MoSS
June 2002

Newsletter

2/2003

A shipwreck research project funded by the European Union Culture 2000 Programme

Theme: The Darss Cog Site

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Introduction

Carl Olof Cederlund
Editor

Of the nine MoSS project newsletters to be published, the first (1/2002) was an introduction to the project. The four following will each be a review of progress on one of the four shipwrecks in the project. The first one (1/2003), recently released, is about the snou Vrouw Maria, which foundered off the Finnish coast in 1771.

This issue concentrates on the wreck of a medieval cog found off Darss on the German Baltic coast. It has been produced by the Archaeological State Museum of Mecklenburg-Vorpommern.

What is MoSS?

Sallamaria Tikkanen

MoSS is a three year shipwreck research project funded by the European Community Culture 2000 Programme. The project opens an underwater window to four significant European shipwreck sites in the Netherlands, Germany, Sweden and Finland. The project is organized by six European countries in 2001-2004. The project deals with the monitoring, safeguarding, and visualizing of shipwrecks. The project aims at telling European citizens about underwater cultural heritage and the importance of its protection.

The MoSS project is based on four shipwrecks, all of which are of great significance from a European point of view and show a diversity of intercultural relationships throughout a long period of history. The wrecks are located in Netherlands, Germany, Sweden, and Finland, and they represent different vessel types. The oldest of the wrecks is dated to the 13th century whereas the youngest is from the middle of the 19th century. The wrecks are in different kinds of underwater environments; in sea, lake, and brackish waters, and the conditions on the sites are both stable and unstable. The wrecks have been preserved extremely well; two of them are almost intact.

The MoSS project has three main themes: monitoring, safeguarding and visualizing shipwrecks. The first theme includes monitoring the condition of the wrecks, or in other words doing research on the degradation of shipwrecks under water.
The aim of this theme is to develop and improve the methods used in monitoring the physical and environmental conditions of shipwrecks. The second theme is safeguarding, which aims at outlining and developing models to protect shipwrecks so that also the needs of different public groups are taken into account. The third theme is visualizing. The four shipwreck sites will be made physically visible using underwater and other images. The project will be advertised multilingually to the European public.

The MoSS project will consist also of fieldwork, Internet site, publications, posters, leaflets, reports, articles, meetings, and seminars. One of the objectives is to produce information not only to the general public but also to the experts in the area of protecting the cultural heritage. The aim is to awaken European peoples' interest to our common underwater cultural heritage and to have the general public participate in protecting the heritage. The wrecks of the project - ships that sailed on European waters - act as examples of maritime history as they tell us about the many local and international dimensions of the European culture.

The MoSS project is organized by The Maritime Museum of Finland (co-ordinator), The Mary Rose Archaeological Services Ltd. (United Kingdom), The National Service for Archaeological Heritage: Netherlands Institute for Ship- and Underwater Archaeology ROB/NISA (the Netherlands), The National Museum of Denmark/Centre for Maritime Archaeology (Denmark), The Department for Preservation of Archaeological Sites and Monuments / Archaeological State Museum of Mecklenburg-Vorpommern (Germany), and Södertörns högskola – University College (Sweden).
The MoSS Project is the first international shipwreck project that European Community Culture 2000 Programme funds. The European Community Culture 2000 Programme is a programme that supports international cultural co-operation projects that involve organizers from several countries. The objectives are among other things to encourage co-operation, to promote the common European cultural heritage, and to disseminate the knowledge of the history and culture of the peoples of Europe.

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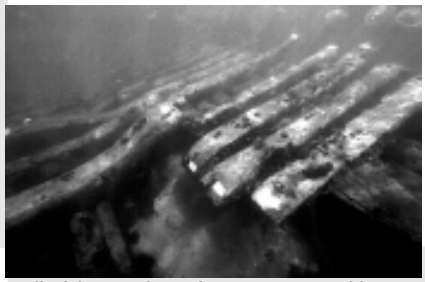
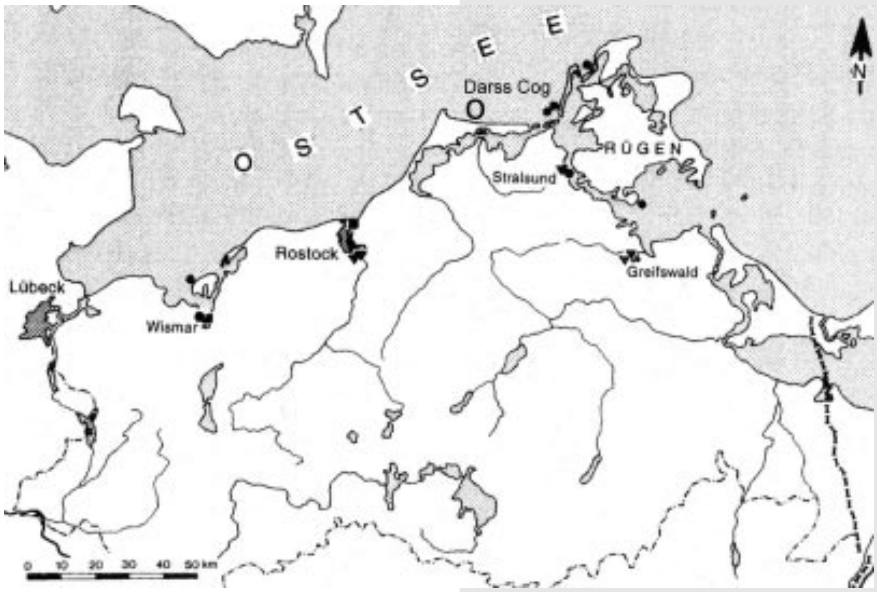
Late medieval shipwreck-sites of the south-western Baltic

In the coastal waters of Mecklenburg-Vorpommern more than 750 underwater archaeological sites are registered. Before 1990 archaeological research in the Baltic Sea was restricted, most of today's registered sites were located by systematic survey during the last decade. Most of these wreck-sites date from the 18th century. Ten late medieval shipwreck sites are considered to be of scientific interest; they give important insights into the transport organization of the Hanseatic League, the history of coastline-occupation and development of shipbuilding technology. Most of these sites amount to little more than fragments of hull, located during survey and excavation in the harbours of Stralsund, Greifswald, Rostock and Wismar. However some better-preserved late medieval sites have been investigated during the last few years. One of the better known is the Gellen Wreck [1339] that was excavated and recovered from near the small island of Hiddensee, west of Rügen. The wreck was displayed at Expo 2000 in Hanover. Another significant wreck is the Poel Cog [1354], which was located to the west of Poel Island and later recovered because it was threatened by construction of a harbour pier. A full-size replica of the Poel Cog is being built by the harbour in Wismar, and will probably be launched in 2004. Both the Poel Cog and the Gellen Wreck are typically representative of Baltic cogs, which differed in shape and construction from the Frisian North Sea cogs.



Hull of the Poel cog from 1354, a Baltic ship with a cargo capacity of more than 200 tons. Photographer: Klaus Andrews, Hamburg.



13th to 15th century shipwrecks and harbour remains off the coast of Mecklenburg-Vorpommern (Circle: shipwreck, Triangle: ship-parts in secondary use, Square: harbour remains) Drawing: Bernd Froese, Thomas Förster, LBD.

The Darss cog is the third well-preserved late medieval shipwreck in the coastal waters of Mecklenburg-Vorpommern. Built towards the end of the 13th century in the Vistula estuary region, but constructed in the Frisian shipbuilding tradition. The wreck lies off the old mouth of the River Prerowstrom at a depth of 6 metres. The Prerowstrom was a natural waterway that connected the Baltic Sea with the lagoon-like Barther Bodden until it was in-filled by flood deposition in the late 19th century. Strong coastal dynamics including erosion, transport and deposition of sediments characterize the area. Evidently, use of the waterway was hazardous, because four more wrecks have been located nearby dating from the 16th to the 19th century.

The Darss cog is an important indicator of the evolving Baltic shipbuilding technology during the 13th century, when influences from the North Sea area, such as the flat-bottomed, carvel-built hulls – as in the Darss cog – were adopted. This change reflects ethnic, social and cultural changes in the local population. At this time the power and influence of the Slavonic tribes of northeastern Europe declined in favour of the German knights and the colonization of the area by west European settlers. This was followed by the foundation of thousands of new villages and some towns as well as vast deforestation. The adoption of the Frisian carvel technology reflects the social upheaval of the 13th century.

The surveys and interdisciplinary investigations undertaken on the Darss cog and their current results shall be described in detail in this newsletter.

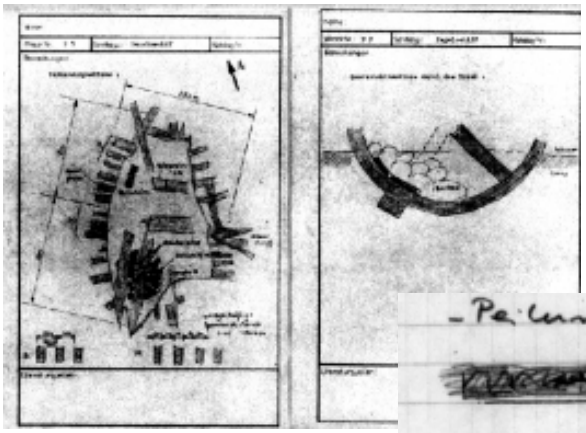
Hauke Jöns

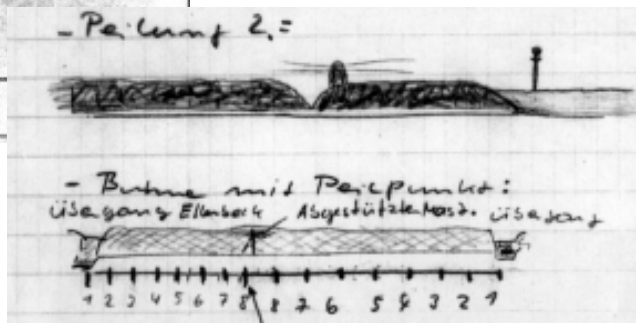
The Darss Cog-site and its research history

The Darss Cog was discovered not once, but twice. In 1977, local fishermen found parts of the wreck in their nets. Sports divers were alerted and located the wreck, made a rough drawing and carried out first technical measurements. Detlef Mohr, a member of the diving team, realized the special importance of the wreck and informed the Maritime Museum in Rostock. The political conditions in the then German Democratic Republic restricted the freedom of the museum to react and the wreck was left and forgotten. It was not until 2000 that the wreck-site was reported for the second time. Again it was Detlev Mohr, who informed the responsible state authority, the Archaeological State Museum of Mecklenburg-Vorpommern. Preliminary investigations were carried out immediately. It was noted that the wreck was still exceptionally well preserved, although there was some fishing net and sports diving predation. More significantly, it became clear, that the shipworm Teredo navalis was about to become a major threat to the wreck. Shortly after sinking the wreck had been covered by silt sediments, which explains the state of preservation. The starboard side, which is embedded in silt, is well preserved and the keel, stem, and parts of the deck beams all survive. The wreck's structure of a flat, carvel bottom and clinker-built hull sides identify the ship as a late medieval cog. The Darss Cog offers an opportunity to gain a valuable insight into the history of seafaring in the late medieval period.

The life savers show the cog site to the research divers. Photographer: Roland Obst, Erfurt

For the MoSS Project, detailed investigation of the Darss Cog will be the task of the German group. Geophysical investigations and aerial photographs will be used to acquire detailed information about the wreck-site and its environment. In addition, the whole wreck will be excavated and recorded three ways by, video, photo and drawing. Furthermore, the whole wreck will be recorded by photogrammetry. The environment of the wreck will be documented using a data logger supplemented by research from biological and geological archives.





Find drawing of the Darss cog made in 1977. Drawing: Detlev Mohr, Potsdam.

The detailed documentation and analysis of the Darss Cog will enable us to study how sea salinity and marine currents influence the spread of shipworm. The objective of the project is to develop a strategy to protect wooden wrecks from destruction by Teredo navalis. Accordingly, an underwater covering-system using a fine polypropylene gauze, developed by the Netherlands Institute for Ship-and Underwater Archaeology to protect wrecks in the Dutch Wadden Sea, will be tested for the first time in the Baltic.

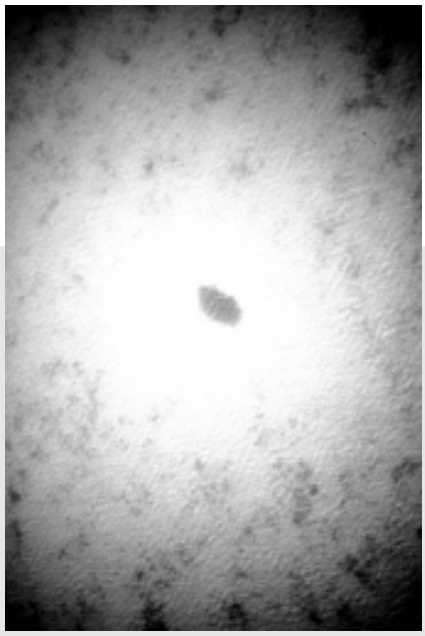
Aerial Photography and Geophysical Survey

The recording of the Darss Cog began in summer 2001. In order to determine precisely the position and the context of the wreck site its environment was examined by means of side-scan sonar (sonar - sound navigation ranging) and aerial photography over an area of 4 sq km. Additional geophysical measuring methods were employed using sediment sonar and georadar (radio detection and ranging) to ascertain the wreck's position in the sediment. The effectiveness parameters of these locating methods have been established in earlier projects.

Aerial photography

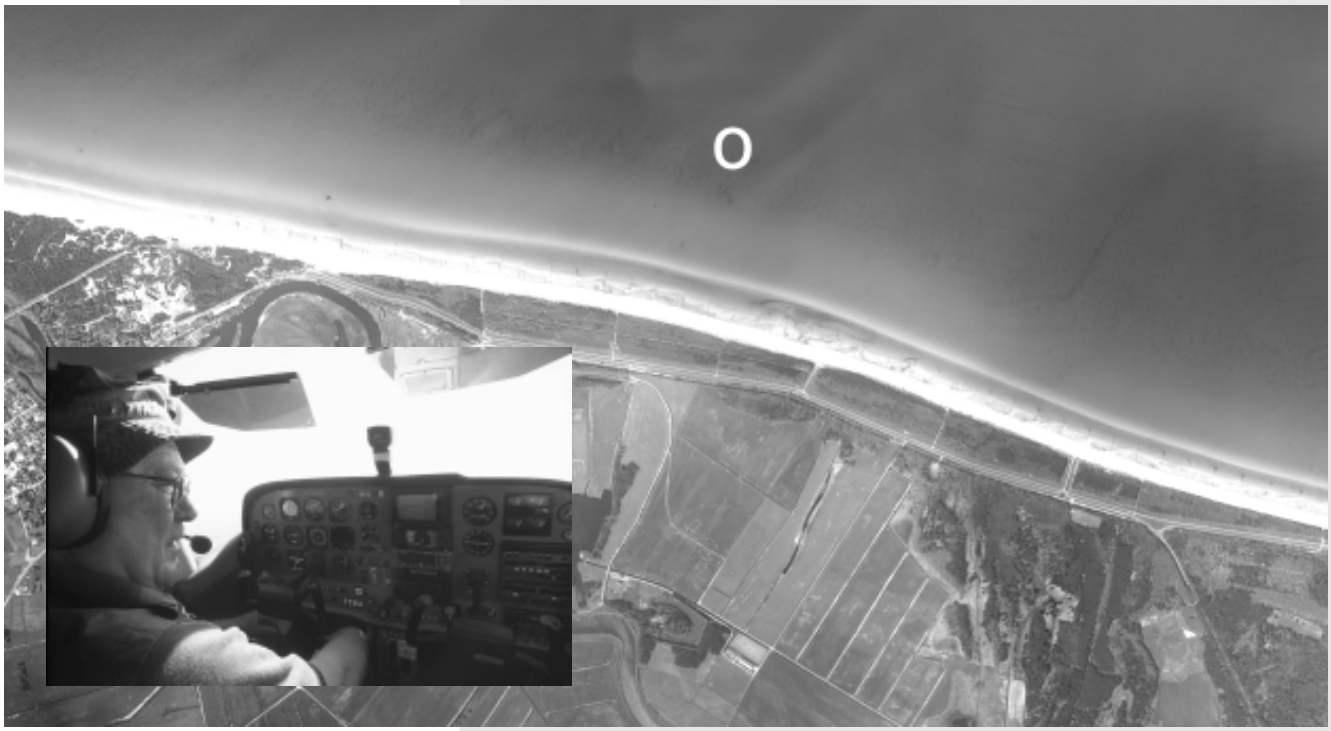
Aerial photography is an important method for recording sites. About 300 sites of archaeological interest have been located by aerial photography in the region. Visibility through the water in this part of the Baltic allows identification of anomalies to a depth of 5 - 6 m. The seafloor is light and sandy, producing the right conditions for aerial photography. During the survey the pilot O. Braasch, Landshut, was in constant communication with ground control and explored and observed the entire area around the Darss Cog. The condition of the Darss cog and the movement of sediments within the wreck area can be monitored by regular inspection flights. The data is transferred to CD-ROM so that divers using laptop computers on site can access data; also digital aerial photographic charts with geo-references are employed to locate single objects. The position of objects can be located from such a chart to within a meter. The Following results were gained:

·The cog was located in springtime at 6 m+.



Aerial photograph of the stone wreck from 1523 situated 1 nm east of the cog. Photographer: Otto Braasch, Landshut.

·Depth and water condition limited detail recognition.
·Near the cog eight anomalies were

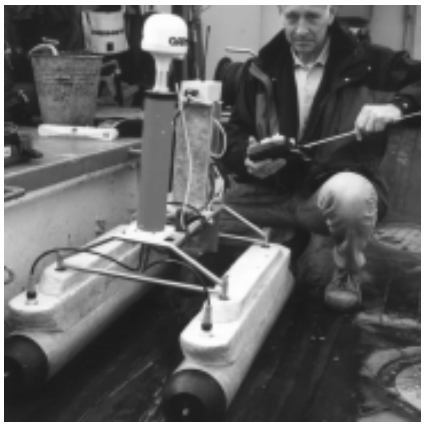


Aerial photograph of the Darss cog site off the old mouth of the river *Prerowstrom* and the aerial photographer Otto Braasch in his Cessna. Photographer: STAUN, Rostock and Roland Obst, Erfurt.

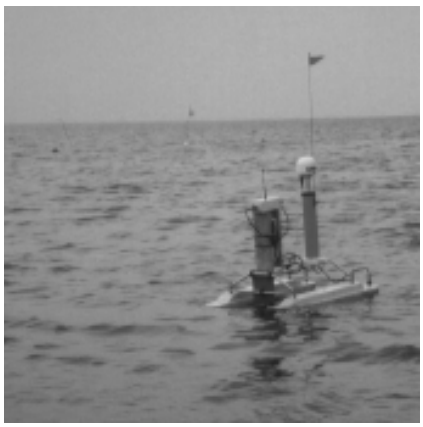
located and investigated by divers.
·The collateral objects were not part of the cog and date from later periods.
·A 19th-century wreck lies at a distance of 150 m
·An 18th-century wreck lies 500 m away from the cog.
·1800 m east of the cog lies a carvel-built ship with a stone cargo dating from the 16th century
·The rest of the anomalies included one stone depth weight and four more wooden ships from the 19th and 20th century.
The Darss Cog sank in the 14th century in the old mouth of the River Prerowstrom, the course of which is still recognizable on the seabed.

Side-Scan Sonar
Side-scan sonar was used to record the site of the cog and those areas not visible by aerial photography. The Federal Authority for Seafaring and Hydrography lent the team a Klein 2000 Side-scan sonar, with a capacity of 500 KHz and a survey area of 75 m. The close cooperation with the maritime survey authority, has led since 1993 to the location of 193 ship-wrecks, in the coastal waters off Mecklenburg-Vorpommern. The Darss Cog site was too shallow for the survey ship Deneb and so the sonar fish was towed by the ship's dinghy. The position of the cog was precisely recorded. Scanning of the seabed showed that no parts of the wreck had become separated.

Sediment Sonar
After the position of the Darss Cog had been accurately recorded further survey devices were used to probe the seabed. One of these was a sediment sonar [Sonder-Sonar Jena], a hydro-acoustic instrument transmitting two sound frequencies of 70 and 180 KHz from the water surface into the ground. Changes of density within the sediment are registered by measuring the variations of echo time, which are recorded on a chart.



Use of the sediment sonar. The sonar's transmitting and reception unit is placed on the catamaran. Photographer: Matthias Orgeldinger, Nürnberg.

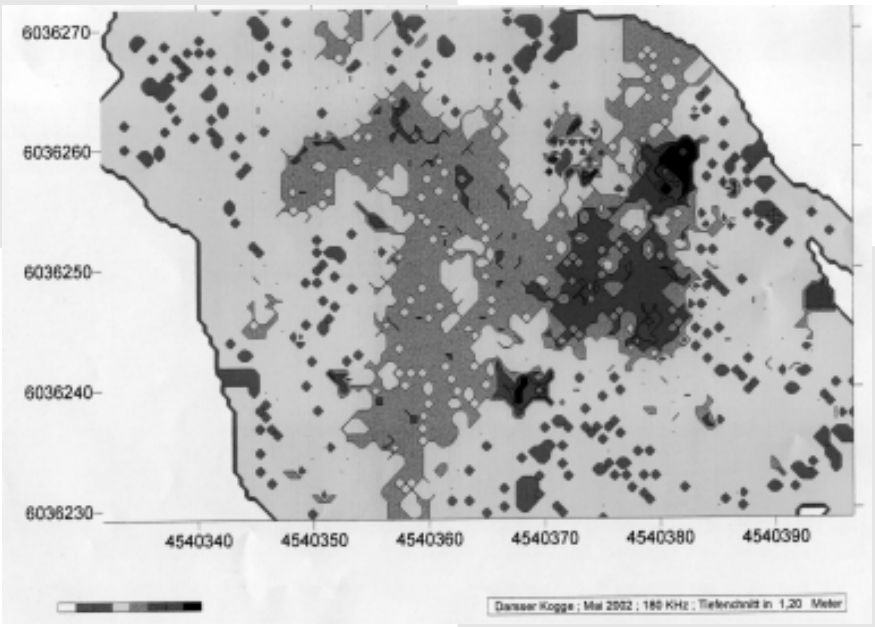


The sonar's transponder and receiver are installed on a remote-controlled highly manoeuvrable catamaran which is GPS located to +/- 10 cm. Sonar and GPS readings are permanently transmitted to a processing unit with the result that the screen simultaneously displays position, sediment constitution and time. The data is processed to show the surface profile in detail, the sediment in 3-D and any recorded anomalies.

Research divers placed vertical galvanized steel pipes in a rectangle around the Darss cog site. The corner points of the survey area were marked with buoys that served as base points for the geophysical survey. An area of 25 x 50 m was scanned and anomalies were identified to a depth of 2.8 m in the substrata. Interpretation of the data showed:

-The ship's hull is lying on its starboard side, and must have been covered with sediments shortly after the sinking.
-Parts of the wreck and remaining cargo are covered with sediments to a max depth of 1.5 m.
-Underneath the wreck are some objects up to 2 m down.
-A section of the portside [lying to the west] was removed by an east-west current.
-Through the portside lost section has been deposited a darker sediment that surrounds the site.
-Northeast of the wreck in the bow area a single solid object lies in the sediment at a depth of 2.8 m; possibly an anchor.

A sediment sonar survey is useful for planning excavations because the extent of a site can be displayed in 3D. A computer model has enabled us to graphically simulate excavation before fieldwork. The sediment sonar



Sediment sonar reading visualizing the conditions in a depth of 1.2 m in the ground. Wreck, cargo and ballast are shown for the higher density in cyan, magenta, red and black whereas the sediment is depicted in yellow and green. Recording: Klaus Storch, Jena.

penetration is limited if the sub-strata is composed of compressed sand, or an accumulation of stones or sediment containing gas. In these a high density or gaseous conditions georadar is required rather than hydro acoustic sonar.

Georadar

For the complete recording of the Darss Cog site the geophysical investigations were supplemented by the use of a georadar produced by the Texplor/Brandenburg Company. It works like conventional aerial radar measuring the time lapse between the transmissions and receiving back of a reflected radio signal. Georadar enables anomalies to be investigated by subsoil geology and sediment strata. The so-called 'scuba radar' antenna is fixed on a sledge-like frame which is either carried by divers or dragged by a boat over the survey area, it is effective to 30m. The Darss Cog site was surveyed at a frequency of 500 MHz, which penetrates the sub-strata to a depth of 15m. Narrow vertical sections of the survey area enabled a high resolution of the wreck and its components. In addition for visual orientation a video camera transmitted a record of the survey to the surface.

Results were obtained as follows:

-The recordings of the longitudinal profile shows circa 18 m of the extant starboard side and a width section of circa 6 - 8 m.
-Within the ship's shell a number of single objects can be recognized which belong to the ballast, the cargo or the collapsed parts of the ship.
-Several single objects were located in the southern section of the wreck.
-In the western external section a few unidentified objects have been found.
-Few single objects are east of the wreck.
-Objects are concentrated to the north and south of the wreck.

Compared to the sediment sonar the georadar can penetrate the ground deeper and dense layers on the surface of the ground do not interrupt signals. The disadvantage is the low resolution and the limited ability to produce of three-dimensional sections.

The excavation of the bow section in August 2002 partly confirmed the geophysical investigation. The hull is covered in up to 1.5 m of sediment. Ballast stones, parts of the cargo, ship's equipment and collapsed ship timbers were found within the wreck.

Preparing the georadar. The scuba radar antenna with the video camera as well as a screen for observation can be recognized. Photographer: Matthias Orgeldinger, Nürnberg.

Thomas Förster and Hauke Jöns

Excavation and documentation of the Darss Cog

One of the three goals of the MoSS-project is to develop shipwreck site documentation routines using a variety of techniques. Wooden wrecks off the coast of the western Baltic are at an increasing risk from shipworm Teredo navalis and have to be recorded quickly with fast documentation methods. Therefore, new methods and techniques superior to conventional drawing and photography have been developed. Photogrammetry might in the near future be a standard method for precise and timesaving recording of submerged wrecks. As a part of the MoSS-project, the virtual reconstruction of shipwrecks, based on photogrammetry, will be developed in a pilot-study at the Darss Cog site. The German MoSS-project partner, the Archaeological State Museum of Mecklenburg-Vorpommern, in this pilot-study is co-operating with a working group from University College Neubrandenburg and the University of Rostock in order to gain from their experience.

As a starting point, all exposed parts of the wreck were recorded using a series of overlapping photographs, were assembled to scale and measured using AUTOCAD. The next step was to document all sediment-covered parts of the ship in the same way. To achieve this the complete hull of the wreck had to be excavated in three operations. The work started in August 2001, when a trial trench of 2 m width was excavated in the forward part of the ship to determine the preservation state of the ship-timbers. In August 2002, excavating from the 2001 level down to the mast step and the third crossbeam continued the excavation. The ballast stones around the keelson were left in situ, because they stabilized two unfixed deck

Uncovering the wreck by water dredging. Photographer: Roland Obst, Erfurt.

The diving base ship Seefuchs served as working base and accommodation for a crew of 15 divers and assistants. Photographer: Frank Kleeblatt, Dessau Photographer 1: Roland Obst, Erfurt.

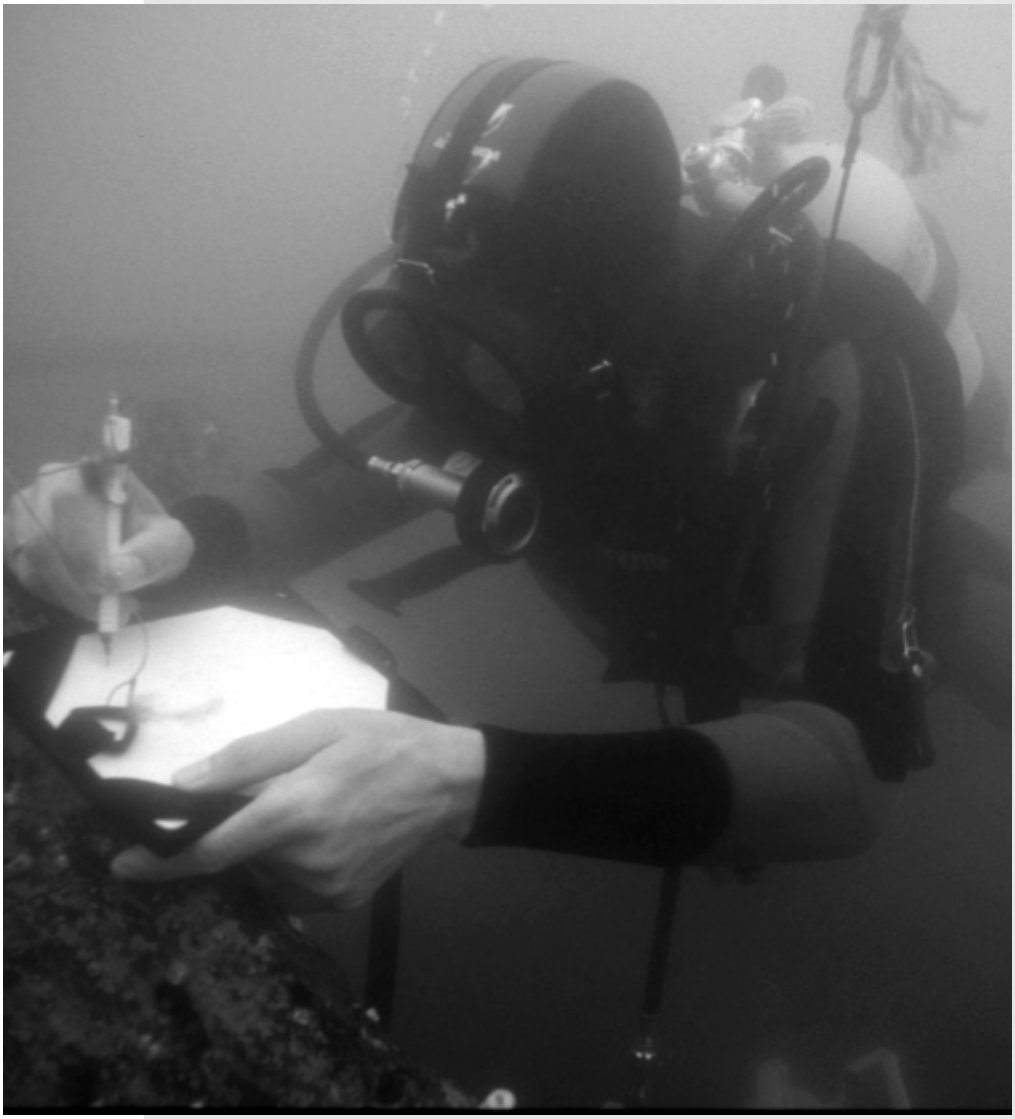
planks. The excavation is scheduled to be complete by Autumn 2003 with a detailed investigation of the stern and the central part of the ship. In addition to the photogrammetrical recording, the wreck was drawn with the help of measuring squares, digitally photographed and filmed.

During underwater excavations, the converted cutter SEEFUCHS served as working base for the research team. The team consisted of 12 to 15 research divers, draughtsmen, photographers and students. Before excavation, a survey system was established at the wreck-site, based on a steel-pipe framework of 5 by 5 m grids at a height of 1.2 m above the wreck. The small gap between the frame and the wreck was chosen because visibility was impaired by entangled vegetation. The frame is the reference point for the draughtsmen and photographers. The photographers found it convenient to use moveable threads of stainless steel within the grid frames as reference lines. Additionally, measurement tapes were fixed at regular intervals to orientate and link the photos for photogrammetry.

Excavating the wreck was carried out with suction-pipes of only 12 cm diameter. This small diameter was to minimize possible damage to the hull or items of ship's equipment. The removed sediments were sieved for small finds. Fencing nets around the site gave some protection to exposed parts from currents, wave action and vegetation [to reduce active biodegradation on the timbers].

Enough information was collected during the excavations, to describe the ships construction in detail. Additionally two well-preserved finds have been recovered, indicating the ships cargo and life onboard [see following articles]. The wreck can now be visualized in detail positioned on the seabed and progressively through the stages of excavation by using the photogrammetrical data. In addition, the data can be animated to show the wreck excavation process (see following articles).

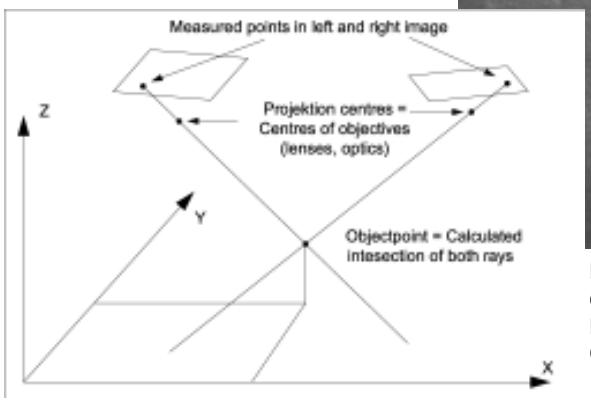
A diver surveys the wreck. Photographer: Roland Obst, Erfurt.



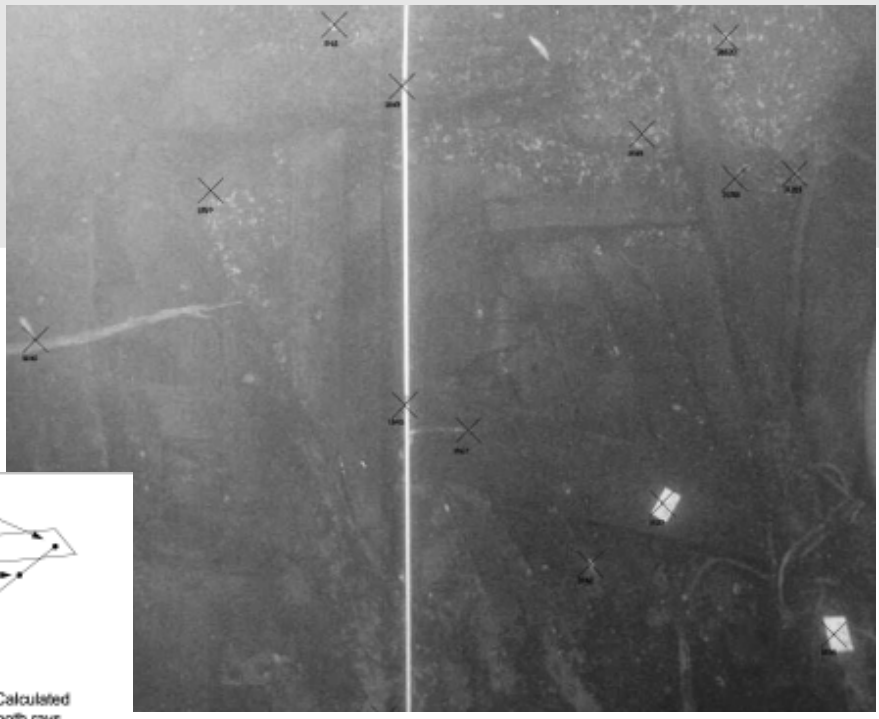
Sybille Brozio, Wolfgang Kresse, Lars Büttner, Frank Wehden

The Darss Cog: Surveyed by Photogrammetry – Principles, Data Processing and Future plans

Photogrammetry allows for the precise three-dimensional survey of objects using geometrically well-defined images. The following two sketches explain the basic measurement principles. The first sketch shows the geometric method by which the spatial intersection of the two rays ranging from two measured image-points is calculated. This intersection is one of many object points measured with an accuracy of a few centimetres. The second sketch shows the footprints of a subset of the photographed images. In the lower section the image geometry is shown from the side.

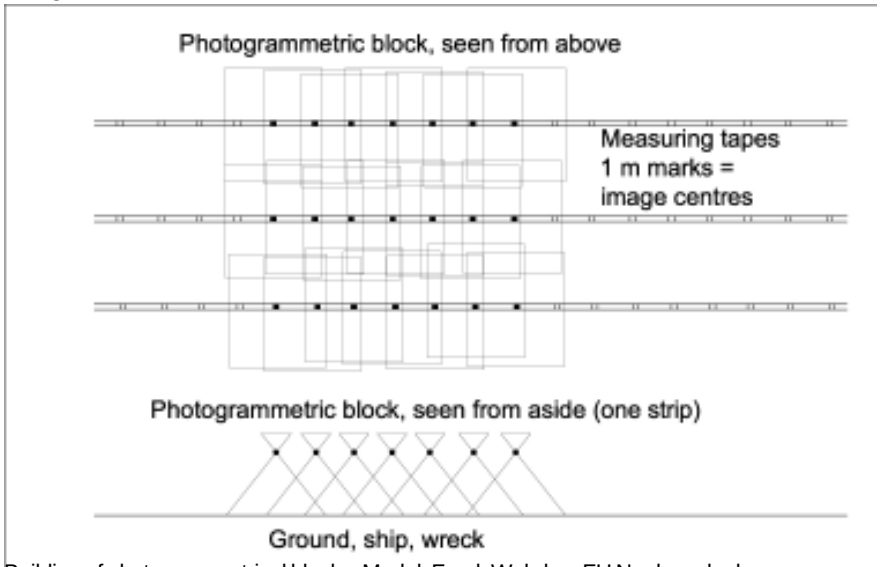


Principles of Photogrammetry Model: Frank Wehden, FH Neubrandenburg.



Photographic mosaic of the Darss cog. Photographer: Roland Obst, Erfurt.

As part of the MOSS-project, the University college of Neubrandenburg conducted a pilot study, which showed that photogrammetrical techniques could be useful for the recording of the Darss Cog. The results encouraged the use of the same or similar techniques in recording the numerous other endangered wooden wrecks, still lying on the floor of the sea.

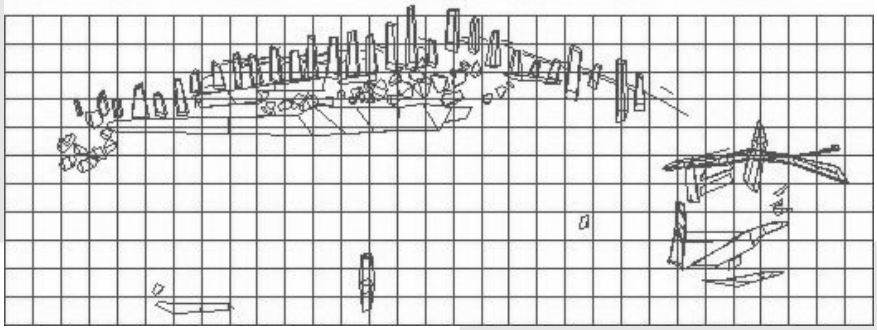


Building of photogrammetrical blocks. Model: Frank Wehden, FH Neubrandenburg

Feasibility study

As a diver had to take the required photos of the Darss Cog under water accurately, the preliminary work included plotting-out the wreck with five metal measuring tapes, which were aligned in parallel along the overall length of the wreck. The tapes provided the photographer with accurate alignment of the images. Black adhesive tape at every meter marked the centre of each image. For later photogrammetrical assembly it was essential to fix the camera settings, particularly, focal length.

The photogrammetrical block was set up using the same geometry as a



Through interpretation of the recording a grid model of the Darss cog can be created. model: Frank Wehden, FH Neubrandenburg.

block in aerial photogrammetry. The overlap between images along the strip was 60% and across the strips 30%. The images were scanned with a resolution of 15µm. The preparation of the data for a stereo model includes measurement of the interior orientation, point measurement for the block triangulation and the block triangulation itself.

A local image coordinating system was established by measuring the four corners of each image, the so-called interior orientation. About 15 points [tie-points] have to be measured in each image in order to combine all of them to a photogrammetrical block. This can be a tedious job, as the current software requires manual point measurement. The third step is a network adjustment calculated with the group of all images.

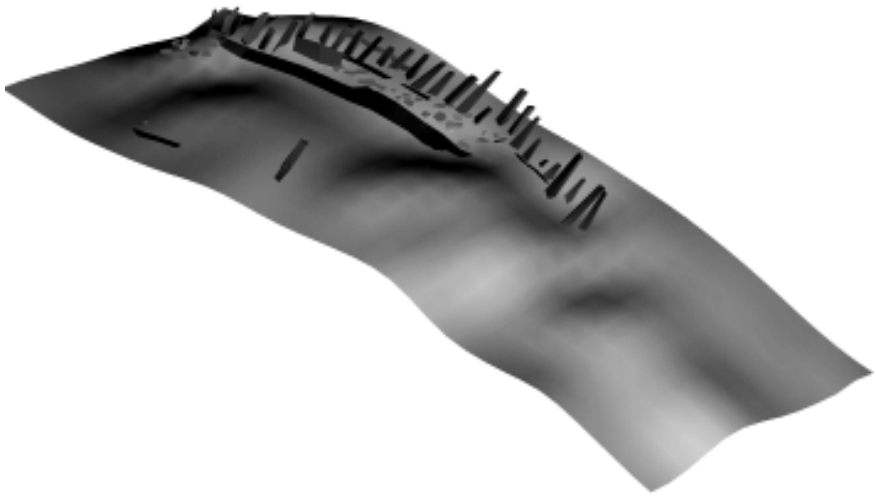
Having completed the photogrammmetrical block the measurement of the three-dimensional structure of the wreck started. The software used was PHODIS-ST, which was composed of a stereo display for the manual measurement of the points and a CAD-package Micro Station, used for the online storage of points and lines. The geometric accuracy was determined by the multiple measurements of single points or whole objects. The accuracy for points is 0,7cm in the X-Y-plane and 1,3cm in elevation. The accuracy of the measurement of a whole object is 3cm in the X-Y-plane and 5cm in elevation. The result of the photogrammetrical measurement is a wire frame model. It is based on the fully three-dimensional data set of the cog.

Finally the edges of the wire frame model were combined to create a three-dimensional model of the cog.

Development of a strategy for a mass recording of wooden wrecks:
The same procedure used in the pilot study can be used for mass recording. The photogrammetrical measurement logistics are available, but because of the limitations of existing software, full three-dimensional recording of wrecks will be time consuming. Automatic geometry software packages are becoming available to replace the manual work.

Major challenges:
Manual measurement of the tie-points for image triangulation is very time-consuming. For aerial photo-grammetry with simple geometries an automatic measurement is available. But these programmes do not yet work for underwater photogrammetry. Automatic 3D point measurement has only been available for digital surface models but does not include automatic edge detection. Software for edge detection of houses and roads are currently being tested. Methods of automatic object recognition have still to be developed.

Animation of the wreck in situ based on the readings. Animation: Frank Wehden, FH Neubrandenburg.



Peter Korduan and Roland Obst

Photogrammetric measurements at the Darss Cog

The process, documentation and modelling of the shipwreck Darss Cog by close range photogrammmetry:

-Place spherical marks and scale rods on the wreck and site
-Take photographs from different directions
-Digitise photos with photo scanner
-Compute the orientation of the camera stations
-Measure the features in photos and calculate 3D coordinates by intersection
3D-model can be transferred to any other graphic software or CAD programme.

To enhance identification of tie points in different corresponding photographs; spherical marks at a distance of 50 to 100cm were placed over the whole shipwreck. Additionally scale rods were placed vertically around and through the wreck site. Convergent photographs were taken to get good intersections. A camera with a Dom port, a 36x24mm slide film and 18mm focal length was used at an object distance of approximately 1m. The slides were scanned at 1350 dpi in a normal photo scanner. It is important to check that the four corners of the photographs are visible within the DIA frame.

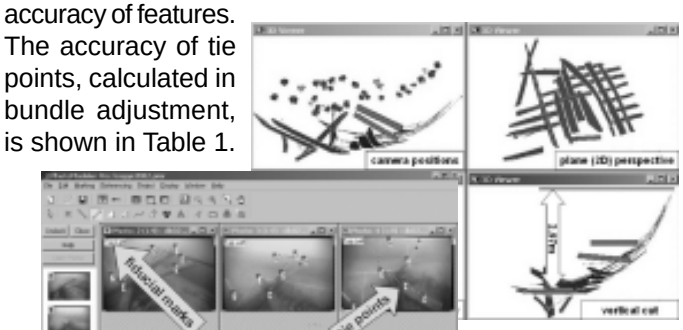
The process was undertaken using “photo modeller” software from EOS Systems Inc. Stage one sets the range, photo size, control point coordinates and camera parameters. To compute the orientation of camera stations two separate photos were positioned. For each photo the four corners in the images were marked up as control points. Then tie points were marked and referenced in the next photograph. After processing the bundle adjustment, other photographs were added. Process constraints were then added with known distances between points to stabilize the scale. Because there were few control points in contiguous photographs, additional non-signalised points like shells or stones on the seabed or holes in the timber of the wreck were used. The edges of the beams, planks, frames and the keel were drawn. Feature edges were sometimes unclear and were synthesized by 3D intersection rather than by bundle adjustment with the tie points to give greater accuracy during processing. The surfaces of the features were generated in surface mode. Different colours were used to separate different materials and layers. Photo modeler provides the opportunity to project the points and lines from 3D positions to the plane of each photo. This function is used to control distances and to check the accuracy of features. The accuracy of tie points, calculated in bundle adjustment, is shown in Table 1.

The errors between measured distances by tape and calculated distances in 3D model were rarely greater than 5cm.

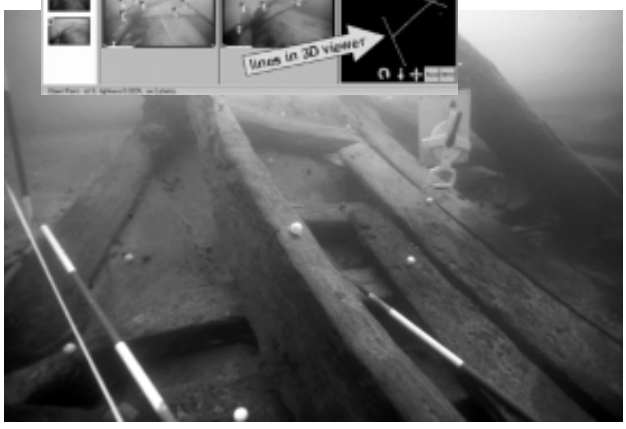
Table 1: The precision of tie points

X Precision 0.1-1.7cm
Y Precision 0.2-1.9cm
Z Precision 0.1-2.9cm

To improve accuracy, it will be necessary to consider some extra controls.
A calibrated camera such as a digital camera or a camera with reseau grids would be better.
More tie points in the corresponding and overlapping photographs.
Signalise more points on the wreck.
And/or plan a better configuration.
Photography should be undertaken in better visibility.
And/or with a better illumination in the water.



Screenshot from the program Photo modeler. Peter Korduan, Rostock.



View into the fore ship with the construction of stem, side stems, crossbeams, frames and stringers. Photographer: Roland Obst, Erfurt.

The construction of the Darss Cog.

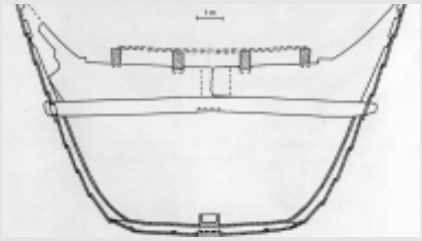
The first archaeological investigation of the Darss Cog indicated that the wreck was well preserved. The portside bottom shell, the keelson, the crossbeams and the starboard side that was exposed above the seafloor were almost completely preserved. This observation was confirmed by geophysical measurements with the sediment sonar and georadar. The hull appears out of the seabed for 17 m with an apparent beam of 8 m, and is buried to 1.5 m in the sediment. Other parts of the cog that had broken away were found in the surrounding debris field.

In August 2002 the starboard side of the wreck was uncovered from the stem up to the midship section to the level of the third crossbeam and the mast step in the keelson. During this process a wealth of constructional details were recorded. The wreck was almost entirely built of oak, with a flush-laid, flat carvel-built bottom up to the 4th plank strake, with planks of 45 - 50 cm width. The plank seams in the bottom of the ship were caulked with animal hair. The clinker-built sides consist of another 15 plank strakes of 30 cm width each. They are fastened to each other with double-clenched nails. The moss caulking between these planks is covered by caulking laths and fastened by caulking clamps. The wreck's keel has been distorted and can hardly be recognized. It has a width of 30 cm and a thickness of 10 cm. Being formed to the keel plank the stem post carries a rabbet for the fastening of the plank strakes. A beam found lying near the stem is perhaps one of the two side stems. The construction of the frames combining floor timbers and futtocks can be seen in the exposed interior.

The third crossbeam sits in front of the mast step and supports the mast. Beneath the crossbeams one can see the stringers and ceiling planks. Photographer: Roland Obst, Erfurt.

The first five floor timbers are made of v-shaped angled wood and are supported by beams that run from port to starboard. This possibly created a small cargo area because it is where the sulphur barrel, reindeer antler, two pairs of shoes, ropes and textiles were found. The keelson starts at the fifth floor timber and has a maximum width of 70 cm at the thickened section of the mast step. The mast step itself is 70 cm long and 30 cm wide. An incorporated ledge in the mast step served for wedging the mast tight. Three uncovered crossbeams penetrate the hull at the twelfth and thirteenth plank strake. From the upper side knees provide for cross stability and deck fastening. The deck edge is still to be found at the bulwark. A circular and a square opening in the hull were probably scuppers to allow water to clear from the deck. The ship's interior is lined with ceiling planks, which are either nailed to the floor timbers or in case of pine planks more loosely attached. Stringers are attached to the sideboards to increase the cross stability. Treenails of 30 to 45 cm diameter were used to fasten the frames, keelson, knees, ceiling planks and stringers.

Traces of a pitch-like coat could be detected at the inner and the outer side of the hull. A second method of wood preservation was identified where the inner sides of the ceiling planks and stringers had been surface charred. Certain areas showed only a partial charring caused by covering. Numerous timbers carry traces of saw, axe and cut marks. As already described, the Darss Cog was built after 1293 in the Vistula region, although the construction is similar to North Sea cogs. Comparing the Darss Cog with the famous Bremen 1380 cog, several common characteristics can be identified such as the flat carvel-built bottom, the lap strake sides and the steep alignment of the stem. This shows that along with German eastern colonization of the Baltic coast and the growth of hanseatic towns at the end of the 13th century came the transfer of the North Sea ship building technology.



Cross-section of the almost equally built Bremen cog from 1380. The drawing shows the function of the crossbeams and deck knees. Drawing from the book: D. Ellmers, The Cog of Bremen. 1979.

Thomas Förster and Hauke Jöns

Cargo and personal equipment, the find-material from the Darss Cog

The position of the wreck 800 m off the coast and in 6 m of water, prevented early people from recovering the cargo. Additionally, the wreck has not been affected by shore wave action or pack ice drift that damage wrecks. Consequently the cargo, equipment and personal belongings of the crew remained to be found, recorded and some recovered. These finds are an indication of trading contacts and give a unique insight into life on board. Some of the most important finds were a lamp made of a leather tube stiffened by bronze rings. The light of the flame shone through a transparent thin horn plate, hook fastened to the tube. Similar bronze rings have been discovered in other wrecks and in urban excavations, but only the complete lamp found in the Darss Cog shows their use. Ships´ pots and pans were generally made of metal, because pottery was too fragile. Metal articles often carry signs of origin and indicate the distribution of new ideas and better technologies by ship. Some metal vessels from the Darss cog are good examples. One complete Bronzegrapen - a three-footed bronze cooking-pot and fragments of two others were found in the wreck. Material analysis and a mark on the pot indicate they were all cast in Lübeck, one of most important towns of the Baltic Sea region in the 14th century. Whether these pots were used onboard for preparing food or whether they were trade goods is not known. Some more extraordinary bronze-vessels have also been found at the wreck-site. A very rare find in the Baltic is a three-legged bronze can. By comparison with similar cans and material analysis it was concluded, that it had been cast in Wales. Additionally, a pewter can was found in the ship's interior, which is common in the area and known as a hanseatic can. A depiction of the crucifixion is shown on the lid. The handle carries the inscription 'AVE REG(ina)' and an owner's monogram. Close to the hanseatic can, a flat pewter bottle with a different owner's mark appeared. A leather stopper was still attached to the bottleneck.

A pewter Hanse can with the depiction of the crucifixion on its lid. photograph: Frank Kleeblatt, Dessau.

Diver salvaging a three-footed bronze pot with a mark of Lübeck. Photographer: Roland Obst, Erfurt.

The cargo of the ship consisted mainly of roof tiles, mica schist whetstones and sulphur. These were trade goods of great importance to the expanding hanseatic towns because they were widely distributed across northern Europe at the time. The whetstones probably came from quarries in Norway. They were roughly worked and shipped as bars of up to 60 cm length. These bars were bound with vines in bundles of approximately 20 kg. Along with polished limestone slabs, the cargo also contained crumbled lime for mortar production and building timbers, similar cargos have been discovered in other late medieval shipwrecks. Roof tiles appeared only as single fragments and might have belonged to a previous cargo; further proof of the long-distance trade in building materials in late medieval times.

A wooden barrel with a branded coat of arms and owner's monogram was found. The dendrochronological analysis indicates, that it was oak, from the Vistula estuary area dated 1335, so that the Darss Cog must have been in use for at least 40 years. The barrel contained sulphur. Sulphur is well known from medieval texts, it was known as "brennistein". At the time most of the sulphur in the Baltic area was used for sterilisation of wine and beer barrels. It was produced in Iceland and was imported via Bergen, Norway to East and Central Europe. Sections of reindeer antler were recovered, probably from Norway or Sweden, they were being shipped as semi-finished product, which was later processed for use as combs, knife fittings, gaming pieces and beads.

Additionally, some of the crew's personnel affects were found in the wreck and its surroundings. They cast light on living conditions on board. As part of the navigational equipment, a depth sounding lead line was discovered; frequent use had heavily squashed the base. A small bronze disc was found which might have been the centrepiece of an hourglass. Hourglasses came into use in the 14th century and served as navigational instruments on ships up to the 18th century. As examples of the crew's personal belongings, two pairs of leather shoes were found in the forward part of the ship. The uppers of one pair were artistically perforated with a wheel-like design. The shoes were laced up onto the foot using leather strips. Wear marks suggest they were well worn. In addition, remains of dried fish were found in the wreck. Wooden skewers, over 30 cm long were stuck through the upper part of the fish to hang them for drying. The find positions indicate that the dried fish were shipped in bundles. In medieval times, dried fish was a typical product of the Norwegian coastal zone; they fit with the context of the other cargo. The dried fish could belong to the food store of the sailors or be a part of the cargo. A number of lead weights from the find layer must have been part of a fishing net. It's obvious that the sailors would try to supplement their diet with fresh fish. Apart from dried and fresh fish, mammal bones and hazelnut shells were some of the other provisions found.

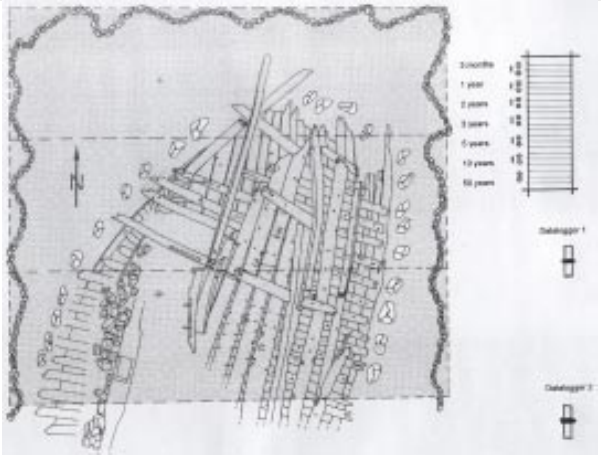
The handle of the *Hanseatic can* carries the inscription 'AVE REG(ina)'. Photographer: Frank Kleeblatt, Dessau.

Most of the cargo is of northwest Scandinavian origin. This indicates that the ship probably came from western Norway with goods for the Baltic area. It is assumed that the Darss Cog was one of the vessels travelling from Norway via Skagerrak to the Baltic. This was a well-documented hanseatic trading-route, and is described in numerous late medieval texts. Possibly, the cog was on its way from Bergen, Oslo or Tønsberg for a town on the southwestern Baltic coast, when it sunk in the Darss area.

Thomas Förster

New methods in monitoring shipwreck-sites

A programme of site safeguarding and monitoring routinely accompanies the recording of archaeological sites along the coast of Mecklenburg-Vorpommern. Side-scan sonar survey and aerial photography provide an indication of the condition of the objects. The monitoring of wrecks in shallow coastal waters is a priority because wrecks at depths of more than 10 m are less vulnerable. These areas are over-flown 3 - 4 times a year. Particular attention is made after storms or strong sediment movements. Wreck impact can be observed and appropriate measures taken for protection. Research divers then evaluate the wreck-site with the help of sonar data and aerial photographs, samples are recovered for dating and a case-study/review initiated. The existing condition is digitally recorded both by video and photographically together with a comprehensive risk analysis.



Drawing of the sample station and data loggers east of the covered Darss cog Drawing: Daniela Hinz, Bernd Froese, Thomas Förster, LBD.

The biggest risk to the long-term safeguarding of wooden shipwrecks in the southwestern Baltic is the shipworm. The shipworm is a mollusc of the family Teredinidae and arrived on ships coming from warmer regions and spread from the North Sea during the last century. In the Netherlands the mollusc destroyed lock gates as early as 1731. In the late summer of 1993 an infestation was recognized on wooden breakwater structures in the Darss – Zingst – Hiddensee area. This is the greatest mass occurrence of this species in the area since an outbreak in 1932/34. It is estimated that Teredo navalis has damaged 50% of all breakwater structures on the coast of Mecklenburg-Vorpommern. Financially it has been estimated that to repair the damage would cost about 13 million•. More crucially from our perspective Teredo navalis was also observed on most exposed wooden shipwreck-sites in the area. A monitoring programme on the problem initiated by the State Authority for Environment and Nature shows that the shipworm has adapted to the conditions in the Baltic and the concern is that the threat is not going to disappear quickly.

Station of the samples at the Darss cog. Photographer: Roland Obst, Erfurt.

Apart from the recording and protection of infested or endangered wrecks the monitoring of the not affected sea areas north and east of the island of Rügen is increasingly important. The monitoring programme of the MoSS-project is designed to deliver basic data on existing conditions in the Baltic. West of the cog site there is a submarine ridge [The Darss sill], which influences the water circulation in the Baltic. This sill impacts on the oxygen content and salinity in the eastern Baltic Sea by affecting the circulation of the water mass in the area.

On behalf of the countries bordering the Baltic a monitoring mast was installed on the Darss sill in 1992 to monitor the local ecosystem. The Warnemünde Research Institute installed the mast and the readings are published on (www.io-warnemuende.de/projects/

The destructive effect of Teredo navalis is shown on this sawn-open plank. Photographer: Matthias Orgeldinger, Nürnberg.

monitoring/de_home.html). The MoSS-project has access to data from the region east to the Darss sill. The monitoring programme at the Darss Cog involves the operation of two data loggers and the installation of a framework on which are suspended wood decay samples. The data loggers were mounted on a frame 5 m east of the cog. The frame is 2.2 m high, implanted 1.2 m deep in the seabed. The data logger is held in a stainless steel mounting horizontally 1 m above ground. The battery packs to power the data logger are also mounted on the frame. The data loggers measure temperature, turbidity, depth, dissolved oxygen, conductivity, pH-value, redox potential and salinity by date, time and monitors battery capacity. Frameworks of wood decay samples were erected east of the cog. Samples of oak, pine and archaeological oak were partly wrapped in different materials and fastened to a frame of galvanized pipes (3 m long, 1 m wide). The fastening straps were additionally secured at the frame by a synthetic band. A net was finally drawn over the whole frame. The samples were arranged from the north to the south in order of the duration of their stay (3 months, 1 year, 2 years, etc.). In front of this frame a number of Perspex bars wrapped in different fabric samples [Shirley Samples] were placed vertically 50 cm deep into the ground. Additionally plastic pipes containing wooden samples were placed vertically into the seabed. The two sample rows were positioned in chronological succession and connected to a synthetic orientation rope between two steel pipes.

At another shipwreck site 500 m away from the cog another wood sample frame, Perspex bars and plastic pipes were installed. This ship was not infested by Teredo navalis. It is assumed that low-salinity caused by fresh water flowing from the River Prerowstrom inhibits the shipworm. Monitoring shipwrecks off the coast of Mecklenburg-Vorpommern is an important part of safeguarding and preservation management.

Traces of Teredo navalis on the wood of the Darss cog. Photographer: Roland Obst, Erfurt.

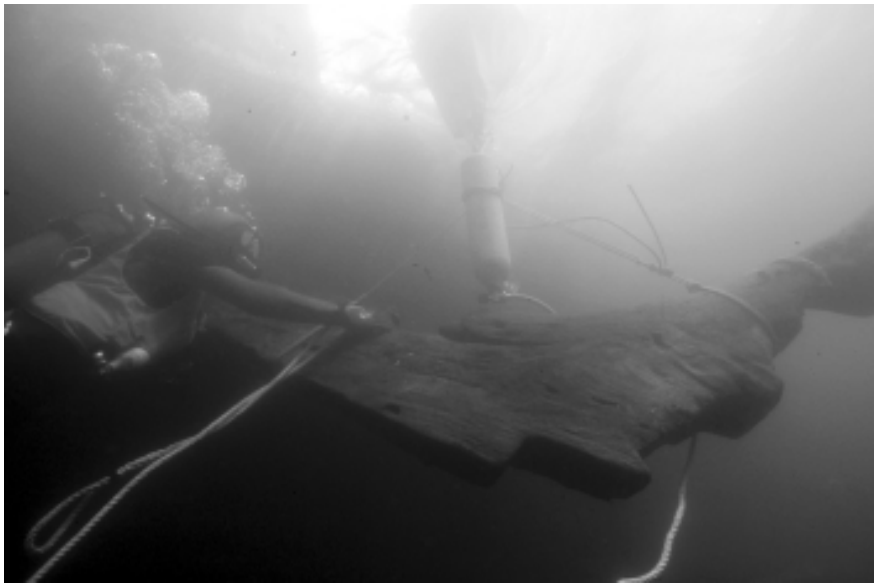
Claudia von Laar

Drill resistance measurements on the starboard knee of the Darss Cog

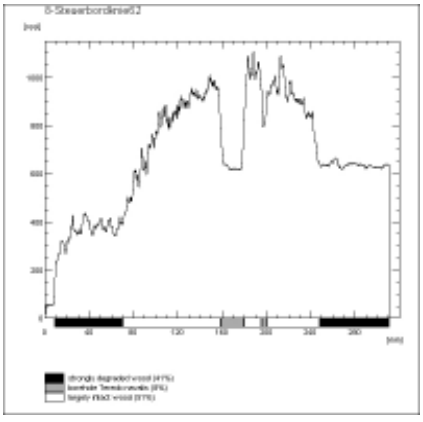
Archaeological waterlogged wood from Mecklenburg-Pomerania was drill resistance tested in the summer term 2002. This research was in preparation for a diploma dissertation for the Department of Civil and Structural Engineering, University of Wismar. A starboard knee from the Darss Cog was one of the pieces of archaeological wood tested. The objective of this research was to validate the methodology as a degradation measure. Drill resistance testing is used for the investigation of internal decay damage in timber. The drilling device measures the rotation resistance of a thin needle. The head of the needle is only 3 mm diameter and can be regarded as quasi-non-destructive. Drilling was done using a RESISTOGRAPH 3450 of Rinntech (Heidelberg). The starboard knee to be investigated was recovered from a depth of about 6 m. The test was done immediately after recovery, on board the dive-ship. The knee was 2.5 m long, 1.2 m wide and

Examining the deck knee with a device measuring the bore resistance.
Photographer:Roland Obst, Erfurt.

16 to 22 cm high. There was little visible external damage caused by shipworm, the state of preservation was good and the wood was only degraded superficially. Nine drill tests were carried out, well distributed over the starboard knee. Degraded wood at the surface of the wood could be identified in the drilling profile by a lower drilling resistance compared to new wood. The analysis of eight drilling profiles showed degraded wood to a depth of 0.5 to 3 cm below the surface. Drilling No.62 indicated degraded wood to a depth of 6 to 7 cm. Damage caused by the shipworm was proved by two drillings at one end of the knee and one drilling in the middle.



Salvage of the first deck knee of the Darss cog for the purpose of sampling.
Photographer: Roland Obst, Erfurt.



Result of the drill resistance measurement
Graph by:Claudia von Laar, Wismar.

Safeguarding and Management of the Darss Cog-site

Activity on the Darss cog started in 1977, when the wreck was first discovered. The site was surveyed, samples were taken for dating and the Maritime Museum (Schiffahrts-museum) in Rostock was informed about the wreck. After German reunification, sports diving increased along the Baltic coast of Mecklenburg–Vorpommern. Sports divers now and then visited two well-known 18th- and 19th-century wrecks, lying close to the Darss cog position, but the cog itself was not re-discovered because the position had been kept secret. In 2000, the re-discovery of the Darss cog was reported to the Archaeological State-museum of Mecklenburg-Vorpommern. This important wreck site was immediately registered with the coastguard, which is the responsible authority for the protection of submerged monuments. The Cadet channel is one of the busiest in the Baltic and is close to the Darss, so coastguard ships permanently patrol. The site is constantly monitored to prevent illegal diving and interference and a warning buoy has been positioned at the wreck site. Local fishermen were informed about exclusion zones. The wreck position was also published in the German Notices to Mariners to warn against mooring. In this way the site was protected from human intervention.

Awareness of the need to protect the Darss Cog site has also been helped by the media who have made much of the historical significance of the shipwreck and the scientific research on site. An exhibition about the Darss Cog was held in the neighbouring seaside resort of Prerow in 2002 when more than 10,000 local people and tourists came to visit. Last but not least, a meeting was held in the Darss museum, for local sports divers to inform them about the site and arrange for diving access during the excavation.

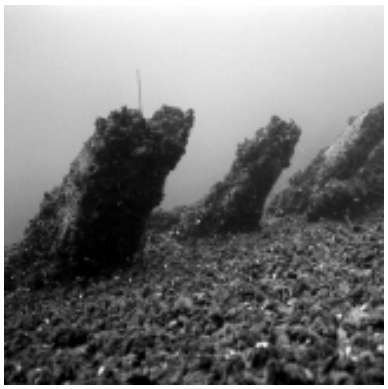
During excavation, the safeguarding of the site was a significant part of the research-strategy. The dive ship Seefuchs was moored 100 m from the wreck to avoid damage. The underwater excavation and recording was carried out using small working boats, which were moored with ground weights 10 m away from the wreck. After recording the ships timbers, the hull was immediately refilled with sediment and covered with a fleece material and sandbags. In addition, the exposed parts of the ship were covered by polypropylene gauze, as used in the Netherlands (see MoSS-Newsletter No. 4). The single strips 3 m wide were connected by plastic straps and held in place by anchor chains. All wooden parts of the ship are covered to safeguard against shipworm re-infestation. Four months after the excavation, the wreck, the fleece material, the sandbags and the gauze are completely covered with sediment. By Autumn 2003 the excavation and recording of the Darss cog will be finished. Based on photogrammetry, video recordings and the drawings, the wreck can be virtually reconstructed and visualised for the benefit of academic study and for the general public via publication and the Internet. The ship will not be recovered, it will be safely entombed in sediment and conserved in situ, where it sank more than 650 years ago.

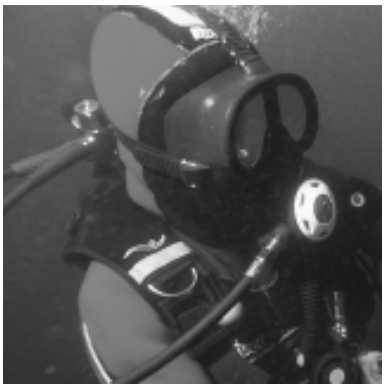
Public lecture and exhibition about the protection of wreck sites, *Darss museum* Prerow. Photographer: Roland Obst, Erfurt.

Marking the wreck site and sinking of an anchor weight for the base ship *Seefuchs*. Photographer: Roland Obst, Erfurt.

what's on?








meetings & seminars

Meetings:

The project meetings are staged for discussion within the project and are mainly held for and by the representatives of the different nations in the project. At the meetings the partners discuss the project, its general aims, the development and planning of the different themes within the project. The different themes may also be discussed in sub groups. Practical and scientific questions are discussed and the project progress and methodology is evaluated. The aim is to arrange two meetings a year, one in early March and one in November. Extra theme meetings have been held when required. Since the first newsletter was published one meeting has been held in Schwerin in early November 2002 following the open project seminar and two extra monitoring project meetings were held in January 2003 one in Portsmouth and one in Helsinki. A regular meeting was held in March in Stockholm. The next meeting will be held on June 29 following the June 27 and 28 open seminar in Sweden. This meeting was originally scheduled for autumn of 2003.

Seminars:

Maritime archaeological scholars, experts and practitioners from around the world are invited to these open seminars to hear and discuss progress and evaluation of the project themes. Two more seminars are scheduled, one has already been held.

The first open seminar was held in Schwerin on November 10 2002 on the theme of "*Documentation of Shipwreck Sites and Photogrammetry."*

The second seminar will be held at the Vasa Museum in Stockholm the 27th of June and at Forsvik Shipyard Association, Karlsborg, on June 28 2003. To discuss "Visualization of Shipwrecks and Shipwreck Sites*." It is to be arranged by Södertörns högskola (University College), The Maritime Museum of Finland, Helsinki, The Swedish National Maritime Museums / The Vasa Museum, Stockholm, and The Forsvik Industrial Heritage / Forsvik Shipyard Association.*

The third seminar will be held in Portsmouth, UK, during June 3rd to 6th 2004, on the theme of: Monitoring, Safeguarding and Management of Ship Wreck Sites. More detailed information will be available in spring 2004.

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