides of the stem forward of the rabbet. Some of these were noted in 1977, but drying of the timber has revealed several more. Most appear in clusters.

Little remains of the false stem, but fastenings reveal that it was moulded 4 to 5 inches (10-12.5 cm). It must have been sided 3 inches (7.5 cm) at the after edge toward the bottom and tapered in the same manner as the stem proper. The false stem was fastened to the preserved portion of the stem (and through it to the apron) by two heavy forelock bolts 15.75 and 21.25 inches (40 and 54 cm) long and 1 inch (2.5 cm) in diameter, as well as at least two iron spikes.

The apron spanned the joint between bottom and stem and was cut from a naturally-curved timber of substantial size. Although the portion of the apron fastened to the after face of the stem is sided from 5 to 8 inches (12.5-20 cm) and moulded 3 to 5 inches (7.5 -12.5 cm), the foot of this timber broadens to 19.25 inches (49 cm) sided over the bottom planking, which it covers for a length of 2 feet 7 inches (79 cm). The apron is fastened to the central bottom plank with eight treenails 1.125 inches (3 cm) in diameter and to the stem by the same two forelock bolts that attach the false stem, as well as at least five iron spikes. In addition to strengthening the stem/bottom joint, the apron acted as a nailer for the hood ends of the lower planks.

In the stern, all that survives is the broad, horizontal portion of the inner sternpost (similar to the apron). The after end of this timber appears to preserve some original surface, for a horizontal length of 2 feet 9.5 inches (85 cm) and a sternpost rake of approximately 15° from the vertical. The inner sternpost is sided from 3.25 to 13.5 inches (8.2-34.3), although originally it was slightly larger, and moulded from 2.5 inches (6.4 cm) at the forward end to 4.5 inches (11.5 cm) at the aftermost bit of preserved upper surface. The inner post is fastened to the bottom

by nine treenails, and there is evidence in the after extremity of iron spikes used to fasten the sternpost proper. Like the apron, this timber also served as a nailer for the garboard hood ends. While none of the post or other stern structure survives, there is other evidence strongly suggesting a narrow but deep transom.

The framing is quite regular, with twenty-two frames, each consisting of a floor timber and a pair of futtocks, complemented by several evenly distributed free futtocks (Plan XIV). Twenty frames rest on the bottom, with two resting on the lower end of the apron. Similar frames may have been set on the inner sternpost, but no fastenings for them remain. For convenience of reference, the frames are numbered consecutively from aft, assuming that there were no frames on top of the inner sternpost.

For the twenty central frames, the floor timber is typically a symmetrical timber consisting of a straight central section over the bottom and two arms angling off over the planking. In most, the grain is curved and the timber cut to minimize short grain at the angle, but a few are cut from straight-grained timber. All are carefully finished square on all four faces, with parallel sides. They vary in sided dimension from 4 to 6.5 inches (10-16.5 cm), but all are nominally moulded 4.5 inches (11.5 cm) with slight variations due to shrinkage and joggling over the uneven inner surface of the bottom planks. Floor timber 13, the midship floor, is not joggled; instead, the bottom is dubbed flat in way of the frame. The ends of fifteen floor timbers are finished square; the remainder (Floors 4, 9, 13, 16, and 20) have the forward faces of the ends beveled nearly to vertical feather

edges. The upper, forward edges are chamfered. A rectangular limber passage, usually 2.25 inches (5.7 cm) wide and 1 inch (2.5 cm) high is cut by saw and chisel into the bottom surface of each floor timber on the centerline, or nearly so. Each timber is fastened to the bottom by four to eight treenails 1.125 inches (3 cm) in diameter, normally two treenails into the center bottom plank, and one to three into each side bottom plank, depending on width. In addition, the keelson is fastened through each floor timber to the bottom by two similar treenails.

The floor timbers on the apron were not very well preserved, but were apparently similar in shape, with short central sections and nearly vertical arms. Unlike the bottom timbers, the end floors were each fastened to the apron by iron spikes.

Two futtocks, one on either side, lie against the after face of each bottom floor timber. This does seem a bit unusual for the period, as one should expect to see futtocks forward of amidships on the opposite side of the floor timber from the futtocks aft. The futtocks are sided 3.5 to 5 inches (9 to 12.5 cm) and moulded a nominal 4.5 inches (11.5 cm) over the bottom, but taper toward their upper ends. Many of the futtocks are not nearly as regular in shape or finished dimension as the floors. Some wander or have rounded surfaces where the log was not of sufficient size to fill out a perfectly rectangular section. Where the timber is squared up, the upper, after edge is chamfered. The lower/inboard ends are normally finished square (where scantling allows) and rest on the bottom, sometimes as far inboard as the central bottom plank (the futtocks of the midship

frame meet at the centerline). The inboard ends of the futtocks at floors 4, 9, 13, 16, and 20 are beveled on their after faces nearly to vertical feather edges.

Several futtocks abaft amidships required softwood wedges between futtock and bottom (Fig. 22). The wedges appear to be original construction rather than repair and probably fill gaps where the futtock log was of insufficient scantling. It seems odd that these wedges are concentrated in one area of the hull.

The inboard ends of the futtocks are each fastened to the bottom by one to four treenails, and many have a single nail driven through the toe into the bottom. While almost all of these futtocks lie hard against their floors (a few of the most crooked are only approximately aligned with the floor, so that their ends wander away in places), only those of frames 4, 9, 13, 16, and 20 are fastened directly to the floors. At these frames, a horizontal treenail (generally square or hexagonal, 1 inch/2.5 cm across) and two nails (one through the beveled floor tip, one through the beveled futtock tip) fasten floor and futtock together.

Additional, free futtocks are fastened to the bottom and sides after every third frame (forward of floors 3, 6, 9, 12, 15, and 18). These are of similar scantling to the other futtocks, but are often irregular in contour and lack the chamfering of the full frames. The lower ends rarely reach the center bottom plank and are each fastened to the outboard bottom planks by one to three treenails and a nail in the toe. It is impossible to say from direct evidence whether these are original construction or a later addition, as they do not contact other timbers, but they were definitely installed after the hull was planked; they are fayed to the inner surface of the planking, while the planking has been backed out

in the way of all the floor futtocks. The free futtocks also seem of different workmanship than other timbers. My intuitive feeling is that they are a later reinforcement to cope with heavy cargoes, such as the bricks found in the hull, but the opinion is more subjective than objective.

Each of the frames reaches the caprail, but a few frames have additional second futtocks in line with the floor. These are, for the most part, badly eroded and appear in no regular pattern, with recovered examples from frames 4, 8, 14, and 21. The second futtocks at frames 8 and 14 are matched, port and starboard, suggesting that they are not simply repairs or local sistering to reinforce old or weakened frames. It may be possible that some of the timbers identified now as second futtocks were originally the lower ends of knees to support beams across the hold.

The futtocks of the two frames on the apron are poorly preserved and irregular in shape and dimension. The forwardmost floor carried its futtocks against the forward face, as the futtocks of both apron frames are canted. A free futtock, a straight timber little more than a heavy batten, originally lay in the angle between the after face of the apron and the inner surface of planking, but this does not appear to have survived conservation.

The keelson consists of a single cypress timber 36 feet 4.6 inches (11.08 m) long, sided up to 15.75 inches (40 cm) and moulded up to 4 inches (10 cm). At the bow, it tapers to 13 inches (33 cm) sided and 3.25 inches (8.3 cm) moulded; at the stern the dimensions are 10 inches (25.4 cm) sided and 3 inches (7.5 cm)

moulded. The keelson lies atop floor timbers 2 through 20 and the after edge of the apron. It is fastened through each floor (except floor 2; on which it only rests) to the bottom by two treenails, 1.125 inch (3 cm) in diameter. One treenail fixes the forward end to the upper surface of the apron.

The section is hexagonal, but might be more accurately described as half of an octagon: a narrow top flat and short, vertical sides are joined by broad chamfers. Mortises for the heels of two masts are cut into the upper surface. The forward step is 5.5 inches (14 cm) long, 3.5 inches (9 cm) wide and is cut completely through the keelson over the twentieth bottom floor, although there are no relevant tool marks in the upper surface of the floor timber itself. The other step, 10 inches (25.4 cm) long, 4 inches (10 cm) wide, and 2.75 inches (7 cm) deep does not pass all the way through and is located just abaft floor 12, 24.5 inches (62 cm) abaft midships. The purpose of a third step, formed by a short section of softwood board 1.5 inches (3.8 cm) thick, nailed to the top of the apron between the end of the keelson and floor timber 21, is not completely certain - perhaps for a windlass pawl post or bitt.

The upper surface of much of the keelson forward of the central maststep is badly scarred by knife and hatchet cuts. In some places, the moulded height of the keelson has been reduced by an inch (2.5 cm) or more. Steffy suggested that the keelson was used as a chopping block by the cook (there is some evidence of a brick hearth on board), but the damage extends over quite a large area. I am afraid I have no better explanation.

Either side is covered by eight strakes of pine planking, 1.125 to 1.25 inch (2.8-3.2 cm) thick. Width varies, from 5.75 to 11.25 inches (14.6-28.5 cm), with the upper planks averaging slightly more than the lower. While the hood ends of the upper strakes are gone, the run of the planks indicates that all strakes were continuous, without drop strakes or stealers in the bow. The poorer preservation of the stern makes it impossible to say with certainty if the planking was similar there, but there is no direct evidence of any difference. Frequently, transoms over a hollow run necessitate a stealer or two. Each strake is made up of two to four planks meeting in butts. The butts occur symmetrically to port and starboard on frames and are staggered so that they are not concentrated in any one area. Curiously, rather than cutting flats on the frames for the planks, the inner surfaces of all planks above the garboard are backed out with an adze to fit the frames. In contrast, the planking is not backed out under the free, intermediate futtocks (in every third room) or the second futtocks. Each plank is typically fastened to each frame by a treenail and a nail, with wider planks getting an additional nail or treenail but the pattern is not perfectly consistent. Treenails are sometimes omitted and extra nails added. Hood ends at the bow are back-bevelled to catch in the rabbet and are fastened with nails into both the stem rabbet, narrow though it is, and the side of the apron.

The plank edges are normally bevelled slightly to fit against the adjacent planks and provided a slight gap for caulking. The garboard seam differs, in that the lower edge of the garboard is strongly beveled to fit the bevel on the outboard

edge of the bottom. Many of the plank edges show compression and other damage caused by caulking irons.

At the stern, only the garboards survive as far aft as the inner sternpost. All the after ends of strakes are severely eroded, except where fastening to other timbers (frames and the inner sternpost) protected the surface.

There is a single cypress wale on either side of the hull. This lies atop the uppermost strake and is fastened to the frames. A section from the starboard side 24 feet (7.315 meters) long survives, but the after half of it is badly eroded. Where the original contours survive, the section is pentagonal (really square with a wide chamfer on the outboard, lower edge), 4 inches (10 cm) wide and 3.25 to 3.5 inches (8.2-9 cm) thick. It is irregularly nailed or treenailed to most frames, and two large iron bolts are preserved at frames 4 and 12. At the mainmast step, there is a pair of eroded vertical holes, 1.5 inches (3.8 cm) long, 1.25 inches (3 cm) wide, and 5.5 inches (14 cm) apart, bored through the wale. These are probably the attachment points for the mainmast shrouds.

There is no observable evidence of a clamp, other than the length of the iron bolts in the wale, suggesting some sort of stringer on the inside of the frame heads.

A rail 3 inches (7.5 cm) square is nailed to the upper surface of the wale in the waist of the vessel. Only a short section of it survives on the starboard side,

but several of the heavy, vertical spikes that once attached it at irregular intervals can still be seen in the upper surface of the wale. A minimum length of 20 feet (6.10 m), extending nearly to the transom, can be confirmed from fastenings. Preservation is insufficient to determine whether the rail continued forward to the stem or was replaced at the bow by a wash strake.

There is no evidence of any permanent ceiling. There were some loose boards under the brick cargo, probably to distribute the load and protect the frames. These are up to 12 inches (30.5 cm) wide and generally less than 1 inch (2.54 cm) thick.

Other than an oddly-shaped knee that must be associated with some sort of superstructure, there is no direct evidence for decks of any sort. The hull is shallow enough that decks would not have been strictly necessary for moving around the ship, but the vessel could have benefitted from a few beams to tie the sides together. There must have been partners for the masts, even if these were only notched beams. Small decks at either end would have made line handling and steering easier. A vessel of this configuration was drawn by Philip Georg Friedrick von Reck, a German traveller who passed through the Carolinas and Georgia in 1736.²³

²³ Fleetwood, *Tidecraft*, p. 27.

Construction

The basic element in the construction of the Brown's Ferry vessel is the bottom. Construction began with the assembly of the three thick planks, probably roughly cut to shape. After these planks had been temporarily fastened or clamped together, the bottom was trimmed to shape and the upper and lower bevels cut. It is interesting to note that the bottom is very nearly symmetrical, but the axis of symmetry does not coincide with the centerline of the center plank. The axis is not offset, but skewed relative to the plank centerline. Stem and sternpost assemblies (probably including the transom) were fashioned and fastened in place.

Once the backbone was finished, the basic shape of the hull was determined by five assembled frames distributed over the length of the hull. These frames, the fourth, ninth, thirteenth, sixteenth, and twentieth, are the only assembled frames in the vessel and divide the hull into segments roughly equal in length. The most important of these frames, and probably the first erected, was the midship frame, the thirteenth. Unlike all other frames, the midship frame is not joggled to fit the uneven bottom plank thicknesses. Instead, the bottom is dubbed smooth under the frame. It is possible that the key frames were erected before final trimming of the bottom, but there are no tool marks in the bottom planks or the floors to indicate that the rabbet was cut after the permanent installation of the floor timbers.

The upper surface of the bottom is no longer flat, but crowned. Slight compression of the lower edges of the planks suggests that the bottom has

"hogged" transversely with time. Since the bottom was almost certainly erected on trestling, the bottom surface should have been flat when the vessel was built. The tapering thickness of the port and starboard bottom planks suggests that the bottom wore more rapidly along its outboard edges than it did down the center. Whether the bottom hogged transversely as a result of accelerated wear along the edges (this sort of wear pattern is not uncommon),²⁴ or the wear is the result of transverse hogging, caused by heavy loads in the bilges, is difficult to determine. This is very much a chicken-or-egg question, but I suspect that the worn edges came first. It is possible, but not probable, that the hogging occurred after the vessel sank, or even during conservation.

In any case, after the midship frame was erected, the shapes for the other four key frames were determined, either empirically, using battens, or geometrically (see below). These were then erected. With these five frames fastened in place, planking could begin, but there is no evidence in the planking itself that the key frames were planked before the rest of the frames were erected. All the planks above the garboard are backed out under every frame, and the tool marks do not appear to cross the seams. If they did, it would mean that backing out had occurred after planking. It seems more likely that after the five key frames were set up, the shapes of the rest of the floors and futtocks were determined from battens, although the undubbed garboard suggests the possibility that it was attached immediately and provided both a guide for the shaping of the floors and

²⁴ Modern dories, and other vessels with wide keels or flat bottoms, often add wear guards, either of wood or metal, along the outboard edges of the keel or bottom plank.

added strength to the futtocks once they were installed. The remaining frames were gotten out and fastened to the bottom. The feet of the futtocks are long and securely fastened to the bottom, so it was probably possible to plank them directly. Some of the planks must have presented bending problems in the bow, as they have been kerfed on the inside, making them easier to bend.²⁵ Sometime after planking was complete, the intermediate and second futtocks were added.

The complex shape of this vessel shows fairly clear evidence of the use of whole moulding to determine the shapes of the five key frames. The shape of the turn of the bilge remains relatively constant, but is placed higher and farther inboard toward the ends. The exaggerated hollows at the forefoot and skeg often associated with whole moulding are easily observed in the frames. The question arises, "Why choose this shape?" It negates two of the traditional advantages of the flat bottom: greater capacity for limited beam and draft, and simplified construction. It does avoid one of the weaknesses of traditional flat bottoms, the harsh transition from bottom to side, but so does a keel. The flat bottom was probably chosen for a specific functional reason: the vessel was intended to be grounded for loading and unloading in the tidal reaches of the Black River and at coastal ports, and so needed a broad "foot" on which to rest. At the same time, the complex shape suggests that the designer of the vessel wanted to give it some seaworthy qualities, to make it more than a river barge.

²⁵ Steffy, *supra* n. 19, p. 13.

The origins of the construction are just as perplexing. In many ways, the vessel is less a bottom-built gundalow than a conventional round-bottomed, carvel vessel with a *very* wide keel. Later vessels from the Carolinas seem to have abandoned this approach. They are either built on keels, such as the Mepkin Abbey wreck,²⁶ or are simple barges. It is possible that this style of construction is ultimately derived from a combination of European and Native American traditions. The vessel type is probably that referred to in contemporary documents as a *periagua*,²⁷ derived from Spanish *piragua*, etc., which denotes a dugout. The flat bottom of the Brown's Ferry vessel may well be a vestigial log boat, similar to the multiple-log boats of Chesapeake Bay.²⁸ If so, it presents the interesting case of an Anglo-American bottom-built vessel not derived from a European bottom-based tradition, but incorporating native bottom elements into a largely traditional skeleton hull.

²⁶ R. Wilbanks, "A Preliminary Report on the Mepkin Abbey Wreck, Cooper River, South Carolina: An Early 19th-Century River Trading Vessel," in *Underwater Archaeology: The Challenge Before Us. The Proceedings of the Twelfth Conference on Underwater Archaeology*, ed. G.P. Watts, Jr., pp. 151-157.

²⁷ Fleetwood, *Tidecraft*, pp. 30-32, with contemporary accounts suggesting that a *periagua* was a vessel larger than a dugout canoe, but still based on a dugout bottom.

²⁸ John Lawson, on a tour through the Carolinas in 1710, noted that particularly large "Pereaugers" were made by hollowing a cypress log, splitting it down the middle, and inserting a central plank; J. Lawson, *A New Voyage to Carolina*, n.p., quoted in Fleetwood, *Tidecraft*, p. 22.

CHAPTER VII

CONCLUSIONS AND PROBLEMS

The foregoing is by no means a complete or exhaustive study of bottom-based shipbuilding in Europe, much less in the rest of the world. The last chapter, on bottom-built vessels in the New World, only hints at the wide geographical and cultural range of such craft. A large number of predominantly flat-bottomed vessel types, from all over the world, are probably the products of bottom-based concepts. I have attempted to trace the development of a particular strain of shipbuilding and through it the existence of a broader concept distinct from the shell and skeleton families into which most shipbuilding has previously been divided.

This tradition is easily distinguished in its earlier stages from the shell-based technologies of the ancient Mediterranean and Scandinavia by its reliance on the bottom of the boat as a structurally distinct component that is assembled first (often in a different manner than the sides) and defines the essential shape of the rest of the hull. In the vessels from Blackfriars and Lake Neuchâtel, a flat, lanceolate bottom is made up of thick, relatively straight planks temporarily fastened together and shaped as a composite panel, rather than built up in a conventional strake-by-strake manner. The bottom is stabilized and reinforced by heavy floors, which provide points of attachment for the lighter side planking. In the Swiss lake boats, the limits of the bottom are defined and a smooth, solid bilge provided by L-sectioned chine girders, which also make up much of the lower

sides. The larger Rhine barges, such as those from Zwammerdam, are essentially similar to the Swiss boats, but are more angular in plan. Framing systems vary somewhat, with the Blackfriars ship having a more conventional floor timber and futtock arrangement, while the Swiss and Rhine vessels are characterized by knee-ended floor timbers set singly or in pairs with the knee-ends alternating sides. In neither case does the framing resemble the alternating floor timbers and half-frames of Mediterranean construction, nor the continuous ribs of Scandinavian craft.

Roman influence can be seen in several shell-built, mortise-and-tenon hulls in the north, from County Hall in England to Vechten in the Netherlands to Oberstimm on the German Danube, but the bottom-based vessels remain essentially indigenous in construction. Some Mediterranean features may be seen in the rudder from Zwammerdam and the mortise-and-tenon joints used in the sides of one of the Zwammerdam barges, but the latter only highlight the unimportance of side construction relative to the bottom. I cannot agree with de Weerd that the barges represent a wholly Roman type, especially since there is no evidence for the diffusion of the type southward and ample evidence that when the Romans wished to build their own vessels in the north, they relied on traditional mortise-and-tenon construction.

In the later Middle Ages, the essential features of this tradition can be recognized in cogs and other flat-bottomed inland craft, especially in the Low Countries. Cogs maintained the bottom-first assembly sequence and some structural distinction between flush-planked bottom and lapstrake sides, but the

framing system was much better integrated with the shell than in earlier vessels. The bottom-based construction of the Roman era survived nearly intact in cruder inland craft, such as the river barge from IJsselmeerpolders plots K 73/74. Except for higher sides and the absence of chine girders, this vessel is nearly identical to the Zwammerdam barges in shape, proportions, and construction.

With the introduction of carvel planking to northern Europe in the fifteenth century, cog builders were able to transfer their traditional, bottom-first assembly to the new technology with little alteration. The flush-laid bottom planks were still assembled first, temporarily tied together by short wooden cleats across the seams, until floor timbers were inserted. Although bottom-based in design and assembly, once complete there was little or no structural difference in Dutch carvel vessels between bottom and side. The expression of the new technology in traditional terms allowed Dutch shipwrights to avoid the period of experimentation and development normally required before technical innovations can be adopted profitably, but it also discouraged them from developing the design skills necessary to take full advantage of carvel planking. By the eighteenth century, after English and French shipbuilders had relegated the once dominant Dutch shipbuilding industry to secondary status, Dutch shipwrights adopted more modern methods for the design and construction of large ships.

Bottom-based methods survived in the small craft of northwestern Europe and the European colonies in the New World. Dutch boatbuilders continued to build inland vessels with cleat-fastened carvel planking until well into this century, and several classes of popular small craft, such as dories, are built in a simplified

version of traditional bottom-based methods. Some larger inland vessels in North America, such as the *goelettes* of the St. Lawrence and the gundalows of New England, were built in a bottom-based tradition quite similar to that seen in the "celtic" craft of northern Europe. Lanceolate bottoms were cut from panels made up of thick, straight planks, then reinforced with heavy, straight floor timbers. The sides of these vessels met the bottoms in sharp chines. In other cases, such as the Brown's Ferry vessel, the bottom-based approach may be the result of a mixture of indigenous dugout traditions with conventional, European frame-based construction.

In most cases, bottom-based construction offers several advantages to the builder. It is relatively simple, with a minimum of complex curved joinery, even in hulls with fairly easy lines. As the Revolutionary War gundalow *Philadelphia* demonstrates, this style of construction is easily adopted by woodworkers with minimal boatbuilding experience. It can be adapted to round-bottomed shapes, but is probably best suited to flat bottoms. Many of the round-bottomed ships built in this way display some sign of a flat-bottomed heritage; the large Dutch ships of the seventeenth century are not, strictly speaking, flat-bottomed, but do have a hard or angular bilge where the bottom-based construction ends.

Several major problems remain if the picture of this tradition is to be complete. These fall into three areas: origins, continuity, and cultural affiliation. Although a well-defined style of indigenous shipbuilding can be identified in Roman Gaul and Britain, its origins are murky at best, largely due to a dearth of

archaeological evidence. Similarly, the lack of extensive hull remains from the early Middle Ages makes it difficult to tie Gallo-Roman shipbuilding to cogs, despite apparent conceptual similarities. Finally, the regional distribution of the Roman bottom-built vessels seems to suggest an association with the dominant Celtic culture of northwestern Europe, but ship historians have tried to avoid tying the two together in recent years.

It is logical to ask how far back the bottom-based concept can be traced in northwestern Europe, and from what primitive root it evolved. The degree to which it had developed by Roman times suggests fair age, but archaeological confirmation is sparse. Pre-Roman vessel remains in the region are confined to dugouts and a few simple plank boats from England. The English remains are from two sites near the mouth of the Humber River.

Since 1937 E.V. Wright has studied and published a series of finds from Humber mud near North Ferriby.¹ Three of these are substantial fragments of similar, plank-built boats. The remains have been C¹⁴ dated to the second millennium BC, which corresponds to the Early or Middle Bronze Age in Britain.² The basic features are a central strake with upswept ends, another, shorter bottom

¹ E.V. Wright and C.W. Wright, "Prehistoric Boats from North Ferriby, East Yorkshire," *Proceedings of the Prehistoric Society*, New Series 13 (1947): 114-138; E. V. Wright and D.M. Churchill, "The Boats from North Ferriby, Yorkshire, England, with a Review of the Origins of the Sewn Boats of the Bronze Age," *Proceedings of the Prehistoric Society*, New Series 31 (1965): 1-24; E.V. Wright, "Boats of North Ferriby," in *Three Ancient Boat Finds in Britain*, ed. S. McGrail, pp. 3-7; E.V. Wright, *The North Ferriby Boats: A Guidebook*; E.V. Wright, "The North Ferriby Boats - A Revised Basis for Reconstruction," in *Sewn Plank Boats*, eds. S. McGrail and E. Kentley, pp. 105-144; and E.V. Wright, *The Ferriby Boats - Seacraft of the Bronze Age*.

² Wright, *The North Ferriby Boats: A Guidebook*, pp. 34-39.

strake on either side, two or more side planks stitched to the bottom and each other with yew withies, and a peculiar series of separate crossbars passing through raised cleats carved from the interior surface of the central three strakes. Boat 1, found in 1937 and completely excavated and raised in 1946-7, is the most complete, but the other fragments correspond quite closely so that a composite reconstruction is possible. The central strake itself is up to 13.30 m long (the preserved length of boat 2), 64 cm wide, and up to 12 cm thick, made up of two planks joined by a short, flat scarf amidships. The central planks are carved from the log to produce upswept ends and raised lugs and cleats on the inside. The strakes to either side of this, which make up the remainder of the bottom, also have raised cleats on the inside. The cleats house pairs of transverse ash bars (the planks are of oak) passing across the entire bottom. The lugs are more problematical. Wright hypothesizes that they locate simple frames or bulkheads.³ The side planks are thinner and meet the bottom in a V-shaped rabbet. The planks are held together by stitches in holes cut so that the stitches pass through the rabbet rather than reaching the exterior. The stitches also hold moss caulking, consisting of a moss string in the angle of the rabbet and wads in the planes, held in place by tying down a thin lath over the interior of the seam. The resulting boat is relatively heavy, with minimal capacity, but no doubt adequate for river transport. It requires large amounts of sculpting with simple bronze hand tools, and periodic renewal of the stitching.

³ Ibid., pp. 46-49.

The Brigg vessel, formerly referred to as the Brigg "raft," due to the wide, flat bottom, was first discovered in 1888 on the Ancholme River, a tributary of the Humber.⁴ Re-excavation and recording in 1974 revealed a coffin-shaped flat bottom, made up of five heavy planks, with fragmentary remains of a vertical, flat side. Each of the bottom planks is carved from a log so as to leave a line of projecting cleats down the center of the interior surface. Each plank is not rectangular in section, but thick (up to 5 cm) in the center with thinner flanges at the edges. The flanges were pierced and stitched together and caulked in a manner similar to that in the North Ferriby boats. The cleats house oak crossbars in elongated openings. As in the Ferriby boats, the exact function of the crossbars is uncertain, although it has been suggested that they may have been proto-frames, or that they kept the bottom planks aligned during renewal of the stitching.⁵ Either explanation is possible, although difficult to prove. Only enough remained of the sides to say that they were made up of at least two flat strakes stitched to the outboard edges of the bottom. The complete boat must have been fairly flexible, even with the ash crossbars, and was little more than a watertight box, with a capacity of about 5 tons.⁶

⁴ J. Thropp, "An Ancient Raft Found at Brigg, Lincolnshire," *Associated Architectural Societies Reports and Papers* 19, Part 1 (1887 cover date, but did not appear until 1889): 95-97. The original excavation is also described in S. McGrail (ed.), *The Brigg "Raft" and her Prehistoric Environment*, pp. 2-6. The latter is an exhaustive and definitive report following the re-excavation and analysis in the 1970s.

⁵ McGrail, *The Brigg "Raft" and her Prehistoric Environment*, pp. 236-239.

⁶ The reconstructor sets a minimal solution of sides 34 cm high, which, in theory does not provide sufficient buoyancy to carry any load "safely" if bilge water is allowed to flow freely around the hull. If bilge water is stabilized and the free surface effect eliminated, the maximum safe load

It would be hard to deny that these vessels were bottom-built, but their relationship to later northern European boatbuilding traditions is uncertain. There does seem to be a connection between the Ferriby and Brigg vessels, evidenced by the stitching and the mysterious crossbars,⁷ but the gap between Brigg and Blackfriars is hard to cross. Most scholars see some sort of relationship between these vessels and the "celtic" tradition represented by the Blackfriars ship, although it requires something of a leap of faith.⁸ If they are indeed related, the Blackfriars ship represents some significant advances in the intervening centuries. Edge fastenings were abandoned, true frames replaced the crossbars and cleats, and iron nails were introduced.⁹

There are conceptual similarities between the Bronze Age and Roman craft. As noted, both families are bottom-built. The crossbars of Ferriby and Brigg are secondary additions to the primary structure of the bottom, but necessary in the Brigg vessel to provide some transverse stiffness. The bottom construction of the Blackfriars vessel is conceptually similar, if more sophisticated,

is just over 5 metric tons. Increasing the sides to a height of 55 cm gives a safe load of up to 7 tons in the absence of the free surface effect; J. Coates, "Safe Carrying Capacity of the Hypothetical Reconstruction," in *The Brigg "Raft" and her Prehistoric Environment*, ed. S. McGrail, pp. 261-270. See also S. McGrail, "The Brigg 'Raft' - Problems in Reconstruction and Assessment of Performance," in *Sewn Plank Boats*, eds. S. McGrail and E. Kentley, pp. 165-194.

⁷ B. Greenhill, *Archaeology of the Boat: A New Introductory Study*, pp. 111-14; S. McGrail, *The Ship: Rafts, Boats and Ships*, p. 21.

⁸ For example, L. Basch, "Ancient Wrecks and the Archaeology of Ships," *IJNA* 1 (1972):42; this is implied by McGrail, *The Ship: Rafts Boats and Ships*, p. 24; Greenhill, *Archaeology of the Boat*, p. 114, notes a possible connection to later Portuguese vessels, based on carved endposts.

⁹ Basch, *IJNA* 1 (1972): 42 suggested that the use of metal is the most significant difference between the Brigg and Blackfriars vessels, but he wrote before the former had been re-excavated and the stitching discovered.

but the Rhine barges of Zwammerdam exhibit more obvious affinities of shape and structure. It is possible that the development of true frames and the adoption of iron fastenings eliminated the need for stitching in a development parallel to the abandonment of mortise-and-tenon joinery in the medieval Mediterranean. Still, I am reluctant to draw a direct line of descent from the Brigg vessel to Roman craft. The broad conceptual similarity does allow the possibility that the Bronze Age and Roman vessels are derived from a common root.

That root is itself rather elusive, although there are a couple of obvious choices. Most boatbuilding traditions can be traced back to one (or more) of four simple roots: rafts, skin boats, bark boats, and dugouts.¹⁰ Skin and bark boats can be eliminated on structural grounds; they are both watertight skins stretched over frameworks providing most of the rigidity and strength. On the other hand, log rafts and dugouts can both lead logically to bottom-based building methods if developed into planked vessels. Both rafts and dugouts are easily extended by washboards or full-length strakes to increase capacity or seaworthiness. At some point, the raft must be made watertight in order to become a true boat. This can be done most simply by caulking the spaces between logs and adding sides. The result would not be vastly different from the Brigg or Zwammerdam 2 vessels. As the dugout is developed by the addition of planks, the hollowed log forms an increasingly smaller portion of the whole, until it may be no more than a single, heavy central strake, as is seen in the Ferriby boats, where the central part of the

¹⁰ Greenhill, *Archaeology of the Boat*, pp. 91-154.

three-strake bottom is a curved timber carved from one or two logs.

The raft suggests the flat bottom common to many northwestern European bottom-built vessels,¹¹ but dugouts can also be flat-bottomed. One of the Zwammerdam finds, vessel 3, is a flat-bottomed dugout, and Ellmers has noted a flat-bottomed dugout tradition and its descendants in Germany.¹² Unfortunately, these finds all date rather late, so that flat-bottomed dugouts may be a back formation to resemble existing plank boats.

My own feeling is that the bottom-based tradition described here is derived from a dugout root, although I must admit that the reasoning is largely intuitive. Most of the vessels are already so complex by the Roman period that they are far removed from whatever root produced them. Interaction with other traditions and common evolutionary trends in boat design tend to obscure rather than enhance evidence on origins. Disparate traditions and concepts end up producing essentially identical vessels. Thus by the seventeenth century, Dutch shipbuilding was distinctive only in the design and assembly processes, which could not be easily detected in the finished product.

If the Ferriby vessels are related to the Roman craft, then a dugout origin seems more certain. The basic structure of the Ferriby boats is a bottom made up of hollowed/carved logs, rather than a flat platform with attached sides, but even

¹¹ One of Basch's three roots of flat-bottomed boats is a raft origin. The others are limited resources/technology and conscious choice to suit prevailing conditions of navigation; *JNA* 1 (1972): 18-19.

¹² D. Ellmers, "Keltischer Schiffbau," *Jahrbuch des Römisch-Germanischen Zentralmuseums Mainz* 16 (1969): 75-83.

these boats are already far removed from their origins. The bottoms of later craft could then be interpreted as vestigial carved logs. The Brown's Ferry vessel may illustrate a similar development from Native American traditions. In this regard, some have proposed that the Zwammerdam and Swiss lake vessels, with their L-sectioned bilge girders, are conceptually dugouts split longitudinally and expanded by the addition of central planks.¹³ As both McGrail¹⁴ and de Weerd¹⁵ have noted, such is in fact not the case; rather, the bilge girders represent transitional strakes carved out of half-logs. Still, they represent a dugout technology used to produce a planked boat, and may well point to a dugout rather than raft origin.

Romano-Celtic shipbuilding is not only isolated from its past in the archaeological record, it is also divorced from its future. This problem has been discussed in Chapter III, where the lack of early medieval bottom-built remains is disconcerting. As with the pre-Roman period, the problem may simply be one of preservation. Compared to the Roman occupation, the late La Tène and early medieval centuries saw much less waterborne trade and consequently a reduced demand for bottoms. Fewer ships mean fewer wrecks and fewer chances for one to survive and be found. In the Netherlands, where the later focus of this study is concentrated, major geographical changes have taken place since the Roman period, assisted by conscious Dutch efforts to alter the landscape and dredge

¹³ D. Ellmers, "Punt, Barge or Pram - Is There One Tradition or Several?" in *Aspects of Maritime Archaeology and Ethnography*, ed. S. McGrail, pp. 155.

¹⁴ McGrail, *The Ship: Rafts, Boats and Ships*, p. 24, although he interprets the idea too literally.

¹⁵ M.D. de Weerd, "A Landlubber's View of Shipbuilding Procedure in the Celtic Barges of Zwammerdam, the Netherlands," in *Local Boats*, ed. O.L. Filgueiras, p. 40.

navigable waterways. Later periods are better represented due to the development of the Zuiderzee and its reclamation.

In the absence of an unbroken string of vessels, the connection between Roman vessels and cogs depends on basic conceptual similarities. Both families share a nearly-identical construction sequence, which implies related design methods. Cogs had evolved past the point where the bottom was a flat panel of straight planks, but the bottom was still used to determine the basic shape of the hull. The invention or adoption of the keel(plank) may be related to the change in bottom construction. A central backbone, with firmly attached posts, allowed a more streamlined bottom with increasing deadrise toward the ends by providing a strong point of attachment for the hood ends of the bottom planks. In contrast, simpler inland vessels such as the fifteenth-century vessels from IJsselmeerpolders plots K 73/74 and B 55 continued to be built on flat bottoms cut out of a panel assembled from straight planks. These vessels are perhaps the truest descendants of the Zwammerdam type, with very little change over more than a millennium and a half. The cog, with its fair (relatively speaking), continuous plank runs and edge-joined, lapstrake seams, may represent Nordic or Wendish influence on the basic concept.

While clinker shipbuilding is quite strongly associated with the Scandinavian and Anglo-Saxon (originally south Scandinavian) cultures of Europe, ship scholars have shied away from a similar ethnic affiliation for the ships of the Roman Northwest. Originally, these had been called "Celtic" or "celtic" vessels, as many were found in the areas occupied by the Gauls and Britons, and because the

Blackfriars ship seemed to resemble the Gaulish ships described by Julius Caesar. More recent finds on the Lower Rhine, specifically the barges of Zwammerdam, Druten, etc., are from areas more ethnically German, or strongly German-influenced. I am not sure that this is a problem, as there is evidence from the Zwammerdam barges that they were built upriver, in Upper Germany, where the population was more heavily Celtic. The barges are also distinctly different from the patrol vessels of Mainz, which may represent traditional German types. Of course, it is also possible that the patrols boats are a mixture of Roman and native technology, a sort of river Liburnian adapted to the materials and skills of the Rhine Valley. In this regard, it may be useful to note that the framing system of these long, narrow boats is very much in the Mediterranean tradition, with alternating floors and half-frames.

Part of the problem in calling these ships, boats, and barges Celtic is that their descendants, such as cogs, are heavily used by peoples of non-Celtic stock. In contrast, Nordic shipbuilding remains confined to Scandinavian peoples and places heavily settled or influenced by Scandinavians, such as northern and eastern Ireland,¹⁶ northeastern England, and Normandy. This is hardly a major stumbling block either, as it is difficult to imagine a product or idea more pre-disposed to diffusion than boats and boatbuilding. After all, the reason for building boats is to be able to go somewhere else.

¹⁶ M. McCaughan, "Ethnology and Irish Boatbuilding Traditions," in *Local Boats*, ed. O.L. Filgueiras, p. 110. This is not the direct result of Viking settlement, but the introduction in the late nineteenth century of superior Norwegian boat types to the coastal net fishery.

The history of this type of ship- and boatbuilding is evolutionary, as succeeding generations of northwestern European shipwrights adapted the basic concept and technology to changing geographical and economic circumstances. Roman demands for tonnage stimulated the development of larger versions of indigenous craft, but did not substantially alter the way in which such vessels were built. Cogs represent another wave of enlargement and adaptation of flat-bottomed shapes for seagoing ships in response to the rising demand for tonnage in the Middle Ages. Cogs also demonstrate a fairly common trend away from pure forms to hybrids, as bottoms became less structurally distinct and framing systems more important. Even after carvel construction, a potentially revolutionary technology, was introduced from the Mediterranean, bottom-building shipwrights in the Netherlands treated it as an evolutionary improvement to an established technology. While this approach offered immediate economic benefits, it is one of the factors responsible for the eventual decline of their shipbuilding industry. With no incentive to revolutionize, the Dutch shipbuilding industry became the General Motors of the eighteenth century, left behind as former consumers who had chosen the longer, revolutionary path succeeded in realizing all of the benefits of the new technology.

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APPENDIX I
A SHORT HISTORY OF THE ZUIDERZEE,
THE ZUIDERZEE PROJECT, AND
THE MUSEUM VOOR SCHEEPSARCHEOLOGIE

The modern freshwater lake called the IJsselmeer is only the most recent incarnation of a constantly changing body of water. Since Roman times it has passed from marshy freshwater lake to brackish lake to saltwater sea and back to freshwater lake, with important consequences for settlement, economy, and transportation in the surrounding, low-lying land.¹ Most of these developments are the result of changes in climate, sea level, and sedimentation. In recent years, the region has been the subject of one of the most extensive human attempts at large-scale, drastic alteration of the landscape, the Zuiderzee Project.

The Romans called the shallow lake north of the Old Rhine Flevo Lacus and generally tried to avoid it. The area around it, which was inhabited by Germanic tribes, the Frisii and Batavi, was boggy and dismal. Military campaigns in the muddy, trackless wastes of the region were never popular, and may help explain why early Roman policy in the region relied on the Frisii as a client state. A canal was built by Drusus, connecting the lake to the Rhine, and used by his son, Germanicus to invade northern Germany. The lake was sheltered behind a line of coastal dunes occasionally broken by tidal inlets, such as the Vlie, which

¹ A. Lambert, *The Making of the Dutch Landscape: An Historical Geography of the Netherlands*.

connected the lake to the North Sea. The lake was filled by the IJssel and Vecht Rivers, outlets of the Rhine flowing into the northeast and southwest corners of the lake, respectively.

During the early Middle Ages, rising sea level claimed large amounts of land. By Carolingian times, the former Flevo Lacus had become a large, fresh to brackish lake, the Almere. This stretched east almost to the North Sea in places, but to the north, the low-lying land was extensively settled as farmland in the tenth and eleventh centuries. The Almere was still largely protected from the North Sea by the coastal dunes of West Frisia and Groningen. To the north, the coast of Frisia and Groningen was protected by a line of barrier islands stretching away to the east as far as the base of the Danish peninsula. The Waddenzee, the shallow sound behind these islands, offered a sheltered route from Frisian ports in the west to German and Danish ports in the east.

Rising sea level after 1130 and storm flooding in the thirteenth century greatly expanded the Almere and broke through the dunes, turning the lake into a tidal arm of the North Sea. The Marsdiep and the Vlie, the primary inlets into the Waddenzee, were extended by storm floods into the Almere, allowing direct navigation from lake ports to the east. Continued flooding throughout the Middle Ages, culminating in the St. Elizabeth's Flood in 1421, created a large, navigable salt sea connected to but protected from the North Sea by the Waddenzee. The new body of water was called the South Sea (Zuiderzee) by 1340.

The Zuiderzee formed the principal highway within the northern Netherlands from the late Middle Ages onward, with navigable connections to the

rest of northwestern Europe via the Marsdiep and Vlie. The IJssel and Vecht Rivers continued to provide access to the Rhine and Germany. The Vecht also offered an entrance to a network of lakes and rivers in Holland. This network, called the *binnenweg*, or inland waterway, connected the Zuiderzee to the Scheldt, a navigable estuary that in turn connected Holland and Zeeland with the commercial and industrial centers of Flanders and Brabant to the south. Canals and rivers leading to the Zuiderzee allowed traffic between inland towns and the major ports on the Zuiderzee. Foreign trade also passed through the Zuiderzee, as it offered, in combination with the Waddenzee, a safer, sheltered route than the North Sea from the Hanse towns around Hamburg to the markets of Flanders.

Despite the advantages to navigation, the Zuiderzee was an ever-present threat to the land around it. Storms could produce devastating surges and flooding, despite extensive diking of vulnerable areas. Toward the end of the nineteenth century, various plans were formulated to dike off the entire Zuiderzee or a substantial part of it, drain the isolated area, and convert it to farmland. The plan eventually chosen, largely developed by the turn-of-the-century Minister of Public Works, Lely, was implemented in 1920. This called for a barrier dam, the Afsluitsdijk, across the Zuiderzee at its narrowest point, between Zurich in Friesland and den Oever in North Holland (old West Friesland), and the creation of five polders, or large tracts of land, within their own boundary dikes. Each polder would be largely surrounded by the fresh water retained behind the barrier dam, but connected to the mainland and other polders by causeways, bridges, and

some common dikes.² The reclamation of land had been an ongoing task in the Netherlands since the tenth century, with extensive projects in Friesland and Waterland, a marshy area to the northwest of Amsterdam,³ but the scale of the Zuiderzee Project was unprecedented.

The barrier dam and the first polder, the Wieringermeerpolder, which was directly attached to the West Friesland peninsula, were begun at the same time, in 1920. Completion of the Afsluitsdijk in 1932 created the IJsselmeer, a freshwater lake, which flushed the sediment of some salt before diking and draining. Diking of the Wieringermeer had been completed in 1929, so that the polder formed was developed directly from a saltwater state. The first of the IJsselmeerpolders to be drained was the Nordoostpolder, bordering directly on southern Friesland and incorporating the two former islands of Urk and Schokland. Diking was completed and drainage begun in 1940. Work was begun in 1941 on dikes for the Markerwaard, the polder intended to be reclaimed in the southwestern corner of the IJsselmeer, but this work was stopped by occupying German forces shortly after. Development of the Nordoostpolder continued during the War.

After World War II, activity shifted to the big polder, Flevoland, along the eastern shore of the IJsselmeer, although some abortive work on the Markerwaard

² R.H.A. van Duin and G. de Kaste, *The Pocket Guide to the Zuyder Zee Project*, is an excellent history of the Zuiderzee Project, up to about 1985.

³ W.H. TeBrake, *Medieval Frontier: Culture and Ecology in Rijnland*, chronicles an early series of reclamations in coastal Holland.

dikes was carried out in the early 1950's. Flevoland was divided in half, East and South, and drained in stages. Drainage of East Flevoland, the largest polder, began in 1956. South Flevoland followed in 1968. The northern boundary for the proposed Markerwaard was completed in 1975 to act as a causeway from Flevoland to Enkhuizen in North Holland, but work on the fifth polder has gone no farther. It has been decided to keep that section of the IJsselmeer a lake. The total area diked and reclaimed is 166,000 ha.

When drainage of the Noordoostpolder began, it was expected that the remains of tenth- and eleventh-century farming communities would be found. Little evidence of these has surfaced, but a large number of shipwrecks have been discovered. Partly this is the result of dense traffic on the Almere and Zuiderzee from about the twelfth century onward, but it is also the result of the drainage schemes used to keep the farmland dry. Ditches are dug at regular intervals throughout the polders to collect and direct runoff to pumping stations. The close spacing of these ditches results in a fairly thorough, if unintentional, test trenching of the land. City and town development, necessitating the digging of numerous holes, canals, trenches, etc., has also turned up a large number of wrecks (the two hulls examined in detail in the preceding pages, the Almere cog and Oost Flevoland B 71, were both found in urban sites).

The first ships were discovered in the Noordoostpolder during World War II. One of these, a late medieval vessel excavated at plot M 107, was investigated

in detail in 1944 and published in 1945.⁴ In the 1950's, investigations were carried out by the staff of a museum on the former island of Schokland. The archaeological team, like all other services operating in the polders after they were drained, was under the direction of the Rijksdienst voor de IJsselmeerpolders (IJsselmeerpolders Development Authority). Archaeology was placed in the Wetenschappelijke Afdeling (Scientific Division), responsible for research into many aspects of polder development. Eventually, the Museum voor Scheepsarcheologie (Ship Archaeology Museum) was established in a former granary in Ketelhaven, on the northern tip of East Flevoland. Under their first director, G.D. van der Heide, the archaeologists investigated a large number of wrecks, often with an emphasis on sediment stratigraphy.⁵ This allowed the development of rough dating techniques, as well as illuminating the process by which the Zuiderzee had been created. Under the second director, Reinder Reinders, the Museum concentrated on a conscious program of excavation, recording, and publication, with the goal of producing a representative sample of Zuiderzee shipwrecks, from medieval to modern times.⁶ Publications since 1976 have covered cogs,⁷ other medieval

⁴ P.J.R. Modderman, *Over de Wording en de Beteekenis van het Zuiderzeegebied*.

⁵ G.D.H. van der Heide, "Archeological Investigations on New Land. The Excavation of Wrecked Ships in the Zuyder Zee Territory," *Antiquity and Survival* 3 (1955): 243-250. A more detailed history of the Museum voor Scheepsarcheologie and its work is available in H.R. Reinders, *Shipwrecks of the Zuiderzee*, pp. 5-13.

⁶ Reinders, *Shipwrecks of the Zuiderzee*, pp. 15-30.

⁷ H.R. Reinders, *Cog Finds from the IJsselmeerpolders*.

inland craft,⁸ a sixteenth-century fishing vessel,⁹ workboats,¹⁰ and a late nineteenth-century cargo carrier.¹¹ The large sample of vessels investigated (over 350 since 1944) presents a unique opportunity to study chronological developments in shipbuilding, seafaring, and many other aspects of material culture.

Because the Museum may have to investigate quite a few vessels in a year, not all can be excavated and studied in detail. Many excavations are rescue digs, a step ahead of the bulldozers. This also means that the staff have limited time for research, so that major projects must be carefully chosen. Consequently, the Museum has developed a protocol for the investigation, excavation, and preservation of ship finds. Where possible, wrecks are not disturbed any more than is necessary to establish size, date, type, and extent of preservation. Once the survey is complete, the hull is reburied and the water table artificially raised to keep the timbers waterlogged.¹² Where the hull cannot be left in place, the decision must be made how to handle the timbers. Small finds are mapped and removed to the Museum for conservation and curation, but conservation, storage, and display space are limited. If the hull is exceptionally well preserved or of an important

⁸ H.R. Reinders, H. van Veen, K. Vlierman and P.B. Zwiers, *Drie Schepen uit de Late Middeleeuwen*.

⁹ H.R. Reinders, H. van Veen, K. Vlierman, and P.B. Zwiers, *Het Wrak van een 16e Eeuws Visserschip in Flevoland*.

¹⁰ H.R. Reinders, H. van Veen, K. Vlierman, and P.B. Zwiers, *Vier Werkschuiten uit de Zeventiende Eeuw*.

¹¹ P.B. Zwiers and K. Vlierman, *De 'Lutina': Een Overijssels Vrachtschip, Vergaan in 1888*.

¹² Reinders, *Shipwrecks of the Zuiderzee*, pp. 12-14.

but under-represented type, it may be removed to the Museum for conservation (normally by controlled air drying¹³) and display. At present, three hulls have been treated this way: the B 71 (now in storage), a late-seventeenth-century fish buy-boat or *ventjager* excavated in 1986, and the bottom of a large, seventeenth-century *pinas* (find E 81). Other hulls that must be excavated are normally mapped, dismantled, recorded, and moved to a plot of land in South Flevoland, where the tagged timbers are buried below the water table in a "ship cemetery" to await further study. The Almere cog was handled this way. In earlier years, before the storage plot had been acquired, ship remains were sometimes destroyed after recording.

¹³ J. de Jong, W. Eenkhoorn, and A.J.M. Wevers, *The Conservation of SHipwrecks at the Museum of Maritime Archaeology at Ketelhaven*, pp. 25-28.

APPENDIX II

GLOSSARY

ABAFT (prep.): Closer to the stern, behind; traditional form of more common "aft of." See **AFT**, **AFTER**.

AFT (adv.): Toward the stern. See **ABAFT**, **AFTER**.

AFTER (adj.): Pertaining to the stern or closer to the stern. See **ABAFT**, **AFT**.

AMIDSHIPS (adv.): In the middle of the vessel, midway between bow and stern, or at the widest part of the vessel. See **MIDSHIPS**.

APRON (n.): Reinforcing timber fastened to the inboard face of the stem and spanning the keel (keelplank)/stem joint. The apron may also be a point of attachment for plank hooding ends and form part of the rabbet.

BACK OUT (v.): To hollow out the inboard surface of a plank so that it will fit against a curved frame or other timber.

BEAM (n.): A transverse timber, straight or crowned, which is fastened at its ends to opposite sides of the vessel; frequently they support decks.

BEAM SHELF (n.): A stringer, often a clamp, which supports the ends of beams.

BEFORE (prep.): closer to the bow, in front of. Traditional form of more common "forward of." See **FORE**, **FORWARD**.

BILGE (n., also TURN OF THE BILGE): The area of transition from bottom to side; also the place in the bottom of the vessel where water collects.

BILGE KNEE (n.): A frame component spanning the floor-futtock join at the bilge, typically in vessels with flat floors and hard bilges.

BITT (n.): A heavy post rising above the deck for either the belaying of lines or to carry gear such as a windlass.

BOLT (n.): Metal fastening of constant diameter or section. Those which pass completely through the joined timbers and are headed or otherwise restrained at both ends are called **THROUGHBOLTS**. See **DRIFT**.

BOLT (v.): To fasten together by means of bolts.

BOW (n.): The end of the vessel toward the normal direction of travel.

BREASTHOOK (n.): A transverse internal timber in the bow, crossing the stem and joining the sides of the hull; typically it is fastened to or through the inboard surface of the frames.

BULKHEAD (n.): An internal, vertical partition.

BULWARKS (n.): The topsides above the deck. In many vessels, these are only lightly planked to keep water off the deck.

BURR (n.): A washer placed over the shank of a clenched fastening prior to clenching. See ROVE.

BUTTOCKS (n.): The underbody of the hull, below the quarters, especially if it broaden noticeably above a fine run.

CANT FRAME (n.): A frame (typically made up of half-frames) set at an angle to the centerline rather than square, in order to fit the contours of the ends of the hull, where square frames would have to be beveled too much.

CAPRAIL (n.): A railing atop the sheerstrake or bulwarks, normally defining the upper edge of the side of the vessel.

CARLING (n., also **CARLIN**): A longitudinal beam, spanning the space between transverse beams.

CARVEL (adj.): Planking laid flush, edge-to-edge, rather than lapstrake.

CAULK (v.): To render a hull watertight, either by forcing compressible material, such as moss or oakum, into the seams, or by covering the exterior and/or interior of the hull with a layer of watertight material. See **LUTING**.

CEILING (n.): Planking over the inboard surface of the frames.

CHAINWALE (n., also **CHANNEL**): Heavy external longitudinal timber (not necessarily a continuous strake) to which or over which the ends of the shrouds are anchored.

CHAMFER (n.): a bevel on the exposed corner of a faced timber to prevent wear on cargo and to discourage splitting of the edge.

CHINE (n.): Angular join of bottom to side, rather than a rounded bilge.

CHINE GIRDER (n.): A heavy, carved, L-sectioned bilge strake used in a variety of flat-bottomed, inland vessels in northern Europe.

CLAMP (n.): A heavy stringer on the side of the vessel, often opposite a wale.

See **SHELF CLAMP, BEAM SHELF.**

CLEAT (n.): A small block of wood, nailed to the surface of another timber either to fasten it to another timber or to act as a stop.

CLENCH (v.): To spread or bend one end of a metal through fastening in order to prevent it from withdrawing. Normally this is done by upsetting the metal to form a head, but may also be accomplished by bending the protruding shank over.

CLINKER (adj., also CLENCHEE in British usage): Often used to describe several varieties of lapstrake/clenched lap planking, but more specifically applies only to lapstrake planking joined with metal rivets (clinker nails).

CLINKER NAIL (n.): A nail driven completely through timbers (typically lapstrake planks) to be fastened and clenched or headed over a rove or burr.

COAMING (n.): A raised border around a hatch to keep water out.

COVERING BOARD (n.): Deck plan against the inboard surface of the exterior planking, to cover the heads of the frames.

DEADRISE (n.): The transverse rise of the bottom of the hull; the greater its angle above the horizontal, the greater the deadrise.

DEADWOOD (n.): Filling pieces added on top of the keel, especially in large barks at the extremities.

DOUBLE-CLENCHED (adj.): A nail or spike having the protruding portion of the shank bent over twice - once at the end to turn the point back and again at the surface of the timber, so as to drive the turned point back into the wood, thus preventing the nail from turning or working loose. Double-clenched nails are a common alternative to clinker nails in lapstrake construction.

DRIFT (n.): A bolt which ends inside one of the fastened timbers and thus relies on friction to resist withdrawal; a blind bolt.

DROP STRAKE (n.): A strake that does not reach either end of the vessel but fills a gap where vessel girth increases amidships. See **STEALER**.

ENTRANCE (n.): The underwater shape of the bow.

EASY (adj.): A curve having relatively few or gradual changes in radius or direction.

FALSE KEEL (n.): A heavy longitudinal timber, fastened to the underside of the keel; see **SHOE**.

FAY (v.): To shape one timber so that it joins another tightly, generally over a broad area; the rudderpost is fayed to the sternpost, but plank seams are not fayed.

FINE (adj.): Sharper, having less curvature or bluffness; generally applied to the underwater shapes of bow and stern. See **FULL**.

FLAT SCARF (n.): Scarf cut with straight tables ending in feather edges rather than nibbed ends; commonly used for scarfing clinker planking.

FLOOR (n.): The bottom of the vessel amidships.

FLOOR TIMBER (n., sometimes abbreviated to FLOOR): The central component, which crosses the keel (thus spanning the floor), in a frame.

FORE (adj.): Pertaining to the bow or closer to the bow. See **BEFORE**, **FORWARD**.

FORELOCK BOLT (n.): A throughbolt having a slot near one end through which a metal key (the forelock) can be driven to prevent withdrawal of the bolt.

FOREFOOT (n.): The curve or angle where the foot of the stem joins the keel.

FORWARD (adj. or adv.): Toward the bow, pertaining to the bow. See **BEFORE, FORE.**

FRAME (n., also TIMBER): A transverse reinforcing member, made up of one or more components, fastened to the interior surface of the exterior hull planking and often the keel. See **FLOOR TIMBER, FUTTOCK, RIB, TOP TIMBER, BILGE KNEE, HALF FRAME, SIDE FRAME, HAWSE PIECE.**

FULL (adj.): Bluffer, rounder, having more curvature; generally applied to the underwater shapes of bow and stern. See **FINE.**

FUTTOCK (n.): In a frame made up of several components, a member other than the floor timber. In its simplest version, a symmetrical composite frame is made up of a floor timber with one futtock on either side. An even simpler version is to use an asymmetrical floor timber, with one arm extending completely up one side; this requires only one futtock, on the other side. See **TOP TIMBER.**

GANGWAY (n.): A narrow deck running along the side of the vessel amidships, often to connect short fore- and afterdecks; in Dutch inland vessels, the

gangway is a single, structural timber providing considerable longitudinal and transverse strength to the vessel.

GARBOARD (n.): The strake nearest the keel, or the lowest side strake in some bottom-based vessels.

GRIPE (n.): The broadened lower end of the stem, sometimes a separate piece fastened to the forward face of the stem, normally added to improve sailing performance.

GUDGEON (n.): The female half of the iron rudder hinge commonly used in the West; it consists of an iron ring, which is rigidly attached to the sternpost (or sometimes the rudder) and accepts a downward-facing pintle (q.v.) attached to the rudder.

GUNWALE (n.): A wale at gundeck level to support the weight of ordnance.

GUNWALE (N.): The upper edge of the side of a small, open boat; often misused to indicate the uppermost strake, correctly called the sheerstrake (q.v.).

HALF-FRAME (n.): A frame component, typically occurring as one half of a pair, reaching from the keel (or nearly so) most of the way up the side.

HANGING KNEE (n.): A vertical knee, the vertical arm of which "hangs" below the timber supported, usually a beam.

HAWSE PIECE (n.): A frame running fore and aft in the bow, with its foot against the forwardmost square frame; used in extremely bluff bows, where the curvature is too full even for cant frames.

HAWSEHOLE (n.): A hole through the bulwarks, often reinforced with timber or a metal lining, for the passage of hawsers (heavy lines used for mooring a vessel) and other large lines.

HOG (n.): Centerline strake serving primarily as a point of attachment for the garboards. British usage.

HOG (n. and v.): Vertical distortion of the hull in which the ends droop and the middle rises.

HOODING ENDS (n., also HOOD ENDS): The ends of the planking strakes, normally fastened to the stem and sternpost assemblies.

HOOKE (n.): A knee forming the angular transition between the keel (or keelplank) and the stem or sternpost; considered a diagnostic feature of

cogs. A similar timber found in some Iberian vessels of the Renaissance is normally called a "heel".

HOOK SCARF (n.): A scarf in which the table is joggled so that the two halves cannot be pulled apart longitudinally; several varieties exist, all with their own names and peculiarities.

HORIZONTAL SCARF (n.): A Scarf in which the table lies in an approximately horizontal plane i.e. one component lies on top of the other.

INWALE (n.): A stringer at the heads of the frames; the term originally applied to small craft, but cogs have a similar timber.

JOGGLE (v.): To cut a step or series of steps in a timber to fit another. Some lapstrake boats have the frames joggled to fit the stepped interior surface of the planking.

KEEL (n.): Central backbone timber, of sufficient cross-sectional area to offer significant longitudinal strength to the hull. In most cases, a portion of it projects below the bottom planking and offers lateral resistance. See **KEELPLANK**.

KEELPLANK (n. - also **PLANK KEEL**): Centerline strake, often thicker than the adjoining garboards, but not sufficiently stiff to be considered a true keel. See **HOG**.

KEELSON (n. - also **KELSON** in British usage): An internal, centerline timber lying atop the frames, of sufficient length, cross-sectional area, and rigid fastening to add significantly to the longitudinal stiffness of the hull. The maststep may be cut into the keelson, or it may be a separate timber fastened to the upper surface of the timber. See **MASTSTEP**.

KEYED SCARF (n.): A hook scarf with a transverse wedge or key driven through the center to tighten the joint.

KINGPLANK (n.): A heavy deck plank, often inlet for other timbers.

KNEE (n.): An angular, V- or L-shaped timber cut from a naturally-curved crotch or bend. The extremities are called "arms," the hollow on the inside the "throat," and the exterior angle where the arms meet the "breech." If one arm is substantially larger than the other, it may be called the "balk."

LAPSTRAKE (adj.): Having planks which overlap at the seams, typically with the lower edge of the upper plank outboard, regardless of how, or even if, the planks are fastened together. See **CLINKER**, **REVERSE CLINKER**.

LEDGE (n.): A partial beam, spanning only part of the breadth of the hull.

LIMBER (n., also LIMBER HOLE, LIMBER PASSAGE): A channel in the underside of a frame (or occasionally in the upper surface of the planking) to allow bilge water to flow past the frame toward a central sump or bailing well.

LIVELY (adj.): Sheer having relatively great vertical curvature.

LODGING KNEE (n.): A horizontal knee, one arm longitudinal, the other transverse, to brace a transverse timber, usually a beam.

LUTING (n.): A form of caulking in which compressible material, such as moss or hair, typically in the form of a string or loosely spun rope, is inserted into the seams during construction rather than after the hull as been planked. It should be noted that the caulking/luting distinction is an archaeological imposition and that the majority of boatbuilders in northern Europe do not distinguish philologically between the two approaches.

MASTSTEP (n.): A mortise to house the heel of a mast, and/or the timber into which it is cut.

MIDSHIPS (adj.): Pertaining to the middle of the vessel or located amidships (q.v.).

MORTISE-AND-TENON JOINT (n.): An edge-to-edge planking fastening commonly used in the ancient Mediterranean. Each joint consists of a free tenon housed in mortises in opposing edges of a seam; in its fully developed form, the tenon is locked into either plank by a wooden peg driven through plank and tenon.

NAIL (n.): A metal fastening of tapered diameter or section, smaller than a spike.
See SPIKE.

NIBBED (adj.): Having a thin, square end rather than a feather edge; often done to the ends of tapering deck planks and other timbers to make joinery easier and to discourage rot.

NOTCH (v.): To join by cutting a notch into one component to fit the other. If a timber is "notched over" another, it has a notch cut into it to fit the other; if it is "notched into" another, it fits into a notch cut in the other timber.

PINTLE (n.): The male half of the iron rudder hinge widely used in the West; the pintle is a downward-facing pin, which is rigidly attached to the rudder (and

occasionally an upward-facing pin attached to the sternpost) and fits into a gudgeon (q.v.) attached to the sternpost (or sometimes the rudder).

PLANK (n.): A wide, flat member, relatively thin but thicker than a board. Such pieces are used to cover the exterior and interior of the hull, the deck, etc.

POST (n.): Upright (or nearly so) backbone timber at either end of the hull. See **STEM, STERNPOST.**

QUARTER (n.): The side of the vessel at the stern.

RABBET (n.): V-shaped groove in the keel, stem, and/or sternpost into which the hooding ends and the lower edge of the garboard are fitted. The rabbet may be a cutting in the side of a timber or a channel formed at the angular join between two timbers, such as the stem and apron.

RAKE (v.): To incline forward or aft.

RAKE (n.): The amount of inclination forward or aft. It may be expressed in degrees relative to horizontal or vertical, or in horizontal linear measure.

REVERSE CLINKER (adj.): Having lapstrake planks with the upper edge of the lower plank in each seam outboard of the lower edge of the upper plank,

or opposite to "normal" lapstrake planking; such an arrangement has been suggested for some medieval northern European vessels, largely on the basis of iconographic evidence, but there is no archaeological or ethnographic evidence of such planking in Europe.

RIB (n.): A frame made of one continuous piece from sheer to sheer. This term is often found in British archaeological publications where "frame" is more correct, but I can find no indication that this usage has any basis in British nautical tradition.

RIDER BEAM (n.): A heavy beam above another, often above the deck; such construction is often found on Dutch inland craft, but is also known from the ancient Mediterranean.

ROCKER (n.): deliberate upward curvature at the ends of a longitudinal timber, such as the keel.

ROCKERED (adj.): Having rocker.

ROOM (n.): The area between adjacent frames.

ROVE (n.): A washer placed over the shank of a clenched nail prior to clenching.

See BURR.

RUDDERPOST (n.): Straight, upright timber, to which the rudder hardware (normally gudgeons) is attached, fastened to the after face of the sternpost assembly,

RUN (n.): The underwater shape of the stern.

SCAB (v.): To fay one timber to fit against the unworked surface of another, rather than constructing a more complex joint.

SCANTLING (n.): The principal dimensions of the major structural components of the hull; such information is sometimes presented in the form of a "scantling list."

SCARF (n. - also SCARPH in British usage): A joint in which timbers with parallel axes overlap longitudinally. Many varieties, of inconsistent nomenclature, are known. See **HOOK SCARF**, **HORIZONTAL SCARF**, **FLAT SCARF**, **KEYED SCARF**, **STRAIGHT SCARF**, **VERTICAL SCARF**, **TABLE**.

SCARF (v.): To join two timbers with a scarf.

SCUPPER (n.): A passage through the bulwarks to allow water on deck to drain overboard.

SHEER (n.): The upper edge of the uppermost continuous strake of exterior planking. In many, smaller vessels, this is the upper edge of the side. In larger vessels, the sheer, sometimes called the planksheer, may be below the bulwarks and other upper works. See **SHEERSTRAKE**, **GUNWALE**.

SHEERSTRAKE (n.): The uppermost continuous strake of structurally significant planking; on vessels with light bulwarks, the sheerstrake may actually be a deck level. See **GUNWALE**.

SHELF CLAMP (n.): A clamp which also supports the ends of beams.

SHOE (n., also WORMSHOE): A thin longitudinal timber, often easily replaceable, fastened to the underside of the keel or keelplank to prevent wear to the structural timber.

SIDE FRAME (n.): A free futtock, independent of floor timbers and other framing elements, reinforcing the topsides; such timbers are a characteristic feature of Viking shipbuilding.

SINTEL (n.): An iron staple with broadened head used to hold caulking materials (typically a wooden lath over driven fiber) into a seam in many types of medieval northern European vessels; originally a Dutch and German word now used by English-speaking archaeologists and ship historians.

SKEG (n.): A projection at the after end of the keel to protect the leading corner of a sternpost rudder; the term can also be applied to an external deadwood that smoothes water flow into the rudder.

SLACK (adj.): A bilge with curvature of relatively large radius, making a gradual rather than abrupt transition from bottom to side.

SPIKE (n.): A metal fastening of tapered diameter or section, larger than a nail. There is no specific demarcation between nails and spikes, but I was taught as an apprentice that if it took a two-handed hammer to drive it, it was a spike. See NAIL.

STANDING KNEE (n.): A vertical knee, in which the vertical arm "stands" above the supported timber, usually a beam.

STANCHION (n.): A vertical post supporting a load above.

STEALER (n.): A strake that is not continuous from one end of the vessel to the other. Typically, a stealer is a relatively short plank added where vessel girth increases too rapidly to be accommodated by the number of continuous strakes e.g. in the hollow below the buttocks of a transom-sterned vessel. See DROP STRAKE.

STEM (n.): The upright backbone timber rising from the forward end of the keel or keelplank; may denote the specific timber into which the plank hooding ends are rabbeted in a complex assembly, or the entire assembly. See **APRON**, **GRIPE**. "Stempost," commonly seen in archaeological works, is a modern back-formation based on "sternpost" and cannot be found in traditional marine dictionaries or in common use among traditionally trained shipwrights.

STERN (n.): The end of the vessel away from the normal direction of travel.

STERNPOST (n.): The upright backbone timber rising from the after end of the keel (keelplank); may denote the specific timber into which the plank hooding ends are rabbeted in a complex assembly, or the entire assembly. See **RUDDERPOST**.

STRAKE (n.): A continuous run of planking, made up of one or more planks joined or butted end-to-end.

STRAIGHT SCARF (n., also **NIBBED SCARF**): scarf with straight tables and nibbed ends.

STRINGER (n.): A heavy, longitudinal timber, such as a clamp, on the interior of the vessel.

TABLE (n.): the longitudinal joining face of a scarf.

THWART (n.): Transverse bench, normally placed high enough in an open boat to act as a seat for oarsmen; in many vessels, thwarts also act as beams.

TOPSIDES (n.): The sides of the vessel, particular the portion above the waterline.

TOP TIMBER (n.): The uppermost futtock.

TRANSOM (n.): A transverse timber in the stern, crossing the inner face of the sternpost assembly and holding the sides together. Sometimes called a **TRANSOM TIMBER** to distinguish it from the flat, transverse plane forming the sterns of some vessels.

TRANSOM (n.): A flat, transverse plane forming the stern of the vessel.

TRANSVERSE WATERWAY (n.): A heavy, transverse timber at a rider beam; it supports the ends of the deck planks and directs water to the scuppers at either side.

VERTICAL SCARF (n.): A scarf in which the table lies in a vertical plane i.e. the components lie side by side.

WAIST (N.):The area in the middle of a vessel, particularly the area of low freeboard in a vessel with raised decks or bulwarks at the ends.

WALE (n.): An exceptionally heavy strake.

WASHSTRAKE (n.): A light plank, temporarily or permanently fastened above the sheer or caprail amidships, to keep spray off the deck or protect deck cargo.

WATERWAY (n.): A heavy timber along the outboard edge of the deck to direct water to the scuppers.

VITA

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