Recording Manual for ship timbers (Project 3544-6152 - Mönchgut, Ostsee VII, Fpl. 46, ALM 2023/384)

11/2023

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Remarks

The latest edition of the excavation guidelines (Grabungsrichtlinien) of the State Office for Culture and Monument Preservation in Mecklenburg Western Pomerania (LAKD-MV) applies to all archaeological activities in Mecklenburg-Western Pomerania and is available on the LAKD-MV website (https://www.kulturwerte-mv.de/Landesarchaeologie/Archäologisches-Kulturerbe/Ausgrabungen/downloads-ausgrabung/).

This document serves as a practical supplement to the excavation guidelines.

Preparation

Prior to documentation, structural timbers and ship timbers must be labelled with numbers. For this purpose, pre-stamped cattle ear tags are used, which are attached to the timbers either with copper nails or stainless steel screws. When positioning the numbers, care must be taken to ensure that no details on the wood surface are obscured. Numbers should always be attached to the inboard side of ship timbers. For timbers that are transferred to the LAKD M-V archive, an activity number (ALM number) and an artefact ID (FundID) are assigned in addition to the timber number. These are initially recorded on timber recording forms or in the master timber list. Suitable ear tags with barcode imprints can then be produced at a later date.

Timbers that are disposed of after documentation or timbers, which are intended for wet storage on-site or in a depot, are only assigned a timber number (Holz_XXX).

Master timber list and sample list

The master timber list and the master sample list are both hosted in **Google Drive** and shared with all project participants. This allows for real-time editing by multiple parties. Both lists are saved in .xlsx format in the project folder at the end of the project.

Master timber list:

Timber ID (ALM?)	Fund-ID	Type	Location-Side	Location-Strake	Length cm	Date lifted	Vierow basin	Comment
85		Ceiling, log	Starboard	between 1st and 2nd ceiling strake	120	5/08/2023	6/08/2032	

Cleaning comments	Caulking/ Surface Covering samples (enter Sample ID)	Cleaning photographs (Date, Initials)	Cleaned (Date, Initials)	Photographed (Date, Initials)	Detail photograph comments	Scanned (Date, Initials)		Processed (Date, Initials)	Annotation (Date, Initials)	Dendro samples (enter sample ID)	Catalogue (Date, Initials)	Disposal (YES, NO)	Reason
Traces of moss caulking in the scarf. Sampled on bow scarf. Photographs taken of sample	000000456789	22.11.23, JA	22.11.23, JA										

Sample list:

Probennr	Fund-ID	Befnr	Planumsnr	Profilnr	Probenart	Fragestellung	Labornr	Ergebnis	DigitalbildNr	Datum	BearbeiterIn
Laufende Nummerierung der Proben	nur bei botanischen Proben und Dendroproben	Befundnummer	Planumsnummer	Profilnummer	Dendroprobe; C-14 Probe; Botanik; Sediment	Warum wird die Probe genommen?	Vom Labor zugewiesene Nummer	Ergebnis der Beprobung (Datierung etc.)	welche Aufnahme zeigt die Probe	TT.MM.JJJJ	Vor- und Zuname
1					Dendrosample from the keelson (6,14m from the aft					30/09/2023	J. Auer

Project data archiving and backup strategy

All project data is archived on the project NAS drive in the project folder (3544-6152) and the relevant subfolders according to the LAKD M-V guidelines. A synchronised copy is stored on a separate 8 TB hard drive, which is taken to the project accommodation every day.

The project data is collected in the subfolder:

05_Digidok

- **02_3D_Scans**
  - **Nummer (Rename: Holz_XXX)**
    - **01_Rohdaten (Raw scanning data)**
    - **02_Modell (.obj file of the scanned timber)**
    - **03_Beschr (.3dm annotated Rhino3D file and .txt file with timber desc.)**
    - **04_Fotos (.jpg files of timber detail shots and cleaning shots)**

Stage 1: Cleaning the timbers

- Make sure that all parts of broken timbers are retrieved - known breaks are annotated in the master timber list
- Carefully clean the timbers, remove all concretions and traces of metal and caulking
- Assess caulking, describe it and take samples where appropriate: Record the sample in the sample list, note the sample location and assign an artefact ID (Fund ID).
- Assess for surface covering, describe and take samples where appropriate Record the sample in the sample list, note the sample location and assign an artefact ID (Fund ID).
- Samples are packed according to the LAKD M-V guidelines. Sample cards are filled in with pencil.
- Where appropriate, take field photographs of samples or removed concretions (use scale) and archive photos in subfolder **04_Fotos**
- All photos should be named sequentially by timber number (Holz_XXX_01, etc)

Cleaning comments	Caulking/ Surface Covering samples (enter Sample ID)	Cleaning photographs (Date, Initials)	Cleaned (Date, Initials)
Traces of moss caulking in the scarf. Sampled on bow scarf. Photographs taken of sample	000000456789	22.11.23, JA	22.11.23, JA

Animal hair mat in scarf

moss caulking in scarf

three strands of animal hair

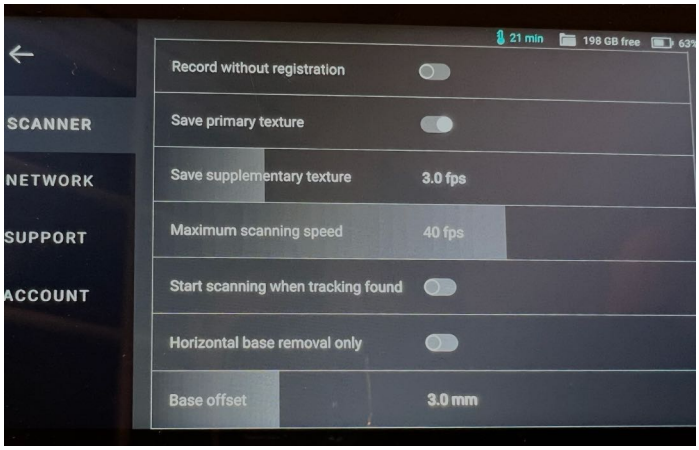
Stage 2: Timber detail shots

- Where necessary, select areas for detailed photographs. These should always provide supplementary information to the scan or be typical for an observed feature. Examples include very clear tool marks, repairs, intentional marks, decorations, characteristic fastenings, etc.
- Always use a scale
- Ideally, a ring flash should be used for lighting. Remember: Photos are best taken in AV mode with the smallest possible aperture (high value) for max. depth of field.
- Annotate the master spreadsheet with the date and initials and comments regarding the subject of the detail shots
- Download detail photographs in subfolder **04_Fotos** and name them sequentially by timber number (Holz_XXX_01, etc)
- **After photography, all protruding trenails are carefully removed from the timber or cut close to the timber surface.**

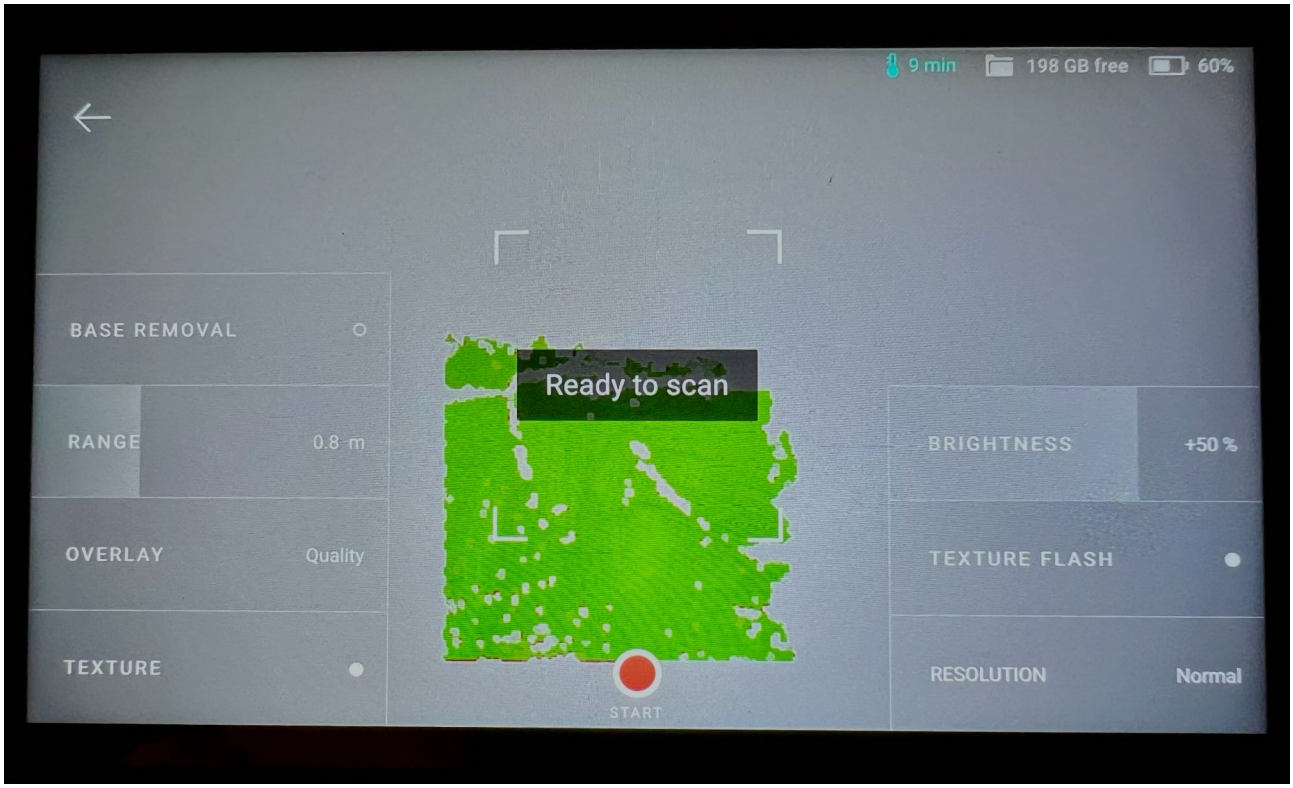
Detail shot of axe marks in the joggle of a clinker frame.

Stage 3: Scanning the timber

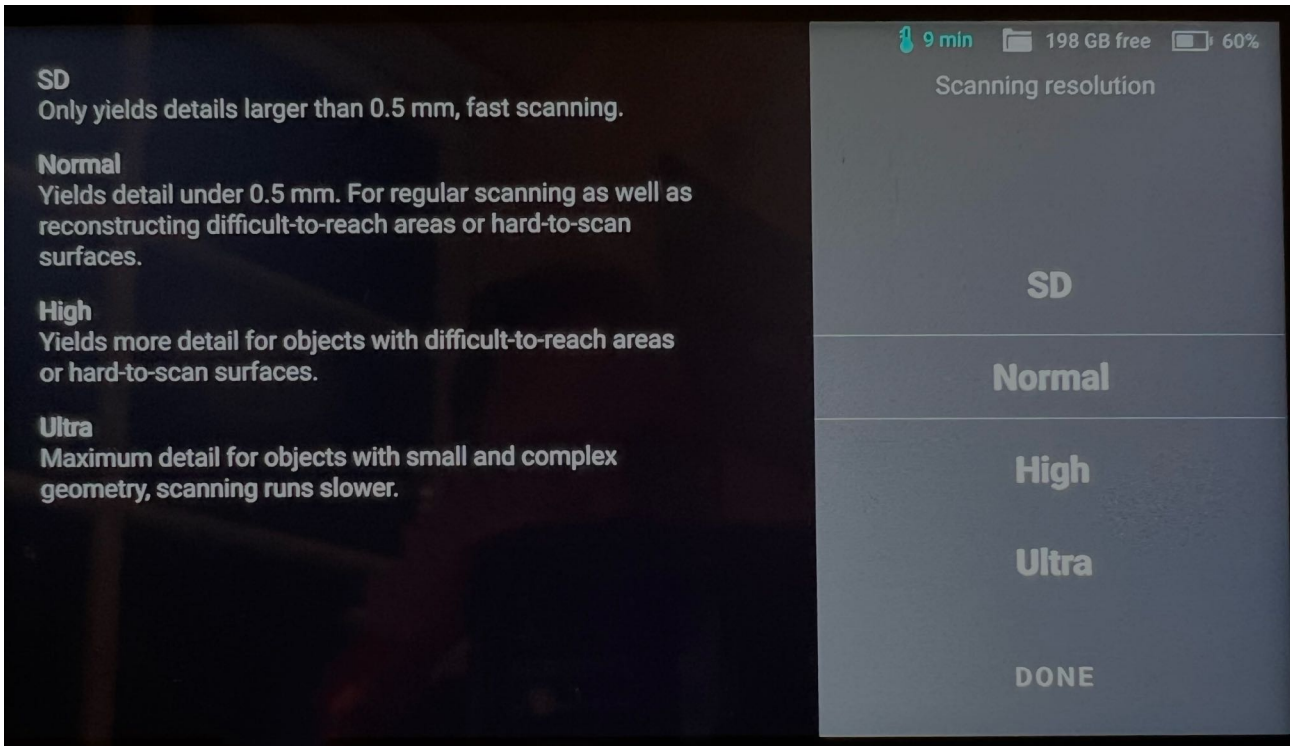
- Let the timber dry to avoid reflection (you can use a sponge or paper towel to dry the timber)
- mount the timber securely and level on the scanning table (ideally EURO palettes) and use dark foam supports to keep the timber above the surface.
- Planks with sufficient thickness are best scanned lying flat on the inboard or outboard surface. Very thin timbers might have to be placed on their short edge.
- Flexible timbers have to be stabilised sufficiently to prevent a change of shape when turning to record the other side. Again, dark foam supports can be used to facilitate this.
- The Artec LEO scanner needs a well-lit environment. Use strong photo lights around the work table, but avoid harsh shadows.
- Warm up the Artec Scanner
- Adjust Scanner Settings (Settings-Scanner-Scanning):
  - *Toggle Optimize Project Size and Compress HD data*
  - *Save Supplementary Texture: 3.0 fps*
  - *Maximum scanning speed: 40 fps (this can be adjusted lower for inexperienced users)*



- Each object is recorded as a single LEO project, ideally with two scans, one for each side of a timber.
- Naming Scan: In LEO name the project by timber number according to naming convention: **Holz_XXX**
- Scan timber:



- Set BASE REMOVAL OFF
- Adjust range to 0.8m. The ideal scanning distance is between 50 cm and 60 cm.
- The OVERLAY can either be shown as Scan quality or distance. This is a user preference.
- TEXTURE should be toggled ON
- EXPOSURE (texture flash off) and BRIGHTNESS can be adjusted individually. Good results have been obtained with an exposure of 300 ms and a brightness of 50%.
- Set TEXTURE FLASH ON
- Adjust RESOLUTION: Normal is sufficient for most timbers, however High might be appropriate for shiny or extremely detailed timbers. Maximum (full HD) is mostly overkill in timber recording



- After scanning, save the project and add initials and date to the master timber list.

Stage 4: Processing

File transfer

- Connect LEO to the processing PC with an Ethernet cable (ideally class 6 or higher)
- Select Connection mode: COMPUTER
- On PC open Artec Studio
- Choose Import from LEO
- Select LEO scanner and CONNECT
- Choose Project to download
- Toggle Import RAW data. DO NOT CHOOSE: Use HD reconstruction

Processing in Artec Studio (17 or 18)

- Delete the SD scan and create a copy of the original scan - from now on you will only work on the copy
- Save Artec Studio Project in the timber folder (**Holz_XXX), subfolder 01_Rohdaten** on the PC hard drive (this allows faster data processing). After processing, the file can be transferred to the NAS server for archiving. As space on the PC hard drive is limited, make sure you keep a limited number of files on the PC.

HD Reconstruction

- On the copy, run TOOLS - Raw data - HD-scan reconstruction.
  - Set Frame Frequency to 1 (full frequency depending on the scan mode chosen)
  - Set Point density to 4 for simple timbers. This setting relates to the amount of points in the reconstructed scan. A density of 8 means 8 x more points than in an SD scan.
  - For complicated timbers you can use a factor of 8, however if a timber was scanned in the high setting, a factor of 4 is sufficient.
- When done, delete the raw scan (you still have the project backup)

ERASE Background

- Use EDITOR - Eraser to remove background and unwanted data
- Repeat the above procedure for all scans in the project

Align

- Using ALIGN roughly position the two scans of the timber relative to each other
- Use Best fit rigid alignment and define corresponding points on each of the two sides. Make sure points are distributed on both sides of each half. 4 to 5 points should be enough. Do not use texture alignment.
- Click Align and if both sides are well aligned, Apply
- You should now have a complete model of the timber

Global Registration

- Run global registration using only Geometry and the Separate than collective settings. Leave other values on standard settings.
- The max error should be less than 1 mm.
- Erroneous frames should be removed and global registration repeated if errors occur.

Outlier Removal

- Run outlier removal on standard settings

Sharp Fusion

- Use sharp fusion with a resolution no smaller than the error
- use setting watertight and leave HD sensitivity on Medium

Small Object Filter

- Use small object filter with standard settings

Fast Mesh Simplification

- Use fast mesh simplification to reduce to ca. 60% of the original polygon count. Keep boundary enabled

Texture

- Use all available HD frames for texturing
- Select texture for Export. Enable texture normalisation and reduce glare (around 6). If the timber is very dark and the background is lighter, you may want to also suppress background colour, use a value of 6-7. Enable inpaint missing texture. Output texture size 8192 x 8192.
- Adjust result and apply

Output

- Save final model as .obj, following naming convention (Holz_XXX) in subfolder 02_Modell
- **Move data to NAS Server and mark in master timber list!**

Stage 5: Annotation

The principle

The basic concept behind the 3D annotated scans method is straightforward and consists of the 3D scanning phase described above, which is followed by a 3D annotation phase. An archaeologist proceeds to interpret (or annotate) the ship timber by tracing the timber's diagnostic features directly onto the timber's digital 3D model. During this phase, it is essential to still have the actual physical timber available; even high-resolution geometry and texture (colour) data cannot serve as a replacement for the physical object when it comes to recognising details such as repairs and small fastenings. For 3D annotation, the CAD software Rhinoceros3D is used.

In order to add archaeological interpretation to the timber scan, the .OBJ file is imported into Rhinoceros. In Rhino, a layering convention similar to that used for contact digitising was implemented. Different coloured layers represented different feature types such as wood grain, trenails, nails, repairs, tool marks and intentional markings. These are traced digitally using the 'PolylineOnMesh' command in Rhino, which allows users to draw 3D polylines directly onto the textured mesh.

As such, the end result of the 3D annotated scans method consists of a digital 3D record containing both an objective digital copy of the timber, and the archaeologist's interpretation of that timber layered on top. This 3D record is further supplemented with a short, written description of each timber, as well as pictures of important details. The interpretation is based on the physical timbers as well as on relevant data from the excavation, such as site plans or notes.

The Rhinoceros3D templates

The Rhinoceros3D templates are the basis of the 3D annotation process. Two main Rhinoceros3D templates have been prepared for this project:

- **Four-sided-template_2023.3dm**
- **Two-sided-template_2023.3dm**

Four-sided templates are used for all four-sided timbers, such as frames, keel and keelson, knees, etc.

Two-sided templates are used for planks and similar timbers without substantial thickness.

The template system can be amended and extended based on project needs.

The layer system

The annotation in Rhinoceros 3D follows a systematic approach, which is guided by the layer dialogue. By following the layer menu during the annotation process, the operator makes sure no relevant details are omitted. It can be useful to lock or turn off layers, once the relevant information is stored. It is essential to bear in mind that not all layers are relevant for every timber. Information is only annotated where necessary.

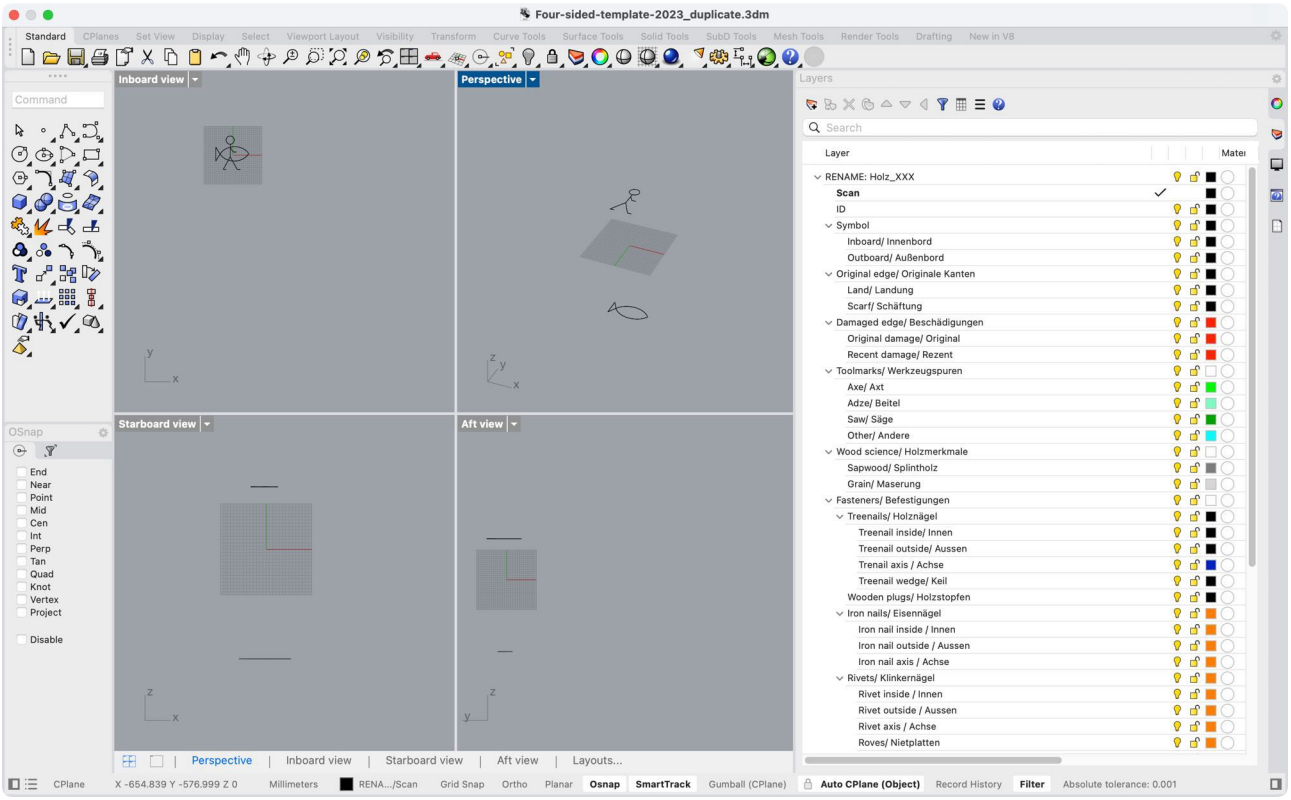
The layer system is described in detail in **Appendix 1**.

Importing a timber into Rhinoceros3D

The relevant Rhinoceros3D template is selected and opened on the annotation computer. The file is then renamed to **Holz_XXX.3dm** and saved to the project directory into the subfolder **03_Beschr**. The parent layer (RENAME: Holz_XXX) is then named according to the timber number.

Now the .OBJ file can be imported into the prepared template:

- Set layer SCAN active.
- Import the .OBJ (Holz_XXX.obj) into Rhino. As timbers are recorded in 1:1 and the template is also set up in 1:1 using mm as a unit, no resizing is necessary.
-



The four-sided template prior to the import of a mesh.

- Now, using the fixed viewports and the commands **Rotate** and **Move**, orient the imported mesh following the convention. The man (🚶) indicates the inboard side of the timber and faces the bow, the fish (🐟)indicates the outboard side of the timber and swims towards the bow.
- You can view the imported mesh in different render settings (texture, shaded, etc.). If the mesh appears glossy, adjust the material properties of the mesh.
- Once you are satisfied with the timber orientation (check on site plan!) enter the timber ID (layer **ID**) using the **TextObject** command. Set height to 30 mm and output as curves. Place the text over the timber tag, floating above the surface of the timber. Turn off the layer **ID**.
- You are now ready to start the annotation process following the layer system in **Appendix 1**.

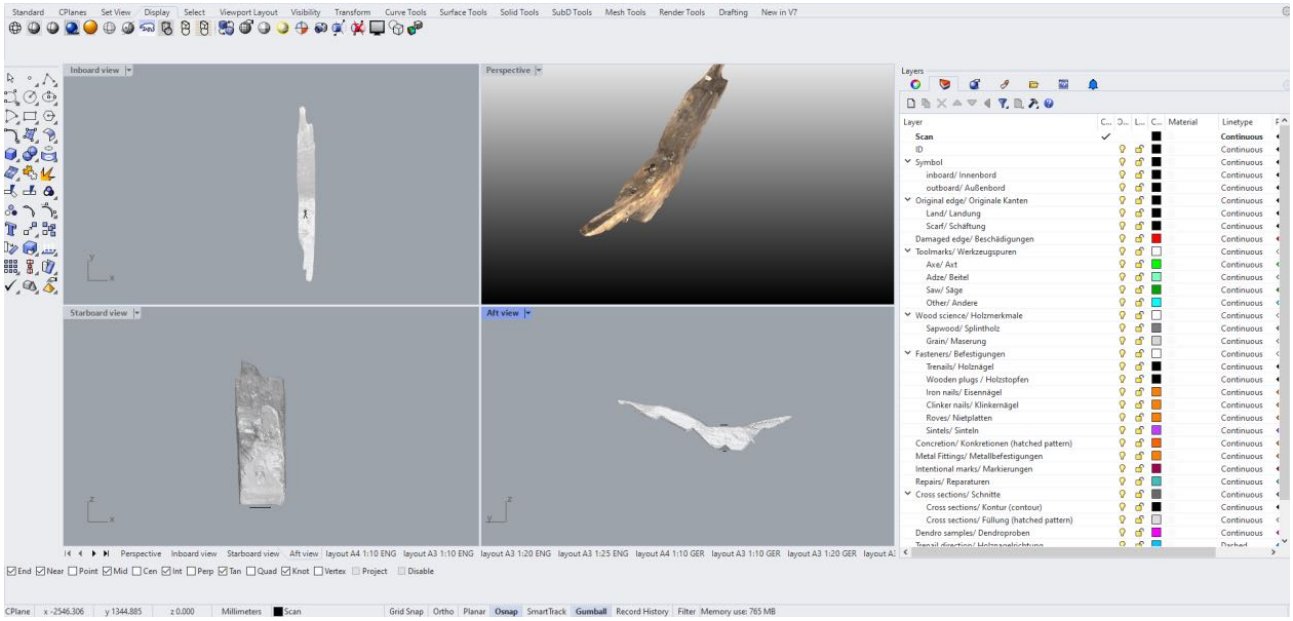
Annotating in Rhinoceros 3D

Annotation is best carried out in perspective mode and switching between different render settings. Work your way through the layer menu and use the **PolylineOnMesh** command to annotate on the surface of the mesh.

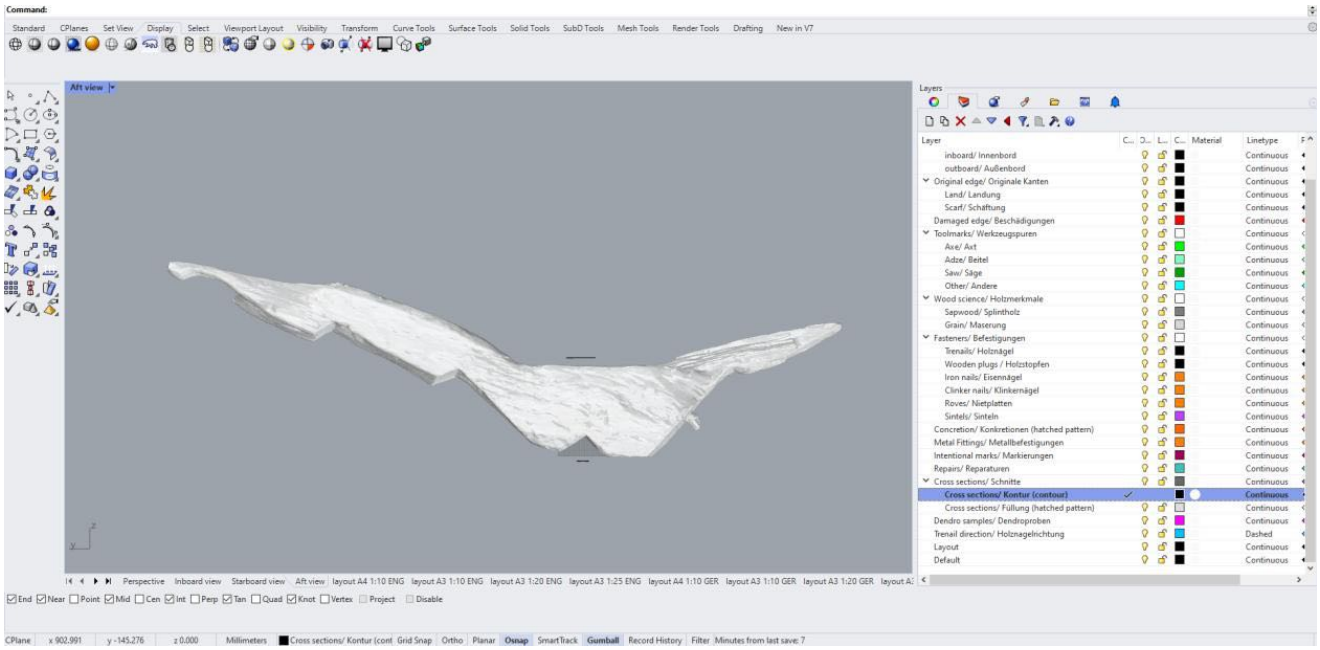
- You are now ready to start the annotation process following the layer system in **Appendix 1**. It's useful to start with the text description at the same time and keep both text document and Rhinoceros3D file open during the process.

Creating sections

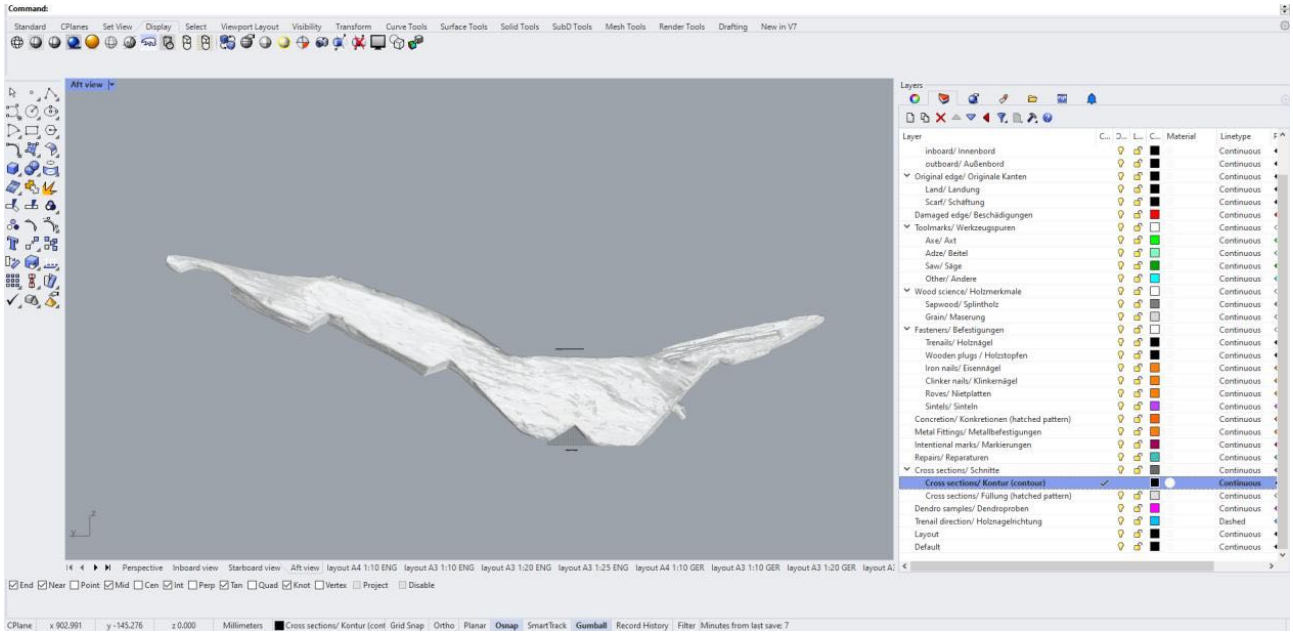
- Go to the side/aft view



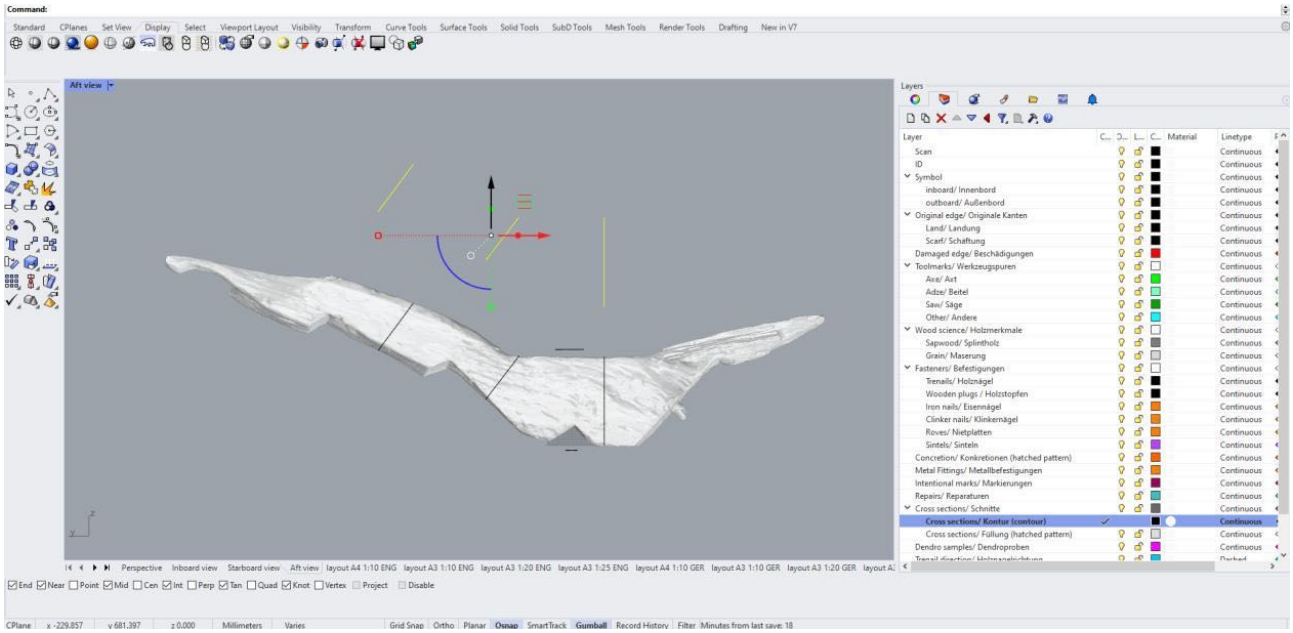
- Turn on the layer: **Cross-sections (Contour)**



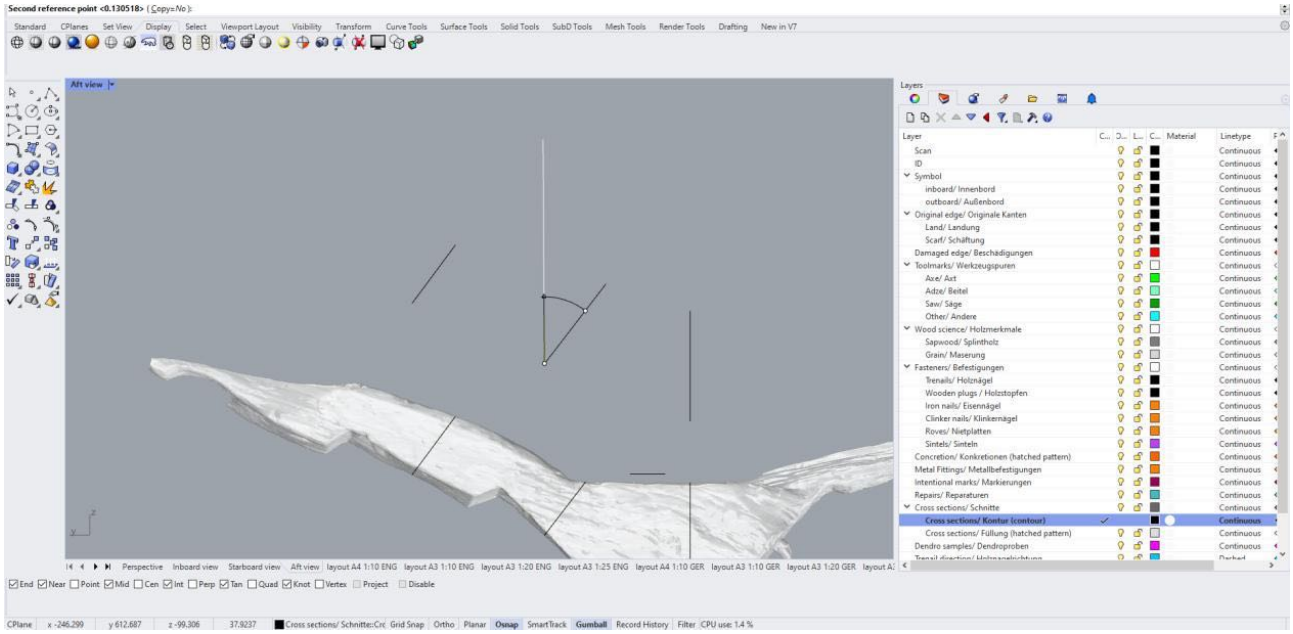
- Type the command: **Section** and select the mesh
- Now draw lines where you want to place sections. Sections should be perpendicular to the visible edge of the inboard/outboard face

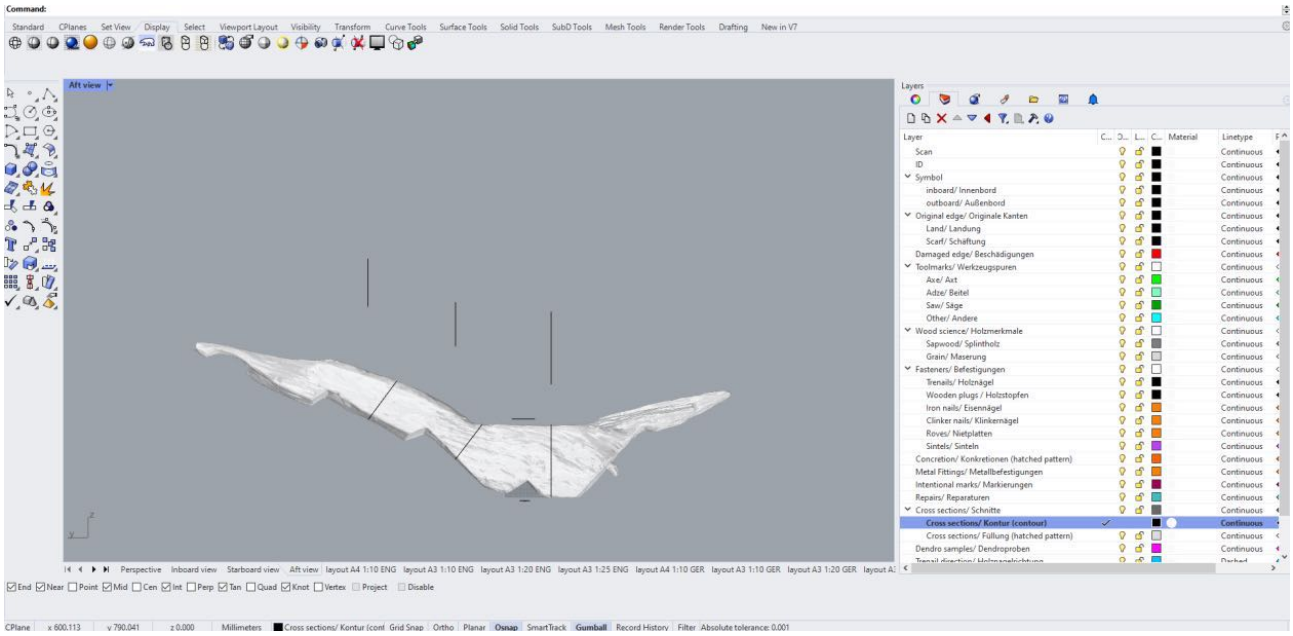


- When all sections are done click **ENTER** to finish the section mode.
- Right click on the **Cross-section (Contour)** layer to **Select Objects** and use **CRTL+C** to copy them. Click on the view to deselect the original sections and then use **CTRL+V**. Now only the copies of sections are selected. Now drag the copies above the timber

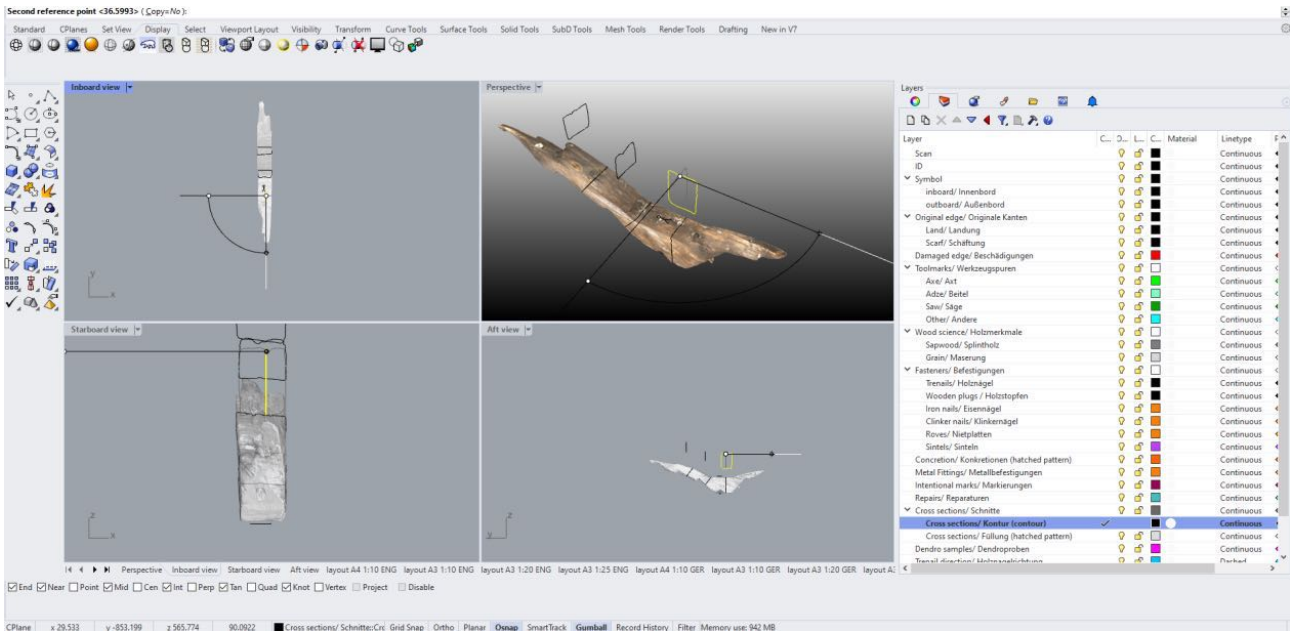


- Some sections might be angled (especially those on frame arms). These have to be rotated to a vertical position (rotate only copied sections. Don’t touch the original lines!)

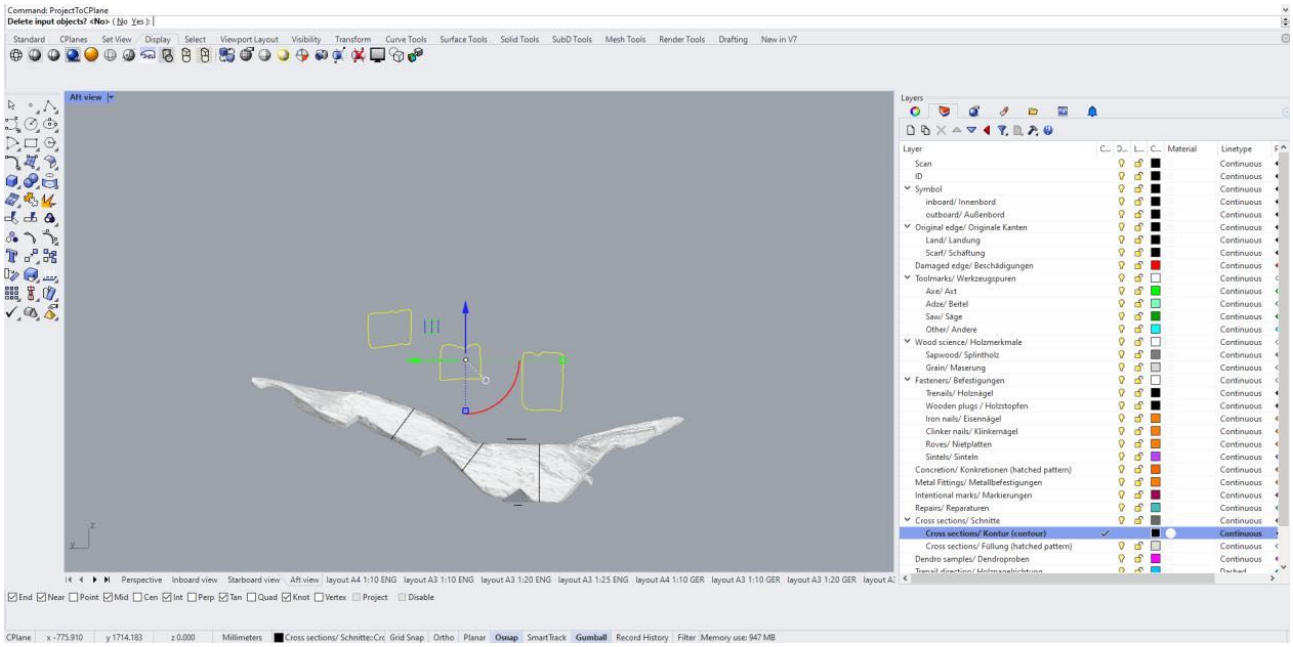


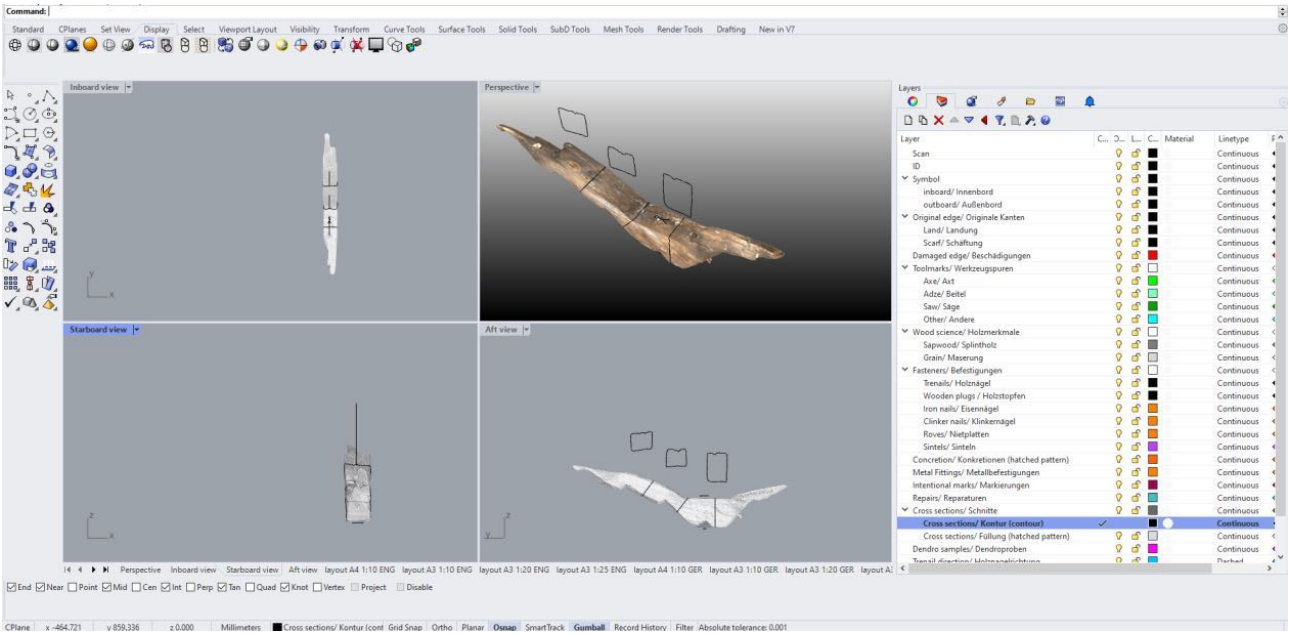


- Now go to the Inboard view and **Rotate** each of the sections 90 degrees **counterclockwise.** Remember to rotate only the copied sections (those above the model). Don’t touch the original sections!

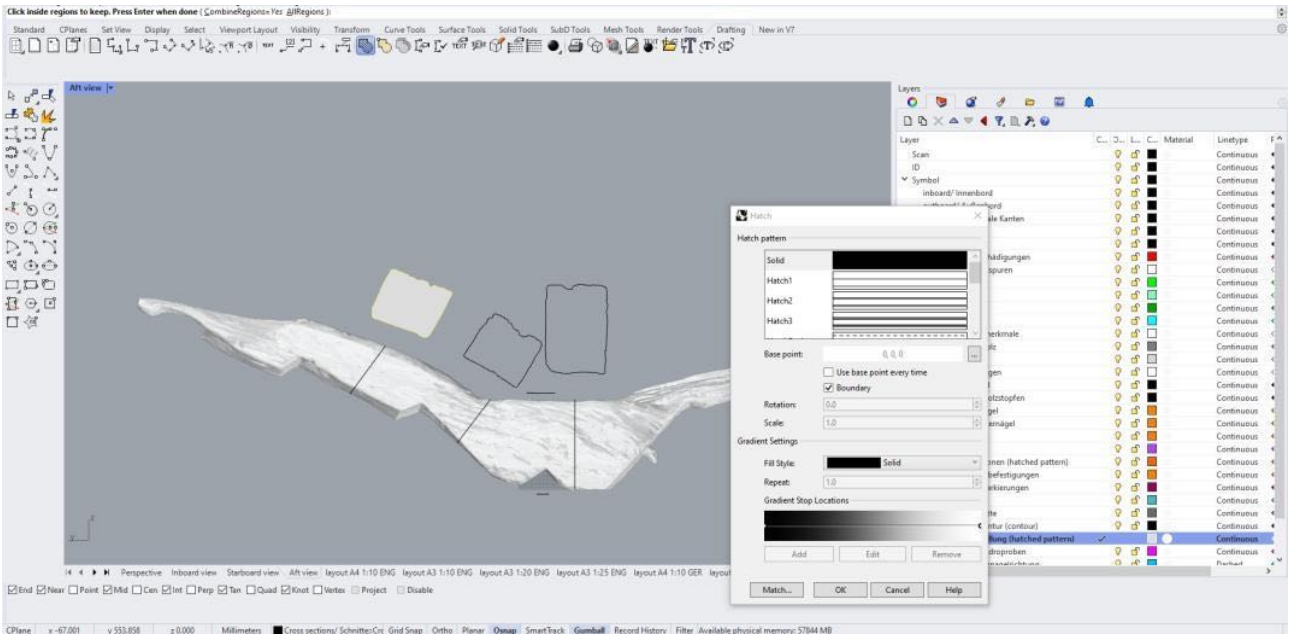


- Because of the rotation, the sections will not be level if you look at the starboard view. To keep them at the same level, select the sections and in the aft view use the command: **ProjectToCplane** (Click <**Yes**> **to Delete input objects)**
- For final adjustments, move the copied sections to place them above the original sections.





- When all sections are correctly positioned, click on the **Cross-section (Hatched pattern)** layer to make it active. Now select each section and on the **Drafting** panel click on the button **Hatch**
- In the top setting use **Solid hatch pattern**
- Continue this process for the rest of the sections



Indicating fastener direction

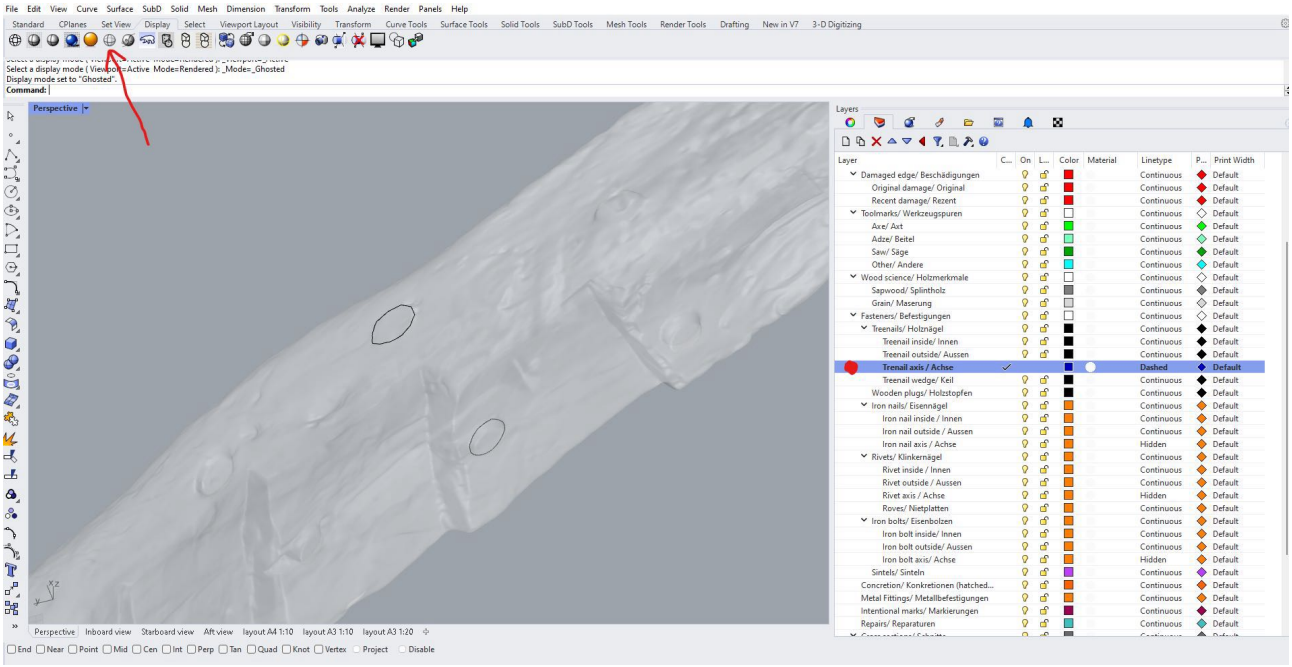
In order to understand how fasteners were driven into the timber, fastener direction is indicated in the annotation.fastener direction should be indicated for treenails, clinker rivets and iron nails and bolts. In this case a treenail is used as an example, but the method applies to other types of fastenings as well.

Initially, the inside and outside perimeter of the nail is marked on the respective layers in the layer dialogue.

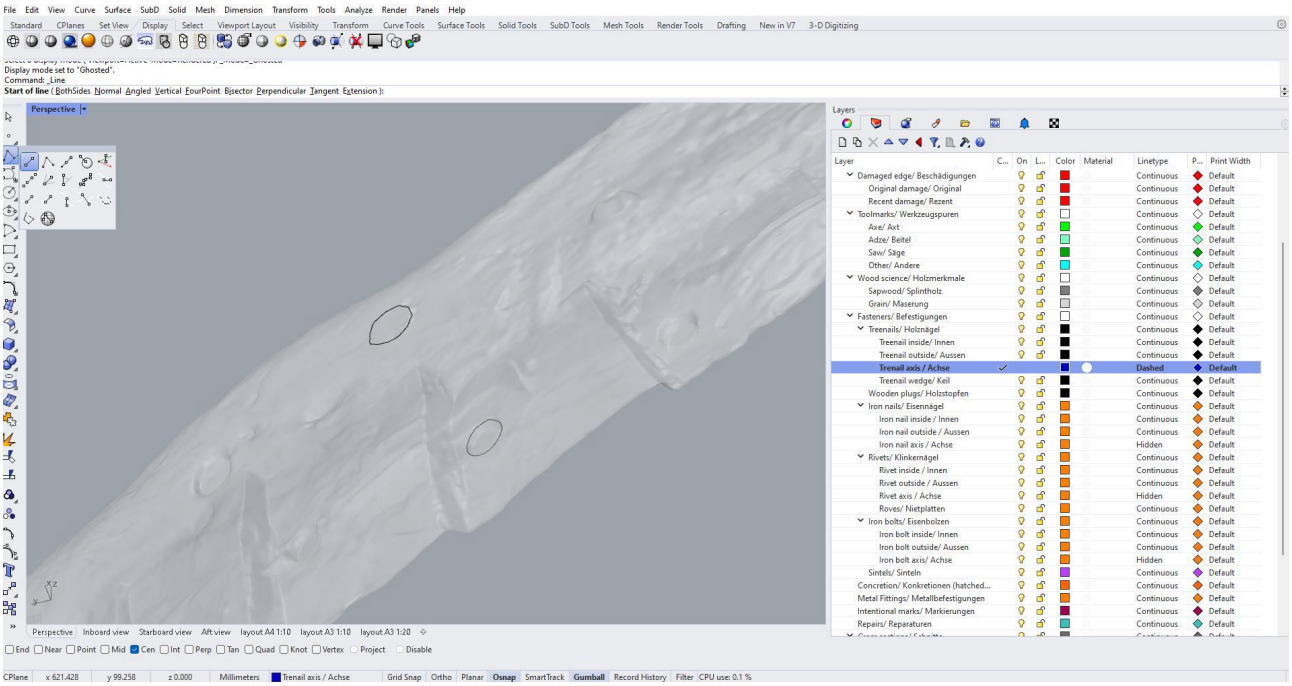
If at all possible, the closed polyline showing the outside of the nail should be created as close to the original nail hole as possible.

Once both inside and outside outline of the nail have been drawn, the axis showing the treenail direction can be created:

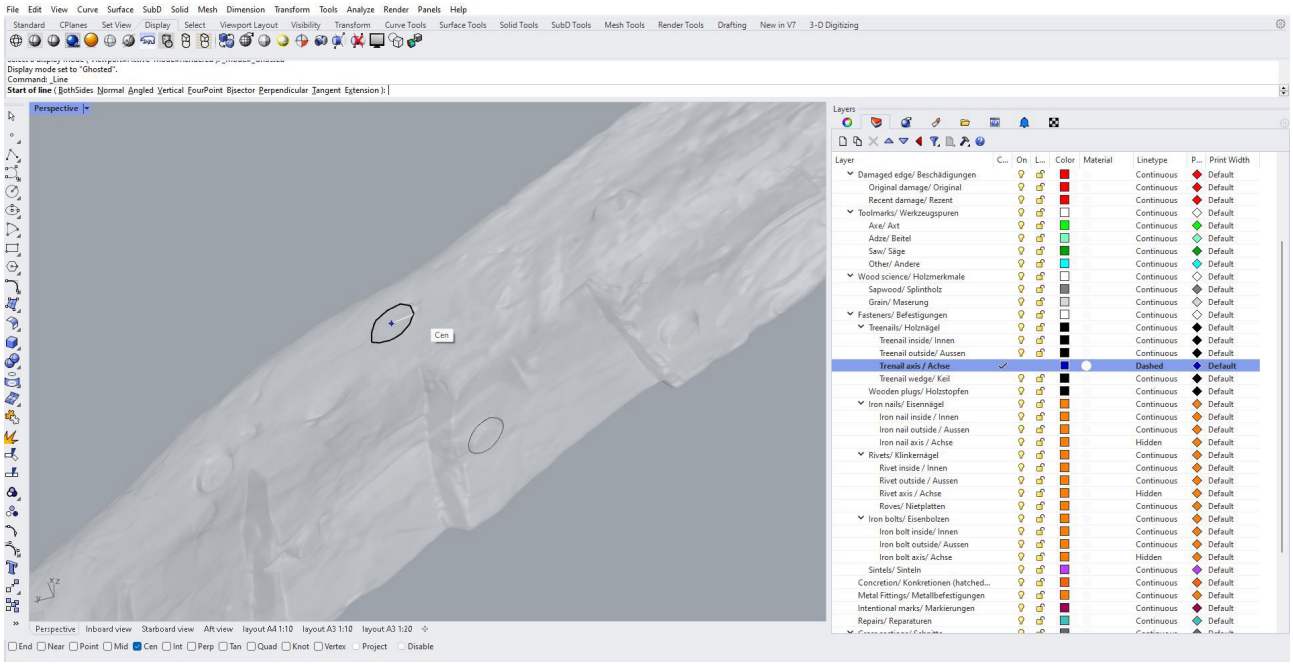
- Change a viewport to **Ghosted**, so both treenail outlines: Inboard and Outboard will be visible



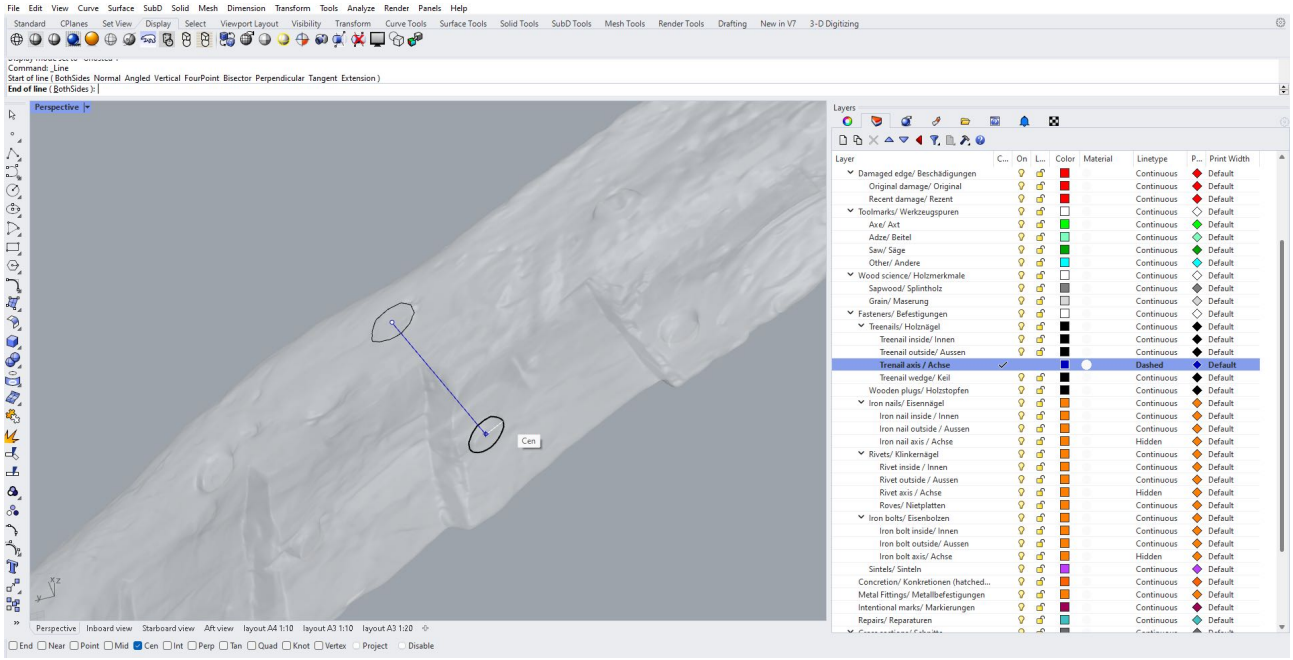
- In the lower bar, click the **Osnap** button and activate only **Center Object Snap**. The rest of the snap options should be turned off.
- From the sidebar, choose **Polyline > Single Line**



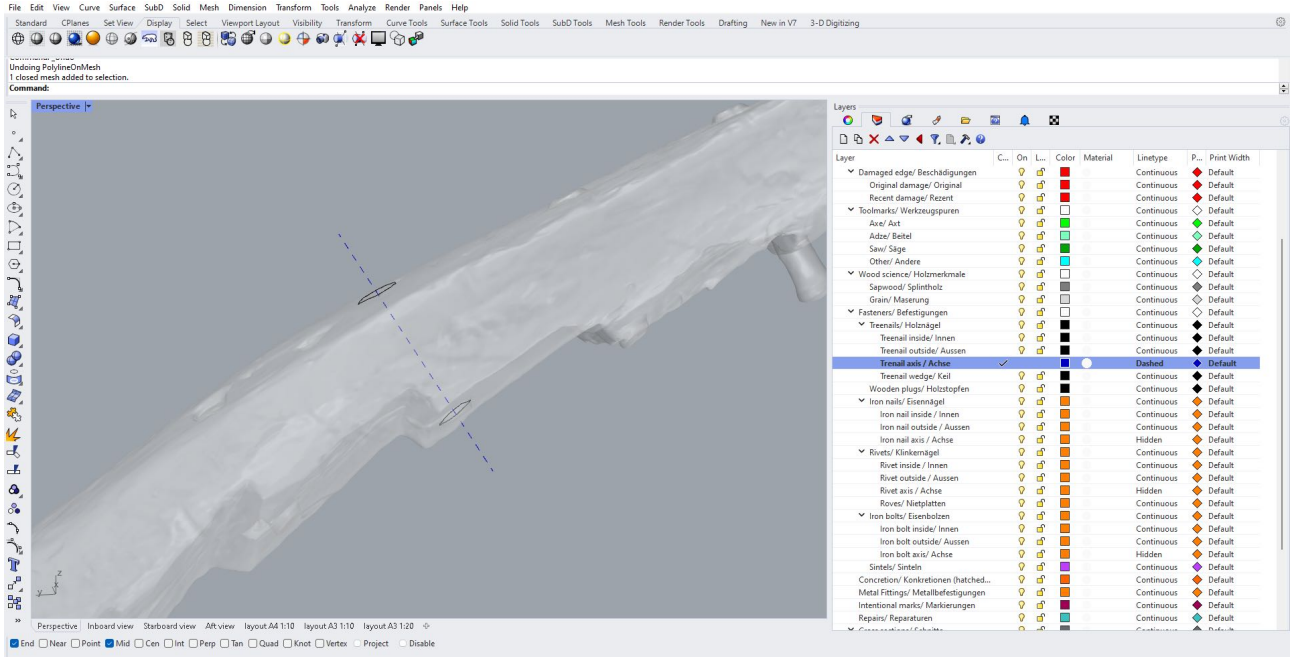
- Snap the outline of the fastener with the cursor. The software will automatically put the start point of the line in the centre of the snapped object.

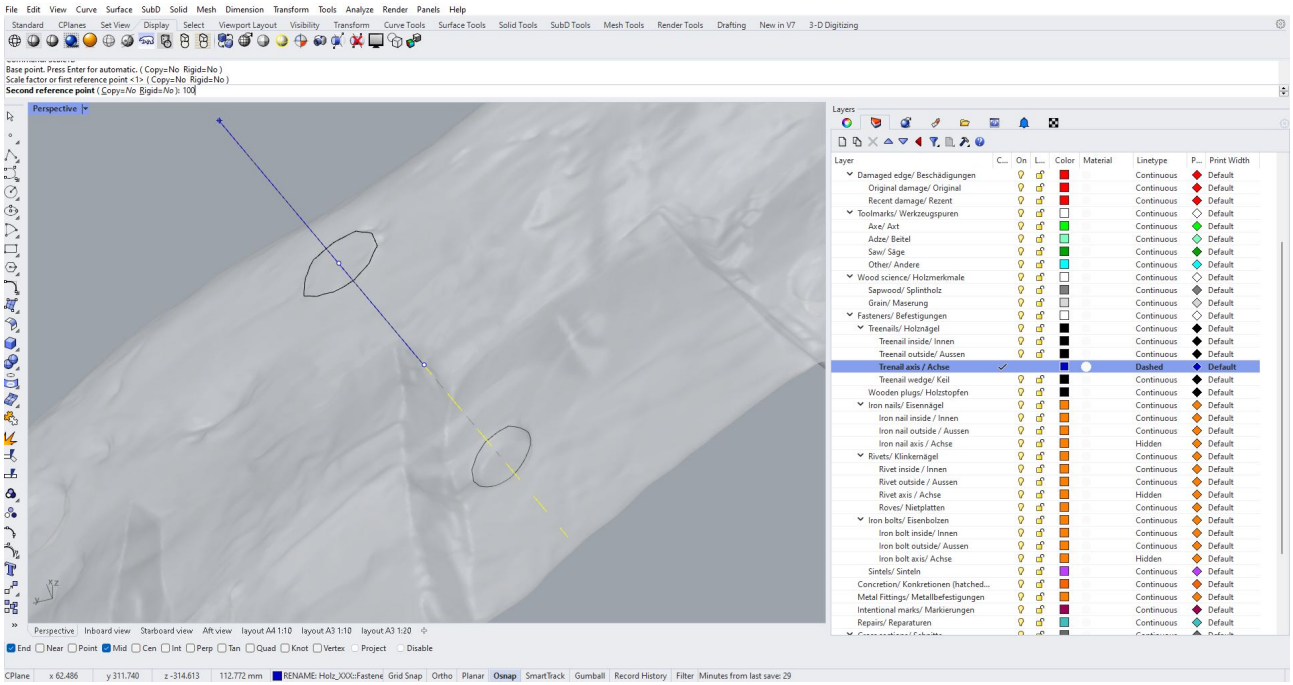


- Do the same with the opposite fastener outline. Now you should have a straight line between the center points of both outlines. The line should be on the layer **Trenail axis/ Achse**



- In the **OSNAP bar**, turn on '**Endpoint Object Snap**' and '**Midpoint Object Snap**'. The rest should be off.
- In the Command line, type **Scale 1D**
- Select the Axis line to be scaled. As a base point, select '**Midpoint'** and as the '**First Reference Point'** select one of the endpoints of the line
- For the '**Second Reference point**' instead of choosing a point on the model, type a value of 100 (for treenail holes) or 60 (for iron/clinker nail holes).

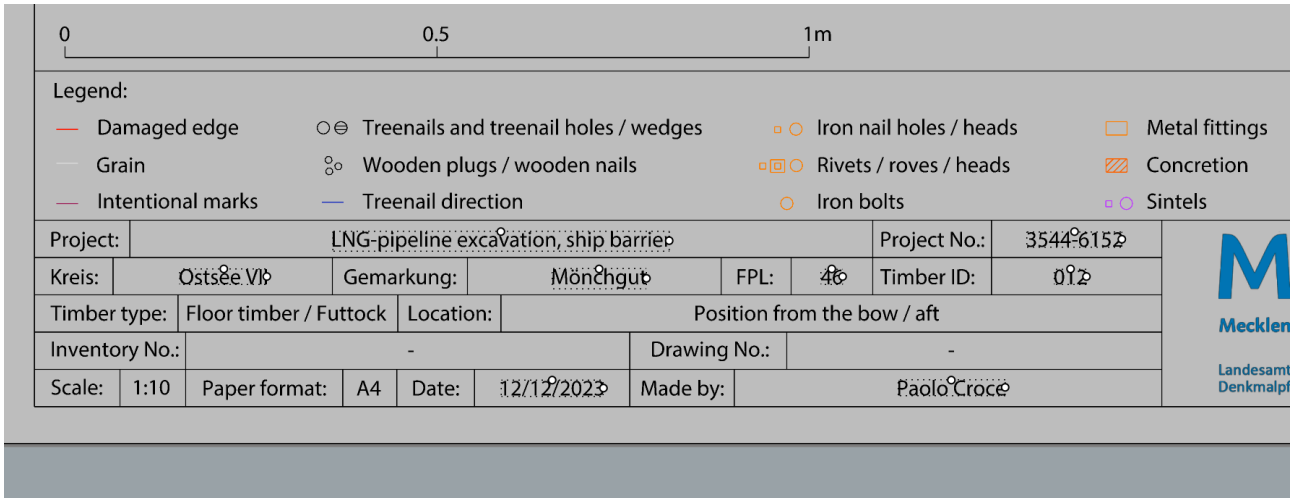




- You have now created a treenail axis line!

Layout description

Once the timber annotation is completed, select a Layout which suits your timber size. In the selected layout, enter relevant information in the drawing legend as per the example below.



Creating a text description

The written timber description supplements the 3D timber annotation and is prepared by the archaeologist during or shortly after the work in Rhinoceros. It is compiled using standard templates and a standard vocabulary (see glossary- **Appendix 2**). Examples of both, a frame and a plank description can be found below.

The following measurements can be used: g, kg, mm, cm, cm2 , cm3 , m, m2 , m3 , km, km 2 (superscript digits).

Metric units of measurement are to be used. Leave a space between the number and the unit of measurement. Decimal places are marked with a dot.

The timber description is saved in .rtf format (**Holz_XXX.rtf**) together with the 3D annotation in the subfolder **03_Beschr**.

Example of a plank description

Outer plank (316), Fund ID 3920084

Short description and location
Portside plank from section 1, recovered on 15.06.221. Both ends are preserved with slight damage at the ends of the lands.

Wood science
The plank is radially cleft from straight-grained oak.

Shape and dimensions
The plank has an overall length of 2.45 m. The maximum width is 25 cm, while the maximum thickness was measured to 3.5 cm. Scarfs are preserved at both ends. The outboard face is convex and the inboard face is almost straight in the cross section.

Scarf
The outboard scarf measures 18cm in length and tapers to a thickness of approximately 0.8 cm at the centre of the plank. The inboard scarf is 20cm long, while the thickness at the centre of the plank is 1.5 cm. The lands at both scarfs were feathered down to a thickness of 1 mm -2 mm.

Land
The inboard and outboard land have a width of ca. 6cm. The inboard land was furnished with a slight groove to accommodate the waterproofing material.

Fastenings
11 treenails or treenail holes for treenails of 30 mm diameter are present in the plank at four frame stations spaced approximately 50 cm to 65 cm apart. At the first frame station, two intercutting trenails with dome-shaped heads were cut in antiquity and a new hole was augered next to these. Another cut off nail is present at the height of the upper land just aft of the first frame station. At the second frame stations, one old trenail was left in situ with a new hole augered directly below. At the third frame station, a total of three old trenails were cut off in antiquity and a new hole was augured beside. The fourth frame station was fastened with a single nail which belonged to the last phase of usage.

10 clinker rivets are spaced between 17 cm and 26 cm apart along the upper edge of the plank, while 11 where observed along the lower land. The nails with rectangular shafts (8 mm x 8 mm) were clinched over rectangular roves measuring 20-22 mm x 25 - 26 mm. The clinker nails had round heads measuring 25 mm to 30 mm in diameter.
Both scarfs were secured with two additional rivets along the centreline of the plank.
On both lands old clinker rivet holes were plugged with small wooden plugs.

Toolmarks and markings
-

Waterproofing
Waterproofing in the lands consisted of two strands of tarred animal hair. The scarfs were sealed with a mat of animal hair and tar.

Repair and maintenance, miscellaneous
This plank is likely reused as indicated by the multiple fastenings.

Example of a frame description

Futtock (313), Fund-ID 392023

Short description and location
Portside futtock, found as a part of section 1 recovered on 15.06.21. The futtock is preserved over its full length. Minor damage was observed along the edges and at the foot.

Wood science
The futtock is cut from a compassed oak timber with the grain following the natural curvature of the timber. There are only a few knots present. Remains of sapwood are present on the edges of the inboard face.

Shape and dimensions
The length, measured from tip to tip is 1.84 m. The cross-section is regular with a moulded dimension (measured at the first joggle) of 10.5c m and a sided dimension of 21 cm. The upper arm tappers to a moulded dimension of 4 mm at the tip of the last joggle. The foot is cut out to fit over the underlying floor timber. It tapers to a moulded dimension of 5 mm at the tip. Nine joggles were cut into the outboard face with an axe. Their length varies between 10 cm and 22 cm while the depth measures between 2 cm and 3 cm.

Scarf
The foot of the futtock or side timber is cut flat for a length of 34.5 cm to fit over the underlying floor timber (232?).

Fastenings
11 treenail holes of 30 mm diameter were augered through the timber. The lowermost two holes, which connected the futtock to the floor timber are broken and bear witness of the forceful removal of the futtock from the main structure. Generally, a single treenail was used in each joggle to secure the futtock against the outer planking. All preserved nails had dome-shaped heads and were expanded with rectangular wedges on the inboard face of the futtock.

The lower end of the futtock was secured with at least one square-shafted iron nail, located near the tip. The nail hole, roughly 5 mm x 5 mm is visible inboard and outboard.

Toolmarks and markings
Axe marks are present in the joggles.

Waterproofing
-
Repair and maintenance
-

Stage 6: Dendro samples

Selection

In principle, samples should only be taken if there is a clearly defined research question (e.g. dating, wood ID, timber origin, etc.). The question must be noted on the sample slip and in the sample list.

For dendrochronology samples, care must be taken to ensure a sufficient number of tree rings (at least 50 - 60 rings for oak). In addition, samples should be selected where sapwood or bark edge are recognisable.

In the case of ship finds or finds of a large number of timbers, attention must also be paid to the distribution of the samples in order to obtain as representative a statement as possible on the time of construction and any repair phases.

If the timber to be sampled is to be conserved at a later date, the sample location should be selected in such a way that the overall impression of the timber is preserved (e.g. not in the middle of a very well-preserved structural plank)

A thickness of approx. 5 cm is sufficient for dendrochronology samples.

Documentation

Samples are labelled in accordance with the guidelines for archaeological excavations in Mecklenburg Western Pomerania (Grabungsrichtlinien) and receive an artefact ID (FundID) barcode. The barcode is attached to a find- or sample label, which is filled in with pencil and packed in a separate waterproof ziplock bag.

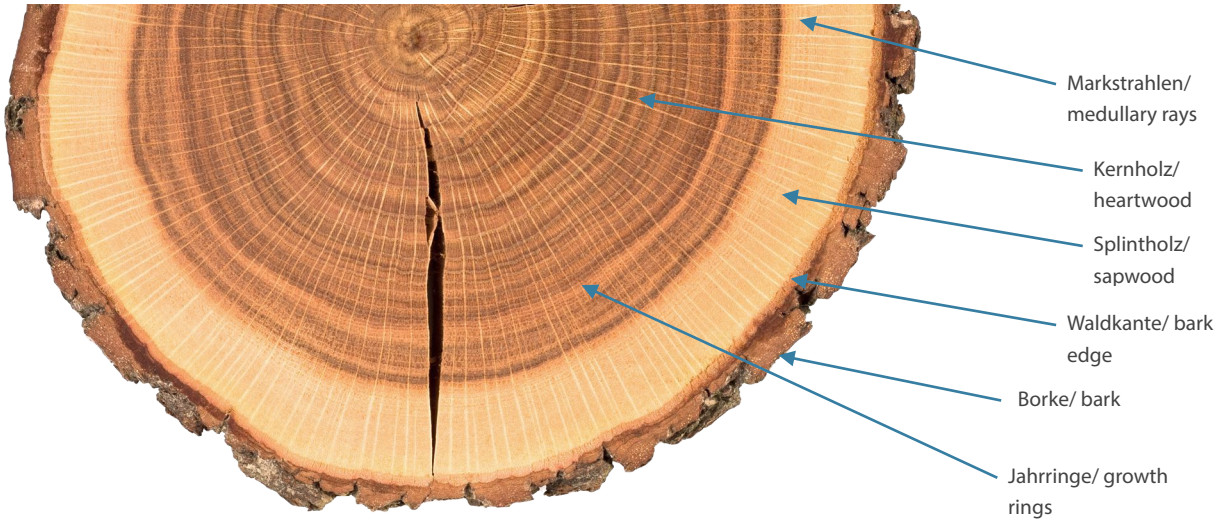
Each dendrochronology sample is documented with a photo on which the sample card and the location of the sample are clearly recognisable.

In addition, the sample number is added to the master timber list and the sample list.

In the Rhinoceros3D annotation file of the sampled timber, the sample location is indicated on the layer **dendro samples**. A TextObject with the respective FundID is created on the same layer.

Packaging

Dendro samples are wrapped in cling-film and then packed into a zip-lock bag together with the sample card. They are submitted to a dendrochronologist together with the sample list.



Appendix_1_Layers.xlsx

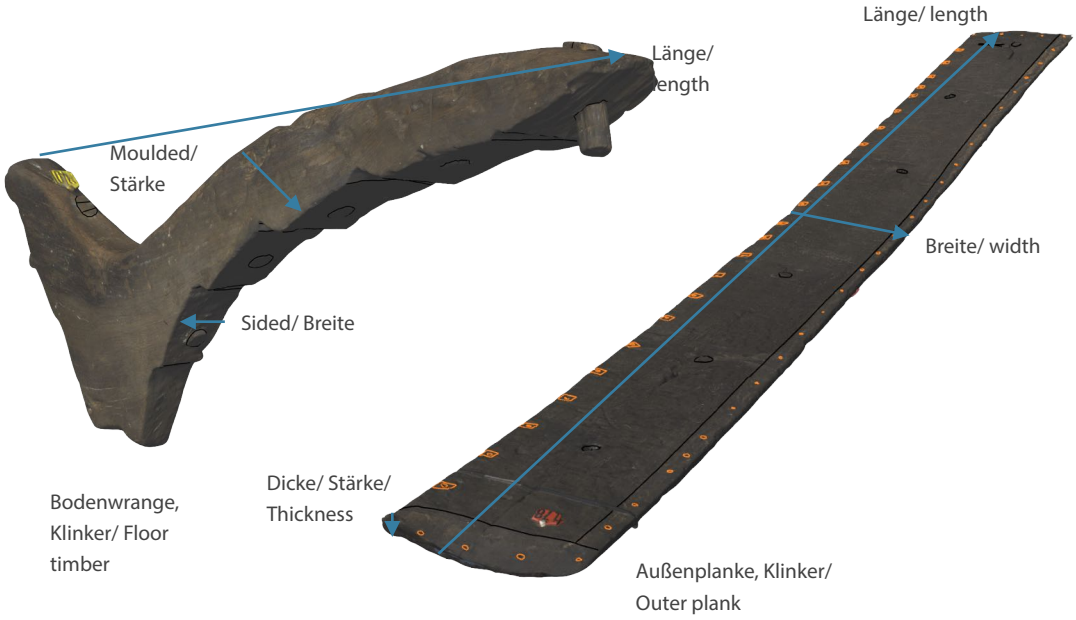
Main layer	Sublayer L1	Sublayer L2	Colour	Description
Scan				This layer contains the original mesh
ID				Layer for the timber number annotation (TextObject, curves)
Symbol				Parent layer for the drawing symbol
	Inboard/Innenbord			Man symbol
	Outboard/Außenbord			Fish symbol
Original edge/ Originale Kanten				This layer is used to annotate original edges where deemed necessary
	Land/ Landung			Annotation of land where necessary
	Scarf/ Schäftung			Annotation of scarfs where necessary
Damaged edge/ Beschädigungen				Annotation of damaged edges which are not obvious. If source of damage is unclear on this layer
	Original damage/ Original			Original damage on timbers
	Recent damage/ Rezent			Recent damage, e.g. caused during excavation
Toolmarks/ Werkzeugspuren				General annotation of toolmarks of unclear source
	Axe/ Axt			
	Adze/ Beitel			
	Saw/ Säge			
	Other/ Andere			
Wood science/ Holzmerkmale				Top layer for wood science: No annotation
	Sapwood/ Splintholz			Exemplary annotation of sapwood where clearly recognisable
	Grain/ Maserung			Exemplary annotation of grain, ideally growth rings in joggles or on timber ends
Fasteners/ Befestigungen				Top layer for fasteners: No annotation
	Treenails/ Holznägel			Top layer for treenails: No annotation
		Treenail inside/ Innen		Inside perimeter of treenail or treenail hole
		Treenail outside/ Aussen		Outside perimeter of treenail or treenail hole
		Treenail axis / Achse		Axis showing the direction of a trenail
		Treenail wedge/ Keil		Wedges or other methods of expansion in trenail heads
	Wooden plugs/ Holzstopfen			Wooden plugs in plugged nailholes
	Iron nails/ Eisennägel			Top layer for iron nails: No annotation
		Iron nail inside / Innen		Inside perimeter of iron nail or hole
		Iron nail outside / Aussen		Outside perimeter of iron nail or hole
		Iron nail axis / Achse		Axis showing the direction of iron nail
	Rivets/ Klinkernägel			Top layer for iron clinker rivets: No annotation
		Rivet inside / Innen		Inside perimeter of iron rivet or hole
		Rivet outside / Aussen		Outside perimeter of iron rivet or hole
		Rivet axis / Achse		Axis showing the direction of iron rivet
		Roves/ Nietplatten		Outline of clinker rove
	Iron bolts/ Eisenbolzen			Top layer for iron bolts: No annotation

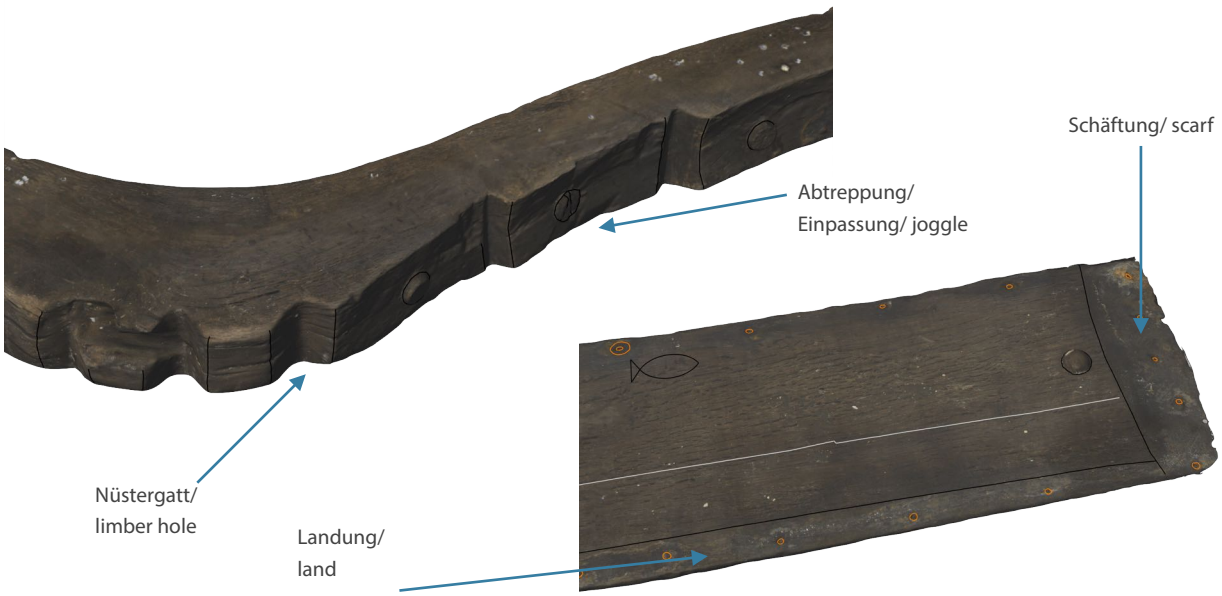
Appendix_1_Layers.xlsx

Main layer	Sublayer L1	Sublayer L2	Colour	Description
		Iron bolt inside/ Innen		Inside perimeter of iron bolt or hole
		Iron bolt outside/ Aussen		Outside perimeter of iron bolt or hole
		Iron bolt axis/ Achse		Axis showing the direction of iron bolt
	Sintels/ Sinteln			Outline of sintels and sintel holes
Concretion/ Konkretionen (hatched pattern)				Concretions or leftovers thereof are outlined on this layer and hatched
Metal Fittings/ Metallbefestigungen				Metal fittings or traces thereof in and on the timbers (gudgeons, plates, braces, etc.)
Intentional marks/ Markierungen				Intentional marks on the timbers (carpenter marks, decoration, etc.)
Repairs/ Reparaturen				All original repairs (patches, plugs, etc.)
Cross sections/ Schnitte				Top layer for the creation of sections: No annotation!
	Cross sections/ Kontur (contour)			Contour of final cross sections
	Cross sections/ Füllung (hatched pattern)			Fill of final cross sections
Samples/ Proben				Top layer for the annotation of samples: No annotation
	Dendrosamples/ Dendroproben			Location and number (FundID) of dendrosamples
	Other samples/ Andere Proben			Location and number (FundID) of other samples
Miscellaneous/ Verschiedenes				Objects like modern supports that are used to stabilise timbers, etc.

Appendix 2: Glossary

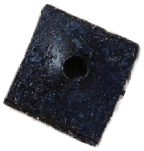
Visual Glossary





Holznagel mit konvexem Kopf und Keil/ treenail with dome-shaped head and wedge

Eiserner Klinkernagel mit rechteckiger Nietplatte/ iron clinker rivet with rove



based on nautical terminology of the Centre for Maritime Archaeology in Roskilde (NMF) - Englert 2005 and Steffy 1994.		
English	**German**	**Definition**
aft	(nach) achtern, (nach) hinten	Adverb; toward the stern. The braces lead aft from the yardarms.
afterbody	Achterschiff (n), Hinterschiff (n)	The part of the hull abaft the midship section.
after stem	Achtersteven (m)	Stem (meaning 1) at the stern of a double-ended vessel of traditional Nordic construction.
amidships	mittschiffs	Adverb; the point at the middle of the ship's length. The main hatch is normally found amidships.
batten	Stab (m)	A light strip of wood fastened over a seam, either inside or outside. Heavier than the lath in sintel technique.
beam	größte Breite (f)	The maximum breadth of the hull, to the outside of the structural timbers of the hull
beam	Balken (m), Decksbalken (m)	Transverse timber, usually relatively straight and strongly fastened to the sides of the hull, providing significant strength to the structure. May be used to support a deck.
below	unter Deck	Adverb; underneath the deck.
bevel		The fore-and-aft angle or curvature of an inner or outer frame surface
bilge	Boden (m), Flach (n)	That part of the bottom of a ship on either side of the keel which approaches nearer to a horizontal than a vertical direction. The transition towards the sides is called turn of the bilge accordingly.
biti	Bite (f)	(From Old Norse) In traditional Nordic construction, the lowest beam in a framing unit, directly above the heads of each of the floor timbers and fastened to the sides by standing knees.
bottom	Boden (m)	The part of the ship's hull below the waterline, especially the part from the turn of the bilge and below.
bow	Bug (m)	Either the forward part of the ship, or the direction off to one side of the bow. A ship was sighted off the port bow.
breast-hook	Bugband (n), Heckband (n, if used aft)	Transverse internal timber at the bow, across the centreline, reinforcing the bow against spreading. Performs same function as a transom timber at the stern. In double-ended ships there can be breast-hooks at the stern as well.

English	German	Definition
caulking	Kalfaterung (f}, Kalfatmaterial (n)	Material inserted into or applied to the hull to make it watertight. In medieval and later ships, usually refers to soft material driven or placed into the seams.
caulking cove	Kalfatnut (f)	A groove in the land of a clinker seam, into which inlaid caulking is placed.
chamfer		The flat, sloping surface created by slicing the edge of a timber
chock	Keil (m)	an angular block or wedge used to fill out areas between timbers or to separate them
clinker, clinker-built	geklinkert, in Klinkerbauweise	Shell-based shipbuilding methods characterised by overlapping planks which are fastened together.
covered caulking	verdeckte Kalfaterung (f}	Caulking method in which fibrous material (usually moss) is set into the seam after construction and covered with a wooden lath. The lath is held in place with nails, staples, or sintels.
deck	Deck (n)	Planking over the beams to provide a working surface and in late medieval and modern vessels to keep water out of the ship.
deck beam	Decksbalken (m)	A beam supporting deck planking.
double- bent nail	zweifach umgeschlagener Nagel (m)	Nail driven through two or more elements, with the point turned back and driven into the wood, typical of cog and other non-Nordic clinker construction.
double-ended	spitzgaltig, rundgattig, doppelendig	Hull form with full stems at both ends and the sheer strake turning into the stems at both ends, without a transom.
draught	Tiefgang (m)	The distance from the load waterline to the bottom of the hull, the minimum depth of water needed for the hull to float.
driven caulking	eingetriebene Kalfaterung (f)	Caulking forced into the seams, usually by a hammer applied to a specially shaped iron.
fair	strakend (adj.), ausstraken, strakend machen	(Adj.) a curve or surface that is smooth and sweet, without irregular humps or flats. (Verb) to produce a fair surface by careful carving or hewing.
false keel	Loskiel (m)	Substantial timber fixed to the lower surface of the keel to increase its depth and strength.
filling frame		A frame composed of a single row of timbers that filled the space between the main or double-rowed frames to maintain rigidity
floor	Boden (m)	The part of the ship's bottom below the turn of the bilge, especially the part with relatively straight transverse curvature.

English	German	Definition
floor timber	Bodenwrange (f), Bodenstück (n), Lieger (m)	Central frame element that crosses the keel at the lowest point in the section, over the floor.
flush-laid	karweelgeplankt, bündig gelegt	Planks laid edge-to-edge, so that the finished surface is smooth, rather than stepped.
fore-	Vor-	Adjective, usually attached to the word modified; pertaining to the area toward the bow. The foremast is shorter in schooners.
forebody	Vorschiff (n)	The part of the hull before the midship section.
fore deck	Vordeck (n)	Small deck in the bow of the vessel.
fore stem	Vorsteven (m)	Stem at the bow of a double-ended vessel of traditional Nordic construction.
forward	vorn	Adverb; in the direction of the bow. The anchors are usually kept far forward.
frame	Spant (n)	A transverse timber or group of connected/related timbers against the inner surface of the planking, providing substantial strength and stiffness to the hull.
frame spacing	Spantabstand (m)	Distance from the centre of one frame to the next.
freeboard	Freibord (m)	The distance (rom the waterline to lhe top of the ship's side at its lowest point.
futtock	Auflanger (m)	Frame element against one side of the hull, associated with a floor timber, to which it may or may not be fastened. A frame may be made up of a number of overlapping futtocks.
garboard	Kielgang (m)	Strake next to the keel in a round-bottomed hull.
graving piece		A wooden patch or insert let into a damaged or rotten plank
hood-end	Plankenende (n)	End of a strake, where it attaches to the keel, stern, sternpost, or stern-wing.
hook scarf	Hakenlasche (fi	Scarf with a stepped table arranged so that the assembled joint resists tensile lorce.
horizontal scarf	horizontale Schäftung (f), horizontale Lasche {f)	Scarf in which the table is more or less horizontal.
hull	Rumpf	The structural body of the ship, not including the rig.
inlaid caulking	eingelegte Kalfaterung (f)	Caulking laid into the seams of a clinker-built boat during assembly of the planks rather than driven in after assembly.
inner edge line	Innenkantenlinie (f)	In describing the form of a clinker-built hull, the line followed by the upper, inboard corner of a strake.

English	German	Definition
intermediate or side frame	Zwischenspant (n)	Independent frame element against the side of the hull, usually equally spaced between two more extensive frames.
joggle	ausnehmen,einpassen	To cut steps into a timber so that it will fit tightly against a stepped surface, such as the interior of a clinker-built planking shell.
keel	Kiel (m)	Longitudinal centreline limber providing substantial strength and resistance to leeway. Should be at least twice the thickness of the garboard (see keel plank).
keel plank	Kielbohle (f), Bohlenkiel (m)	Centreline longitudinal member to which the stems and frames may be attached, but which does not contribute significantly to longitudinal strength or resistance to leeway. Less than twice the thickness of the garboard.
keelson	Kielschwein (n)	Centreline timber on top of the frames, distributing the weight of the mast, often a long timber offering increased longitudinal strength and stiffness to the hull.
knee	Knie (n)	L-shaped timber in which the grain follows (at least approximately) the sweep of the timber, typically used to reinforce the angular joint between two other timbers, such as the keel and sternpost.
land	Landung (f), Lannung (f)	The area or surface where two planks or strakes overlap in traditional clinker technique.
lath	Sintelrute (f), Kalfatleiste (f)	A light batten of wood, laid over the caulLing to protect it, and held in place by sewing or iron staples, clamps or sintels.
limber hole	Nüstergatt (n)	Notch or opening on the underside of the frames to allow water to circulate through the bilge and reach the pump or bailing well.
mast step	Mastspur (f)	Mortise or cavity in the keelson or other timber into which the heel of the mast is stepped.
meginhufr	meginhufr (m)	(From Old horse) A heavy strake, descended from the heavy sheer strake of earlier Nordic craft (such as the Nydam vessels), normally found at the upper end of the floor timbers.

English	German	Definition
midship section	Hauptspant (n)	The transverse section at the widest point in the hull. It may or may not be in the middle of the length.
midship	Mittschiffs-	Adjective; pertaining to things located amidships. The midship cleat was used to belay the fall of the running shroud.
mortise and tenon joint		A union of timbers by which a projecting piece (tenon) was fitted into one or more cavities (mortises) of corresponding size
moulded	hoch	A dimension, generally speaking, measured from the inside of the hull outward, such as the height of the keel or a frame. Not applied to planking. The frame is 12 cm moulded.
moulding (1)	Höhe (f)	The dimension of a timber measured from the inside of the hull outward, such as the height of a frame. The moulding of the frame is 12 cm.
moulding (2)	Zierprofil (n)	A decorative profile in the edge of a plank or timber, typically made with a shaped scraper, a typical feature of Viking construction.
oar	Riemen (m)	Long shaft with a broad blade at one end for propelling a boat, the oar bears on a thole or rowlock to transfer energy to the hull.
oar hole, oar port	Riemenpforte (f)	A hole in the side of the hull through which an oar is inserted, the edge of the oar hole usually acts as the pivot point for the oar.
peg	kleiner Holznagel (m)	Small wooden fastening, typically used to keep another fastening in place or to secure a light element. Usually tapered.
plank	Planke (f)	A single board of the planking.
planking	Beplankung (f) Außenhaut (f)	Collectively, the planks fastened to the outer surface of the frames.
port	Backbord (n)	Having to do with the left side of the ship.
protruding beam, throughbeam	durchgehender Balken (m)	Beam whose ends penetrate the sides of the hull and are at least partly held in place by joinery or fastenings to the planking.
quarter	seitlich achtern	The side at the stern. In Viking ships, the rudder is normally mounted on the starboard quarter.

English	German	Definition
radially cleft	radial gespalten	Components produced by splitting the log along the medullary rays, producing wedge-sectioned pieces of great strength and stability.
rabbet or rebate	Sponung(f)	Longitudinal groove cut into the side of the keel/keel plank or stem/sternpost to receive the edge or hooding ends of the planking.
rib	Spant (n), durchgehendes Spant (n)	A frame that is one continuous piece of wood from one sheer to the other, may be either cut, grown or bent to shape.
rig	Rigg (n), Takelage (f), Takelung (f)	The spars, sails and rigging as a unit.
rigging	Takelage (f), stehendes und laufendes Gut (n)	All of the ropes and blocks etc. used to support the spars and sails and control them.
rivet	Klinkernagel (m), Niet (m) when finished)	Nail driven through two elements and then clenched or peened over a rove.
rocker	Kielsprung (m), Kielbucht (f)	The upward curving of the ends of the keel or keel plank, relative to its centre. be adjective form is rockered.
room	Spantraum (m)	The longitudinal space between two frame units.
rove	Nietplatte (f)	Small, pierced metal plate over which the point of a clinker nail is clenched or peened.
rowlock	Dolle (f)	Fitting at the side of the hull to serve as the pivot point for an oar and to help keep it in place. Keipar, oar holes, and thole pins are all forms of rowlock.
rudder	Ruder (n)	Device for steering a vessel, operates by turning in the water and generating either lift or drag in a lateral direction.
rudder frame	Ruderspant (n)	In vessels with side rudders, the frame that supports the rudder, normally heavier or bulkhead-like.
scarf	Schäftung (f) or Lasche (f)	Joint behveen two long timbers aligned on approximately the same axis.
seam	Naht (f), Plankennaht (f)	The joint between the edges of two planks.
shank	Schaft (m)	The shaft of an iron nail or spike.
sheer	Sprung (m), Decksprung (m)	The upper edge of the ship's side, as well as its curvature.
shell clamp	Balkweger (m)	Clamp on which the ends of beams rest.

English	German	Definition
side rudder	Seitenruder (n)	Rudder mounted on the side of the hull, typically toward the stern. On northern European craft before ca 1200 it is the most common type of steering device, mounted on the starboard quarter.
sided	breit	A dimension, generally speaking, measured along the periphery of the hull, such as the width of a frame. Not applied to planking.
sintel	Sintel (f), Kalfatklammer (f)	(From Middle Low German) A metal staple of particular form, with two points to be driven into the planks either side of a seam and ears extending along the seam, to hold the caulking and a wooden lath in place and protect them. Typical of cogs.
stanchion	Stütze (f)	Turned or carved post supporting a beam.
starboard	Steuerbord (n)	Having to do with the right side of the ship.
stem (1)	Steven (f)	Centreline timber at either end of the hull of a double-ended vessel, to which the hooding ends of the planking are attached.
stem (2)	Steven (m), Vorsteven (m)	The centreline timher at the bow, to which the hooding ends of the planking are attached. In complex assemblies (such as cogs), refers to the main timber to which the planks are attached, as long as at least part of the timber lies outside the plank.
stem-wing	Stevenflügel (m)	Extension of the inboard edge of a stem (1) toward amidships in order to provide a landing for the hooding ends of the strakes.
stepped stem	Treppensteven (m)	Type of winged stern in which the wings have individual steps for the hooding ends.
stern	Heck (n)	The after part of the ship, particularly the after end and its structure.
sternpost	Achtersteven (m)	The main centreline timber at the stern, to which the hooding ends of the planking are attached. It is usually straight along its after edge.
sternpost rudder	Stevenruder (n), Heckruder (n)	Rudder mounted, usually by iron fittings, to a straight or slightly curved sternpost. Invented in northern Europe in the second half of the 12th century
stop scarf	einfache Lasche (0	Scarf with a flat, straight table and nibbed ends inlet in each other.

English	German	Definition
stopwater		A wooden dowel inserted athwartships in the scarf seams of external timbers to prevent shifting of the joint or to discourage water seepage along the seams
strake	Gang (m), Plankengang (m)	A continuous run of planking, one plank in width and made up of one or more planks.
stringer	Stringer (m), Weger (m)	Longitudinal internal timber providing strength to the structure. May either be attached directly to the inner surface of the planking or to the inner surface of the frames.
table	Kontaktfläche (f), Auflagefläche (f)	The primary mating surface of a scarf, usually at a slight angle to the axis of the joined timbers.
tangentially cleft	tangential gespalten	Components produced by splitting the log in half and splicing or hewing off the round sides to produce a small number of wide planks.
through scarf	Schäftung (f)	Scarf with a straight, flat table passing completely through both elements and ending in feathered edges.
thwart	Ducht (f)	Light beam or plank intended to act as a seat for rowers or paddlers. May or may not be rigidly fastened to the rest of the hull structure.
treenail	Holznagel (m)	Wooden fastening of relatively constant cross-section, usually used to fasten major structural elements together.
tum of the bilge	Kimm (fl	the area where the more or less horizontal part of a ship's bottom (the floor) meets the more vertical portion of the side, in a conventional round-bottomed hull.
vertical scarf	vertikale Schäftung (f) vertikale Lasche (f)	Scarf in which the table is vertical.
wedge	Keil (m)	Small slip or peg of wood driven into the end of a treenail to spread it and prevent it from being withdrawn.
winged stem	Flügelsteven (m)	A stem in which the inboard edges are extended towards amidships in a wing or series of steps to provide the landings for the handing ends. Typically found in Nordic clinker construction.