NEW INFORMATION FROM OLD TIMBERS?

A RE-ANALYSIS OF WRECK LHL-81 FROM ØSTERBY HARBOR, LÆSØ DENMARK

Sarah Madden
Master thesis
Supervisor: Jens Auer
Maritime Archaeology Programme
University of Southern Denmark
June 2016

TABLE OF CONTENTS

ABSTRACTS

ABSTRACT- English

Once a shipwreck is found, what steps are taken to ensure it's inclusion in the archaeological record? And is this enough? This thesis looks at wreck LHL-81, originally found and recorded in March 1980 in Østerby Harbor in Læsø. After three decades of sitting on land in an open air exhibit in the Esbjerg Fiskeri og Søfartsmuseum, what new information, can be discovered? Paleography and further research into the ship's construction are helpful but not any more definitive as to the specific ship identity. However, as a case study of the legislation procedure for archaeological materials and cultural heritage awareness in Denmark, wreck LHL-81 can contribute to the importance of awareness and biases in the archaeological research agenda.

A documentation portion of this thesis delves into the usefulness and viability of making three dimensional models, and what purpose they can serve to the archaeological community at large for remote research.

As a whole, wreck LHL-81 was not used to full potential in the 1980 investigation. By analyzing prior work and critiquing the educational efforts of preservation and conservation in Denmark, the wreck LHL-81 is able to offer new information to the archaeological record regarding the wreck itself, while also contributing to the discussion of cultural heritage and it's role in public outreach and the variations of truth required for research and educational agendas.

ABSTRACT- Dansk

Når et skibsvrag bliver fundet, hvilke forholdsregler bliver så taget for at sikre vraget, eller en dokumentation af vraget, for fremtiden? Og er det nok? Dette speciale omhandler vraget LHL-81 der blev fundet og dokumenteret i marts 1980 i Østerby Havn ved Læsø. Efter at have indgået i udendørsudstillingen på Fiskeri- og Søfartsmuseet i Esbjerg i tre årtier, gemmer vraget så stadig på ny viden? Paleografi og nye undersøgelser af skibets konstruktion kan hjælpe til at få en bederne forståelse af vraget, men bidrager ikke til at afdække skibets specifikke identitet. Vraget kan derimod indgå i et case studie af den dansk arkæologiske lovgivningen og den fælles bevidsthed om kulturarven, og dermed en diskussion om vigtigheden af bevidstheden om den arkæologiske kulturarv og bias i den arkæologiske forskningsagenda.

I dokumentadelen af dette specialet undersøges det endvidere hvor anvendelig og holdbar en metode det er, at producere tredimensionelle modeler, og hvordan disse kan anvendes i en større sammenhæng til at studerere vrag uden at have adgang til det arkæologiske primærmateriale.

Overordet set blev det fulde forskningspotentiale af vrag LHL-81 ikke udnyttet i 1980 undersøgelsen. Gennem en analyse af tidligere arbejde med vraget og en kritik af den uddannelsesmæssige indsats for bevaring og konservering i Danmark, kan vrag LHL-81 bidrage med ny arkæologisk viden om vraget selv, og samtidig bidrage til diskussionen om formidling af kulturarven, samt de forskellige hensyn der må tages for at tilgodese henholdsvis den forskningsmæssige- og den formidlingsmæssige indsats.

ACKNOWLEDGEMENTS

The course at Syddansk University has been a long and surprising journey. I am humbled and indebted to everyone who has contributed to my life with their friendship, support and encouragement while I worked to complete this thesis. This would not have been possible otherwise.

First and foremost, to my thesis advisor Dr. Jens Auer for all his help, advice, and support in all stages of this project. I never would have started (or finished) without his guidance. Similar thanks to Dr. Athena Trakadas and Dr. Thijs Maarleveld for their teaching and instruction during my time at SDU. I would also like to thank Dr. Morten Ravn at the Viking Ship Museum in Roskilde who gave his time and provided the original report which formed the foundation of this thesis.

Robert de Hoop and Nicole Schoute: without your help, photogrammetry recording would have been a stressful mess. And to Massimiliano Ditta: you are a technical wizard with all the answers.

Thanks to Aiofe Daly, who was kind to examine photographs and lend her dendrochronological expertise.

Also thanks to Lili Jepsen and Niels Erik at the Læsø Museum for being my eyes and ears when I could not make it to the island to study the cannon in person.

I am so grateful to Mum, Chica, and Dad, who have given their support through the thick and thin. And of course to friends who gave their encouragement throughout. Special thanks to Jessica Neal, Mike and Alex for their couch and company on Esbjerg visits; to Michelle Pare for my motivational posters; to Klara Fiedler for her editing skills; and to Christopher Olsen who helped keep my sanity in check.

Last but certainly not least, a huge thank you to the very kind and very patient Ellen Margrethe Møller Andersen, SDU Counsellor, for all her invaluable help that was able to keep me in Denmark long enough to complete this course.

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CHAPTER 1:
INTRODUCTION

On March 20, 1980 a local fisherman discovered a wreck in Østerby Harbor, on the island of Læsø, Denmark. Along with timbers from two separate wrecks, two cannons were also lifted from the harbor.

Investigation showed that one set of timbers belonged to a fishing ship from the 1930s. However, the other timbers were far older, and there were no recollections in the collective town memory of an older ship having sunk there.

An initial report was created in 1981 by the National Museum's Michael Teisen and naval architect Morten Gøthche. The report gives an approximate date of the wreck as 1750 to 1850. The cannons which were raised were separated; one was taken by a local and deposited in their garden, the other went through multiple owners before being lost.

The remaining timbers were eventually moved to the Esbjerg Fiskeri- og Søfartsmuseum in 1989, where they were reassembled into a shipwreck display and put in the open-air area. The wreck has been sitting there since with no further research done, and other wreck pieces added onto the exhibit.

1.1 AIMS AND OBJECTIVES

LHL-81 has not been the focus of major archaeological research in it's thirty years on land. Dredged up, it was necessary to deal with the pieces as a rescue operation. The peculiarities of the timbers and their fittings created a need for a second investigation. However, no further research was taken up at the time. Efforts to use the timbers as a tool for public outreach and education were considered and praised, but the actions fell short of accomplishing these goals. Documentation of the

timbers after the initial inspections is lacking, leaving no clues as to the Fiskeri- og Søfartsmuseum's original intent or thought process in how to utilize the wreck. In short, it has simply been sitting untouched for three decades.

With so many gaps in the research and preservation techniques, it is important to return to LHL-81 and take a look at this wreck after thirty years on land, to learn information not only about the date and provenance of the wreck, but also in how cultural heritage is ascribed, interpreted, and utilized in Denmark, and what steps can be taken on future wreck finds to avoid similar cases of apathy. This thesis will hopefully shed new light on an old case.

The aim of this thesis is two-fold. The first focus will be to discover what, if any, new information can be gleaned from the timbers of LHL-81 that have been more or less abandoned for thirty years. The initial report was brief and while it suggested further research, none was undertaken. By examining the material as it stands in Esbjerg, more details can be recorded and used to find more information as to the timeframe and provenance of the wreck. A photogrammetric model will be useful to highlight the details on the timbers and will prove useful in identifying the details and gleaning more information from them.

Using photogrammetry to record and document the wreck in it's current state will give a better overview of the reassembly of the wreck as a whole, but also offers easier and less time consuming documentation of the timbers than traditional timber sheets and offset drawings. While measurements and observations were done in the 1980s, to redo them again three decades later would do little to improve upon the data already gathered, as the timbers have been weathered, warped, and disintegrating under the weather conditions. The images used to create the photogrammetric model have a high resolution and even small features, such as construction sequence carvings, can be seen. This model can provide remote access for researchers not located in Denmark.

The second set of questions focused at the wreck deal with its' current state. At present, it is

lying in an open-air space at the Esbjerg Fiskeri- og Søfartsmuseum, partially reassembled. However Gøthche made note that this construction assembly is not correct at all. Rather, the museum used this assembly in order to give the public a better impression of a shipwreck. LHL-81 can serve as a case study in a discussion on options for wrecks post-excavation.

This project on LHL-81 serves as a good combination of physical research as well as a study of the lifecycle of an artifact affected by C-, N-, and L-transforms as it passes in and out of the archaeological record.

1.2 ARCHAEOLOGICAL QUESTIONS

1- Can the identity of LHL 81 be discovered through re-analysis of the timbers and archive research? If the wreck cannot be linked to a specific ship, can the timeframe be narrowed down?

2- How does archaeological theory and legislation impact an item's cultural heritage value? Do any of these spheres on their own drastically impact the role an item will play in research and the public perception of history? Does an item have to be in the archaeological record to be considered a significant piece of cultural heritage?

3- Is 3D modeling an appropriate form of documentation for LHL-81? What gains can come from photogrammetry of a whole wreck assemblage as opposed to individual timber recordings?

CHAPTER 2:
METHODOLOGY

This project looks at LHL-81 from two different angles. The first part of this project is to re-analyze the timbers in order to find more concrete information of the origin, time period, and identity of LHL-81. The second portion of this study looks at LHL-81 as an item of cultural heritage and how it has been used since discovery.

The following chapter will discuss the materials available for study as well as the methods employed. This is intended to add transparency to this project and give a full picture of the logic behind the steps taken. Information here can be used by future researchers in order to track the decision process for this portion of LHL-81's lifecycle.

2.1 MATERIALS AVAILABLE

In the case of LHL-81, there is not much physical primary material to work with. Ten frame pieces, a portion of the keel, and a few stringers and hull planks were lifted, as well as two cannons. Considering that the wreck context had already been destroyed by dredgers, it is not unusual that there are no other finds. The only remaining materials to work with are the timbers themselves and two cannons.

2.1.1 TIMBERS

Ten floor frames, a keel piece, a few stringers, and hull planks are the only remaining timbers found from LHL-81. Although there is not much to work with, the frames are from the midships

portion of the hull, which can provide size information about the wreck. The timbers are well preserved enough to see construction sequence symbols engraved on one of the moulded sides.

2.1.2 CANNONS

Two cannons were also raised in 1980. Cannons can also be dated based on material, style, and designs. Engravings and designs can also pinpoint the foundry that cast the weapon.

2.1.3 DOCUMENTATION

There is a good amount of documentary evidence to work with. The Nationalmuseet, Skibshistorisk Laboratorium report by Teisen and Gøthche (1980), while it does not have any conclusions, does have important materials, such as timber recordings of the frames when first raised from the water. Both men also recommended that more archive and local research be done. However, some documentation is completely missing, such as the decisions in the wreck re-assembly.

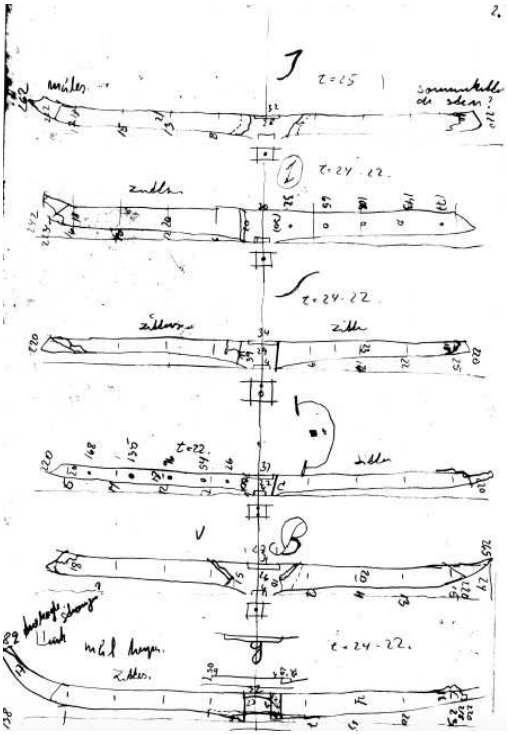


Figure 1: LHL-81frame sketches by M. Gøthche (Gøthche, 1981:0776-TO-0004).

The Læsø local archive has been helpful in providing information about the history of the island, as well as doing some investigative interviews with locals to try and locate the raised cannons.

Other documentation resources have been used to create a full picture of the area history and ship construction context. Full references are cited in the Bibliography.

2.2 APPROACHES

With so few materials to physically work with, much of this project is desk-based research. The events in LHL-81's timeline since discovery also lend itself as a case study in terms of archaeological significance and cultural heritage.

The Nationalmuseet, Skibshistorisk Laboratorium report (1980) is the foundation of this project. Both Teisen and Gøthche handled the timbers directly and recorded them. They were also able to talk with locals and uncover information regarding the distribution of the found cannons and other timber pieces.

However even without cargo and personal item materials, the timbers themselves are clues. Wood can be dated through dendrochronology and they can be tested for dendroprovedence. The construction process is visible in the timbers, and that can give data for interpretation as well.

2.2.1 DENDROCHRONOLOGY

Dendrochronology has been a very reliable scientific method to help date timbers since the 1900s. In simplest terms, a tree produces one ring for every year that it is alive. Not only can the rings determine the age of the tree, but the “year-by-year record or ring pattern is formed that in some way reflects the climatic and environmental conditions in which the tree grew”, which can give suggestions as to the geographical origin of the tree (Dendro.cornell.edu, 2015).

Dendrochronology is a nuanced field that makes use of many different types of wood materials to continually add to tree-ring chronologies. Cross referencing of many tree samples in one area allows for exact year identification (Ltrr.arizona.edu, 2012). This index offers a master chronology against which other wooden items from the area may be compared (Daly, 2007:x).

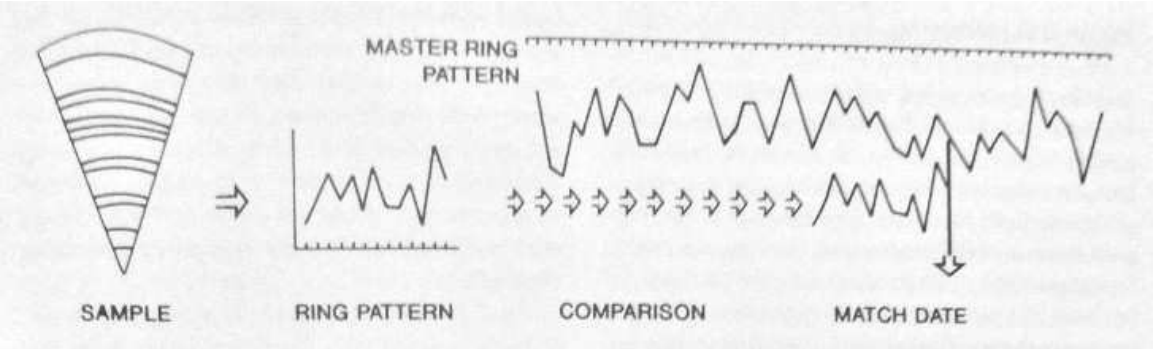


Figure 2: Dendrochronology dating. Ring patterns from wooden samples are compared against a master chronology to find a matching pattern for a date (Braillie, 1995:7).

Comparing these area patterns creates a chronology that can offer insight on environmental changes as well as social economy with wood technology and it's role in the historical landscape (Dendro.dans.knaw.nl, 2016). Chronologies are largely dependent on surviving wooden structures, and in Europe there is a large gap when there was a building hiatus in the 14th century due to the Black Death (Baillie, 1995:124). Denmark, on the other hand, has an unbroken chronology which dates back to 352 BC (Skalk.dk, 2016).

However, obtaining this information is not always easy. Many institutions study the particular region that they are located in to create their own master chronology (Daly, 2007:6). The *Digital Collaboratory for Cultural Dendrochronology* (Dendro.dans.knaw.nl, 2016) is one of many recent initiative to collaborate and share tree ring data in multiple languages and formats for researchers in western Europe, as well as the International Tree-Ring Data Bank, which is mainly focused on European oak, although neither are anywhere near completion (Daly, 2007:6).

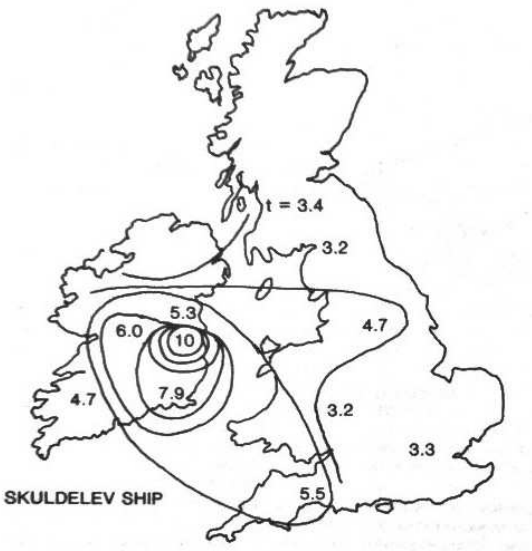


Figure 3: Correlation lines showing Irish origin of Skuldelev 2 timbers (Baillie, 1995:132).

Comparing correlations and overlap between chronologies can offer evidence as to the provenance, or

original location, of a timber (Ltrr.arizona.edu, 2012). Aoife Daly has engaged in much research to move away from a master index provenance chronology and is working to make more localized chronologies, which can offer more exact origins of a timber. This dendroprovenance has been instrumental in identifying timber trade in a number of high profile wrecks, such as the Danish Skuldelev 2 which was made of Irish oak (Daly, 2007:3 and Baillie, 1995:132).

The hope is that samples taken from LHL-81 can be analyzed for date as well as provenance.

2.2.2 PALEOGRAPHY

Since the timbers of LHL-81 are fortunate enough to have the construction sequence symbols still visible, there is a chance to analyze them using paleography, or the study of handwriting evolution. Over the course of centuries, handwriting styles change and evolve, with styles specific to a particular area at a certain point in time (Familysearch.org, 2016).

Using paleography samples and tutorials from national archives was the best way to access clear and accurately dated and geo-referenced materials. However, in most cases, numbers were not included in the archives' sample sheets. This meant that comparison could only be done with the letters. Ten samples are not many to work with, but it was immediately obvious as to which fonts have little to no correlation.

Charts were made of each LHL-81 symbol and the closest corresponding letters from each sample group. This would allow for better side-by-side comparison of the individual characters. Comparing the single letters against the different styles then lead to determining which alphabet was the best-fit for LHL-81. This is very difficult as it is highly subjective and is based on handwriting samples which are considered typical of their respective time periods, but they do not allow for small variations on local levels or date. Samples from Germany, Scandinavia, and Russia were used for

comparison, ranging from 1600 to 1900, in order to give a wide range of styles from all over the North Sea and Baltic areas.

Analysis of the letter styles can also give insight as to the date and provenance, if not of the wreck itself, at least of the shipbuilder.

2.2.3 LOCAL ARCHIVE COLLABORATION

Tracking down the location of the cannons has not been easy. Help from the Læsø musuem staff has helped in many ways. The 1980 report cites Kaj Klitgaard as the recipient of one of the cannons. The Danish online database (Krak.dk) was used to locate Kaj Klitgaard, but there were a number of entries for the island. Læsø Museum assistant Lili Jepsen was able to meet in person with Kaj Klitgaard on Læsø to discover that he was not the original Kaj Klitgaard in the report.

When this turned out to be a dead-end, Lili investigated further, interviewing a former port captain, Erik Møller Sørensen for more information.

2.2.4 PHOTOGRAMMETRY- RECORDING LHL-81

Recording the timbers of LHL-81 by hand would be a difficult task due to the size and the current state that the pieces are in. The timbers have been sitting out in the elements for two decades, where the weight of snow and of children have warped the timber shape. In order to efficiently record the current state of the wood, as well as to interact with the assemblage as a whole, a 3D model was determined to be the best option.

Offset measuring is certainly an option, but with a large three dimensional object, there are many opportunities for errors. In this particular case, an offset drawing would be very difficult due to

the tilt of the wreck and would require multiple drawings to show the different sides of the timbers. In contrast, a 3D model allows for manipulation of viewing angle and zoom. With modeling options so readily available, a 3D model can "considerably enhance recognition of construction material, shape and area, and their spatial distribution" (AL-Ruzouq, 2012:104) rather than just using drawings and photographs. While photographs of object details can enhance a report, a three dimensional model of the entire object with the ability to zoom in and out of details can offer "high accuracy analysis in the archaeological data collection process" (Farjas, 2009:1) and such as the clenched nails or construction sequence marks on LHL 81.

While there are many options for three-dimensional recording of LHL 81, photogrammetry was the best option. Other technologies such as the a total station connected with software like Site Recorder are an option to measure and triangulate objects, however, "the manual entry of measured points resulted in only a relatively small number of 3D points which enabled a "postproduction" reconstruction of an object but without any details that could be studied in the future" (Eric et al., 2013:5). While a Faro Arm can make exceptionally detailed recordings of objects, size and location are a huge factor in deciding when and where to use it. A Faro Arm can be used in the field; this would not be an option for this project. LHL 81 is restrictive in terms of size, taking up almost thirty square meters.

Photogrammetry with handheld cameras can offer "low-cost, portable, flexible and [are] able to deliver [...] highly detailed geometries and textures, (Nicolae et al., 2014:451). Single software alignment that can create the model with limited human interaction, as opposed to a total station, for initial recording is convenient and has a lower risk of human error. However, models made via software alignment requires further manipulation to make a mesh over the point structure and further post processing to make a complete model with texture (Van Damme, 2015:232).

Although it is relatively simple to make a 3D model with the technology available today, it is

also important to understand why these efforts are being taken. Understanding cultural heritage and the benefits, as well as the dangers of history versus heritage, are important when looking at the use of digital object. The biases of the information must also be taken into account when considering the availability of open access archaeological data.

2.3 PHOTOGRAMMETRY METHODOLOGY

2.3.1 RECORDING LHL-81: TECHNIQUES

Two cameras were employed in order to make the most of our short dry period. A GoPro camera was used and took 350 images. A colleague used a Sony Cyber-shot camera and took 280 .JPG images. Two cameras were used to ensure that there would be enough good quality images to use in the photo processing.

With one person starting in one corner, and the other in the opposite, images were taken all around the wreck and from above, with each photo overlapping the last. The Agisoft PhotoScan offers a recommendation of three points per photography to overlap (Agisoft, LLC, 2012), while Kjellman offers his rule of thumb as 60% of overlap from the previous photograph (Kjellman, 2012:21).

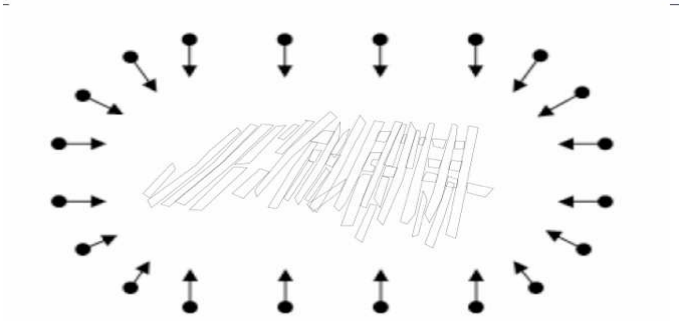


Figure 4: Proper photogrammetry techniques of LHL-81.

Once both cameras had made full circles around the wreck, a few last images of details were taken, such as of the construction sequence letters and large nails.

Photographs from both cameras were uploaded onto a laptop and quickly inspected. With the images from the Sony camera being of higher quality and clarity than the GoPro, it was decided to make a model using only those images, in order to yield a clearer and better detailed model. Although a GoPro with its' fisheye lens can sometimes offer more object surface area coverage with less photographs (Van Damme, 2015:234), in this particular case, the lower resolution was deemed a disadvantage for the model. More photographs of details could have helped achieve a more complete model, but the extra images would have required more time and processing power to align all the images. With this logic, the images from the Sony Cyber-shot were the only ones uploaded and utilized in this model.

2.3.2 PHOTOGRAMMETRY SOFTWARE: AGISOFT PHOTOSCAN

Agisoft PhotoScan is “an advanced image-based 3D modelling solution aimed at creating professional quality 3D content from still images” (AgiSoft LLC, 2012) and has been the subject of a number of reports investigating the reliability in reference to an archaeological scope (Van Damme, 2015 and Kjellman, 2012) as well as having received “positive reviews in scientific articles which compare various photogrammetry software applications to one another” (Van Damme, 2015:232).

This software was chosen for this project for a number of reasons. First, the software is used in the University of Southern Denmark Maritime Archaeology Programme coursework; my colleague is already familiar with the software and he was able to help with the rendering of the model. Second, Agisoft has the advantage of being a complete package in terms of combining different steps of processing, from camera calibration to textured mesh generation, rather than having to use multiple softwares for each separate step (van Damme, 2015:232). Finally, Agisoft was used because of it's financial availability in a free trial package. Agisoft offers two editions, Standard (179 USD) and

Professional (3,499 USD), while also offering educational licenses for researchers and students at educational facilities (59 USD for Standard edition and 549 USD for Professional edition). The trial package of the Standard edition offers more than enough options for the recording of wreck LHL 81; however, the Professional edition would be far superior for a project which would need options for geo-referencing, DEM export, and orthophoto production (Kjellman, 2012:24).

Complete step-by-step instructions for the software are available through the Agisoft PhotoScan's user manual and many online tutorials written for both basic and advanced users. Rather than going in-depth on the exact procedures followed, a basic outline of steps taken by my colleague and I show the decisions made in the process of the LHL 81 wreck model.

2.3.3 CREATING THE LHL-81 MODEL

The chosen images were first uploaded into Agisoft PhotoScan. The next step was to "Align" all the images into one cohesive photo mosaic. The software "uses a 'feature detection algorithm' to automatically identify and match features in overlapping pictures" (van Damme, 2015:232) and then uses 'feature-based alignment' to match features found in numerous images to create intersecting rays which are then calculated to determine the camera position. This step results in a point cloud, a 3D approximation of the scene in the images

(Semtonov, 2011).

"Masking", or hiding superfluous background, can be done at this stage, but requires going through each individual photo. By waiting to do this step at a later point, there are more points available for the software to align the images, and the masking process will take much less time when working on the image collection as a whole rather than each individual piece.

Once the images are aligned, the "Point Cloud" button shows the point cloud. This point cloud of the object shows where a majority of the points of the object are, allowing a boundary box to be drawn around the relevant point cloud, quickly eliminating outliers. This is an efficient way to utilize the 'Mask' feature without having to go through each individual image.

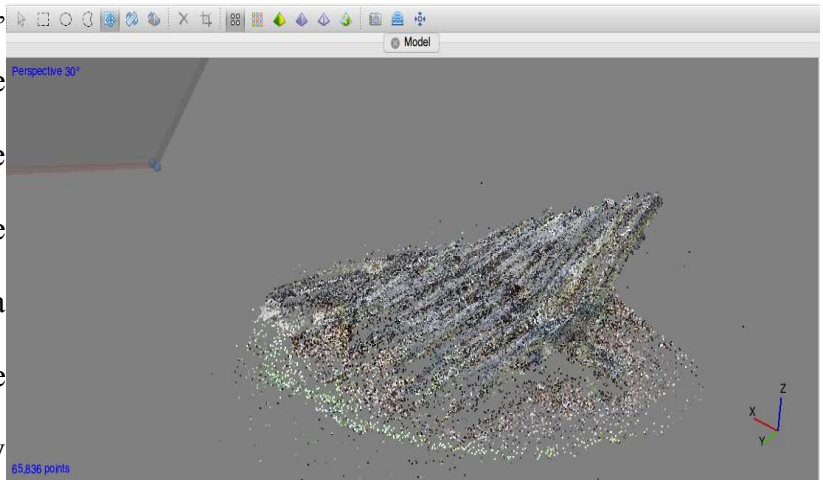


Figure 5: Dense point cloud of LHL-81. Photographs are aligned based on overlap, which uses algorithms to calculate depth and perspective information. The point cloud is used as a framework for a mesh covering in the next step (Image created using Agisoft software, Model by De Hoop and author).

The next step was to "Build Dense Cloud". Using "estimated camera positions the program calculates depth information for each camera to be combined into a single dense point cloud" (Agisoft, n.d.:4), which is then used to create a 'mesh' in the next step. The first run through is on low setting with a moderate filter, to cut down on processing time and ensure that it will work.

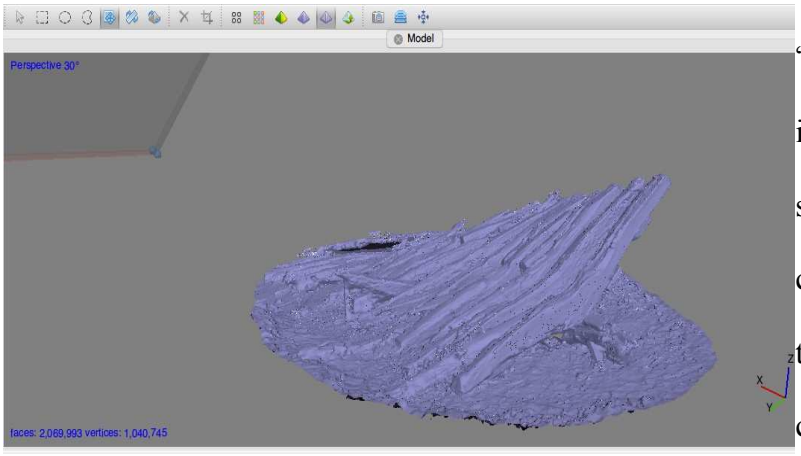


Figure 6: Model of LHL-81 at the mesh frame stage. The model is now ready for a superficial photomosaic mask (Image created using Agisoft software. Model by DeHoop and author).

"Build Mesh" is the next step. A 'mesh' is built up on the point cloud, using standard settings again. The mesh is created by each of the points connecting to the other points in it's vicinity, creating a frame of adjoining polygons, which give a more solid surface area (Agisoft, n.d.:5) Using the mesh frame as

the base, it can be covered with a mask created from the imported images. Selecting the 'Apply all cameras' option wraps the original photo mosaic onto the mesh frame. “Build texture” is the final step, which highlights and refines the texture of the images, making a fully textured three-dimensional model.

This completes the initial model. The cameras were then exported and imported again and run through at high resolution settings. This makes a very detailed and very clear model which can utilize the zoom functions to a high detail. The final product can then be exported in a number of formats, .psz in this case, and uploaded to a publishing platform with the 'Rotate Object' tool selected. Screenshots can also be acquired by exporting the file to a PDF (Agisoft, n.d.:7).

Figure 7: Final result of photogrammetry with texture added. Once published to a viewing platform, the model can be manipulated to view the wreck from any angle.

2.3.4 LHL-81 MODEL PUBLICATION

Once a model is made, there is the question of how to disseminate and publish that object. In a physical paper report, images and screenshots of the model from different perspectives can be used. Special software is sometimes needed to open, view, and manipulate a model, but this can be bypassed by using a publishing platform.

With more than thirty different 3D formats, it is imperative to find a platform that can display

the format correctly. Currently the leading platform for 3D models and VR content online is Sketchfab. It was created in 2012 with the goal to integrate major forms of 3D creation and publishing platforms, collaborating with Adobe Photoshop, Facebook, Microsoft HoloLens and Intel RealSense (Sketchfab, 2016). The advantage to Sketchfab is that the models are easily embedded into webpages and social media outlets and the 3D view works in all browsers and operating systems without any plugins necessary. This makes it easy to share results with fellow researchers and the public at large. Individuals are able to publish their results, as well as institutions, such as the Maritime Archaeology Trust Southampton, UK; Institute of Archaeology University of Warsaw; Archaeological Services ULAS; and the British Museum. On top of distribution advantages, this service is free for unlimited number of files up to 50MB. This makes it a financially viable option for large institutions as well as the individual to publish their models, so long as the model is not too large. The Pro account is also inexpensive (10 USD per month) for models up to 200 MB, and the business account can accommodate models up to 500 MB (29 UDS per month).

2.4 CRITICAL DISCUSSION ON APPROACHES

Even with the analysis of physical attributes, much of the interpretation will be inferencing the line of best fit from the available data. This reliance on secondary evidence can be slightly dangerous when interpreting a shipwreck. Harpster notes that many maritime archaeologists take a documentary approach, using archival evidence before archaeological remains (Harpster, 2012). For this reason it is especially important to have a firm grasp on the theory driving this project in order to be aware of potential biases. Further discussion on biases and research agenda awareness will be discussed in Chapter 5-Theory of this thesis.

Research on the importance of cultural heritage will be important for this perspective.

Unfortunately it is not possible to gauge how much impact LHL-81 has on a museum visitor in a quantitative way. Assumptions will have to be made as to the amount of attention the wreck receives in its current state.

There is very little concrete data that can come out of this project. However, it is important to be aware of the limitations of materials and to not make assumptions and find conclusions through patterns that may not be real. Awareness of biases and of the potential pitfalls will help to put LHL-81 in better perspective for analysis and avoid overarching generalizations that attribute too much fine detail. By being able to separate fact from assumption is the only way that useful information can be found.

CHAPTER 3:
BACKGROUND INFORMATION

The island of Læsø is located in the North Sea, less than twenty kilometers from the coast of north-east Jutland, mainland Denmark. It is the largest island in a small archipelago of approximately fifty other islands, all of which cover less than 300 square kilometers. The island has had a dynamic history due to it being the largest island in the Kattegat. It is currently home to just under 2.000 residents and is a popular tourist destination for the nature and cultural heritage.

3.1 GEOGRAPHICAL LOCATION

Læsø is the largest island in the Kattegat Bay. This stretch of water is the transition between the North Sea and the Baltic. The Kattegat is bordered by Sweden and Denmark, with the water flowing into the Great Belt, the Little Belt, and the Øresund, around Denmark's landmasses. The waterway is 240 kilometers long and a maximum of 145 kilometers wide. The area is filled with reefs and shoals, and has depths varying from a mere twelve meters to sixty (World Heritage Encyclopedia, 2016).

Figure 8: Map of the Kattegat waterway (Modified image from Kort over Skagerrak og Kattegat (Danmark, Norge, Sverige), Wikipedia, 2006).

Originally called the "Jutland Sea", it became known as the "Kattegat". The name derives from the Dutch words *kat* (cat) and *gat* (gate, hole), when Hanseatic sailers in the late Middle Ages would compare the area to a hole so narrow that even a cat would have difficulty squeezing its way through, in reference to the many reefs and shallow waters (Denstoredanske.dk, 2016). Until the Eider Canal, which eventually grew into the Kiel Canal, opened in 1784 the Kattegat was the only water route into and out of the Baltic Sea (Kiel-canal.de, 2016). The Kattegat water has a generally brackish consistency due to the lower salinity of the Baltic mixing with the higher salt content from the North Sea and Atlantic.

On top of the physical obstructions of the narrow and shallow waters, rapidly changing currents and stormy weather also contributed to the difficult navigation of the waterway. Raised stone and boulder reefs in the archipelago have caused hundreds of ship-wrecks and strandings during the 18th and 19th centuries (Bing, 1802 and Hansen et al., 2016:185).

3.2 THE KATTEGAT: HISTORY OF POLITICS AND TRADE

The Kattegat has always been an exceptionally busy and volatile waterway. The 16th to 19th centuries were strong years for international trade in Europe. Economies were heavily based on shipping, with raw materials exported from the Baltic states and manufactured goods from England heading into the Baltic (Rönnbäck, 2010). Ships went between ports on specific trade routes as well as tramp trade. Cargo and commodities formed political allies and international warfare both supported and impeded trade. High volumes of goods were transported through the Kattegat, but it was also an important sea route for war.

This section is not meant to be an in-depth discussion of the socio-economic repercussions of trade in the area, nor is it meant as an analysis of trade dynamics. Rather this chapter is designed to

give the most basic outline of the various trade routes and dynamics occurring around Læsø. This brief synopsis can offer insight as to the nationalities using the Kattegat waterway and for what purposes, illustrating the political and economic backdrop of the area. For Baltic trade specific studies, Brand and Müller (2007), Müller (2011), North and Kronenberg, (2015) and Tielhof (2002) are suggested sources.

Figure 9: Major trade routes and cities of the North Sea and the Baltic Sea. Raw materials would leave the Baltic headed to the west. Manufactured items and colonial commodities flowed from the North Sea to the east. (Map produced based on region map from Bluebird Marine Systems, 2016).

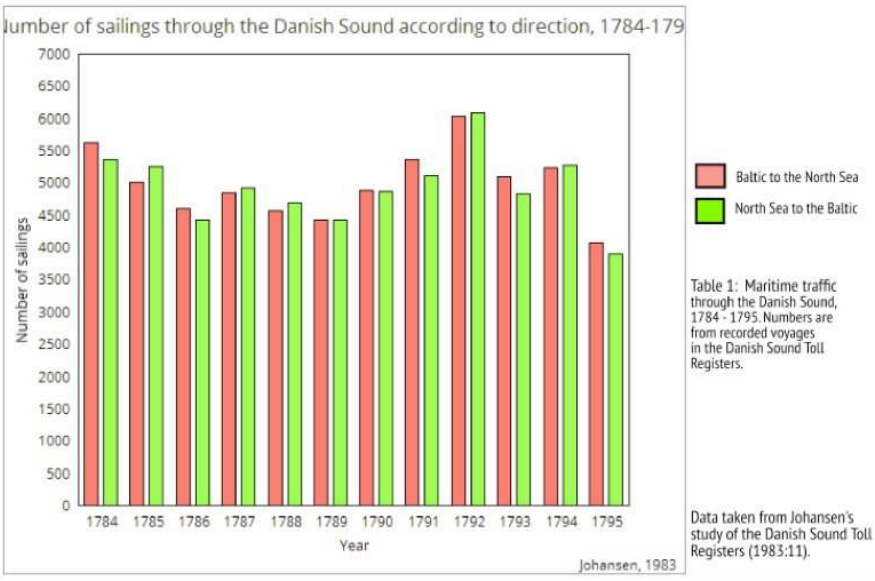
3.3 TRADE IN NORTHERN EUROPE, 16th – 19th CENTURIES

Beginning with the widespread success of the Hanseatic League in the middle ages, large scale shipping routes became the norm (North, 2015:4). As populations increased and supply and demand fluctuated, trade continued to grow domestically as well as abroad. "From the 1200s to the 1500s a

complex network of small, independent shipowners and shipbuilders had developed all around Europe, but by the 1600s a group of powerful state-supported companies came to dominate oceangoing trade" (Ferreiro, 2007:p32), these being the East India Companies. These companies had the resources to establish monopolies on long distance routes, widening the trade spheres of influence (Ormrod, 2011:136-137).

As the main route between the North Sea and the Baltic, control over the Kattegat was a major military and economic asset. Denmark laid claim to the waterways early in the 1420s, building a castle at Helsingor, the most narrow point in the Ørsund. The military fortifications here imposed the Ørsund Sound Toll (*Øresundstolden*), and in return for the payment, would provide safe travel to the passing ships. These heavy taxes frustrated most of the countries which ran this trade route (Johansen, 1983:7), but the other smaller waterways around the Danish islands were taxed as well (Hvidegaard, 2005). The Sound Tolls were a huge source of income for the Danish kingdom (North and Kronenberg, 2015:67); by the late seventeenth century it was the source of approximately 4.5 % of the state income, and increased to about 10 % in the first half of the nineteenth century. The Sound Dues were eventually disposed of in 1857 (Veluwenkamp, 2011).

Trade between the Baltic and North Seas was a very lucrative business and allowed countries to capitalize on their natural resources. Over the years, this trade exchange would involve many different players and trade routes, with politics



Graph 1: Visual representation of the number of ships passing through the Danish Sound 1784 - 1795

and economies shaping the shipping lanes (Rönnbäck, 2010:197). Ormrod (2011:135) suggests that this trade zone was a subsystem of the European *economie-monde;* however, his analysis of the area as a macro-region has been considered a bit too simplistic (Hutchison, 2012: 581). Regardless of the discussion of the area, the Danish Straits saw the passing of many trading vessels, with Scandinavian merchant fleets making up 30% of northern Europe shipping, with the Netherlands in second place at 22% (Ormrod, 2011:139).

The two basic categories of items that made up this system of trade were raw materials and manufactured goods. The Baltic states were agriculture lands that had surplus of food items and raw materials, while cities to the west were busy producing manufactured goods. In order to fuel the Industrial Revolution, the Baltic exported major amounts of materials, while in return it "became the principal channel for the introduction of colonial produce and British manufactures into Europe," (Ryan, 1959:445).

The agriculture of the Baltic lands were important exports, particularly in the early years of England's Industrial Revolution, "with 60% of all flax, 80% of all hemp and 98% of all the iron imported to Britain during the period 1784 1856 came from the 'North' (i.e. the Baltic, and other ports in Scandinavia and Russia)" (Rönnbäck, 2010:197-8). Semi-processed goods such as flax, grain, tallow, and leather were also important imports to Britain (Hutchison, 2012:581).

Timbers were also imported in high numbers for both civilian and naval purposes. Britain was suffering the effects of deforestation and relied on trade to obtain materials to "uphold its military and economic expansion and development" (Hutchison, 2012:583-4). It was widely known that "The best timber for medium sized masts came from Russia; Baltic oak was widely used by British shipbuilders for underwater planking; Russian fir deals for the decks of vessels" (Ryan, 1959:444), and it was far better quality at less cost than importing timber from America (Hutchison, 2012:584).

While many items were leaving the Baltic, many different goods were moving in. Colonial

commodities were flooding Baltic markets (Rönnbäck, 2010:189). East India Companies were established starting in the 1600s to import goods from the Far East. These companies were all based in the North Sea, in Britain, the Netherlands, Denmark and Sweden. Items such as porcelain, tea, spices and furniture were imported to a home port and excess goods were re-exported to the Baltic. American colonies were also playing a major part in trade via England, with the triangle trade supplying Britain with resources to export further to the east. "As the Atlantic economy developed, colonial commodities became ever more important for the leverage over the trade on the Baltic" (Rönnbäck, 2010:189), with sugar, coffee, cotton, and tobacco as the most important colonial items that were imported (Rönnbäck, 2010:190).

Britain was a main exporter of goods. Goods recorded in the Sound Toll Register note that British ships were carrying ale, beer, olive oil, salt, lead, pewter, copper, tin, brass, glass ware, stone, bricks, marble, malt, rice, barley, cloth, guns, carriages, and even horses, on top of miscellaneous manufactured goods (Hutchison, 2012: 592). French wine was also imported to the Baltic by the cask (Johansen, 1983:106). Salt was also a huge commodity desired by the Baltic countries, although some ports, such as Danzig, limited the amount imported in order to protect local production (Johansen, 1983:107).

The cross-roads between East and West resulted in a dynamic atmosphere of not only political struggle but also of massive trade traffic, with over 1.8 million ship passages recorded in the Sound Toll Registry between 1497 and 1857 (Veluwenkamp, 2011). Denmark was able to harness the power of the trade industry with local islands, such as Læsø, by establishing small fleets and opening ports in order to accommodate this business. The impact of the political and economic climate on Læsø was not as drastic as in larger ports, but the effects of the "complicated interplay of alliances and partnerships between naval and merchant fleets" (Ferreiro, 2007:33) can be seen in the island's fortifications and privateering economy.

3.4 LÆSØ

3.4.1 HISTORY OF THE ISLAND

The first indication of permanent habitation on the island was in the year 1200. The Cistercian Monastery of Vitskøl and the Chapter of Viborg Cathedral combined forces and created the salt industry on the island, taking advantage of the large pine forest and geological resources that Læsø had to offer (Stoklund, 1999). One of the first industries of the middle ages, the salt production was a double edged sword for Læsø. The sandy soil of the island collects the salt from the seawater, resulting with brine strength between 12% and 16% (Erih.net, 2016). Salt was collected by seething - a process where the saline ground water is heated in large iron pans until the salt crystalizes (www.saltsyderiet.dk, 2016). Almost 2,000 kilns covered most of the island, only seventeen have been excavated thus far (Erih.net, 2016).

Figure 10: Location of LHL-81 on the island of Læsø. Inset: Østerby Harbor. The jetty construction from the 1930 expansion are still in place. LHL-81 was discovered parallel to the pier, perpendicular to the shore (Map produced based on Google maps).

The shoreline chronology has been detailed further in a study of the Medieval–Renaissance large-scale salt industry of Kringelrøn, Langerøn and the Bangsbo–Stoklund area, where no less than 1700 ruins of salt-production huts are linked to a series of 23 distinct shorelines formed simultaneously with the building of salt-production huts in the period from 1150 to 1652 (Vellev, 1993; Stoklund, 2007; Hansen, 2010). Excavations resulting in salt wells, pans and pieces of constructional timber have shown that the island was capable of supporting a maximum of 135 simultaneously active production huts (Hansen, et al, 2011:186).

While the salt production lead to prosperity for the island, the kilns required a massive amount of wood for constantly burning fires. As a result, salt production ceased in the 16th century due to the complete deforestation of the island (www.saltsyderiet.dk, 2016). This lack of timber on the island resulted in the use of turf for property walls (Stoklund, 1999), and shipwreck timber as housing material (Kyhn-Madsen, 2016 and Skov, 2016). However, due to the prosperity of the salt industry and the effects of the sand drift, most of the island was not plowed at all, resulting in a majority of the land being undisturbed by systematic agriculture. These almost 2000 square kilometers of land are now protected under Danish forestry law and nature conservation regulations (Hansen, Aagaard and Binderup, 2011:182).

With the island's deforestation, much of Læsø's topsoil was eroding into the sea. Sand drift was devastating, and the sand cover ruined a large portion of potentially farmable land and destroyed other natural

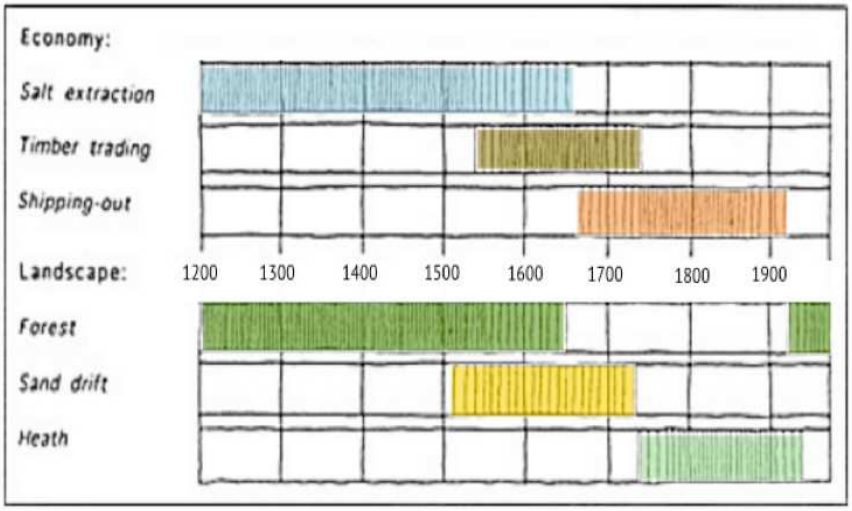


Figure 11: Timeline showing the reliance of Læsø's economy on the landscape (Image modified from Stoklund, 1999).

resources. It was not until 1750 that lyme grass and other vegetation was start growing. This began a period of reforestation, as well as the shift to a more agricultural-based economy. Fishing and small scale farming was sustainable for the population, but economically stagnant. Small ships began working the timber trade between Norway and Denmark, bringing in wages. By the end of the 18th century this was no longer profitable, and sailors began to work in the export business, moving wares from Denmark to the Low Countries or into the Baltic (Stoklund, 1999).

In the 1800s there were many international disputes and aggressions throughout Northern Europe. To protect itself, the island armed itself with a number of batteries and fortifications in the years 1763 to 1814. Military companies were temporarily stationed to protect against an attack by the British Navy. Sixteen batteries were spread out along the coast of the island, armed with a limited number of cannons deployed from the Danish Crown, with more artillery added through wreck salvage and privateer attacks (Wiis, 1998:82).

Denmark was in an economic crisis due to Napoleon's movements in Europe. England forced Denmark to halt all production of merchant ships; all shipbuilding supplies were to be used for the British Navy. With trade stagnating, otherwise unemployed sailors and merchantmen turned to privateering. The Danish Straits were notoriously dangerous for British ships. The narrow and shallow waterways were treacherous on their own, but local Danish and Norwegian privateering syndicates, which used both sailing and rowing boats for pursuit, were very dangerous. In order to protect themselves, British ships would convoy through this area (Ryan, 1959: 446-8).

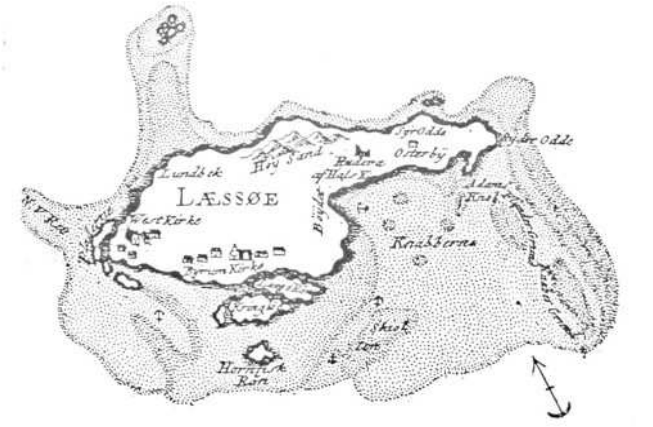


Figure 12: Island of Læsø (Bing, 1802).

As peace spread through the North Sea area, by the mid-19th century the Danish Coast Guard withdrew and the island was de-militarized. Batteries were broken down and cannons were sold back to the Danish Crown and other buyers (Wiis 1998:82). International trade picked up and Denmark's economy began to increase. Fishing became a primary source of income on the island of Læsø, with fishermen using natural harbors, such as the one at Krogen. However, with more men going to sea, fishing accidents increased dramatically at the end of the 19th century, and new precautions were taken, such as life-saving services and constructed harbors (Bibby and Pedersen, 2007)

A number of life-saving houses were built on the island in 1891, one at Lilleday, as a sub division of the station in Vesterø, and one in Østerby, just east of the present day harbor. Fishing and small scale farming continued on the island until World War II when the German army began construction on a tipping wagon rail from Vesterø to Højsande and Nordmarken, with a major fortification at Højsande. However, these projects were never completed due to time and money (Walther Ax, 2016).

3.4.2 LÆSØ NOW

The island is now a popular tourist summer holiday destination. Many areas of the island are under forestry protection, ensuring that the new pine forest that has been re-planted will not disappear again. The people of Læsø are proud of their heritage and a number of projects have been undertaken in order to share knowledge that could be lost. Seaweed roof houses are maintained and created through the Læsø Seaweed Project (Skov, 2016). In conjunction with the archaeological work done, a salt factory was established in 1991 and is one of the island's most popular tourist attractions (Christensen, 2016). The combination of nature and sea activities draw a large number of travelers every season and is a major source of the island's income. While not the primary port on the island, Østerby Harbor is the

busiest in terms of tourism, with visitors coming to the fishing boat harbor to experience the quaint maritime heritage first hand (Bibby and Pedersen, 2007).

3.4.3 ØSTERBY HARBOUR

Figure 13: Current image of Østerby Harbor (Bibby and Pedersen, 2007).

Østerby Harbor was constructed between 1903 and 1905. Originally just two piers, the harbor was a haven for fishermen on the rough waters of the Jutland peninsula. The harbor was constructed with a budget of 90,000 Danish kronor, with half of the funds coming from the government. The harbor was a great boom to the area's economy, with a number of fishing-related businesses opening around the harbor area. In 1930 the harbor needed an expansion. To the west, the existing breakwater was expanded, and a new one was built to the east. The 1905 structure became an inner harbor. (Bibby and Pedersen, 2007 and Jensen, 2002:34-37).

Although the harbor structure has not changed since the 1930s, the types of ships have. In order to fit motor boats and other larger vessels, the harbor began with routine dredging in the 1980s. It was during one of these dredging occasions that the wreck of LHL-81 was exposed and reported (Nationalmuseet, Skibshistorisk Laboratorium, 1980:14).

3.5 SHIPWRECKS AROUND LÆSØ

Surrounding the islands are at least ten prominent raised boulder reefs within ten kilometers of

the island, with levels of two meters above mean sea level. Glacial deposits left large stones and boulders, which eroded from the land masses and out to the shallow waters. Boulder reefs formed, and as sediments moved due to currents and erosion, landmasses were eventually formed. The largest reef, Engelskmandens Grav ("Englishmen's Grave"), measured about 300 meters long and 100 meters broad and is the foundation of the island Hornfiskrøn (Hansen, Aagaard and Binderup, 2011:185).

Many ships have wrecked in this area, known to be dangerous for the shallow waters and the unpredictable weather. The Danish wreck register (*Dansk Søulykkesstatistik*) is a record of the known wrecks in Danish waters from 1893 to 1996, with all wrecks after 1997 available from the Maritime Accident Investigation Board (*Den Maritime Havarikommissions*) (Mfs.dk, 2016).

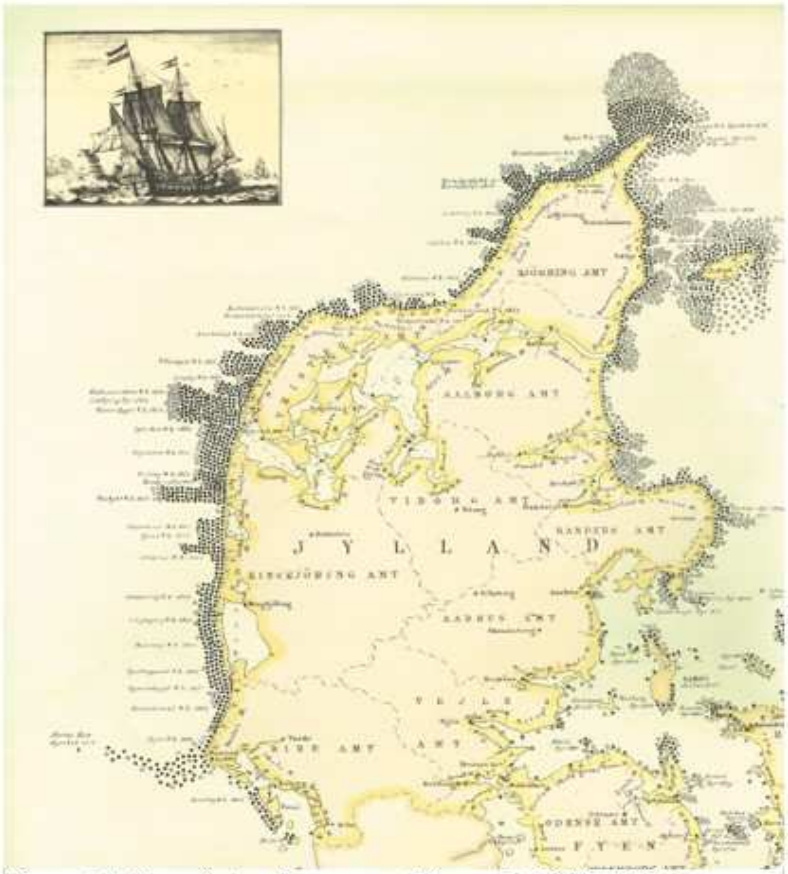


Figure 14: Map of strandings around Denmark 1858 - 1882 (Strandingsmuseum 'St. George' og Marinarkæologisk Center, 2016).

2009 saw a joint project between Northern Jutland Coastal Museum and Syddansk University where an archaeological survey of the waters on the north and north-west corner of the island. Sonar and proton magnetometer scanning was undertaken, with culture remains recorded and cross-referenced with GPS and the Danish wreck register. This survey discovered eight wrecks in the area as well as evidence of submerged prehistoric landscapes (Larsen, 2010).

CHAPTER 4:
LHL-81: PRIOR RESEARCH

4.1 WRECK DISCOVERY

LHL-81 was officially discovered in Østerby Harbor on March 20, 1980. The wreck had been visible from the pier in favorable weather for about ten years, but since it was not causing any disturbances it remained there, occasionally having timbers salvaged by locals for their home projects. While the harbor was being dredged and timbers were surfacing, a local fisherman called the town mayor to inform him of the wreck. The wreck's original orientation was parallel to the pier, perpendicular to the coastline.

Mayor C. Tage Jacobsen then contacted the National Museum and archaeologist Michael Teisen was dispatched to the island to investigate. Teisen was in Østerby from March 24-26 to look at the timbers that were already raised from dredging and to conduct an underwater survey to determine if there was more material still on the harbor floor.

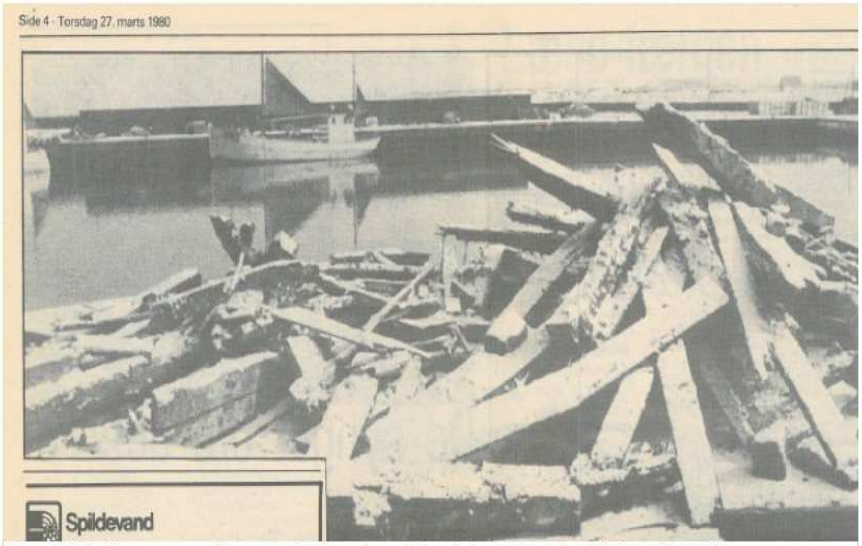


Figure 15: Newspaper photograph of timbers lifeted from Østerby Harbor (Læsø Posten, 27.03.1980:4)

4.2 FIRST INVESTIGATION: TEISEN, MARCH 24-26, 1980

While on the island, Teisen learned that the local fisherman, Kaj Klitgaard, who had called the mayor about the wreck, had been aware of its existence for a few years. Klitgaard had already salvaged a number of timbers that he had picked up in his trawl. He believed them to be teak and had placed them in his yard. He had also lifted a canvas-wrapped cannon from the site years before, which was also in his garden. Teisen went to Klitgaard's home to identify the pieces. He was not able to identify the timber wood as teak, but noted that the wood was hardwood and in remarkable condition for having been on land for five years. Based on the measurements, Teisen suggested that the pieces were longitudinal stringers.

An underwater survey was conducted. Teisen was unable to identify much more on the harbor bottom. The few pieces he did encounter were from a 1930s fishing boat which was then raised. A semi-circle sweep was done of the area once the large pieces of wreckage were removed. The top layer of the harbor bottom was a thick sludge and had normal items of port waste in it. Underneath was a thick clay. However, even with 1 meter gouges from the dredger, there was no sign of any more material from either wreck buried in the bottom.

With the materials on land, Teisen completed a short descriptive analysis of the timbers available to him. His investigation concluded with a report describing the situation, timber documentation, short conclusion of the ship type, and suggestions for further archival and documentary research. Teisen also suggested conservation of the timbers for exhibition. The timbers were then carted away and deposited for storage.

4.3 SECOND INVESTIGATION: GØTHCHE, NOVEMBER 1-2, 1980

Teisen requested that a naval architect, Morten Gøthche, be called in to analyze the wreck pieces. Gøthche was contacted and he made a visit to Læsø at the beginning of November 1980. He spent two days with the timbers; documenting them and attempting to re-arrange the timbers in their original order.

After two days of study, Gøthche was unable to fit the frames on the remaining keel. Gøthche suggested that the frames would fit onto a piece of the keel that was not recovered. His analysis gives a description of the timbers as well as notes on construction details. He concludes that the ship was approximately 35.2 meters long, with two or three masts, and a very full hull shape.

Gøthche offered some advice on archival research, agreeing with Teisen on potential sources. His personal opinion rests on the Russian frigate "Poul" transporting tar and oats as a possible identity based on the local history as told by Bing (1802:109).

Gøthche concludes his report with a suggested display assembly that would give the most re-construction to the pieces. Included in this recommendation is re-assembly order as well as advice on how to properly maintain and preserve the timbers. A diagram is provided to show the ideal display design.

4.4 DELIVERY AND RE-ASSEMBLY

Both Gøthche and Teisen believed that the timbers could be used in an educational setting rather than be destroyed. This could be that they both had research interest in the materials, or it could have been driven by the National Museum's experiments with wood conservation (Christensen, 1970). There is no documentation in the report to indicate their motives.

The timbers were offered to th
Fiskeri- og Søfartsmuseum in Esbjerg to b
part of their open air exhibit. Deliver
occurred on 20 September1989, a
documented by the receipt of delivered iten
written by the museum. However, re
assembly plans by Gøthche were either n
delivered with the pieces or they we
overlooked. There is no documentation as
the logic or method for the wreck re-
assembly, nor any explanation for why
Gøthche's suggestions were not followed. The keel was deposited in the sand of the outdoor area and the frames were bolted on in chronological order.

Figure 16: LHL-81 (left) at the open air exhibit at the Fiskeri- og Søfartsmuseum, Esbjerg. The second wreck is on the right (Photography by author).

4.5 ESBJERG EXHIBIT: WRECK PIECES

LHL-81 was deposited in a corner of the Esbjerg Fiskeri- og Søfartsmuseum. Currently, the wreck of LHL-81 has been re-assembled. There is one other wreck pieces in the corner, but only one sign for the area. These separate pieces are presumed to be two parts of the whole, and the signage suggests that they are from a Finnish ship that wrecked in 1798.

The timbers are exposed to the elements. The large portion of LHL-81 is still in recognizable form, but a few of the timbers have already begun disintegrating into the sand and soil it sits on. The second wreck piece is disappearing under the ivy ground covering and low hanging branches of a tree. These timbers are still accessible and can easily be compared with LHL-81 to determine if this second

wreck is another part of LHL-81.

4.5.1 SECOND WRECK ASSEMBLAGE OVERVIEW

This second assemblage of timbers is comprised of six timbers. The whole assemblage is less than 0.5 meters tall, and barely 4 meters long. The timbers are held together with long cylindrical iron bolts made from a lathe. Most interesting on these timbers is the indication of copper sheathing. One timber face is covered with small nails, indicating that they once held down copper plates.

Figure 17: Second wreck assemblage at the Fiskeri- og Søfartsmuseum open air exhibit. Analysis of this wreck piece can be found in Chapter 10.4 of this thesis (Photography by author).

4.6 CANNONS

After a routine dredging of the harbor, timbers were raised with only a most basic of underwater surveys done. The only non-timber items recovered from the wreck were two iron cannons that were each wrapped in canvas-like cloth (Nationalmuseet, Skibshistorisk Laboratorium, 1980:17, 30). No other artifacts were found to offer evidence as to the cargo, or the lack thereof, on board the vessel at the time of sinking.

Unfortunately, these cannons were not fully recorded at the time of the archaeological investigation. A quick sketch was done on an envelope, but no details or dimensions were described on the drawing. The official report lists dimensions of the cannon as 22 centimeter muzzle diameter with an 8.5 centimeter bore diameter, indicating that the cannon was able to fire 4 pound shot (Nationalmuseet, Skibshistorisk Laboratorium, 1980:17).

According to the story in the report, one went to a Kaj Klitgaard's garden while the other was placed as a bollard at Østerby Harbor (Nationalmuseet, Skibshistorisk Laboratorium, 1980:17). Kaj Klitgaard was unavailable to discuss this, as he passed away years ago (Jepsen, 2016).

In corresponding with the Læsø Museum for this project, it has come to light that the cannon bollard was not one of the cannons raised in 1980; former port Captain Erik Møller Sørensen recalls the cannon being in place since before 1966 (Møller Sørensen, 2016).

Captain Møller Sørensen did confirm that two cannons were raised and that one went to a fisherman's home. The other cannon was given to Willy Larsen, the Chairman of the Østerby Fishermen organization. He sold the cannon to Svend Larsen, date unknown, after a night out at the pub. The cannon was placed in Larsen's garden, until Møller Sørensen asked for the cannon on the behalf of the Søfarts- og Fiskerimuseet in Vesterø, of which he was an organization member. The cannon was given with no charge and placed in the yard at the Museum (Møller Sørensen, 2016). The Museum has since closed, and no information about the cannon's current whereabouts was given (Jepsen, 2016).

Figure 18: Sketch of the cannon raised from Østerby Harbor at the same time as LHL-81 (Nationalmuseet, Skibshistorisk Laboratorium, 1980).

Figure 19: Cannon used as a bollard at Østerby Harbor (Photograph by Niels Erik, Læsø Museum, 2016).

CHAPTER 5:
ARCHAEOLOGICAL THEORY

Theory plays an important function in archaeology. It gives perspective for research as well as a framework for methods in the field. When research agendas are dictated by national politics and international relations, as well a large public audience and other area stakeholders, the development of maritime archaeology as a discipline is less in the hands of academics than anticipated (Maarleveld, 2007:10). Maritime archaeology has only been an established discipline since the 1960s but research trends and stakeholders have shifted the research strategy to a culture historical perspective.

Archaeological theory has had a definite impact on the analysis of LHL-81. Due to the lack of archaeological materials and the complete loss of context, along with a shortsighted research agenda, the investigation of LHL-81 was a low priority. As a result, two short investigations were done, further research was not carried out, and the wreck was deemed "too ugly" for display at Østerby Harbor; it was eventually dropped off in the Fiskeri-og Søfartsmuseum in Esbjerg with no clear purpose, which is evident in its display. In this re-analysis of LHL-81, it is important to realize the biases that can shape the interpretation of a wreck with so few evidential features.

5.1 TRENDS IN MARITIME ARCHAEOLOGY

Gibbins and Adams (2001) see all wrecks as having fundamentally similar data available, and with uniform methodology and research agendas the context of any wreck can give conclusive data. They argue that all wrecks are a single context find; the "wreck preserves a largely contemporaneous group of material which was not intended for discard; the nature of a ship as a self-regulating system would have counted against the retention of significant quantities of redundant

materials" (Gibbons & Adams, 2001:280). This can be considered a relatively true statement for ships that have not undergone drastic transformations.

Schiffer's 'Site Formation Processes' (SFP) describe the two types of processes that affect an artifact after deposition: Culture (C-transforms) and Nature (N-transforms). C-transforms are human induced changes, such as dredging in the case of LHL-81, that disrupt a site. N-transforms are naturally occurring changes, such as natural decay or animal destruction. Both have drastic impacts on a site (Schiffer, 1996). Carmen has added an 'L-transform', Law, to the list as a specific type of C-transform, highlighting the impact that legislation also provides to a site (Carman, 1996). Maarleveld's article "Fish and 'Chips of Knowledge'" (2010) offers a more in-depth look at the process involved for an archaeological find to exist, discussing the C-, N-, and L-transforms that all must occur. Maaleveld gives these transforms broad categories of *what happened originally*, *what happened in the meantime*, and *what happened upon discovery* (Maarleveld, 2010:257).

The seven steps of archaeological discovery		
Exposed	Earth moving or natural erosion	Short or prolonged
Provisionally recognized	Non-specialist observation	Many do not notice
Reported	Telephone call to presumed specialist or authority	Often goes astray
Recognized as relevant	Receiver decides on follow-up	Interest defines priority
Assessed	Observation by presumed specialist	Keep or discard
Described and inscribed	Note in official or specialist register	Registers vary
The archaeological find exists		

Table 1: Lifecycle of an artefact: What happened upon discovery? (Maarleveld, 2010: 262).

What happens upon discovery is a very important category and has the largest impact on the archaeological record. Maarleveld outlines the seven steps necessary for a find to enter the archaeological record with each step requiring a level of awareness, without which items and information are lost (Maarleveld, 2010:262). While much time can pass between an items' deposition and its exposure, the steps that follow its discovery are the ones which define whether or not the item is allowed to exist in the archaeological record.

Within maritime archaeology, Harpster has noticed trends that present a number of interpretation biases. In many cases, a historical perspective places an unnecessary focus on attributing a specific identify on a wreck, where the identification makes a more complete narrative (Ahlstrom, 1997). Working with a specific shipwreck makes the research feel more significant, as " 'big histories' are important to us, and tend to make themselves heard above the cacophony of 'ordinary histories'," (Arnshav, 2013:53). The main difficulty with this position is that "the historical record [...] shapes the investigators' perceptions of the ships for which they are searching" (Harpster, 2012:8). As Maarleveld warns, "We only see when we look and we only look for what we want, or expect, to see" (2010:262).

In other cases, attributing an identity with a historically attested nation, culture, or empire typologies, such as "English" or "Etruscan" "eases the interpretive process, for the affiliation provides a context within which the assemblage of material on the seabed may be understood" (Harpster, 2012:2). However, these expectations give limitations, again, only allowing a researcher to see what they expect to see within the pre-defined context of the classification (Harpster, 2012:5).

Other issues within maritime archaeology can be attributed to research agenda. Carman's L-transform is at the forefront here, where "archaeological material is not protected because it is valued, but rather it is valued because it is protected" (Carman 1996:115), with the legislation assigns heritage legitimacy to a site. This can be seen in the shipwreck protection acts which put a time limit on sites that are culturally significant. Wrecks over one hundred years old are automatically protected, but as

Arnshav seeks to answer the question of age and significance correlation (2013:47), it is eventually concluded that "In the long run, it is the research focus, rather than the age of remains or finds, that determines the usefulness of a source material" (Arnshav, 2013:54), and this in turn can impact legislation.

Research agendas are formed by a multitude of stakeholders outside of academia, not to be limited to "national politics, nationalistic sentiments, international relations, military security zones, recreation, collection, competition between dive-industry or recreational diving ego's, pure contingencies, trade in antiquities, and the all-powerful public eye" (Maarleveld, 2007:10). Each of these groups brings with them their own bias, with different expectations of what is significant. National identity certainly plays a key role in developing research focus areas, one strong example being Denmark. The national pride relating to their seafaring Viking ancestors has had strong reverberations in the Danish archaeology sector, cultivating a world leading Centre for Maritime Archaeology in Roskilde (Maarleveld, 2007:22).

5.3 PERSPECTIVE ON LHL-81

Maarleveld's seven steps to the archaeological record are very visible in the case of LHL-81. Dredging of Østerby Harbor exposed the wreck, and a fisherman was able to identify the wreck as an abnormality and report it to the correct authorities. Interest in maritime archaeology at the time period in Denmark made the wreck worth an investigation. It was considered relevant not only for maritime archaeologist Michael Teisen to investigate but also garnered an inspection from naval architect Morten Gøthche (Nationalmuseet, Skibshistorisk Laboratorium, 1980:9). The two men performed two separate assessments and combined the two documentations into one report, *Vrag 1750-1850. Læsø, Østerby Harbor, JourNo.776* (1980) (found in Appendix 1).

Following these steps, LHL-81 did enter the archaeological record, but then disappeared. Although over one hundred years old, and thereby considered "historically significant" in the eyes of the Shipwreck Protection Law, the wreck did not fall into a research scope for further analysis; the stakeholders at Østerby Harbor could find no purpose to have the wreck displayed there. Delivery of the wreck timbers to the Fiskeri- og Søfartsmuseum in 1989 offered the chance to use the materials as a cultural heritage learning tool; but instead of a coherent display, LHL-81 was haphazardly re-assembled with no regard to the original construction and then placed in an area with other jumbled wreck pieces. Continued conservation or analysis of LHL-81 has not been a concern.

For the re-analysis of LHL-81, it is important to interpret the material evidence without preconceptions. Harpster warns of the dangers of "interpret[ing] archaeological assemblages within a narrative and context previously created by sources beyond the archaeological sphere" (Harpster, 2012:2), and that is a large concern with this particular wreck. Investigation has already been done, and conclusions have been drawn by professionals in the official report from 1980. With no physical archaeological material aside from the timbers to work with, it is very tempting to blindly rely on the research conclusions already reported. It is evident that a number of assumptions have already been made, such as the inclusion of the cannons, as well as the re-assembly of LHL-81 and the combination of wreck parts at the Esbjerg Fiskeri- og Søfartsmuseum.

Most specifically, relying on the original interpretation of the time frame would be a handicap. Although it would certainly make things easier to only focus on the one hundred year time span offered in the report, 1750-1850, taking it at face value with no other documentation would be irresponsible. It is vital to take an inductive research approach, using the archaeological materials as evidence and working towards a hypothesis (Adams & Gibbins, 2001:280). While this approach is difficult with wrecks such as LHL-81 which have no site context and limited materials to work with, it is tempting to find "parallels between [...] perception and the archaeological data... [leading one to] attribute a

particular historical affiliation" (Harpster, 2012:10). This can be seen with the case of the cannons and LHL-81. While they were dredged up at the same time and in the same location as the wreck, without the context of the site preserved and no other linking evidence, it cannot be known for certain that the cannons belong to LHL-81.

Although Gøthche offered advice on the display and conservation of LHL-81, these suggestions were largely ignored. Rather than achieving an accurate representation of the wreck, the museum placed importance on the impressions of 'pastness', hoping to engage the public's interest with more 'traditional' imagery of a shipwreck (Holtorf 2009:35). With no research goal, there was no point in expending efforts on further research. As a result, this haphazard re-assembly can be seen as yet another C-transform of the wreck.

Even though the original context of LHL-81 has long since been destroyed due to dredging (another C-transform), the lack of effort to obtain any further information is compounded daily by the natural process of decomposition (more N-transforms). In order to preserve LHL-81 in a more lasting way, digitalization of the wreck into a 3D model was undertaken for this project. Photogrammetry and digitalization is a growing trend in archaeology. As quality of recording technology increases and the cost goes down, digital recording has become a new research focus. This agenda to test and apply new recording techniques gives forgotten archaeological finds, such as LHL-81, a chance to be recorded and studied remotely before eventually breaking down and being lost forever.

Lastly, there is the L-transform to discuss. Denmark has made efforts early on to use their legislation to protect archaeological materials, starting as far back as the 19th century. This attention to the past is what really caused LHL-81 to be considered 'important' enough for a post-dredging investigation but not important enough for prior research even though it was locally known to be in the harbor (Nationalmuseet, Skibshistorisk Laboratorium, 1980:14). Although the wreck was protected by heritage laws, there was no interest in this particular wreck, nor any research agenda to make better use

of it, whether i*n situ* or on land.

5.3 SUMMARY

Archaeological theory is important to take biases within methods and approaches into account. In the case of LHL-81, not much thought was focused on the timbers in 1980 and that can be seen in the handling of the research and post-report deposit at the Esbjerg Fiskeri- og Søfartsmuseum. While it is too late to salvage original context and too late to create a better open-air exhibit with a proper re-assembly, using archaeological theory is necessary for this re-analysis. Culture, Nature and Law transforms as discussed by Schiffer, Carman, and Maarleveld offer insight as to the different forces acting on these timbers, while research methods and agendas are a core focus of Harpster and Arnshav. By combining these approaches to archaeological research for LHL-81, the goal is to use a more inductive analysis approach of the remaining physical materials for interpretation, whilst LHL-81's re-assembly is used as a case study of the cultural heritage protection and educational drive of materials in Denmark's archaeological record.

CHAPTER 6:
ARCHAEOLOGICAL LEGISLATION IN DENMARK

Scandinavia has a long and vibrant history, and has some of the oldest laws in place regarding the protection of their cultural heritage. The long tradition of protection and preservation began in the 18th century in Sweden, quickly followed by legislation in Denmark in the 19th century (Eze-Uzomaka, 2014:138). At a recent count, Denmark has over 1,300 heritage sites, almost 33,000 archaeological sites, and almost one thousand of known shipwreck sites (Kulturarv.dk, 2016). In order to fully appreciate decisions surrounding the LHL-81 investigation, it is important to have a basic background of archaeology and corresponding legislation in Denmark. This is not intended as a full report, critique, or evaluation of the legislation surrounding the treatment of archaeology in Denmark; rather, it is a brief overview of the ideas, perspectives, and finances that shaped the framework that LHL-81 and other maritime objects are handled in. For a fuller discussion of current and suggested practices, see the International Evaluering Af Marinarkæologi I Danmark: Slots- Og Kulturstyrelsen (2013), found in Appendix 4.

6.1 A HISTORICAL PERSPECTIVE ARCHAEOLOGICAL LEGISLATION IN DENMARK, 1880 – 1980

Archaeology has been ongoing in Denmark since the 1800s, although systemic excavations were not conducted until the later end of the 19th century. Redistribution of land in the industrial age lead to a rise in agriculture, which increased the amount of land tilled, resulting in leveling of barrows and discovery of hordes and graves which were destroyed and items were kept or sold as valuables (Kristiansen, 1981:80). As Europe had the Enlightenment period, thoughts of nationalism were high, as

well as preserving and protecting the people. In 1802, Danish treasures, the gold horns from Gallehus, were stolen and melted down, becoming a symbol of lost glory and fueling the fire to preserve Denmark's past (Kristiansen, 1982:81).

In 1807 the National Museum of Denmark was founded and the *Royal Commission for the Preservation of Northern Antiquities* enacted. The *Society of Northern Antiquaries* was established in 1825 with the intention to familiarize the public with the old Nordic sagas, and in 1832 began to include archaeology. While the Danish public was relatively slow to warm to archaeology, Danish archaeologists Jens Jacob Asmussen Worsaae and Christian Jurgensen Thomsen were making huge impacts in the field. Thomsen is famous for his three-age system, a chronological system to date objects based on other artifacts in closed finds, and Worsaae made the system popular by proving it's legitimacy by using stratigraphy in excavations (Gräslund, 1987).

Interest in archaeology began to spread among the population and fourteen provincial museums were opened between 1850 and 1900, while small private museums were opened by individuals interested in the antiques trade (Kristensen, 1981:84-85). 1873 saw the beginning of the National Registry of Monuments (Eze-Uzomaka, 2014:138). Also during this period “systematic excavations, classifications and publications of finds become the main objectives, soon creating a basis for elaborate chronological systems and detailed culture-historical accounts” (Kristensen, 1981:85), lead by Sophus Müller, National Museum director 1895-1921. His attempts to centralize archaeology, requiring all provincial museums to have their excavations regulated by the National Museum, created feelings of elitism and had negative impacts, such as robbery on sites (Kristensen, 1981:86,89). With the emergence of 'folk' high schools and studies, many new museums opened with a focus on 'folk culture' of local regions as well as interest in documenting local histories (see Bing,1802, as an example).

Attempts to engage with the public interested boomed in the 1930s with a new wave of archaeologists. New research trends came into place focusing on protection and popularization, and in

many cases, collaboration with non-professionals and amateurs were encouraged (see e.g., Therkel Mathiassen's Northwestern Jutland survey projects of 1948 and 1959). This spurred a new law in 1937, forbidding all private excavations, but promoted cooperation from farmers and locals who were finding artifacts in their fields, with the archaeologists. The Nature Protection Act of 1937 protected all ancient monuments whether registered or not (Eze-Uzomaka, 2014:138).

In 1958, the *New Museums Legislation* decentralized archaeological practice, putting the responsibility of archaeology on the local museums in terms of research and budgets (Lyne, 2013:35), with professional archaeologists joining museum staff starting in the 1940s (Kristensen, 1981:96). In 1961, the Danish Ministry of Culture (*Kulturministeriet*) was founded to protect and promote culture, sport and media (Kum.dk, 2016). Over the years more sub-divisions have been created to take responsibility for the different categories of specialized interest (Kum.dk, 2016). Also in 1961, all ancient monuments automatically acquired 100 meters of free zone around them. Section 49 of the Nature Protection Act, passed in 1969, made it mandatory that all monuments, even ones not in the National Registrar, be investigated before any construction work is begun (Eze-Uzomaka, 2014:138).

6.2 INTERNATIONAL LEGISLATION

International legislation has also impacted Denmark and the interaction with their physical past remains. Denmark has been able to impose strict legislation regarding archaeological objects and sites, and this has created a strong sense of community and pride around their archaeology (Eze-Uzomaka, 2014:145). The small country is currently home to five UNESCO World Heritage sites, with seven more sites on the Tentative List (UNESCO), and considered one of the best examples of archaeological practices (Eze-Uzomaka, 2014).

The UNESCO (United Nations Educational, Scientific and Cultural Organization) hosted the

World Heritage Convention in 1972, linking 'concepts of nature conservation and the preservation of cultural properties' (UNESCO, 1972). This document has served as a basis for many countries taking responsibility for the conservation and preservation of their cultural heritage. Denmark ratified the Convention in 1979 (Eze-Uzomaka, 2014:143).

The Valetta Treaty of 1992, also known as the Malta Convention, became the basis for the Danish museum system. The Treaty is a revision of the European Convention on the Protection of the Archaeological Heritage and aims to protect European archaeological heritage "as a source of European collective memory and as an instrument for historical and scientific study." (Article 1). Article 1 made important inclusions of items considered as artifacts, including objects immovable or movable, regardless of their context, on land or sea. Articles 2 deals with establishing proper authorities for reporting sites, as well as protective zones around areas of known archaeological importance. Article 3 discusses a code of conduct for digging and preservation methods, citing *in situ* preservation as the best, and most cost efficient, option. Finally, Article 5 dictates that developers who have projects that unearth archaeological objects pay for the necessary excavation. While not officially ratified by Denmark until 2006, this Treaty had a heavy impact on the restructuring of Denmark's heritage and cultural ministry in the early 2000s.

In 2001, UNESCO held the Convention on the Protection of Underwater Cultural Heritage. This Convention intended to support and expand the *United Nations Convention on the Law of the Sea* (UNCLOS) in 1956, 1960, and 1982. UNCLOS attempted to extend the protection of shipwrecks, from the traditional 17th century 'canon shot rule' of three nautical miles, to the creation of new limits on territorial waters, including exclusive economic zones (EEZs) and continental shelf jurisdiction (Un.org,2016).

The UNESCO Underwater Convention expanded articles on the protection and preservation of cultural heritage in the contiguous zone, the exclusive economic zone, and on the continental shelf

(Articles 8 through 12), as well as rules concerning activities directed at underwater cultural heritage, including research directives, project methodologies, funding, and information dissemination (Annex, rules 1 through 36).

6.3 ARCHAEOLOGICAL LEGISLATION IN DENMARK, 1980 - 2016

As noted, the *New Museum Act* (2001) and the *Valetta Treaty* (1992) both support developer paid work models for archaeological excavations. Development projects must inform the local museum so that a desk-based assessment may be conducted, researching the scope, nature, and condition of archaeological sites in the area (Kulturstyrelsen, 2014:5). Advice is given on whether the project should be moved to a different location, or if an excavation should be undertaken before the project begins. If construction begins and archaeological materials are found, the work is put on hold and archaeologists are brought in to assess the extent of the site. This is obviously an expensive option and many developers do their best to avoid these cost and time delays (Kulturstyrelsen, 2014:11). These same rules apply to sites and artifacts

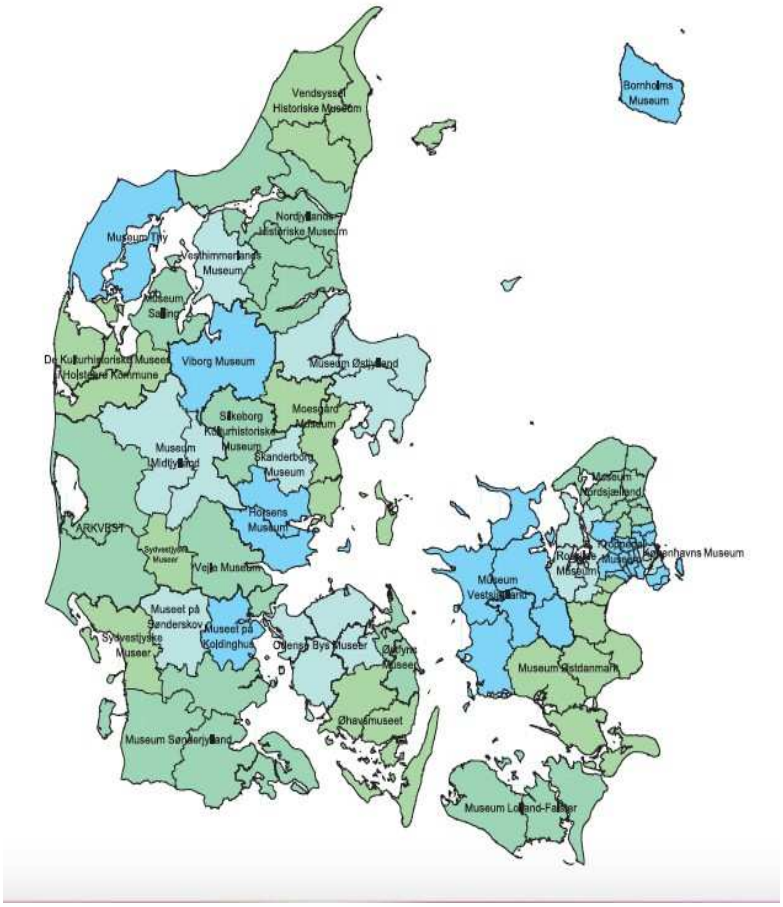


Figure 20: Denmark's division of museum regions in 2014 (Image by Thomas Eriksen in Kulturstyrelsen, 2014).

discovered underwater.

The Danish Agency for Culture (*Kulturstyrelsen*) was established January 2002, merging the Danish Heritage Agency, the Danish Arts Agency and the Danish Agency for Libraries and Media. Kulturstyrelsen became responsible for monitoring and managing archaeological heritage at a national level, including databases and registries of sites; universities took on sole responsible for the scientific education process, and the regional museums were left to implement developer-funded contract archaeology within their region. Adding items and sites to the Ministry of Culture database are the individual museums' responsibilities (Slks.dk, 2013:1).

In 2011 an evaluation was conducted to determine the efficiency of the Danish system. While the local museum system was unique and effective, it also had serious drawbacks, such as a lack of research strategies and falling professional standards (Lyne, 2013:36, Slks.dk, 2013:6). While developers are required to pay for excavation and documentation, "the same is not true of the proper contextualization or dissemination of the knowledge gained" (Lyne, 2013:38). Developers do have options on how to create exhibits, or offer lectures, or hand out promotional material, which creates additional value to the developer (Kulturstyrelsen, 2014:8), but it is not necessary for them to pay for further research or publication (Slks.dk, 2013:12). In order to combat these challenges, Kulturstyrelsen reduced the number of local museums from forty-two to twenty-seven, re-drawing jurisdiction lines to create fewer but larger and more efficient organizations (KUAS 2011: 25-27).

While this has been working relatively well, there have been internal problems as a number of museums have been clumped together under a new regional umbrella. Budgets have become more complicated, and projects that involve collaboration between other museums are favored over individual projects, and resulting in competitions between the institutions (Slks.dk, 2013:3). A new organizational structure was rolled out 01 January 2016, with more restructuring and merging of departments. The new Department and Palaces Culture Agency (*Slots og Kulturstyrelsen*) consists of

25 specialized divisions including a number of group divisions that provide services to the whole Ministry of Culture (Slks.dk, 2016). The hope is that the new organization will "create a better use of resources so that there will be more cultural value," (Slks.dk, 2016). With such a recent change, it will take some time before a substantial changes can be seen and an evaluation can take place.

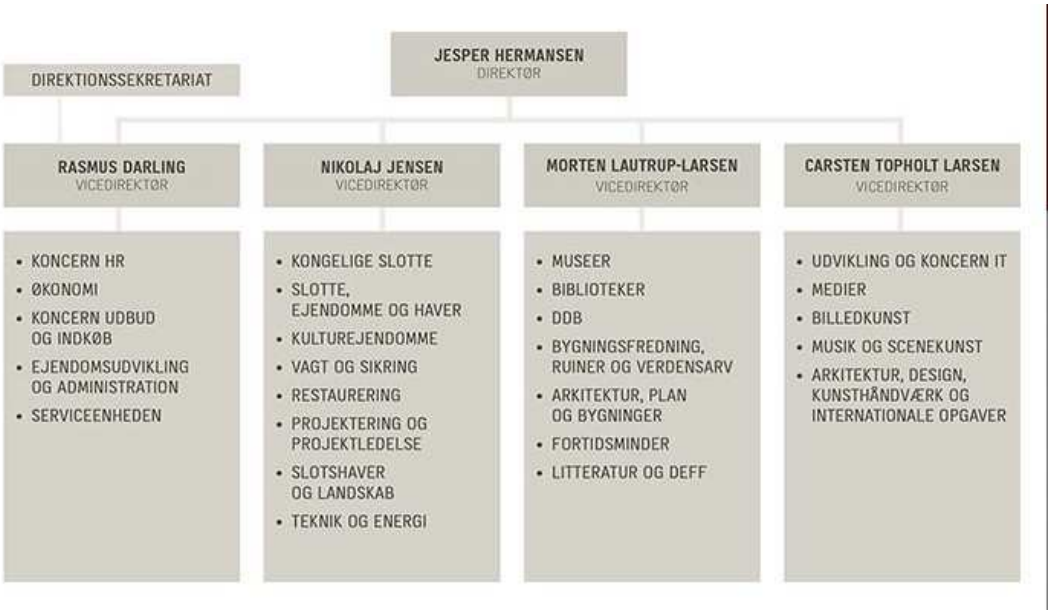


Figure 21: The new organizational structure of the Slots og Kulturstyrelsen, effective 01 January, 2016 (Organisation: Slots- og Kulturstyrelsen. Slks.dk, 2016).

6.4 MARITIME ARCHAEOLOGY IN DENMARK

Maritime archaeology has had a major impact in Denmark due to the country's long tradition of interaction with the surrounding waters. However it has been difficult to create and maintain a proper organization that can control all of the maritime archaeology done in Denmark, with few attempts made to integrate it with the terrestrial archaeology departments, leading to a lack of representation on the *Kulturstyrelsen* Advisory Board for Archaeology (*Arkæologisk Råd*) (Slks.dk, 2013:12).

Denmark created the Institute of Maritime Archaeology *(Nationalmuseets Marinarkæologiske*

Undersøgelser) in 1962 in order to deal with the National Museum's excavation of the Skuldelev viking ships in the Roskilde fjord (Denstoredanske.dk, 2016: Nationalmuseets Marinarkæologiske Undersøgelser). This organization was able to work with shipwreck identification as well as preservation, undertaking tests and the process of PEG (Polyethylene glycol) impregnation of the Skuldelev wrecks. (Christensen, 1970:38). This department was a large and expensive undertaking and not financially sustainable on its own, resulting with the department shutting in 1995.

In 1993, the National Museum's Center for Maritime Museum (*Nationalmuseets Marinarkæologiske Forskningscenter*), also called *Skibshistorisk Laboratorium*, opened under the National Museum of Denmark. It was established on a ten year grant from the Danish National Research Foundation (Bill, 2003:33). The Center was based in Roskilde, and worked in conjunction with the Viking Ship Museum. This was the high point of the research with projects happening all over Denmark, yielding many publications (Bill, 2003:33). Underwater excavations made up around ten projects per year (Slks.dk, 2013:3), but with a lack of continuous incoming grant funds, plus another economic re-structuring of the National Museum, and the Center closed in 2003 (Bill, 2003:34).

An international committee research group wrote in their evaluation in the International Evaluering Af Marinarkæologi I Danmark: Slots- Og Kulturstyrelsen (2013) that with "no one organization […] adequately fulfill[ing] the leadership role for Underwater Cultural Heritage. This is considered to be a serious weakness in the present structure" (Slks.dk, 2013:3). Five museums are now responsible for maritime archaeology, although even this is fragmented. Four regional museums, the North

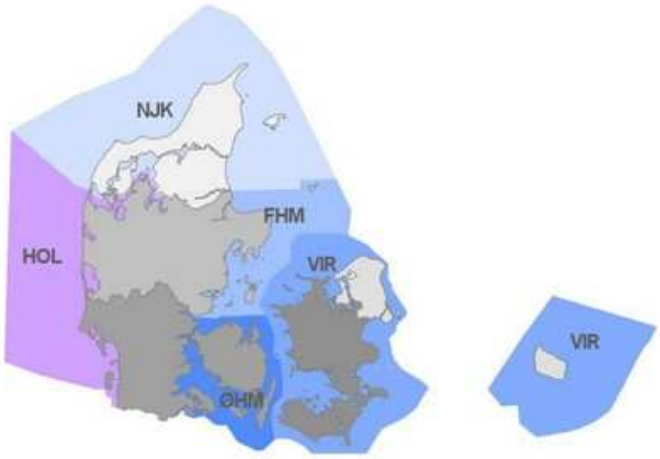


Figure 22: Division of regional areas under the five maritime museums in Denmark (Slks.dk, 2013).

Jutland Coast Museum, Bangsbo, the Strandingsmusuem St George, the Moesgård Museum, and the Øhavsmuseet, are under contract from *Kulturstrelsen*, while the Viking Ship Museum is under a separate contract from the National Museum (Slks.dk, 2013:4). While the regional museums use local contacts and self-funded contract work, the Viking Ship Museum is paid by the National Museum to undertake specialized contracts. This extra work has a primary role to be nationally focused, in terms of maintaining a national library and archives, while also dealing with developer-funded contract archaeology in the area not covered by the other four museums (Slks.dk, 2013:4). On 01 January, 2016, maritime archaeology responsibility of Denmark has been given entirely to the Viking Ship Museum (Vikingskibsmuseet.dk, 2016).

With limited budgets and a lack of centralized or integrated standards and practices there is a significant drop in the development of technologies and techniques in maritime archaeology that Denmark has been known for (Slks.dk, 2013:12-13). The Viking Ship Museum has been able to maintain a high standard, partaking as a partner in the European Commission's Seventh Framework Programme project SASMAP; a project to develop tools and techniques to Survey, Assess, Stabilise, Monitor and Preserve underwater archaeological site. (Slks.dk, 2013:1, "The SASMAP Initiative Investigates Underwater Environments. -"Sasmap", and Vikingeskibsmuseet Roskilde, 2016).

The International Evaluation of Maritime Archaeology that was performed in 2014 outlines in more detail the issues mentioned above and offers specific suggestions on how to better manipulate the legislation and organizational requirements to make a more cohesive and integrated maritime archaeology not only within the five museums, but also with terrestrial archaeology of the country (Slks.dk, 2013:23-26). Whether or not the suggestions will be taken and improvements made will be seen as the new Museum Act of 2016 takes hold and begins to make changes.

6.5 IN RELATION TO WRECK LHL-81

Wreck LHL-81 was discovered and excavated in November 1980. This was almost two decades after the Skuldelev wrecks were excavated and preservation processes began. The *Nationalmuseets Marinarkæologiske Undersøgelser* was still being funded by the National Museum, and would be for another fifteen years after LHL-81 was lifted. So why was LHL-81 investigated twice and impregnated with PEG if there was no intention or interest in further research opportunities?

As always, a lack of interest in research areas is detrimental to archaeology. While it is fortunate that the wreck was identified before it was completely destroyed, the lack of interest in it's period of shipbuilding definitely lead to a lack of further research at the time (Slks.dk, 2013:15).

Timing was also an issue, as it was a rescue operation rather than a fully funded and researched excavation. While developer-funded projects could have provided some excess money, it seems as though the *Nationalmuseets Marinarkæologiske Undersøgelser* was solely responsible for footing the bill, using this less as a research project but more as a chance to experiment with PEG impregnation techniques for conservation (Nationalmuseet, Skibshistorisk Laboratorium, 1980:32).

Finally, what happened after the excavation is also an indication of a centralized body for maritime and terrestrial archaeology that Denmark has been lacking. With such a fragmented museum structure, each one operating in relative isolation, artifacts and collections were an individual responsibility. Restructuring of the museums resulted in transfer of items, but the accompanying information was occasionally lost, and sometimes never there to begin with (Kristensen, 1981:91). This is one possible explanation for the lack of information presented in the receipt of transfer for the timbers to the Esbjerg Fiskeri- og Søfartsmuseum. The receipt proves that LHL-81 was indeed delivered to the museum in 1989, but there is no inventory of items, nor is there any other record in the Museum that could explain the other two wreck pieces that are sitting in the same exhibit as LHL-81.

6.6 SUMMARY OF ARCHAEOLOGY IN DANISH LEGISLATION

As Bill notes, Denmark was able to create a "powerhouse of maritime archaeology research" at Roskilde Viking Ship Museum (Bill, 2003:35) through a number of large grants and an unprecedented attention to the "cultural oriented marine archaeological environment," (Bill, 2003:33,34). In the case of LHL-81, even with such heavy focus on the maritime world, a lack of research framework has had a detrimental effect on archaeological research. With too many players responsible for the different aspects of archaeology, maritime versus terrestrial, there are many ways for information to be lost. Limitations such as insufficient expertise and finances can result in subpar work (Bill, 2003:36), culminating in a loss of knowledge for future generations.

This very brief history of the legislation and bodies controlling archaeology in Denmark should serve as an overview of the political context for LHL-81. This background gives a better perspective of the stakeholders and powers at work in Danish archaeology in the 1980s, which caused LHL-81 to be initially rescued but then overlooked and forgotten for three decades.

CHAPTER 7:
CULTURAL HERITAGE

> The theoretical basis and the legislative solutions do mutually affect each other. It is on their interaction that a consistent policy for the management of the underwater heritage should be formulated. (Maarleveld, 1998:35)

Where does archaeology cross the line into cultural heritage? Cultural heritage has the ability to be tangible or intangible, a solid artifact or a specialized skill set. The vagueness of the definition allows any solid artifact to be cultural heritage. Yet only some items are kept and used for display and to gain public interest. What makes these particular items more interesting than others? What creates the value that turns an archaeological find into an object of cultural heritage? Display and public interaction are an integral part of data dissemination, and these decisions are made as the values of identity and ideology overlap with tourism and an experience economy (Maarleveld, 2012:419).

Displays incorporating archaeological finds encourage interaction between the public and the past, and there are whole educational tracks devoted to museology and how to create exhibitions. Books and dissertations have been written on this topic from a museum perspective, which do not always align with an archaeology framework. The discussion here will be a brief summary of the gap between the two fields and how an artifact is transformed and utilized from one group to the other. This chapter will give an overview of the role of cultural heritage in society and the specific corner of maritime cultural heritage and its display. The role that digitalization is playing in the development and presentation of cultural heritage will also be discussed. The last part of this chapter will look at LHL-81 and how the constructs and expectations of cultural heritage have shaped its' current identity in the Fiskeri- og Søfartsmuseum, and how digital recording can potentially add research value to an otherwise forgotten material.

7.1 CULTURAL HERITAGE AND VALUE

One of the driving factors for cultural heritage is globalization. Globalization is seen as the appropriating of cultures, destroying cultural identities as it pulls everyone under the umbrella of westernization. While it is important to find the commonalities cross-cultures and show a unified history of mankind and his experiences, it also becomes essential to carve out individual national histories that are unique (Jeroscenkova et al., 2016:19). Heritage, according to Lowenthal, is intuitive, presentist, not overly concerned with historical accuracy, and gives shape to national identity and narratives (Lowenthal, 1998).

When looking at heritage as a socio-economic benefit, there can be many pitfalls in the promotion of information. Maarleveld (1998) warns about research dissemination and "not allowing a stereotyped interpretation of heritage to set its agenda" (1998:76), which can occur through sensationalized interpretations for click-bait articles for promotion or increased museum attendance.

Jeroscenkova's (2016) study in Romania and Latvia shows that cultural heritage has a large socio-economic impact according to local populations.

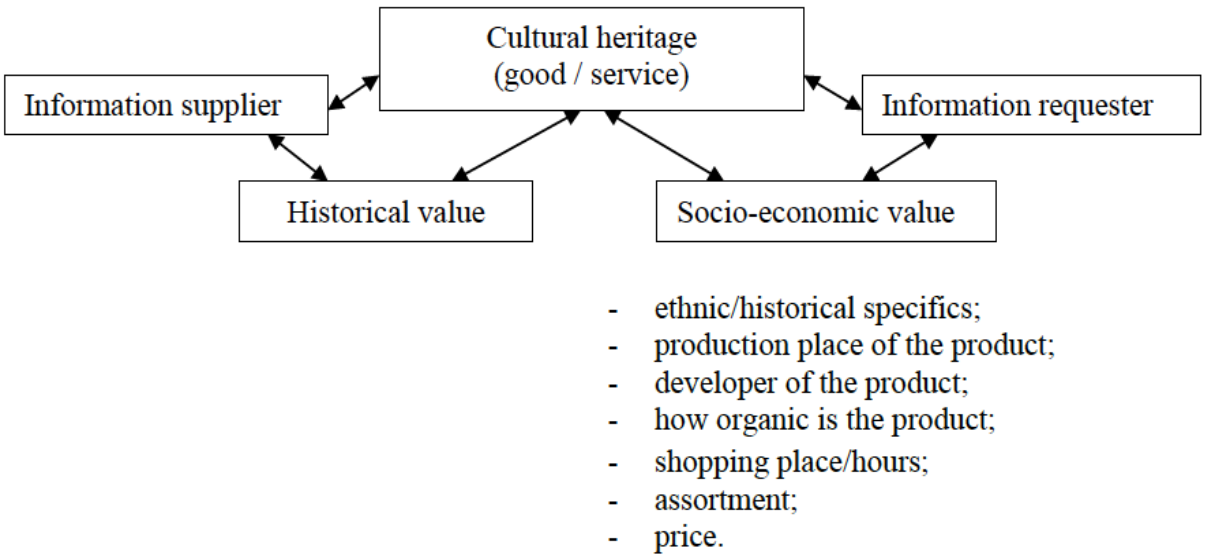


Figure 23: Jeroscenkova's diagram of perceived value of cultural heritage (from Jeroscenokova et al., 2016:24).

This can also be seen in Firth's (2015) analysis of the benefits of maritime cultural heritage in the UK. The impression that cultural heritage is a tangible item or service affects its use and value (Firth, 2015).

Both Firth and Jeroscenkova note how a perceived monetary value of an item can impact the impression of worth that an item has in the public eye. Materials that offer individual narratives to the themes of human experience are the ones that are more likely to connect with the public (Crooke, 2010).

7.2 MARITIME CULTURAL HERITAGE

In general, maritime cultural heritage has been viewed in environmental terms as "a fragile, finite non-renewable resource that should be safeguarded for future generations," (Firth, 2015:9), underlying the fact that in archaeology, the "creation of knowledge results from the physical destruction of primary evidence" (Richards, 2014:17). By citing specific contributions that special items or information makes to different sectors and stakeholders creates a worth more tangible than simple value "for its own sake" (Firth, 2015:26 and Maarleveld, 1998:420).

Maritime cultural heritage can be difficult to define, as artifacts can be found both underwater and on land and it encompasses everything, from shipwrecks to dockyards, and everything in between (Firth, 2015:1). In asking if there can be wholly "international heritage", Maarleveld (2012) suggests that maritime heritage offers a "unique origin and international dimension it has prime importance to overarching themes in the history of humankind" although legislation tends to see these sites and items claimed under more national lines and boundaries (Maarleveld, 1998:420).

Shipwrecks are indicators of global interaction, they incorporate timber from Norway, hemp from Russia, built in a shipyard in the Netherlands, with repairs made on Java. Although international in their function, they also hold great impact on local communities by reflecting the history of the local

maritime activity and highlighting the link to a more global sphere of foreign trade and interaction (Maarleveld 1998:422).

Location of a maritime cultural heritage also makes an impact on stakeholders and interested public. Sites and artifacts that remain under water are limited to a small number of individuals who have diving licenses and can actively participate in heritage experiences, such as underwater culture trails or memorial sites (Firth, 2015:15). Yet age or historic significance do not always play a role in the public interest. Recreational divers are far more interested in more recent wrecks, as "... steel wrecks tend to be larger, more intact (three-dimensional) and relatively rich in details and finds – characteristics that make them more intelligible and more of a challenge to diving" over wooden shipwrecks which tend to be flat and features indiscernible to leisure divers (Arnshav, 2013:51).

While maritime archaeology attempts to preserve wrecks *in situ*, this is not always an option. Depending on the condition of the wreck as well as the significance and local interest, post-excavation work can lead to further research. In the example of the Newport Ship in Newport, South Whales, local fundraising and contributions allowed for a full excavation and PEG preservation (Trett, 2010). However, in some cases, such as the Kolding Cog, there has been funds enough for preservation but a lack of display finances and display space, resulting in materials left in storage indefinitely (Koldinghus.dk, 2016).

7.3 CULTURAL HERITAGE ON DISPLAY

With so much of Scandinavia's history based on the sea, it is no surprise that maritime archaeology has played a large role in their cultural heritage. As described in Chapter 6, Danish legislation has been involved in protecting archaeological sites in Denmark since the 19th century. However, what is done with the materials after excavation is also critically important. While items

could be discarded after recording and all data extracted, in some cases, large-scale items are chosen to be displayed. What makes, in these cases, entire shipwrecks worth the conservation and preservation costs for display?

The Skuldelv ships of Roskilde, Denmark, and the Vasa in Stockholm, Sweden, are two famous examples of maritime archaeology in Scandinavia in terms of the completeness of the wrecks and in the conservation and presentation of the finds. Full preservation of these wrecks is achieved and is a major part of their appeal, both to researchers and to the public. A physical wreck, especially one well preserved and easily identified is a "intact gateway to the past" which can generate more interest than a diagram or report (Arnshav, 2013:48).

Figure 24: "Identity and ideology overlap with tourism and an experience economy," (Maarleveld, 2012:419). The Skuldelev 2 ship on display in the Vikings Exhibition at the National Museum of Denmark, Copenhagen, June-November 2013, (National Museum of Denmark, 2013).

However, there is more at work than simply the number of intact timbers. Both of these finds represent important periods in Scandinavia's history and the national identity of the individual countries. In particular relation to these nationalistic feelings in Scandinavia, the emphasis of post excavation is placed on display rather than research, which is evident when one sees that whole museums have been constructed around these finds (Maarleveld, 1998:29). Museums are "engaged in constructing, preserving and interpreting heritage experiences," shaping the narrative that a visitor experiences (Crooke, 2010:17).

When sites cannot be maintained *in situ*, a number of options are available. Discard of materials

post-excavation is a relatively sustainable option as it does not require further financial burdens for conservation and preservation. However, some items are deemed significant enough for conservation and public display. These items no longer in the care of archaeologists for interpretation, but enter into the sphere of cultural heritage where they are manipulated for public display.

Firth (2015) notes a number of C-transforms that an item may undergo as it moved from it's primary location to a secondary location, and the effects and levels of 'curation'. Firth tells an anecdote about a cannon found in a trawl which is then placed on the quayside for public viewing. “The cannon has been ‘cared for’ because of its character as heritage, irrespective of the standard of care that has been applied” (Firth, 2015:17), meaning that the cannon was recognized as significant, but not for any reason aside from its perceived age. Returning to Maarleveld's 'Fish and Chips' article (2010), the cannon may have been physically found, but all context and information is lost due to it's absence from the archaeological record (Maarleveld, 2010).

This story of the cannon can serve as a reminder of the dangers of assuming and applying stereotypes without applying research data (Maarleveld, 1998:76). These heritage displays can have no archaeological or historical value, but are perceived as a part of a general historical narrative, a symbol of the “general passing of time” (Arnshav, 2013:52).

Museums are in possession of many items which tell individual stories and add to the collective of man's experiences, but the need to create new and interesting ways for the public to interact with is a challenge. In many cases, “ the interpretation of a certain object on display is decided a priori by the curatorial team, thus the narrative that is presented to visitors is not really open to challenges or external contributions” (Ciolfi, Bannon and Fernström, 2008:356) which is certainly the case in many older museum exhibits. Older museum exhibits that do encourage participation are usually tactile experience based, such as trying on Viking clothing at the Roskilde Viking ship museum (Vikingeskibsmuseet Roskilde, 2016). It is only relatively recently that museums are focusing on more

technological tools for visitor engagement (Ciolfi, Bannon and Fernström, 2008:354)

"Exhibition development is a complex activity, which is expanding beyond the design discipline. Various kinds of specialist have brought a new perspective to museum exhibitions especially in terms of digital technology" (Lin, 2003:7) which can be seen as installations stray from information signs with chronological and categorical data, and head towards large orchestrated performances that give an experiential narrative. Studies in the early 2000s have attempted to determine the usability, usefulness and educational value of these interventions, both design and technological, in regards to museum visitors (Ciolfi, Bannon and Fernström, 2008:355). Findings thus far have shown that while technology and human-centered interaction displays are innovative in the way that the public connects with installations, it is still ultimately dependent on visitors requesting and receiving more information (Ciolfi, Bannon and Fernström, 2008:355).

7.4 LHL-81: A CASE STUDY

As already noted in earlier chapters, LHL-81 did not receive much attention when it was discovered in 1980. Maarleveld (1998) notes that "In the maritime sector, where people with maritime experience are confronted with remains from a maritime past, their own cultural environment or tradition will definitely determine their valuation of such remains" (1998:17), but this was not the case with LHL-81. The wreck was seen as a result of dredging and the proper steps were taken according to Danish legislation for archaeological finds. There was no local interest to maintain the wreck or connect local history with it, and although there was an opportunity for the wreck to be part of an exhibition at the harbor, at the time it was deemed to be too ugly for the tourist area (Nationalmuseet, Skibshistorisk Laboratorium, 1980:10).

Maarleveld (1998) notes how an item's value is reliant on "the construction of the past by

scholarly and scientific means" (1998:75), and this can be seen in the case of LHL-81. Both Teisen and Gøthche believed that there was educational value in the timbers, which resulted in the preservation of the wreck pieces and the eventual offer to deposit the wreck at the Esbjerg Fiskeri- og Søfartsmuseum for an open air exhibit.

During the assessment done by Morten Gøthche, he created a 'best fit' exhibition plan on how to display the re-assembled timbers in the most appropriate sequence as well as offering the best overall impression of the wreck (Gøthche, 1981:0776-TR-00010) . Gøthche suggests using brass, stainless steel, or galvanized iron bolts to connect the timbers. He also includes directions for a metal framework underneath the re-assembled timbers that would help with the impregnation process while also supporting the heavy timbers and forming an irrigation system that will allow excess water to run off and not stagnate on the wood. The framework should be lifted off of the ground to allow for ventilation, and should preferably be located in a gravel bed to help prevent fungi and other growth from attacking the timbers (Nationalmuseet, Skibshistorisk Laboratorium, 1980:35).

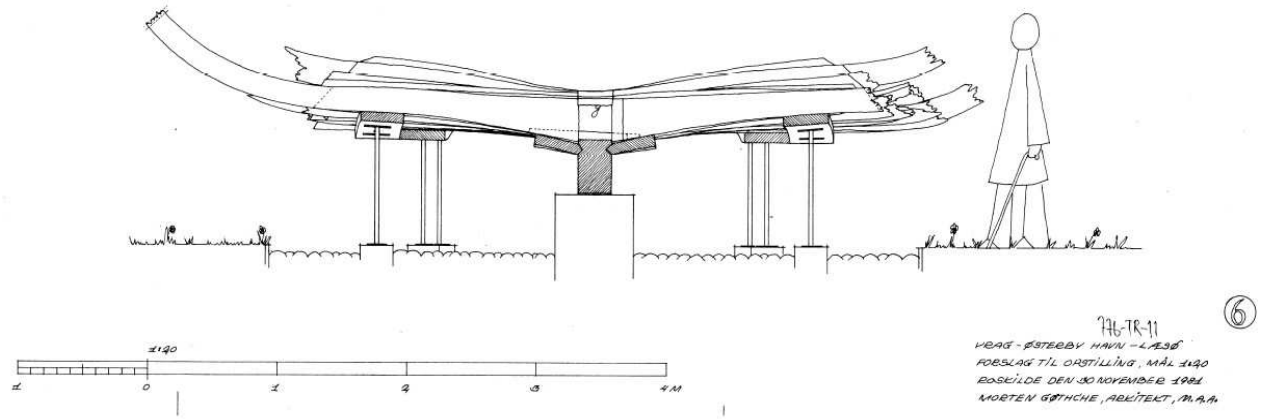


Figure 25: Recommended display for LHL-81 (Drawing by Gøthche, 1981:0776-TR-00010).

However, Gøthche's plans were ignored for the open air display. While Gøthche explicitly states that the frames do not match the keel section, and therefore should not be mounted on the keel for the display, this is exactly what happened. The frames have been put in the correct numerical sequence (2 to 8), but no other efforts were made to accurately display the wreck as it was once assembled. The wreck is also placed directly on the ground, resulting in many of the timbers being covered in sand and slowly disintegrating over the years.

The Fiskeri- og Søfartsmuseum has no record of receiving the wreck, there is only a receipt from the National Museum of the transfer of timbers. There is also no documentation as to the logic behind the re-assembly decisions. It seems that the Museum was more concerned with creating an impression of a shipwreck rather than an accurate impression of the ship itself. As Arnshav (2013) has noted with recreational divers, it is the experience that holds more value, and while the historical aspect of the wreck is somewhat noted on the museum signage, the real "... importance is instead attached to impressions of 'pastness'" (2013:35). Arnshav (2013) describes the concept of romantic ruins, and even notes how other shipwrecks have been put on display to allow the public to experience "the aesthetics and existential dimensions associated with the past" (Arnshav, 2013:52), with little to no historical information presented.

The sign in the open air exhibit is lacking in information and does not differentiate between the different wreck pieces. Basic information about LHL-81 does not correlate to the Nationalmuseet, Skibshistorisk Laboratorium report (1980), and instead makes overarching generalizations. The sign offers visitors the most basic of observations and leaves no room for further thought or questions. As an educational tool, LHL-81 is not living up to potential. Not only is it tucked away while the lack of maintenance has it slowly being covered by growth, there is no attempt made at connecting the wreck with any form of history or heritage, leaving visitors unimpressed and disengaged.

Although legislation and archaeological theory can dictate the excavation of a site or wreck,

when the artifact is handed over to a museum it becomes the focus of different stakeholders who may be more interested in creating "empathy of the past" rather than focusing on plain history (Maarleveld, 1998:76). Archaeologists can identify their biases and offer interpretations, but ultimately it is the museum which decides the narrative, and "Authenticity is in the eye of the beholder" (Holtorf, 2009:37). In the case of LHL-81, the Fiskeri- og Søfartsmuseum has taken an approach closer to representing the "ravages of time", rather than relating to accurate historical context (Arnshev, 2013:52).

The creation of a three-dimensional model of LHL-81 can provide remote access to the wreck to researchers. It can also be used as a preservation tool and to chart the degradation of the wreck if the Museum decides that maintenance is not an option for the open air exhibit.

7.5 FINAL THOUGHTS ON CULTURAL HERITAGE

Arnshev (2013) argues that "age does not matter scientifically nor when experiencing heritage" (2013:53), and while legislation puts a numerical threshold on what should be protected, it is clearly not the only aspect that contributes to a wreck's value. Cultural heritage can force social and economic values to be placed on items, but it does not necessarily mean inclusion in the archaeological record. This can be clearly seen in the case of Firth's (2015) cannon example, which has a real life parallel in the cannons of Østerby Harbor (2015:17).

"Community heritage has become a means to mould and communicate histories, understandings of identity, and definitions of culture and cultural relevance within groups and to others" (Crooke, 2010:28), where museums create narratives and installations. The importance of display creation is the interaction of 'history' and 'heritage', where 'empathy with the past' and 'construction of the past' are balanced and not overshadowing one another to create a biased, or stereotyped, narrative (Maarleveld,

1998:76). Overlapping values and stakeholders, however, play a large part in how information is interpreted and displayed. LHL-81 is a good example of how data interpretations are subjective to groups based on their backgrounds and their intentions in relation to cultural heritage. LHL-81 could have been positioned in Østerby Harbour, where its' ties to the local community could be explored and appreciated; however, opinions at the time saw little value in this, and instead the wreck was transported to another location.

In his examination of the socio-economic benefits of maritime cultural heritage in the UK, Firth (2015) notes that "The revolution in digital access also means that audiences for cultural heritage that is itself localised can be global in extent" (2015:19), allowing for remote research and widespread dissemination. Cultural heritage is important, but it is necessary to find ways to develop national identities and constructed narratives in the context of a history. Up to this point, LHL-81 has been lost to the ideals of 'pastness', but hopefully can serve as a case study of the dangers of bias and the lack of forethought in using materials as display without proper documentation.

CHAPTER 8:
LHL-81: THE WRECK

Descriptions of the timbers are taken from the original report by Teisen and Gøthche (Nationalmuseet, Skibshistorisk Laboratorium, 1980). Measurements and angles are not expected to be accurate to the original building designs, but these are far more accurate than measurements taken on LHL-81 now, after the pieces have been re-assembled and left un-supported and un-covered in Esbjerg for almost three decades. The wreck description layout will follow the best practices format outlined by Steffy (1994:236), although it will be relatively short due to the small amount of material recovered: only sixteen frames and futtocks, a keel piece and a few pieces of planking.

8.1 TIMBER DESCRIPTION

8.1.1 KEEL

The keel portion was the largest portion of the wreck to be discovered. The piece measures 7.2 meters in length, 65 to 75 centimeters molded, and 35 centimeters sided. A 40 centimeter long rabbet goes along the sides, 3.5 centimeters deep with a 85 degree angle. There are also 13 notches in the keel, 22.5 centimeters long, 3.5 centimeters deep, and 4 centimeters wide, for frame placement. These recesses are spaced 32 to 34 centimeters apart.

There are traces of iron rivets embedded in and around the rabbet. On the intact end of the keel piece there is a scarf with a groove for caulking. The keel is a softwood, likely spruce. Gøthche noted that the wood was likely sawn with a machine saw and then finished with a hand plane, however there are no evidential markings left on the timbers now (Nationalmuseet, Skibshistorisk Laboratorium,

1980).

Typically ships were equipped with false keels. However, there is no evidence of this on LHL-81.

The keel was made of multiple pieces held together by a scarf joint. The scarf joint is a hooked scarf, although there are no indications of keys or fastenings. Gøthche believed that this particular style of scarf joint would be typical in a Dutch shipyard (Nationalmuseet, Skibshistorisk Laboratorium, 1980:36).

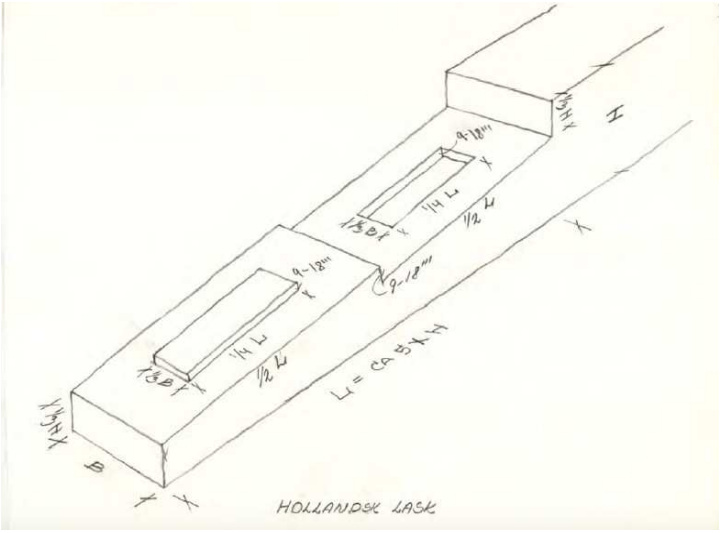


Figure 26: The hooked scarf joint, 'Hollandsk Lask', on LHL-81 keel, drawn by Gøthche (Nationalmuseet, Skibshistorisk Laboratorium, 1980:36).

Neither the stem- or stern-post pieces were recovered.

8.1.2 FRAMING

Ten oak floor timbers and futtocks were recovered from the dredgers' pile. A floor frame and corresponding first futtock are nailed together with iron nails and then stuffed with wooden pegs, approximately 32 centimeters between nails. In some places, needing more stabilization, treenails are also used. Frame and futtock pieces are all of oak. All pieces have some damage from the aquatic environment.

The floor timbers are about 4.35 meters long. Moulded measurements have a maximum of 29 centimeters at the center while the ends are 18 centimeters. Timbers range from 22 to 24 centimeters sided dimension. The frames fit into the keel recesses with a 20 centimeter wide, 4 centimeter deep cut,

made at a 65 degree. The frames from keel to bilge have a reached angle of 85 degrees. All frames are broken on the butt end, where it meets with the keel. The floor timbers are attached to the keel with iron bolts over 50 centimeters in length.

The frame pieces have construction sequence symbols in the center of the frames on one of the moulded sides. The letters and numbers are framed by vertical lines, one on each side, going the full length of the frame side. Letters and numbers will be discussed in more detail in the Paleography chapter.

The first futtocks are a bit more narrow than the floor timbers, 18 to 22 centimeters wide. These timbers are also all broken. These are attached to the floor timbers with hand forged iron square head nails, measuring 3 by 3 centimeters.

8.1.3 MAST

There is no mast piece remaining, but there are features indicative of a mast step on the floor timber labeled '4'. On the aft side of frame '4' there is a recess for lead pump pipes that continues hack two frame sections. The pump pipes would have to be lead, as a wooden one would have taken up more room. The pump placement indicates that this frame is around where the main mast would have been raised, as pumps were immediately adjacent to the mast.

8.1.4 PLANKING

A number of spruce hull planks were recovered. One garboard was found with both edges of one side chamfered at 45 degrees, creating a 90 degree angle which fit into the rabbet of the keel.

Planks range from 25 to 35 centimeters in width, and an average thickness of 7 centimeters. The planks have been cut with a long saw. The planks were placed edge to edge to form a carvel hull. They are attached to each frame with two or three iron nails.

Nail holes on the outer side of the hull planks indicate that wooden sheathing was once attached to the hull.

8.1.5 CAULKING

Caulking remains have been found along the rabbet as well as on the hull planks. The caulking is long, coarse, vegetable fibers. Samples were taken but never tested. It is assumed that the materials are likely hemp.

Figure 27: Sample of caulking material taken from LHL-81 in March 1980. The sample was never tested but is assumed to be hemp (Image from Nationalmuseet, Skibshistorisk Laboratorium, 1980).

8.1.6 FASTENINGS

Iron nails, iron clenched nails, and treenails are all used to fasten the timbers together. Treenails have an average of 4 centimeter diameter, and are spaced 40 to 43 centimeters apart, center to center. The iron nails are 3 by 3 centimeters square. A few clenched iron nails have been hammered into the framing timbers, attaching the floor timber and futtock. These long iron nails are minimum 50 centimeters, measured through the timbers.

8.1.7

8.2 CONSTRUCTION METHODS AND SEQUENCE

8.2.1 SYMBOLS ON LHL-81 FRAMES

The symbols on the timbers of LHL-81 are construction sequence numbers, indicating the order of the timbers during ship construction. Both numbers and letters are present. Numbers indicate the order of the frames from midships going aft while the letters are the order going from midships towards the bow. Some timbers have the same number or letter, indicating which first futtock timber coincides with the frame (Nationalmuseet, Skibshistorisk Laboratorium, 1980:24).

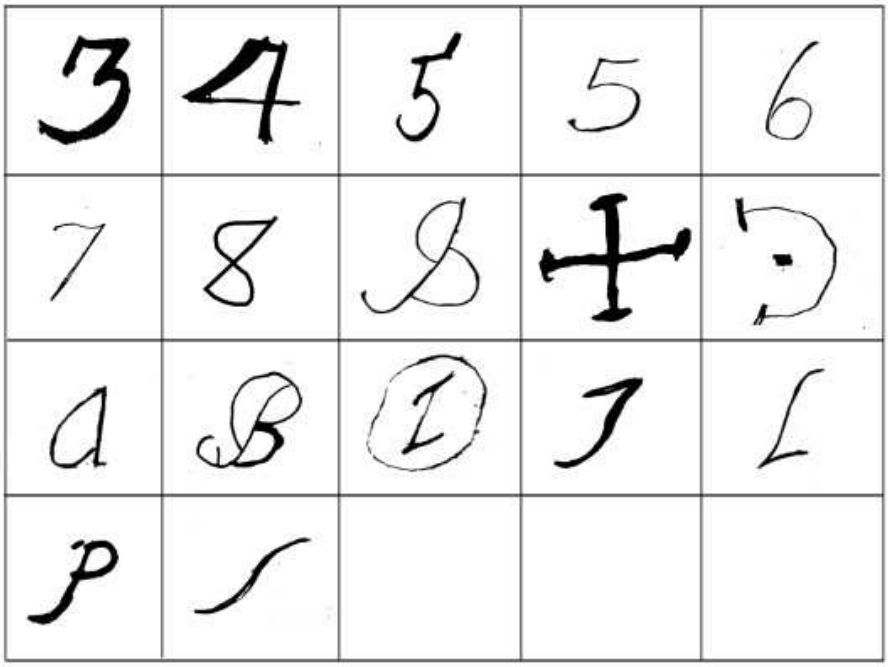


Table 2: Symbols found on the frame pieces of LHL-81 (Based on drawings by M Gøthche, 0776-TO-00003 through 0776-TR-00009, in Appendix 2).

The symbols are on one moulded side and are located towards the centerline of the ship. All symbols are approximately seven to ten centimeters from top to bottom. The markings are are not engraved deep into the wood, making small details difficult to see in wet conditions.

Some of the symbols are not immediately recognizable letters or numbers. The X marking has been interpreted as a cross and therefore the midships frame by Gøthche (Nationalmuseet, Skibshistorisk Laboratorium, 1980:24). The '3' marking could be a number, however, it could also be an 'I' or a 'J' or even 'Z'. Two symbols are particularly distinctive from the other characters due to their elaborate flourishes. The '&' and 'B' are intricate and very detailed, and these two characters will be very useful in comparing the styles, as they are more distinctive than a more simple letter.

The sequence symbols on the floor timbers offer insight to the construction process as well as the placement of frames within the ship. In ship construction, frames with letters are placed forward of midships, while numbers are put aft. Midships is marked with a cross. Standardization in shipbuilding began in the 1600s in order to build naval warships more efficiently.

The numbers on the timbers are 3, 4, 5, 6, 7 and 8. Letters are A, B, C, and D. There is also a timber with an X, which is the midships timber.

8.2.2 CONSTRUCTION MARKINGS

There are no indications that clamps were used in the construction of the ship frame. The size overall ship size indicates that it was likely to have been built in a small private shipyard. The carvel hull indicates a frame-first construction order.

8.3 CANNONS

As noted in Chapter 4.6, two cannons were raised from the harbor in 1980, while one was already on the quay as a bollard since the 1960s. Through interviews on the island, Lili Jepsen at the Læsø Museum was able to piece together a narrative of what happened to the three individual cannons

that were raised from the harbor.

The Nationalmuseet, Skibshistorisk Laboratorium report (1980) gives the dimensions of 22 centimeter muzzle diameter with an 8.5 centimeter bore diameter, indicating that the cannon was able to fire 4 pound shot. Recent pictures confirm that the cannon is indeed still in the pier at Østerby Harbor. Over the years it has been covered in epoxy paint and no distinguishing marks can be made out.

Another picture of the cannon that was given to the Søfarts- og Fiskerimuseet in Vesterø shows that the cannon was placed in a small carriage made for its display. Yet again, no marks or distinguishing traits are visible.

Figure 28: Cannon raised with LHL-81, donated by Captain Erik Møller Sørensen to the Søfarts- og Fiskerimuseet in Vesterø, Læsø. The Museum is permanently closed (Photograph from Læsø Museum archive).

CHAPTER 9:
PHOTOGRAMMETRY AND 3-D MODELING

9.1 DIGITALIZATION

New technologies are allowing for the widespread dissemination of data in real-time. Long periods of waiting between conclusions and publication are becoming shorter, and more and more open-source options for data are being offered (Richardson, 2013). Museums and libraries are taking up the cause to digitally preserve items of cultural heritage (Scandinavian Library Quarterly, 2012), expanding their audience far beyond the local realm and opening to a global sphere of influence (Firth, 2015:19).

Jeroscenkova's study (2016) of the public perception of cultural heritage showed a heavy reliance on digital technology. The study revealed that an individual's interest in something is closely related with the availability of information and the degree of awareness of what they are interested in. In other words, those who felt cultural heritage was important already had some knowledge of cultural heritage. In this age of information, the main tool for accessing information is the internet, with 74% of the Romanian group and 60% of the Latvian group claiming that they had learned about the impact of cultural heritage via internet connection (Jeroscenkova et al., 2016:21-22).

While Jerscenkova's study (2016) is limited to only two countries, it does show the importance of internet access in the spreading of information. Internet and social media has been cited as a new platform to "foster new dialogue, underpin new power relations and support representations of community constructed archaeological knowledge, whilst subverting archaeological data from structural control and redistributing access to cultural resources" (Richardson, 2013). While internet

access has been noted as a large source of information, it is important to also realize that in 2012 only 1.8% of the Internet-using public in the UK had ever participated in a heritage forum online or made comments on a heritage-related website (Richardson, 2013). This reinforces that while access may be available, there also must be an interest to search out the information.

Critically speaking, although digital projects are able to offer a wide range of participation in archaeology, it also allows for anyone to use data and create narratives that "can be used to assert local identity or used to stake claims of legitimacy within politicised communities" (Crooke, 2010:25). Richardson acknowledges that amateur archaeologists have access to open data and can create their own archaeological content to upload (Richardson, 2013), but without professional affiliation, the adage "You can't trust everything you read on the Internet" holds true.

As technology improves, global media sites also contribute to cultural heritage. Dances, songs, oral histories, and other forms of intangible cultural heritage can be displayed and experienced (Pietrobruno, 2013:743) by a world-wide audience. YouTube and other video-sites can host a list of related videos, thereby offering different perspectives of one particular performance (Pietrobruno, 2013:749). As digitalization continues to participate in public archaeology, "contributions of 'crowd-sourced' archaeological content; to share and discuss archaeological news and discoveries; foster online community identity, situated around the topic of archaeology and wider heritage issues" (Richardson, 2013) can continue to gain support.

9.2 3-DIMENSIONAL RECORDING

3D recording and modeling has been a growing trend in archaeology, both on land and underwater. Advances in technology have made 3D modeling options more available to archaeologists on a time and money budget. Hermon and Nikodem (2007) focus on the advantage of better

interpretation of the past: “Since our world is also a three dimensional one, and we are used to acquiring and assimilating large amounts of 3D data from our interaction with our environment, there is seemingly no reason why the same medium shouldn’t be used when attempting to analyze a past environment”, (Hermon and Nikodem, 2007:2). Other archaeologists see the advantages of accuracy, as “analog documentation was mainly recorded with single measurements and therefore systematic errors or mistakes...”, and running triangulation of points through software can create a 3D model with “errors on the order of millimeters” (Eric et al., 2013:7).

Three dimensional models of objects can offer wide audiences the experience of an artifact, while an individual never leaves the comfort of their living room. News stories focus on the ability of a layman being able to access an artifact in a more concrete way than from behind a glass wall (Maynard, 2015). Virtual tourism, such as *The Virtual Museum of the Aegean and Cypriot Antiquities Collections in Tuscany*, funded by the Region of Tuscany, Italy, and coordinated by Professor Anna Margherita Jasink of the Department of Antiquities of the University of Florence, a project started in 2010, is one of many examples of how cultural heritage is making its way online (Tucci, Cini and Nobile, 2012). In addition, many items that undergo photogrammetry by scientific institutions can allow for remote measuring and data accumulation by researchers abroad (see Hermon and Nikodem (2007) for more information on 3D models as a scientific tool).

9.3 CRITICAL DISCUSSION

There are many advantages to digital access for artifacts and heritage objects. In addition to remote access, there is also the potential of preservation. A final, but large, drawback to digitalization trends is the necessity of storage and format compatibility as data readers continue to develop (Richardson, 2013). In many ways, it is the “same preservation issues as other archaeological datasets

although, in some cases, certain problems are somewhat heightened, including issues of data storage, ensuring adequate metadata, documenting processing techniques, and dealing with proprietary software," (Richards, 2014: 23), all of which also must be accompanied by full documentation since the primary evidence is destroyed as excavation is undertaken (Richards, 2014:17).

3D recording has been a huge asset for underwater archaeology. In terms of efficiency, "manual 2D documentation required at least 30 diving hours while on the other side a series of photographs needed for the 3D reconstruction were taken in just 35 minutes" (Eric et al., 2013:5). Although there are many challenges, such as low visibility and currents, that divers or ROVs need to compete with, the "Progress in computer technology as well as development of powerful new 3D recovery and modeling methods, in particular open source solutions, have transformed in practice the methodology of documenting cultural heritage *in situ* in the last ten years" (Eric et al., 2013:4) resulting in an increase in underwater recording. When the models are published online, "...while interesting for the public, also allows researchers to continue searching [the site] even after its closure" (Daly, 2016), which offers major research opportunities in post-excavation.

Archaeologists are also using these technologies for artifact recording. Museums have been experimenting with small and medium sized artifacts, especially with object reconstruction. The Department of Antiquities and University of Florence have been collaborating on a project to connect local and remote archaeological collections of Agean and East Mediterranean regions for information and research sharing in a virtual museum (Tucci, Cini and Nobile, 2012:1). When proper scanning techniques are applied, these models offer ways to measure, inspect, and analyze artefacts from afar.

In terms of cultural heritage protection, photogrammetry and laser scanning has been a driving point of virtual preservation since the early 2000s (Kjellman, 2012:11 and Remondino, 2011). A recent public outreach use of this technique has been Project Mosul, an effort to create three-dimensional models of objects destroyed by IS and earthquakes in the Mosul Museum in northern Iraq (Maynard,

2015).

This project is a crowd funded volunteer-based and is working with photos taken from tourists to retroactively create models. While researching a number of photogrammetry options in his thesis, Kjellman (2012) notes that "With sub-par raw data it can be a very disappointing experience trying to generate something useful," (2012:19). While this may be true in a scientific research sense, Matthew Vincent, co-founder of Project Mosul, notes that "These models don't have the same scientific value as if we were able to do this with calibrated cameras, laser scans, etc. But the 3D models still have the value of the visualisation - being able to see what the artifact was like" (Webb, 2015), and is better than nothing at all.

3D models of artifacts are even being considered for 3D printing, offering students and researchers physical items to study without the risk of damage to the original materials, such as Chinese oracle bones being studied by Cambridge University (Phys.org, 2016). This technology has even been extended to the public wanting to 3D print their own items from the British Museum or New York Metropolitan Museum collections (Vincent, 2014 and The Metropolitan Museum of Art, 2016) as less professional, and keepsake, oriented replicas. With all the advantages being touted in the medias, it remains to be seen if it is a passing trend or will continue to develop.

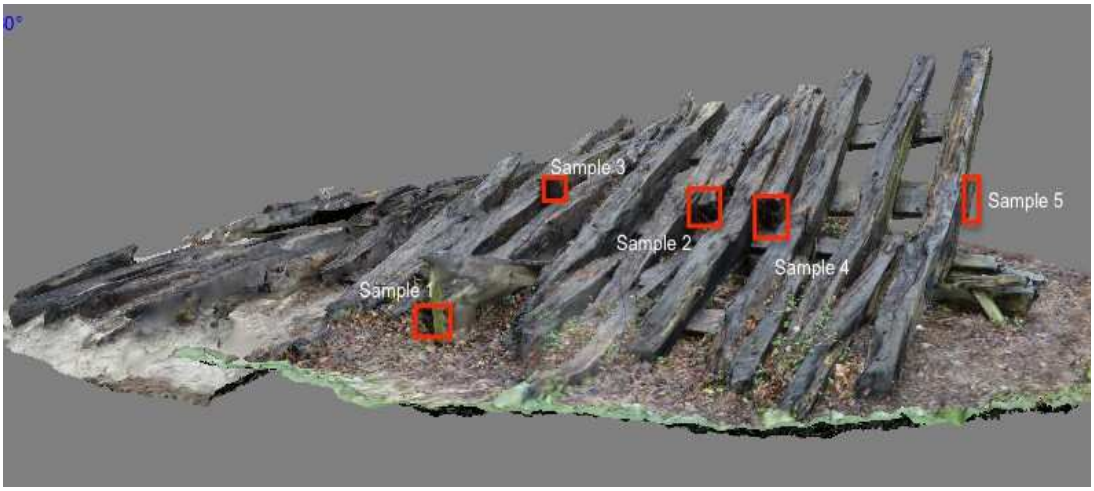


Figure 29: Location of possible dendrochronology samples on LHL-81. Model by De Hoop and author.

9.4 PHOTOGRAMMETRY OF LHL-81

Photogrammetry recording of LHL-81 was done in one afternoon. For full description of the recording methods, please see Chapter 2.3 (Photogrammetry Methodology) in this thesis. Photogrammetry was decided as the most logical and efficient way of recording for a number of reasons. Time-wise, this was the most efficient method to record the timbers, as well as the final result being more accurate than hand-drawn offset measurements. Secondly, it offers the opportunity to record the wreck as a whole piece which can then be manipulated for viewing, whereas 2D drawings could never offer the same perspective.

The timbers had all been individually recorded by Teisen and Gøthche in 1980. While it could have been useful to record each timber again in order to track the degradation and warping of the frames, it would not have given much more information about the timbers themselves.

Instead, the re-assembled wreck was recorded as a whole. Had the purpose been to do detailed recording of each individual piece, this would have been a drastic disadvantage, as timber surfaces were obscured by the attached pieces. Similar to the difficulties with recording the Gresham Ship (Auer et al., 2014), the paper timber recordings were useful to cross reference with the 3D model.

The intention to capture LHL-81 re-assembled as a whole is to capture the essence of the wreck that is currently being displayed at the Fiskeri- og Søfartsmuseum. LHL-81 is not being used as an archaeological artifact, but as a piece of cultural heritage designed to evoke the experience of the presence of another past period (Holtorf, 2009:31). Capturing it as a whole will allow remote and future researchers to comprehend the use of the wreck as a tool for cultural heritage while also being able to glean ship construction details on the timbers in photographic detail.

CHAPTER 10:
ANALYSIS OF LHL-81

In this chapter, all data and information is brought together in analysis in order to more closely define LHL-81 as a ship. Dating and provenance techniques include dendrochronology and paleographic analysis. Construction details will be looked at as well to see if there is any evidence of where the ship was built. Ship size and type will be examined by comparing hull shape and ship size and tonnage from known ships. A brief investigation of the second wreck piece in the Esbjerg Fiskeri- og Søfartsmuseum open air exhibit will offer an evaluation as to the likelihood that the two wreck pieces are from the same whole. The final section will discuss the cannons as armament, ballast or cargo.

10.1 LHL-81 DATING

10.1.1 DENDROCHRONOLOGY

Perhaps the most accurate way to date a wooden item is through dendrochronology. By dating the wooden timbers, the date for the construction of LHL-81 will be more obvious. Dendroprovenance can also give additional information about the origin of the timbers. This information can then be used to determine if materials were imported or if they were locally produced based on further dating and geographical information gleaned from the paleography analysis and ship construction details.

10.1.1.1 LHL-81 SAMPLES

With a wreck in such a decayed condition, finding timbers that could be used as samples is very difficult. Aoife Daly suggests that ideally, the timber should have "at least 100 tree-rings in the sample. Even though there is no sapwood on any of the timbers, you can still date the remaining material, and get a terminus post quem date for the boat" (Daly, 2016). Five potential samples were identified in the assemblage and photos were sent for appraisal before any cutting was done.

All of the possible samples are from the oak frames, which were best preserved and had the best cross section available for sample, pith in the center, surrounded by heartwood. No sapwood is present on any of the samples.

SAMPLE	IMAGE	No. RINGS
1		c. 30
2		c. 40
3		c. 45
4		c. 30
5		c. 26 - 30

Table 4: Dendro samples from LHL-81. Ring number analysis by Aoife Daly, personal correspondence (Daly, 2016).

10.1.1.2 DENDROCHRONOLOGY RESULTS

Unfortunately there were not enough tree-rings left to date the timbers. With a requirement of one hundred tree rings, the highest number of rings was approximately forty-five.

Although it is not possible to use the tree rings to get an accurate time period, the lack of rings may still be of use, as "it says a lot about the availability of oaks in the 18th century" (Daly, 2016).

Had the timbers been dated and given a provenance, it does not necessarily give the origin port of the ship itself. As Daly noted, a lack of tree rings could identify that the timbers came from an area where fully grown trees were scarce, thereby using trees that were far younger than normal for construction. In this case, MacGreggor (1980) discusses the lack of trees in England which impacted the country's shipbuilding during the 18th century (1980:148, and Hutchison, 2012:6-7).

While LHL-81 cannot be dated or given a provenance, we are left with many interesting possibilities. Timbers made of teak could imply repairs en route, while a spruce hull could indicate Finnish origins in terms of construction preferences (Ojala, 1977:177).

10.1.2 PALEOGRAPHY

Construction sequence symbols on LHL-81 are another interesting feature to the wreck. These indicate what part of the ship they come from, which is an advantage in estimating size. They also indicate that the ship building process was standardized, and that the ship was likely to have been built in a yard with a number of workers. The characters themselves, which are from a Latin based alphabet, can be analyzed to determine the time period and geographic location that the style best matches.

Naval architect Morten Gøthche in the Nationalmuseet, Skibshistorisk Laboratorium report gave an estimated date range of 1750 to 1850 (1980). While his expertise in ship construction analysis

is not under question, handwriting samples from 1600 onwards will be used in order to offer a wide range of comparison and to ensure that there is not a bias to ignore potential information.

Gothic style handwriting began to spread across Europe in the 9th century, replacing the Roman alphabet completely in Western Europe by the 1500s (Familysearch.org, 2016). While this Gothic, or Black letter, basic style was used, many variations developed in different places and at different points in time. Certain styles of letters were used in particular areas, especially in Scandinavia with the Æ, Ø, Å characters. Norway was part of the Danish kingdom and was expected to adopt the same form. To ensure this, the central government in Denmark would send regulations and samples to Norway in order to maintain uniformity (Familysearch.org, 2016). Sweden and Finland were also one kingdom, and therefore shared the sam Old Swedish version of Scandinavian Gothic (Familysearch.org, 2016).

10.1.2.1 SAMPLES

For the analysis of the symbols on LHL-81 timbers, samples from all over Europe were compared in order to give a wide range of areas for potential origin. Samples from the time period 1600 to 1900 were chosen, again to cast a wide net to avoid the bias of the initial interpretation of 1750-1850. Letters which matched LHL-81 symbols were chosen for a comparative chart. Once in a table form, it was easier to see which styles were most similar to LHL-81 characters.

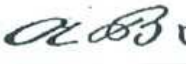
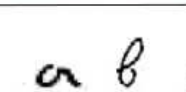
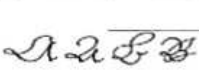
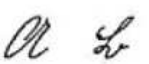
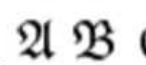
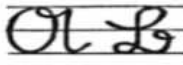
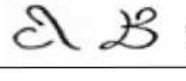
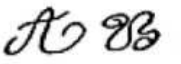
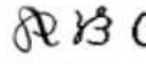
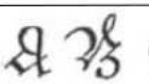
STYLE	TIME PERIOD	LOCATION	SAMPLE
Gothic / Blackletter	1150 - 1940	Western Europe, Germany	
Modern Cryllic	1700 +	Russia	
Scandinavian Gothic: Sweden	1200 - 1800	Sweden	
Scandinavian Gothic: Denmark. 1600-1699	1600 - 1699	Denmark and Norway	
Scandinavian Gothic: Denmark. 1700 -1799	1700 - 1799	Denmark and Norway	
Scandinavian Gothic: Denmark. 1800-1875	1800 - 1875	Denmark and Norway	
Kurrentschrift: 1400 - 1799	1400 - 1799	Central Europe	
Kurrentschrift: 1800 - 1899	1800 - 1899	Central Europe	
Kurrentschrift: 1900 - 1940	1900 - 1940	Central Europe	
Fraktur	1500 - 1941	Germany	
Sutterlin	1900 +	Germany	
Italic	1500 - 1599	France	
Ronde	1600 - 1699	France	
Ronde	1700 - 1900	France	
Italic	1600 +	Netherlands	
Italic	1500 -1699	Great Britain	
Secretarie	1700 - 1807	Great Britain	
Carstairs / "English Hand"	1800 +	Great Britain	

Table 5: List of the handwriting samples used in the LHL-81 paleography analysis. Table includes time period and region of use.

10.1.2.2 STYLE COMPARISON

These markings were not easy to place into one particular style. Each individual has their own distinctive penmanship, and the same is true here. Especially important to consider is the fact that these letters were not written on the timbers with a pen, but were carved with tools. This means that some of the smaller handwriting flourishes were either ignored in favor of a more simple letter form or the flourishes were not carved deep enough into the timber to allow for preservation. In any case, the characters on LHL-81 timbers can not be expected to be perfect matches with the handwriting samples.

It is also significant to note that shipyards had many workers, and that many people were involved in the building of a ship, even a small one. Worth noting on LHL-81 is the variation between the repeated characters, such as the number '5'. The '5' on the full frame is tall and narrow, almost italic in style, while the one on the futtock has a fuller and more round bottom curve, more childlike in appearance. This differentiation between the styles indicates that two timbers were marked by two separate individuals although the basic number form is the same.

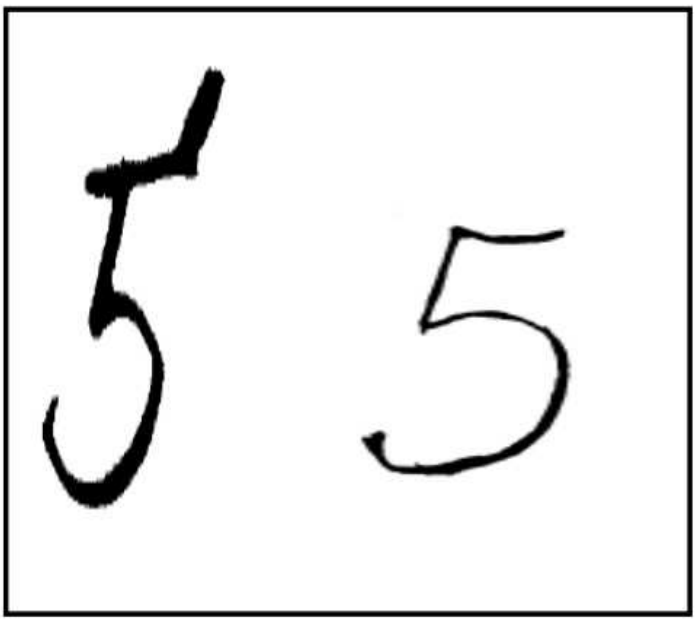


Figure 30: The different styles of 5 on the frame and on the futtock of LHL-81 (Based on drawings by Gøthche, 1980: 0776-TO-00006).

While it is difficult to match whole alphabets, it is also easy to see which alphabets do not match at all. Cryllic had almost no matches. French, English and Dutch all have very different letter 'A' styles than the one on LHL-81, and as a whole, these have far less matches than the Scandinavian and German alphabets.

PALEOGRAPHY COMPARISON

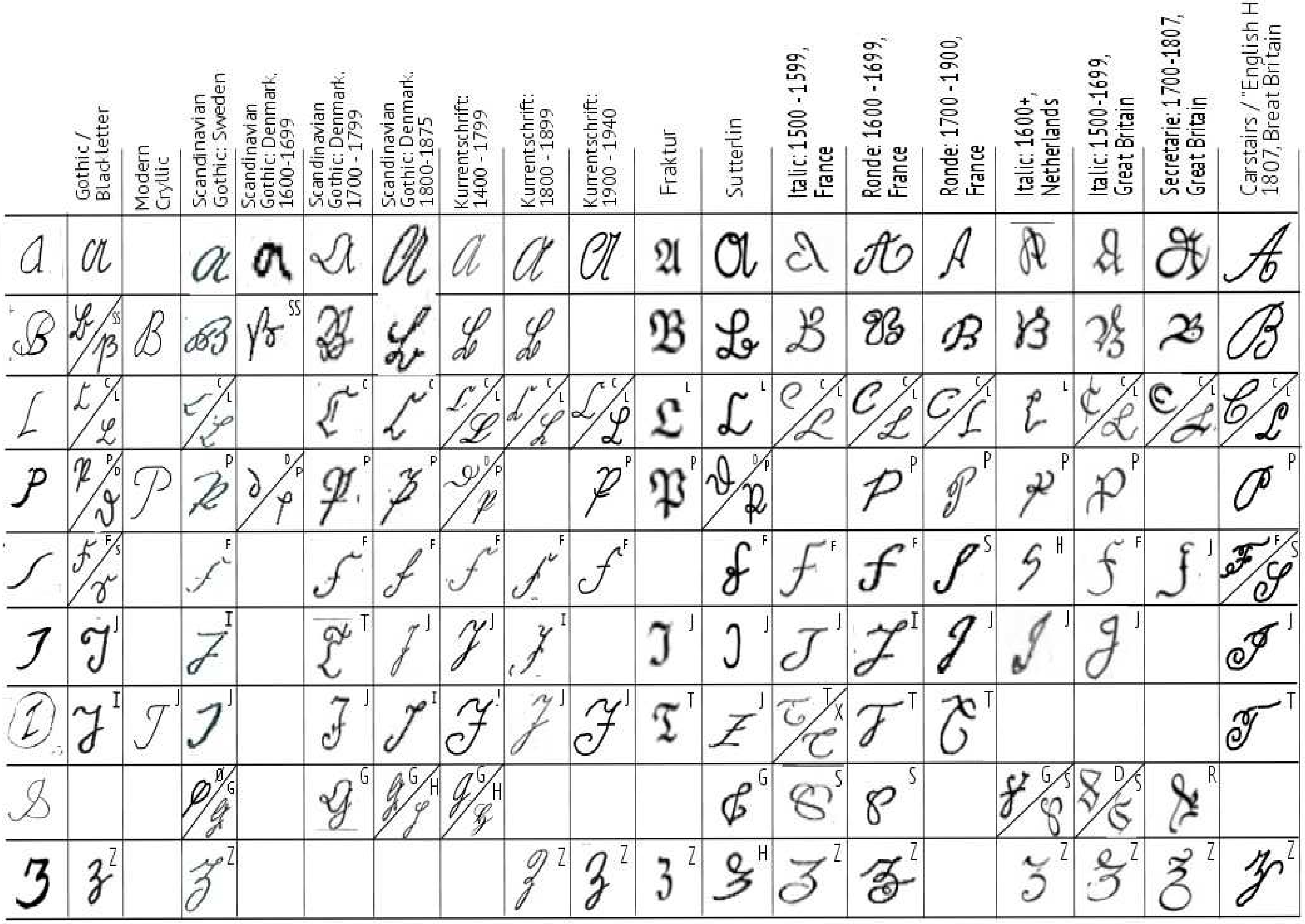


Table 6: Table of the best matching handwriting samples and LHL-81 characters. Full handwriting alphabets in Appendix 3.

When comparing the letters, it is important to not only look at the shape itself, but when there are multiple potential matches, it is based on alphabetical order. It is imperative that the character matches also correspond with the ship dimensions. For example, in Gøthche's interpretation, he notes that the 'S' looking character is highly unlikely to actually be an 'S', as that would put the frame very far forward in the ship, and the frame dimensions do not support this location. Gøthche suggests that the 'S' should actually be considered an 'f'. He makes similar conclusions with the 'p', believing it to be a 'd', which would line up the frames according to their proportions (Nationalmuseet, Skibshistorisk Laboratorium, 1980:24). In many cases, the letter 'J' was often used to represent the number '1' (Nationalarchives.gov.uk, 2016), and Gøthche confirms that the circled 'J' frame fit much better as a '1' frame, next to midships, rather than further from it (Nationalmuseet, Skibshistorisk Laboratorium, 1980:25).

Matching letters and numbers with their dimensional properties is useful as we can easily eliminate the 'S' and special Scandinavian letters, as well as the '3' symbol as 'Z'. Frame dimensions help determine the more-likely letter match when we acknowledge that we are left with only the frames from close to the midships section.

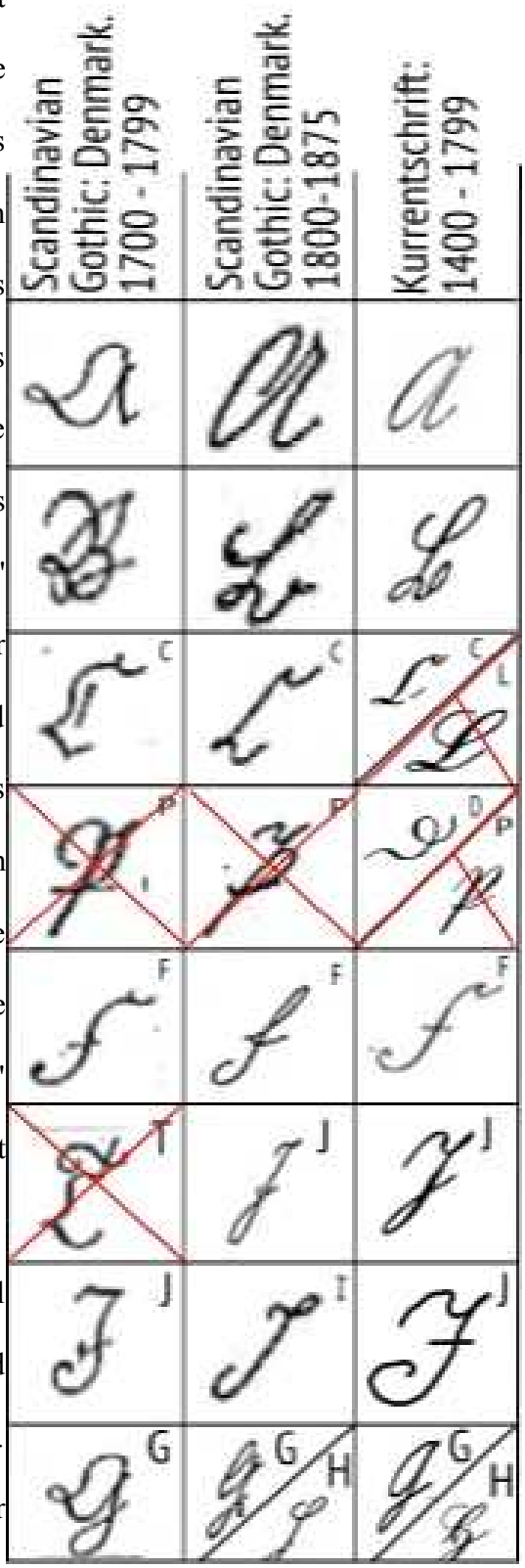


Table 7: Handwriting styles with closest matches to LHL-81.

10.1.2.2 PALEOGRAPHY RESULTS

Side by side comparison of LHL-81 timber symbols and handwriting samples from 1700 to 1900 in Europe show that the style has a close match with the Scandinavian Gothic of Denmark for time periods 1700 – 1799 and 1800 – 1875, and with the Kurrentschrift used from the 15th century until the 19th. This gives a possible range of 1400 until 1875.

The next step is to compare the three styles side-by side. Then by going through the matches and eliminating the unlikely characters based on Gøthche's suggestion to pay attention to the early letters in order to fit the midship frames.

By eliminating the later letters, the 'P' in both Scandinavian Gothic, and the 'T' in Scandinavian Gothic 1700-1799, and the 'L' in the Kurrentschrift, we see that Kurrentschrift has a logical match for every letter. The 'B' letter seems to have been the more telling of the characters, as the 'B's from the Gothic are not a terribly good match, while the German letter 'ß' as well as 'B' could both be matches. However, the Eszett is one of the last letters in the alphabet, following either after 'Z' or occasionally between 'S' and 'T', and it would not make sense with the the frame dimensions.

The numbers are also an important feature to notice on LHL-81. The Arabic numerals had made their way to Europe in the 1200s. Although Roman numerals were still used by people, Arabic numerals were the dominant form by the 16th century (Nationalarchives.gov.uk, 2016).

Theoretical treatises were being written in the 1600s in Europe, but not by the ship builders. Prior to the 1700s, most shipbuilders were illiterate without a formal education system in place, and without the need for lines plans, they needed only to rely on practical training (Ferreiro, 2007:23-24). Since the symbols on wreck LHL-81 are letters, it would imply that the shipwright was literate, placing time of construction after 1700, and probably close to 1800, when literacy had increased to over half of the male populations of Europe (Melton, 2001:81-82).

Building upon the time frames of handwriting style, number style, and then taking into accounts the rate of literacy in Europe, this gives a more narrow time frame of 1700 to 1800, with the shipbuilder from Germany.

10.1.2.3 PROBLEMS WITH PALEOGRAPHY AS A DATING METHOD

Paleographic analysis is useful in that it can provide some answers, however, it is not terribly accurate and should be used as a last resort for dating (Turner, 1987). In written texts, paleography also uses written clues for context to lend support to a date. Even so, the general "rule of thumb" is to avoid trying to date more precisely than a range of at least seventy or eighty years (Nongbri, 2005)

When faced with these limitations on a written document, it is important to keep these limitations in mind when looking at characters engraved in wood. Although Turner and Nongbri are focused on the ancient Mediterranean area, their concerns are still valid. Schniedewind (2005) also voiced the similar concerns about using paleography, which relies on human action, to be used as a scientific method. He notes the dangers of circular thinking and simplifying rather than admitting the potential of complexity .

Trying to make characters fit, like Gøthche with the 'S' as an 'F', and 'P' as a 'D', is an example of this circular thinking. By trying to see the assumed order, perhaps a unique ordering sequence is missed. Without accurate provenance or dendrochronology dating with which to cross-reference the date, there is no way to narrow down the time frame of the wreck. Although the style can offer an indication of geographic location, that location is only reliable as the origin of the shipbuilder, and the regions offered here are large and expansive. That does not even take into account the fact that shipwrights moved all over Europe to work for different shipyards and navies, going where they would be best paid (Ferreiro, 2007:28).

10.2 CONSTRUCTION DETAILS

The sequence markings indicate that the vessel was built in a shipyard. Sequence numbers would be used to maintain organization in a yard with many workers and many projects. It is also evident that at least two individuals worked on this particular ship. The number '5' on the floor timber and the corresponding futtock ave very different styles are indicate that they were carved into the wood by different hands.

The symbols also indicate the amount of planning that went into the building of the ship. “Where there is no design in advance, there can be no prefabrication and very little preparatory conversion of timber” (Maarleveld, 1998:100) which means that LHL-81 with symbols on frames for construction order was a very well planned project. With these efforts of standardization, it can be assumed that the ship was built from lines plans.

10.2.1 CONSTRUCTION DETAILS OF LHL-81

10.2.1.1 KEEL

The keel has a hooked scarf joint. There is no evidence of it having been locked with a wedge or key. The keel also has no ax marks, implying that the keel was shaped with a plane to make it smooth.

10.2.1.2 TREENAILS AND CLENCHED NAILS

Frames and futtocks are connected with long clenched nails, at least 50 centimetres long. Treenails connect the frames and futtocks to the hull. Treenails have a 3 centimetre diameter, and no indication of wedges.

10.2.1.3 FRAMES

Many of the frames show signs where the lower end was carved out of the tree shape during felling in the forest.

There is an abnormality on Frame 7: this frame a wide notch cut into its underside, leaving a wide space between the frame and the planks. It seems that a second smaller piece would have been used to wedge between the frame and the hull; however, this second piece is missing. This notch is only present on one other timber.

The large frames and wide angle to the bilge shows that the vessel was wide and chunky.

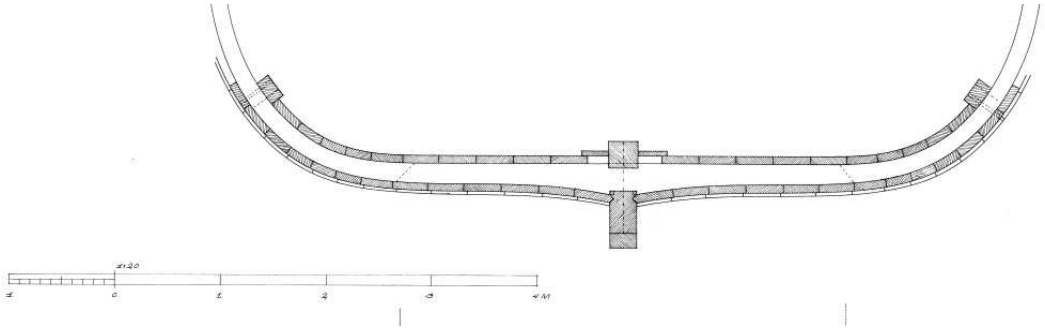


Figure 31: LHL-81 hull shape, interptreted by M. Gøthche (Gøthche, 1981:0776-TR-00010).

10.2.2 STANDARDIZATION IN SHIPBUILDING

The Dutch were the prominent shipwrights in the 16th and 17th century. By the late 1500s, Dutch ship builders were busy with adapting ship design, eventually creating the fluyt for trade. This type of ship was stable and fast and had a large cargo capacity, vital to the Dutch grain trade (Eriksson, 2014). These ships sailed unarmed in order to be efficient, but in times of war, convoys with armed protection had to be utilized, counteracting profitability (Tielhof, 2002:214).

However, by the 18th century, the English were top market builders for low-cost bulk carriers thanks to efficient man to ton ratios (Unger, 2011:149). While ships of the 14th and 15th were able to realistically have a ratio of 10 tons per man, innovations in the 18th century saw a rise to 18 tons per man by 1780, and close to 30 tons per man after 1850 (Unger, 2011:149).

With shipping costs fluctuating due to warfare, both in America and in Europe, new cost-advantages were needed. Ojala (2011) notes that technology and design was essential to the purpose of the ship and it's intended trade (2011:184). Building costs and materials were high in Europe, especially as war interfered with trade. Finland was far enough removed and had the materials at hand as well as low labor costs (Ojala, 2011:187). During the 18th century, many shipowners would build ships with cheap domestic softwood, and after a year or so of service, would sell them at a higher price than production costs (Ojala, 2011:187).

As war in Europe spread over the course of the 18th century, the focus of design was for naval warfare, with the French leading the race (Ormrod, 2011:140-1). The Scientific Revolution was impacting all of Europe and even began to make its way into shipyards by the 17th century. “Military and naval requirements in the 16th and 17th centuries demanded growing scientific awareness and technical ability...” (Pritchard, 1987:3), with studies on ship stability, hull design and sailing attributes

(Unger, 2011:258). Rapid training of shipbuilders was an option in Britain, while the French created textbooks and schools of naval architecture (Unger, 2011:258). This transition from shipwright to naval architect was fully realized by 1740, as professionalism through education was deemed necessary by societal hierarchy (Pritchard, 1987:11). Accountability and transparency of tasks were now required from the ship yard, leading to two dimensional design and lines plans, which also contributed to the standardization of shipbuilding (Ferreiro, 2007:38).

10.3 LHL-81: THE SHIP

10.3.1 SHIP SIZE

As a rule of thumb, ship breadth is approximately double the length of a floor frame. With the frames measuring 4.4 meters, the width can be assumed to be between 8.80 and 9.0 meters. Steffy suggests that “a merchantman's beam should be 1:3 of the keel length”, which gives an overall keel length of 26.5 meters (1994:158). Gøthche cites Chapman's latitude width ratio of 4:1 to gives an approximate overall hull length of 35 meters (Nationalmuseet, Skibshistorisk Laboratorium, 1980:17).

Draft of the vessel is not known, but it is possible to use the British Registration Act measurement to calculate approximate tonnage. This formula was used to give a slight under-estimate of the cargo capacity of a ship in order to avoid overinsurance (Johansen, 1983:22-24). The formula, also called the Builder Old Measurements system in London, was popular with shipbuilders as it gave a quick estimate of the ship's displacement and was in use from from 1650 to 1849 (Steel, 1805). This equation uses the difference in draft between a vessel empty and fully-loaded to discover the tonnage.

$$\frac{\text{Length} \times \text{Breadth} \times \text{Depth of hold (area below main deck)}}{100}$$

Since there is no draft measurement for LHL-81, another formula needs to be used. 1678 Thames shipbuilders used an equation that assumed that a ships burden would be 3/5 of it's displacement. Therefore it is reasonable to use this formula to get an rough estimate of the ship tonnage in the absence of a draft measurement.

$$\frac{(\text{length} - 0.6 \times \text{breadth}) \times \text{beam} \times (0.5 \times \text{beam})}{94}$$

LHL-81 has a breadth of 8.8 meters and a length of 35 meters. However it is vital to recall that England did not measure in meters during the 1800s, and foot was the unit of measurement (Steel, 1805). This means that LHL-81 has an overall length of 115 feet and beam of 28 feet. Putting these numbers into the equation becomes:

$$\frac{(115 - 0.6 \times 28) \times 28 \times (0.5 \times 28)}{94}$$

With a resulting tonnage of 409 tons. Taking the inaccuracy into account, it is reasonable to expect LHL-81 to have a carrying capacity of between 400 and 450 tons.

Returning to the first equation, we can plug in tonnage, and work backwards to find estimated draft:

$$410 = \frac{115 \times 28 \times D}{100}$$

Which yields 12.7 feet of draft, or 3.9 meters.

It is important to keep in mind that these size estimates are very rough. With the timbers in poor condition and only ten frames to work with and a keel portion, there is no way to tell how accurate these numbers are. The equations are estimates, based on an original calculation of measuring how many *tuns*, or casks of wine, a ship could hold (Steffy, 1994:144-145).

It is also important to keep in mind that the timbers were on the seabed for many years, which would allow for degradation and warpage. Therefore, all equations should be taken with the knowledge that they are estimates and nothing more.

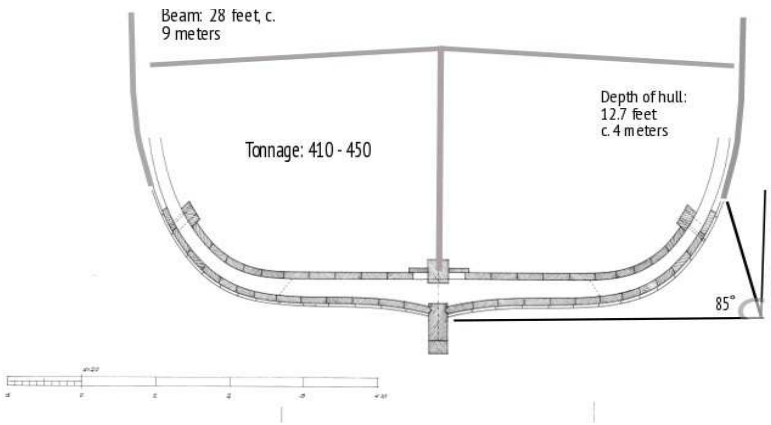


Figure 32: Estimated hull size and shape based on M. Gøthche (Gøthche, 1981:0776-TR-0009).

	Length, in feet	Beam, in feet	Draught, in feet	Burden, in tons
LHL-81	115	28	12	410

Table 8: LHL-81 statistics, based on beam estimate by M. Gøthche (Nationalmuseet, Skibshistorisk Laboratorium, 1980).

10.3.2 SHIP TYPE

Ships in the 18th century were classified by hull types, while in the 19th century they were classified by their rigging (MacGreggor, 1977:10). LHL-81 was likely built between 1700 and 1800, so it is reasonable to judge the ship by the hull shape.

Chapman's 1768 *Architectura Navalis Mercatoria* describes six hull shapes as frigates, barks, pinks, cats, and hagboats, all of which could then have rig structure of ships, snows, brigs, ketches, schooners, sloops, and cutters. While there is no rigging left to inspect for LHL-81, the shape of the hull can be narrowed down.

10.3.2.1 FRIGATES

Frigates were known for their speed and light construction frame, able to sail up to 14 knots. This type of ship was extremely maneuverable. Frigates were generally too small to be a ship of the line, but were rated as fifth and sixth rates by the British Navy. Frigates were able to have one or two decks, and by the late 18th century, military frigates had all guns on the main deck, while a lower deck under the waterline, was used for crew habitation. Frigates were used for both military as well as merchant shipping (Henderson and Henderson, 2005).

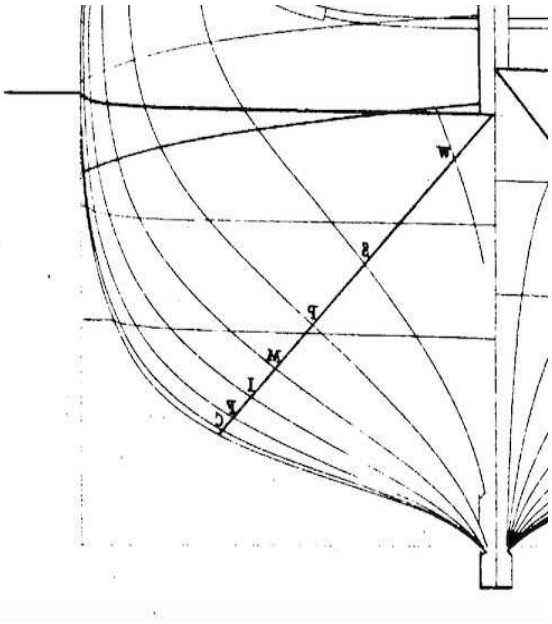


Figure 33: Frigate hull lines (Chapman, 1768:Plate No. 1).

Chapman Plate No.	Length, in feet	Beam, in feet	Draught, in feet	Burden, in tons
I	160	41.4	22.1	1140
II	149	39	20.6	900
III	136	36	19	760
IV	124.2	33.7	17.5	572
V	115	31.2	16.1	424
VI	89	26	13	244
VII	79.5	20.6	8.1	115

Table 9: Frigate dimensions from Chapman's 1768 Architectura Navalis Mercatoria.

10.3.2.2 BARKS

Barks were the British response to Dutch ships; ideal for cargo carrying with large and wide h This hull shape could maximize cargo capacity minimize crew number. This efficiency yielded a high to-man ratio (Unger, 2011:249) and was profitable. construction process also conserved timber, which highly desirable, as England was importing vast quan at high prices (Rönnbäck, 2010).

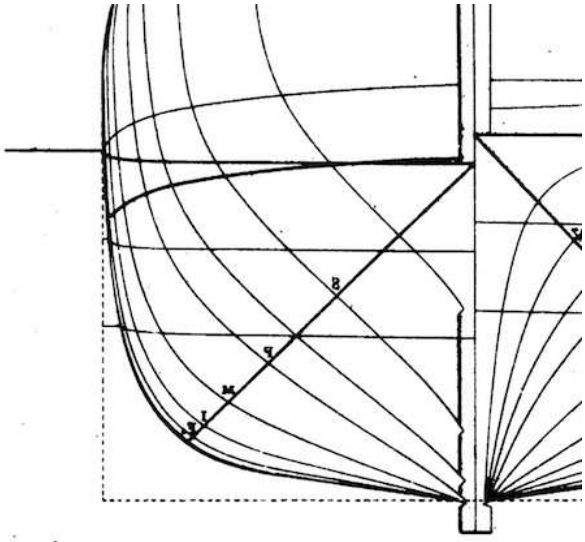


Figure 34: Bark hull lines (Chapman, 1768:Plate No. XXII).

Often associated with colliers, the bark shape was very boxy and ideal for transporting cargo. Barks typically had a square transom like a frigate, but this is where the similarities end. James Cook's famous *Endeavour* was originally a collier bought for him by the Royal Navy (National Museum of Australia, 2016)

Chapman Plate No.	Length, in feet	Beam, in feet	Draught, in feet	Burden, in tons
XXI	150.8	28	20	1257
XXII	138.4	33.8	18.5	996
XXIII	127.3	32.3	17.3	840
XXIV	115.7	29.8	15.8	608
XXV	80.8	21.7	11.3	227
XXVI	68.8	19.5	9.5	139
XXVII	108.7	26.3	9.8	416
XXVIII	80	21.5	8	159

Table 10: Bark dimensions from Chapman's 1768 Architectura Navalis Mercatoria.

10.3.2.3 PINKS

Pinks were designed with the intent to increase
Similar to Dutch built fluyts, these ships were wide a
flat bottoms, resulting in a very shallow draught . Th
large cargo capacity as well, making them very use
trade and passenger transport (VanHorn, 2004:25).

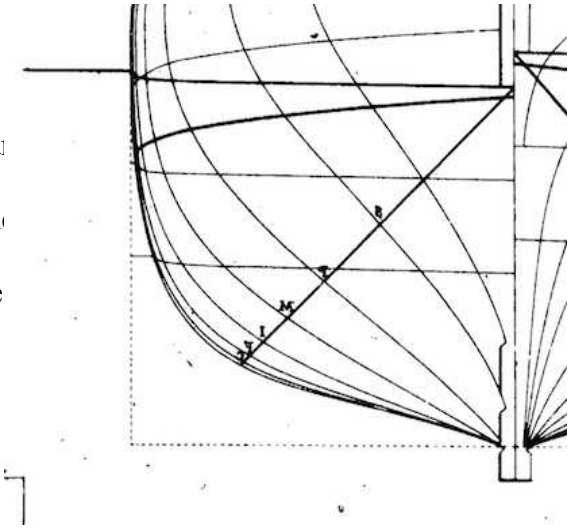


Figure 35: Pink hull lines (Chapman, 1768:Plate No. XII).

Chapman Plate No.	Length, in feet	Beam, in feet	Draught, in feet	Burden, in tons
XII	109.2	29.5	15.3	416
XIII	86	24.4	12.4	215
XIV	62.8	18.8	9.3	89

Table 11: Pink dimensions from Chapman's 1768 Architectura Navalis Mercatoria.

10.3.2.4 CATTS

Like the bark, these ships were designed for high efficiency cargo transport, especially coal and timber, although they were relatively small at only 250 to 300 tons. Catts are unusual in that they have very vertical side, which did not make them the fastest ships on the water at the time. They were sturdy enough to carry ordnance for protection (VanHorn, 2004:28).

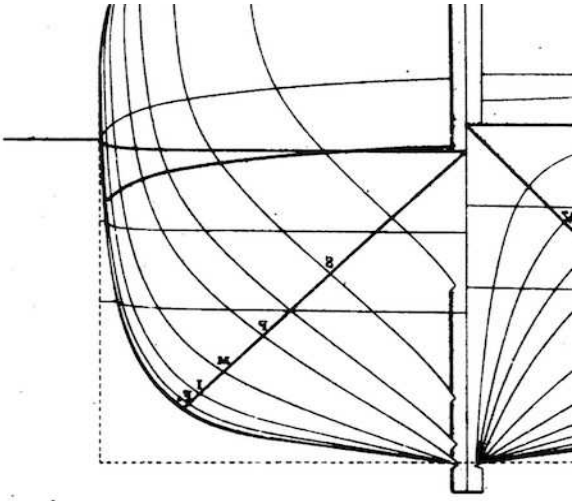


Figure 36 Catt hull lines (Chapman, 1768:Plate No. XVI).

Chapman Plate No.	Length, in feet	Beam, in feet	Draught, in feet	Burden, in tons
XV	151.8	37.5	19.5	1097
XVI	141	35.5	18.5	833
XVII	130.8	33.1	17.5	711
XVIII	118.3	30.5	16.1	575
XIX	83.5	22.8	11.9	237
XX	60.3	18	8.8	93

Table 12: Catt dimensions from Chapman's 1768 Architectura Navalis Mercatoria.

10.3.2.5 HAGBOATS

Hagboats were optimized to carry cargo but at frigate speeds. These ships were large and very wide, with low dead rise and near vertical sides above the waterline. Generally these were so large that they required a full-rig structure. While he lines are similar, the stern is the differentiating shape, with the hagboat being much wider and higher (Anderson, 1946).

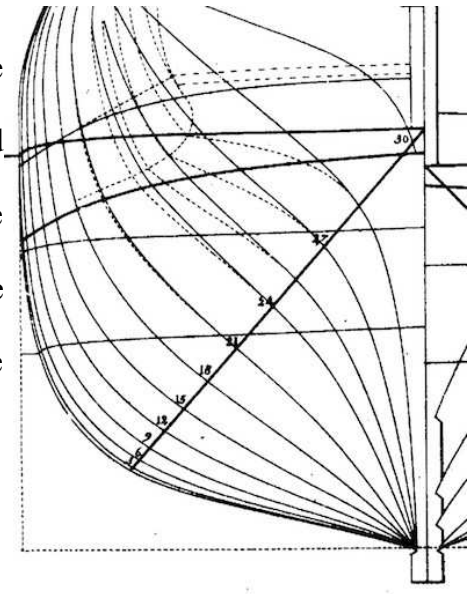


Figure 37: Hagboat hull lines (Chapman, 1768:Plate No. VIII).

Chapman Plate No.	Length, in feet	Beam, in feet	Draught, in feet	Burden, in tons
VIII	156.2	38.9	21.2	1164
IX	144.3	36.2	19.2	903
X	132.5	34.5	18.3	716
XI	1224	32.2	16.2	548

Table 13: Hagboat dimensions from Chapman's 1768 Architectura Navalis Mercatoria.

10.3.2.6 COMPARISON

Comparing size of the different types of hull can help evaluate which type is closest to LHL-81. Dimensions from Chapman's *Architectura Navalis Mercatoria* (1768) drawings were put into a table and the ships with the most similar dimensions were highlighted.

Closest dimensions were Plate numbers V, XI, XII, XVIII, and XXIV. The shape of these ships was then compared through a diagram of the ship hull shapes superimposed on the hull shape of LHL-81.

Hull Type	Chapman No.	Length, in feet	Beam, in feet	Draught, in feet	Burden, in tons
Frigate	V	115	31.2	16.1	424
Bark	XXIV	115.7	29.8	15.8	608
Pink	XII	109.2	29.5	12.4	416
Catt	XVIII	118.3	30.5	16.1	575
Hagboat	XI	122.4	32.2	16.2	548

Table 14: Table showing the dimensions of each of Chapman's type that most closely resemble LHL-81.

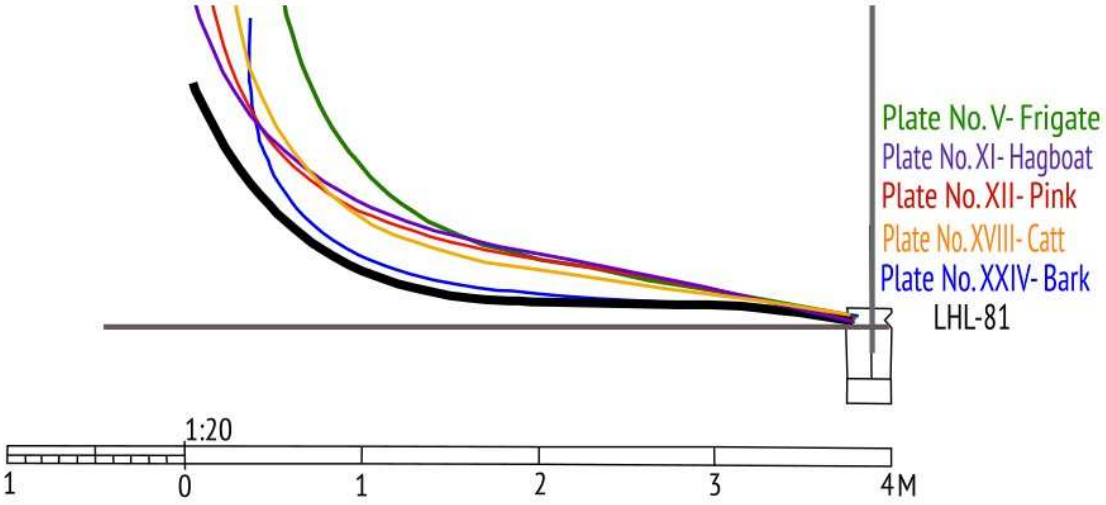


Figure 38: Hull comparison of hull bottom shape. Bark (blue) is the closest match. (Lines traced from Chapman, 1768, and Gøthche, 1981).

The diagram shows that the bark hull shape (blue) had the flattest bottom and is the closest match to the LHL-81 hull. Barks were cargo ships, and it was not unusual for merchant ships to be armed with small ordnance, such as 4 pdr cannons. Unfortunately there is no way to tell if LHL-81 was rigged as a ship, snow, brig, bilander, ketche, schooner, sloop, or cutter.

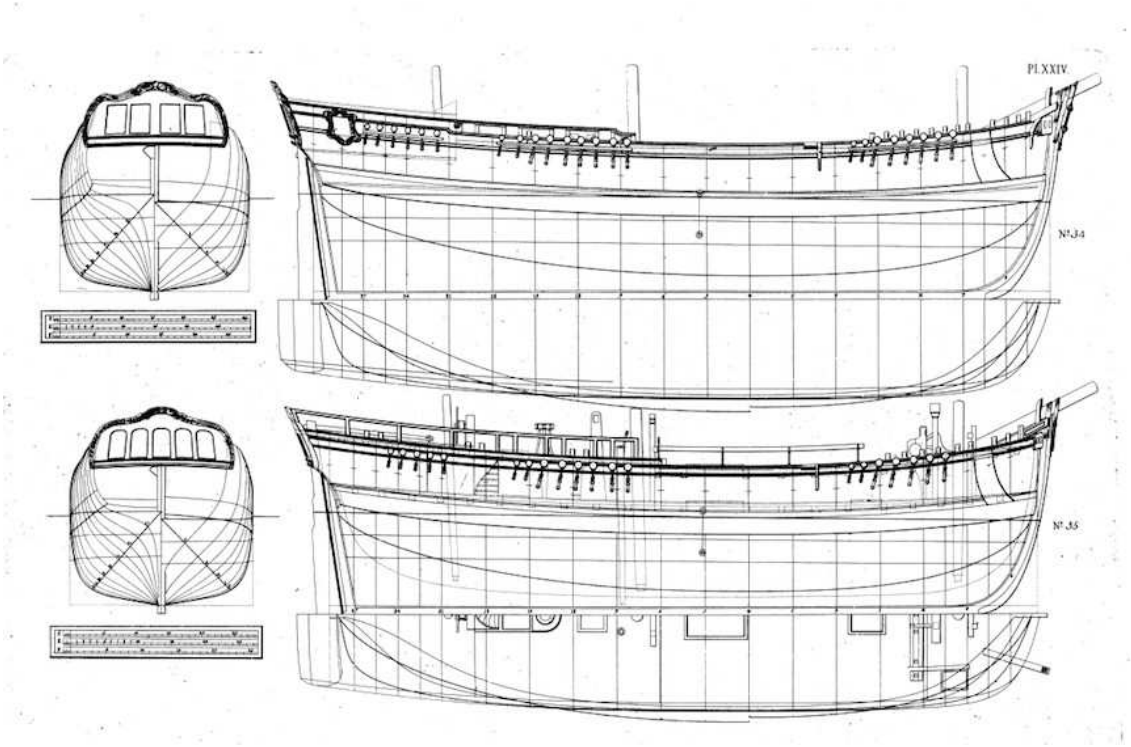


Figure 39: Full bark lines by Chapman (Chapman, 1768: Plate No. XXII).

10.3.3 SHIP HOMEPORT

There is very little information to indicate where LHL-81 originated from. The ship builder wrote with a Kurrentschrift style, which indicated a German origin, and the timeframe is estimated to be 1700 to 1800. However, shipbuilders were not limited to one location; for example, many Dutch shipbuilders moved to the Baltic region for better paid work (Ferreiro, 2007).

Construction-wise, it is likely that the oak frames were imported timbers, while the spruce exterior planking could have been locally available to reduce costs. Finland was well known for their

abundance of spruce materials and cheap labor costs (Ojala, 1977:187). However, without accurate provenance identification, nothing conclusive can be said about the origin of the wreck materials.

LHL-81 has a wide and chunky beam, indicating that it is likely a merchant vessel rather than a swift warship. Since it clearly did travel through the Kattegat, it could also be likely that the vessel would not have a large draft in order to navigate the shallow and narrow waters around the Danish islands. LHL-81 was found in six meters of water, and the water level was not likely to be much different at the time of sinking.

With no cargo to attribute found in context with LHL-81, there is no chance to determine a likely trade route that was underway.

10.4 SECOND WRECK ASSEMBLAGE IN ESBJERG

10.4.1 COPPER SHEATHING

Copper sheathing was not the first material used to cover ship hulls for shipworm protection. Lead was used on ancient Roman sailing vessels, but it fell out of practice (Kahanov and Ashkenazi, 2011). By the Middle Ages, compositions containing pitch, tar, sulphur and oil were being used to protect hulls from organisms attaching to the hull (Pike, 2011, and Hutchins, 1952).

In the early 1500s Spain began to sheath their ships in lead again, a trend which continued until almost the 19th century, although they did eventually reverted to only using the lead plates on vessels heading to Mexico in order to minimize the expense (Pike, 2011). England followed Spain's example and used lead for sheathing but sought other options as it impeded sailing abilities. In the 1670s milled lead sheets were adopted, but abandoned a century later due to the expense, the overall inefficiency against shipworm, and the corrosive damage.

Sacrificial planking of cheaper woods was the most common option in Europe. Cheap wood could be easily attached or replaced in dry dock. Wood planking was thin and did not impede the structural stability of the ship. However, the wood did not stop shipworm, and many weeds were able to attach, significantly slowing down sailing. Although it had its disadvantages, most countries of Europe used this technique since materials were so readily available.

The British Navy first considered copper sheathing in 1708. However, the idea was rejected based on cost. Over the next fifty years experiments were done to find suitable materials for hull protection, copper again being one of the metals used. In 1761, the first ship to be fully sheathed in copper was 32-gun English frigate, *HMS Alarm* (Trethewey and Chamberlain, 1988). It was a large success until it was noticed that electrolytic reaction between the copper and iron parts of the ship were causing the iron bolts to corrode at a swift pace. Techniques to avoid the chemical reaction were undertaken, such as using copper nails below the waterline during ship construction (Pike, 2011).

The Royal British Navy outfitted their entire fleet with copper sheathing in order to keep their ships at sea longer while at war with France, Spain, the United States, and the Netherlands between 1766 and 1784. A Welsh copper mine was able to provide the copper in excess and at cheaper prices for England (Pike, 2011).

British merchant ships were also able to make use of the materials, and by 1786 three percent of the merchant fleet was coppered. By 1816, the number was up to eighteen percent. Merchant ships sailing in warm waters and at higher risk for shipworm were chosen for coppering. almost thirty percent of Indian ships were coppered by the early 19th century (McCarthy, 2005:109)

However copper sheathing was a costly addition to a ship, as well as expensive to maintain. The United States used brass to sheath their ships, as it was cheaper more durable than copper. Other countries did not ever bother to use metal sheathing, instead only relying on the old wooden sheathing techniques. Ships in the Baltic were less prone to *teredo navalis* attacks, as the species requires warmer

water temperatures and more oxygen than is typical in the Baltic Sea. With less risk of shipworm, there was no point in investing large amounts of money on copper or brass sheathing.

This is not to say that there were no copper sheathed ships in the Baltic at all, but the likelyhood of it occurring is heavily skewed to it being an English vessel, or a ship that participated in long distance trade to India or the Americas (Ferreiro, 2007:37 and Steffy, 1994:175) rather than only limiting itself to Baltic trade.

10.4.2 SECOND WRECK IN RELATION TO LHL-81

The copper sheathing indicated a potential time range of 1780 to 1900. It is also likely that the wreck is English, since most other countries did not bother with copper sheathing their ships.

While the time frame does overlap with that of LHL-81, that is where the commonalities end. Construction-wise, the timbers are of different proportions, and the materials do not match. LHL-81 has no evidence of copper sheathing. The nails on LHL-81 are iron square nails, while the nails on this wreck are small and round. There are large iron bolts made with a lathe, while the timbers of LHL-81 are held together with treenails and large iron bolts made by a blacksmith.

Figure 38: Second wreck in the Fiskeri- og Søfartsmuseum. Fragments of copper plating are left. On the timbers (Photograph by author).

Not only do the material pieces correlate with the construction details of LHL-81, there is also documentary evidence, or the lack thereof, which indicates that they are separate entities.

When recording LHL-81, Morten Gøthche made a very detailed inventory of all timbers salvaged. While there is no receipt or inventory of timbers delivered to the Museum, there are no timbers in the report that have matching descriptions in Nationalmuseet, Skibshistorisk Laboratorium (1980) report.

10.4.3 FINAL DISCUSSION ON SECOND WRECK

This wreck piece does not belong to LHL-81 and is from a separate and unknown wreck. What ship it is from, and why it is in Esbjerg, are interesting questions, but are out of the scope of this research project. Further study could be undertaken to discover more details, similar to this project on LHL-81. This particular wreck is much more limited in details, and would be very difficult to find more information. However, if it is an English ship, there could be more documentary evidence in the Lloyd's Registers and other archival sources. The construction details of this wreck portion are drastically different that that of LHL-81 and will not be further examined or discussed in this thesis.

10.5 CANNONS

Two 4 pound cannons, each wrapped in canvas cloth, were raised in 1980 with LHL-81 timbers. It has been assumed that the cannons were associated with the wreck.

10.5.1 CANNONS IN SCANDINAVIA

The first recording of cannon use onboard ships in Scandinavia is the Battle in the Sound in 1362, between Danish and German fleets (Peterson, 2014:173). Cannons were originally used on land, but eventually their weight and size limited their mobility in battle and they were eventually left for ship warfare while field technologies focused on smaller and lighter armaments (Manucy, 2001:9).

Cannons were first made out of iron and then brass; however, traditions of casting were not easily changed; old and new methods overlapped for long periods of time, based on skills and materials available (Peterson, 2014:174). Localized customs and standards were the rule until standardization of guns was introduced and enforced in the 17th and 18th centuries (Roth, 1999). Even with standardization, each country was left to their own designs and relied on their own weight and measurement systems (Roth, 1999).

Although each country had their own standards, and foundries were secretive about their works and captured guns were often imitated. French cannons from the Kellery brother foundry were highly efficient in order, method, and standardization, and many countries in Europe were eager to copy, such as Savoy, Prussia, and Denmark (Peterson, 2014:176). This lead to English patterns being cast in Sweden with Dutch measurements, as well as other combinations that served the conditions at hand (Roth, 1999). A number of foundries were active in Scandinavia, making it easy to arm the country's military powers (Petersen, 2014:215-237).

FOUNDRY	LOCATION	DATES IN SERVICE
Aker Cannon Foundry	Sweden	1588 – 1840*
Borchart Foundry at Saint Clare Monastery	Denmark	1588 – 1603
Moss Iron Works	Norway	1704 – 2012
Morsø Iron Foundry	Denmark	1853 – 2016
Erhendal Works	Sweden	1700 – 1800*
Fispong Works	Sweden	1800 – 1900
Fossum Works	Norway	1669 – 1702
Stafiso Foundry	Sweden	1800 – 1900*
Wergeland Works	Sweden	1600 – 1700

*Table 15: List of Scandinavian foundries 16th century to present. * indicates foundries that supplied the Danish Navy (data from Petersen, 2014).*

10.5.2 4 POUND CANNONS

4 pound cannons were some of the lightest cannons available, weighing around 289 kilogram. The heaviest ordnance on ships in the 17th century were 36-pounders, as this was the largest artillery that would not disrupt the ship's stability (Litwin, 2008:32), although most British ships of the line preferred 24-pounders ss the accuracy was better (Pike, 2016). By the 18th century, ships of the line generally preferred 32- or 36-pounders on a lower deck, with 18- or 24-pounders on the upper deck (Cooper, 2013). 4 pounders could be added onto the top decks of warships for additional firepower when repelling boarding parties (Cooper, 2013).

Many merchant ships would be outfitted with smaller caliber weapons. Although they were too small to inflict much damage at far distances, they were still powerful enough to discourage pirates. Their light weight made them ideal as they did not take up room that could be used for cargo. Merchant ships, such as the *General Cartleton*, wrecked in Poland, were outfitted with 6pdr cannons (Litwin, 2008), and the merchant ship *Santo Christo de Castello*, wrecked off the coast of Cornwall was equipped with 4pdrs, although these were made of bronze (McBride, Larn and Davis, 1975). The wreck on Odessey Marine Exploration's Site 35F had over thirty iron cannons in the wreckage, these were assumed to be “salable ballast” (Dobson and Kingsley, 2011:4). 4 pdr cannons were also used onboard the *Endeavour* in 1770. On June 11, 1770, the *Endeavour* ran aground on the Barrier Reef. In his voyage journal, Cook notes that six guns were thrown overboard in order to lighten the load and sail free. The cannons were found and recovered in 1969 and have been conserved by the National Museum of Australia (Sharman, 1971).

Figure 40: Cannon retrieved from the Endeavour (National Museum of Australia, 2016).

10.5.3 CANNONS ON LÆSØ

Læsø's location between mainland Denmark and Sweden put the island in a conflict area, especially during the late 18th and early 19th century when many countries were spreading their political reach and privateers were abundant in the Kattegat. In his history of the island, Bing notes that islanders were buying and selling cannons salvaged from ships starting in the early 1700s (Bing,1802:46-57). Worrying about the encroaching Swedes, the people of Læsø began petitioning Danish King Christian VII for armaments and fortifications in 1788 (Wiis, 1998:12). England was also attempting to force Denmark out of a neutrality pact with Russia and Prussia. England's navy attacked Copenhagen in 1801 and in 1807, further enforcing the need to arm and defend the island of Læsø (Wiis, 1998:12-13).

A coastal militia for Læsø was established by the Danish royalty in 1801. In 1808, a list of the islands coastal defenses was written. Fifteen batteries were placed on the island. At the time, the inland town of Østerby had a population of fifteen men and was considered dangerous due to the relatively large distance to the next town. The fortification at the Østerby coast was equipped with a mobile 3-pound cannon, as well as two fixed 4-pound cannons (Wiis, 1998:55). Although a 4-pounder was light to carry into battle, needing only two horses

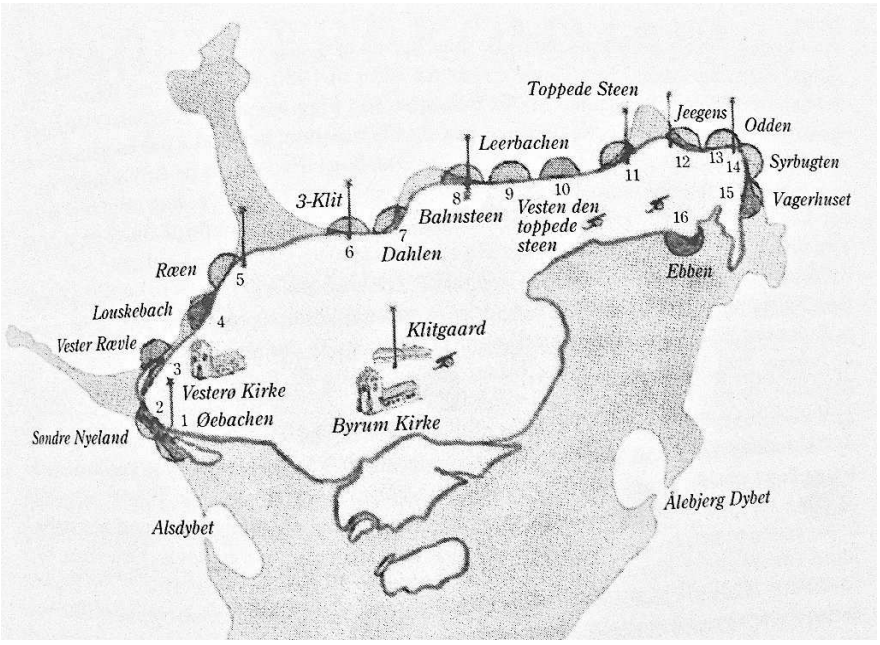


Figure 41: Map of coastal militia fortifications on Læsø (from Wiis, 1998:59).

to pull it, and only three men to serve it (Manucy, 2001:7), these were fixed in permanent position on the coast to make better use of the fortification and soldier distribution. King Christian VII initially only provided sixteen iron cannons to the island, but artillery salvaged from ships, such as the cannons for the English ships *The Avon* and *Constantin*, were allowed to stay on the island (Wiis, 1998:84).

The Danish coast guard worked in conjunction with local militia to keep English ships from coming to shore on Læsø. The Danish economy was suffering from trade blockades and the military spending of Napoleon. This poor financial situation encouraged privateering, as it offered unemployed seamen the chance to make some money (Ryan, 1959:447). Læsø was a tactical location for a number of privateer captains, as the Strait was narrow, forcing convoys of the British Navy to spread out and make for easier targets (Ryan, 1959:446 and Wiis, 1998:65-66). The northern part of the island, where Østerby Harbor currently sits, had a long strand of sandy beach. Even without a harbor, the beach was utilized to beach small privateer vessels. These privateers had a number of "canon boats", also called "gun-sloop" or "or "gun-shallop" (kanonchalup), and the smaller "gun-yawl" or "cannon-jolly" (kanonjolle), at their disposal, which could attack military and merchant ships alike (Nielsen, 2013).

Figure 42: Gunboat battle near Alvøen Norway (©Public Domain, Wikipedia: Kanonbåtkrigen, 2016).

As peace took over the Kattegat area, the cannons were slowly removed and stored in various places on the island after 1841. Three of the cannons that had initially been given by the king were sold off, while the others were discarded over the island. A number were deposited at the Vesterø Church, but no records were kept of the individual guns, and so the fate of many are unknown (Wiis, 1998:108).

10.5.4 CANNONS ONBOARD: ARTILLERY, BALLAST, OR CARGO?

In the particular case of LHL-81, the 1980 report states that the cannons were wrapped in canvas-like cloth (Nationalmuseet, Skibshistorisk Laboratorium, 1980:15). This would indicate that the cannons were not in use at time of sinking. While it is possible that ships could carry extra ordnance, such weapons would be expensive and not worth the cost for them to be un-used. There is also a lack of evidence in terms of a sea carriages for the guns, as well as an absence of shot or projectiles.

The size of LHL-81 also calls into question whether or not the vessel would have been armed. As a relatively small ship at approximately 30 meters length, as estimated by Morten Gøthche (Nationalmuseet, Skibshistorisk Laboratorium, 1980:17), it is unlikely that it would have needed heavy armaments. As a merchant ship, it is possible that one or two guns would be onboard. However, as already noted, if they had been in use they would not have been wrapped.

"Ballast" refers to any extra materials placed in the lowest portions of a vessel, additional to cargo, ordnance, and other supplies. This additional weight lowers the vessel's center of gravity and makes it more stable in open water (McGrail 1989:357; Steffy 1994:8-10). Stones are a typical ballast item, as they are plentiful and inexpensive (Grifford, 2014: 1-3).

McGrail (1989) offers a different approach to ballast, though, categorizing items as "saleable" and "unsaleable" ballast (1989:357). "Saleable" ballast refers to heavy cargo which acts as ballast while on the ship but can be sold at the ship's destination, such as ingots or cannons. "Unsaleable" refers to other objects, such as rocks or sand, that is more unlikely to be sold in port (McGrail, 1989:357). A classic example of the dual functionality of the cargo ballast is the Yassi Ada wreck (Bass and van Doornick, 1982).

If the cannons do belong to LHL-81, they would definitely fall into the "saleable" category, especially during the 17th and 18th centuries, as Europe was engaged in many power struggles and

materials for armaments were scarce.

10.5.5 CANNONS IN ØSTERBY HARBOR

The cannons raised in the harbor were wrapped in canvas cloth, which indicates that regardless of whether the cannons came from LHL-81, another ship, or the local coastal defenses of the early 19th century, they were not in use at the time of deposit.

With the cannons located so close to shore, it would not be unusual for a vessel to jettison cargo in order to keep from capsizing in poor weather, or possibly to lose ballast in order to lighten the ship and float off a sandbank. This could mean that the cannons were lost from a ship that did not wreck in that location (Peterson, 2014:10), much like Cook and the *Endeavour (*Sharman, 1971).

10.5.5.1 WHY WERE THE CANNONS NOT RETRIEVED?

Cannons are a large investment of time, money and resources. There are many examples of cannons being retrieved from shipwrecks for re-use; high profile examples being the Mary Rose, where cannons were salvaged by early divers (Clabby, 2014) and the fifty cannons being raised from the Vasa in the 17th century by Albreckt von Treileben and Andreas Peckell using a diving bell (Cederlund 2006:69). What is unusual is the effort undergone for these examples, where visibility was low, and depths were deep, while the cannons of LHL-81 have been sitting in less than ten meters of water. Bing, a local historian, descried how the selling of salvaged cannons was a highly profitable trade in the early 1700s. So why were two cannons been found on the bottom of Østerby Harbor in 1980?

The local history of the island does not have a memory of a ship being lost in that location (Nationalmuseet, Skibshistorisk Laboratorium, 1980:15). The could mean that LHL-81 was lost in a storm, running aground while trying to get close to shore to avoid the weather. Perhaps no one saw the

ship go down, and therefore the cannons were left untouched. Or perhaps they were jettisoned by a passing ship in order to gain speed and avoid the island's privateers, with the cannons abandoned in favor of freedom. These are only a few of the many possibilities outlined by Peterson (2014:11). Unfortunately so much of the area has been dredged and breakwaters built, there is little chance of finding other materials that could indicate other related abandoned items.

10.5.6 ARCHAEOLOGICAL ISSUES WITH THE CANNONS OF LHL-81

> "The details of the cannon are of interest, for to date the armament of the ship provides a major clue to the size of the wreck and its identification" (Bax and Farrell 1975:134).

Bax and Farrell are not wrong in their assertion of the possible role that ordnance can play in shipwreck identification. Artillery can help pinpoint a timeframe of use as well as a geographical origin or possible trade route based on the designs and foundry information. However, there are also many difficulties in using ordnance as the only way to date a wreck or site. In his cannon identification, Peterson warns about dating a wreck based solely on ordnance, as there are a great number of possibilities for ordnance that does not match the wreck.

The main issue with using the cannons in the re-analysis of LHL-81 is the fact that the artillery has been entirely out of context since its discovery. The timbers were raised by a crane and then documented. The underwater survey was conducted after the context of the site was destroyed. This is a major issue when attempting to attribute artifacts to the wreck. With no clear link observed through an *in situ* investigation, simply taking the cannons as cargo or ballast for granted is an irresponsible decision.

1.	Cannons, for various reasons, may be lost on a site without the ship they came from actually sinking there, or sinking at all, for example: - Stranded ships often jettison their guns, cargo or even anchors in the hope of floating away with the next tide. - Ships in danger of being captured may throw their guns overboard rather than risk seeing the enemy going away with them as trophies. - Ships in danger of sinking because they are bulging with water often leave a trail of jettisoned guns on the bottom, which do not always lead to a wreck.
2	Iron cannons carried on board any ship can be reformed old pieces used for ballast.
3.	Ships can sometimes carry "wrong guns", unexpected guns captured from enemy ships or guns recovered from wrecks or guns purchased form wreckers or purchased from a local foundry at a voyage stop-ver, etc.
4	Pirate ships did carry any artillery piece they could lay their hands on.
5.	Warships in time of penury (and Spanish galleons in particular) often carried such guns as the arsenal could supply at the time of departure, not the theoretical, mandatory complement.
6.	Military transports can be carrying from the motherland to faraway establishments in Asia or in America, cannons destined for some fortresses or to overseas squadrons, not in line with the type of ship they are themselves.
7	Merchant vessels may be carrying cannons as paying cargo.

Table 16: Seven possible scenarios that do not allow for cannons to be the only artifact for dating shipwrecks. The cannons of LHL-81 could fall into categories 1, where they were jettisoned for sailing advantage, or number 7, as paid ballast (Peterson, 2014:10-11).

There is also the issue with using the cannons to date the wreck. By 1900, 6 and 8 pounders were more typical for their stronger firepower and (Mehl and Roth, 2010). This is not to say that 4 pound cannons were no longer in use in the late 19th century, but it is worthwhile to consider that the cannons are perhaps much older and were being recycled rather than new cannons being bought (Peterson, 2014:11). If the cannons are indeed second hand, they could be far older than the ship that carried them. This would lend a very skewed date approximation if it is the only dating method.

While it would make sense that the cannons were related to LHL-81, as they were raised from the same spot as the wreck timbers, it is imperative to keep in mind that timbers from a 1930s fishing ketch were also recovered from very the same location. Further analysis of the cannons along with

cross referencing with paleography analysis of the wreck timber construction sequence details can determine if the cannons are contemporary with LHL-81, but even if they are from the same time period, there is no evidence that they are undoubtably from the wreck.

10.6 LHL-81: THE 3D MODEL

10.6.1 RESULTS

The has been uploaded onto Sketchfab, https://skfb.ly/OLqu. This was not as easy as anticipated, though, as there is a limit of 50MB for free. Even with the Pro and Business options, models of up to 200MB are permitted Sketchfab, (2016). However, the model of LHL-81 is 1.12 GB. Finding platforms that can support this size of file is not easy. SketchUp (Google), P3D.in, and 3dvieweronline.com all have 50 MB caps on uploads.

Cutting down the file to size was the only option. By “decimating the dense point cloud” and converting the file to .fbx format shrank the file to 5.4 MB. However, this was done at a loss of texture and resolution of the timbers in the recording. The resulting model is still a unique tool for interaction and for seeing the timbers remotely, but it is not as scientifically useful as it was hoped for.

Overall, the recording of this wreck was a success. Details, such as the construction sequence markings, nails, and treenails can be seen with clarity, as can the tree rings on the side of the timbers, but only with the original file. The uploaded model on SketchFab is now accessible to all, but it is not of much use to researchers looking for details. However, it does serve its purpose as a model of the re-assembly and can be used for public interaction by the Fiskeri- og Søfartsmuseum as well as by the Læsø Museum. The full overview of the assemblage, makes it easy to see how the timbers have been attached to one another. This makes it very easy to compare Morten Gøthche interpretation of re-

assembly and construction sequence compared to what has been done. The only difficulty with this process is the file size limitations by the model viewing platforms.

10.6.2 CRITICAL DISCUSSION

Once results are in, it is always important to re-examine the process and decide what could or should be done differently in the future. From this particular project there are a number of improvements that could be made for future recording endeavors. First, inclusion of a measurement scale. In this particular case it is not detrimental, as the timbers are unlikely to be used for scientific research in the future. On other objects, however, it would be useful to have a scale reference. Other improvements would be the use of a more powerful camera. While the zoom feature has good detail resolution in the current model, more definition would be needed on objects with more features.

10.7 LHL-81 ANALYSIS SUMMARY

The few timbers left of LHL-81 have given a good outline of what the vessel could have looked like in life. LHL-81 had a beam of approximately 9 meters and a hull length of 35 meters, and 400 – 450 ton cargo capacity. The frames are oak, and likely imported, while the planks and keel are sawn spruce, and likely locally produced to reduce construction costs.

The construction sequence numbers have provided information regarding the origin of the shipbuilder, and have given a more accurate time period of the wreck's construction between 1700 and 1800. The markings also contribute to the conclusion that the vessel was built in a ship yard, with many workers, and was built from paper plans rather than a small model or only from the shipbuilder's skills.

The wide floor timbers show that the vessel was a wide ship and more likely to be a merchants

ship than a warship. Based on hull shape, LHL-81 was likely a bark

The 3D model of the wreck gives a good overview of the assemblage display. Even though the frames do not fit on the keel correctly, the frames do give a size perspective of the wreck hull shape and size by being put on display together. Although it is not an accurate version of LHL-81 construction, it does provide a visitor with the experience of a shipwreck. Photogrammetry offers long term preservation of the wreck in its current state, although more models will have to be done in order to continue to monitor its decay.

CHAPTER 11:
FINAL THOUGHTS

The re-analysis of LHL-81 has given up much information, although not all of it was the expected results. While the original plan of action was to see if there was a specific identity to attribute to the wreck, what was uncovered was a very interesting case study of maritime cultural heritage in Denmark.

11.1 FURTHER RESEARCH POTENTIAL

LHL-81 has no more information to tell about the shipwreck itself, but there are many research opportunities still left in relation to the pieces. LHL-81 itself could be used as a study in the effects of decay and degradation of PEG impregnated timbers.

Læsø has been in a busy and diverse maritime traffic highway. The joint survey project in 2009 by Syddansk Universitet Maritime Archaeology Programme and Northern Jutland Coastal Museum highlighted the existence of 8 wrecks in one very small area off the island (Larsen, 2010). More surveys around the rest of the coast of the island should identify more shipwrecks. LHL-81 is an example of one of the many types of wrecks that could potentially be undisturbed. Island locals are also in search of the lost ship Printz Friedrich (Jessen-Klixbull, 2016:70). Should they find it, hopefully

The cannons of this project can also serve as a further research project. The cannon in Østerby Harbor had all distinguishing marks disappeared from decades of use on the pier. However, finding the other cannons is a possibility. This would require local cooperation, going through the archives and word of mouth to find old addresses, and then to investigate those yards for the missing LHL-81 cannon. Perhaps an island-wide survey of cannons could be conducted; it seems likely that there are

many pieces of unaccounted-for pieces of artillery scattered throughout the communities. These could even be radiocarbon tested if initial findings provided many cannons with no dates and if the research agenda called for it. While radiocarbon testing is generally useless for items manufactured with coal, most items after 1800, it can still lend insight into manufacturing processes (Cook, Southon and Wadsworth, 2003).

Another research path could be the study of Danish museums and their display of cultural heritage. A PhD dissertation has already set up a preliminary study of online museum practices and looks at the digitalization trend from a technical perspective (Holdgaard, 2014). Adding in the archaeological perspective could give a very interesting view of the museum structure, purpose , and research opportunities in the country.

Finally, how many other similar cases are there to LHL-81 around Denmark? A survey of the maritime cultural heritage could show that many of the items are undocumented and likely not fully investigated. Like with the timbers and the cannons of LHL-81, there may be a finite amount of information still able to pull from the materials. However, even with the most basic of information, these items can contribute to the maritime history of Denmark.

11.2 CONCLUSIONS

I would like to return to the original questions asked at the beginning of this project:

> 1- Can the identity of LHL 81 be discovered through re-analysis of the timbers and archive research? If the wreck cannot be linked to a specific ship, can the timeframe be narrowed down?
>
> 2- How does archaeological theory and legislation impact an item's

cultural heritage value? Do any of these spheres on their own drastically impact the role an item will play in research and the public perception of history? Does an item have to be in the archaeological record to be considered a significant piece of cultural heritage?

3- Is 3D modeling an appropriate form of documentation for LHL-81? What gains can come from photogrammetry of a whole wreck assemblage as opposed to individual timber recordings?

The reanalysis of LHL-81 timbers has not given the level of information that was originally hoped for at the start of this research project. At the time of the original report writing in 1993, the only known facts were that it was a two or three masted vessel from some point after 1700, with an assumption of the ships' identity as a Russian tar and oats cargo vessel (Bing, 1802:109).

No new timber details have been discovered since the original documentation. The environment has taken a toll on the timbers for the last thirty years as the wreck has sat outside, and while the construction sequence indicators are still visible, other tool marks and other clues, such as caulking material, has been destroyed.

A focused look at paleography has offered more indication of where the shipbuilder was from and the time period that it would have been built in. It is far more likely that the ship was built between 1700 and 1800 by a shipbuilder from Germany. Hull comparisons between LHL-81 and Chapman's plates in *Architectura Navalis Mercatoria* (1768) show that LHL-81 was most likely a bark. On top of this information regarding the hull, a closer look at the potential cannon cargo revealed that there is no conclusive link to LHL-81 at all.

However there is no indicative damage of why the vessel wrecked where it did. Further inferences have been drawn about ship size and shape, but little more can be done than to compare with

other known ships of similar dimensions.

The second focus area on archaeological theory, Danish archaeological legislation, and cultural heritage has been much more fruitful. Denmark makes great efforts to preserve their history, and this can be seen in the constantly changing museum and Ministry of Culture (*Kulturstrelsen*) structure and organization.

The way that Denmark interacts with their heritage is also very telling. Maarleveld is of the opinion that post-excavation focus is on display (1998:29), and it would be difficult to disagree. LHL-81 was intended as a tangible connection to the romanticized past with no intention of incorporating it into an actual historical narrative. This is not wrong, and as a piece of 'pastness' LHL-81 does quite well in its role. However, it is important to acknowledge this decision in the research agenda process, since if there is no well maintained preservation procedure, returning to the artifacts years, or decades, later will prove ineffectual.

Figure 43: Cannons adorning a driveway in Copenhagen. This is another example of cultural heritage on display that never made it into the archaeological record (Photograph by author, 2016).

Finally, 3D modeling. The recording portion of this project resulted in a very accurate model of LHL-81 which can be used to visualize and interact with on a digital level. The model of the wreck re-assemblage preserves the current state of the timbers, and can be used as a reference for the preservation and display methods used by the Fiskeri- og Søfartsmuseum. By recording the wreck as a whole, the 3D model serves as a way to preserve the timbers as cultural heritage, even though the wooden timbers may rot.

This project set out with the intention of using old materials in order to discover new

information. Although the timbers themselves were not able to give much more information about it's identity, it did show the importance of archaeology in Danish legislation, as well as how Denmark uses its cultural heritage. LHL-81 was not considered important to the Danish research agenda of the 1980s, but can serve as an example of how to better preserve archaeological materials for further research efforts.

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Nationalmuseet

Skibshistorisk Laboratorium

MUSEUMSSAG

journ. nr.	inv. nr.		RFF journ. nr.	NM journ. nr.
776				

emne - datering: Vrag - 1750-1850

sted	matr. nr.	ejerlav		
Læsø, Østerby havn		Stednr: 100502:8 m.st.nr.341741:5		
sogn	**sb. nr.**	**sb. nr.**	**sted nr.**	**top nr.**
Hals	8	NM	10.05.02	
herred	**mb. nr.**	**4 cm kort**		
Læsø		1417 IV NØ	x kortkopi vedlagt	

amt - efter 1970	amt - før 1970	UTM zone	øst	nord		øst	nord
Nordjylland	Hjørring				km		m

sagens opståen	dato	anmeldelse modtaget fra
	24.3.1980	

navne - adresser - telefonnumre. (1. ejer, 2. forpagter, 3. finder, 4. giver, 5. sælger, 6. bygherre, 7. entreprenører, m.v.)

museets besigtigelse er foretaget den af

beskrivelse af fundet (anlæg og genstande), evt. med henvisning til mere udførlig besigtigelsesrapport:

dato underskrift

videre behandling:

Indtastet i DKC

sagen afsluttet d.

Un 14,1-264

Sognebeskrivelsen den 29. maj 2000

SB 8 Hals sogn, Læsø herred, Hjørring amt

Status Kulturhistorisk, stedfæstet lokalitet

Kort 4cm kort: 1417 IV NØ UTM: 628154 / 6355378 Zone: 32
Afsat af museumsmedarbejder

Stednavne "Svenskeren" (1980)
Østerby Havn (1980)

Omgivelser Hav, fjord, strandsø (1980)

Anlæg

1 MARITIME LOKALITETER, VRAG. Antal: 1
Nyere tid (1660 -) måske 1700-tal
Længde: 35 m, bredde: 8,8 m (1981)

Fartøj Fartøjstype: Fragtskib, sejl
Byggested: Baltikum
Klassifikationskriterium: Uspec. helhedsindtryk af anlæg

konstruktion mangler

2 MARITIME LOKALITETER, VRAG. Antal: 1
1900 - 1950

Fartøj Fartøjstype: Fiskebåd, maskineri
Klassifikationskriterium: Uspec. helhedsindtryk af anlæg

konstruktion mangler

Begivenheder

1 USPEC. GRAVNING
1980 til 19. marts 1980
Nationalmuseet, Skibshistorisk Laboratorium (Marine journalsager (NMU)).
Journalnr: 776

2 ANMELDELSE FRA PRIVAT
20. marts 1980
Nationalmuseet, Skibshistorisk Laboratorium (Marine journalsager (NMU)).
Journalnr: 776

3 BESIGTIGELSE FORESTÅET AF MUSEUM
24. marts 1980 til 26. marts 1980
Nationalmuseet, Skibshistorisk Laboratorium (Marine journalsager (NMU)).
Journalnr: 776

4 OPMÅLING FORESTÅET AF MUSEUM
1. november 1981 til 2. november 1981
Uspecificeret: Gøthche,M.
Nationalmuseet, Skibshistorisk Laboratorium (Marine journalsager (NMU)).
Journalnr: 776

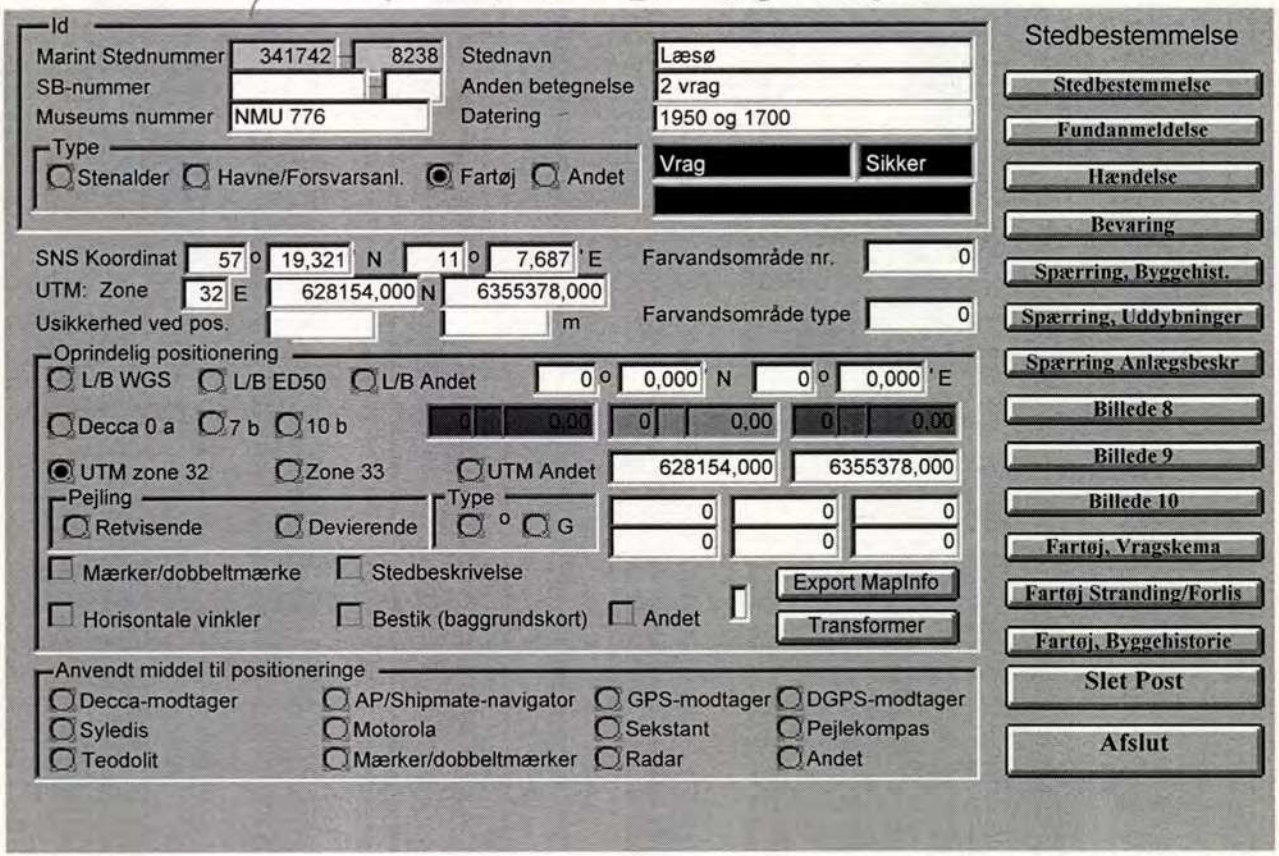
5 USPECIFICERET TRANSAKTION VEDR. GENSTANDE
december 1981
Nationalmuseet, Skibshistorisk Laboratorium (Marine journalsager (NMU)).
Journalnr: 776
Forkortet originaltekst og resumé:
Kanoner findes indmuret i kaj som pullert og privat hos fisker Kaj Klitgård.

6 ELEKTRONISK AFSÆTNING M. KOORDINATER
25. april 1995
Nationalmuseet, Skibshistorisk Laboratorium

Tegningsliste NMU J. nr 776 Sted: Læsø, Østerby Havn

TO	TR	Mål	Arkiv	Tekst
0	1	1:10, 1:25	Skuffe	Køl og bord
0	2	1:25	Skuffe	Dobbeltspant, mærkning af spanter
3	0		Skuffe	Opmålingsskitser af bundstokke
4	0		Skuffe	Opmålingsskitser af bundstokke
5	0		Skuffe	Opmålingsskitser af bundstokke
0	6	1:20	Skuffe	Spanter, skitseopmåling
0	7	1:20	Skuffe	Spanter, skitseopmåling
0	8	1:20	Skuffe	Skitseopmåling af køl, udv. klædningsplanker, forhudning og stringer
0	9	1:20	Skuffe	Spanter, længdesnit og plan
0	10	1:20	Skuffe	Middelspant rekonstruktion
0	11	1:20	Skuffe	Forslag til opstilling

bemærk andet ma.st.nr / 341741 er korrekt!



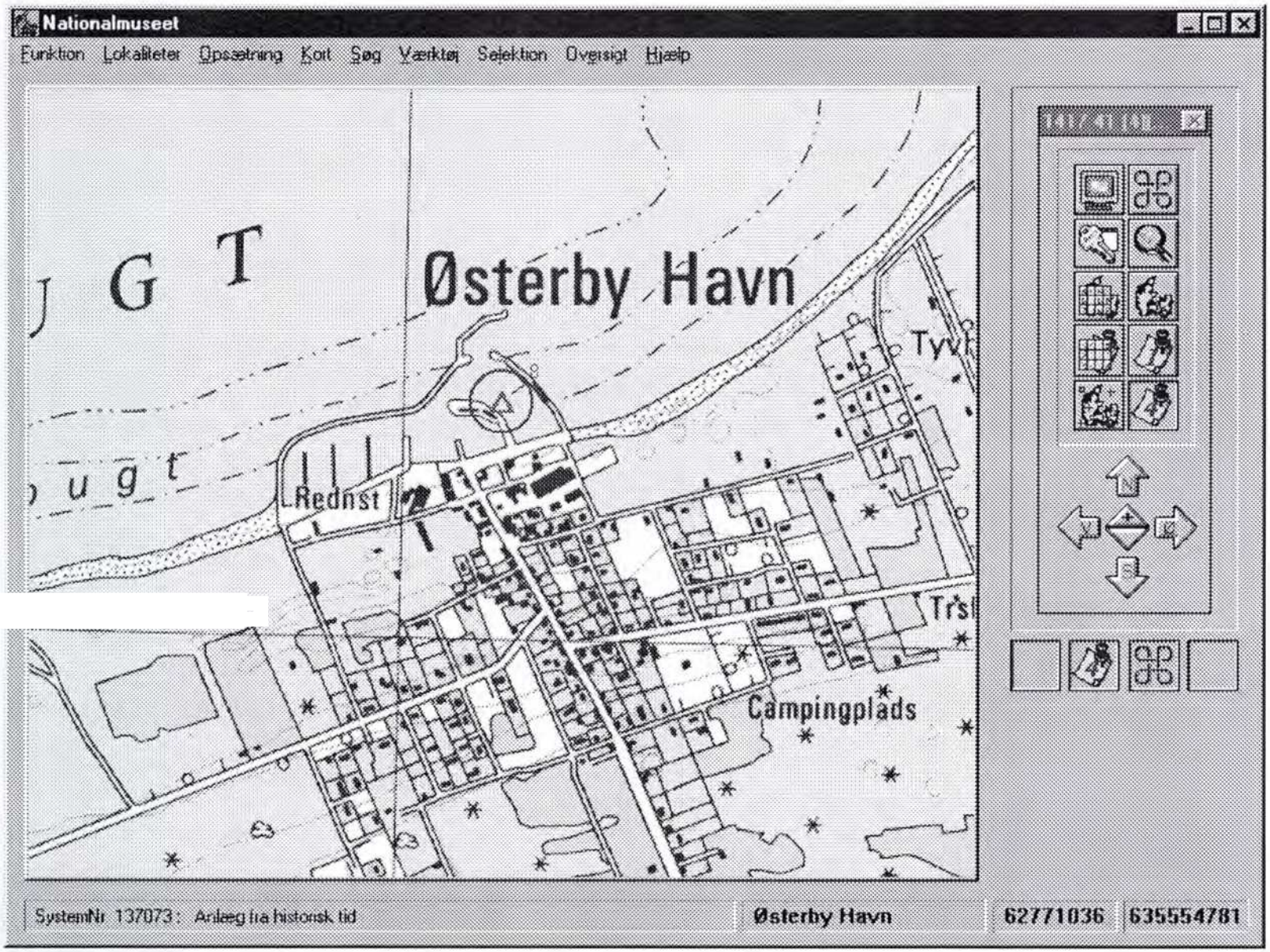
Position fra SNS 6/4-99

GL

Fotoliste

J.nr. 776 Læsø, Østerby Havn

Billednummer	Billedtekst	Fotograf
0776-Bd-01-01	Tømmerbunke	
0776-Bd-01-02	bord	
0776-Bd-01-03	Køllask.	
0776-Bd-01-04	Køllask.	
0776-Bd-01-05	Spant, K1.	
0776-Bd-01-06	Spant.	
0776-Bd-01-07	Spant, 1a1	
0776-Bd-01-08	?	
0776-Bd-01-09	Spant, 1J1.	
0776-Bd-01-10	Spant.	
0776-Bd-01-11	Spant.	
0776-Bd-01-12	Spant.	
0776-Bd-01-13	Spant.	
0776-Bd-01-14	Spant med vandløb.	
0776-Bd-01-15	Køl, med spunding.	
0776-Bd-01-16	Køl, med spunding.	
0776-Bd-01-17	Køl, udsparing til spant.	
0776-Bd-01-18	Spant, 1a1.	
0776-Bd-01-19	Spant, 1a1.	
0776-Bd-01-20	Spant.	
0776-Bd-02-01	Spant med vandløb.	
0776-Bd-02-02	Spanter, længdesnit og plan, 1:20	
0776-Bd-02-03	Spanter, skitseopmåling, 1:20	
0776-Bd-02-04	Spanter, skitseopmåling, 1:20	
0776-Bd-02-05	Middelspant, rekonstruktion, 1:20	
0776-Dc-01-01	Middelspant, rekonstruktion, 1:20	
0776-Dc-01-02	Spanter, skitseopmåling, 1:20	
0776-Dc-01-03	Spanter, skitseopmåling, 1:20	
0776-Dc-01-04	Spanter, længdesnit og plan, 1:20	


Nationalmuseet
Funktion Lokaliteter Opsætning Kort Søg Værktøj Selektion Oversigt Hjælp
Østerby Havn
Campingplads
SystemNr 137073: Anlæg fra historisk tid
Østerby Havn
62771036
635554781

81. Vragfund Østerby Havn 1700-1800 tal

81
~~LE~~

Læsø Museum
Østerby gl. skole
9960 Østerby Havn
Tlf. (08) 49 80 45

MUSEUMSSAG

journ. nr. 81 | inv. nr. | RFF journ. nr. | NM journ. nr.

emne datering: Vragfund 1700 - 1800-tal

sted: Østerby Havn
sogn: Hals
herred: Læsø
amt — efter 1970: N. Jyllands | amt — før 1970: Hjørring

matr. nr. | ejerlav
sb. nr. | sb. nr. NM | sted nr. | top. nr.
mb. nr. | 4 cm kort | ☐ kortkopi vedlagt
UTM zone | øst | nord | km | øst | nord | m

sagens opståen: dato feb. 1980 | anmeldelse modtaget fra: Tage Jacobsen

navne - adresser - telefonnumre: (1. ejer, 2. forpagter, 3. finder, 4. giver, 5. sælger, 6. bygherre, 7. entreprenører, m.v.)
Tage Jacobsen, Bangmester, Læsø Kommune

museets besigtigelse er foretaget den 24-26/3,80 af Michael Teisen
beskrivelse af fundet (anlæg og genstande), evt. med henvisning til mere udførlig besigtigelsesrapport:

Vrag stykker af tilhørende udskylning i Østerby Havn. Fyr på væg, ca 25-35 m langt.
Kanonen hvor vraget findes indemmet i kaj som pullert og privat hos fisker Kaj Klitgård
Tømmer henlagt v. Søfartsmuseet.
Vragtømmer deponeret i Fiskeri og Søfartsmuseet Esbjerg 89.

10

dato 21.8.85 underskrift M.T.

videre behandling:

x besigtigelses rapp.
x rekonstruktions rapp.
✓ opstilling / kassation
✓ deponering

sagen afsluttet d.

14,1-264

Fiskeri- og Søfartsmuseet
Saltvandsakvariet. Esbjerg
DK-6710 Esbjerg V, telf. 05 15 06 66

Ons 20. sep, 1989

Mus.insp. Michael Teisen
Læsø Museum
Østerby gl. skole
9960 Østerby

Hermed skal jeg på museets vegne kvittere for modtagelsen af vragtømmer (LHL sag 81), som er opstillet på vores frilandsudstilling.

Venlig hilsen

Poul Holm

Poul Holm
mus.insp.

Læsø Museum
Østerby gl. skole
9960 Østerby tlf. 08498045

d.24.10.88.

Morten Hahn Pedersen,
Fiskeri og Søfartsmuseet,
Tarphagevej,
6710 Esbjerg V.

Kære Morten!
Jeg fremsender hermed det ønskede materiale vedrørende vragtømmeret fra Østerby Havn, Læsø.

Som du ser er det ganske veldokumenteret af både Morten Götche og mig selv. Endvidere er der udarbejdet et opstillingsforslag, som kan modificeres lidt.

Min forvalter, der er smed, og jeg selv har gjort os en del tanker om den praktiske opstilling af vraget som vi i givet fald kan hjælpe med ved rådgivning.

Teknisk forvaltning på Læsø havde endda med stor glæde godkendt et forslag fra museet om opstilling på en ubenyttet plads ved havnen, men museets bestyrelse fandt det "grimt" .

Jeg ville gerne have kædet vragdelene sammen med søfartsafdelingens udstilling om skibsbygning og strandinger ved udstilling i museets have, der ganske vist ikke er stor, men for hvilken ingen andre konkrete planer foreligger. Jeg finder en klar pædagogisk-faglig linje, der fører fra udstillingen indendørs til de konkrete konstruktions elementer ude og et klart symbol på de mange strandinger, som Læsøboerne har levet af ved bjærgning og nedbrydning af vragene.

Museets bestyrelse finder det dog også for grimt i museets have, og da det fyrretræs-byggede skib, rimeligvis fra den øvre del af Østersøen, i princippet lige så godt kunne være strandet på Vestkysten, finder jeg det rimeligt,at vragtømmeret finder en fornuftig faglig-pædagogisk anvendelse f.ex. ved jeres frilandsudstilling fremfor at blive parteret og fragmentarisk benyttet.

Alt træet er forbløffende friskt og vil ved passende imprægnering kunne holde i mange år, ved en fornuftig opstilling med fri luftpassage og ved at undgå vandpytter inden i det opstillede vrag. Såfremt Søfartsmuseet i Esbjerg kan benytte dette vragtømmer i frilandsudstillingen, vil jeg gerne medvirke til opstillingen med de planer vi havde gjort os, men må også påpege at Esbjerg må påtage sig transport omkostningen for vragtømmeret, der dog nok kan klares rimeligt f.ex. gennem en af Læsøs vognmænd, der kan have returgods med tilbage. Pakket ordentligt drejer det sig om et vognlæs.

Mange hilsener

Michael Teisen

LÆSØ MUSEUM

Sag 81 Februar 1980

Vragfund 1700 -1800 tal.

Anmeldelse om vragfund modtaget af Borgmester Tage Jacobsen Læsø.
Vragstykker opfisket ved yddybning i Østerby Havn, fyr på eg, ca. 25-35 cm langt. Kanonen fra Vraget findes indmuret i kaj som pullert og privat hos fisker Kaj Klitgård.
Vragtømmeret er deponeret i Fiskeri og Søfartsmuseet i Esbjerg i 1989.
Beskrivelser og tegninger findes i sagen.

A-LISTE:

000 A 1

F-LISTE:

000 F 1

Sidst ajourført: 25.2. 1993

B. Dahlerup

NATIONALMUSEET
SKIBSHISTORISK LABORATORIUM
STRANDENGEN . 4000 ROSKILDE
TLF. (03) 35 65 55
NYT TLF. NR.: (03) 356429

ROSKILDE, den 26.marts 1980
SL j. nr.
OCP/dk

Fundmelding vedr. ældre vrag i Østerby havn på Læsø.

Den 20.marts 1980 kl. 9^{45} ringede borgmesteren på Læsø, tlf. 08-49 13 00, og meddelte, at han den 19/3 havde set på havnen, at der var opfisket en del svære bundstokke m.v. fra et vrag i selve havnen. Fiskernes kuttere havde ved flere lejligheder tørnet, hvad de troede var en stor sten i havnebassinet, og en stenfisker var så gået igang med at grabbe op på stedet, hvorved vragdelene var kommet med op. Det forlyder, at der ved en tidligere lejlighed er opfisket kanoner fra vraget.

Det aftaltes, at borgmesteren beordrer arbejdet standset og at jeg søger at få Michael Teisen afsted på en besigtigelse hurtigst muligt.

Ole Crumlin-Pedersen

Un 14,1-194

Adresser Løsø:

Borgmester C. Tage Jacobsen
Havnebakken
9950 Løsø
08 49 91 20

Smed Erik Møller Sørensen
Rylevej 2
9960 Østerby Havn.

Pynner hos Fisker Kaj Klitgård Christensen
Østerbyvej 75 v. bicken
9960 Østerby

Journalistforbundets
Avisudklips-Bureau
Ravnsborggade 2, 2200 Kbh. N
Telf. (01) 39 13 70
(01) 39 16 57

Udklip af:

Vendsyssel Tidende

14 SEP. 1980

Vragresterne skal samles og udstilles

1608

Museumsforeningen på Læsø er langt fremme med planerne om at samle og udstille vragresterne, der i vinter blev fisket op fra det østre bassin i Østerby Havn af stenfiskeren »Bonnie« af Aalborg.

Museumsforeningens formand, borgmester Tage Jacobsen, oplyser, at der i øjeblikket gøres forsøg på at erhverve det fornødne udstillingsareal ved museet i Vesterø Havn. Tage Jacobsen har fra Nationalmuseet fået tilsagn om sagkyndig bistand, når bundstokkene og spanterne skal samles.

Skibets oprindelse og nationalitet er stadig ukendt, selv om læsøboernes viden om strandinger og forlis er stor.

Der må være tale om et skib af anseelig størrelse, som må have efterladt sig andre spor, mener dykker Michael Teisen fra Orlogsmuseet, der var med, da vraget blev fisket op. Han regner med, at skibets bredde er den dobbelte af bundstokkenes længde. Det vil sige op mod ni meter. Forholdet mellem længde og bredde kan sættes til 4:1. Der er efter Michael Teisens udregninger tale om et handelsskib på ca. 35 meters længde.

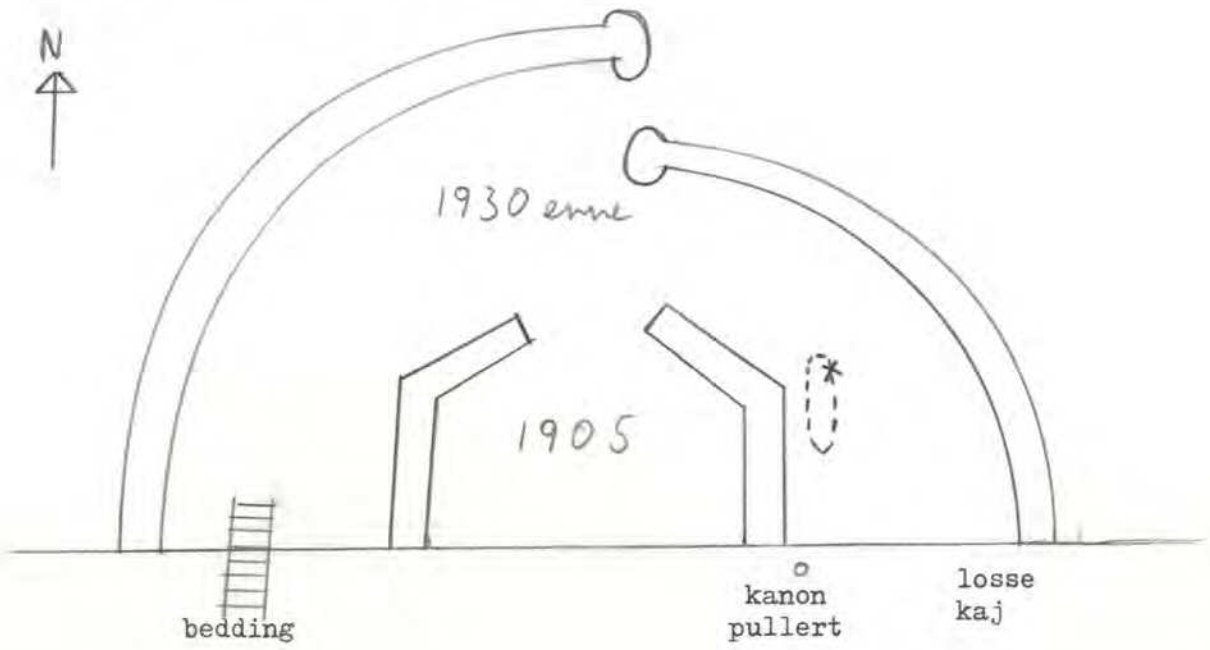
Bundstokkene er afmærkede: a,j,1,5,6 og 8. Bogstavernes og tallenes form tyder på, at skibet er bygget i 1800-tallet. Det gør de konstruktive træk også. Spantformen tyder på et bredt skib med ret flad bund.

Der er tidligere hentet kanoner op fra vraget, og Michael Teisen mener, at disse fund kan tolkes på flere måder. Kanonerne kan have været last i skibet. De kan også have været skibets egen bevæbning (små kanoner var ganske almindelige på handelsskibe), eller de kan have været skibets ballast.

For at identificere vraget vil der blive søgt oplysninger bl. a. i Farvandsdirektoratet og Landsarkivet i Viborg, hvor man bl. a. opbevarer strandfogedindberetninger og referater af søforhør.

Det passerede ved besigtigelsen af ukendt
vrag i Østerby Havn, Læsø d. 24 - 26 marts.

Østerby Havn blev påbegyndt bygget 1903 og blev indviet 8 - 6 1905. Den er ca. 3 m dyb i alle havnebassiner. Havnen blev udvidet i 1930 erne til sin nuværende størrelse ved at anlægge 2 nye dækmoler og lade de 2 gamle moler fungere som pierer. Alle lokale mener samstemmende, at kystlinjen har ligget længere ude før i tiden.



Fiskerne har jævnligt haft besvær med tilsanding ved havneindløbet, og i de senere år med større kuttere har flere ødelagt skruetøjet ved at ramme sten og andet på bunden. Derfor har der regelmæssigt været stenfiskere at uddybe i havnen, sidst " Bunny?" af Århus.

Denne opfiskede meget og kraftigt tømmer på det angivne sted. Noget tømmer og mudder kastede NØ for havnen på dybt vand. Resten blev ved anmelderen, borgmester C.T.Jacobsens mellemkomst anbragt i fisker Kaj Klitgård Christensens, Østerbyvej 75, have (ved Østerby kirke). Det drejer sig om ca. 5 - 10 vognlæs skibstømmer.

Tømmerbunken viste sig at indeholde skibstømmer fra 2 skibe:

1. Et stort træskib, ukendt for Læsø boerne, som ellers har en udmærket mundtlig tradition for forlis.
2. Lidt tømmer fra et mindre træskib i kutterstørrelse. Fiskerne bekræftde dette og fortalte, at "Svenskeren" (en svensk kutter) var forlist i havnen netop dette sted i en Østenstorm pgr. af maskinskade i 1930erne.

De samme berettede, at det store træskib havde man kunnet se fra overfladen under gunstige omstændigheder indtil for knap 10 år siden, og det havde ligget næsten parallelt med pieren dvs. omtrent vinkelret på kysten. Det viste sig ligeledes, at denne fisker med bopæl tæt ved havnen havde 3-4 store planker og bjælker liggende i sin have, bjærget sammesteds af ham selv. Han sagde, at Østerbys bådebygger mente, at det var teak-planker?? Da jeg så dette træværk i nattens mulm og mørke, kunne jeg ikke afgøre træsorten, kun at det var hårdt-træ og særdeles velbevaret, trods det havde været på land i ca. 5 år. Efter længden og formen at dømme var det nogle langsgående stringere og vaterbord og lignende.

Samme fisker havde ydermere en kanon liggende i sit udhus. Desværre under alle sine trawl, som ikke umiddelbart kunne flyttes. Så han lovede, at tage hovedmålene på kanonen ved lejlighed, når trawlene blev flyttet. De berettede, at da kanonen bjærgedes, havde den været omviklet med sække-lærred eller lignende.

Endnu en kanon bjærget sammesteds er indstøbt i kajen som pullert. Denne kanon er rustet, fyldt op med beton og stærkt furet og slidt af wire-fortøjninger, men målte ved mundingen udv. ø. 22 cm, indv. ø. 8,5 cm, svarende ca. til en 4 pundig kanon. (3 p = 7,5 cm, 4 p = 8,3 cm, 6 p = 9,5 cm). Den ragede 62 cm op af kajen. Disse mål må dog tages med meget store forbehold. Det drejer sig i givet fald om en lille kanon.

Man ønskede, at jeg dykkede i havnen for at kunne undersøge for fiskerne, om der var mere skibstømmer, de kunne ødelægge skruer på, eller om alt var kommet op ved stenfiskerens arbejde, som var blevet stoppet.

Bunden i havnen består af slam/mudder i et tyndt lag. Under dette findes blåler i en meget tung og svær kvalitet.

Slamlaget indeholdt alt muligt havneaffald, men ingen løsfund, der kunne stamme fra det ukendte vrag.

I det svære ler sås tydeligt de grøfter - op til 1 m dybe -, som stenfiskeren havde gravet, endda mærker efter tænderne på grabben. I en sådan grøft (x på kortet) fandtes 2 kraftige planker og en del mindre, sidstnævnte fra "Svenskeren". Da det meste af tømmeret alligevel var taget på land, satte jeg en strop på,og fik det hejst på land med havnens kran.

Eftersøgningen blev foretaget med lineholder/halvcirkel metoden og dækkede området effektivt.

I tømmerbunken ved Østerby kirke fandtes:

kølen — Et afbrækket stykke af kølen 7,2o m langt, 25 cm bredt, 40 cm højt. Spundingen var 3,7 cm dyb og havde en vinkel på 85°. Den ene ende af kølen var en lask med en fure til kalfatring. der var rester af jernnagler ved spundingen. På oversiden af kølen fandtes udsparinger til bundstokkene 22,5 cm lange, 3,5 cm dybe, 4 cm brede og havde en afstand på 32-34 cm. Mærkeligt nok var der overhovedet ingen tegn på stråkøl, eller at der havde været en sådan. Prøve på kølens træsort er vedlagt, da jeg ikke har kunnet konstatere den med bestemthed. Muligvis er det bøgetræ ?

dobbelt spant — I den store tømmerbunke fandtes ca. 10 spanter, lavet som dobbeltspant, dvs. bundstok og zitters naglet tæt sammen med jernnagler og proppet med træpropper, nogle steder evt. med trænagler. Afstanden mellem naglerne er ca. 32 cm. Spanterne var alle afbrækkede, hvor bundstokken sluttede.

bundstok — Bundstokkene er ca. 4,35 cm lange, højde på midten ca. 29 cm, højde ved enderne ca. 18 cm, og 22-24 cm brede. Bundstokkenes skaring passende ned i kølens udsparinger er 20 cm brede, 4 cm dybe. Vinklen ved bundstokken/l. oplænger/kalven 65°.

zitters — Zitters er ca. 4 cm smallere end bundstokkene og lige så høje. De er alle brækkede, ca. hvor bundstokken slutter.

materiale — Såvel bundstokke som zitters er af eg.

mærkning — Ved afrensning fandtes på bundstokkens zittersside følgende afmærkning skåret mellem 2 lodrette streger: a, j, L, 5, 6, 8 (se tegning).

andet — I nogle af spanterne fandtes vandløb (lemmergatter) 5-7 cm brede, 3-4 cm dybe.

Spanterne havde alle mærker af økse og skaroeksehug. Spantformen tyder på et bredt skib med ret flad bund.

bord — Bordene fandtes afbrækket i alle længder. Bordene er 32 cm høje = 1' og 7,5 cm tykke= 1". Nådde-vinklen er ca. 85 °. Rester af kalfatringen sidder stadig i mange af nådderne og i spundingen, prøve vedlagt. Bordene har været samlet til spanterne med hånd smedede jernnagler, med firkantede naglehoveder 3 x 3 cm. Bordene er af egetræ.

konklusion Der må være tale om et stort skib af egetræ for det meste tømmers vedkommende. Hvis man regner med, at skibets bredde har været ca. lig med 2 gange bundstokkenes længde, så har skibet været ca. 8,50- 9 m bredt. Har skibets længde:bredde været omkring 4:1 (et bredt,ældre handelsskib), så har skibet været omkring 35 m langt.

Der må derfor være tale om en større stranding, der må have efterladt sig andre spor f.ex. i arkiver.

Fundet af kanoner i vraget kan tolkes på flere måder: 1) Last i skibet, hvilket sækkelærred omviklingen kunne tyde på. 2) Skibets egen bevæbning, idet små kanoner ville være sandsynlige på et handelsskib evt. salut kanoner. 3) Ballast. Gamle kanoner blev brugt som ballast af orlogsskibe - i handelsskibe var det nok mere sjældent.

Spanterne 5,6,8 er spanterne nr 5-8 agten for middelspantet, a= 1. spant foran, j=9. spant foran, L=12 spant foran middelspantet. Dvs. at det er spanterne på skibets bredeste sted omkring midtspantet der er fundet. Med andre ord midtskibet.

Bogstaverne og tallenes form tyder på, at det er et skib fra 1800-tallet, og det gør de konstruktive træk ligeledes. Der fandtes ingen tegn på forhudning af skibet.

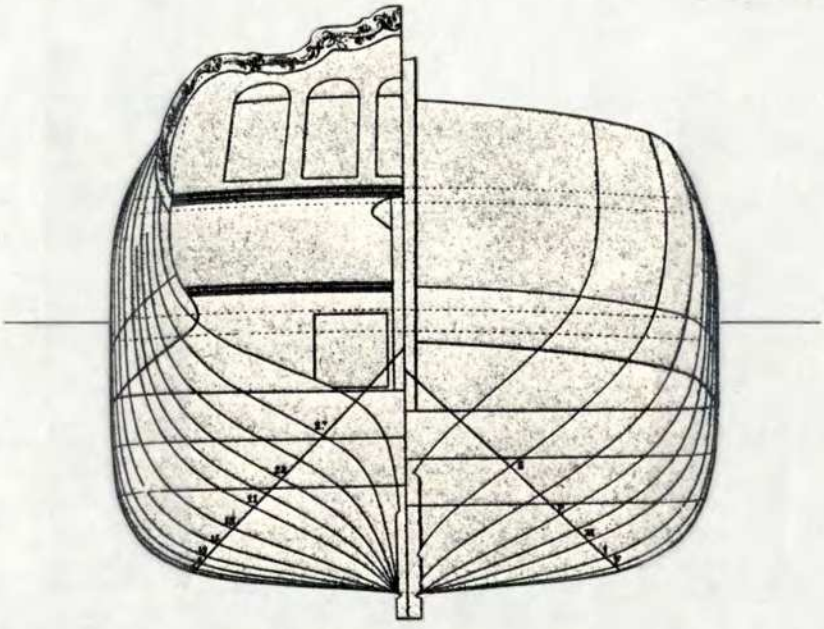
evt. bevaring Lokalhistorisk interesserede har foreslået, at lægge kølresten og derpå oprejse de spanter, der hører til, og evt. bruge noget af klædningen til den langsgående afstivning, for dermed at have en visuelt markering af, hvor store strandinger, der skete på Læsø, hvilke befolkningen i en vis målestok ernærede sig af. Da træet er meget velbevaret kan konserveringsproblemerne måske nok indskrænkes til almindelig trævedligeholdelse med imprægneringsmidler. Jeg ville selv anbefale et sådant projekt.

identificering Foryderligere at identificere vraget må oplysninger søges følgende steder:

1 Farvandsdirektoratet, 2 vandbygningsvæsenet (havneanlæg), 3 strandfoged indberetninger - Hjørring amt - Viborg Landsarkiv, 4 Sørets-forhør i Frederikshavn, Hjørring eller Ålborg - Viborg Landsarkiv, 5 præsteindberetninger - dagbøger, 6 Bing: Physisk og økonomisk beskrivelse over Læsø. Kbh. 1802. 7 Klitgård: Efterretninger om Læsøs havn og søfart 1768, i Vendsyssel Folk og Land 1910. 8 Forespørgsel til Bjarne Stoklund.

Michael Teisen


1417 IV
NØ
Engelskmands Banke
Sælhunderev
Jegens Odde
Jegens
Syrbugt
EGENS BUGT
Østerby Havn
Tyvhullerne
Kirkebugt
Rednst
Trsf
Lergrays Bakke
Campingplads
ORDMARKEN
Syrsig
Mosen
Mosegård
Lillestrøm
Sandvad
Kirkebakke
Oster Kirkesig
Trsfst
Hal
Østerbygård
Pilegård
Sandvadgård
Hals Kirke
Østerby
Kirke
Ellegård
Snaven
Bløden
Evbakke
Bløden Hale
Krogen
Lillebro



Vrag - Østerby havn - Læsø.

Nationalmuseet, Skibshistorisk Laboratorium. Roskilde

December 1981

Vrag - Østerby havn - Læsø.

Indholdsfortegnelse:

Vrag - Østerby havn - Læsø.

Oversigt over bilag:

Bilag I.:	Rapport vedr. besigtigelsen d. 24 - 26 marts 1980. Michael Teisen.
Bilag II.:	Opmålingsskitser af spanter, tre sider, opmålt af Morten Gøthche.
Bilag III.:	Tegninger, Morten Gøthche. Tegn.: 1. Spanter. Tegn.: 2. Spanter. Tegn.: 3. Køl og planker m.m. Tegn.: 4. Plan og opstalt. Tegn.: 5. Rekonstruktion af middelspant. tegn.: 6. Opstalt af opstilling.
Bilag IV.:	Kaperfregat, planche XXXII, "Architectura Navalis Mercatoria" Fredrik Henrik af Chapman.
Bilag V.:	Rekonstruktion af en hollansk lask fra "Praktisk Skibbyggerie" I-II Kjøbenhavn 1833-34, D.H.Funch.
Bilag VI.:	Planche XXVIII, no. 2, no 3., Chapman.
Bilag VII.:	Skeppet "Carolus XI" 1678, side 101, Svenskt Skeppsbyggeri, Gustaf Halldin, Malmø 1963.
Bilag VIII.:	Planche LXII. No 1. fregat. No 2. Snow. No 4. Brig. Chapman.
Bilag IX.:	"Physisk og økonomisk beskrivelse over Læsø" side 108 og 109. Bing København 1802.

VRAG ø ØSTERBYHAVN - LÆSØ.

Indledning.

På foranledning af Michael Teisen blev jeg i oktober måned ringet op af borgmester C.Tage Jacobsen, Læsø, der under henvisning til Nationalmuseets tilsagn om sagkundig bistand, spurgte om jeg ville komme til Læsø og se på vragresterne fra Østerby havn for at man om muligt kunne samle og opstille vragdelene i et hele. Til forståelse af det forud passerede vedrørende dette vrag vedlægges som bilag I Michael Teisen's rapport fra besigtigelsen 24 - 26 marts 1980. Ved en senere telefonsamtale blev besigtigelsen berammet til den 1. og 2. november.

Opmålingen.

Da jeg var ankommet aftenen i forvejen, kunne jeg starte fra morgenstunden mandag den 1. november (et held - idet der samme morgen stod en stiv vestlig kuling, der forhindrede Læsø færgen i at sejle.) Efter at havde fået et overblik over situationen besluttede jeg mig til at gennemgå alle vragbunkens bundstokke en for en. Ved at registere evt. mærkninger og opmåle de enkelte bundstokkes facon mente jeg at kunne finde frem til spanternes oprindelige rækkefølge. To raske folk der var stillet til rådighed for mig , blev straks sat igang med at lægge bundstokkene ud, og jeg begyndte opmålingen og registreringen fra en ende af. Opmålingen af de enkelte bundstokke blev foretaget ved at lægg et retholt med en midterlinie an mod bundstokkens anlægsflade mod kølen, og derefter måle afstanden ind til undersiden af bundstokken i punkter o,5o, 1,oo, 1,5o, 2,oo osv. fra midterlinien. Målene blev taget i anlægsfladen mellem bundstok og zitter.

Uden at skele til en evt. rækkefølge fik jeg efterhånden målt og registreret de 16 bundstokke der var i bunken. Samtidig lykkedes det at få placeret en del løse zitterse, enten ved at de var derekte mærket med en mærkning svarende til bundstokkens, eller ved en simpel udmåling af nagler og spir. Desværre kom jeg til at stå tilbage med 5 zitterse jeg ikke kunne placere, skønt der stadig manglede 8 zitterse på de opmålte bundstokke.

Beskrivelse af spanterne.

På bilag II ses opmålingsskitserne af bundstokke og zitterse. Den første bundstok er mellem den afskrabede stregning for kølen mærket med tallet 5. Zittersen i "venstre" side mangler. Zittersen i "højre" side er mærket med tallet 5. der er på dette spant lemmegatter på begge sider af kølen. Sidens andet spant er mærket med noget der ligner et "p". Den har begge zitterse - det venstre løs og mærket med et tilsvarende "p" på anlægsfladen ind mod bundstokken. Den tredie bundstok er mærket med bogstavet lille a og mangler venstre zitters. Den fjerde bundstok er mærket med tallet 3, og har begge zitterse. Opmålingens femte bundstok er mærket med et kryds, eller mere rigtigt et kors, hvis ender er afsluttet i en tværstreg (næsten så det ligner et malteserkors). Højre zitters mangler og bundstokken er i denne side flækket. Bundstokken nederst på side 1 er mærket med to cirkeludsnit - en kvartcirkel og en halvcirkel. Den har begge zitterse - den venstre løs og mærket med noget der ligner et omvendt lille e på anlægsfladen ind mod bundstokken.

Side 2's første opmåling er mærket med noget der ligner bogstavet "j". Bundstokken har begge zitterser. Næste bundstok er mærket med en lignende mærkning, der her har en tværstreg forneden, og er omtegnet af en cirkel. Højre zitters mangler. Sidens tredie bundstok, der har begge zitterser, er mærket med en skråtstillet svag s-form. Den fjerde bundstok mangler venstre zitters, og er mærket med et stort C vendt på hovedet.Femte bundstok på siden med begge zitterser i behold er mærket med bogstavet store B. Endelig side 2 nederst - en bundstok mærket med bogstavet lille g. Den øverste del af g-et er kappet af af udhugningen i oversiden af bundstokken.

Den første af side 3's opmåling er mærket er mærket med et 4-tal. Bundstokken har begge zitterser. Fra kølen og ca. 4o cm ud er begge zitterserne udhugget ca 4 cm ind i forsiden. Bundstokken har desuden lemmegatter på begge sider af kølen. Den anden bundstok på siden er mærket med et 7-tal, og har begge zitterser. Sidens tredie opmåling er mærket med tallet 8. Bundstokken der kortere end de øvrige mangler begge zitterserne. Side 3's fjerde og sidste opmåling er mærket med tallet 6. Bundstokken har lemmegatter og mangler zittersen på højre side.

Alle bundstokkene er bevaret i fuld længde med undtagelse af a, hvor venstre-siden er afbrækket. Alle zitterserne er knækket lige omkring enden af bundstokken. På spantet g er zittersen knækket ved et naglehul helt oppe i kimmingen, dvs. ved overgangen mellem skibets bund og side. Bundstokkene mærket med lille g og med tallet 7 har begge et bredt hak skåret op i undersiden. Et modsvarende løst stykke, en såkaldt kalv, viste sig at passe i hakket på 7-eren.

Spanternes indbyrdedes placering.

Samme aften tegnede jeg samlige spanter op, for til næste dag at kunne finde frem til den rette rækkefølge af de opmålte spanter. Bilag III, tegning 1 og 2 viser en rentegning af disse skitser. (tegningerne må kun betragtes som skitseopmålinger, da de kun skulle tjene dette ene formål). Der har efter at man begyndte at lave egentlige konstruktionstegninger, det skete omkring 163o-erne, af skibene, også udviklet sig bestemte regler for mærkningen af spantesektionerne på disse tegninger. I midten af 17oo-årene ligger disse regler nogenlunde fast. Gående ud fra skibets middelspant, sædvanligvis placeret på det sted, hvor skibet havde den største fyldighed, mærkedes spantesektionerne agterud med tal og forefter med bogstaver. Middelspantet mærkedes med et kryds oveni en cirkel. Vender man tilbage til de mærkede spanter kan man se, at vi med sikkerhed har spanterne 3, 4, 5, 6, 7, 8, der ligger agten for middelspantet og lille a, store B og C og lille g, der ligger forom middelspantet. For at kunne indpasse de resterende spanter, må man ty til opmålingen, og her er den bundstok, der har den laveste bundrejsning i forhold til vandret, den der er mærket med et kors. Det må derfor være fartøjets middelspant. Som nævnt mærkedes middelspantet sædvanligvis med et kryds oveni en cirkel, men i Chapmann's store værk fra 1768 "Architectura Navalis Mercatoria" er de fleste tegningers middelspanter mærket med et tilsvarende kors. (se bilag IV). Vender man sig fremefter kan man forsøgsvis placere det omvendte lille e mellem C og g, derpå at placere bundstokken mærket med p, der kan tolkes som lille d på hovedet, imellem e og g. Endelig kan bundstokken med den skrå s-form, da den med sin svage bundrejsning ikke kan være spantet S langt forude i skibet, med lidt god vilje tolkes som spantet f.

Denne placering giver en tilsyneladende jævn linieforløb forefter.
Tilbage står de to bundstokke mærket med "j". Igen kan de pga. deres lave bundrejsning ikke placeres forude som j. Bogstavrækken fra a til g er komplet, og kun talrækkens to pladser er ledige. Hvis det ene "j" betragtes som et 1-tal kan det omcirklede "J" med lidt god vilje godt tolkes som et 2-tal.
Men - da viser det sig, at denne bundstok har en lavere bundrejsning end det ikke omcirklede "j". Når det omcirklede "j" placeres som spant nummer 1 agten om middelspantet, og det andet "j" som nummer 2 bliver der et fornuftigt forløb på linierne her. Det kan tænkes at bygmesteren i sin tid er kommet til at hugge forkert - at han er kommet til at hugge et 1-tal i bundstok nr. 2, og at han derfor har været nød til at omcirkle 1-tallet på bundstok nr. 1 for at kunne skelne de to fra hinanden.

Af smigen på spanterne, dvs. den skråhed der er hugget på spanterne for at få den udvendige klædning til at ligge an, ses det at spanterne forom middelspantet har zitterserne på forkanten af bundstokkene og på spanterne agtenom sidder de på agterkanten. Dvs at spantesystemet vender omkring middelspantet. Hvor præcist det vender kan ses af den svage smig, der er på middelspantet. Det viser at zitterserne på middelspantet snarere har siddet på agterkanten end på forkanten. Dermed kan det også fastslås, at middelspantet har siddet lidt agtenfor skibets største fyldighed. Bundstokkene på a og på middelspantet kommer således til at sidde tæt op ad hinanden, som det også kan ses på Chapman's kaperfregat på bilag IV.

Det var det resultat jeg nåede frem til aftenen den 1. november. Den næste dag skulle jeg så forsøge at få spanterne placeret på det opfiskede kølstykke.

Spanternes placering på kølen.

Kølstykket er ca 6,5o m langt. Der er på dette stykke udhugninger for ialt 13 spanter med en afstand på ca 57 cm fra kant til kant. Det kunne med det samme konstateres, at middelspantet må havde siddet udenfor dette kølstykke - idet der ikke på noget sted var to tætsiddende udhugninger (for middelspantets og a's tætsiddende bundstokke). Kølstykket

er i den ene ende brækket i en samling. Der (et) fra undersiden af kølen skåret et snit ca 1/3 op. Snittet, der bærer spor af en iboret skørnagle i stødfladen, har en vinkel til underkanten på ca 110°. Samlingen har formentlig været en skrålask. Hvis man skal stole på gældende praksis kan det fastslås, at den ende, hvor samlingen sidder vender forefter: En køllask vendes altid skråt bagud, dvs. skråt nedad og agterud. Teoretisk set skulle derfor den del af spanterne mærket med tal kunne placeres fra samlingen og agterefter. Dette lader sig imidlertid ikke gøre, idet forboltningen i køl og spanter først og fremmest skal passe sammen. Her tegner der sig for kølens vedkomne et helt klart mønster, - nemlig det, at hvert tredie udhugning i kølen har to huller og de mellemliggende eet hul. Hvor der er to huller er det ene hul ca 1" i diameter. Det andet hul, samt hullerne i de mellemliggende spanter er af en mindre dimension.

En tilsvarende rytme genfindes i spanterne, men hvor rytmen brydes agten for middelspantet. Middelspantet har to huller. Derpå følger spanterne 1, 2, 3, og 4 med enkelthuller, og først ved det femte spant kommer der igen to huller. Derved rykkes muligheden for en placering af spanterne på kølen en god bid agterud. Et konkret forsøg på af få spanterne til at passe på den resterende del af kølstykket gav et negativt resultat. Først og fremmest skulle hullerne passe, to hvor der var to huller og et hvor der var et hul. Dernæst om det store hul sad for- eller agtenom det lille. Om hullerne passede nøjagtig ud for hinanden og endelig, om bundstokkens udhugning passede nøjagtig ned i kølens udhugning. Tilsidst forsøgte jeg på tværs af alle gårsdagens konklusioner, at sammenpasse hvert eneste af de 16 bundstokke til samtlige 13 huller på kølstykket - et nedslående resultat - ikke et eneste passede??

Beskrivelse af de øvrige vragdele.

Foruden spantedelene bundstokke og zitterser og kølstykket fandtes der i vragbunken en del planker fra den udvendige klædning og formentlig også garneringen, samt nogle tyndere planker. Se bilag III, tegning nr. 3. Kølplankerne kunne indentifiseres ved at den ene kant, fra begge sider var affaset i en vinkel på 45°. Affasningen mødtes i en vinkel på 90°, der passer ind i spundingen på kølen. Kølplankerne er

ca 65 - 75 mm tykke og ca 35 cm brede. Kølplankerne har været spigret med to spir i hvert spant, og med tre spir ved stød. Plankerne har ligeledes været spigret ind i spundingen. De øvrige klædningsplanker har samme tykkelse og variere i bredden fra 25 til 35 cm. Der sad på kanterne af de udvendige klædningsplanker flere steder rester af kalfaktringen, der bestod af lange, trevlede, grove plantefibre. Nogle tyndere bord 25 - 35 mm i tykkelse og med samme varierende bredder, som de øvrige planker, lå imellem vragdelene. Nogle af disse tynde planker sad påspigret den udvendige side af klæningsplankerne. De tynde bord var spigret to og to og tre ved stød uafhængig af spanterne. Endelig lå der i vragbunken nogle langsgående tømmerstykker med dimensionen 14 x 23 cm, der med fladsiden har været fastgjort til skrogsiden med trænagler og spir, Fastgørelsen korresponderer med spanterytmen. En af disse tømmerstykker havde en skrålaske, ca 25 - 3o cm lang, på fladsiden.

Materialer og forarbejdning.

Bundstokke og zitterser er tilhugget af kernetræ og er af eg. Kølen er af nåletræ og formentlig af gran (Store knaster der ikke sidder i etager som på fyrretræ). Klædningsplanker, garnering, forhudning og stringer er formentlig også gran. Træet er groft og åbent i strukturen og virker meget magert. Trænaglerne i spantesystemet er af eg. Spir, kølbolte, stuvbolte er af jern. Kalfaktring er plantefibre formentlig af hør eller hamp.

Alle spanter er tilhugget med skar- eller retøkse. Den nederste ende af mange af zitterserne er den hugne ende fra da træet blev fældet i skoven. Kølen har ingen huggespor, og er formentlig efterbearbejdet med høvl. Kølplanken og de øvrige udvendige planker, samt garneringsplankerne er skåret med langsav. De tynde planker er tilhugget indvendig med ret- eller skarøkse. Udvendig er der ingen spor af forarbejdning pga. slid. Den langsgående vægger er tilhugget med økse.

Beskrivelse af skibets konstruktion.

Køl. Kølen er 4o cm høj og 25 cm bred. 3 cm nedfor overkanten er deren 8 cm bred spunding. Bunden af spundingen ligger 4,2 cm

ned og er 4 cm dyb. Kølen har været samlet af flere stykker med en skrå hagelask, en såkaldt hollansk lask. (se billag V).

Stråkøl. Kølen har været forsynet med en stråkøl med en bredde svarende til kølens og en højde svarende til ca ¼ af kølens højde. Stråkølen har været spigret fast til kølen.

Spanterne. Den del af spanterne der er tilbage består af bundstokke og af zitterser. Bundstokkene har et sidehug (bredde) på 23 -25 cm og en førlighed ud og ind (højde) ved kølen på 3o-4o cm og ved enderne 17 cm. Zitterserne har et sidehug på 2o - 22 cm og en førlighed på 17 cm ved kimmingen. Bundstokke og zitterser er samlet med tre trænagler 1¼" i diam. og to gennemgående spir. Trænaglerne er boret vinkelret igennem og slået i, så de ligger glat med oversiden, medens den tilspidsede ende af naglen rager ud på den anden side. Spigrene har et kvadratisk tværsnit, tilspidset og med smedede hoveder på ca 3 cm i diam. Spigrene er vejnet på den modsatte side. Spant 8, der har en kortere bundstok end de øvrige spanter har kun to trænagler og to spir. Alle spanterne har været samlet på et plan og derpå rejst på kølen. Hver bundstok har en 16 - 18 cm bred og 3 cm dyb udskæring op i undersiden. En tilsvarende udhugning i overkanten af kølen, hvor bundstokken passer ned. Hver bundstok er tilpasset individuel: Hvis der har været en barkkant på undersiden af bundstokken har der været en tilsvarende omhyggelig udhugning i oversiden af kølen. Hver bundstok har været fastgjort med en stuvbolt ned i kølen.

Kølsvinet. Kølsvinet har haft et sidehug på 27 cm og en formentlig tilsvarende lavere højde på ca 25 cm. Kølsvinet har været fastgjort med knapt 1 meter lange gennemgående kølsvinsbolte med en diam på ca 1" i hvert tredie spant. Kølsvinet har været skrammet ned over bundstokkene 3 cm ned og ca 2 cm ind fra begge sider.

Udvendig klædning. Den udvendige klædning har været savskårne planker af gran 7 cm i tykkelse og med bredder varierende fra 25 - 35 cm. Plankerne er spigret til hvert spant med to spir og ved stød tre spir.

Kimmingvæger. I overgangen mellem bund og ~~sidet~~ siddet en kimmingvæger 14 x 23 cm lagt på fladsiden og fastgjort med et spir og en trænagle i hvert spant. Trænaglen har været udeladt, hvor

der har været stød i spant eller klædning o.l.

Garnering. Garneringen har samme dimensioner som den udvendige klædning.

Forhudning. Savskårne planker. 3 cm tykke. bredde varierende fra 25 - 35 cm. tilpasset de egentlige klædningsplanker ved tilhugning af anlægsfladen med skar- eller retøkse. Forhudningen forskudt i forhold til den øvrige klædnings stød og nåder, lagt i tjærefilt og spigret med spir to og to og tre ved stød uafhængig af spanterne.

Pumper. Udsparinger for pumperørene på agterkanten af zitterserne på spant nr 4. Lemmegatter på to spantelag agten herfor og på to forom. Pumperørene har været blyrør. (et trærør ville havde krævet en meget større udsparing).

Stormasten. Stormasten har haft sit trædepunkt lige omkring spant 4, enten agten herfor eller forom. (Et skibs pumper var sædvanligvis placeret umiddelbart op af stormasten).

Rekonstruktion.

Skibets størrelse. Vedrørende skibet bredde kan man som en tommelfingerregel regne med, at den er ca det dobbelte af bundstokkens længde. Længden på bundstokken er ca 4,4o m, hvilket svarer til, at skibets fulde bredde har været ca 8,8o m. Regner man på lignende måde med at længde - bredde forholdet er omkring 4:1 (svarende til proportionerne på et ældre handelsfartøj) har skibet været ca 35,2 meter langt.

Skibstypen. At dømme ud fra middelspantets ringe bundrejsning (overkanten af bundstokken er her fuldstændig ret) er der tale om et meget fyldigt skib. Går man ud fra Chapman's klassificering af skibsskrog, uden dog at sige at det pågældende skib er fra denne periode, må vi her stå over for et skrog, der må betegnes som en bark (handelsskib af 5 klasse), eller måske snarere en bark af dem som Chapman betegner som grundgående. Størrelsesmæssig placerer vragdelen sig et sted mellem planche XXVII's no. 2 eller no 3. (Bilag VI). Jeg har for at vise udstrækningen indtegnet vragdelene i henholdsvis opstalten og i planen på planchens no 2.

Skibets alder. Der er ikke umiddelbart noget i vragdelens konstruktion, der peger på en afgrænset tidsperiode. Skibet kan

for den sags skyld være så lang tilbage, som fra slutningen af 1500-tallet til begyndelsen af 1600-tallet, hvor den norderopæ-diske og især den hollanske skibsbygningskunst får stærk indflydelse på skibsbyg-ningskunsten i de skandinaviske lande. Set ud fra middelspan-tets facon kan det ikke være meget yngre end 1800 - 1850. Træforhudningen skulle man mene kunne sige noget om skibets alder, men træforhudningen har sansynligvis været anvendt lige så langt tilbage, som den hollanske skibbygningskunst har haft sin indflydelse. (skibet "Carolus XI" fra 1678 har været for-synet med denne forhudning. 'Svenskt Skibsbyggeri s.101, se bilag VII). I samme bog, side 180, nævnes det at træforhudnin-gen i udlandet 1 1780- erne er begyndt at blive erstattet med metalforhudning og specielt med kobber, og at kobberforhudning er almindeligt i den engelske marine i 1785. I sverrige har udviklingen gået mere trægt. Kobberforhudningen var en kost-bar udgift, og omkring 1808 syntes det at fremgå at de svenske fartøjer endnu ikke er kobberforhudet. Det skal her understre-ges at der er tale om de svenske orlogsfartøjer. Man må formode at kobberforhudningen er kommet langt senere på koffardifartens skibe, specielt på de mere afsidedes liggende private værfter.

Fundet af to mindre jernkanoner (den ene faststøbt i kajen i Østerby havn og den anden hos fisker Kaj Klitgård) indikerer at vraget ikke kan være ældre end fra midten af 1700-tallet, idet man omkring dette tidspunkt begynder at er-statte de gamle bronzekanoner med jernkanoner.

Skibets hjemsted. Normalt byggedes større kravelbyggede far-tøjer af eg. I nogle tilfælde, især ved engelske fartøjer, har der været anvendt oversøiske træsorter, såsom teaktræ eller lignende. Anvendelse af nåletræ til bygning af de større kra-velbyggede fartøjer leder tanken hen på det baltiske område, eksempelvis de finske tømmerskuder, der hovedsagelig var byg-get af den lokale træsort, gran eller fyr. Til det skib, hvor-fra vragdelene stammer har man kunnet anvende det lokale træ, gran til kølen og til de udvendige planker og garneringen, medens man til spanternes mange forstykker har måttet forlade sig på dyrt indkøbt egetømmer.

Konklusion. Vi står her overfor et bredt, fyldigt, grundgående handelsskib, muligvis med en mindre armering, ca 35 meter langt istørrelse som en fregat eller brig og med en fregats-

eller en brig/snow's tåkling (bilag VIII). Skibet er fra perioden 175o - 185o og er bygget i baltisk område (Sverige, Finland, Rusland eller et af ranstaterne) på et mindre afsidedes liggende privat værft. Indkøbet af egetømmer og det at skibet ikke er bygget på klamp, dvs. uden brug af tegninger, tyder på at en større organisation har stået bag byggeriet, snarere en et lokalt initiativ. Hvert spantelag er lavet efter en udslagning på et plan og derpå rejst et for et. Denne udslagning kan kun laves ud fra en eller anden form for tegning.

For yderligere indentification kan det anbefales, som også nævnt i Michael Teisens rapport, bilag I, at søge oplysninger i:

1. Farvandsdirektoratet.
2. Vandbygningsvæsnet.(havneanlæg).
3. Strandfogedindberetninger - Hjørring amt - Viborg Landsarkiv.
4. Søretsforhør i Frederikshavn, Hjørring eller Ålborg - Viborg Landsarkiv.
5. Præsteindberetninger - dagbøger.
6. Bing: Physisk og økonomisk beskrivelse over Læsø. Kbh. 19o2.
7. Klitgård: Efterretninger om læsøs havn og søfart 1768, i Vendsyssel Folk og Land 191o.
8. Forespørgsel til Bjarne Stoklund.

Personlig er jeg faldet over Bing's beskrivelse af fregatskibet "Poul", der strandede østen under øen den 22 okt. 1797. Skibet var hjemmehørende i Archangel i Rusland på vej til Petersborg med en ladning tjære og en del sække havre. Som et af de eneste af de mange beskrivelser af strandinger lægges der særligt vægt på, at skibet var nyt, bygget i Archangel af fyrretømmer. (bilag IX.). En nærmere gennemgang i ovennævnte arkivmateriale vil enten kunne afkræfte eller bekræfte denne mulighed.

Forslag til vragdelenes opstilling og konservering.

Formålet med denne besigtigelse har jo været, at finde frem til vragdelenes indbyrdes sammenstilling, således at de kunne opstilles på kølen for derved at give indtryk af størrelsen af de mange strandinger, som Læsøs beboere i nogen grad enærede sig af. Desværre har det vist sig, at det kølstykke der er kommet op ligger uden for det område, hvor spanterne har siddet. Jeg har på bilag VI indtegnet den mulige placering af kølstykket - nemlig agtenfor spanterne. Agterenden af kølstykket, modsat enden med skrålasken, er stærkt nedslidt, medens den øvrige del af kølstykket står med skarpe kanter. Jeg har på bilaget endvidere forsøgt at indtegne bundniveauet og havnens østre indermole i forhold til vraget. Jeg har her antydet, at den nedslidte ende af kølstykket har stukket ud af blåleret, medens den øvrige del af vraget har ligget godt beskyttet herunder. Ved uddybningen af denne del af havnen har stenfiskeren først fået fat i det udragende kølstykke, det fiskerne ved flere lejligheder har tørnet, dernæst i alle spanterne, der med det samme har sluppet, da alle bolteforbindelser er rustet over. Der er derfor mulighed for, at det kølstykker der passer til opfiskede spanter stadig ligger i blåleret lige under overfladen.

Nationalmuseet kan naturligvis ikke anbefale at spanterne placeres på det opfiskede kølstykke, og mener at man, inden der tages beslutning herom, bør undersøge om der skulle ligge endnu et stykke køl på bunden af havnen i Østerby.

Konservering.

Råd og svampes nedbrydning af træ er en naturlig proces i et større økologisk kredsløb. Ønsker vi derfor at bryde ind i dette kredsløb og "låne" træet for en "kortere" periode til brugstræ i byggeindustrien, til møbler eller lignende eller som her forlænge træets naturlige levetid, må vi opbevare eller behandle træet på en måde, der kan forhale den naturlige proces. Erfaringsmæssig har træ den største holdbarhed, når det opbevares i et tørt tempereret rum, som for eksempel kirkerum. Når man som her har valgt den næstbedste løsning, at opbevare det udendørs, må man ty til en kemisk beskyttelse af træet.

Holdes træet godt fri af jorden, så der er god mulighed

for ventilation omkring træet, er der mindre fare for svampeangreb. Der-imod er der mulighed for svampeangreb i revner og sprækker, i samlinger o.l., hvor vandet kan stå og soppe og således give partielle større fugtighedsprocenter. Som bekendt lader det sig ikke gøre at dybdeimprægnere egetræ, og for fyrretræs vedkomne kun splinten, derfor kan der kun blive tale om en overfladebehandling af vragdelene. - Men her har man også mulighed for at anvende den bedste behandlingsmetode, nemlig neddybning. Imprægneringsmidlet for derved mulighed for at trænge ind i revner og sprækker. Hvilket imprægneringsmiddel og fra hvilke firma kan der ikke gives svar på, da der ikke foreligger nogen sammenlignende undersøgelse af de forskellige produkter. Tage Jacobsen har selv nævnt firmaet Gori's produkter, hvilket vi kan anbefale, idet Gori i samarbejde med Nationalmuseet har udviklet specielle produkter til dette formål.

Samling af spanterne.

De steder, hvor der er løse zitterser afrenses anlægsfladerne omhyggelig. Svindrevner og lignende udkittes med en pasta af træimprægnering, f.eks. Gori 22-5 pasta. Inden de to anlægsflader lægges mod hinanden lægges der en bandage, dvs. et filtlag dyppet eller smurt i samme pasta imellem. Bundstok og zitters boltes derpå sammen med to gennemgående bolte. Forboltningen udføres diskret, men dog alligevel således, at den skiller sig ud fra den oprindelige sammenføjning, f.eks. sortmalede bolte af messing, rustfri stål eller galverniseret jernbolte.

Kølen lægges op på kølklodser ca 3o x 6o cm og ca 4o cm over jorden støbt ned i frostfri dybde. Afstanden forslås til ca 6o- 7o cm imellem hver. Der støbes i klodsernes overflade en bred plade, lidt mindre end kølens bredde, på en konsol, således at kølens underside holdes fri af soklens overside, dog ikke med mere afstand end at man stadig har fornemmelsen af at kølen står ned på kølklodserne. (1 1,5 cm). Hver sokkels bæreplade kan være forsynet med en messingtap, der kan bores op i undersiden af kølen til styr for denne.

Spanter og køl tilpasses hinanden og en messingbolt bores et stykke ned i kølen og et stykke op i undersiden af spanterne. Der lægges en imprægneringsbandage i anlægsfladen

mellem køl og spant. Spanterne, der støttes midlertidig, bør så vidt mulig ligge symetrisk og vinkelret på kølen.

Der forsøges opsat en længde bordplanker i begge sider, evt. i to stykker forskudt for hinanden. I agterenden nærmest kølen, som antydet på tegning 6. bilag III. Når plankerne er tilpasset lægges der en bandage i anlægsfladerne og plankerne fastgøres til spanterne med messingstuvbolte. Derpå støbes der fundamenter til sideafstøtningen i 5 eller 7 punkter, og der tages mål til afstøtningerne. Afstivningen tænkes lavet af en massive gavlvaneserede jernstænger, der kan optage såvel træk som tryk fra spanterne. Jernstængerne forsynes med en tværplade, der passer til smigen på plankerne. (disse afstivninger kan også tillaves med en vis overlængde, der derpå kan støbes fast i fundamenterne, når de er gjort fast på plankerne og rettet ind.

Det foreslåes at der kun sættes et par korte stykker af kølplanken op, da kølplankerne opsat i hele længden vil forhindre vandet i at komme væk fra kølen.

På det stykke af spanterne, hvor der ikke er nogen køl forsættes der med et profil, der i dimension svarer til kølen f.eks. et stykke pladejern øverst 16-18 cm bredt, der passer til udskæringerne i undersiden af spanterne, og nederst et pladejern på 25 cm i bredden svarende til kølens bredde. Mellem de to stykker pladejern placeres der et jernrør under hver bundstok, med en længde, der svarer til højden på kølen. Hvis man slet ikke vil anvende kølstykket kunne alternativet hertil være, at støbe en drager ovenpå kølklodserne svarende til dimensionen på kølen med stråkøl ca 25 x 55 cm, og med en udsparing i oversiden i hele længden, der svarende til hakket i undersiden af spanterne.

Af hensyn til helhedsindtrykket og den fremtidige vedligeholdelse kan det anbefales at lave en kasse ca 5 meter bred og med en tilsvarende længde, der opfyldes med grus og derpå store rullesten. En trykimprægneret planke på højkant afgrænser kassen til det omliggende græs. Det kan endvidere anbefales at placere de opstillede vragdele vinkelret på huset, og med spantet g frem mod huset. Det opstillede vrag vil blive en stor sag, der vil kræve megen plads. Der bør derfor VÆRE

god plads uden om det, dvs god afstand til vejen, de to sider med havemur og til pladsen foran museet.

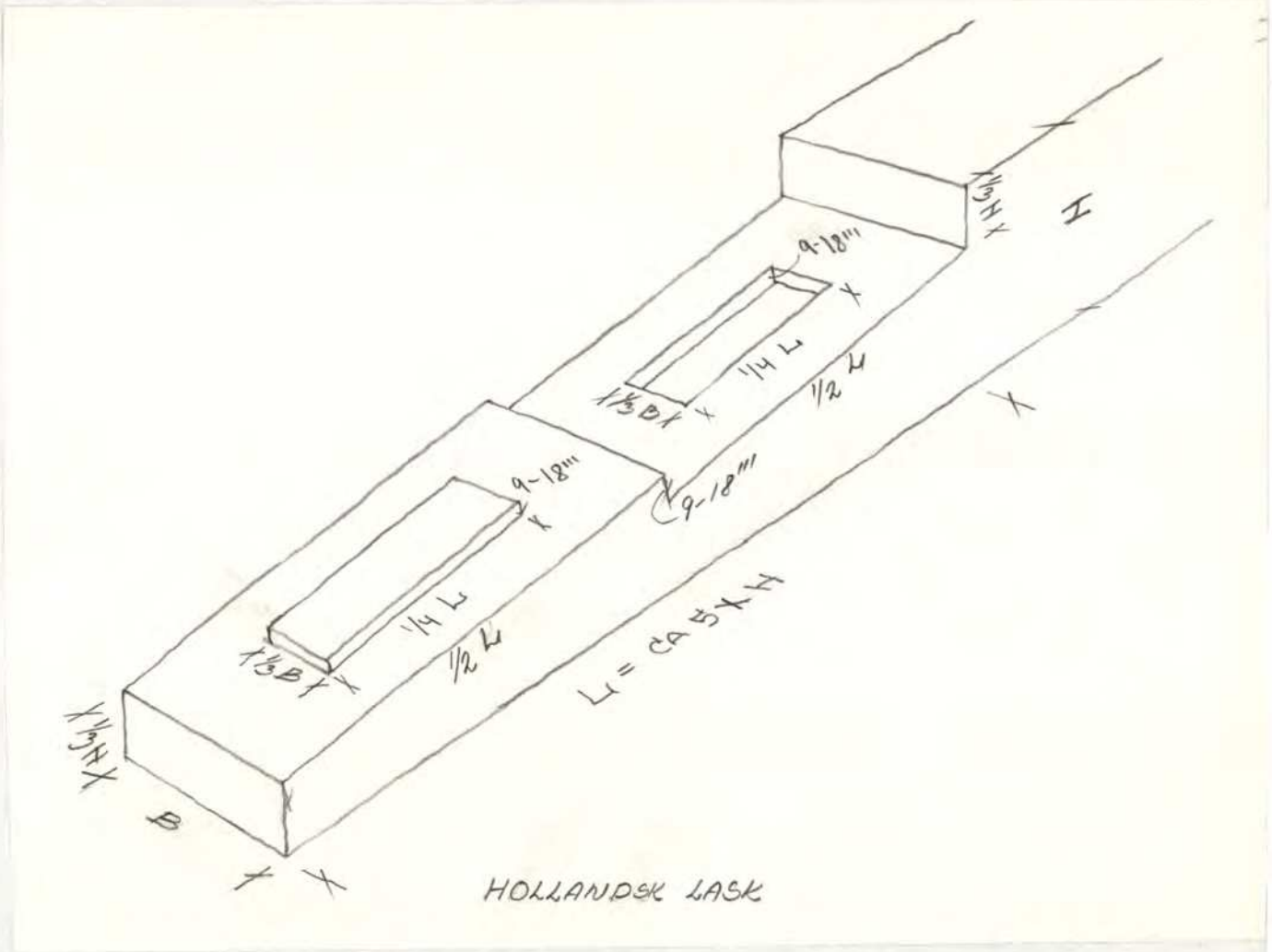
Efterbehandling og vedligeholdelse.

Alle revner og sprækker o.l. kan på oversiderne, eller andre steder, hvor der er fare for indtrængende vand, udkittes med pastaen og derpå forsegles med en plastisk fugemasse. Forseglingen udføres som en indtrukken fuge, der markerer revner og sprækker, så træets naturlige struktur ikke sløres. Der sørges for naturligt afløb fra alle fuger, f.eks ved i den laveste ende at trække fugen frem til overfladen, således at vandet ikke kommer til at stå og soppe noget steds.

Det opstillede vrag behandles jævnligt og/eller når det trænger til det med træimprægneringen, ved påsmøring eller ved spayning. Der bør føres løbende kontrol med de forseglede revner og sprækker, så de ikke kommer til at stå som vandlommer, med alvorlige svampeangreb til følge.

Roskilde den 1 december 1981

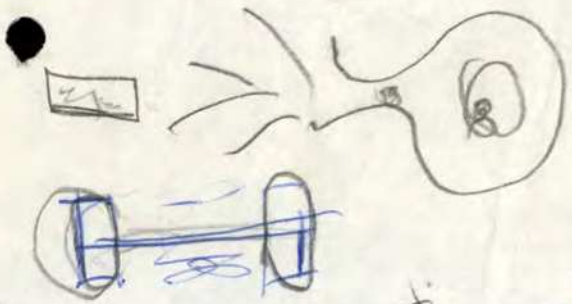
Morten Gøthche
arkitekt M.A.A.



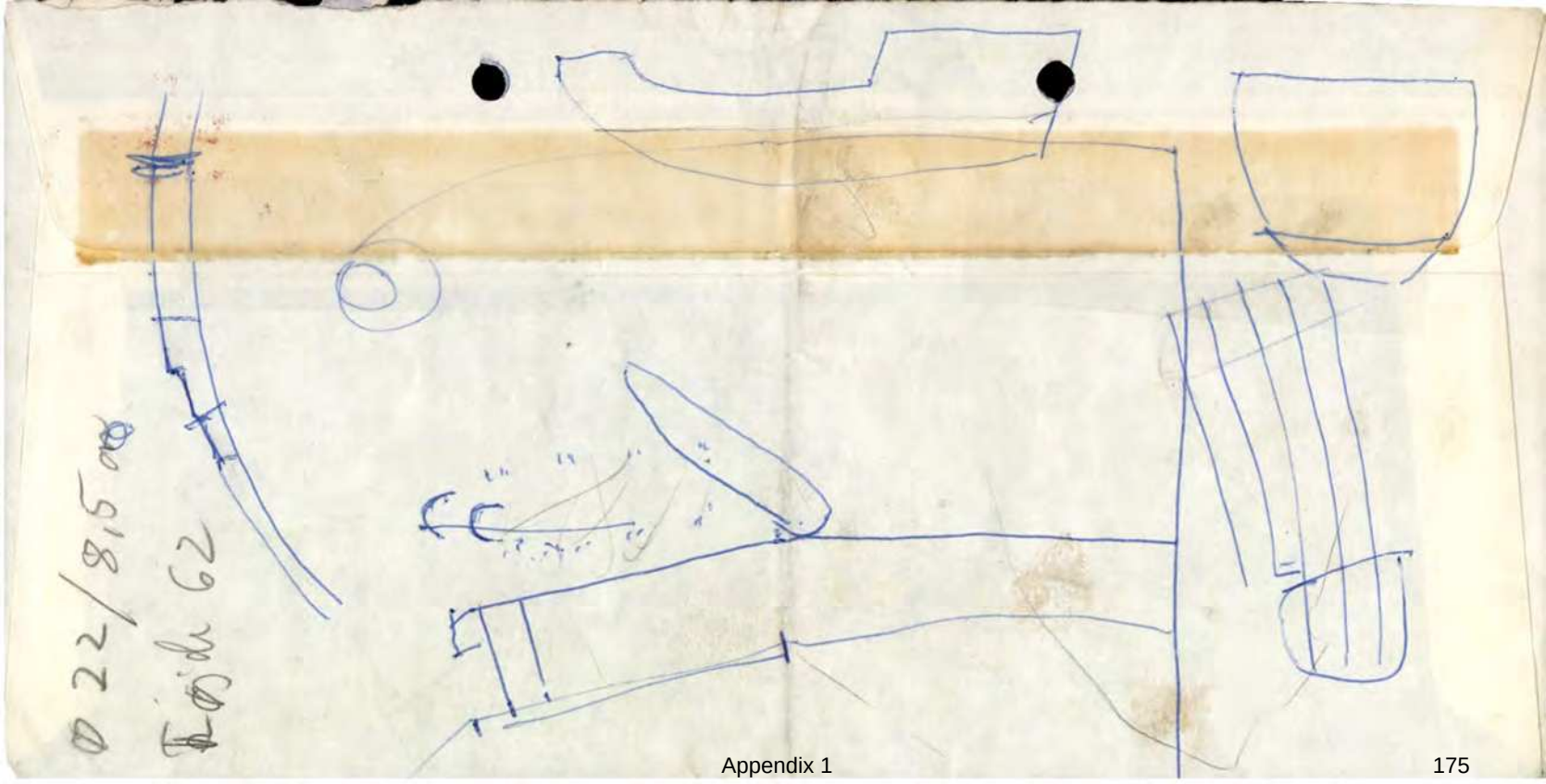
HOLLANDSK LASK

ten af agterstævnen, samt stråkølen under kølen. Da det fra naturens hånd ikke er muligt at få tømmer af tilstrækkelige store dimensioner og længder, er forboltningen og forløbningen af tømmerstykkerne af betydning for sammenbindingen af hovedelen. Tykkelsen på kølen regnes for de større skibe til 4½ linie for hver fod af skibets største bredde på tømmerets yderkant og højden fra kølens underkant og til spundingens overkant regnes til at være det samme som tykkelsen. (en linie er en 1/12 tomme). Ved placeringen af køllaskerne bestræber man sig på at få dem så langt væk fra masternes trædepunkter og det bliver derfor gerne de længste af stykkerne der bliver lagt her. Noget tilsvarende gælder for laskerne i kølsvinet, men de skal samtidig også forløbes i forhold til køllaskerne. Endelig skal laskerne placeres så der kommer /d/ mindst en kølsvinsbolt, som sidder ned gennem hver bundstok, igennem. Ved opklodsningerne er laskerne placeret med det

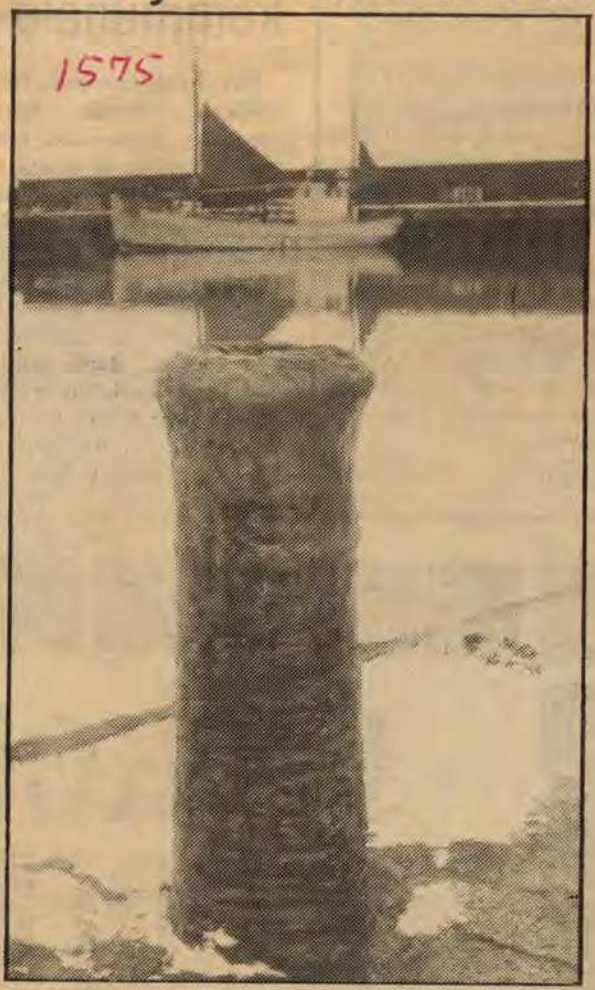
C. Tage Jacobsen
Hammerhavnsvej
9950
Vestervig.



A/S Læsø Fiskeindustri


Ø 22/8,5 oo
Ford 62

Man dykker efter fortiden



Da Nationalmuseet fik meddelelse om, at der ligger et gammelt vrag sunket i Østerby havn på Læsø, sendte man en dykker til Læsø. Man ønsker at få konstateret, hvor gammelt det skib er, der ligger på havnens bund, og som gennem de senere år gang på gang har bibragt Læsø-fiskerne problemer. Dette kanonløb, som ses på billedet, stammer fra vraget og bruges nu af fiskerne som pullert. Læs inde i bladet.

Journalistforbundets
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Frederikshavns Avis
(K)

- 1 APR. 1980

Der dykkes efter fortiden i Østerby

1575

Stenfiskerfartøjet »Bonnie« af Ålborg, som for et par uger siden rensede op i Vesterø havnebassin, fortsatte sit arbejde umiddelbart efter i Østerby havn.

Under oprensningsarbejder i det østre bassin, fik Bonnies store grap held til at få fat i en hel del kraftigt skibstømmer fra et gammelt vrag, der længe har ligget og været til gene for de største fiskekuttere, når de under manøvrering ved kajen ramte vragtømmeret med deres skibsskruer.

Nationalmuseet, der fik en anmeldelse om det opsamlede tømmer, sendte straks en dykker fra Orlogsmuseet i København til Læsø for at kigge nærmere på vragstedet, der har været kendt af læsøboere i mange år.

Adskilligt solidt tømmer er i tiderne hentet op, fordi det generede sejladsen. Nu var der faktisk kun en gammel skibskøl og bund tilbage. Og museet er meget forbavset over, ikke at have fået underretning om vraget langt tidligere.

Dykker Michael Teisen fra orlogsmuseet dykkede i tirsdags på vragstedet, men fandt intet af interesse. Han fik dog bassinbunden ryddet for det vragtømmer, der var til hindring for sejladsen.

Indsamlede oplysninger af Tage Jacobsen og Michael Teisen, sammenholdt med de oplysninger, der er givet af brdr. Svend og Eli Jensen, Østerby tyder på, at det er et gammelt vrag af et udenlandsk bygget skib fra ca. år 1800, af en ret anseelig størrelse samt af en svær bygget kvalitet.

Svend Jensen har tidligere dykket ved vraget og har i sin forvaring en kanon og en del lange sideplanker som vil indgå i en nærmere undersøgelse, for at konstatere skibets alder og tilhørsforhold. Foreløbig må det ilandbragte vraggods ikke tilintetgøres.

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67. Capit. **Christopher Redevenning**, fra Stettin, strandede Østen for Ven Natten til den 12te Oct. med Hukkertgaleasen **Minerva** kaldet, paa Reise fra Schidam, bestemt til Gothenborg baglastet. Takkellagen blev bierget og her bortsolgt tilligemed Vraget. Folkene kom lykkelig i Land.

68. Capit. **Friderich Schyt**, fra **Stettin**, indstrandede øsien under Ven Natten til den 19de Nov., med Galeaseskibet **Sophia Fridericha**, paa Reise fra Leverpol bestemt til Helsingør med en Ladning Salt. Saasom Skiber strax gik fuldt af Vand, kunde intet af Ladningen bierges, men Takkellagen og Vraget blev her solgt. Folkene bleve reddede.

Aar 1797.

69. Capit. **Claus Clausen de Boer**, fra Holland, indstrandede paa Udgrundene 2 Miile Sydost fra Ven, med Smakskibet **Frau Anna Gyna**, Natten til den 11te May, paa Reise fra Pillau, bestemt til Amsterdam med en Ladning Hvede, som for største Deel blev bierget, dog af Søevand noget beskadiget, og blev derfore her strax bortsolgt. Ligeledes blev Skibets Takkellage bierget og solgt tilligemed Vraget. Folkene kom alle lykkelig i Land.

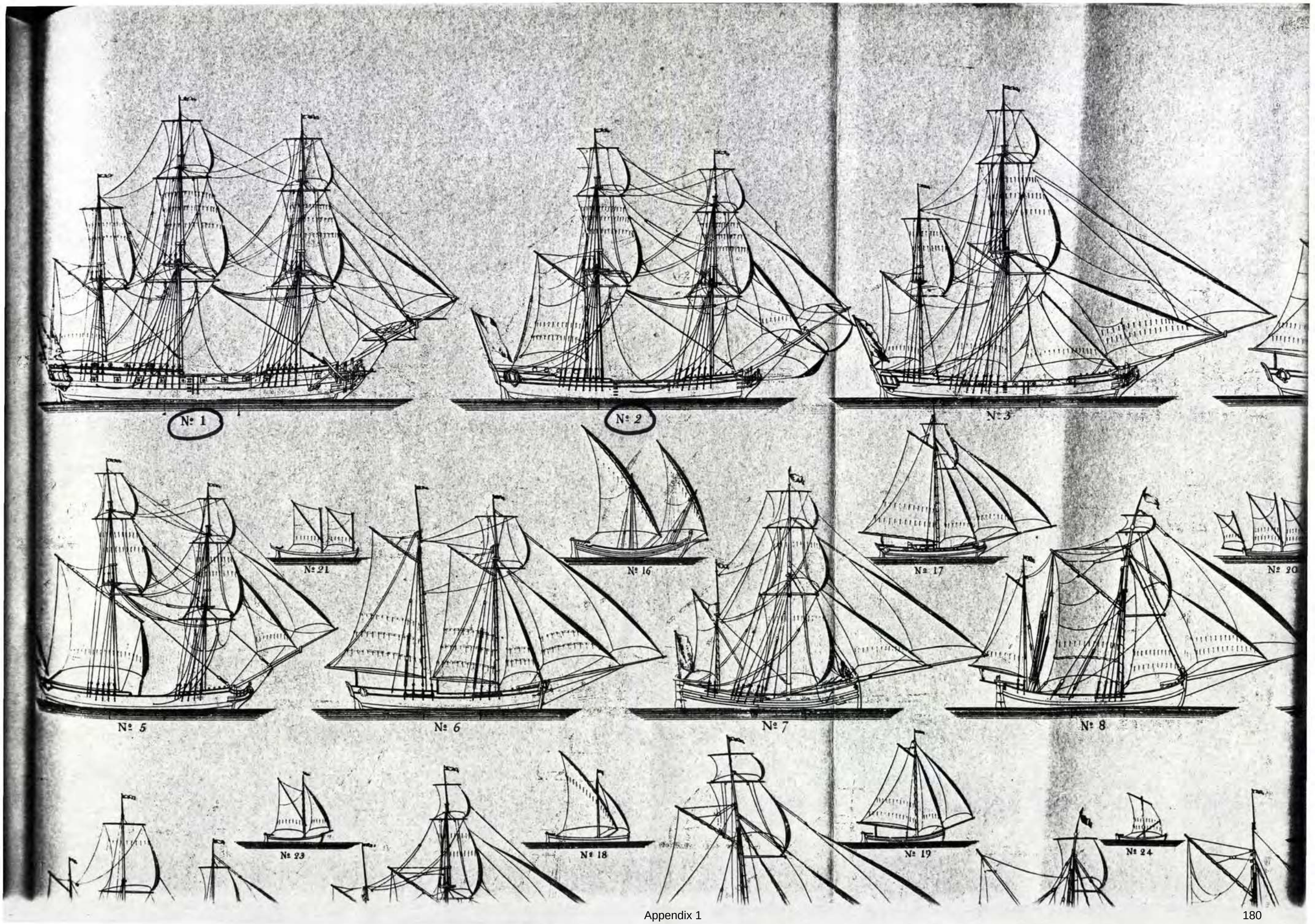
70. Capit. **Harm Wycher**, fra Grøningen, strandede paa Trindelen, Natten til den 13de Maii, med Smakskibet **De gode Forvagten**, paa Reise fra Libau under Preussisk Flag, bestemt til Amsterdam med en Ladning Hvede, Hør- og Hampefrøe. Skibet, efterat det havde

de stødt, drev strax af Grunden og sank, saa at Mandskabet ikke uden Livsfare reddede sig i Skibs-Jollen og kom i Land ved Fladstrand, og derfra hertil. Intet af Ladningen eller Skibets Takkellage kunde bierges.

71. Capit. **Truls Torngreen**, fra **Carlscrona** i Sverrig med hans førende Galease **Anna** kaldet, paa Reise fra **Carlscrona**, bestemt til **London** med Tiære, Jern og Bræder, stødte i Dagbrækningen til den 24de Junii paa et Brigskib under svær Byeveir og Tykke, saa at Galeasen strax blev læk og sank norden under Lesse saaledes, at den med Master og alt staaer under Vandet. Mandskabet fik efter dets Forklaring i Hast Skibs-Jollen kappet fra Skibet og kom med Livsfare i Land.

72. Capit. **Jeronymus Andreas Nordlov**, indstrandede øster under Ven Natten til den 22de Oct., med Fregatskibet **Poul**, hiemmehørende i Archangel i Rusland, og derfra bestemt til **Petersborg** med en Ladning Tiære og endeel Sækker Havre, som her blev bierget; Havren var vaad og noget beskadiget og Tiære-Fustagerne meget forstødt og havde tildeels indtrukket Søevand. Ikke destomindre blev dog Tiæren, paa et lidet Quantum nær, ved Skib fra Assurandeurene i Hamborg udført til det bestemte Stød, formodentlig med større Tab end Fordeel efter Priserne i samme Tid her paa Øen. Resten, som var Slumper, blev tilligemed Skibets betydelige Takkellage her bortsolgt. Skiket var nyt, bygget i Archangel af Fyrre-Tømmer meget suffisant og smukt, og denne var dets første og sidste Reise; thi som det ei stod til Redning, blev det som Vrag solgt og ophugget.

73. Skip-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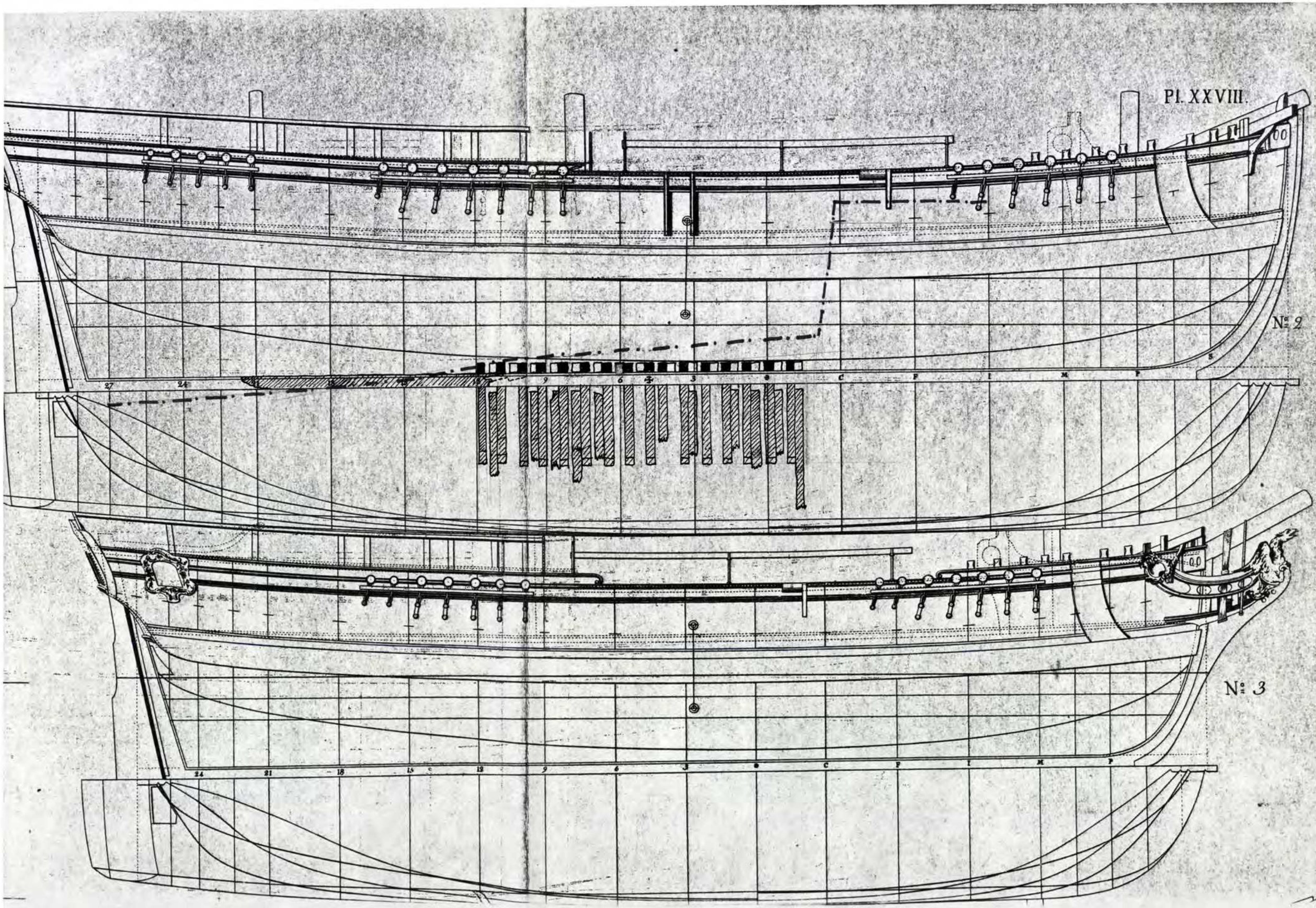
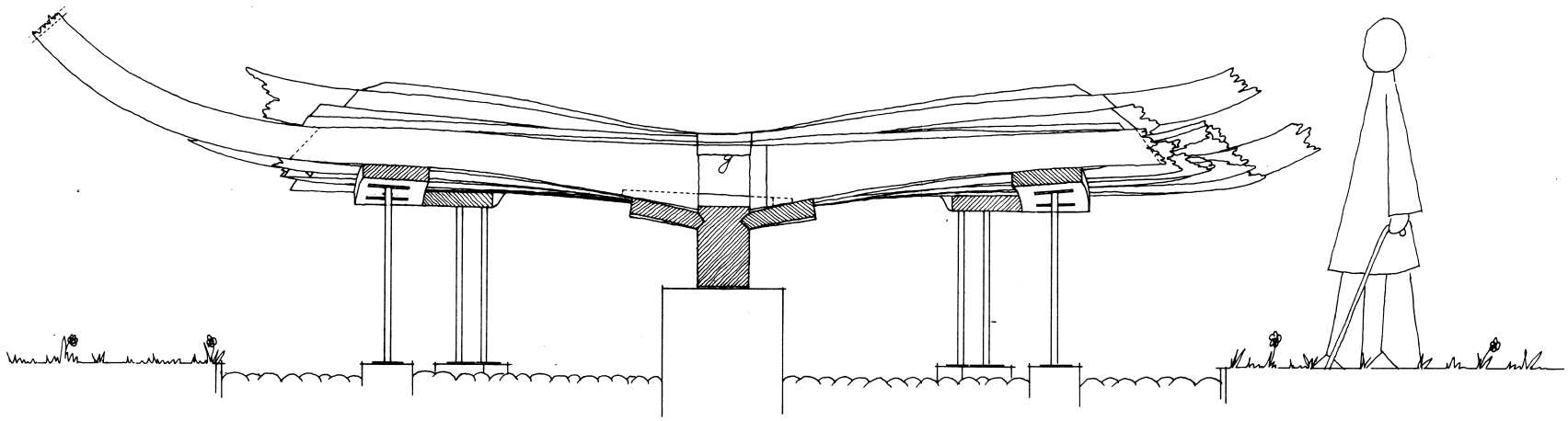
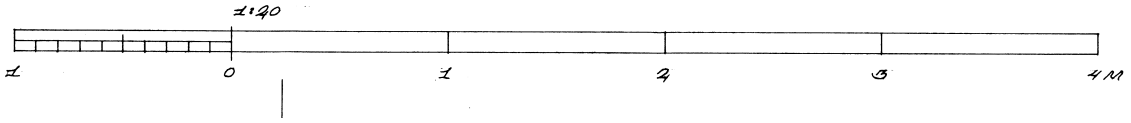
Pl. XXVIII.



APPENDIX II- DRAWINGS BY M. GØTHCHE, 1981.

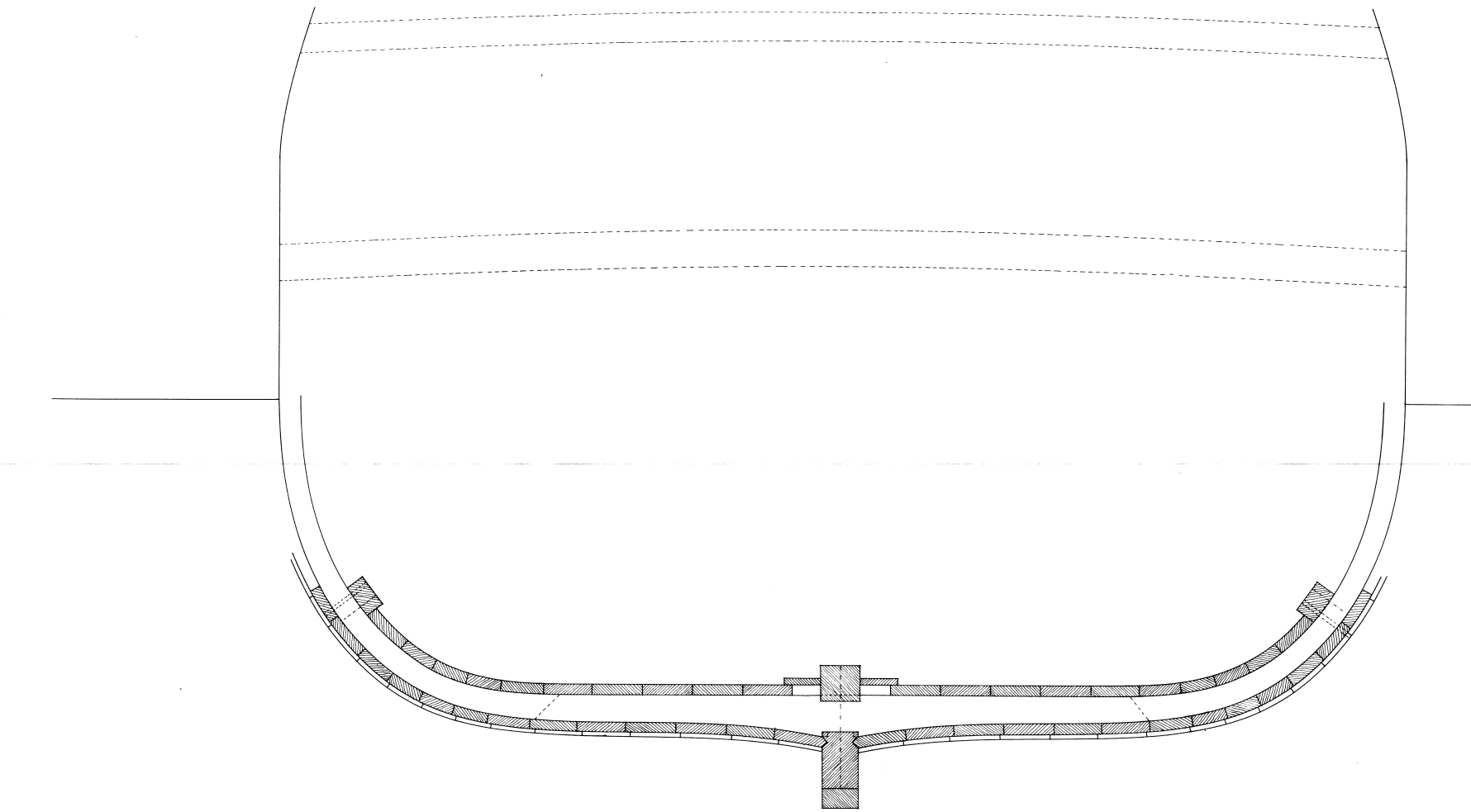




6

776-TR-11

VRAG - ØSTERBY HAVN - LÆSØ
FORSLAG TIL ORDNING, MÅL 1:40
ROSKILDE DEN 30 NOVEMBER 1981
MORTEN GØTHCHE, ARKITEKT, M.A.A.



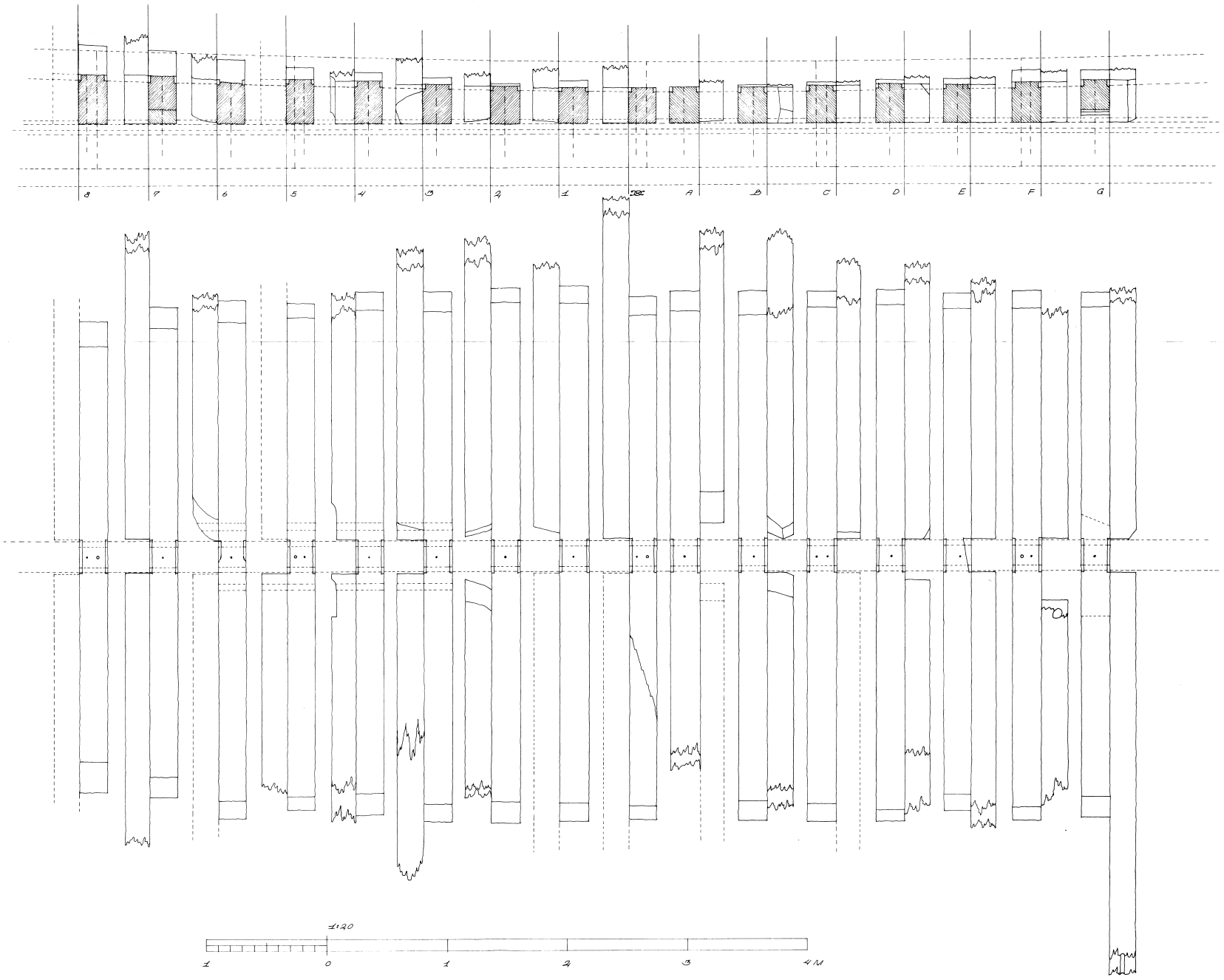
1:20

1 0 1 2 3 4 M

27-TR-10

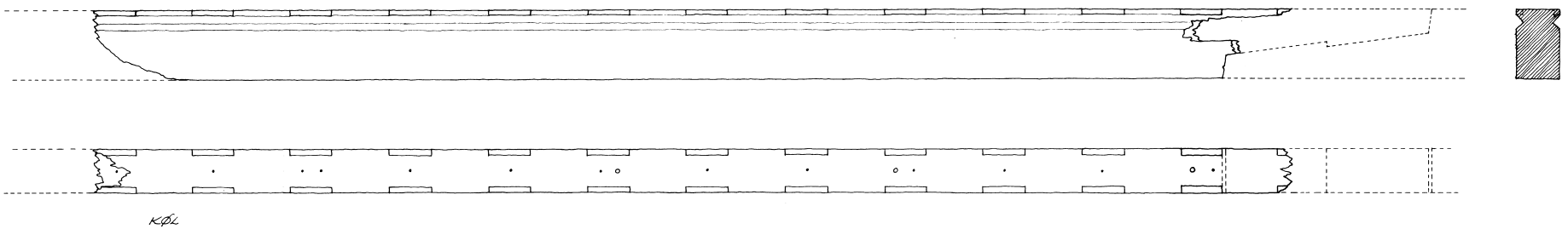
5

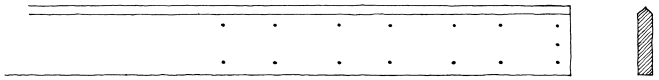
VRAG- ØSTERBY HAVN - LÆSØ
MIDDELSPANT, REKONSTRUKTION, MÅL 1:20
ROSKILDE DEN 30 NOVEMBER 1981
MORTEN GØTHCHE, ARKITEKT M.A.A.

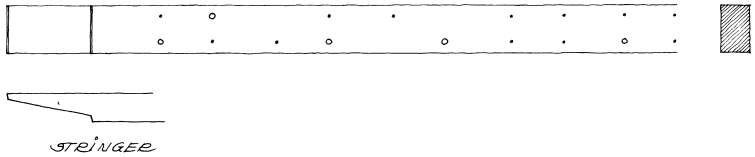


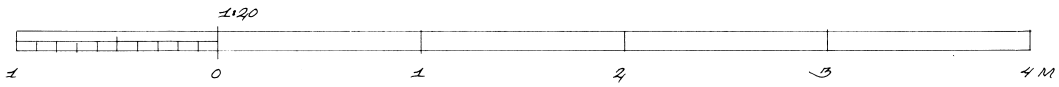
4

VRAG - ØSTERBY HAVN - LÆSØ
SPANTER, LÆNGDESNIT OG PLAN, MÅL 1:20
ROSKILDE DEN 30 NOVEMBER 1981
MORTEN GØTHCHE, ARKITEKT M.A.A.





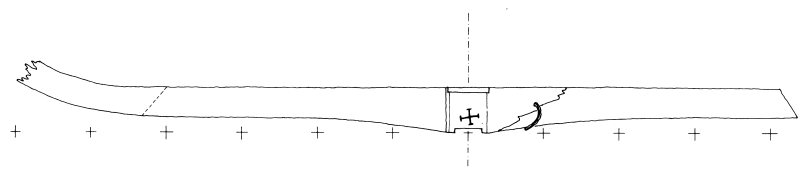


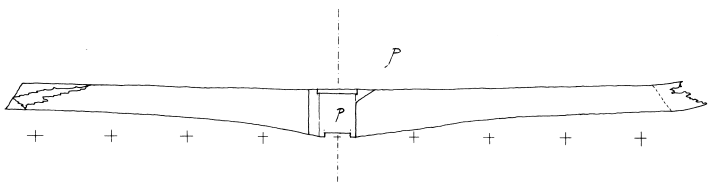


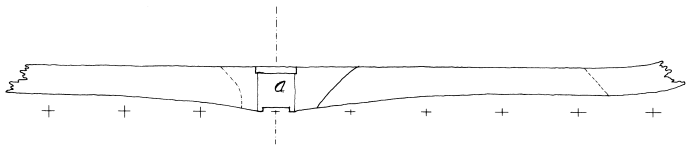
776-TR-8

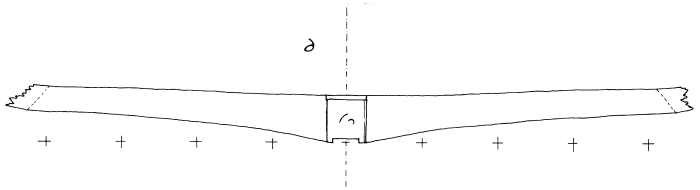
③

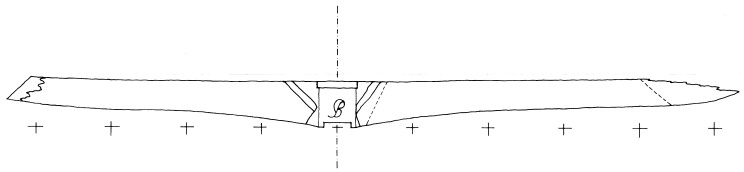
VRAG - ØSTERBY HAVN, LÆSØ
SKITSEOPMÅLING AF KØL, UDV. KLÆDNINGS-PLANKER, FORHUDNING OG STRINGER, MÅL 1:20
ROSKILDE DEN 30 NOVEMBER 1981
MORTEN GØTHCHE, ARKITEKT M.A.A.

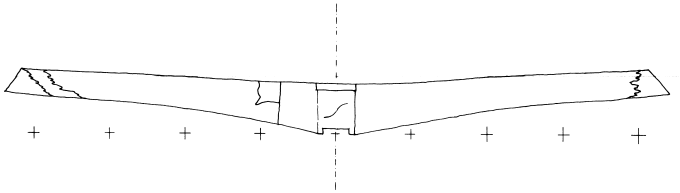


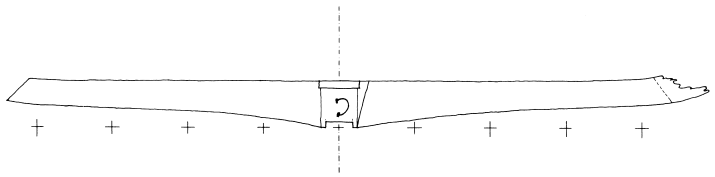


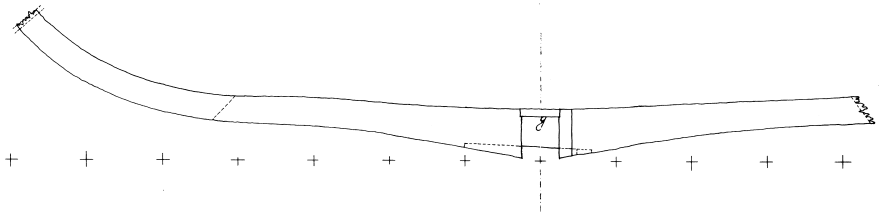


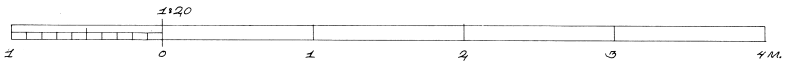






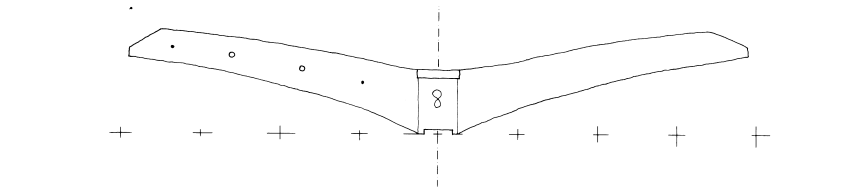


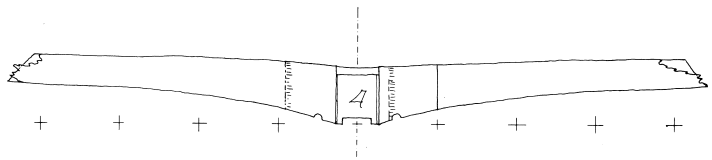


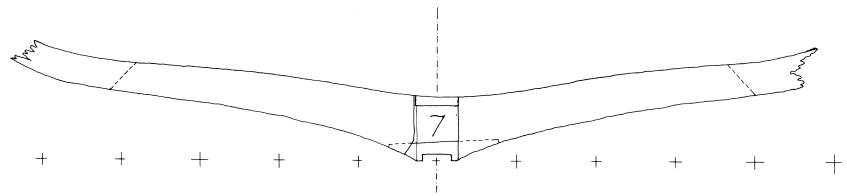


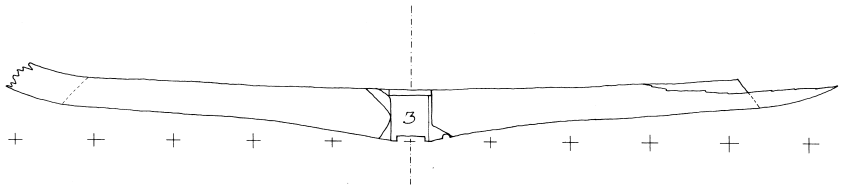
276-TR-1 ②

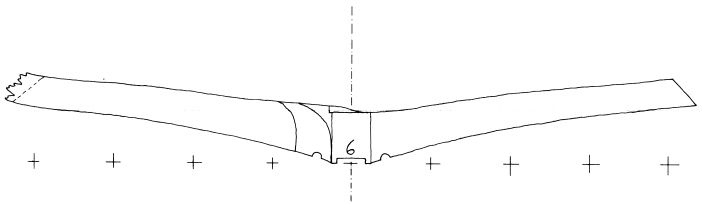
VRAG - ØSTERBY HAVN - LÆSØ
SPANTER, SKITSEOPMÅLING, MÅL 1:20
ROSKILDE DEN 30 NOVEMBER 1981
MORTEN GØTHCHE, ARKITEKT M.A.A.

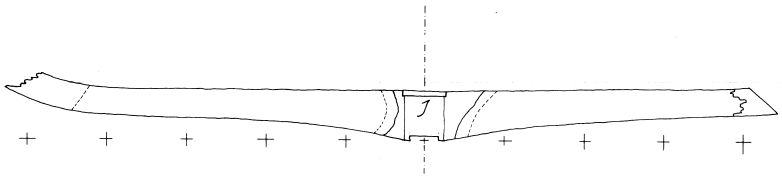


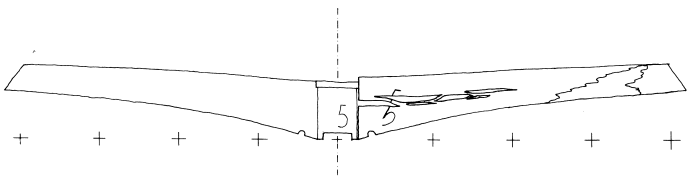


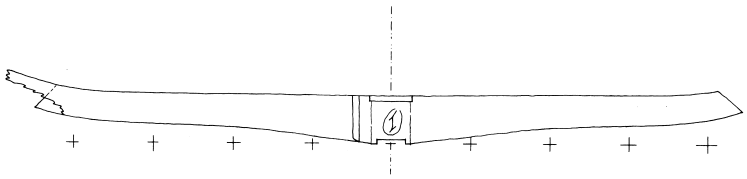


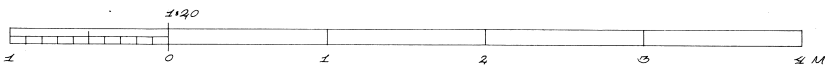






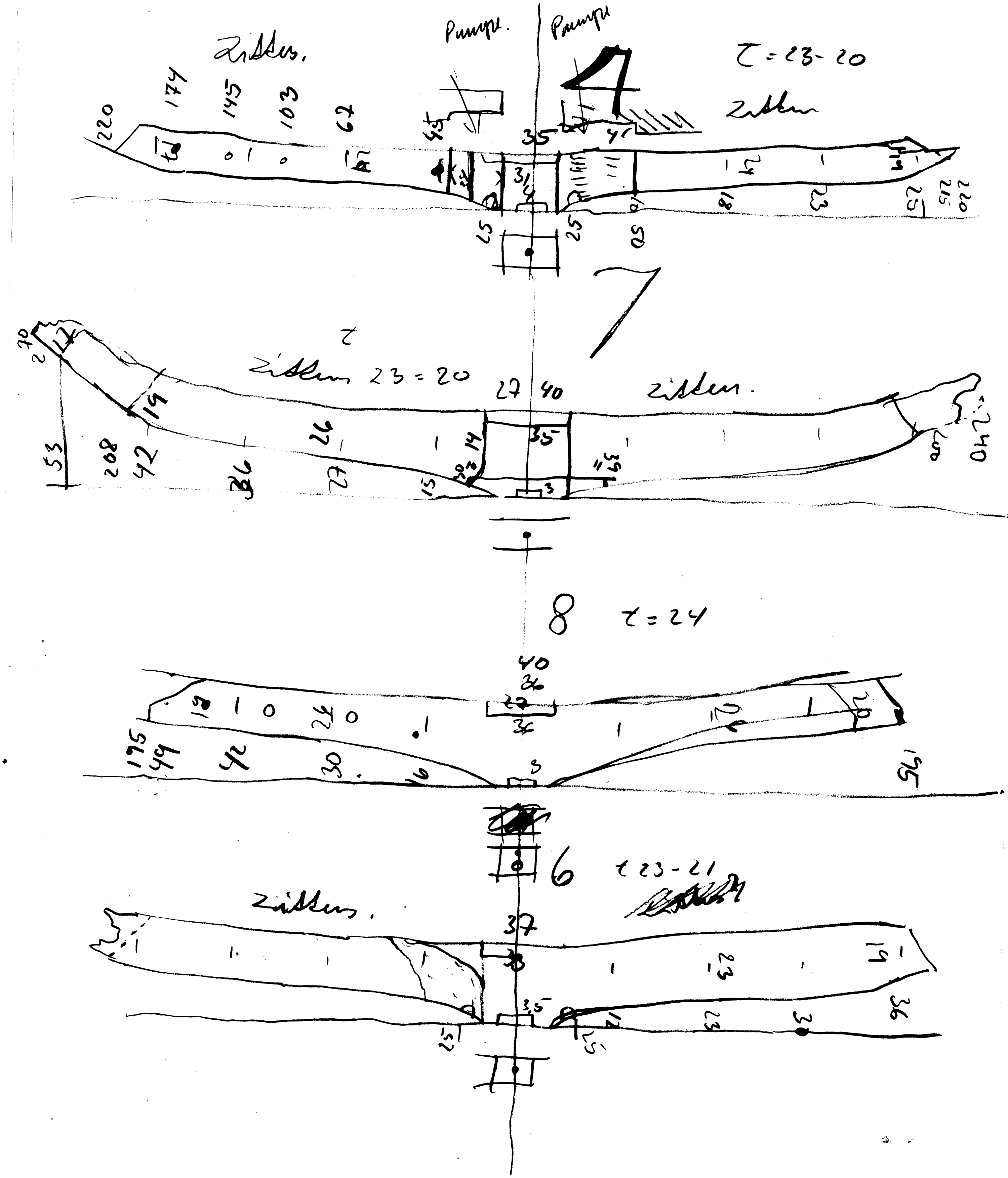






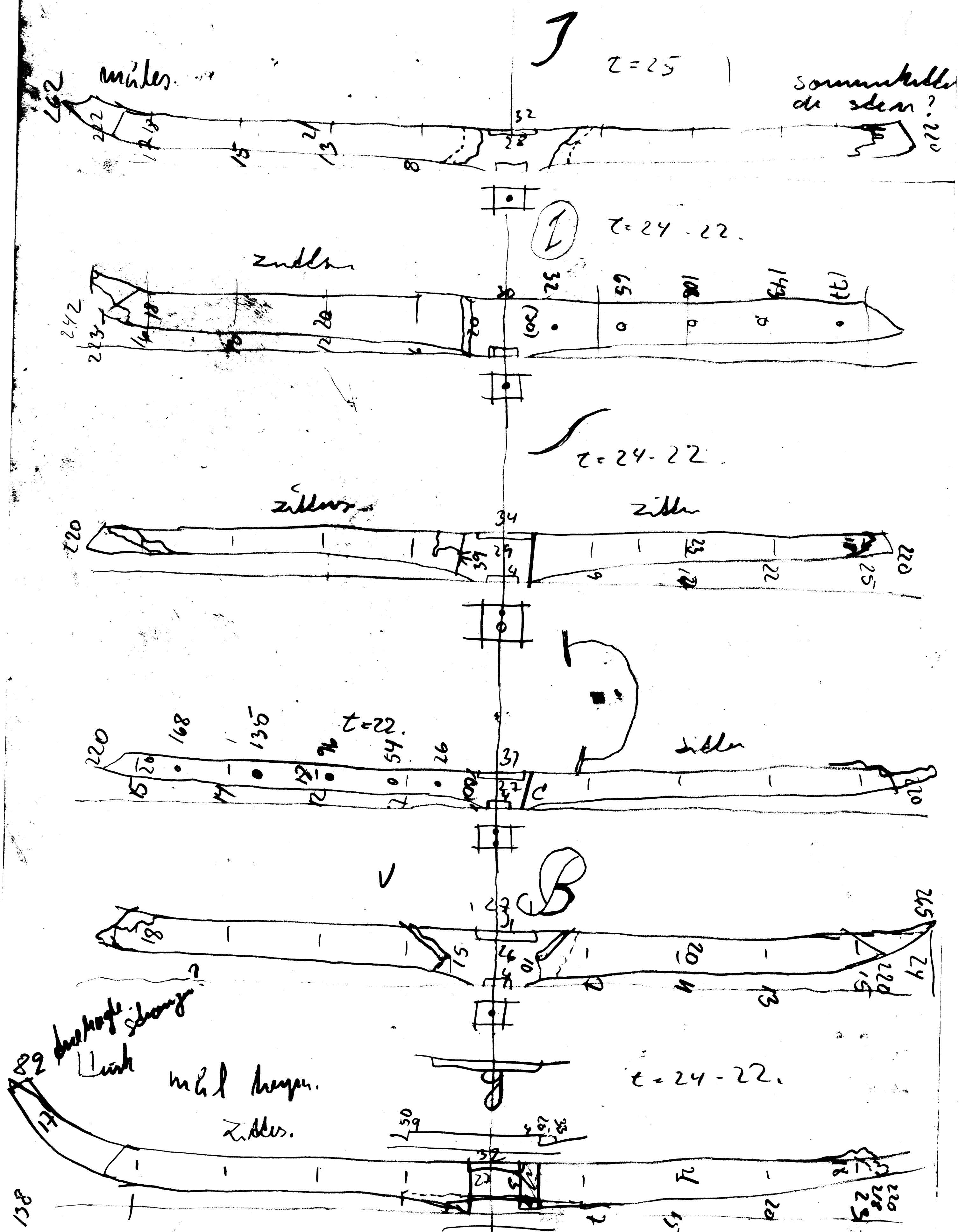
77-TR-6

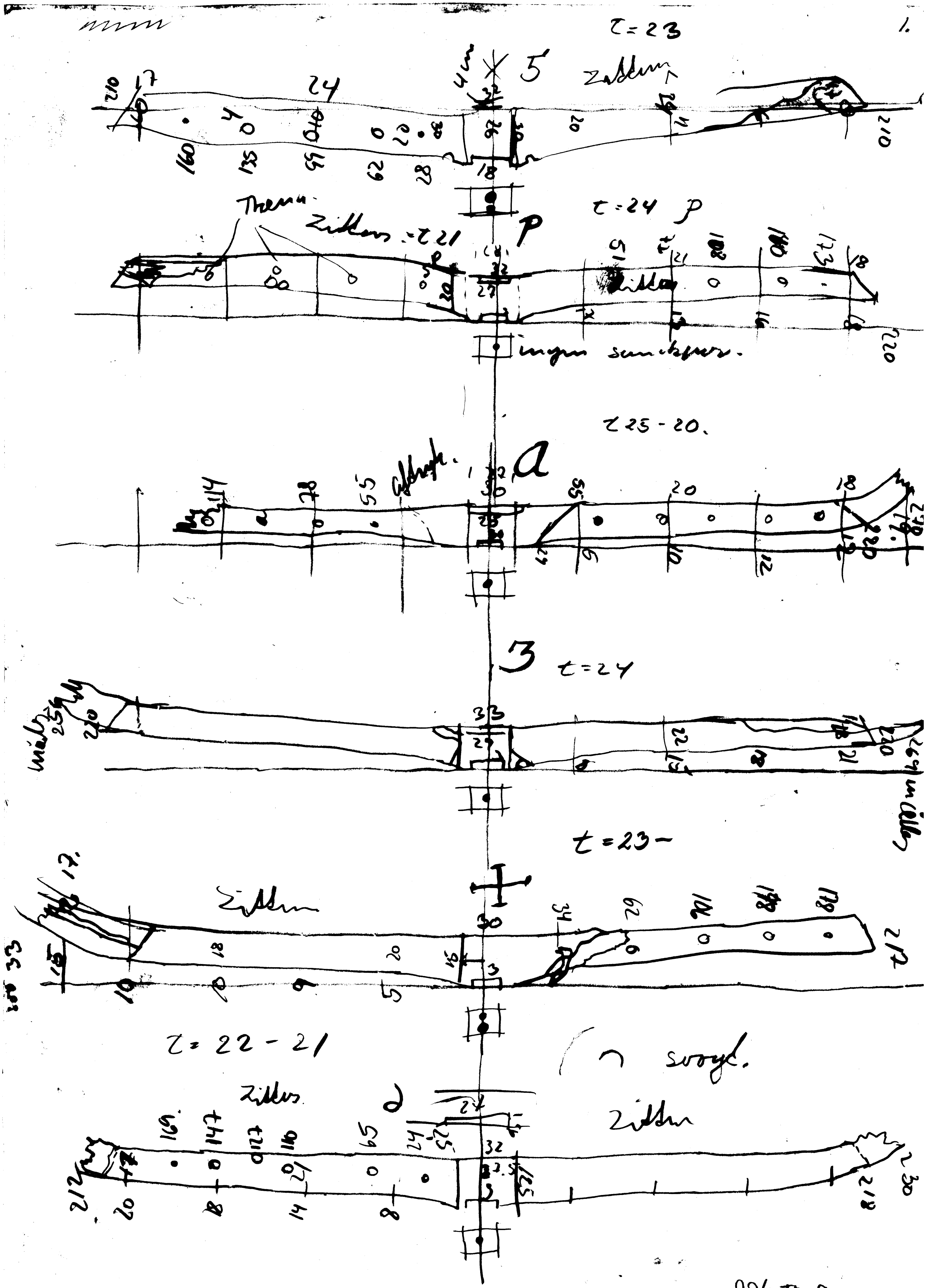
VRAG - ØSTERBY HAVN - LÆSØ
SPANTER, SKITSEOPMÅLING, MÅL 1:20
ROSKILDE DEN 30 NOVEMBER 1981
MORTEN GØTHCHE, ARKITEKT M.A.A.


Pumpe.
Pumpe
Zitters.
4
τ = 23-20
Zitters
7
Zitters 23 = 20
Zitters.
8
τ = 24
6
τ 23-21
Zitters.

776-TO-5

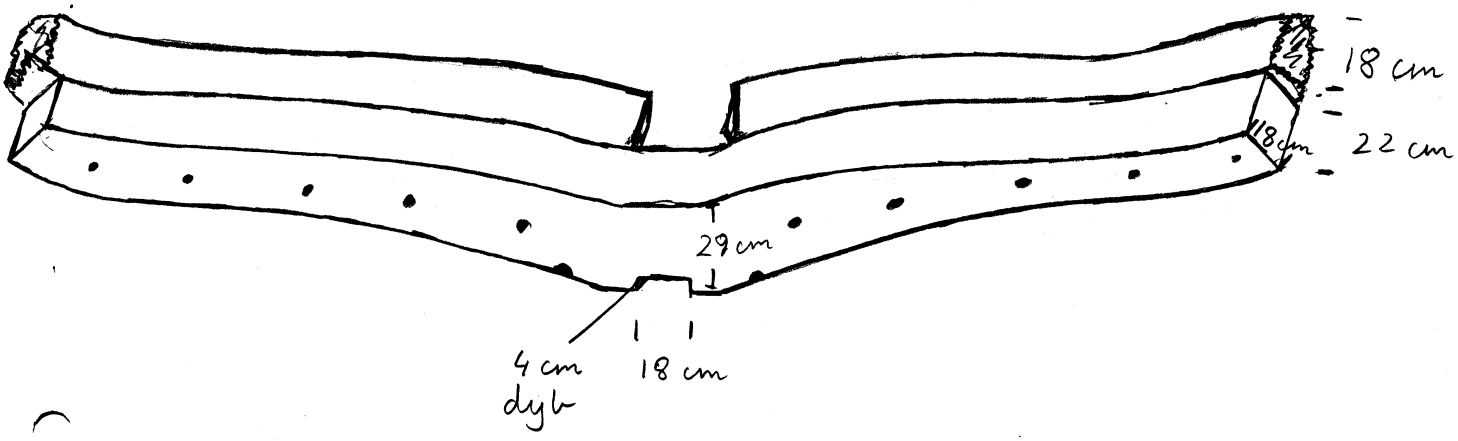
2.





776-TO-3

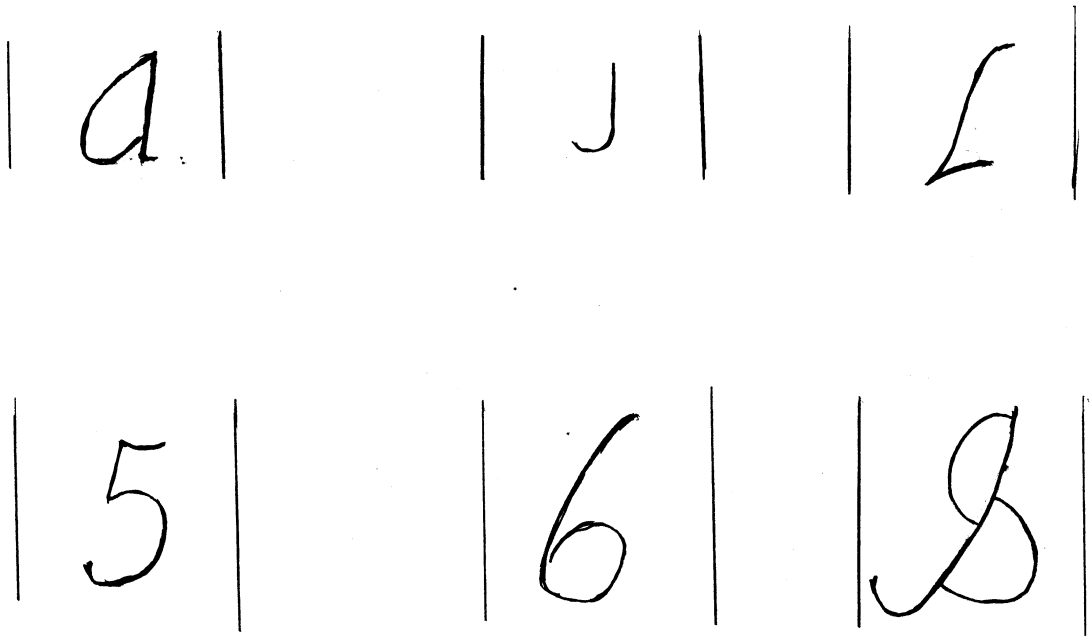
Dobbelt spant



4,37 m

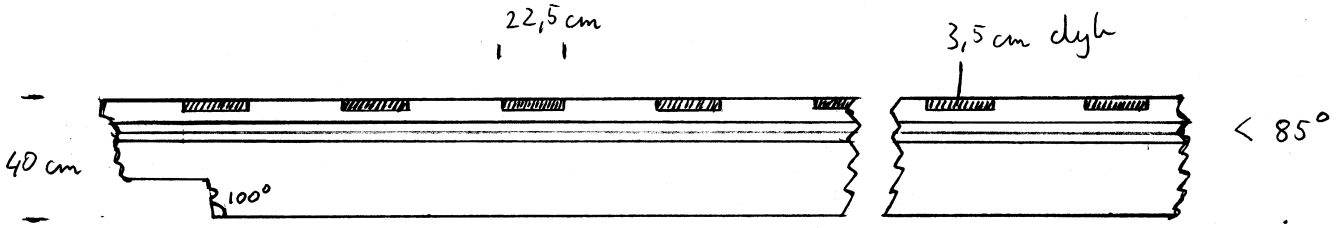
1 : 25

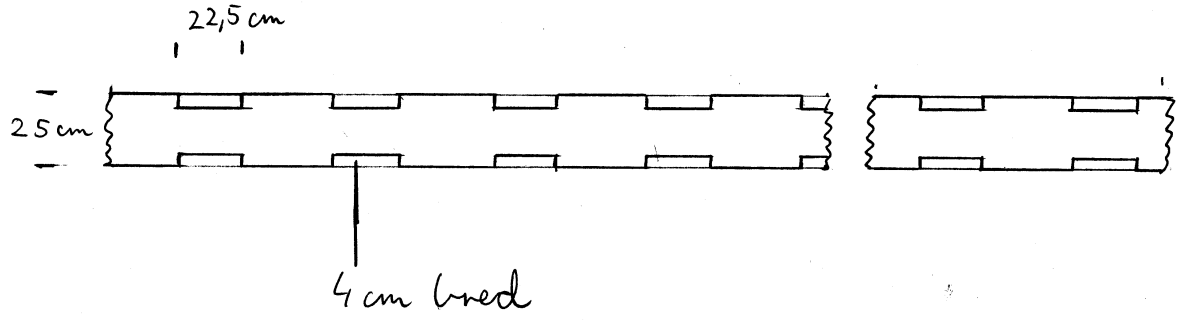
markning af spanter



KØL

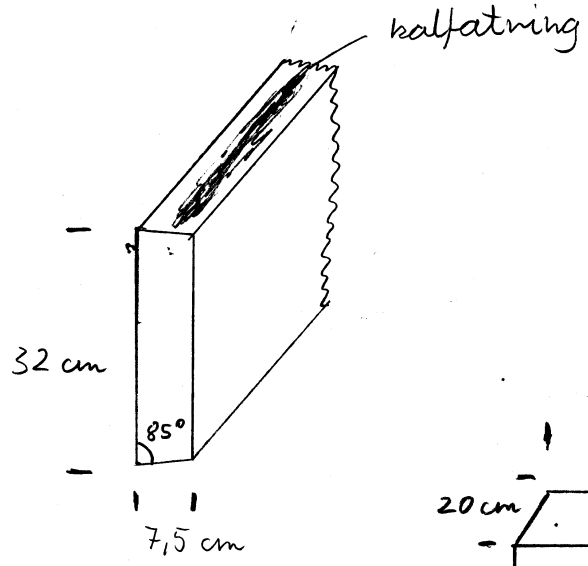
7,20 m





1 : 25

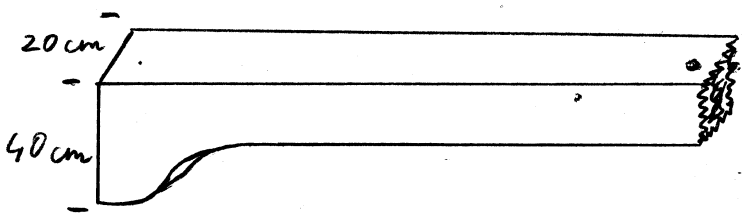
Bord



1 : 10

2

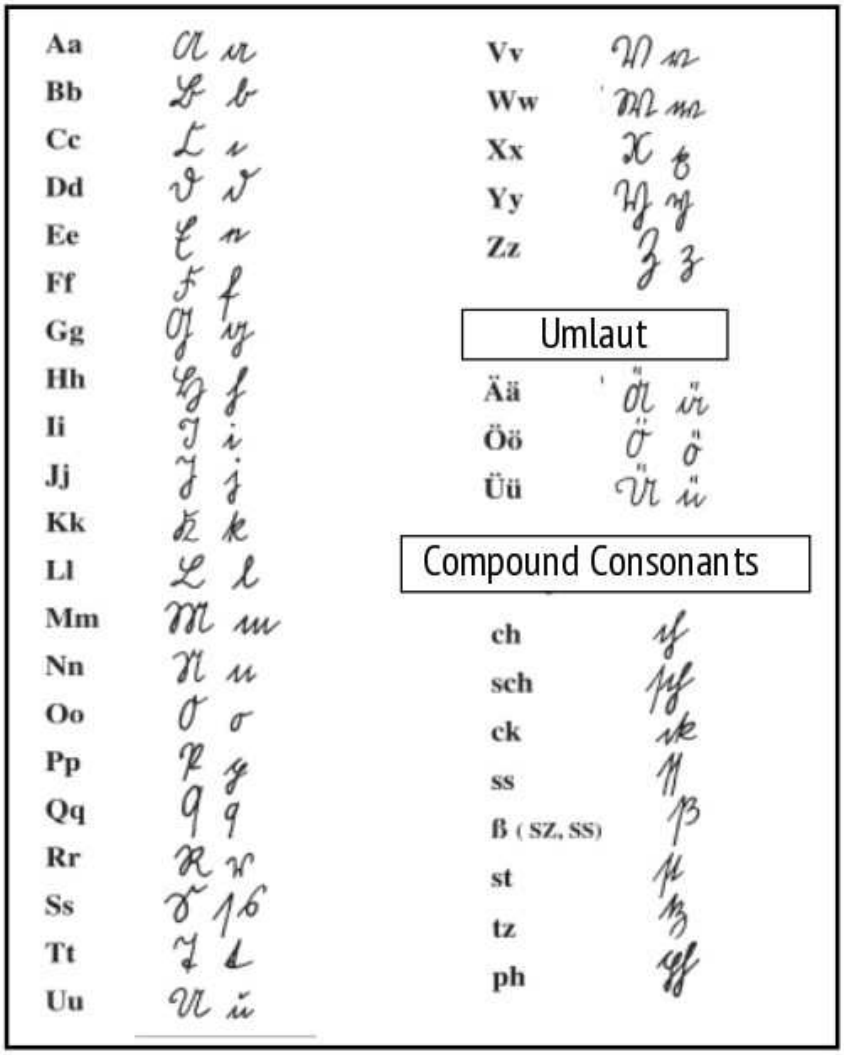
2,10 m



1 : 25

APPENDIX 3: PALEOGRAPHY SAMPLES

Gothic / Blackletter: 12th -20th century

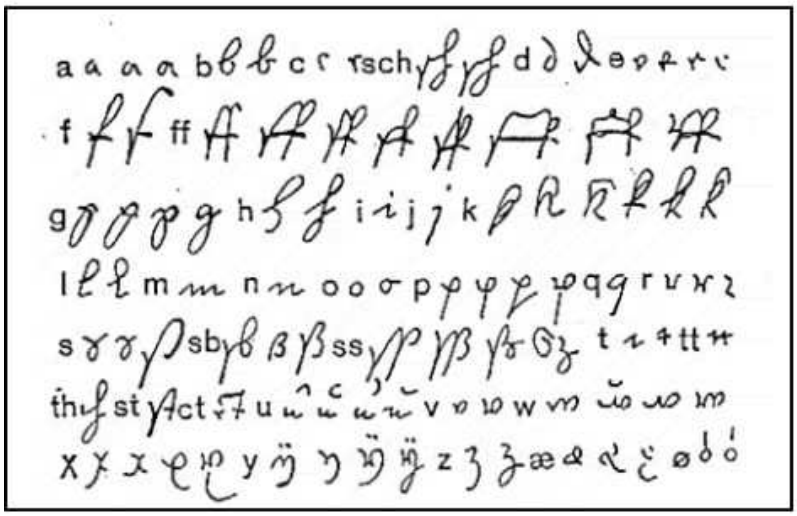


Sample sheet created from: Church of Latter Day Saints, 1999.

Fraktur: 16th to mid 20th century

Sample from: Fraktur- Wikipedia, 2005.

Scandinavian Gothic: Denmark, 1600 - 1699

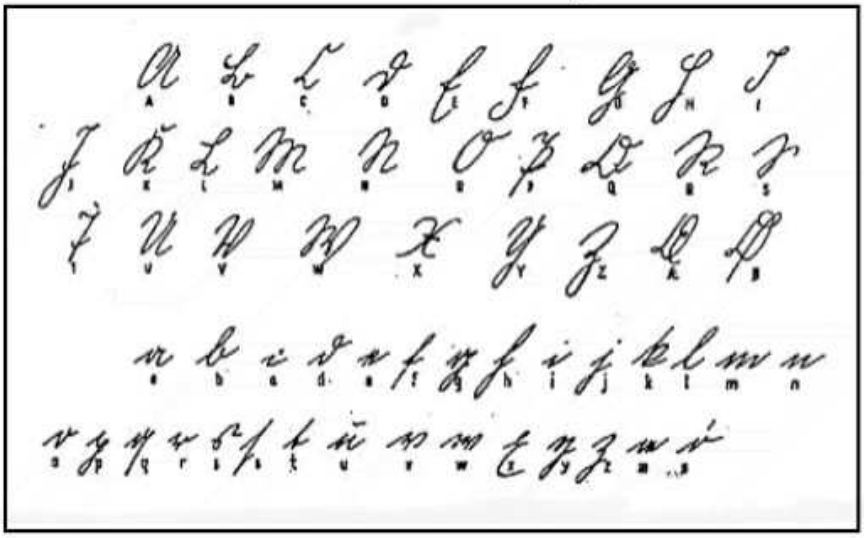


Sample from: Rigsarkivet, n.d.

Scandinavian Gothic: Denmark, 1700 - 1799

Sample from: Rigsarkivet, n.d.

Scandinavian Gothic: Denmark, 1800 - 1875

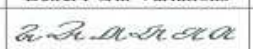
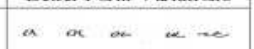
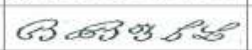
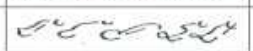
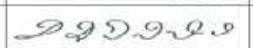
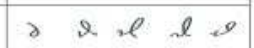
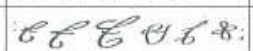
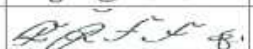
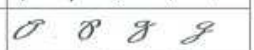
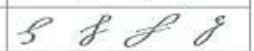
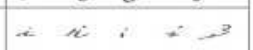
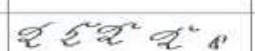
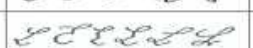
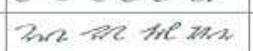
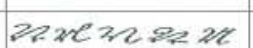
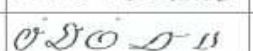
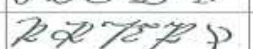
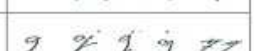
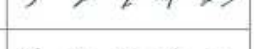
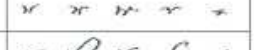
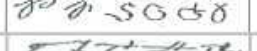
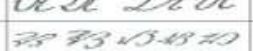
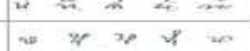
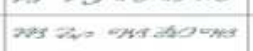
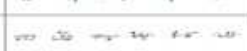


Sample from: Rigsarkivet, n.d.

Modern Cyrillic: 17th century onwards

Sample from: Masterrussian.com, 2016

Scandinavian Gothic: Sweden

Letter	Letter Form Variations	Letter	Letter Form Variations
A		a	
B		b	
C		c	
D		d	
E		e	
F		f	
G		g	
H		h	
IJ		i	
IJ		j	
K		k	
L		l	
M		m	
N		n	
O		o	
P		p	
Q		q	
R		r	
S		s	
T		t	
U		u	
V		v	
W		w	
X		x	
Y		y	
Z		z	
Å		å	
Ä		ä	
Æ		æ	
Ø		ø	
Ö		ö	

Sample from: Family Search: Church of Latter Day Saints, 2010.

Kurrentschrift: 1400 - 1800

Sample from: Herrmann, 2016.

Kurrentschrift: 1800 - 1899

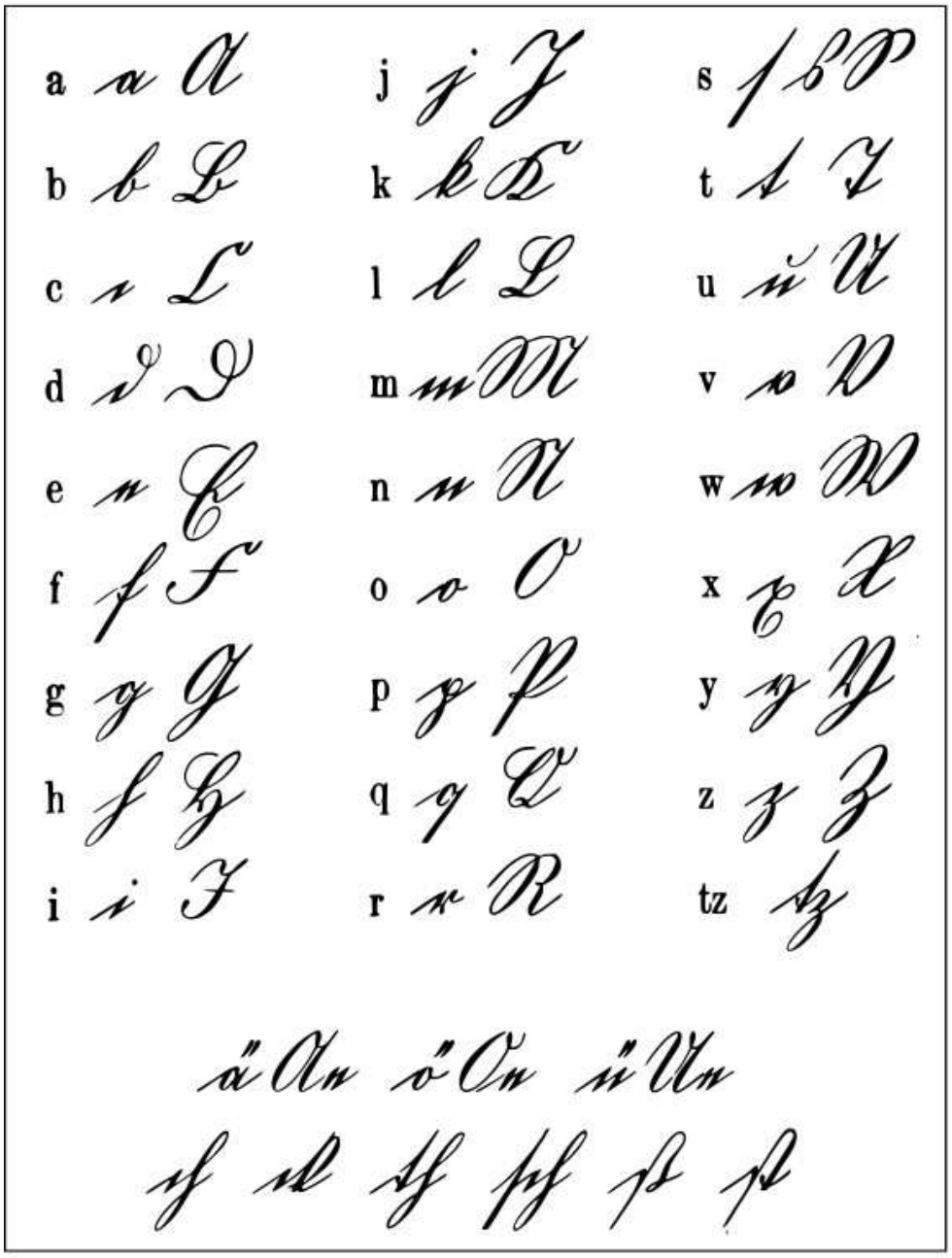
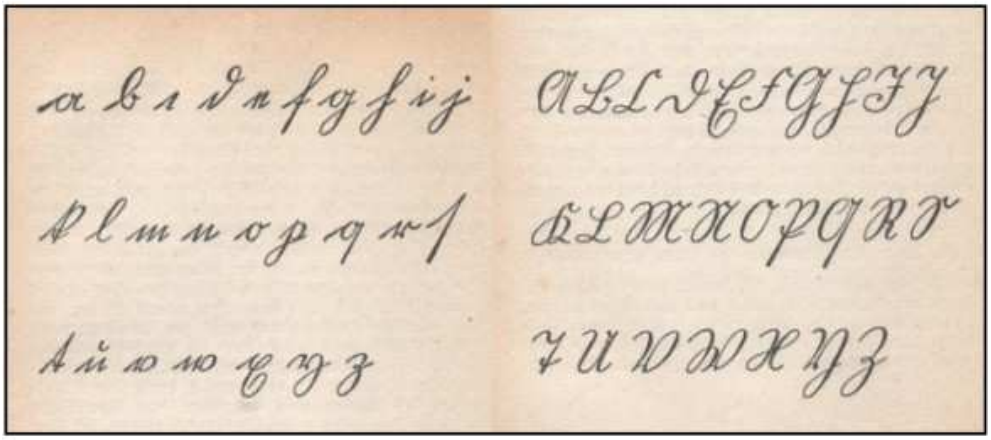


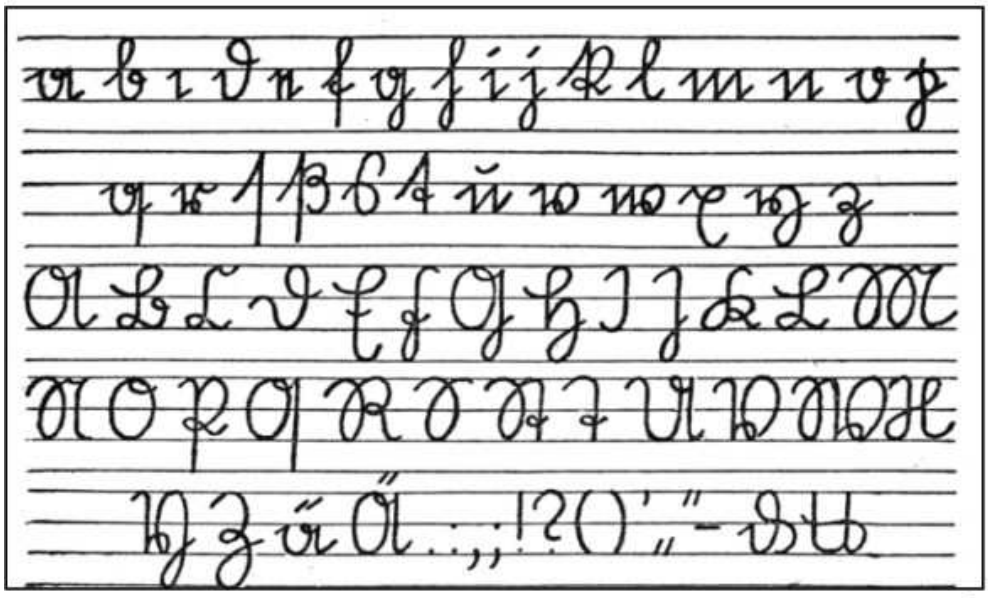
Image from: Kurrentschrift- Wikipedia, 2010.

Kurrentschrift: 1900 - 1940



Sample from: Herrmann, 2016.

Sutterlin: 1910+



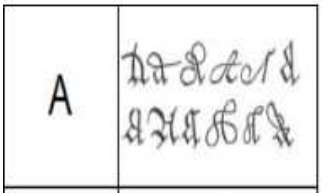
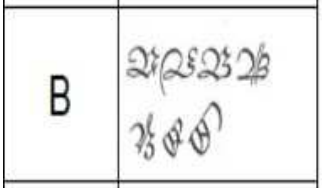
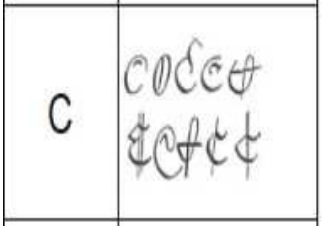
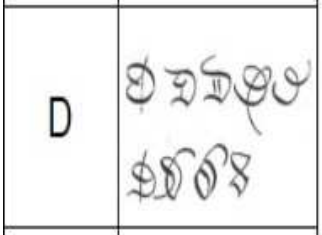
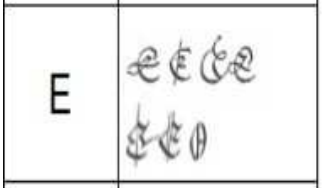
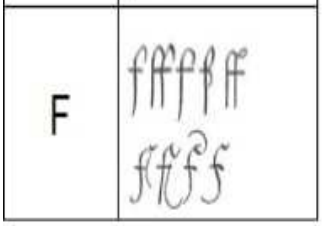
Sample from: Herrmann, 2016.

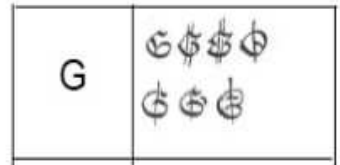
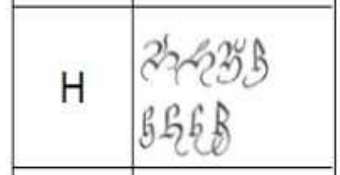
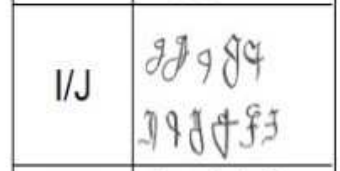
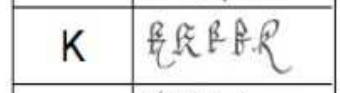
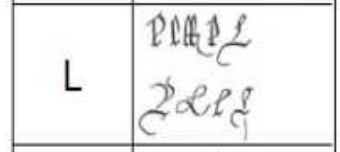
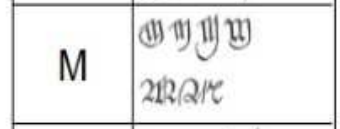
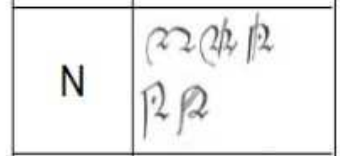
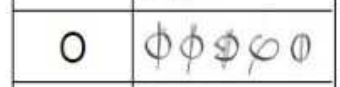
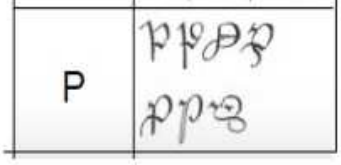
Dutch Alphabet, 1600+

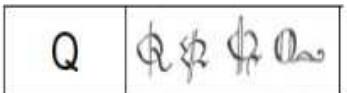
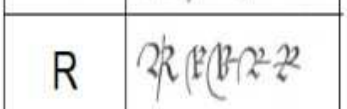
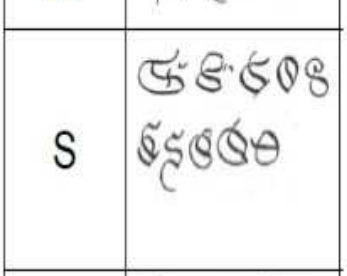
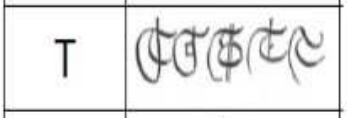
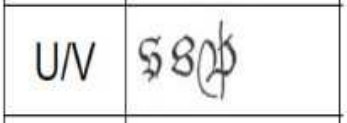
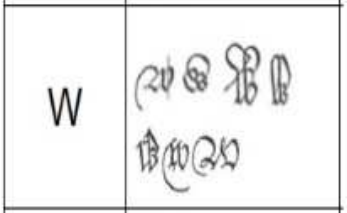
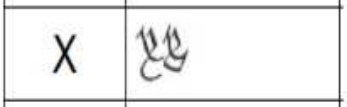
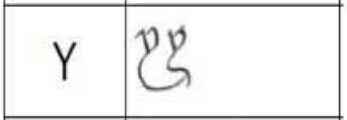
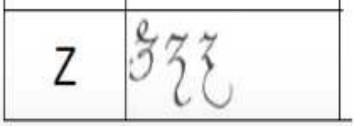
A		a	
B		b	
C		c	
D		d	
E		e	
F		f	
G		g	
H		h	
I		i	
J		j	
K		k	
L		l	
M		m	
N		n	
O		o	
P		p	
Q		q	
R		r	
S		s	
T		t	
U		u	
V		v	
W		w	
X		x	
Y/IJ		y/ij	
Z		z	

Sample from: Church of Latter Day Saints, 1999.

Italic: 1500 - 1600 Great Britain

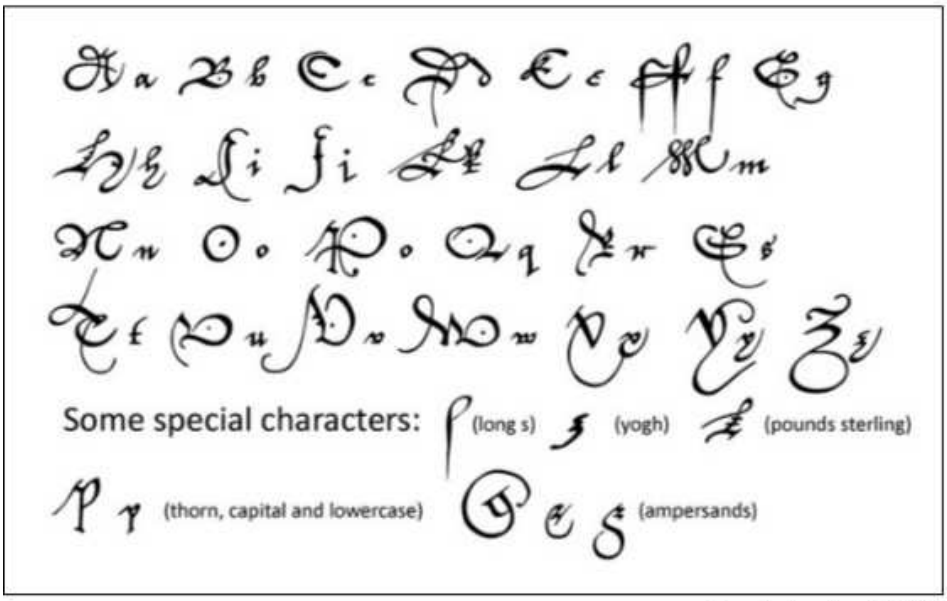
A	
B	
C	
D	
E	
F	

G	
H	
I/J	
K	
L	
M	
N	
O	
P	

Q	
R	
S	
T	
U/V	
W	
X	
Y	
Z	

Sample from: Nationalarchives.gov.uk, 2016.

Secretarie: 1700 - 1807, Great Britain



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Sample from: The Flourish Forum, 2016.

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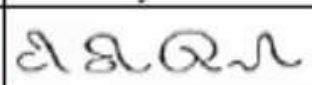
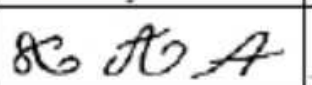
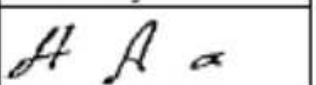
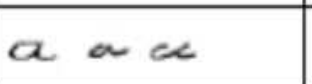
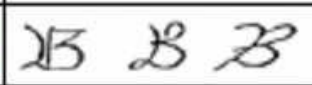
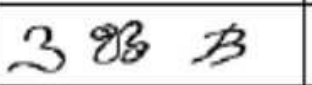
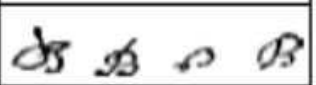
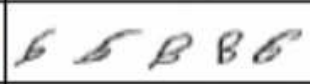
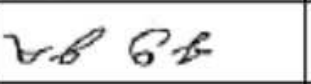
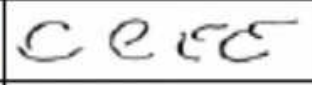
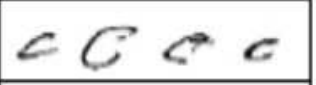
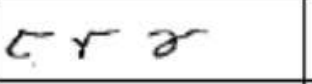
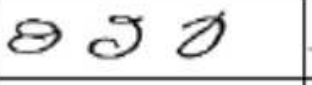
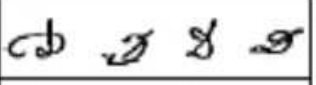
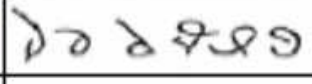
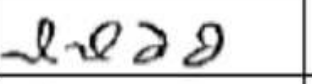
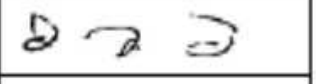
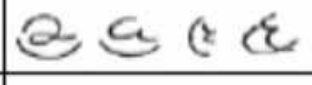
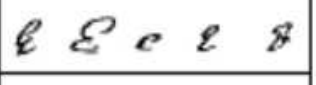
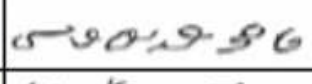
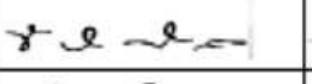
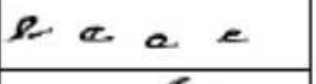
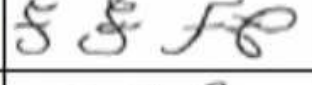
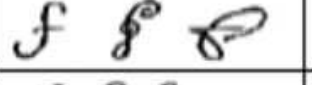
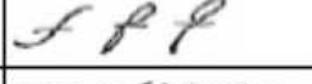
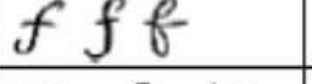
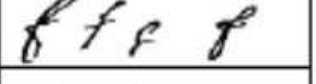
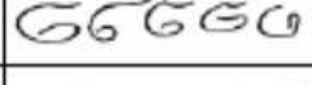
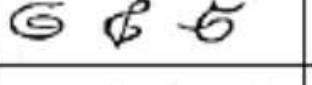
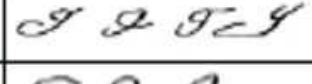
A			
a			
B			
b			
C			
c			
D			
d			
E			
e			
F			
f			
G			
g			
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Samples from: Church of Latter Day Saints, 1999.

Available at: http://slks.dk/fortidsminder-diger/arkaeologi-under-vand/international-evaluering-af-marinarkaeologi-i-danmark/

International Evaluation of Marine Archaeology in Denmark:

INTERNATIONAL EVALUERING AF MARINARKÆOLOGI I DANMARK: SLOTS- OG KULTURSTYRELSEN

2013

Report of the Working Group

Table of Contents

Recommendations have their own sequential numbers, independent of the Chapter numbers. A list of all the Recommendations is provided in Chapter 6.

Background: Maritime Archaeology in Denmark

For many decades Danish archaeologists have been at the forefront of developing methods and conducting research for the open sea (Baltic Sea, post glacial remains of submerged landscapes with human relicts etc). This world-class reputation has resulted in particular from the intensive personal input of the late Dr. phil. h.c. Ole Crumlin-Pedersen who led world expertise in ship and boat archaeology. This was initially focussed on Viking ships but expertise gained from that experience was transferred to the documentation and research into boats and ships of all periods.

The establishment of the research centre Centre for Maritime Archaeology at the National Museum of Denmark (Nationalmuseets Marinarkæologiske Forskningscenter 1993-2003) based in the vicinity of the Viking Ship Museum at Roskilde represented the high point in this expertise. Many research projects on prehistoric submerged sites, harbours and landing places, barriers, and boats and ships resulted in a great number of high quality seminars, colloquia and conferences that all led to major publications and are testament to this most fruitful period of research.

The closure of the Centre for Maritime Archaeology, the restructuring of the National Museum, including the closure of the Institute of Maritime Archaeology (Nationalmuseets Marinarkæologiske Undersøgelser) and the delegation and transfer of its objectives and staff to the Viking Ship Museum, the restructuring of Kulturstyrelsen, and the implementation of the Bologna process at Danish universities, have led to changes in heritage management (including the storage and presentation of artefacts). Kulturstyrelsen is now responsible for the monitoring and management of the (archaeological) heritage at the National level, the universities are responsible for the scientific education process, and the Regional Museums have been given the responsibility for the management of the archaeological heritage on a regional level including the implementation of developer-funded contract archaeology.

The Viking Ship Museum strives to maintain the international research profile of the Centre for Maritime Archaeology (Nationalmuseets Marinarkæologiske Forskningscenter). This is reflected in their participation as one of 11 partners in the European Commission's Seventh Framework Programme project SASMAP; a project to develop tools and techniques to Survey, Assess, Stabilise, Monitor and Preserve underwater archaeological site. The consortium, coordinated by the conservation department of the National Museum, was recently awarded €2.3 million for this three year project. Other research also continues to be undertaken, but mainly at a small and medium scale and often on an individual basis, sometimes to variable standards. There is currently no mechanism to integrate the process of research within a single research body/institution. Consequently there is no specific institution on a national level that is acting as the lead institution in respect of research into the Underwater Cultural Heritage, and although essential, there are no similar mechanisms to integrate maritime and terrestrial archaeological research.

In Annex 3 'International Assessment of Marine Archaeology in Denmark' Kulturstyrelsen (the Agency of Culture) sets out the intentions behind The International Evaluation on Maritime Archaeology in Denmark.

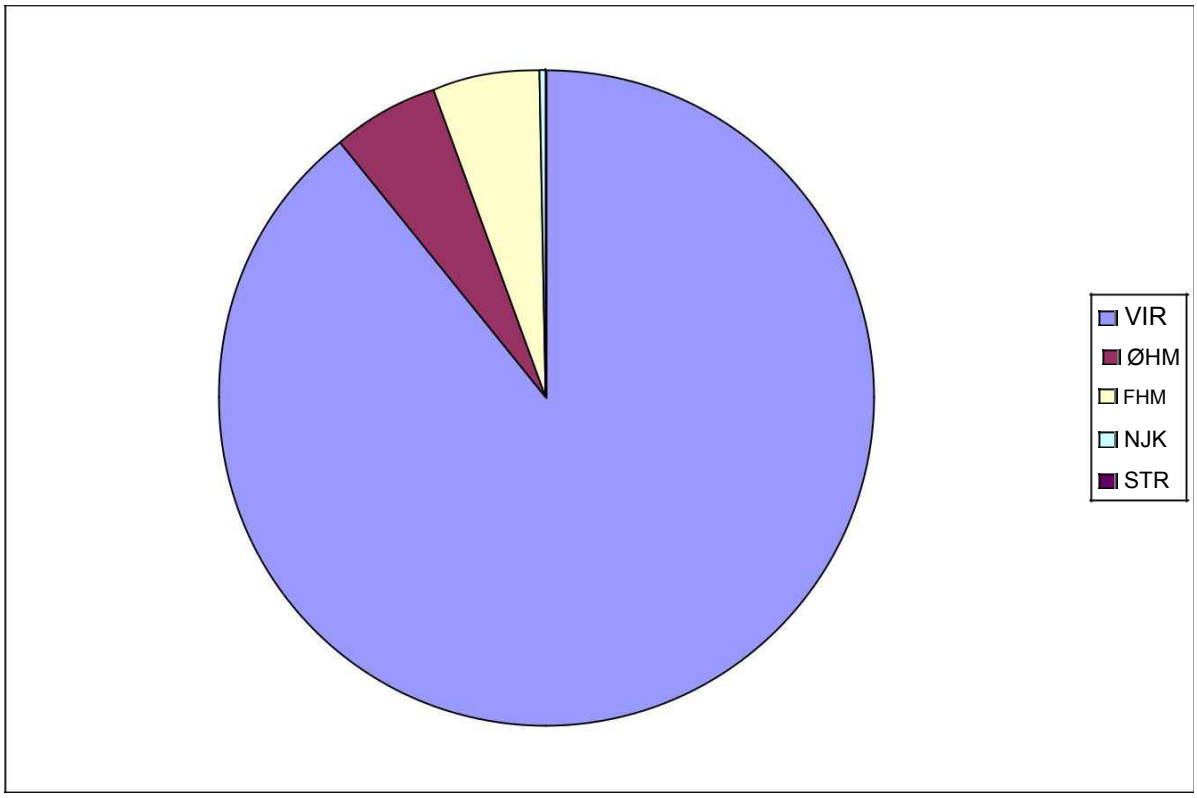
1 Administration

Objective: Ensure that administration works reliably, adequately and efficiently.

1.1 Regional structure

Issues

1 The tables provided by Kulturstyrelsen for the years 2002 until 2011 show clearly that there are significant differences in the nature and scale of developer-funded projects. The Viking Ship Museum and the Øhavsmuseet are by far the most active stakeholders in this field. The other three museums have carried out some developer-funded contract work but not at the same scale (The Strandingsmuseum St. George beginning in January 2004, the Moesgård Museum in December 2004, and the North Jutland Coast Museum, Bangsbo in February 2005).



Relation of summarised budgets spent for underwater developer-funded contract work by the Danish museums between 2002 and 2011 (following tables provided by Kulturstyrelsen).

2 The other three museums are not inactive and do undertake underwater investigations, but usually not as developer-funded projects (Moesgård Museum: stone-age sites survey; North Jutland Coast Museum, Bangsbo: early-modern wrecks; Strandingsmuseum St George: historical wrecks and Stone Age finds).

3 The quality of contract work can be improved if individual museums make better communal use of existing capacity and expertise, which is spread unevenly across the five institutions.
4 There may be some advantages to replacing the current delegated regional responsibility for the management of the Underwater Cultural Heritage with one central institution with a national responsibility.

Conclusions

1 **In present circumstances, the relatively light load of casework in Denmark (resulting in less than c 10 projects per year) is not large enough to put undue pressure on the existing system, although there is not necessarily sufficient critical mass to secure professional management of the process at five separate institutions.**
2 **The regional structure promotes contacts with local divers and fishermen, leading to a better understanding of the special conditions and values of the regional underwater resources. In addition there are good contacts between the Moesgård Museum and the neighbouring archaeological institute, and between the Strandingsmuseum St George and the Maritime Archaeology Program in Esbjerg. The Øhavsmuseum have formalised cooperation with the Syddansk Universitet and The Viking Ship Museum cooperate with the universities of Copenhagen and Århus and international institutions.**
3 **The present devolved structure of maritime archaeology in Denmark has significant advantages in terms of local connectivity, but these may be offset by practical disadvantages related to a potential absence of critical mass and limited infrastructure in most of the regional centres.**

RECOMMENDATION 1

Kulturstyrelsen should review the balance between the operational advantages and disadvantages of the present devolved structure and consider how any changes could increase effectiveness and efficiency.

1.2 Roles and Functions

Issues

1 The organisational landscape of Danish Underwater Cultural Heritage is very diverse and is reflected in the many stakeholders (excluding the legislative/ministerial level): Kulturstyrelsen, the National Museum, the five museums with maritime responsibilities, Contractors, and the various Danish authorities involved.
2 This diversity reflects the participation of a wide range of different actors each with key individual strengths, but also indicates a significant degree of fragmentation. Kulturstyrelsen has the legal responsibility for the Underwater Cultural Heritage, but does not exercise broad strategic leadership for maritime archaeology. Indeed no one organisation or individual adequately fulfils the leadership role for Underwater Cultural Heritage. This is considered to be a serious weakness in the present structure.

3 There are clear differences between the functions and resources (funding) of the five Regional Museums, as well as the competences and relative levels of expertise of their staff.
4 There was a perception during the review that sometimes some museums appear to be in competition with one another; this is counter-productive.
5 Kulturstyrelsen is responsible for the implementation of the legal provisions relating to Underwater Cultural Heritage (within specific parameters), and this focuses mainly on administrative aspects.
6 The senior underwater archaeologist at Kulturstyrelsen appears to be engaged mainly in externally funded research projects apparently without any clear connection to the day to day administrative decisions and tasks. Staff engaged in the administration of the process mainly work reactively, and have little capacity or opportunity to drive this forward proactively (either through the development of standards and guidelines, or through structured monitoring to ensure adequate quality control).
7 The National Museum is a state agency with an apparent obligation to uphold a maritime archaeological contingency service where there is no other candidate. The delivery of this service has been sub-contracted to the Viking Ship Museum, but the National Museum does not appear to be strongly or directly engaged with Underwater Cultural Heritage (with the possible exception of its Conservation Department) and there is little clarity and agreement about the respective roles and responsibilities of the National Museum and the Viking Ship Museum.
8 There are important differences between the formal documents drawn up by Kulturstyrelsen for the four regional museums (the North Jutland Coast Museum, Bangsbo, the Strandingsmusuem St George, the Moesgård Museum, and the Øhavsmuseet) and the contract between the National Museum and the Viking Ship Museum (cf Appendix 1: Contracts Regulating Territorial Responsibility for Maritime Archaeology).
9 Under the terms of its contract with the National Museum, the Viking Ship Museum receives payment in return for the delivery of specific services (only the execution of the tasks is transferred to the Viking Ship Museum, not the actual responsibilities), and for the maintenance of expertise in specific subjects together with defined staff capacity.
10 The Viking Ship Museum appears to have two main roles: 1) national (in relation to library and archives) and 2) regional (for developer-funded contract archaeology in the area not covered by the other four museums); the Viking Ship Museum is paid by the National Museum to maintain capacity to undertake this contract work whereas contract work is entirely self funded in the other four regional museums.

Conclusions

1 **With regard to the general practice and administration of Underwater Cultural Heritage in Denmark, there appears to be an equilibrium that seems to work fairly well at present, but there is no collective sector-wide momentum or drive to maintain or develop further the hitherto extremely high international reputation and standing of Danish Underwater archaeology.**
2 **The differences between the five museums result from three separate parameters: economy/finance, competence, and formal regulations (contracts).**

3 **More consistency about the roles and funding of the five museums would reduce potential problems, and make a better (shared) use of resources in a national context.**
4 **The differences in capacity and resources between the five museums also reflects (partially at least) significant differences in the nature and quantity of work between East (Baltic) and West (North Sea) Denmark.**
5 **The provision of equal payment for equal work in the context of the five museums would address to some extent the present imbalance of resources between the museums.**
6 **Denmark lacks an obvious official central institution that can act not only as a driving force to promote Danish underwater archaeology in an international context, but also is able to develop new research methods and techniques used in a national context.**
7 **Clarity is needed about the role and function of the National Museum with regard to Underwater Cultural Heritage.**
8 **Clarity is needed about the nature of the funding provided by the National Museum for the Viking Ship Museum and specifically what functions this should support in the future and what additional funding this might require.**
9 **Future functions supported by additional funding could for example include the development of expertise and capacity in relevant technical fields (eg in holding and maintaining the specialised remote sensing/sonar technology and the necessary specialised staff to operate the equipment and analyse and interpret the results to the necessary high standards). This central expertise could then be deployed at the service of the other museums as required (charged against the individual project budgets). This would give all five museums effective access to the necessary technical expertise and provide a level playing field for commercially funded projects.**

RECOMMENDATION 2

Kulturstyrelsen should take on the role of the leading central/national institution for Underwater Cultural Heritage in Denmark and act to bring all the Stakeholders together in a positive and cooperative environment.
This could be achieved by engaging the other stakeholders in this process through the establishment of appropriate mechanisms eg a formal national Advisory Board or Expert Group/Panel for Underwater Cultural Heritage (which should include technical and scientific representation and possibly international experts as well).

RECOMMENDATION 3

Kulturstyrelsen should review all the museum contracts and define the responsibilities, competences, and required service levels, so that they are consistent and transparent.
(cf Annex 1: Contracts Regulating Territorial Responsibility for Maritime Archaeology). This will enable Kulturstyrelsen to ensure a more professional and coherent approach to the handling of day-to-day casework, and of future evaluations and analyses, and demonstrate that the five museums should have equal responsibilities (regardless of differences in capacity and resources).

RECOMMENDATION 4

Kulturstyrelsen should work with the National Museum to review and redefine the role of the Viking Ship Museum.
This review should include consideration of the need for additional funding so that the Viking Ship Museum can act as a national centre of expertise for specialised remote sensing/sonar technology; this will achieve better, and in the long-term more qualified results in the analysis and interpretation of geo-physical data on sites, monuments, and submerged (pre-)historic landscapes. In this way, the expertise and capacity of the Viking Ship Museum can be used more efficiently in support of the effective delivery of maritime developer-funded projects in an equal partnership with the other four regional museums.

RECOMMENDATION 5
The Viking Ship Museum should develop more formal and robust mechanisms whereby its in-house expertise can be deployed to support the four regional museums and other stakeholders.
This should include recharging services where appropriate, against individual developer-funded projects. A more structured approach to the provision of central services will contribute to better cross-fertilisation between developer-funded projects and research and dissemination.

1.3 Strategic leadership

1. Standards and guidelines Issues

1 There needs to be clarification about what is expected from maritime archaeologists and museums working within developer-funded contract projects.
2 There appears to be a lack of a common standard in the handling of cases as each museum follows its own methodology and approaches. Diversity can encourage innovation, but as a result of this present scenario, contractors may be in a situation where a project in one area would cost more than the same type of project than in another area for no apparent or visible reason. This can undermine the positive approach of developers to the process.
3 Kulturstyrelsen does carry out quality evaluation of developer-funded contract projects but this is a rather informal process and will require adjustment in the future to reflect any explicit standards and guidelines that may be adopted (below).
4 There needs to be a general standard/framework with consistent routines in place to handle casework and ensure best practice so that maritime archaeologists and museums deliver the necessary products to consistent standards according to properly developed project plans. This is also necessary to ensure that contractors feel that there is a 'level playing field' across Denmark, regardless of the geographical location of individual projects.

Conclusions

1 **Setting standards and guidelines at a national level will assist in leveling out some of the apparent differences between the five regional museums (cf 1.2 above Roles and Functions).**
2 **Kulturstyrelsen should exercise strategic leadership by taking a clearer responsibility for setting standards in maritime archaeology.**

3 **This can be achieved by issuing guidelines for how to design project plans for developer-funded contract archaeology, which will make future projects easier to implement.**
4 **Such guidelines could be based on the Annex to the UNESCO 2001 Convention, but should only be finalised after dialogue and consultation with all the stakeholders (including the five museums).**

RECOMMENDATION 6
Kulturstyrelsen should develop standards and guidelines for Underwater Cultural Heritage, in consultation with relevant stakeholders.

RECOMMENDATION 7
Once standards and guidelines for best practice have been developed, Kulturstyrelsen and the relevant stakeholders should agree to appropriate quality control mechanisms to ensure that practice reflects the requirements of the Museum Act.

2. Long-term strategy Issues

1 There is no evidence for the existence of a coherent long-term strategy for Underwater Cultural Heritage, either in the national bodies (Kulturstyrelsen or the National Museum) or in other organisations (Universities, Museums).

Conclusions
1 **In order to ensure that public money is well spent and that all stakeholders – contractors, governmental agencies, researchers, the public – get what they are entitled to, there must be administrative tools (yardsticks) that enable the Kulturstyrelsen to follow-up individual projects and to assess on a periodic basis whether the system is working properly across the sector (cf 1.3.1 above: Standards & Quality Control).**
2 **This requires a long-term strategy with clear objectives in terms of specific deliverable *outputs* to set standards (eg in project reports) and to ensure measurable *outcomes* in terms of what is trying to be achieved.**
3 **The *outputs* and the *outcomes* need to be reviewed on a regular basis so that progress can be assessed over time.**
4 **Such a strategy is needed to maintain the hitherto very high international reputation of Maritime Archaeology and Underwater Cultural Heritage in Denmark.**

RECOMMENDATION 8
Kulturstyrelsen should develop an explicit long-term strategic approach to maritime archaeology.
This will be the visible expression of the strategic leadership role that is recommended for Kulturstyrelsen.

RECOMMENDATION 9
Kulturstyrelsen should periodically assess the actual relationship between maritime archaeological casework and its links to the knowledge-base / society at large.
This needs to be an integral part of this strategic approach (potential measurable indicators are set out in Annex 2: Review Indicators).

1.4 Simple and effective administration of decision-making

1. Proces

Issues

1 At present, the existing mechanisms appear to work quite well and most institutions involved in the management of the underwater cultural heritage are satisfied with the *status quo* (although this appeared a little surprising to the Working Group).
2 This may simply reflect the relatively low volumes of work (individual projects) required at present, which means that the five museums can more or less easily absorb the necessary work without undue pressure on their resources.
3 The sequence of the process is clear, but from the outside this appears complicated, and could perhaps be simplified.
4 There are differences in approach deployed by the five museums.

Conclusions

1 It should be possible to construct a more streamlined and effective process for the handling of individual cases by reducing the delays inherent in the current system (these were the source of consistent criticism during the review).
2 In doing this it is important to distinguish between reactive and proactive approaches to the decisions that must be made; at a reactive level the system appears to be relatively stable, but in an active sense (using eg predictive modeling to look for new knowledge in areas of low information to inform future decisions) it is not clear whether the right decisions are actually being made.
3 It is important to ensure that areas are actively analysed for archaeological potential independently of the planning process – this could be done through predictive modeling, or through a long-term strategic approach supported by Kulturstyrelsen to encourage the museums and the universities to develop appropriate projects (cf 2.2 below Strategic Research).
4 The existing systems appear to adapt well to increasing pressure, but because of the limited amount of research that takes place in developer funded projects (cf 2.1 below: Current Research) there is limited opportunity to explore 'blank' areas (searching for the unknown) and to assess cases where archaeological potential is not known (but has to be supposed).
5 Because of the nature of the work flows between, on the one hand the museums and developers, and on the other hand between the museums

and Kulturstyrelsen, it is difficult to maintain a broad overview of what is happening.

6 **It would be useful to assess and compare the different methodologies deployed in project plans and to share and build on the different experiences and expertise held in the regional museums.**

RECOMMENDATION 10

Kulturstyrelsen should work with all the stakeholders to define the key competences necessary in the five museums to deliver developer-funded projects and consider what mechanisms might be deployed to share and build staff expertise in the regional museums.

This could be through eg joint working, secondments, training etc.

RECOMMENDATION 11

Kulturstyrelsen should develop a template for all applications.

In addition to simplifying the administrative process, this will encourage more consistency and coherence across the range of developer-funded contract projects.

2. Resources

(Kulturstyrelsen) Issues

1 Kulturstyrelsen is understaffed even for its current functions related to underwater cultural heritage, and this has a negative effect on the smooth administration of the system.

2 In practice, just one person (1 Full Time Equivalent) is responsible for the evaluation of both the methodological and the scientific aspects of the work and also for monitoring all the cases sent to Kulturstyrelsen.

3 This loading already results in some delays to the administrative process, and to some projects, and does not allow any capacity for the production of standards and guidelines (included in existing staff work programs but never achieved).

4 There is very limited capacity (if any) at present to participate in strategic development planning, or to enhance the function and capabilities of the maritime archaeological sector in Denmark.

5 The current inability of Kulturstyrelsen to exercise a strategic leadership role is a brake on the continuing and coherent development of maritime archaeology in Denmark, and ultimately could be a backward step in terms of Denmark's international standing in marine archaeology.

Conclusions

1 **If the current unsatisfactory situation is to be redressed, Kulturstyrelsen must apply more internal staff resources to the function of maritime archaeology, which appear to be seriously out of step with the resources devoted in the agency to terrestrial archaeology.**

RECOMMENDATION 12
Kulturstyrelsen should reassess the relative priorities assigned to terrestrial and marine archaeology.
Consideration should be given to transferring at least 2 FTEs (Full Time Equivalents) from terrestrial to maritime functions in order to exercise the strong strategic role that is so clearly required.

3. Resources (Regional museums) Issues

1 Responsibility for the administrative handling of maritime casework was transferred to the four regional museums at their own request, with no additional transfer of resources (the museums appear to have readily accepted this).
2 In principle, the transfer of responsibility to the museums would have resulted in the saving of resources within Kulturstyrelsen, which could then also have been transferred to the museums to offset the costs of the additional work taken on by them.
3 In practice, no savings were realised within Kulturstyrelsen because the volume of administrative work in the centre actually increased as a result of the increase in the volume of casework that had to be handled by Kulturstyrelsen staff under the new procedures.
4 All the museums possess the basic equipment necessary for maritime survey. Equipment includes highly specialised technology (eg side-scan and multi-beam sonar systems) the use of which is relatively straightforward for metal wrecks, but much less so for other elements of the Underwater Cultural Heritage (submerged prehistoric landscapes, Iron Age barriers, wooden ships etc) and in such cases should only be processed by experienced specialists; only the Viking Ship Museum has the necessary specialist staff expertise for robust interpretation and analysis of such data (cf 1.2 above: Roles and Functions).
5 There are clear differences in the nature and scale of developer-funded projects undertaken by the five museums. This seems to reflect not just the specific focus of the different museums, but also their geographical locations (with major construction projects in the southern and eastern part of the Danish Baltic Sea as well as in the area around Bornholm impacting on an area of concentrated wrecks and submerged stone-age sites.
6 The financing of most developer-funded projects budgets is based on maximum contingency costs, and according to the tables provided by Kulturstyrelsen, the budgets approved by Kulturstyrelsen do not actually get used up in practice. Usually between a quarter and one half of the allocated budget for each project remains unspent; this surplus could be utilised for research and scientific publication. This will not lead to a rise in overall budget allocations, only to a more thorough use of existing budgets (cf 2.1 below: Research Current Situation) as well as enhancing the implementation of the Valletta Convention (cf Recommendation 20 below).
7 The current lack of adequate resources for developer-funded contract projects restricts the ability of the museums to reap the research benefits of this work, and encourages an artificial and unhelpful distinction between commercial projects (no research) and scientific projects (research).
8 Although all finds from the seabed are legally owned by the State, there is lack of clarity about the implications of this in terms of long-term storage and display in the

museums and whether ownership (and therefore responsibility for the costs of conservation and storage) is transferred or not to the receiving museum. With current severe budgetary pressures, this could potentially lead to regional museums charging the State for the long term curation and storage of finds.

Conclusions

1. **The delegation of developer-funded contract work to the four regional museums should in principle have been accompanied by a transfer of an equivalent amount of money in order to ensure that existing museum resources and capacity for research are not eaten up by these additional administrative tasks.**
2. **Alternatively, Kulturstyrelsen could dedicate sufficient staff time and expertise to take a leading role in contributing to the design of projects from the scientific viewpoint (cf 1.3 above: Strategic leadership).**
3. **Additional capacity in Kulturstyrelsen is also required to organise the realisation of a strategic research framework and the development of common standards, guidelines etc).**
4. **Consideration should be given to increasing the level of available resources for developer-funded contract projects by requiring contractors to pay more per project; it may be possible at the same time to reduce the total number of developer-funded contract projects by looking at the thresholds for such work (this would ensure that the overall financial burden on developers is not raised unrealistically). In this way, operations would have the necessary resources and flexibility to go far beyond basic observation and recording, and to integrate research aspects directly in the project.**

RECOMMENDATION 13

Kulturstyrelsen and the five museums should assess the scale of current administrative costs inherent in the existing system.

This will establish whether a lift in resources may be required for the administrative costs of projects or not.

RECOMMENDATION 14

A pool of highly specialised equipment should be maintained at one centre (Viking Ship Museum?) with the necessary additional funding to maintain the relevant specialist expertise to use this equipment.

This will require the development of agreed mechanisms and protocols to ensure that the other museums have the necessary access to this equipment pool. For developer-funded contract projects, there should be a daily fixed rate for the use of this equipment (and for the analysis and interpretation of the results), which is then charged to the individual projects.

RECOMMENDATION 15

Kulturstyrelsen (with the relevant authorities and the National Museum) should initiate a review to clarify the exact conditions under which cultural property is transferred to the five museums.

As part of this review consideration should be given to the necessary safeguards and conditions to ensure that finds are properly and appropriately stored and displayed, and cannot be disposed of.

2 Research

Objective: Ensure that research results are produced commensurate with the research potential and the extent of client-funded preliminary archaeological investigations.

2.1 Current situation

Issues

1 The prevailing attitude towards developer-funded contract projects at present appears to be about removal of risk rather than about research and research priorities; equal weight is given to all Underwater Cultural Heritage under threat regardless of its significance (this may be derived from or necessitated by the approach embedded in the Museums Act and national heritage legislation).

2 Although Kulturstyrelsen and the regional museums all recognise the fundamental importance of research, current practices seem to militate against the effective integration of research values in developer-funded contract projects.

3 There is general acceptance of the principle that developers can only be charged for the costs of basic archaeological recording and *not* research. This impacts in particular on the post-excavation phase of such projects, which then exclude any 'research'. This situation appears to result from established practice rather than from an explicit provision of the Museum's Act.

4 Resolution of this issue will depend on the interpretation, in the Museums Act, of '*investigating*'/'*investigation*' which under the terms of the Valletta Convention are defined as including the need to carry out work '*in a scientific manner*'(article 3b) and to include '*a scientific summary record as well as … the full publications and recording of the findings*' (article 6b)

5 There is a substantial gap between the current products of developer-funded projects, and what is necessary to underpin on-going research. This may result from 1) differences between what is produced by the museums and what the universities and other research institutions actually need; or 2) that researchers traditionally seek their material in other directions (e.g. literature and/or their own data collections) and simply overlook reports from developer-funded contract archaeology.

6 At present, the results of developer-funded contract work are generally not well integrated with, and contribute little to, the results of scientific research. The absence of a strong link between contract-work and the knowledge base is a major concern: it undermines an important reason for upholding the law that requires developers to finance archaeological excavations and it is no longer socially acceptable to spend money on a process which serves public policy but does not contribute to public benefit by building knowledge and understanding and making that new knowledge available to society at large.

7 It needs to be easier to extract knowledge, rather than raw data from developer funded project reports.

8 The results of developer-funded contract projects generally remain unpublished (possibly due to a lack of resources – available time and money).

9 Based on reports and interviews, it seems as if a positive effect occurs only when a museum's general profile (research agenda) is very close to the theme of a certain

project, and that the relevant researchers are allowed to influence the project's design.

10 With few exceptions, universities and other research institutions do not seem to benefit very much from the results of the archaeological investigations carried out by the museums during the last 5-10 years.

11 The universities and research institutions should be seriously concerned by this problem and are morally obliged to seek solutions together with the organisations undertaking developer-funded contract work (the problem is not unique to Denmark).

Conclusions

1 **To some extent the existing system already allows, and indeed is underpinned by the need to include research questions in developer-funded contract projects, but it needs further adjustment to make it function more effectively and as it was originally intended.**

2 **The standards employed in the design of developer-funded contract projects need to be improved and there needs to be a significant uplift in the overall quality of project designs; the basic structure for describing – and hence understanding – what potential a specific site may have is not good enough (structure and skills in writing text is a key factor to success in enhancing the scientific level in any academic subject).**

3 **There needs to be a more problem-orientated way of looking at the developer-funded projects by formulating culture-historically meaningful questions and attempting to relate observations to these questions as projects progress. What is meaningful will be decided by the existing understanding of the archaeological and historical context of each investigation; the existence of well-designed research-themes will assist this process.**

4 **Research issues must be included from the beginning of an investigation, not glued on afterwards 'when you know what you found'. Relevant material must of course be recorded and perhaps also collected, but there must also be a focus on what kind of knowledge is being looked for. As part of this process, sufficient flexibility must be retained to redefine the strategy and the goals of a project and to change priorities in the field as the project progresses (such changes must be discussed and agreed with relevant actors including Kulturstyrelsen, and then documented properly).**

5 **There needs to be a change of attitude about expectations regarding research outcomes; this will necessitate revising the definition of 'investigation' so that it includes a proper report that integrates recording outcomes with research outcomes (cf this can be included in 1.3.1 above: Standards and Guidelines).**

6 **In current economic circumstances more thought should perhaps be given to the need to prioritise developer-funded work *and* to ensure that there is always proper scientific justification for such work (rather than simply being driven by the need for legislative compliance); this can be achieved by integrating research drivers into the project designs of developer-funded contract projects at the outset.**

7 **There is no clarity about the legal position regarding undertaking research as part of developer-funded contracts; many (most?) archaeologists would take the position that all archaeological work is essentially about research, regardless of the origin of the financing of projects.**

8 **It essential that the universities and other research institutions (who should be significant beneficiaries of the results of developer-funded contract archaeology) become more engaged in the research aspects of such work.**

9 **There is too little (if any) input from relevant researchers when developer-funded projects are being designed; this could be achieved through a series of small scale round-table seminars/workshops to establish constructive dialogue between the universities, research institutes, the five regional museums, and individual researchers, to illustrate best practice and to demonstrate how research drivers can be used to add value to developer-funded projects.**

10 **In addition to the straightforward presentation of data, reports of developer-funded projects *must* include proper analysis and interpretation.**

11 **Information derived from developer-funded projects must be rapidly assimilated into the Danish Sites and Monuments Record (Fund og Fortidsminder) in order to inform *both* future management decisions and the direction of future research.**

12 **There should be stronger links in the five museums between the developer-funded contract work that is undertaken, and outreach to the public (through museum displays etc on general maritime questions).**

13 **As already happens in some cases, the results of developer-funded contract work should be published more widely (possibly online?).**

14 **A percentage of the costs of developer-funded projects should be allocated to analysis and publication and to enable maritime archaeologists at the five museums to publish their important results at an international level (c 20% is an accepted minimum/norm in other countries).**

15 **Clearly there is considerable room for improvements, and *all* the actors in the maritime archaeological community (individual museums, universities, and Kulturstyrelsen) have a responsibility for making this a reality.**

RECOMMENDATION 16

Kulturstyrelsen must ensure transparency and synchronisation of geographical data in GIS and ARC MAP between the five museums and Fund og Fortidsminder.

This will ensure that the data held by the museums can be accessed via Kulturstyrelsen.

RECOMMENDATION 17

In developing standards and guidelines, Kulturstyrelsen should set out a clear definition of what is expected as an outcome of developer funded projects.

This should also explore how researchers (especially in the university sector and National Museum) could be drawn into developer-funded projects at the design stage.

RECOMMENDATION 18

Kulturstyrelsen should consider initiating a national discussion about the philosophical approaches underlying the drivers for developer-funded projects (in both terrestrial and maritime contexts).

Such a discussion or debate could usefully contribute to changing prevailing attitudes about the role of research in developer-funded contract archaeology.

RECOMMENDATION 19
Kulturstyrelsen should (with the appropriate authorities) initiate a review of the existing legislation to establish a definitive position about the ability (or not) to include research in developer-funded projects.
This should include a consideration of how the law can be interpreted in a better way in order to fulfil responsibilities under the Valletta Convention (so that '*investigating*' is redefined to include a fuller post-excavation procedure and more interpretative reports that can be legitimately charged to the developer).

RECOMMENDATION 20
Costs for proper scientific publication should be included in all contract costs (as required by the Valletta Convention).
Kulturstyrelsen should consider the various options that might be available to achieve this (eg a change in the law, a change in practice, whether through direct project costs, or as a fixed percentage levy to a fund administered by an Advisory Board which could make grants to suitable bodies including universities). Additional resources for research and publication could come from the unspent (contingency) portion of allocated budgets as a fixed overhead.

RECOMMENDATION 21
Kulturstyrelsen should consider establishing a series of seminars/workshops aimed at spreading best practice in developer-funded projects across the terrestrial and maritime spheres.
Seminars (maximum of two per year) should focus on topics relevant but not limited to maritime archaeology and ideally should mix maritime and terrestrial, academic and museum, and archaeological and historical perspectives etc. A project leader would need to be appointed (preferably employed by Kulturstyrelsen) for at least two years to develop such a seminar series who would also work with the quality control of project designs and reports (especially the strategic development of the necessary tools); the project leader would need to have academic credibility (Ph D) and practical experience in the museum world. A development of this nature would also provide a strong milieu which could contribute to the integration of the terrestrial and maritime archaeological communities, and, through this process, even kick start the creation of an embryonic national research strategy.

2.2 Strategic research

Issues

1 There is a clear requirement for a strategic research framework and a generally agreed research strategy for Underwater Cultural Heritage at a national level in order to inform (amongst other things) the appropriate responses to casework. This must not be proscriptive, and should not restrict or constrain research opportunities but rather should provide a useful framework which can help the on-going development of individual research objectives and priorities.
2 Such a framework must not be driven 'top down' but rather should be developed jointly by all the actors (so that there is joint ownership of the framework); it needs to grow out of the existing links between the five museums and their respective competences, the research areas, and the archaeological cases.

3 The strategic research framework could comprise three or four key themes eg:
   a) Stone Age (submerged sites).
   b) Iron Age to Early Middle Age (focus on wrecks and other complex structures).
   c) North Sea Archaeology (methodology?)
   d) (Post-medieval periods?).

Conclusions

1 **The development of a research framework and a research agenda for maritime archaeology are essential tools that will help connect the spheres of developer-funded contract archaeology and research archaeology across the whole maritime sector.**

RECOMMENDATION 22

Kulturstyrelsen should take the initiative in bringing together the universities dealing with maritime archaeology, the five museums having responsibility for maritime archaeology, the National Museum (including the conservation department) and relevant terrestrial and coastal archaeologists to discuss and develop a strategic research framework and research strategy for underwater cultural heritage in Denmark.

It may be useful to consider involving in this process some external assessors drawn from the international Underwater Cultural Heritage community to provide feedback in a European context.

RECOMMENDATION 23

An internal debate should be initiated within Danish archaeology to clarify which areas and topics have a research potential worth focusing on.

In the first instance it may be helpful to focus only one or two topics, and if successful, increase the number by adding other topics at a later stage.

2.3 Research delivery

Issues

1 There are no obvious coherent mechanisms for the integrated delivery of the sort of strategic-oriented research advocated here.

Conclusions

1 **Once there is an agreed strategic research framework in place, then it will be important to ensure that the appropriate milieu and mechanisms exist for the delivery of associated research in a national and regional context.**

2 **This could be achieved by entrusting a specific regional museum with the responsibility for being a national resource for a particular topic. This could be supported by funding provided by Kulturstyrelsen for particular projects (or the cost could perhaps be divided between Kulturstyrelsen, the museums, and the universities). Any such investments should be subject to appropriate guidelines and conditions and have clear objectives against which they can be carefully assessed and monitored.**

3 **Two existing museums already have their own research profiles and resources – the Moesgård Museum and the Viking Ships Museum – which puts them in a favorable position to take responsibility for themes a) and b) above. The Strandingsmuseum St George Museum is progressing well in the development of a methodology for surveying and mapping the prehistoric maritime landscape of the North Sea region (which to date has been a clear *lacuna* in Danish maritime archaeology) and is a possible candidate for theme c) above.**

4 **It is not necessarily axiomatic that all five museums should each exercise a national responsibility for a strategic research area, and it is not self-evident that all of the themes and subjects need to be developed at once.**

RECOMMENDATION 24

Kulturstyrelsen should initiate a discussion with all the relevant actors, and discuss with them how best to implement and deliver strategic research for maritime archaeology.

This is a key component of the strategic lead recommended for Kulturstyrelsen.

3 Networks for Underwater Cultural Heritage

Issues

1 Marinet provides an existing cross over point for aspects of maritime archaeology in Denmark.

2 To date, the network has provided little more than a relatively informal opportunity to exchange practical information and keep participants up to date with what's going on.

3 Marinet meetings could provide a useful opportunity for all parties not just to learn from shared experiences, but to develop their own day to day operations and business more effectively.

4 There is also potential for Marinet to take on more useful and important functions in terms of carrying out cooperative work between the five museums, coordinating activities and debates, contributing to the development of standards for underwater cultural heritage (through appropriate administrative mechanisms and processes) and participating in the development of a strategic research framework.

5 There is also no national forum for Underwater Cultural Heritage, where all the stakeholders can meet to discuss issues of common concern. Initiating the establishment of such a forum would provide Kulturstyrelsen with a very suitable opportunity to demonstrate strategic leadership.

Conclusions

1 Marinet is a national forum that should bind the five museums together collectively in carrying out developer-funded contract work to common and consistent standards and to discuss practical issues, but it requires proper terms of reference.

2 Marinet should be put on a more professional basis with elected/appointed Officers for a fixed term (at least Chair and Secretary); meetings should be properly organised and regularised by issuing an advanced agenda with appropriate standing items (eg administrative aspects of developer-funded archaeology, research aspects of strategic research areas, practical issues and the taking of minutes of the meeting/actions etc).

3 A separate national forum/task force for Underwater Cultural Heritage needs to be established which includes all the stakeholders with an interest in the subject (including the National Museum and the Universities). This could evolve out of Marinet, or be established as an independent body with a proper structure and agenda (on a c five year cycle?), to discuss strategic issues and perhaps to host amongst other things, the development of a research framework/strategy, organising national seminars on a wide range of topics (cf 2.1 above: Research Current Situation; 4 below: Harmonisation), hosting an annual Underwater Cultural Heritage conference etc.

4 The establishment of such a forum could be initiated at a national event (organised or supported by Kulturstyrelsen) which could include a summary of this review, and discussions/presentations on eg what is need to improve and maintain the position of Underwater Cultural Heritage in Denmark; what are the expectations of, and what is expected from the different stakeholders etc.

RECOMMENDATION 25

Marinet should remain a focus for cooperation between the five museums.

Kulturstyrelsen should consider encouraging and supporting the network to become a more effective mechanism for cooperation and for the five museums to engage collectively in a wider maritime network by discussing administrative matters and improvements to current processes and practical issues (who does excavations where, and with whom, and with which equipment).

RECOMMENDATION 26

Marinet should adopt terms of reference and proper working practices.

A better structure for Marinet meetings will enhance their status and possibly underpin the potential evolution of Marinet into a wider forum for maritime archaeology in Denmark.

RECOMMENDATION 27

Kulturstyrelsen should facilitate the development of a national forum for Underwater Cultural Heritage by inviting stakeholders to discuss this proposition at a key event.

Kulturstyrelsen could enable a national forum by organising meetings together with a host institution, contributing to the agenda, and providing administrative support (minute taking etc). Once a year, the meeting of the forum could include a seminar (cf 2.1 above: Research Current Situation) which would reinforce the understanding that practical matters have a close connection to theoretical issues.

4 Harmonisation with terrestrial archaeology

Issues

1 In principle the administrative processes applied to maritime archaeology should be harmonised with those applied to terrestrial archaeology, in order to have consistent treatment of *all* cultural heritage assets across the full range of the historic environment regardless of which environment it is situated in.

2 However, in practice the expertise, professional capacity, and infrastructure and resources available to maritime archaeology are much lower than those available to terrestrial archaeology; the volume of maritime archaeology being carried out as developer-funded contract projects is also significantly lower, whilst the unit cost of individual projects is likely to be much higher.

3 The organisation and distribution of maritime archaeology is therefore not entirely consistent with terrestrial archaeology, and reflects some of the differences between these two spheres.

4 Nevertheless, the maritime community is too small to be able to exist in isolation, and bonds with the wider archaeological sector in general need to be strengthened.

5 In November 2012, Kulturstyrelsen received 33 applications for funding of research on terrestrial archaeological subject, but none for maritime topics.

Conclusions

1 The underwater cultural heritage community is not taking advantage of existing funding opportunities for research offered by Kulturstyrelsen.

2 The underwater cultural heritage community is not represented on the existing Kulturstyrelsen Advisory Board for Archaeology (Arkæologisk Råd) and apparently is not represented on the new Advisory Boards and Expert Panels that are being set up at Kulturstyrelsen as part of the implementation of the new Museums Law.

3 Improvements have been noted in the context of developer-funded terrestrial projects (merging of museums to increase capacity and expertise leading to improved quality and publication of projects).

4 Maritime archaeological research would benefit from a closer engagement with mainstream terrestrial archaeology by participating actively in debates, conferences, etc. At the same time, mainstream archaeology would benefit from a breaking down of the current over-compartmentalisation of terrestrial and maritime archaeology.

5 A series of national seminars (cf 2.1 above: Research Current Situation) would help establish a broader picture through the inclusion of researchers from wider backgrounds (including historical research).

6 Establishing a separate national journal for maritime archaeology in Denmark is not considered to be desirable, but more efforts should be made to integrate the sectors by better reporting of maritime archaeology in journals devoted to archaeology in general.

RECOMMENDATION 28
Kulturstyrelsen should consider whether there are lessons to be learnt from analogous changes in the context of terrestrial archaeology, and how practice (if not structures) can be better aligned between terrestrial and maritime archaeology.

RECOMMENDATION 29
Maritime archaeologists should participate and engage more in general national archaeological bodies including applications to Kulturstyrelsen for research.
Kulturstyrelsen could advertise the opportunity to the Maritime sector.

RECOMMENDATION 30
If a separate Advisory Board for Underwater Cultural Heritage is not possible (cf 1.2 above: Roles and Functions) then Kulturstyrelsen should include experts in Underwater Cultural Heritage in its other Advisory Boards and Expert Panels.

RECOMMENDATION 31
Kulturstyrelsen should take the initiative (in cooperation with the Directors of the five Museums, the National Museum, and the Universities) to develop a series of national seminars about the integration of research into developer-funded contract archaeology.

5 Key International Conventions for Underwater Cultural Heritage

Issues

1 The European Convention on The Protection of the Archaeological Heritage (revised) Valetta, 1992 defines archaeological heritage as structures, constructions, groups of buildings, developed sites, moveable objects, monuments of other kinds as well as their context, *whether situated on land or under water*, and includes articles to promote the identification, protection, integrated conservation, financing of research and conservation, collection and dissemination of scientific information, promotion of public awareness, prevention of illicit trade, and mutual technical and scientific assistance.

2 The UNESCO Convention on the Protection of the Underwater Cultural Heritage (2001) is an important international instrument and the Annex to the Convention sets consistent international standards for the management of Underwater Cultural Heritage (to date 41 countries have ratified the Convention).

3 Denmark has signed and ratified the Valletta Convention, which came into force on 17/5/2006 but has not signed the 2001 UNESCO Convention.

Conclusions

1 **Both the Valletta and UNESCO Conventions are important instruments for the management of the Underwater Cultural Heritage, but their importance lies in the implementation of and adherence to the consistent and coherent standards which they set out, rather than in ratification *per se*.**

RECOMMENDATION 32

Kulturstyrelsen should review the conclusions and recommendations of this report in the context of the Valletta Convention.

This will help identify how the provisions of the Valletta Convention may assist in the more effective implementation of the Museums Act in relation to the management of Underwater Cultural Heritage in Denmark.

RECOMMENDATION 33

Kulturstyrelsen should consider carrying out an impact assessment to assess the advantages and disadvantages of signing the 2001 UNESCO Convention and to identify any changes or additions to the Museums Act and current administrative processes that would be required by doing this.

Depending on the results of this impact assessment, Kulturstyrelsen should then consider formally adopting the Annex of the UNESCO Convention as a statement of best practice (This has been done in other countries that have not signed the UNESCO Convention eg the UK).

6 Conclusion and Recommendations

All the important elements are present in Denmark: local/regional museums eager and ready to take responsibility for maritime archaeological work, Universities dealing with maritime archeology, an existing network of the regional museums involved in maritime archaeology (Marinet), a research centre of high international standing (the Viking Ship Museum), and a national agency with extremely well qualified and committed expert staff.

As a neutral actor, with specific legal and oversight responsibilities, Kulturstyrelsen should be responsible for elaborating common standards and guidelines for the execution and delivery of Underwater Cultural Heritage commercial contracts.

Kulturstyrelsen should play a central role in terms of international representation (conferences), and research, and should take the strategic lead in inspiring the five museums with responsibilities for maritime archaeology and in connecting the spheres of developer-funded contract archaeology and research archaeology by initiating the development of a research framework and research agenda for Underwater Cultural Heritage.

The results of this review, together with any actions taken forward as a result of it, should be revisited on a regular basis (at intervals of four or five years) to examine the impact (or not) of the proposed changes. This will demonstrate an on-going commitment to improving standards for Underwater Cultural Heritage in the context of the delivery of the Museums Act.

RECOMMENDATION 1

Kulturstyrelsen should review the balance between the operational advantages and disadvantages of the present devolved structure and consider how any changes could increase effectiveness and efficiency.

RECOMMENDATION 2

Kulturstyrelsen should take on the role of the leading central/national institution for Underwater Cultural Heritage in Denmark and act to bring all the Stakeholders together in a cooperative environment.

RECOMMENDATION 3
Kulturstyrelsen should review all the museum contracts and define the responsibilities, competences, and required service levels, so that they are consistent and transparent.

RECOMMENDATION 4
Kulturstyrelsen should work with the National Museum to review and redefine the role of the Viking Ship Museum.

RECOMMENDATION 5
The Viking Ship Museum should consider developing robust mechanisms whereby its in-house expertise could be deployed to support the other stakeholders.

RECOMMENDATION 6
Kulturstyrelsen should develop standards and guidelines for Underwater Cultural Heritage, in consultation with relevant stakeholders.

RECOMMENDATION 7
Once standards and guidelines for best practice have been developed, Kulturstyrelsen and the relevant stakeholders should agree appropriate quality control mechanisms to ensure that practice reflects the requirements of the Museum Act.

RECOMMENDATION 8
Kulturstyrelsen should develop an explicit long-term strategic approach to maritime archaeology.

RECOMMENDATION 9
Kulturstyrelsen should periodically assess the actual relationship between maritime archaeological casework and its links to the knowledge-base/society at large.

RECOMMENDATION 10
Kulturstyrelsen should work with all the stakeholders, to define the key competences necessary in the five museums to deliver developer funded projects and consider what mechanisms might be deployed to share and build staff expertise in the regional museums.

RECOMMENDATION 11
Kulturstyrelsen should develop a template for all applications.

RECOMMENDATION 12
Kulturstyrelsen should reassess the relative priorities assigned to terrestrial and marine archaeology.

RECOMMENDATION 13
Kulturstyrelsen and the five museums should assess the scale of current administrative costs inherent in the existing system.

RECOMMENDATION 14
A pool of highly specialised equipment should be maintained at one centre (Viking Ship Museum?) with the necessary additional funding to maintain the relevant specialist expertise to use this equipment.

RECOMMENDATION 15
Kulturstyrelsen (with the relevant authorities and the National Museum) should initiate a review to clarify the exact conditions under which cultural property is transferred to the regional museums.

RECOMMENDATION 16
Kulturstyrelsen must ensure transparency and synchronisation of geographical data in GIS and ARC MAP between the five museums and Fund og Fortidsminder.

RECOMMENDATION 17
In developing standards and guidelines, Kulturstyrelsen and the five museums should set out a clear definition of what is expected as an outcome of developer funded projects.

RECOMMENDATION 18
Kulturstyrelsen should consider initiating a national discussion about the philosophical approaches underlying the drivers for developer-funded projects (in both terrestrial and maritime contexts).

RECOMMENDATION 19
Kulturstyrelsen should (with the appropriate authorities) initiate a review of the existing legislation to establish a definitive position about the ability (or not) to include research in developer-funded projects.

RECOMMENDATION 20
Costs for proper scientific publication should be included in all contract costs (as required by the Valletta Convention).

RECOMMENDATION 21
Kulturstyrelsen should consider establishing a series of seminars/workshops aimed at spreading best practice in developer-funded projects across the terrestrial and maritime spheres.

RECOMMENDATION 22
Kulturstyrelsen should take the initiative in bringing together the universities dealing with maritime archaeology, the five museums having responsibility for maritime archaeology, the National Museum (including the conservation department) and relevant terrestrial and coastal archaeologists to discuss and develop a strategic research framework and research strategy for underwater cultural heritage in Denmark

RECOMMENDATION 23
An internal debate should be initiated within Danish archaeology to clarify which areas and topics have a research potential worth focusing on.

RECOMMENDATION 24
Kulturstyrelsen should initiate a discussion with all the relevant actors, and canvass opinions about how best to implement and deliver strategic research for maritime archaeology.

RECOMMENDATION 25
Marinet should remain a focus for cooperation between the five museums.

RECOMMENDATION 26
Marinet should adopt terms of reference and proper working practices.

RECOMMENDATION 27
Kulturstyrelsen should facilitate the development of a national forum for Underwater Cultural Heritage by inviting stakeholders to discuss this proposition at a key event.

RECOMMENDATION 28
Kulturstyrelsen should consider whether there are lessons to be learnt from analogous changes in the context of terrestrial archaeology, and how practice (if not structures) can be better aligned between terrestrial and maritime archaeology.

RECOMMENDATION 29
Maritime archaeologists should participate and engage more in general national archaeological bodies including applications to Kulturstyrelsen for research.

RECOMMENDATION 30
If a separate Advisory Board for Underwater Cultural Heritage is not possible (cf 1.2 above: Roles and Functions) then Kulturstyrelsen should include experts in Underwater Cultural Heritage in its other Advisory Boards and Expert Panels.

RECOMMENDATION 31
Kulturstyrelsen should take the initiative (in cooperation with the Directors of the five Museums, the National Museum, and the Universities) to develop a series of national seminars about the integration of research into developer-funded contract archaeology.

RECOMMENDATION 32
Kulturstyrelsen should review the conclusions and recommendations of this report in the context of the Valletta Convention.

RECOMMENDATION 33
Kulturstyrelsen should consider carrying out an impact assessment to assess the advantages and disadvantages of signing the UNESCO Convention and to identify any changes or additions to the Museum Act and current administrative processes that would be required by doing this.

7 Annex 1: Contracts Regulating Territorial Responsibility for Maritime Archaeology

During the evaluation process, it became clear that client-funded maritime archaeology is performed under rather uneven conditions in Denmark. There appear to be three parameters which control this: finance / economy, competence, and formal regulation (contracts).

The state has handed over most of the operative responsibility for client-funded maritime archaeology to a number of regional museums. In this respect, the state is represented by the Kulturstyrelsen with one exception. The National Museum (which is also a state institution) has a special role with an obligation (although it is unclear how and where this is stated) to uphold a maritime archaeological contingency service where there is no other candidate to do so. However, since 2004, the National Museum has contracted the Viking Ships Museum to fulfil its operative duties in maritime archaeology.

There are important differences, though, between the formal documents drawn up by Kulturstyrelsen with the four museums (the North Jutland Coast Museum, Bangsbo, the Strandingsmuseum St George, the Moesgård Museum, and the Øhavsmuseet) and the contract between the National Museum and the Viking Ship Museum. The most important is that the document between Kulturstyrelsen and the four museums is not a proper contract. Instead, Kulturstyrelsen has approved an application from each of the four museums to be given the responsibility for maritime archaeology within a certain territory. This is a one-sided delegation, not a contract.

The document between the National Museum and the Viking Ship Museum is more a traditional contract between two parties. The National Museum has contracted the Viking Ship Museum to perform certain services for which the National Museum carries the formal responsibility. For these services, the Viking Ship Museum receives an annual payment. It is clear from the contract, though, that only the tasks are transferred, not the actual responsibility.

All discussions concerning the formal conditions for the five museums presently performing maritime archaeology should include the different nature of their responsibilities. This also has relevance for an issue that has been identified as an anomaly: that the Viking Ship Museum receives a certain amount of money each year for providing a "maritime contingency service" on behalf of the National Museum.

In addition to the judicial character of the documents that transfer the operational responsibility from the state to the five museums in question, it is equally important to explore the differences in demands between the two types of document.

The Kulturstyrelsen document – which is designed as a response to a request – states that *"[the] Museum is approved as a museum with a marine archaeological area of responsibility, and that the Museum from then on is under obligation to handle ordinary marine archaeological tasks, carry out inspections, receive notifications, carry out commissioned marine archaeological surveys in connection with construction work, raw material extraction and other activities on the seabed within the area of responsibility*."

In the contract between the National Museum and the Viking Ship Museum the demands are considerably more specific:
"It has been agreed between the Viking [Ship] Museum and the National Museum that the Viking [Ship] Museum shall comply with the following:

1. *A professional staff shall be maintained that is capable of handling archive-related case processing in connection with construction cases, harbour deepening, dumping etc. to the extent of approx. 600 hours per year. The task was taken over from the Heritage Agency of Denmark on 1 October 2009 in connection with a restructuring of the Agency's marine archaeological administration.*
2. *Expert knowledge shall be maintained covering the areas of submarine Stone Age settlements, fishing weirs and barriers on the seabed, harbour facilities, wrecks of ships from prehistoric and medieval times, wrecks of ships from recent times and anything else that falls within the Museums Act's preservation regulations.*
3. *A contingency service of at least two diving employees shall be maintained.*
4. *A technical contingency service shall be maintained to ensure completion of documentation and survey tasks on the seabed.*
5. *Inspection and survey tasks shall be carried out in connection with the securing of facilities and wrecks within territorial waters at the request of the Heritage Agency of Denmark for up to 160 hours per year, cf. Transfer Agreement of 1 November 2000 between the Forest and Nature Agency and the Heritage Agency of Denmark.*
6. *Expert culture-historical statements shall be prepared at the request of the Heritage Agency of Denmark for up to 100 hours per year, cf. Transfer Agreement of 1 November 2000 between the Forest and Nature Agency and the Heritage Agency of Denmark.*
7. *Commissioned preliminary marine archaeological surveys and investigations shall be carried out on behalf of clients and construction authorities paid by these.*
8. *To the extent that the management of other tasks allows for this, VM may take the initiative to undertake preliminary marine archaeological surveys, investigations and documentation. Funds for such work can be applied for from the appropriation related to the administration of Section 28 of the Museum Act. VM shall collaborate to a relevant extent with other museums conducting marine archaeological work about the solution of such tasks.*
9. *Scientific staff can, to the extent that the management of the other posts allows for this, publish selected investigation and research results and participate in international collaboration."*

Regardless of the fact that the Viking Ship Museum receives an annual fee to maintain a certain standard, the contract between the National Museum and the Viking Ship Museum

clearly defines what is expected from an institution with a territorial responsibility for maritime archaeological contingency service. Although not all the aspects mentioned above are relevant outside its specific context, Kulturstyrelsen should consider the introduction of a more coherent definition of required competences and skills expected from the museums with a regional responsibility.

This could include for example:

- Capacity and competence for all phases of case processing,
- Knowledge of relevant legislation for archaeological and underwater work,
- Expert competence in maritime archaeological remains, structures and features, artefacts etc, under the protection of the Museums Act,
- Technical competence for underwater work and archaeological interpretation of geophysical data (sonar, multi-beam etc.),
- Methodological competence for conducting all relevant aspects of underwater archaeological surveys, preliminary investigations, and investigations.

Annex 2: Review Indicators

1. How many articles have appeared in the press on maritime archaeological casework?

- ≥ Discussing the actual results and relevance of projects and describing the methods and goals of maritime archaeology.
- ≥ Every project should generate at least a few articles in the press (one national and 2 local/regional?).
- ≥ The number of articles per project.

Agencies generally screen the press systematically so this information should be relatively easy to obtain.

Parallel statistics could be generated for audio-visual media.

2 How many lectures have been delivered to local historians/local societies/amateur groups/schools?

- ≥ The number of lectures delivered by maritime archaeologists on these cases.
- ≥ This is also a measure of the significance of such work to society.
- ≥ The Museums ought to be able to generate this material.
- ≥ In terms of trends over time an increasing target could be set.

3 How many contractors utilize the results of the projects that they have funded?

- ≥ In their communication: publicity folders, on their website, distributing the publication to their employees, organising an event for their employees etc.

4 How many exhibitions use information from maritime archaeological casework?

5 How many times are results of casework being used or being integrated in bachelor/master papers?

6A How many maritime archaeologists involved in this casework attend regional/national conferences on archaeology/history/heritage/conservation?

6B How many maritime archaeologists participate (actively) in such conferences with a paper/in a panel/with a poster on their work?

7A How many Danish maritime archaeologists dealing with casework attend international conferences/meetings/workshops?

7B How many Danish maritime archaeologists participate (actively) in such events with a paper/in a panel/with a poster on their work?

8 The number of articles on maritime archaeological casework in local/regional, national and international journals/books.

All the results should be compared with the number of cases.

Annex 3: International Assessment of Marine Archaeology in Denmark

By Torben Malm and Susanne Bjerknæs Petersen (Danish Agency for Culture)

1. Introduction

It is the policy of the Danish Agency for Culture to ensure a high professional level, both internally and at the museums, as well as to improve handling of the central regulatory tasks continually. This is done, among other things, through assessments. An international assessment of dry land archaeology in Denmark was carried out by the Heritage Agency of Denmark in 2009, which focused partly on user satisfaction and partly on how the area of client-paid surveys is managed in general. An important part of the assessment was to clarify financial conditions and to determine whether excavations generate research results that counterbalance the level of expenditure. The assessment included 43 museums, and as two of these museums (the *Øhavsmuseet* and Moesgaard Museum) also hold marine archaeological responsibility, this 'dry land assessment' also superficially addressed the marine archaeological aspect, albeit without entering into a thorough analysis of the subject. It was therefore a logical step – in continuation of the dry land assessment – to carry out a similar assessment of marine archaeological activities in Denmark as handled by the Danish Agency for Culture and at the five marine archaeological museums: the Viking Ship Museum, the *Øhavsmuseet*, Moesgaard Museum, the North Jutland Coastal Museum and the shipwreck museum *Strandingsmuseum St. George* (The Cultural History Museums in Holstebro Municipality).

2. Task and Purpose of the assessment

The Danish Agency for Culture's management group defined the core focus of the task as a 'service check' of the combined marine archaeological activities in Denmark, partly to ensure that the administration is reliable, adequate and efficient, and partly to assess whether research results are produced that are in reasonable proportion to the research potential and the extent of client payment. At the end of October 2011, the Danish Agency for Culture prepared an internal memo as background material for the assessment; this included proposals for focus points, but also proposals for an assessment process as well as descriptive and explanatory examples of the given conditions and the current administration (Head of office Dorte Veien Christiansen and Archaeologist, Ph.D. Anders Fischer).

3. Working Method for the Assessment

From the outset, the intention was that the assessment should be carried out by an expert, independent international working group – assisted by a group of staff from the Danish Agency for Culture – which would have the option of using various 'tools' in the process.

The first step was to inform the international assessment group of the legislative basis, the marine archaeological regulatory management and the museums' execution of the so-called commissioned marine archaeological preliminary surveys, user-paid diving surveys etc.

A questionnaire was sent to the marine archaeological museums, asking them to provide an account of research publications, equipment stock etc. The museums were also invited to participate in focus group interviews with the international assessment panel.

Other stakeholders, in this case represented by public authorities and private companies, also received questionnaires. The public authorities are the agencies, directorates and others that send cases for hearings, while the private group is made up of the companies and contractors that consider carrying out construction projects or other activities in territorial waters. The two groups were sent each their own version of the questionnaire, which focused on assessing the users' level of satisfaction when they were in contact with the Danish Agency for Culture and the marine archaeological museums, respectively. Contractors were also invited to participate in focus group interviews with the international assessment panel.

Communication between the international assessment group and the Agency has largely taken place via email, and all translation of major documents into English has been carried out by the translation agency Avanti Gruppen.

The panel has held a series of working meetings in Copenhagen; cf. section 6. Series of Meetings.

4. Assessment Panel

One of the experts who participated in the assessment of dry land archaeology in 2009 was Dr Adrian Olivier, and based on the highly competent completion of that task, and considering that Dr Olivier is also knowledgeable about marine archaeology, it was an obvious choice to ask him to head this investigative work. The Danish Agency for Culture is very pleased that Dr Olivier accepted to undertake the role of Chairman of the assessment panel.

In order to carry out the assessment, an international panel was appointed in consultation with Dr Olivier, of experts with in-depth knowledge of archaeological activities, both on land and in territorial waters; in addition, the panel members all have experience of museum management and the production of scientific reports of archaeological work. The panel was composed as follows:

Dr Adrian Olivier, London (England). Dr Olivier served as Chairman of the international assessment assisted by the following members:

Director Björn Varenius, Head of Strategy and Planning, the National Maritime Museums, Stockholm (Sweden)

Dr Marnix Pieters, Director International Activities, Flanders Heritage Agency, Brussels (Belgium)

Dr Martin Segschneider, Landesamt Schleswig-Holstein, Schleswig (Germany)

Professor Dr Friedrich Lüth, the German Archaeological Institute, Berlin Head Office, Workspace Cultural Heritage Protection and Site Management, Berlin (Germany)

Curator Lene Høst-Madsen, Chairman of the Danish Archaeological Advisory Board, Museum of Copenhagen, Copenhagen (Denmark)

The Agency appointed an internal support group consisting of Chief Consultant and Archaeologist Michael Lauenborg, Consultant and Archaeologist Susanne Bjerknæs Petersen, Consultant and Archaeologist Torben Malm and Office Trainee Pernille N. F. Nielsen. The support group served as the secretariat for the panel, and its primary task was to assist in organising meetings, preparing memos, procuring data, and in any practical way to help the panel with its work as required.

5. Working Process

The Chairman of the assessment, Dr Adrian Olivier, was contacted at the beginning of 2012 with a request that he participate in the international assessment. On 16 April 2012, the first meeting was held between Dr Olivier and the Danish Agency for Culture in Copenhagen. At the meeting, the final process for the assessment was agreed along with proposals for participants of the assessment panel who were to assist Dr Olivier. During the meeting, it was also agreed which stakeholders were to be consulted in connection with focus group interviews and questionnaire surveys.

During April, the Danish Agency for Culture prepared and sent out questionnaires to the marine archaeological museums. The questionnaire included questions about marine archaeological activities carried out at the museums between 1 October 2009 (when the Agency handed over archive control to the marine archaeological museums) and April 2012. The questions were particularly related to the museums' management of marine archaeological hearing cases, reporting on these cases, and any further processing in scientific articles. The questions also addressed the individual museum's collaboration with the Danish Agency for Culture and the other marine archaeological museums. In addition, each museum was asked to submit lists of scientific articles, books and other publications produced in the period 1 October 2009 to April 2012.

The final composition of the assessment panel was completed during April and early May. The panel received written background material for the assessment, and the members were invited to the first working group meeting. The meeting took place in Copenhagen at the Danish Agency for Culture on 21 May 2012. At the meeting, the procedure for the working group's work was established, including the collection of data from stakeholders and a plan for focus group interviews.

By the expiry of the response deadline, 23 May 2012, the Danish Agency for Culture had received the completed questionnaires from the museums along with the requested material for clarification of the answers. All materials received from the museums were forwarded to the assessment panel.

In June, the Danish Agency for Culture prepared and sent out two questionnaires, one for relevant public authorities and one for large private companies that deal with construction works and similar in territorial waters. The questions focused particularly on the

relationship and collaboration with the Danish Agency for Culture and the museums, respectively. At the same time, the large private companies were invited to participate in focus group interviews. During the summer, the Agency received responses from several public authorities, but only a few responses from the large private companies.

On 26 June 2012, focus group interviews with the five marine archaeological museums were held at the Danish Agency for Culture. The focus group interviews were held in such a way that each of the five museums had three quarters of an hour with the panel, during which the panel, in dialogue form, asked the museums to expand on the questionnaire sent out by the Agency. The panel strongly emphasised that the museum representatives should feel free to talk about any topic on their minds.

Another focus group interview was held on 22 August 2012, this time with representatives from research institutions. Museum Curator Peter Vang Petersen, the National Museum of Denmark, and Professor Thijs Maarleveld, University of Southern Denmark, participated in this interview.

A focus group interview with contractors, which was also planned to take place on 22 August 2012, was cancelled, as there was no support for it.

The assessment panel held their final meeting on 30-31 October 2012 in Roskilde at the Viking Ship Museum.

6. Meetings

Meeting 1 Danish Agency for Culture, Monday 16 April 2012
Adrian Olivier, Michael Lauenborg, Susanne B. Petersen and Torben Malm.
Meeting on content and execution of assessment.

Meeting 2 Danish Agency for Culture, Monday 21 May 2012
Adrian Olivier, Björn Varenius, Martin Segschneider, Marnix Pieters, (Lene Høst-Madsen and Friedrich Lüth were unable to attend), Michael Lauenborg, Susanne B. Petersen and Torben Malm.
The working group gathered to adjust terms of reference and content, process and working method, time schedule and expectations.

Meeting 3 Danish Agency for Culture, Monday 26 June 2012
Adrian Olivier, Björn Varenius, Martin Segschneider, Marnix Pieters, Lene Høst-Madsen, (Friedrich Lüth was unable to attend), the Viking Ship Museum, the *Øhavsmuseet*, Moesgaard Museum, the North Jutland Coastal Museum, *Strandingsmuseum St. George* (see section 8, List of Participants. Interviews with the Museums, 26 June 2012), (Michael Lauenborg was unable to attend), Susanne B. Petersen and Torben Malm.
All-day meeting with five focus group interviews. Three quarters of an hour's interview with each of the five marine archaeological museums. The museums were represented by a director or manager and by one or more marine archaeological staff members.

Meeting 4 Danish Agency for Culture, Wednesday 22 August 2012.

Adrian Olivier, Björn Varenius, Martin Segschneider, Marnix Pieters, Lene Høst-Madsen, Friedrich Lüth, Professor Dr Thijs Maarleveld and Museum Curator Peter Vang Petersen; (Michael Lauenborg was unable to attend), Susanne B. Petersen and Torben Malm.
The working group held focus group interviews.

Meeting 5 Viking Ship Museum 30 October 2012
Danish Agency for Culture, 31 October 2012.
Adrian Olivier, Björn Varenius, Martin Segschneider, Marnix Pieters, Lene Høst-Madsen, Friedrich Lüth, Michael Lauenborg, Susanne B. Petersen and Torben Malm.
The final working group meeting of the Assessment Panel.

7. Stakeholders

Museums:

The Viking Ship Museum, Roskilde
Vindeboder 12, 4000 Roskilde

Øhavsmuseet (The South Funen Archipelago Museum), Svendborg
Fruestræde 3, 5700 Svendborg

Moesgård Museum, Århus
Moesgård Allé 20, 8270 Højbjerg

Nordjyllands Kystmuseum, Bangsbo
Dr. Margrethes Vej 6, 9000 Frederikshavn

De Kulturhistoriske Museer i Holstebro Kommune, Strandingsmuseum, ST. GEORGE
Vesterhavsgade 1, Thorsminde, 6990 Ulfborg

Researchers:

Prof. Thijs Maarleveld, Syddansk Universitet

Curator Peter Vang Petersen, Nationalmuseet

Public Agencies:

The Danish Maritime Authority repr. by Jan Anker

The Danish Coastal Authority repr. by Maja F Mikkelsen

The Danish Nature Agency, Odense, repr. by Nikolaj Holmbroe

The Danish Nature Agency repr. by Stig Helmig

The Danish Nature Agency, Roskilde, repr. by Jane Brøns

The Danish Directorate of Fisheries repr. by Stig Prüssing

Privat companies:
NIRAS A/S repr. by Jørn Jensen

Ole Askehave A/S Consultants (Raw materials industry) repr. by Ole Askehave

Nord Stream repr. by Samira Andersson

8. List of Participants. Interviews with the Museums, 26 June 2012

The Viking Ship Museum

Tinna Damgård-Sørensen, Director
Jørgen Dencker, Marine archaeologist, Head of Marine archaeological team
Morten Johansen, Marine archaeologist
Mikkel H. Thomsen, Marine archaeologist
Andreas Kallmeyer Bloch, Marine archaeologist
Anton Englert, Marine archaeologist, Ph.d., Reseach coordinator, Head of reseach team
Athena Trakadas, Marine archaeologist, Ph.d., employee in both marine archaeological team and reseach team

Øhavsmuseet, The South Funen Archipelago Museum

Peter Thor Andersen, Director
Otto Uldum, Marine archaeologist
Christian Thomsen, Curator

Moesgård Museum

Jan Skamby Madsen, Director
Lars Krants Larsen, Head of Department
Claus Skriver, Marine archaeologist

The Costal Museum of Northern Jutland

Michael Ax, Director
Jan Hammer Larsen, Marine archaeologist

Strandingsmuseum St. George (The Cultural History Museums in Holstebro Municipality) Ingeborg Svennevig, Director
Lars Froberg Mortensen, Marine archaeologist