Arq. en Aguas Profundas I

Especialización en Patrimonio Cultural Sumergido
Cohorte 2019

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Bogotá, April 2019

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ShipLAB
TEXAS A&M UNIVERSITY

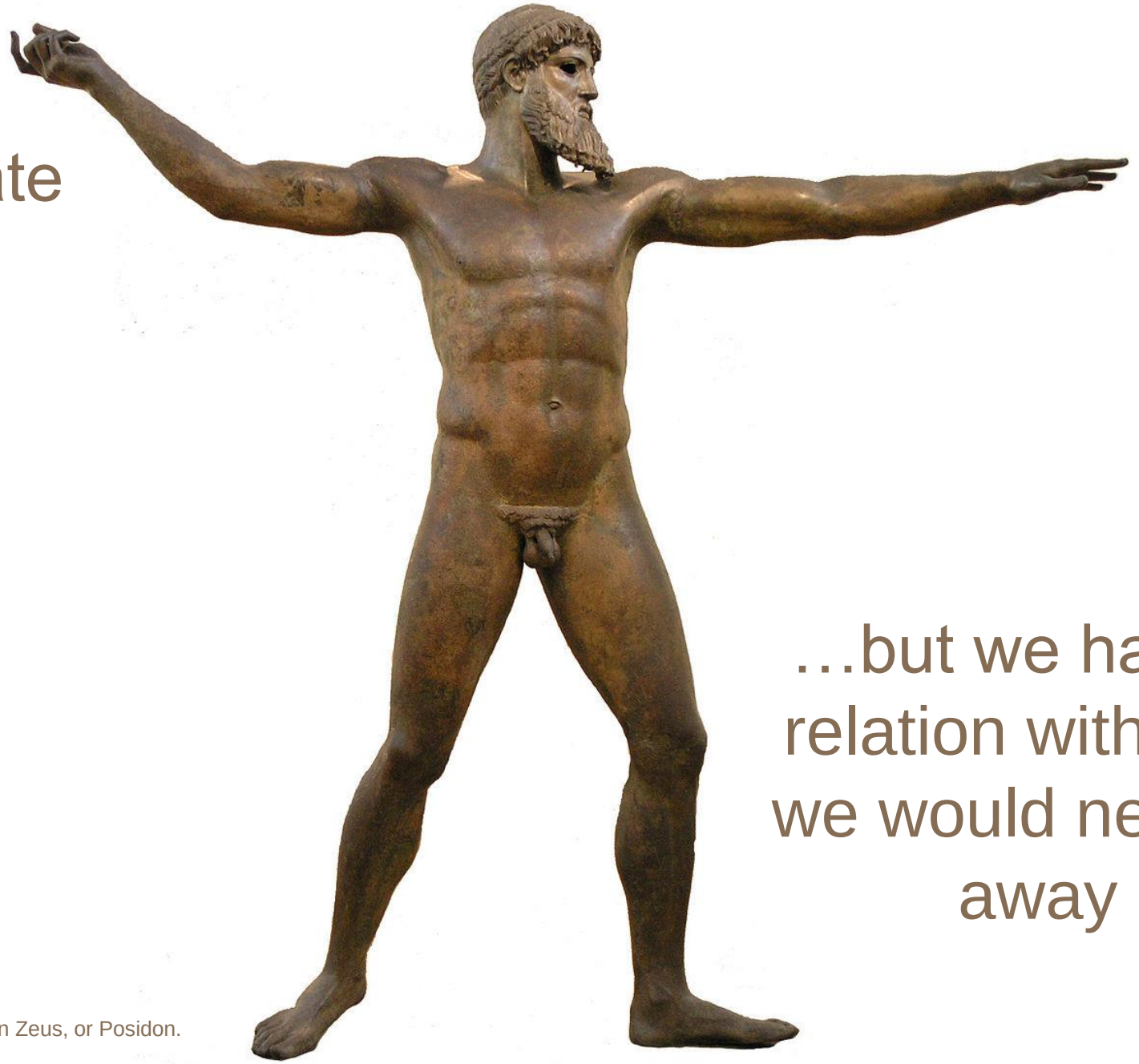
Part 1

Society is an organism…

Matt Ridley **TED Talk** ***When ideas have sex***

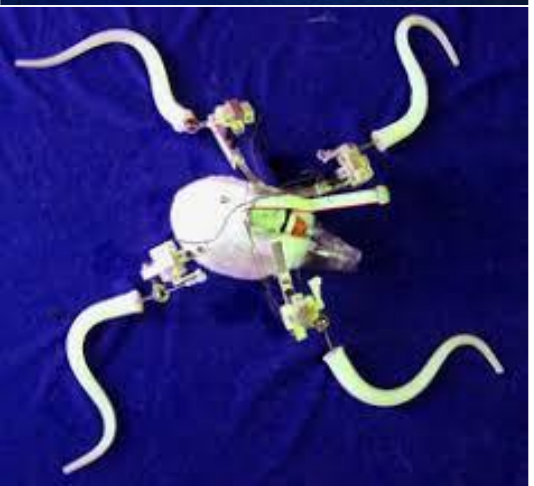
…we cannot do anything alone.

Archaeology doesn’t generate much profit…



Mid-5th century BC Artemision Zeus, or Posidon.

…but we have a tight relation with our past: we would never throw away our family albums.



If marine robots can do archaeology, they can do anything.

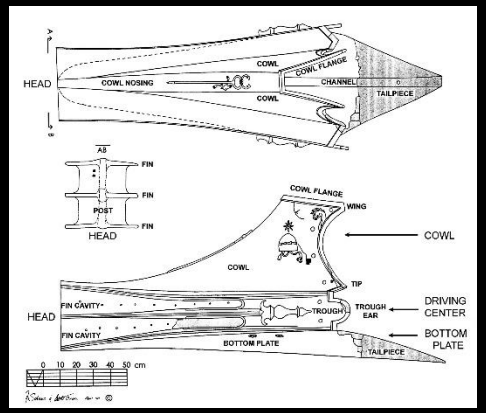
Marine archaeology can be a good testbed for marine robotics:

1. Shipwrecks frequently occur in places with currents and waves;
2. Often deep;
3. Often in places with low visibility and suspended sediment;
4. Marine archaeology requires surgical precision;
5. It generates large amounts of data that need to be synchronized, stored, migrated, classified, and analyzed, in order to allow for interpretations of the sites and reconstructions of the past.

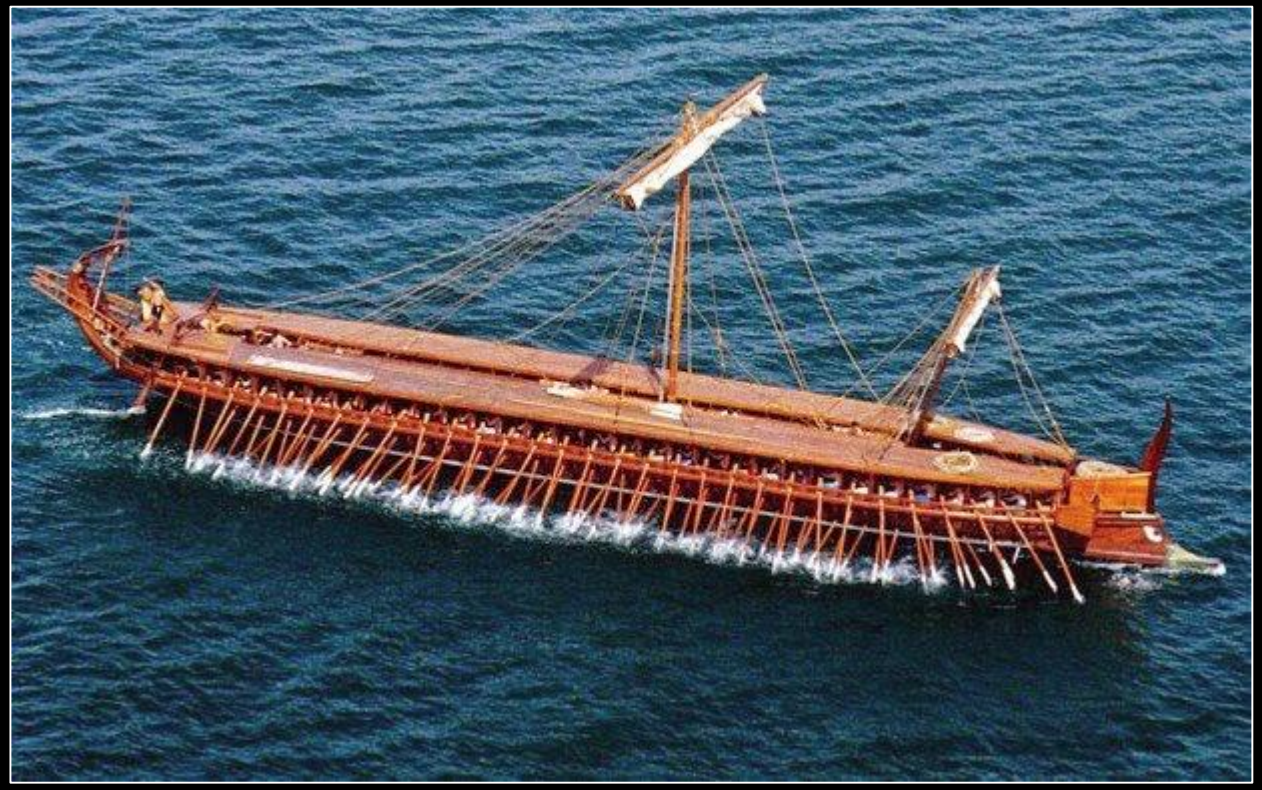
Archaeologists try to reconstruct the past from the remains of past human activity.

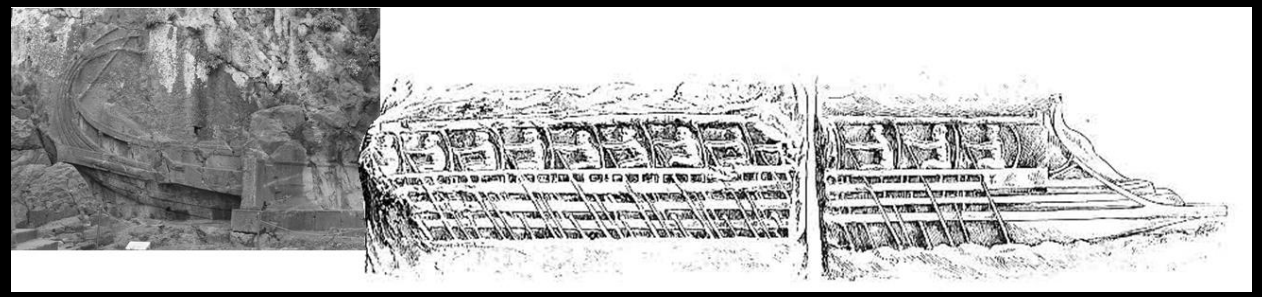
Nobody knows what an Athenian trireme looked like.

All we have is a ram (190 BCE)…



…a few timbers preserved inside it…





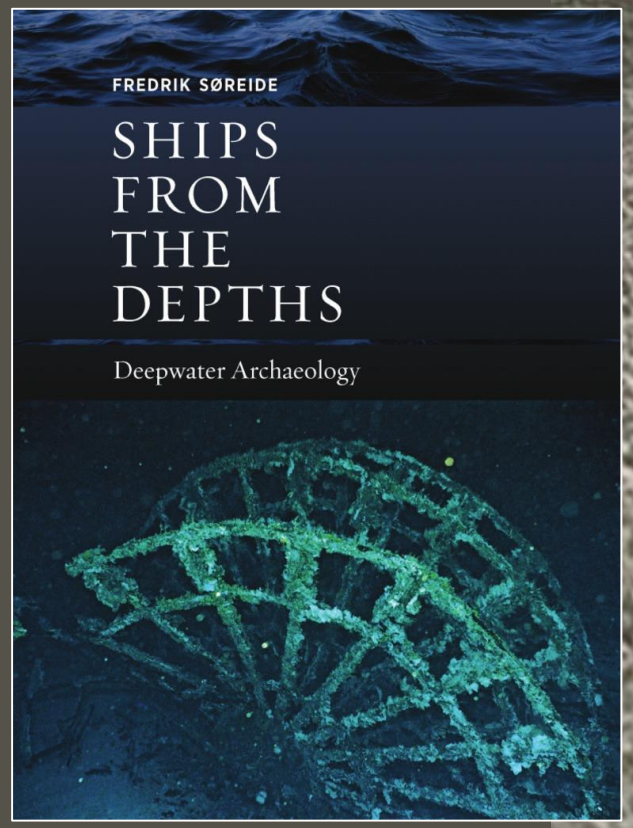
…and some sculptures:

The history of warship design is largely unknown to us.

. . .

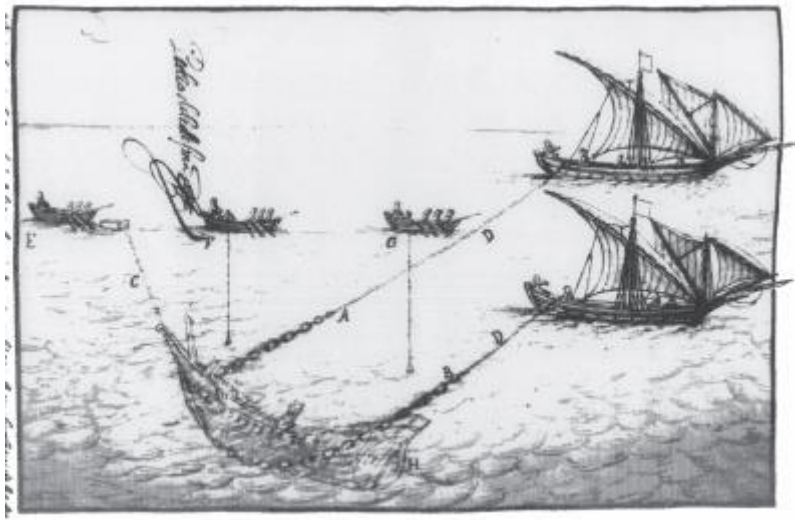

Archaeologists rarely try to work beneath air / nitrox diving depths.
bbm

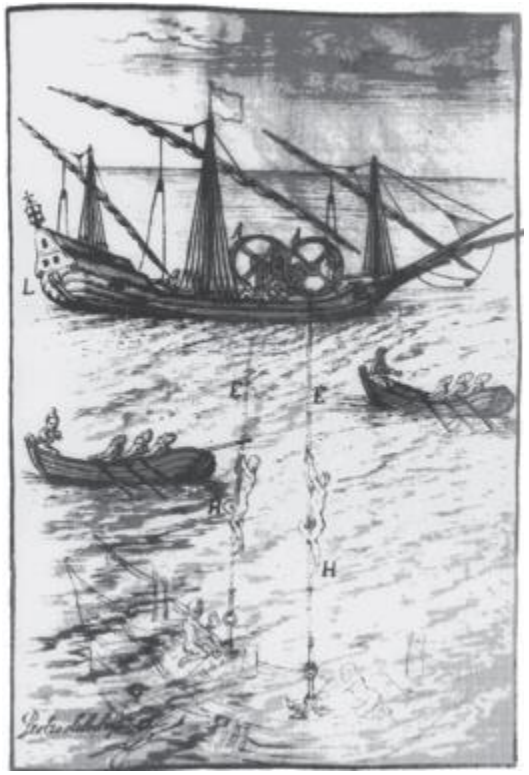
A few attempts were made to work in deep water, following archaeological standards.

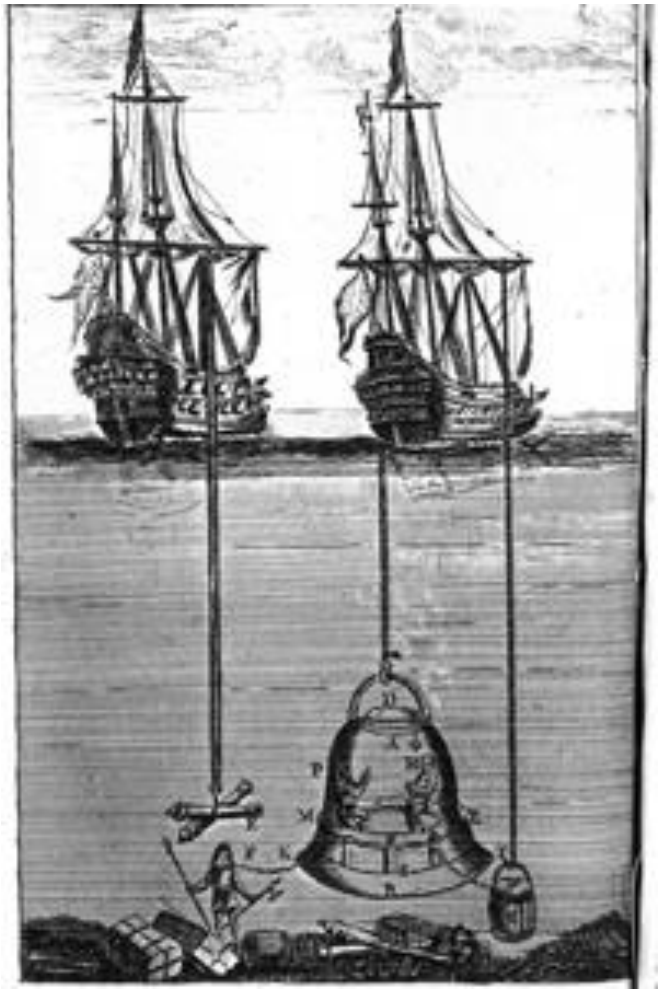


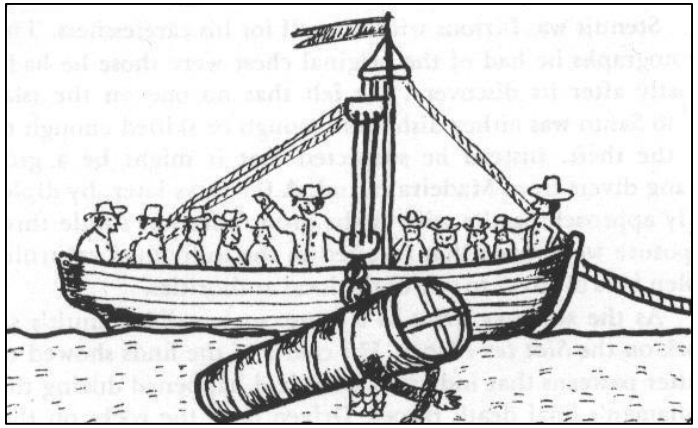
Ormen Lange, Norway, 2003

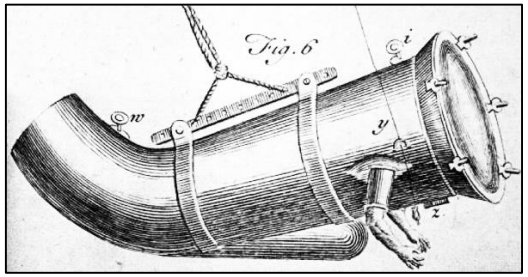
The salvage industry has a long experience recovering cargos from shipwrecks.











Treasure hunters destroy the sites they salvage

In 20107 Greg Stemm recovered 17 tons of silver coins from a Spanish shipwreck.

Deep sea archaeology is in its infancy and marine robotics is the answer to the most relevant problems.

Archaeologists work within a 19th century paradigm, and what we do can be roughly divided into four main categories:

1. Surveying;
2. Excavating;
3. Conserving; and
4. Publishing.

1 Surveying requires an array of remote sensing tools:

a. Magnetometers;
b. Side scan sonars;
c. Multibeam ecosounders;
d. Video;
e. Photography;
f. Sub-bottom profiling.

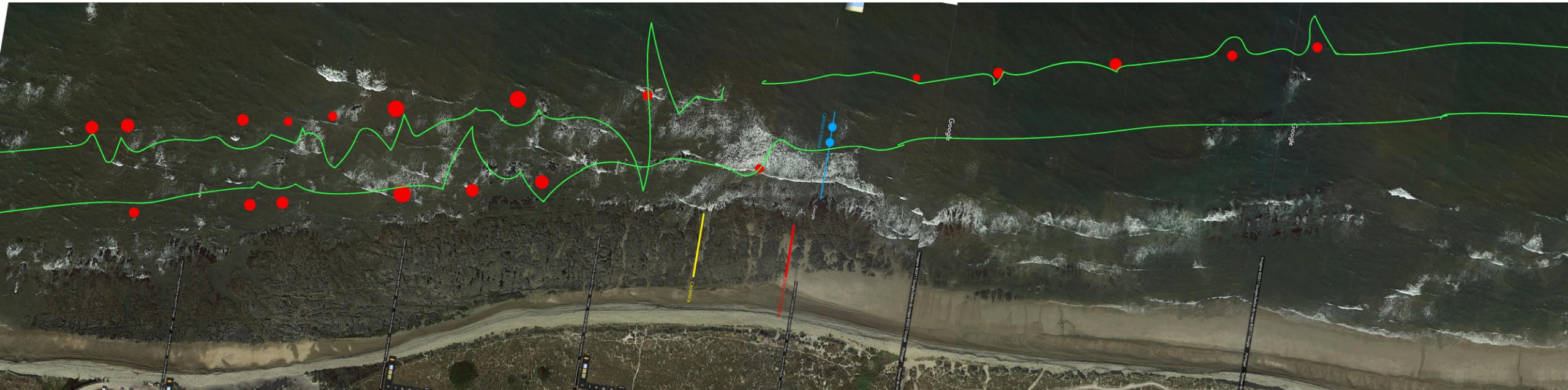
Ground truthing generally requires diving or the use of ROVs.

Besides cost, survey problems include:

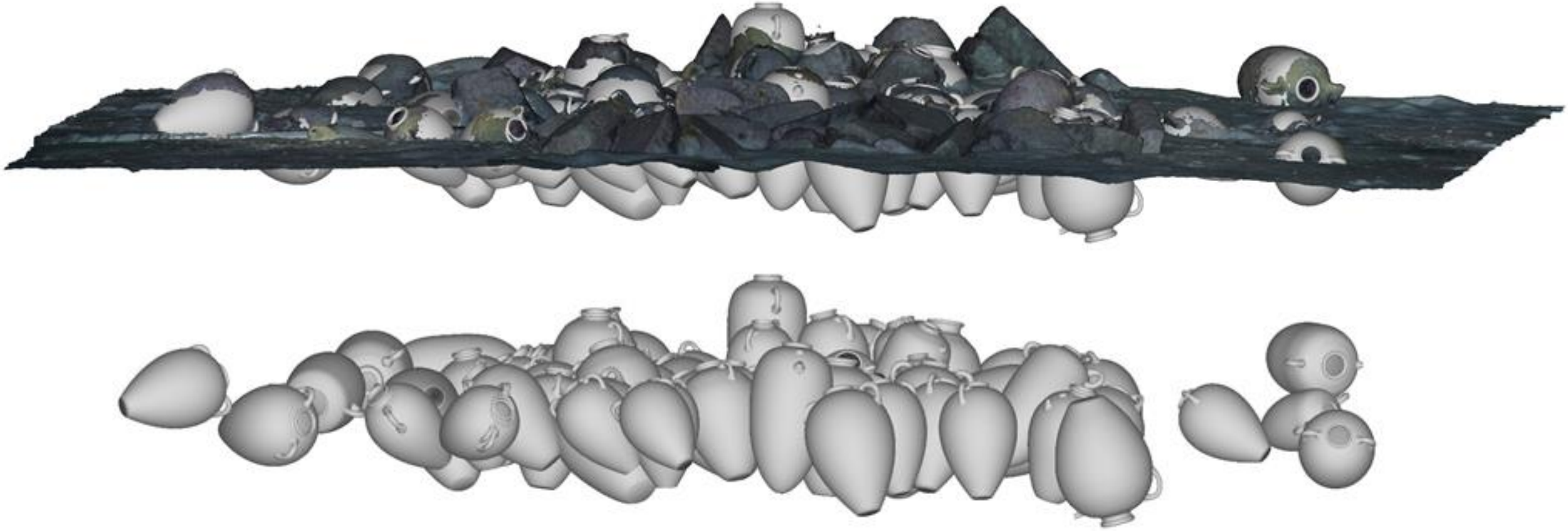
a. AUV payload;
b. AUV autonomy;
c. AUV stability (pitch, roll, and yaw control);
d. AUV path control;
e. Communications (data migration).

Related problems are:

a. Data integration;
b. Interaction of multiple vehicles collecting data at the same time (e.g. sonar and magnetometer).



Ultimately, the main goal of a collaboration between marine robotics and archaeology would be the acquisition of accurate data.



Computer Science: Pierre Drap (CNRS) and the c. 700 BC Xlendi shipwreck, Malta.

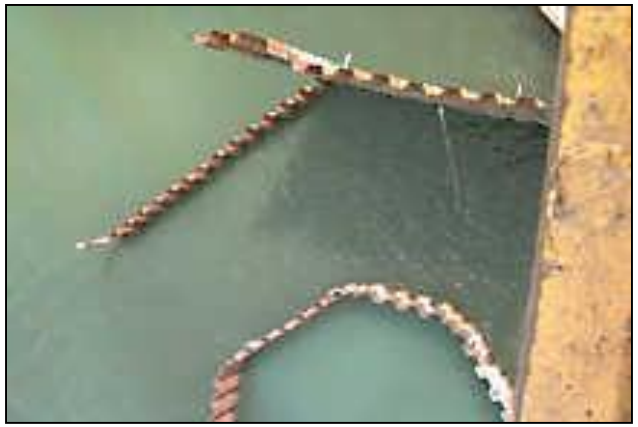
2 Excavation consists of six main tasks:

1. Mapping
2. Digging
3. Cleaning
4. Tagging
5. Recording (plans and sections)
6. Covering, or raising and conserving

Chevalier de la Salle's *Belle*, 1686

Archaeologists destroy the sites they dig and must record everything they find as carefully as possible.

In this project, to overcome the problems created by the strong currents and low visibility, a cofferdam was built around the wreck site and the water pumped.



The excavation was carried out by the Texas Antiquities Committee between 1996 and 1997.

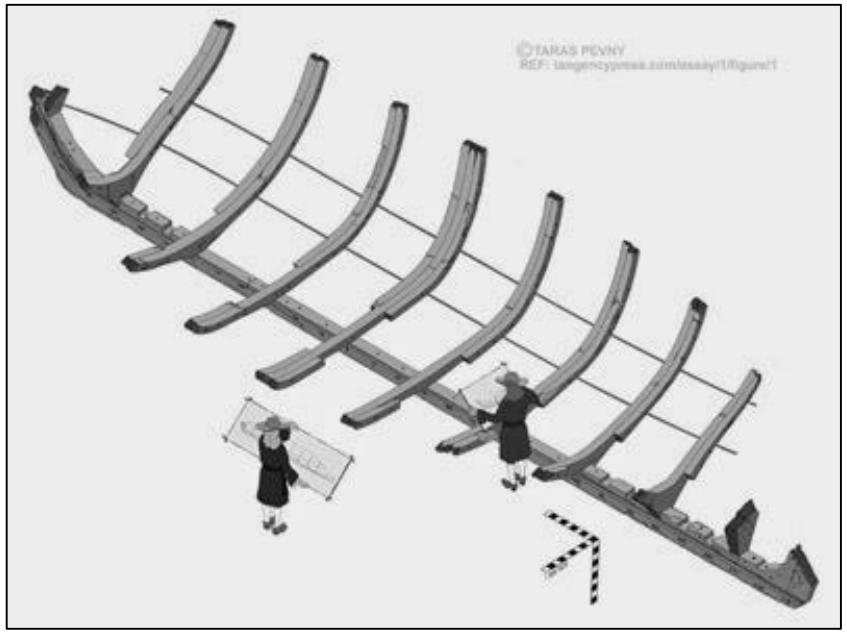




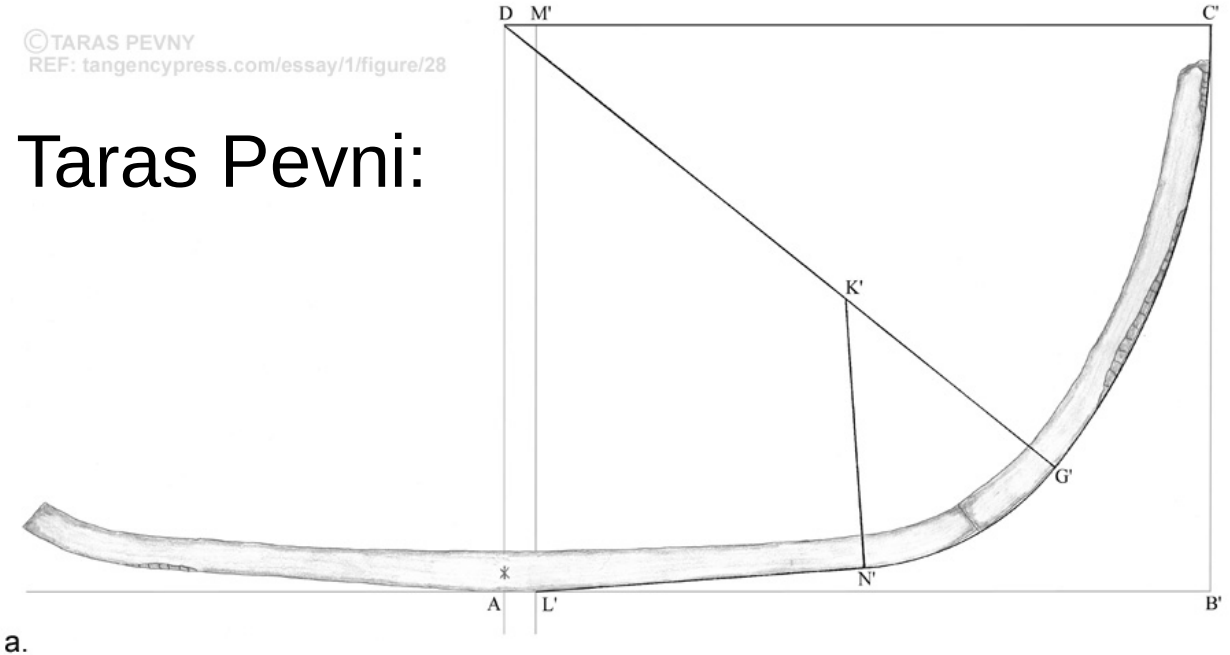




The hull was disassembled, each timber recorded separately, cleaned, and reassembled before conservation treatment started.



Taras Pevni:



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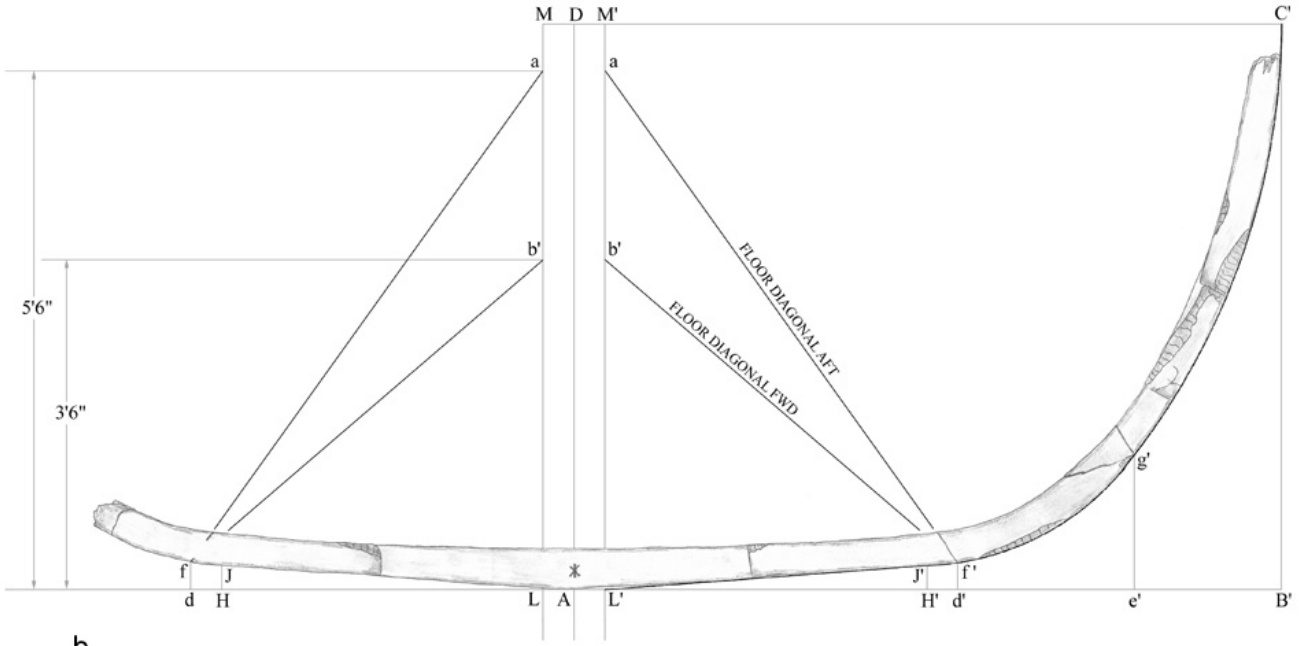

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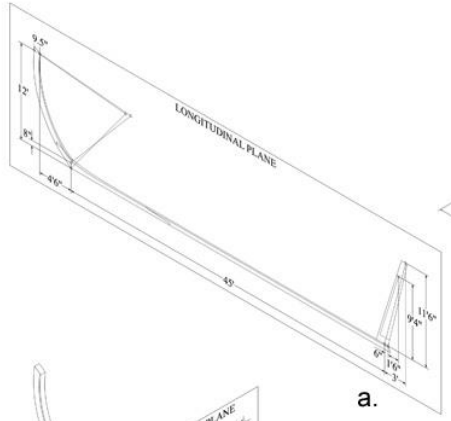

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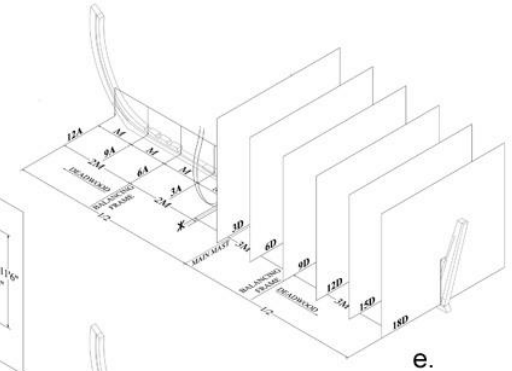
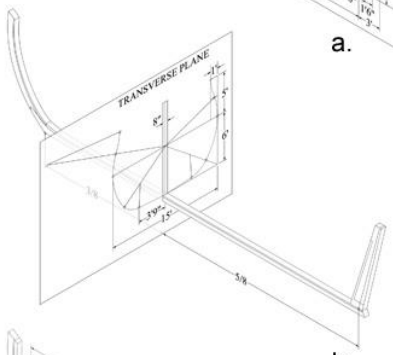


e.



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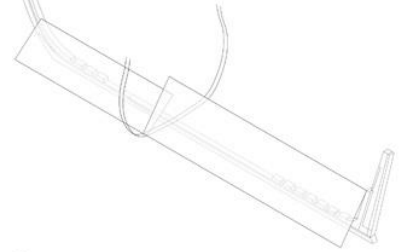

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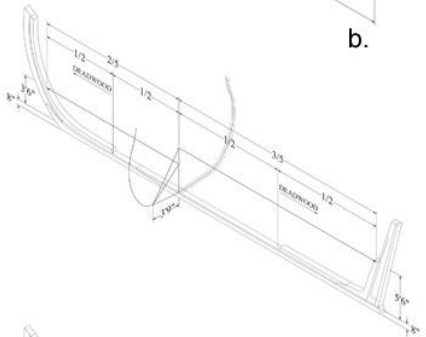

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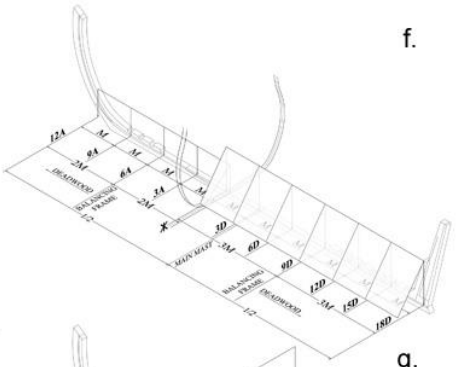

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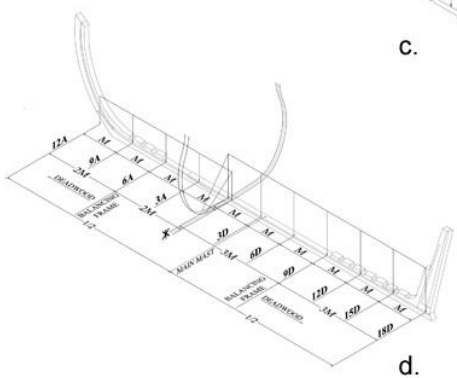

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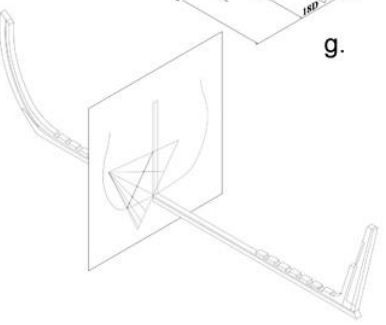
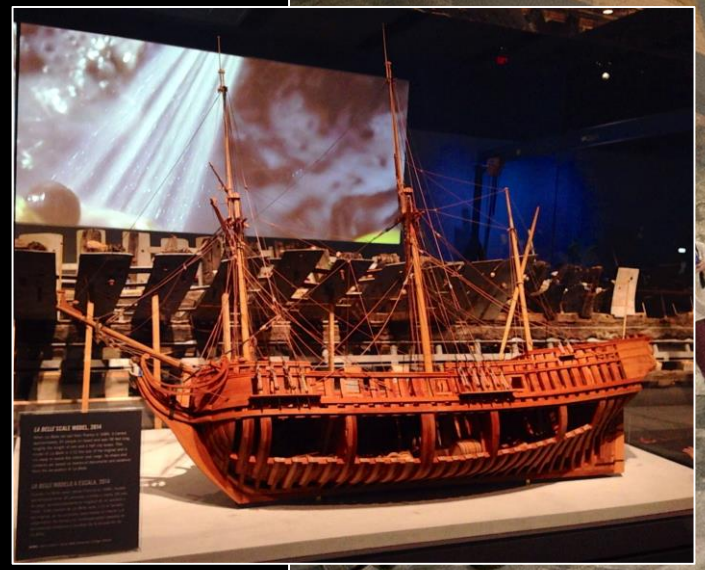
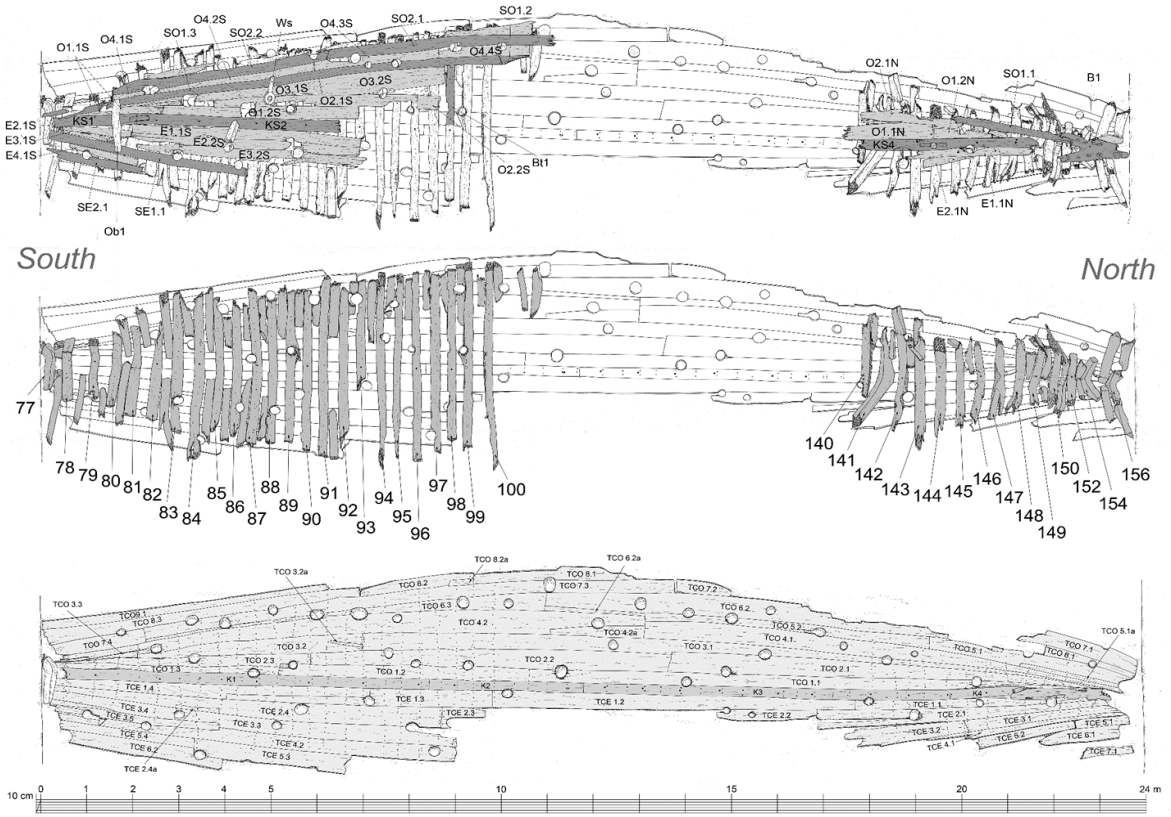


h.

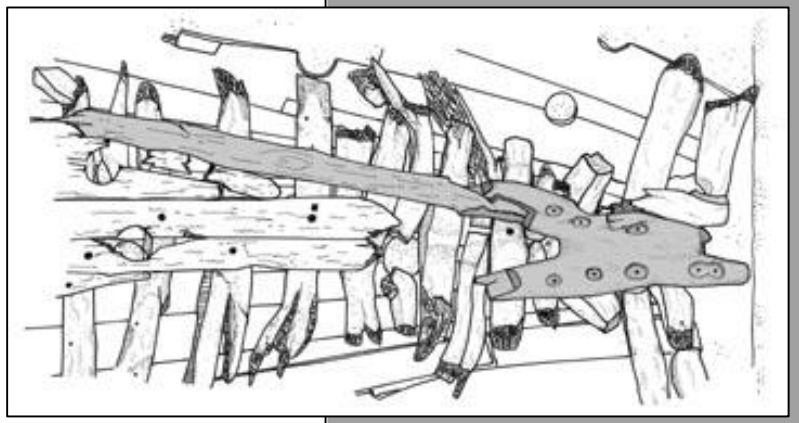
After conservation the hull was exposed in Austin, at the Bullock Texas State History Museum, and an attempt to reconstruct the ship and its rigging was made.

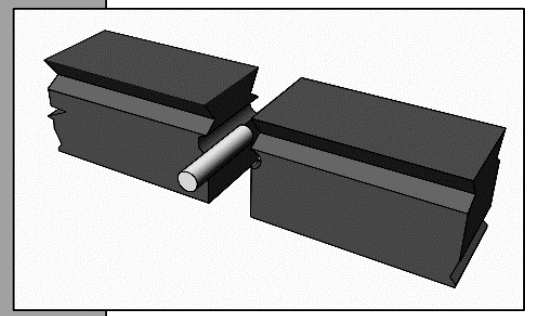


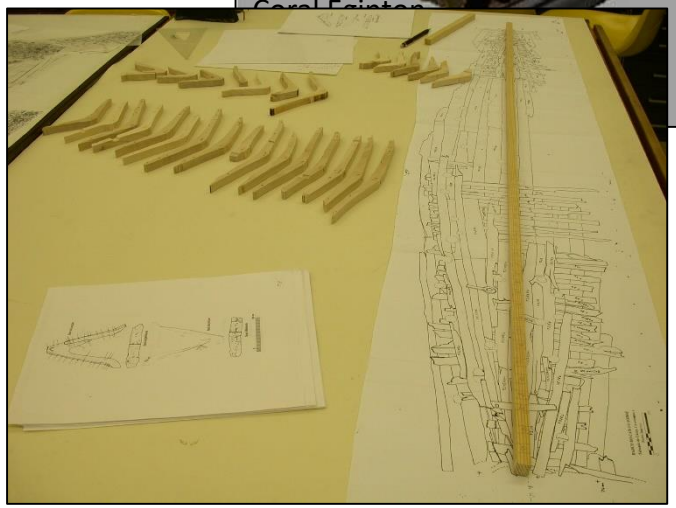
The excavation process is always the same: map, dig, clean, tag, record (sketch, measure, and draw plans and sections), and cover.

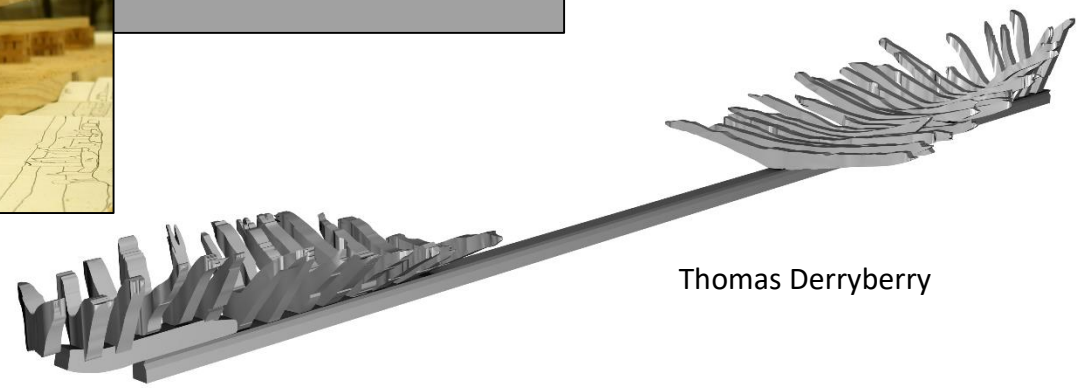


Cais do Sodré shipwreck, Lisbon (C14 dated to c. 1500)

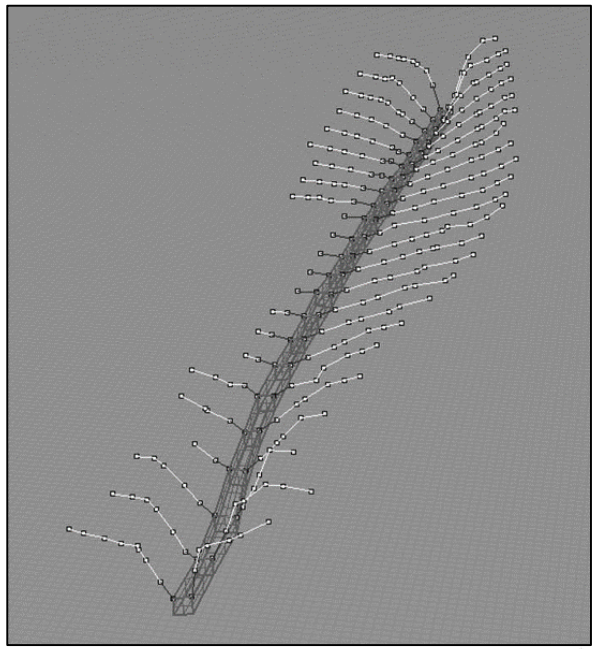


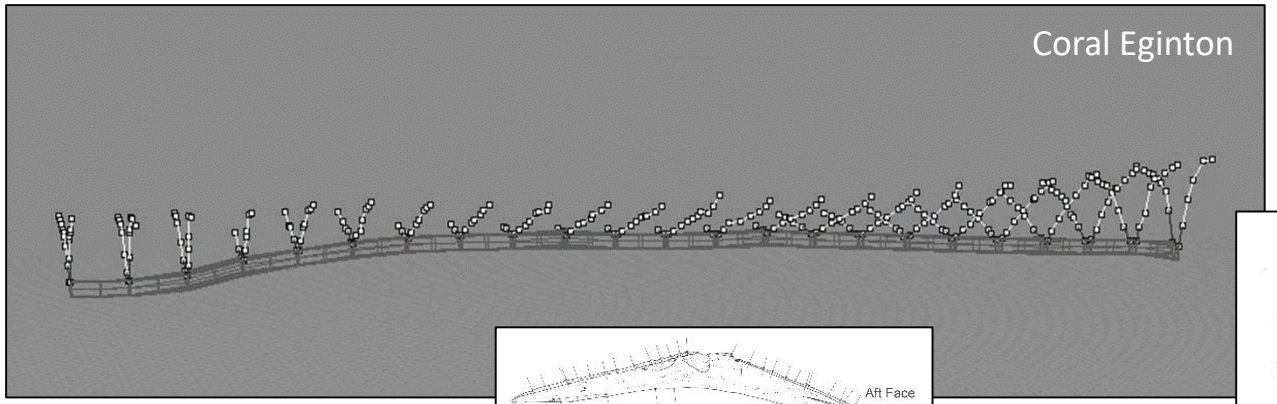


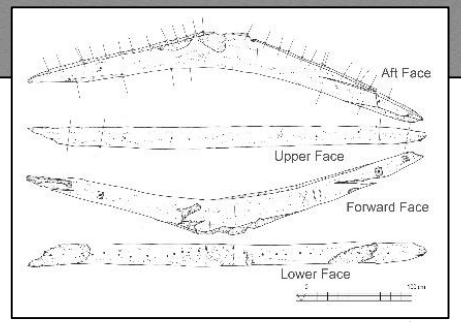


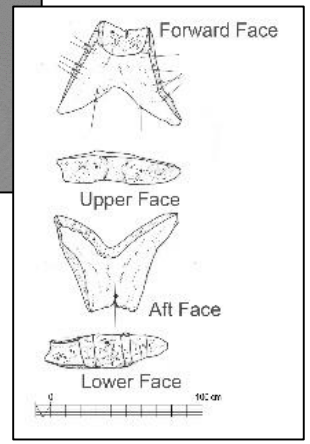


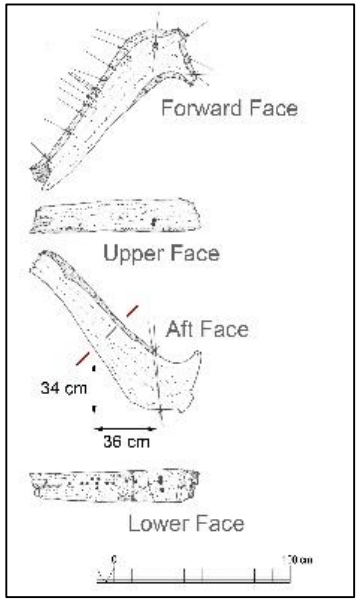
Thomas Derryberry

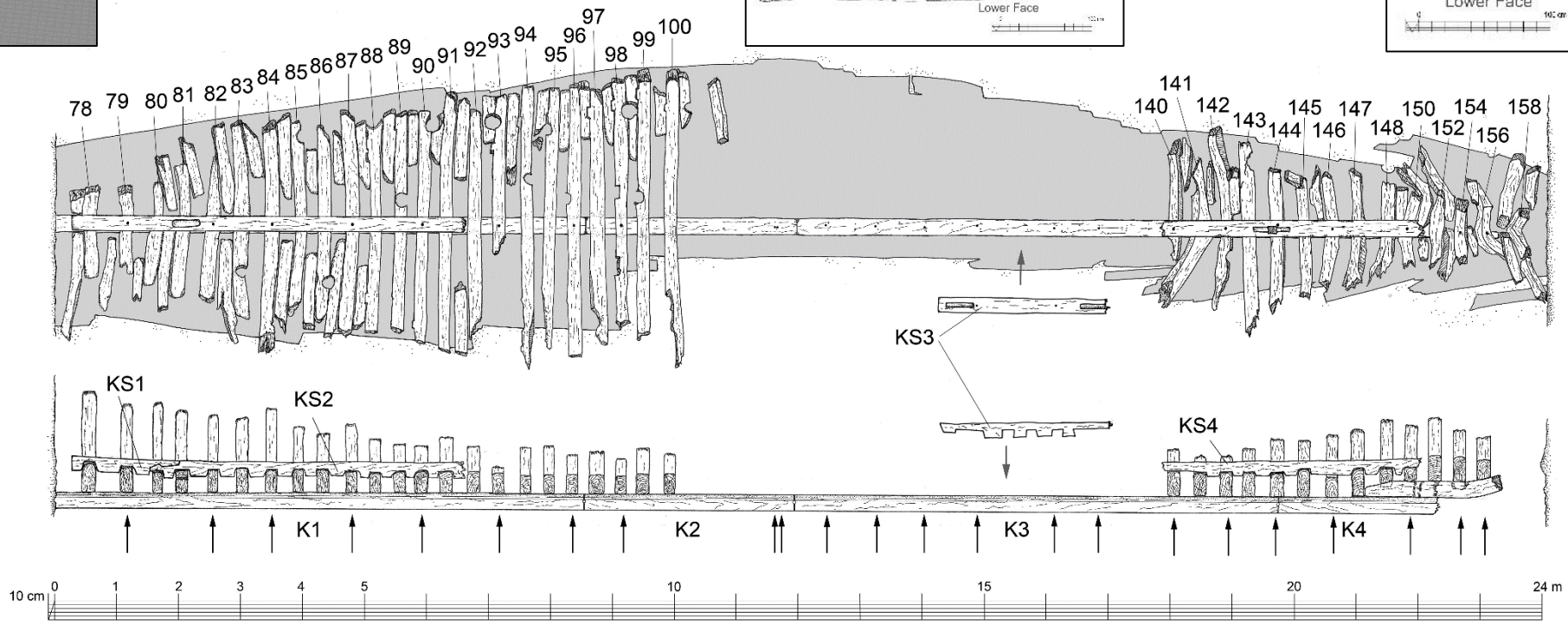



Coral Eginton


Aft Face
Upper Face
Forward Face
Lower Face


Forward Face
Upper Face
Aft Face
Lower Face


Forward Face
Upper Face
Aft Face
34 cm
36 cm
Lower Face


78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100
140 141 142 143 144 145 146 147 148 150 152 154 156 158
KS1
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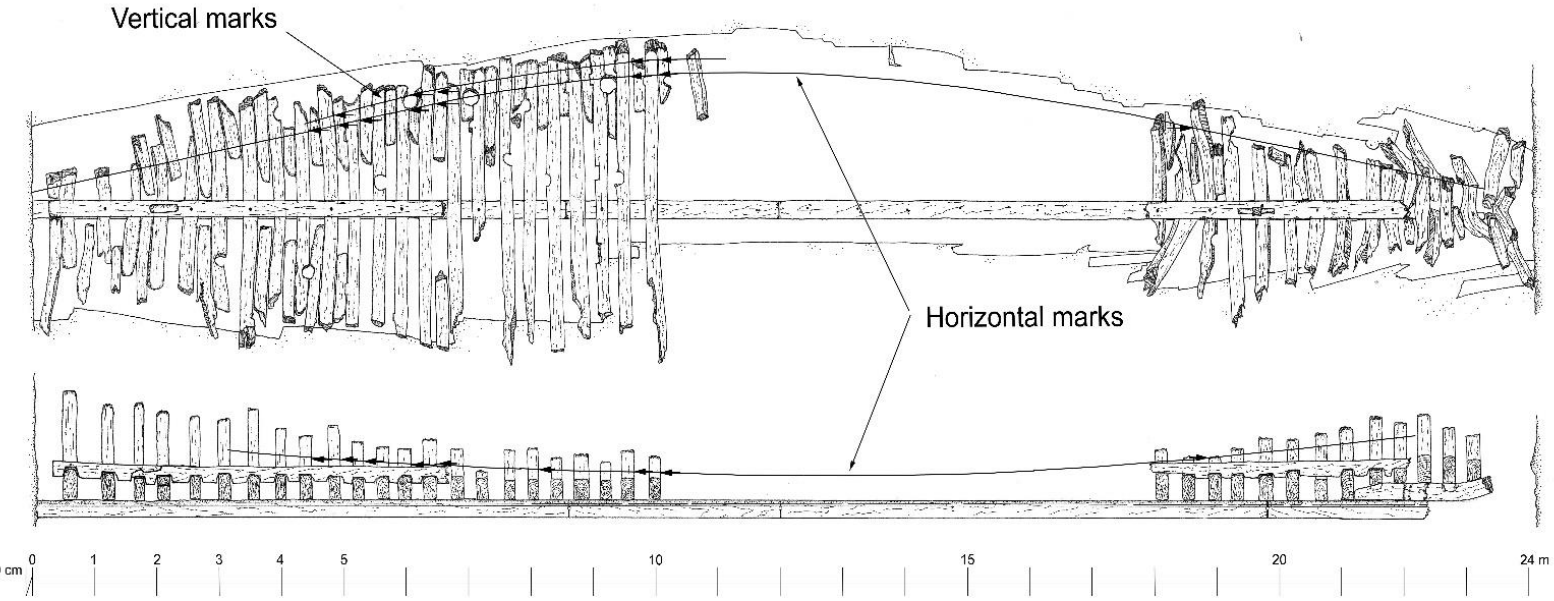
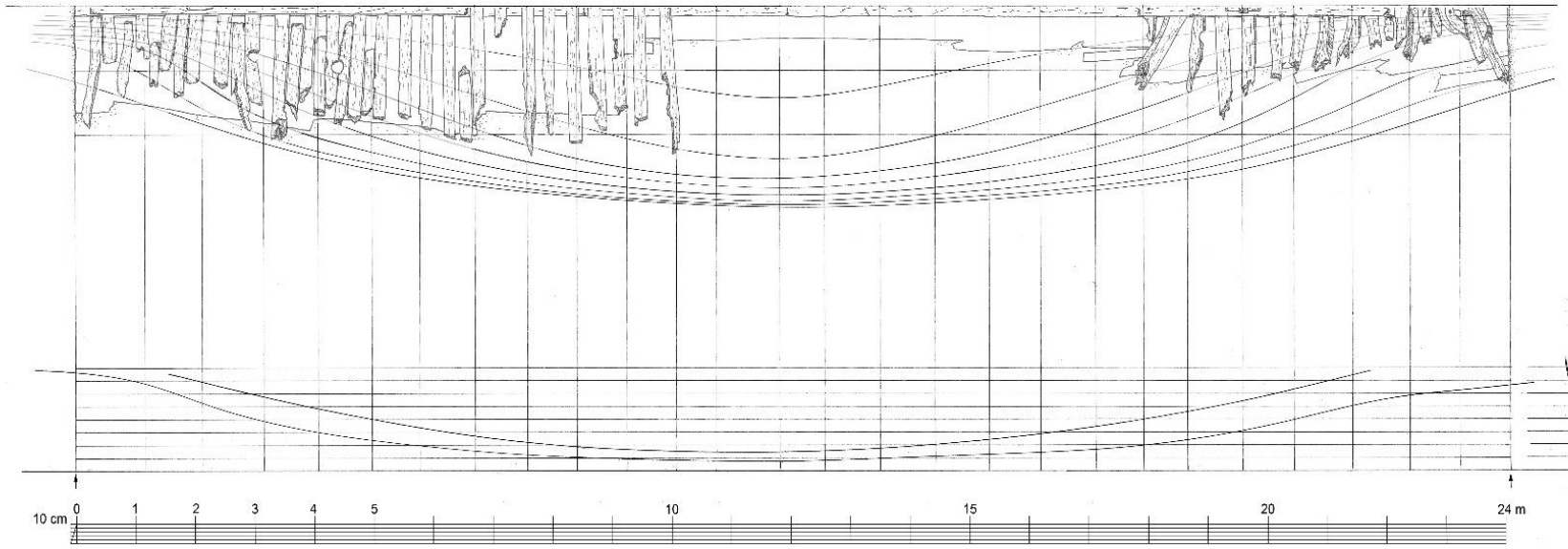
10 cm
0 1 2 3 4 5 10 15 20 24 m


Vertical marks
Horizontal marks

10 cm
0
1
2
3
4
5
10
15
20
24 m


10 cm
0
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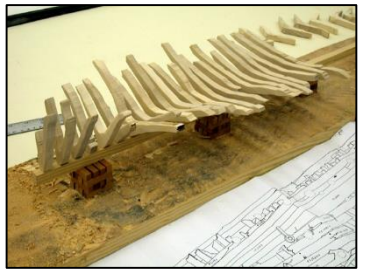
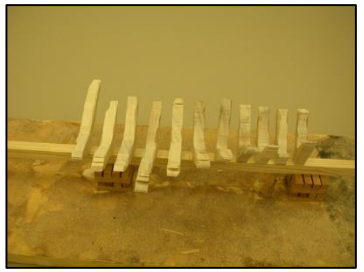
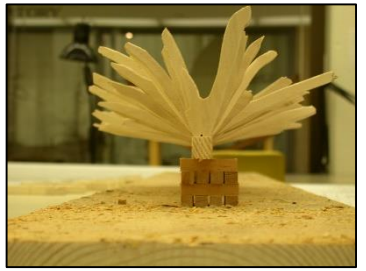
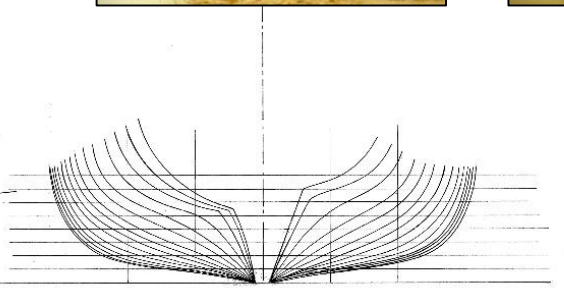
20
24 m









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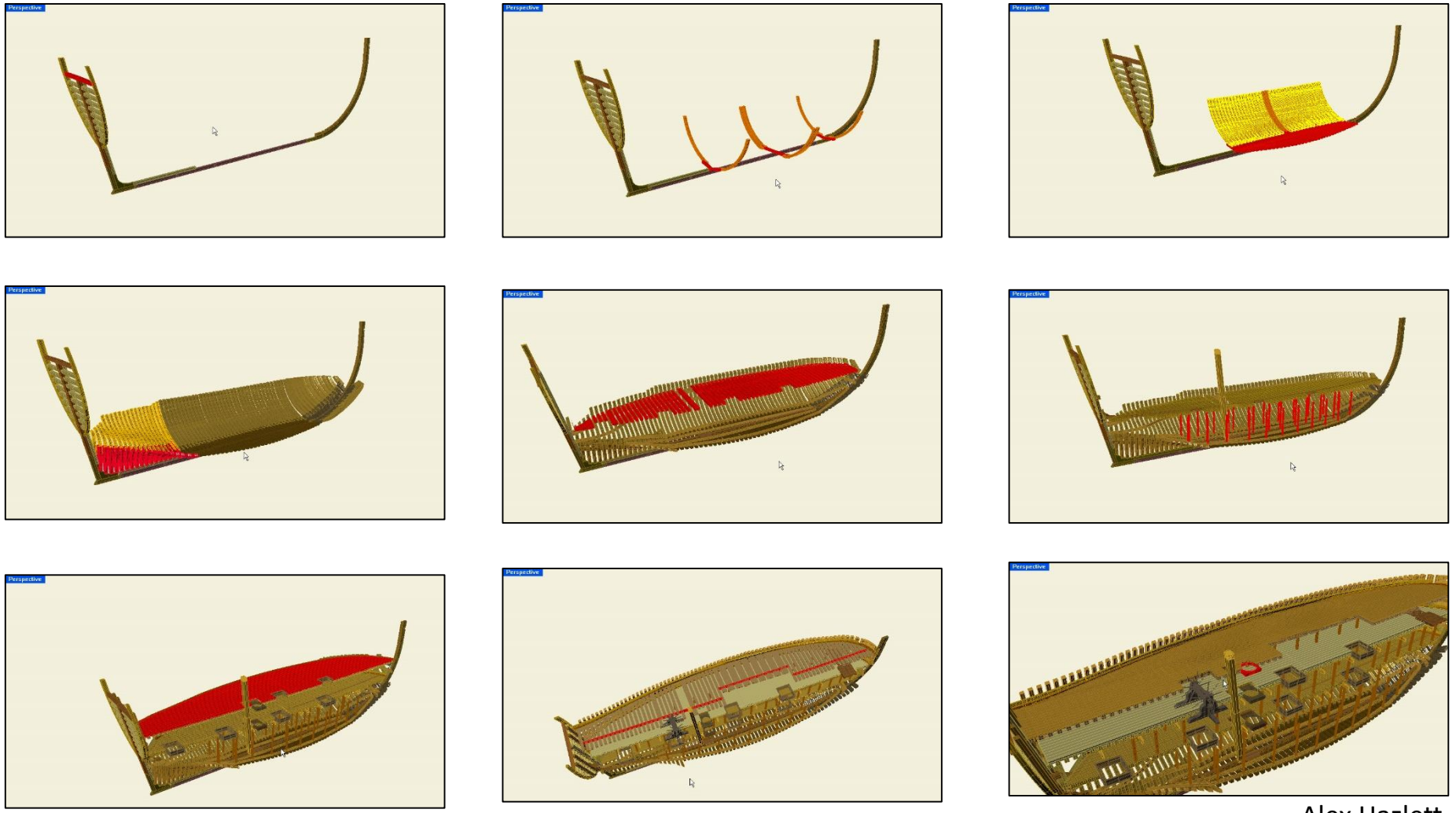
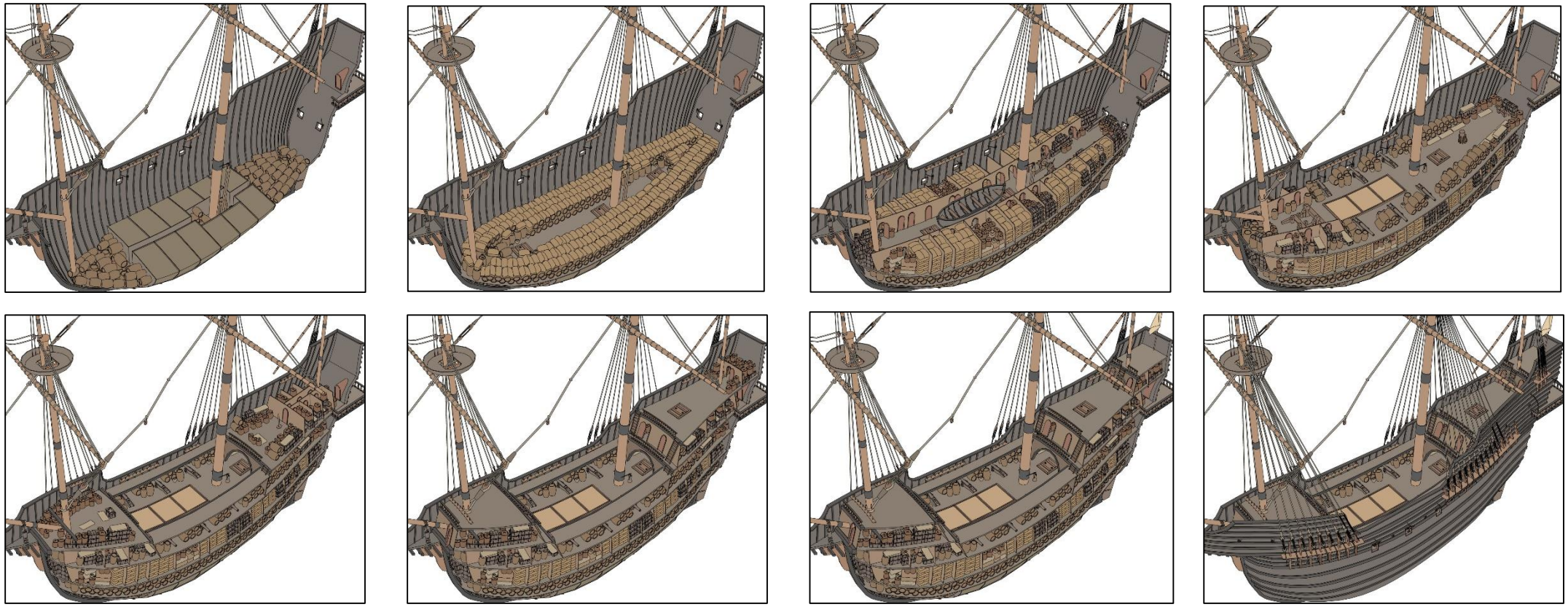
Ships have a stratigraphy in themselves: they were built following a traditionally established construction sequence.



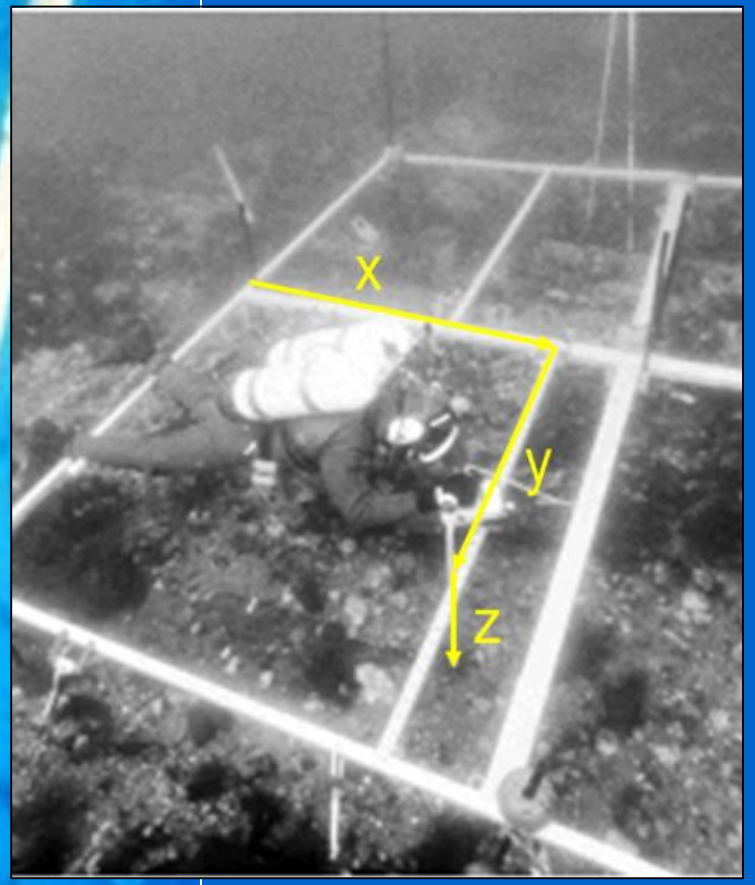
Alex Hazlett

We want to reconstruct them, populate them, and understand the world in which they sailed:

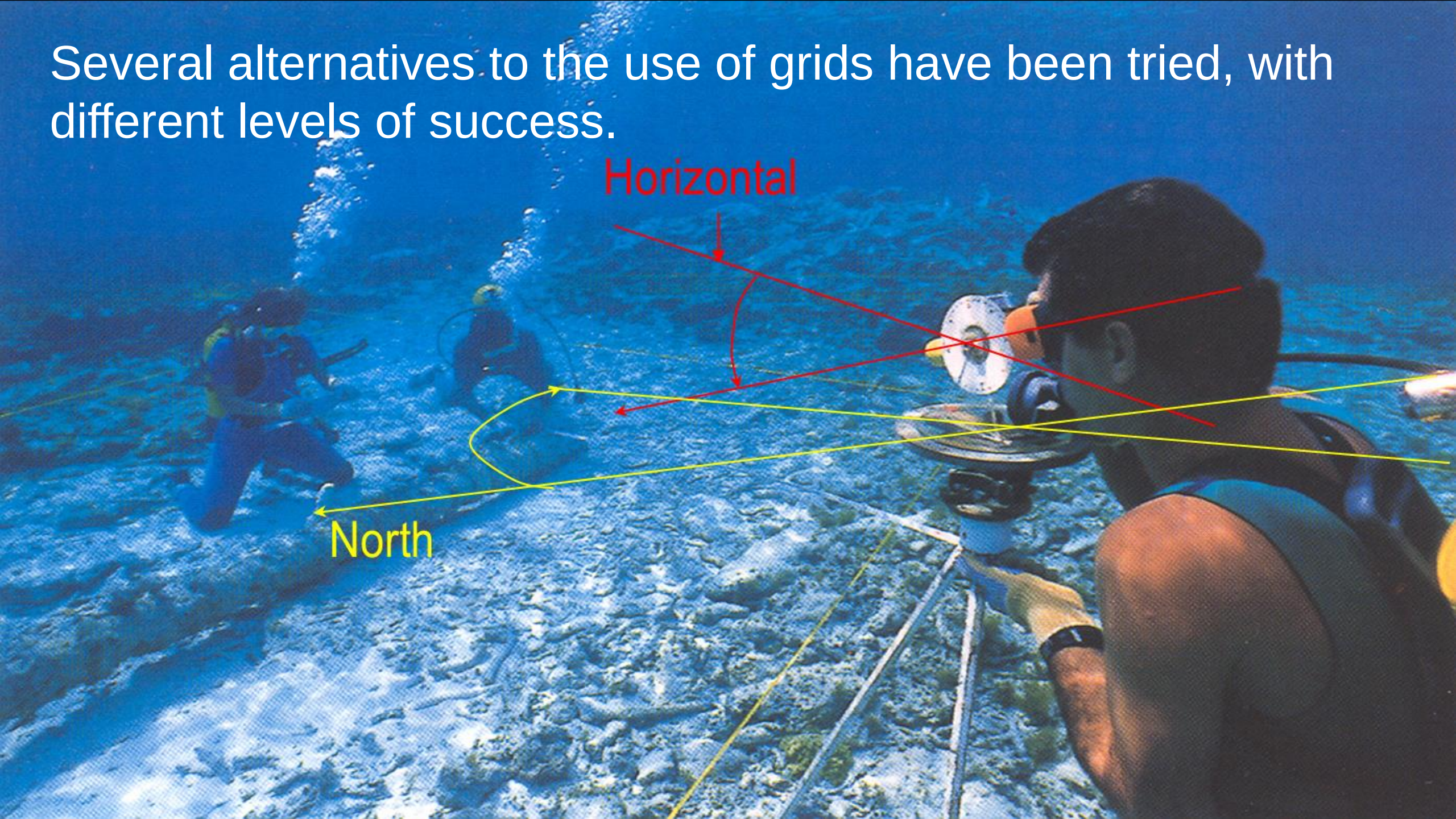


Cody Leuschner
Bruce Gooch’s student

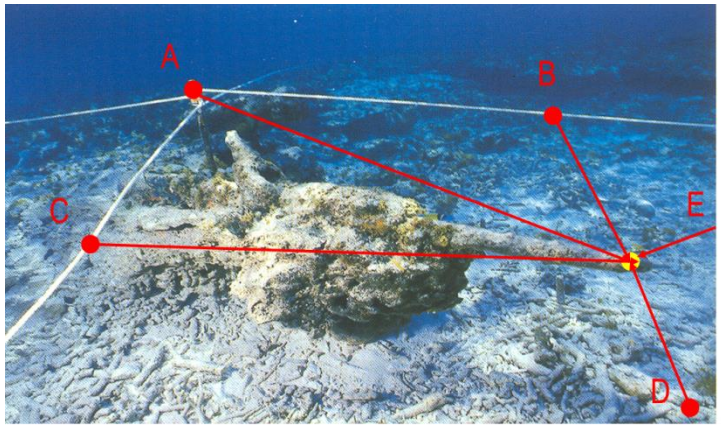
Traditionally mapping was done with sketches and metric tapes, levels, and scales:

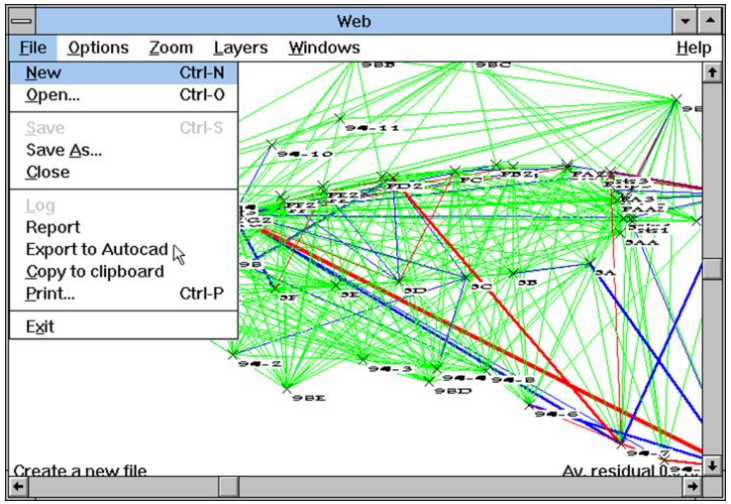


Several alternatives to the use of grids have been tried, with different levels of success.

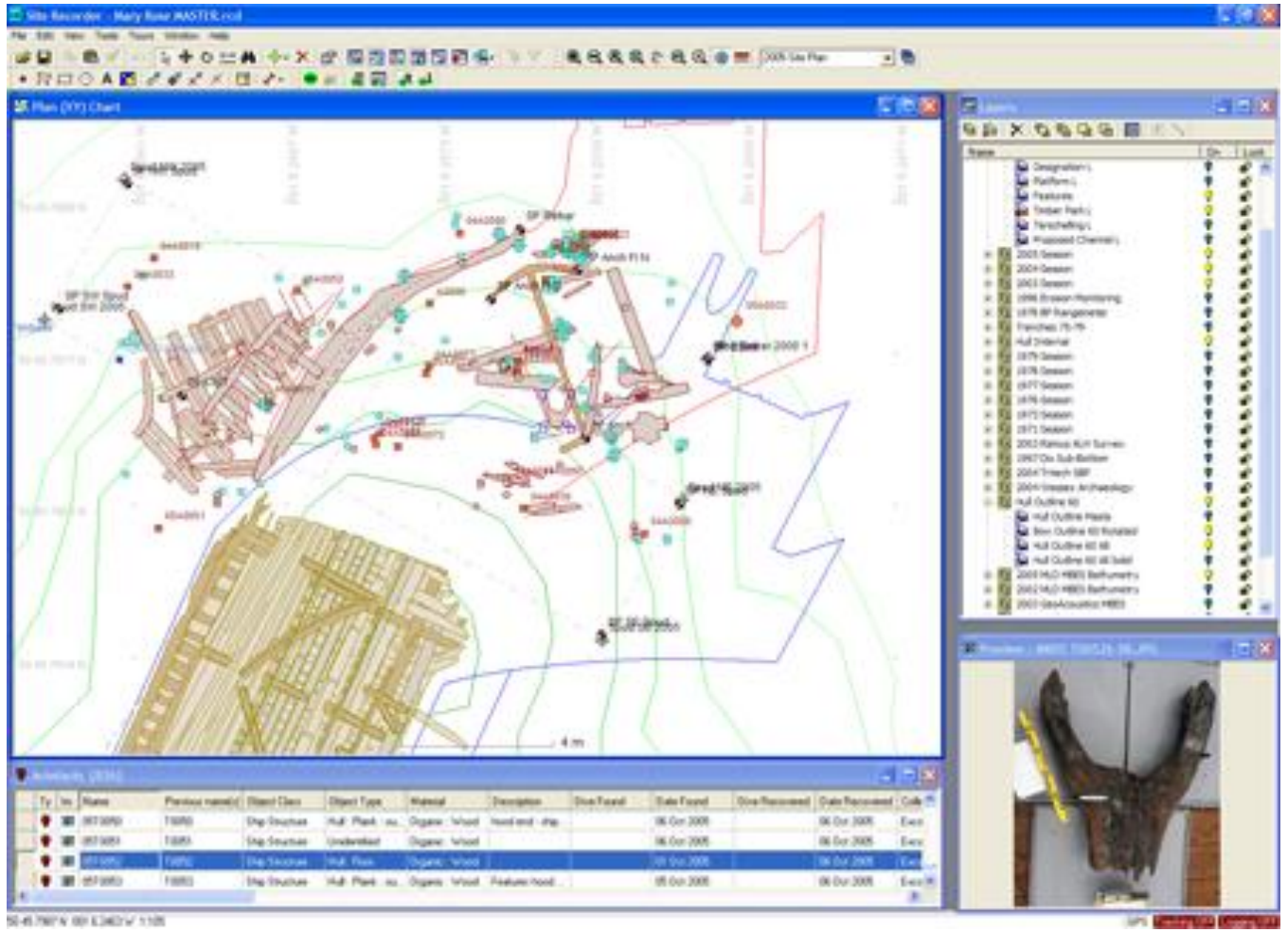


Triangulation from datum points, an alternative to the use of grids, was greatly simplified with the development of dedicated software (1980s).





Nick Rule's DSM

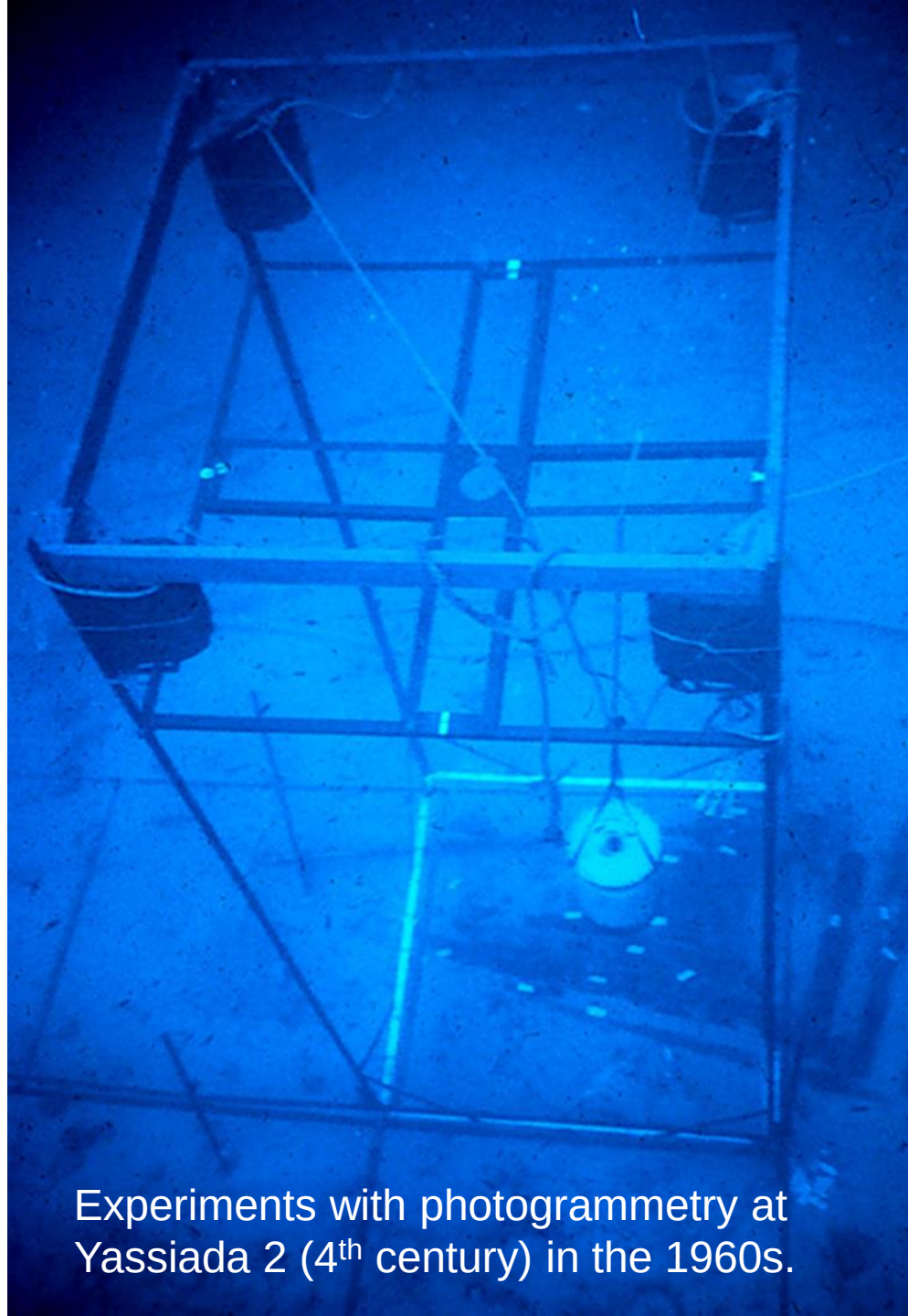


3H Consulting Site Recorder Software

From the beginning, photography looked like the archaeologist's best friend.

Photogrammetry has been around since the 19th century, and its applications in maritime archaeology were obvious because bottom time is often scarce and expensive.

As long as there is visibility…

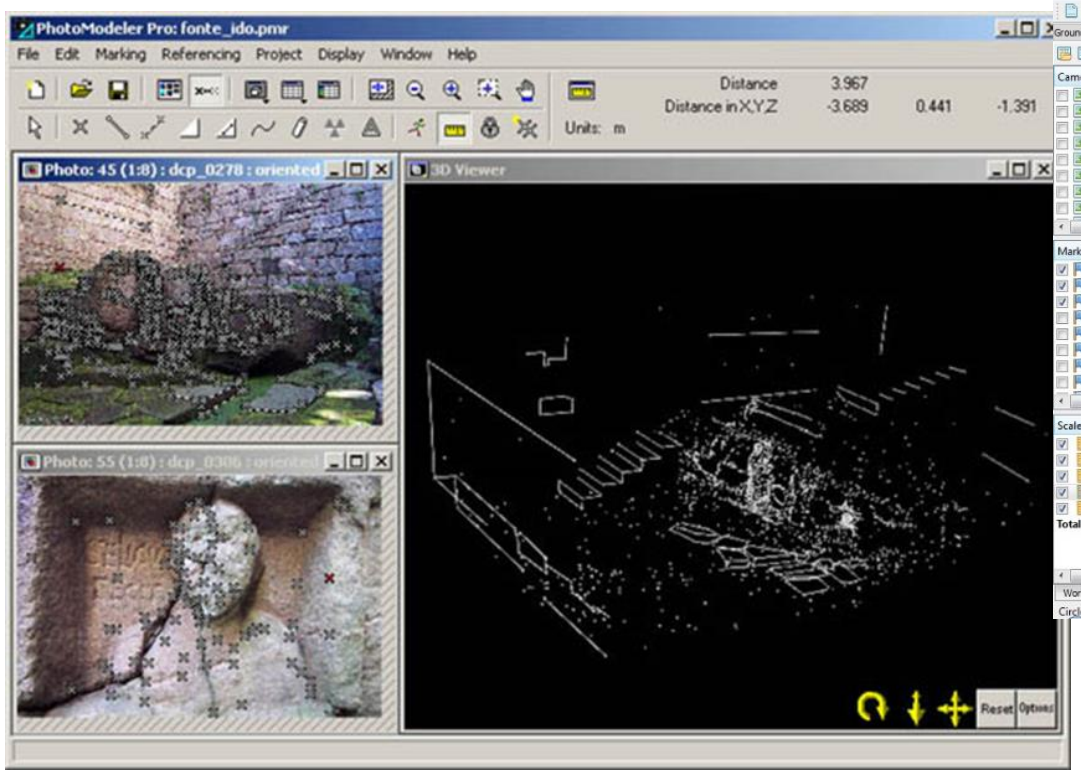


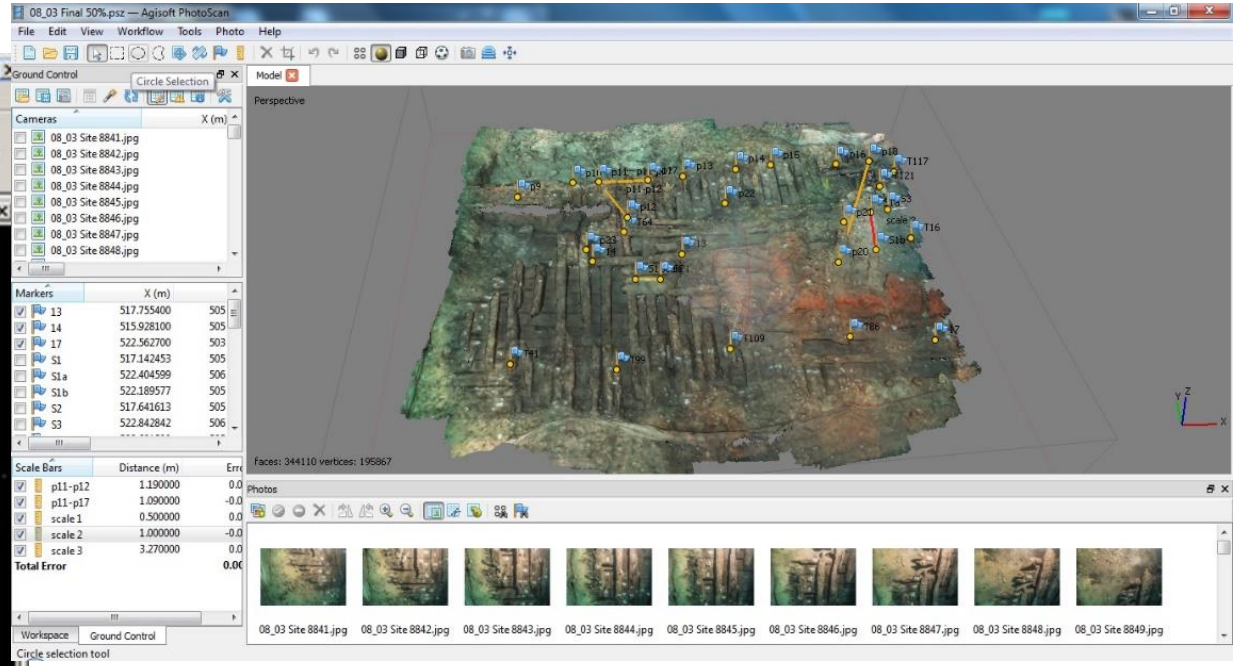
Experiments with photogrammetry at Yassiada 2 (4th century) in the 1960s.

Marine robotics brought about the possibility of making images – photography or video – with remotely operated or autonomous vehicles.

Photogrammetry software made it possible to transform large batches of pictures into tridimensional color meshes of points or into large orthogonal, scaled photos.

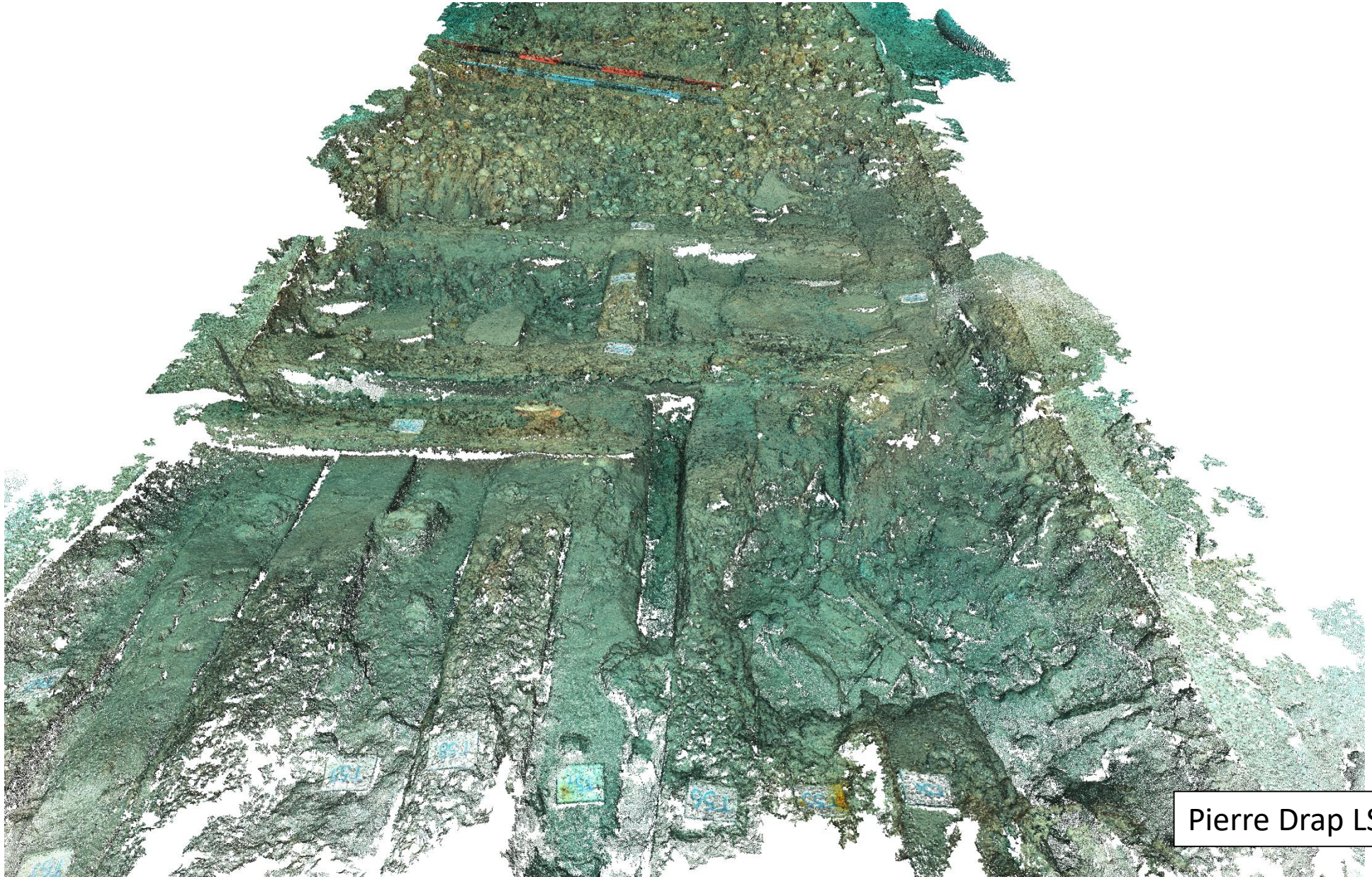
PhotoModeler





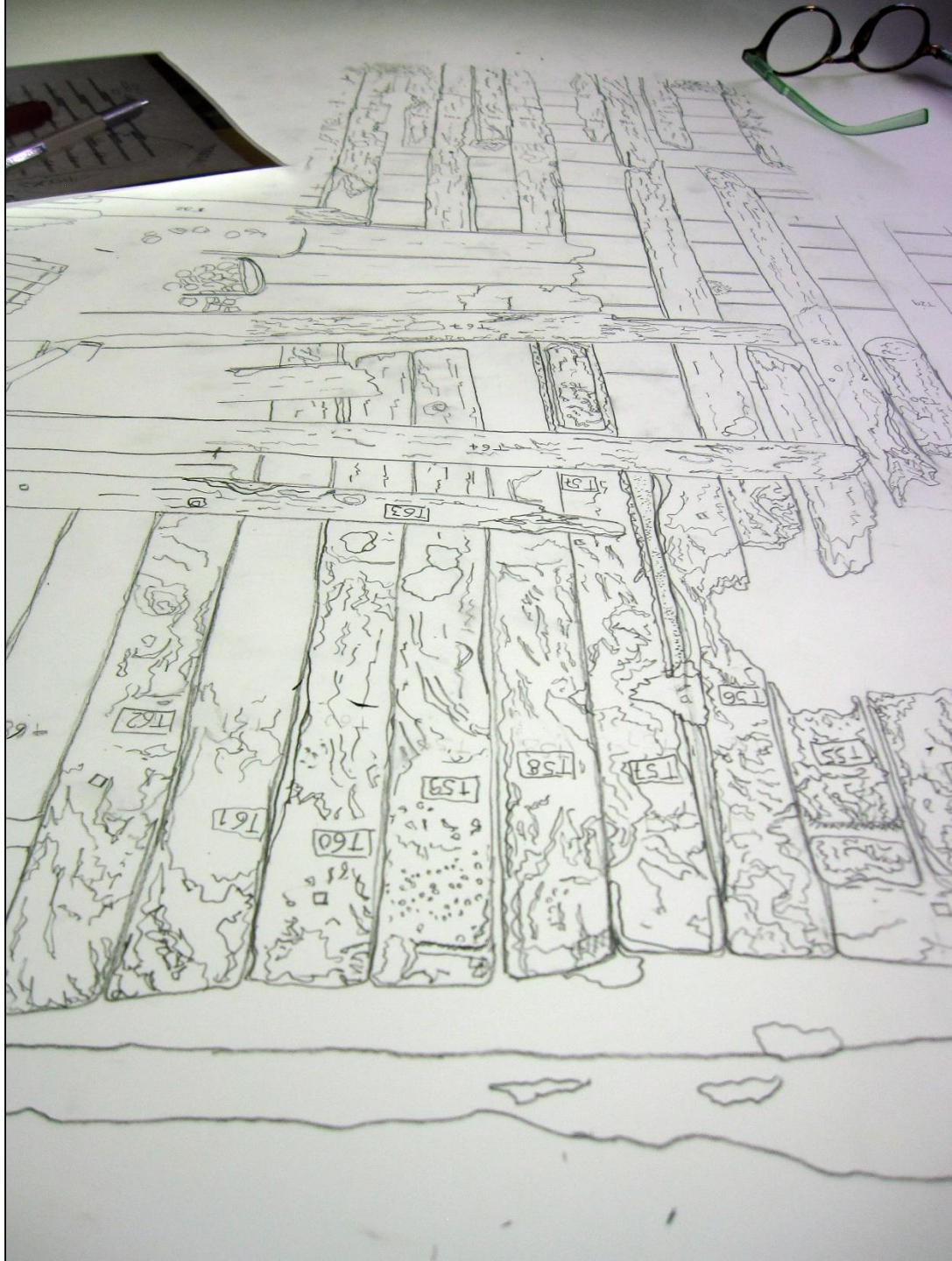
PhotoScan

From scaled meshes of points, archaeologists make their site plans.

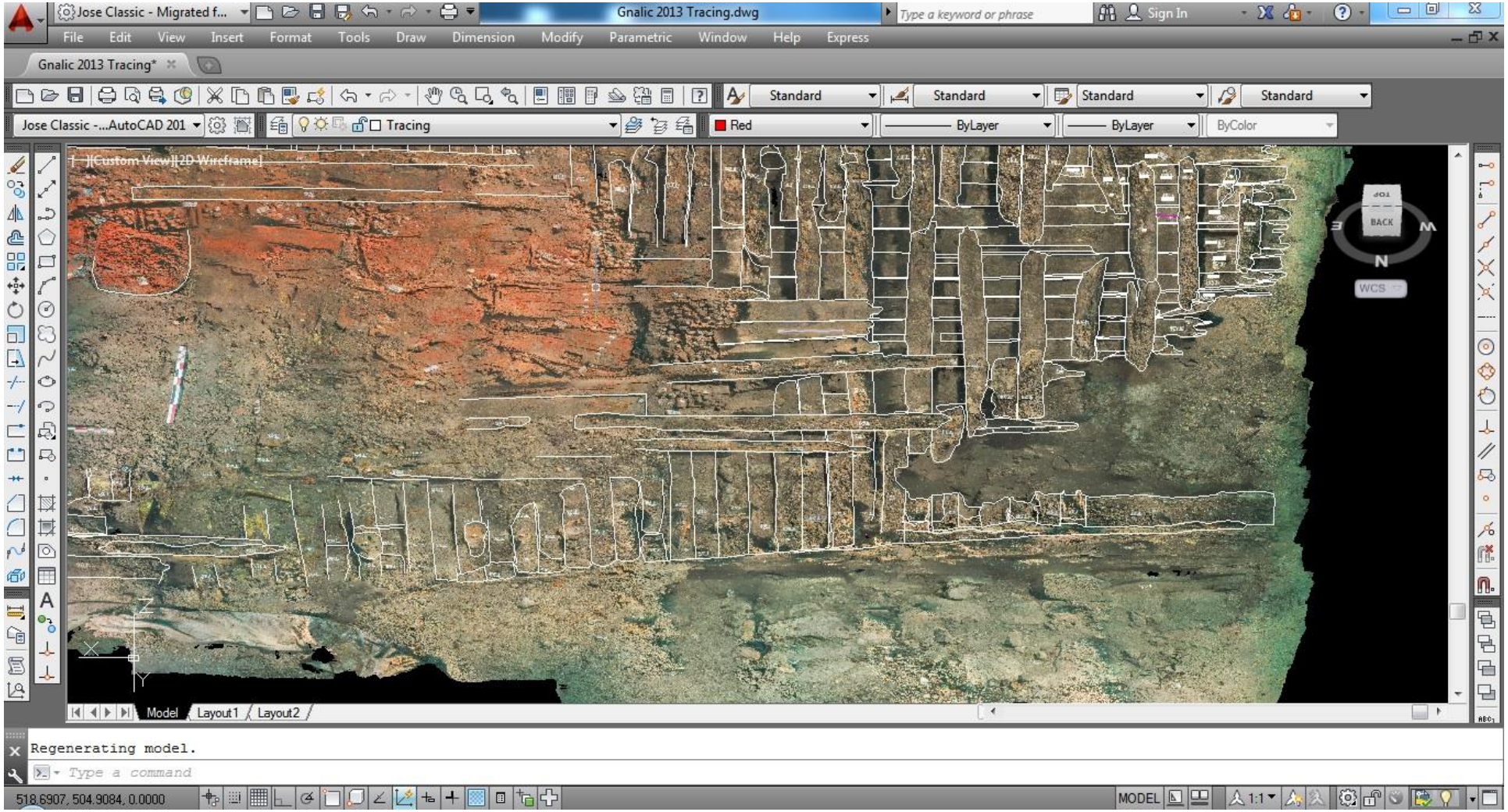


Pierre Drap LSIS-CNRS

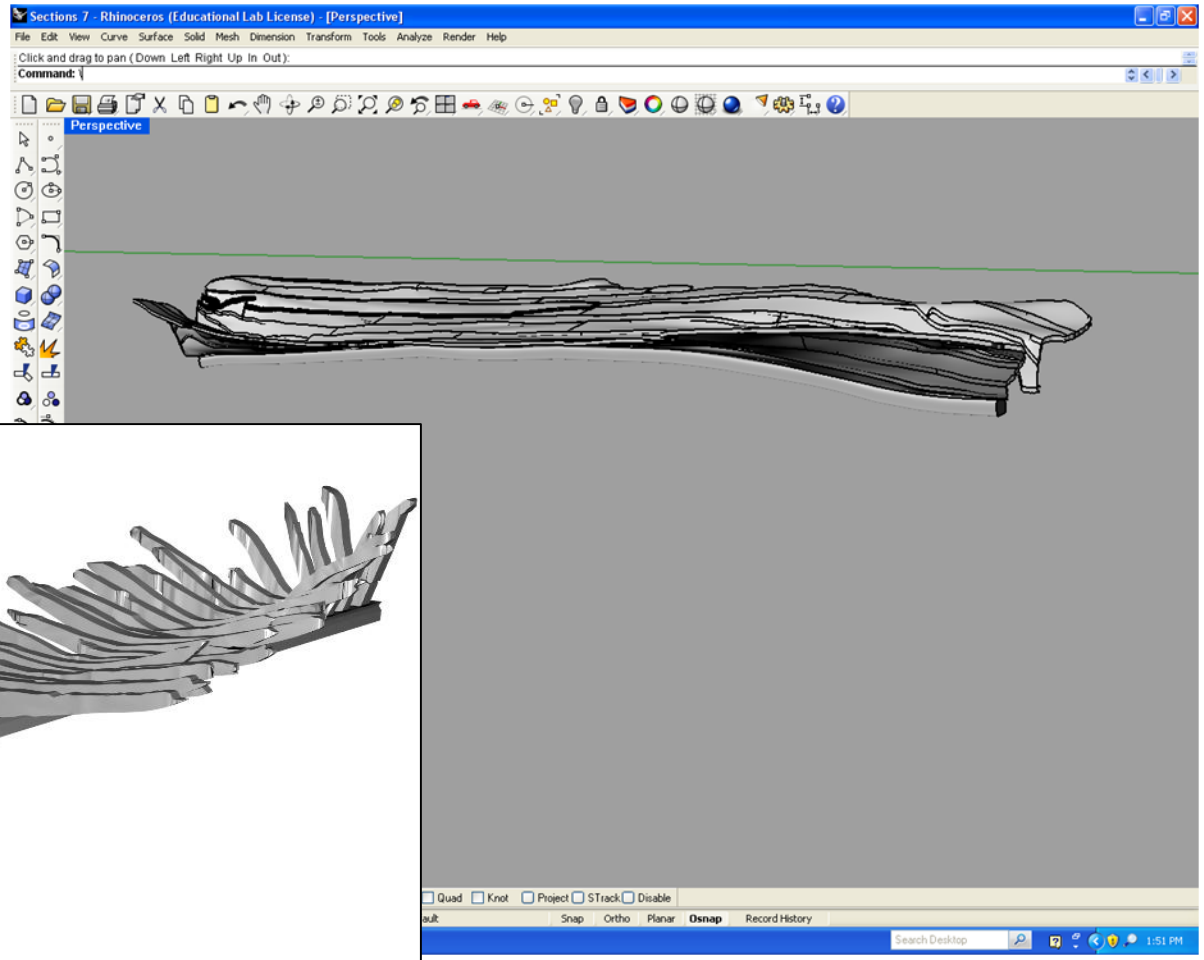
…sometimes by hand.



…sometimes using off the shelf drafting software, such as *AutoCAD* (2D), *Adobe Illustrator*, *Corel Draw*, or *Inkscape* (open source), more often using GIS.

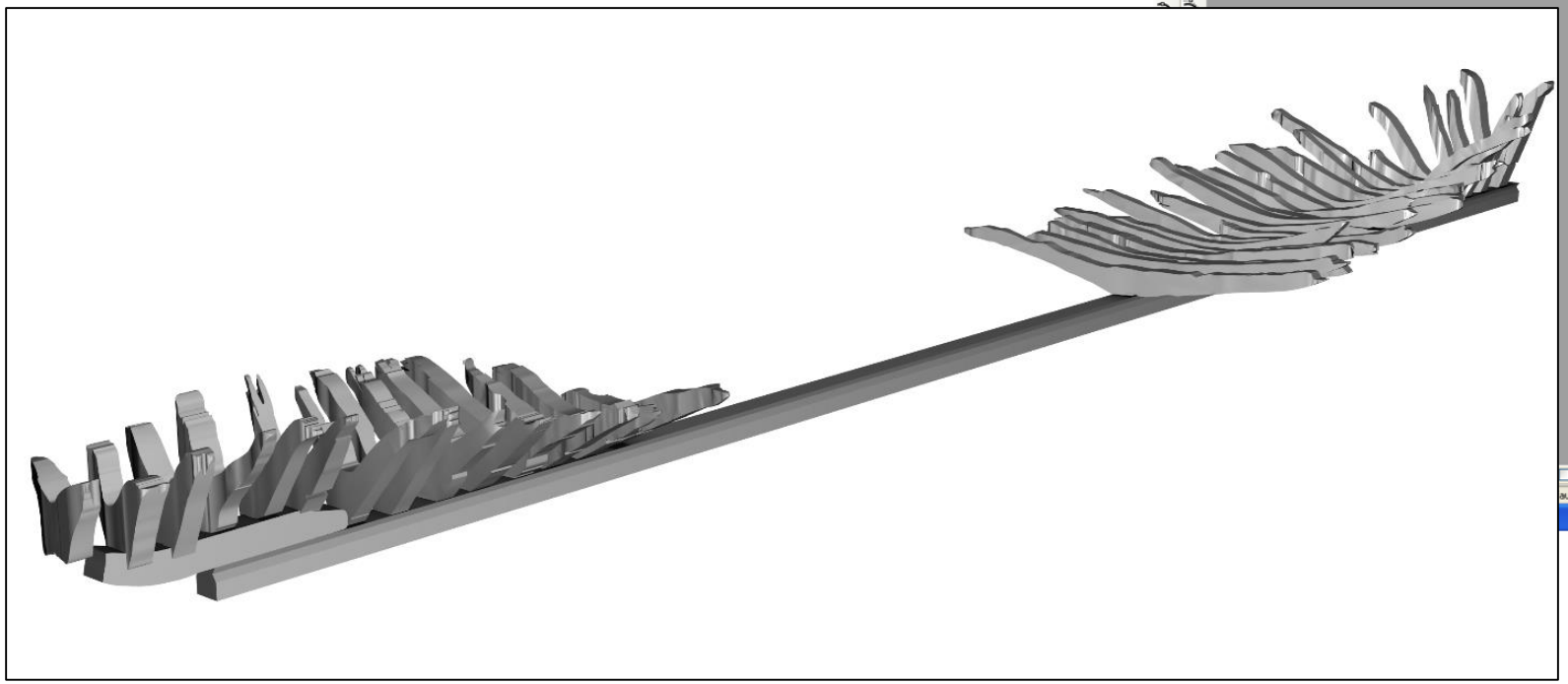


Three dimensional site maps can be obtained with off the shelf software as well.



Coral Eginton

Thomas Derryberry

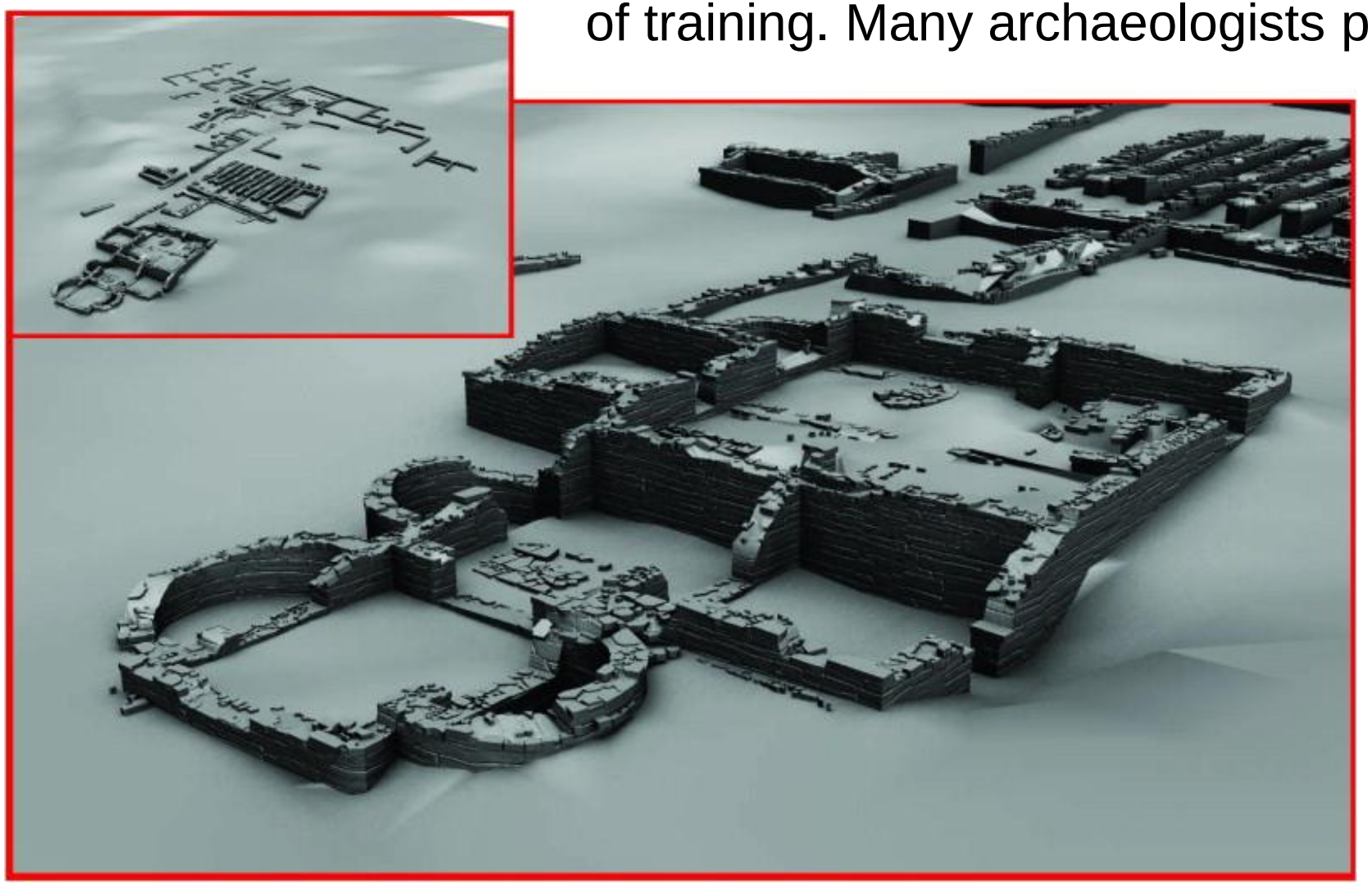


Again there are many software packages available, although the best require a level of mastery that is time consuming to acquire.

Corpo Santo shipwreck,
Lisbon (C14 dated to c. 1400)

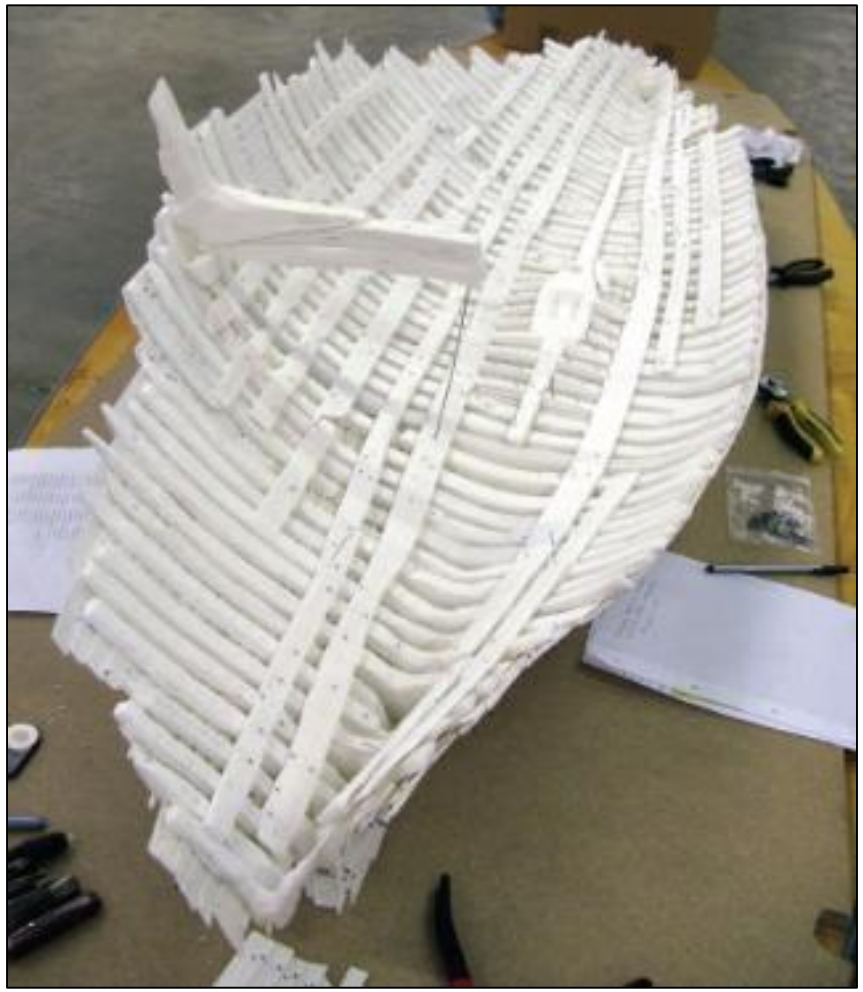
Kevin Gnadinger

AutoCAD (3D) is sometimes used but requires some level of training. Many archaeologists prefer *Rhinoceros*.

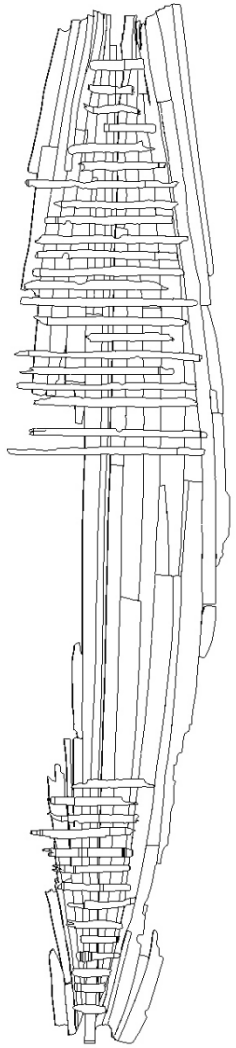


Helena Rua and Pedro Alvito, "Living the past: 3D models, virtual reality and game engines as tools for supporting archaeology and the reconstruction of cultural heritage – the case-study of the Roman *villa* of Casal de Freiria," in *Journal of Archaeological Science* (2011) 38.12: 3296–3308.

Rhinoceros became extremely popular in the last decade and is perhaps the most commonly used software among archaeologists.



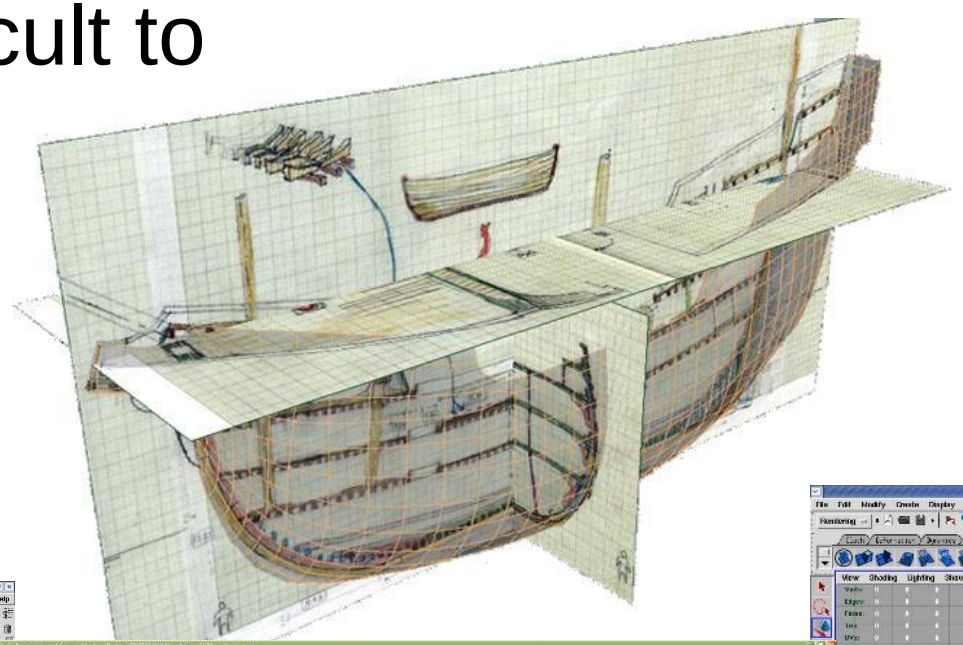
Recorded with FARO Arm, assembled in Rhinoceros, and printed.

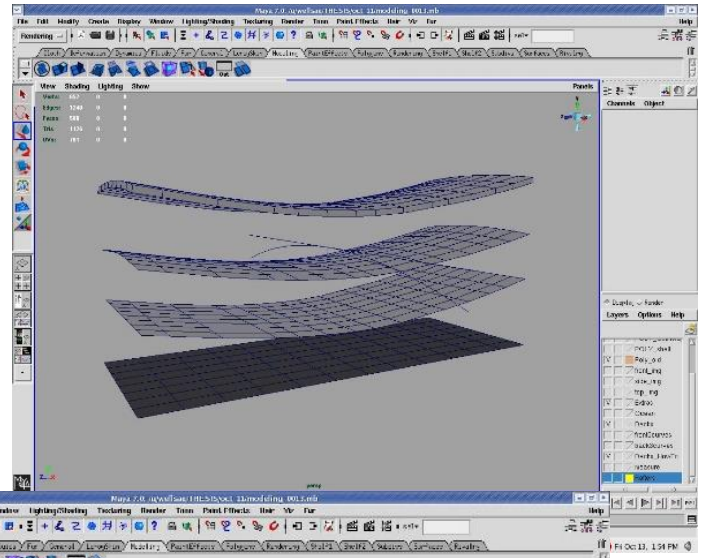


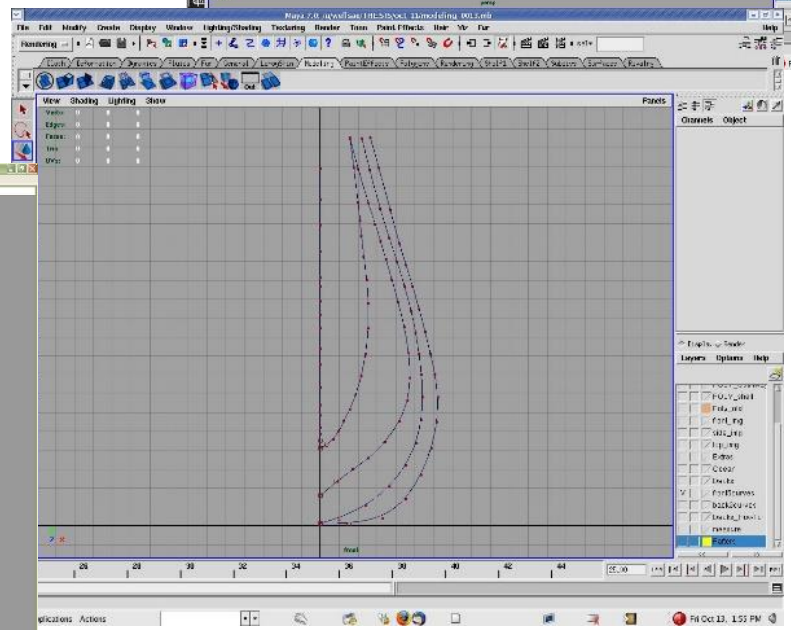
Its rendering capacity is poor (there are no lines, just surfaces), but this problem is easily solved with a renderer plugin (*Penguin*).

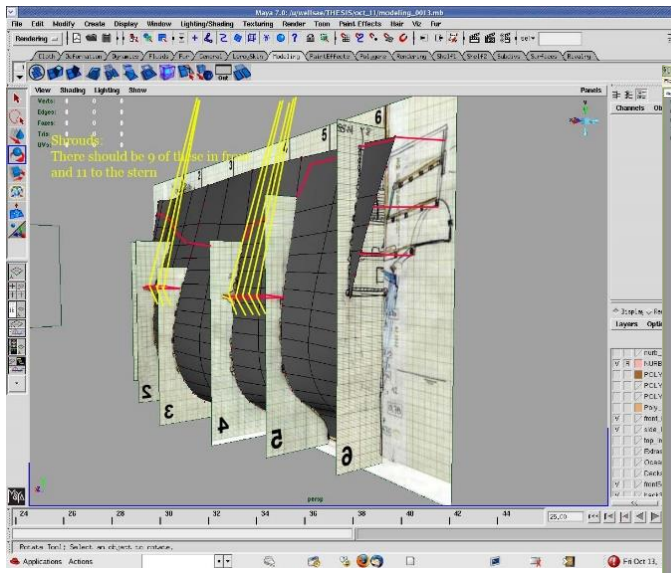
Thomas Derryberry

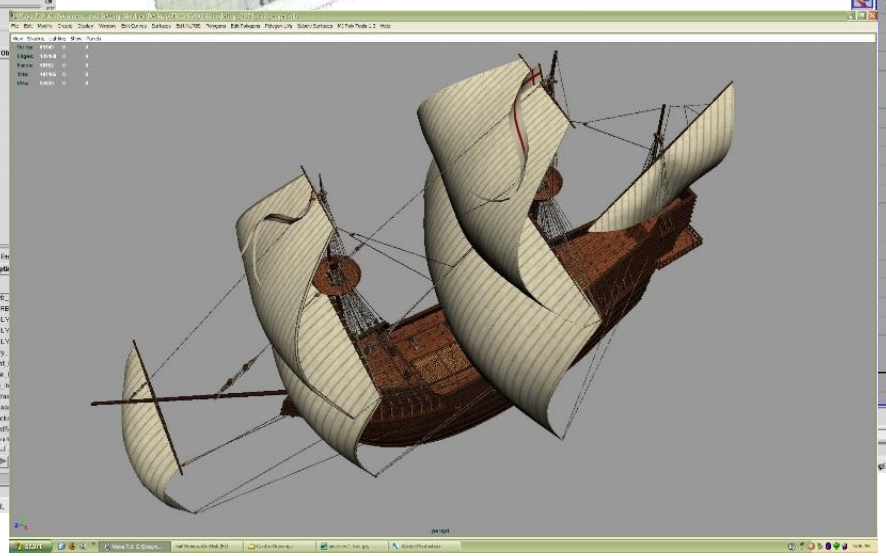
Autodesk Maya is a powerful software but difficult to master.





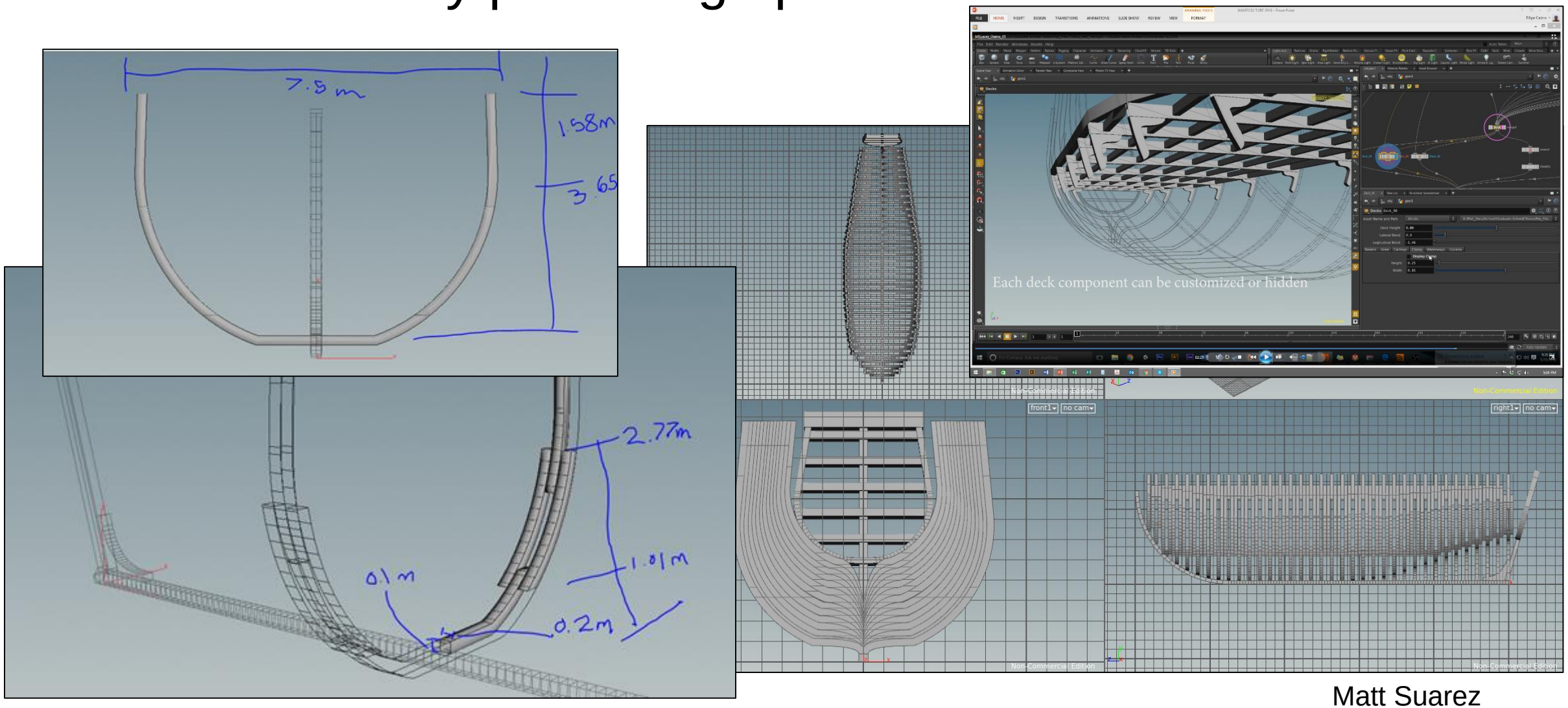




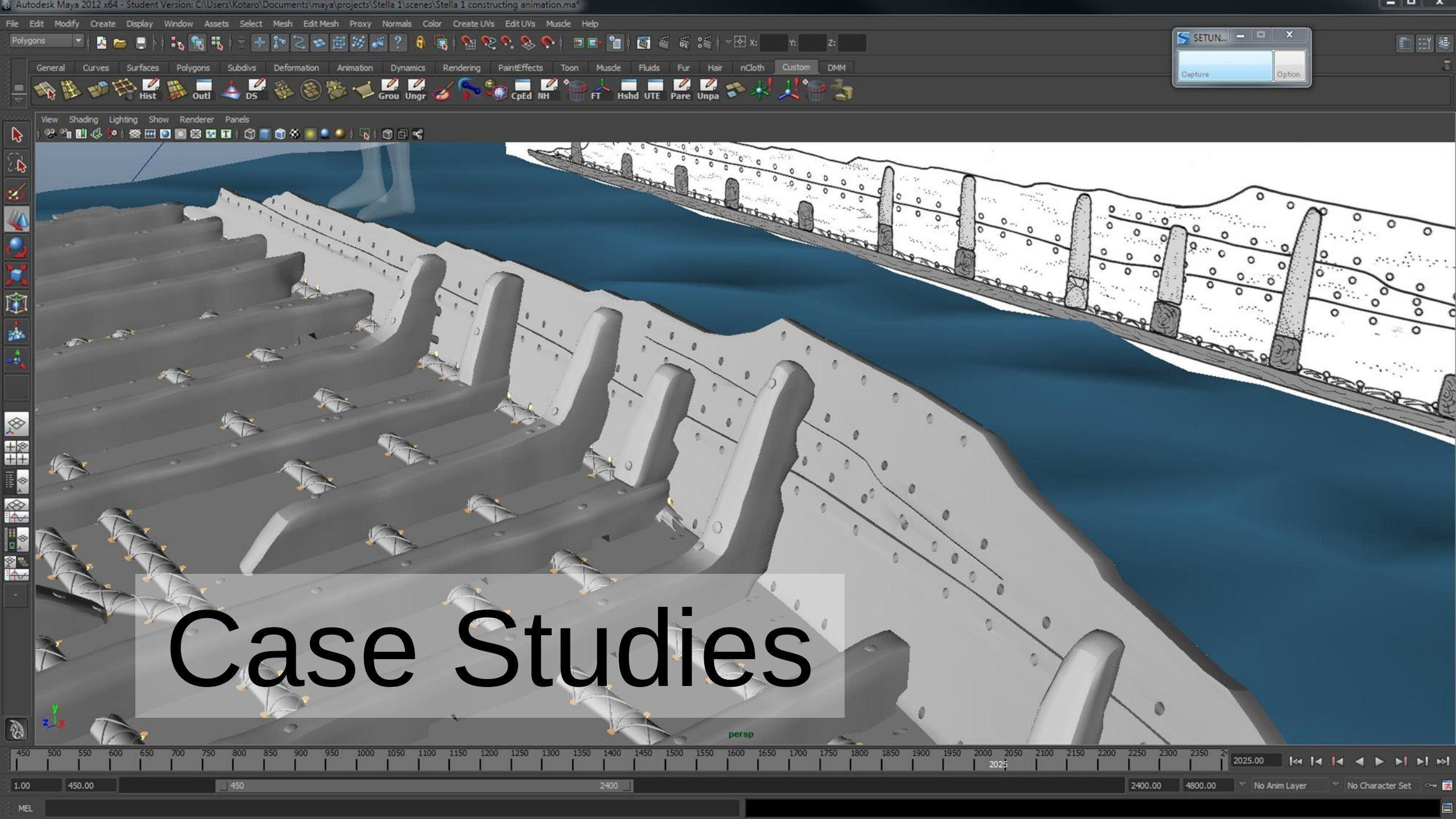


Audrey Wells

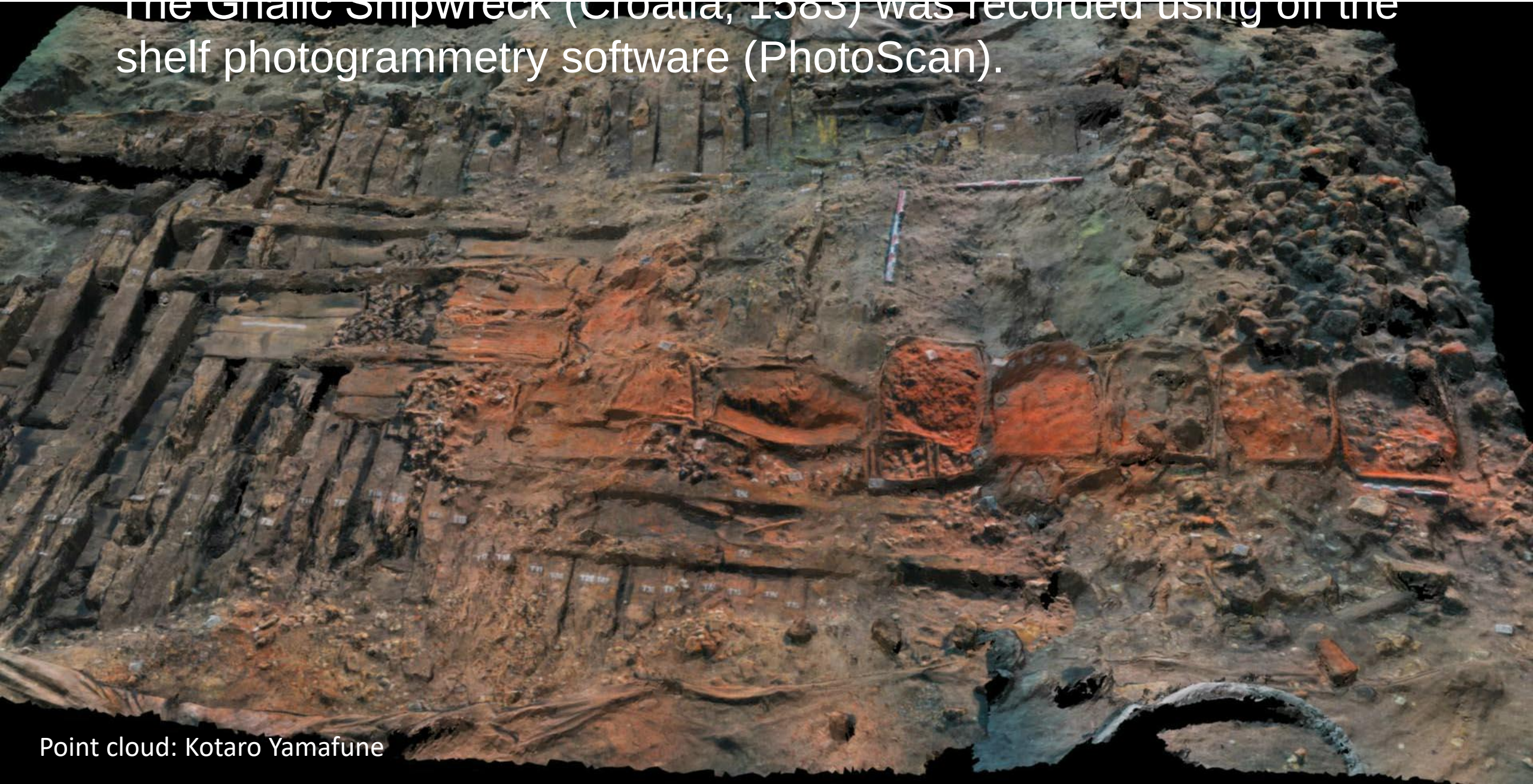
We made a procedural modeling experiment with *Houdini* that showed very promising options.



Matt Suarez
Andre Thoma's idea

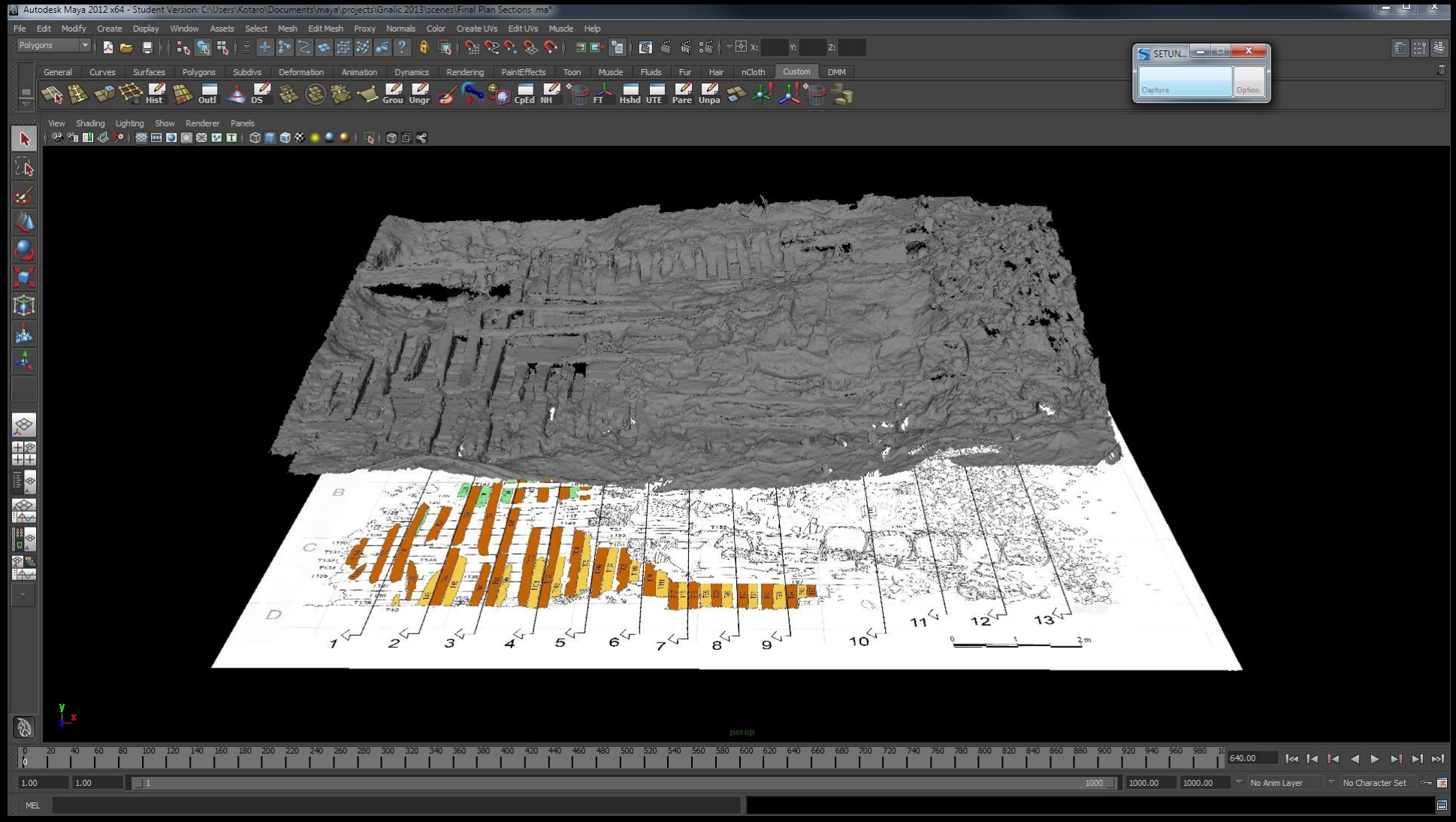

Autodesk Maya 2012 x64 - Student Version: C:\Users\Kotaro\Documents\maya\projects\Stella 1\scenes\Stella 1 constructing animation.ma*
File Edit Modify Create Display Window Assets Select Mesh Edit Mesh Proxy Normals Color Create UVs Edit UVs Muscle Help
Polygons
General Curves Surfaces Polygons Subdivs Deformation Animation Dynamics Rendering PaintEffects Toon Muscle Fluids Fur Hair nCloth Custom DMM
View Shading Lighting Show Renderer Panels
persp
Case Studies

The Gnalic Shipwreck (Croatia, 1583) was recorded using off the shelf photogrammetry software (PhotoScan).



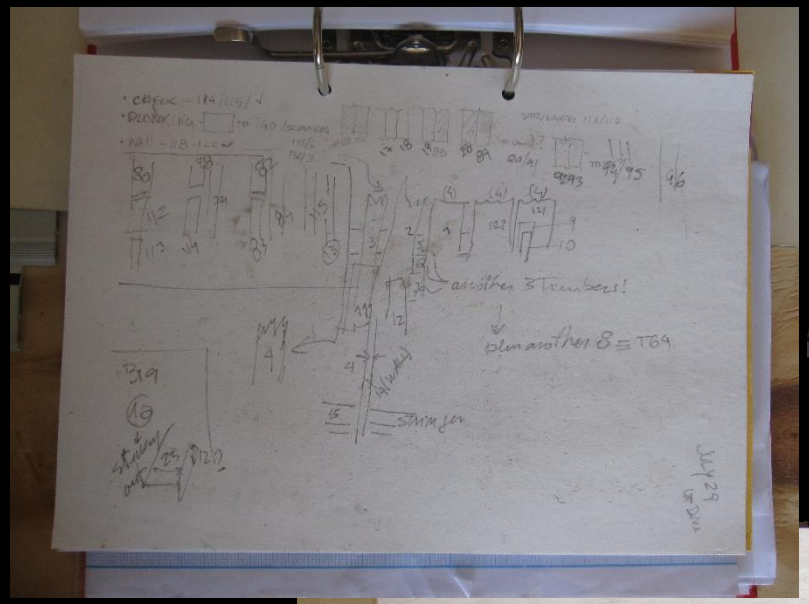
Point cloud: Kotaro Yamafune

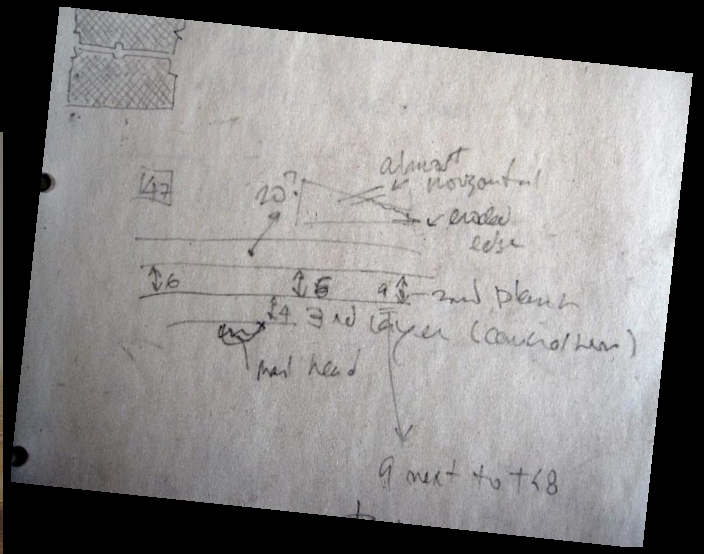
From the pictures we have obtained a mesh of points and a scaled orthophotography (PhotoScan).

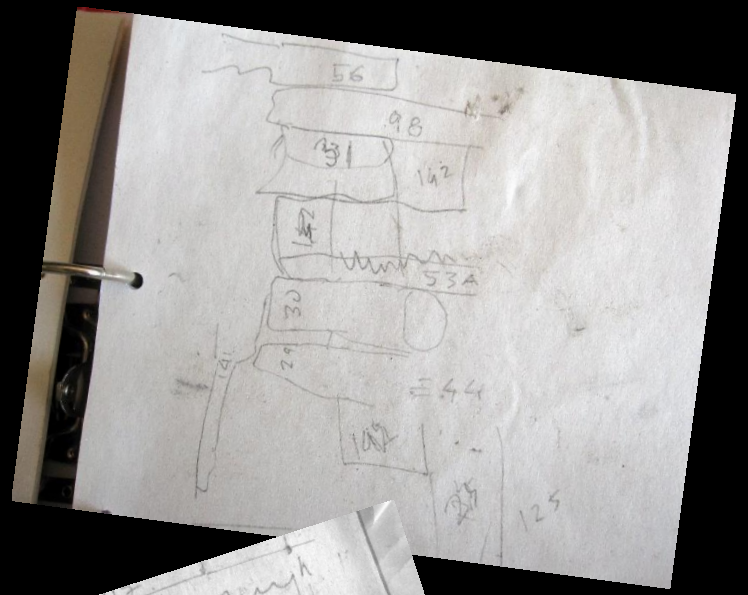


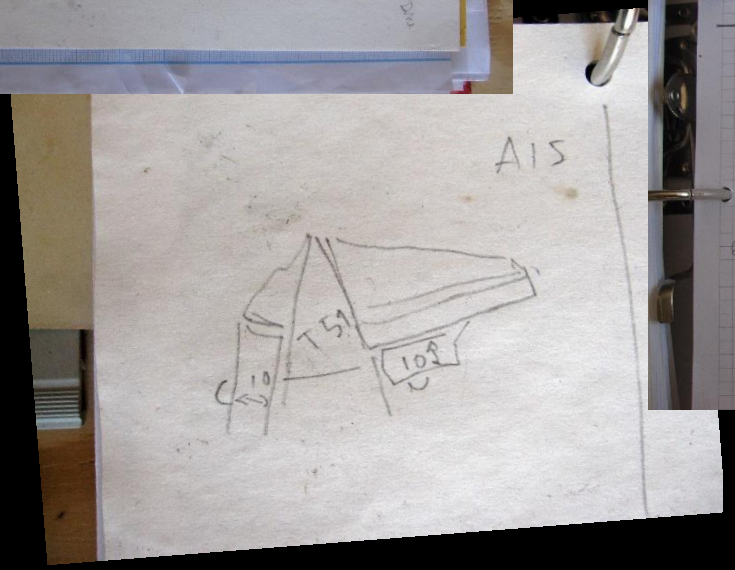
Kotaro Yamafune

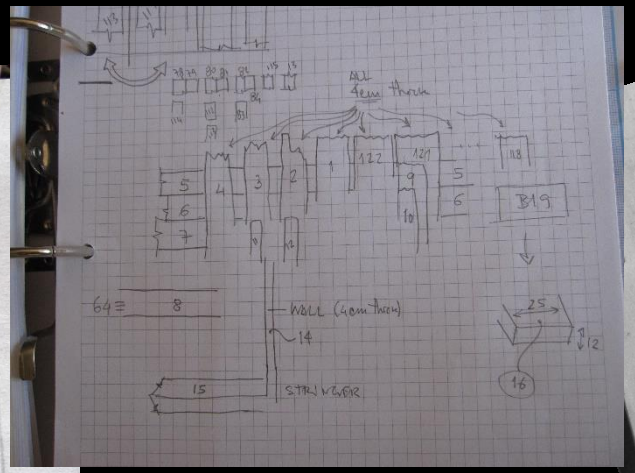
Details must still be sketched, measured, and annotated separately.

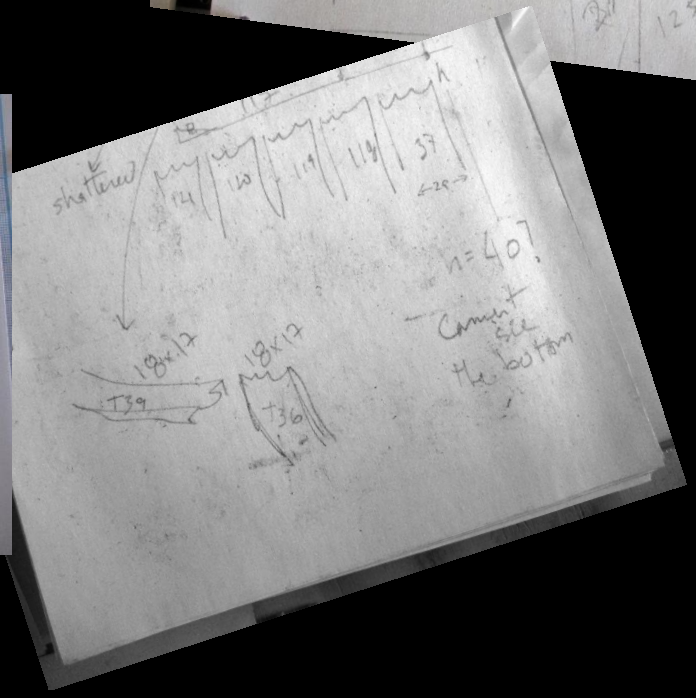


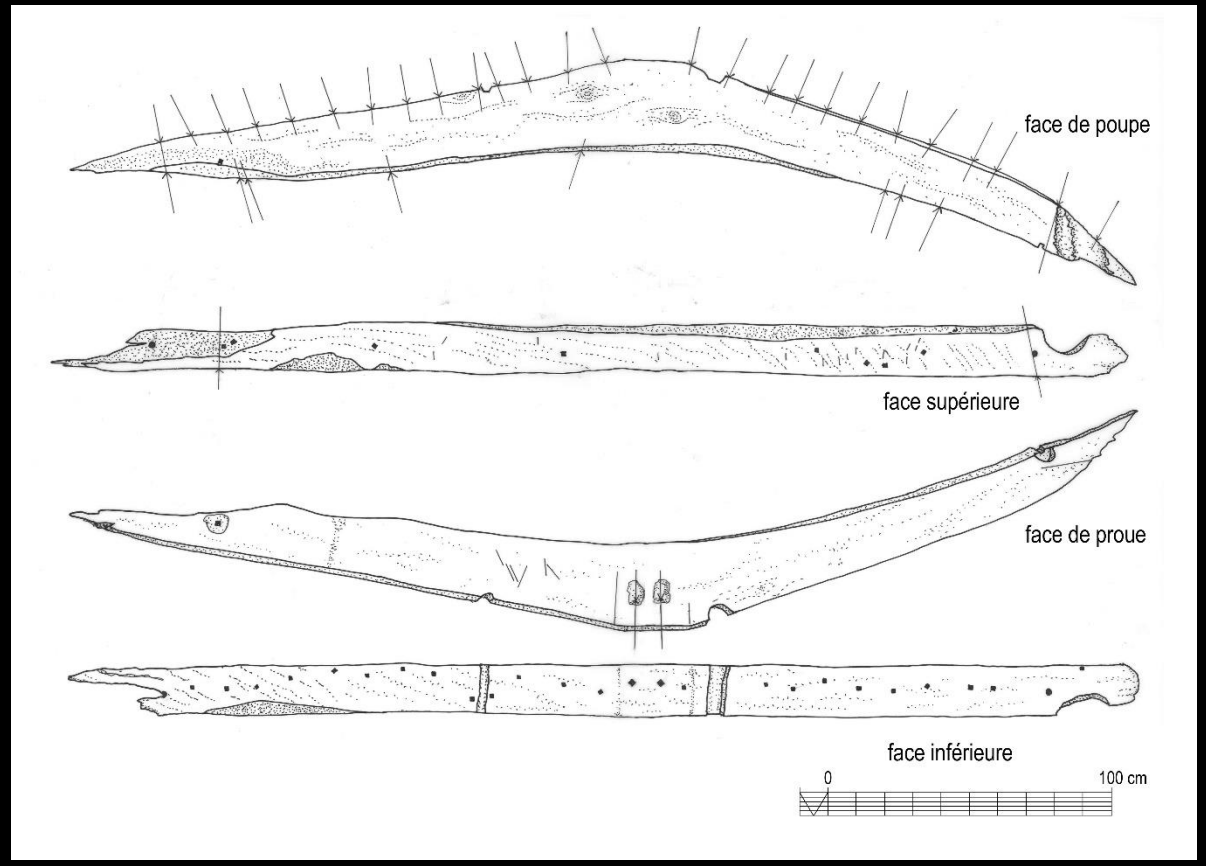








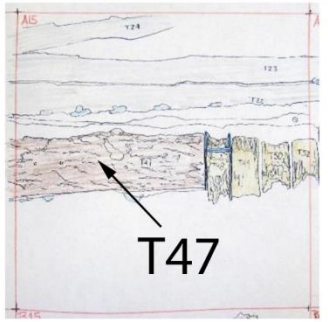




Each timber must be individualized.

T47

(A15)



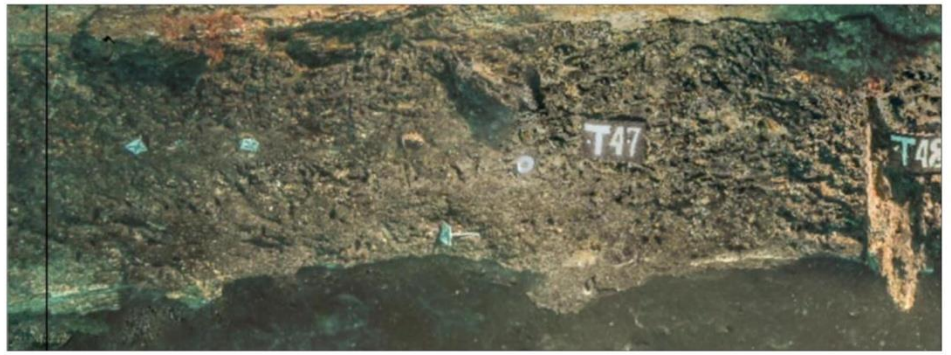
Longitudinal timber

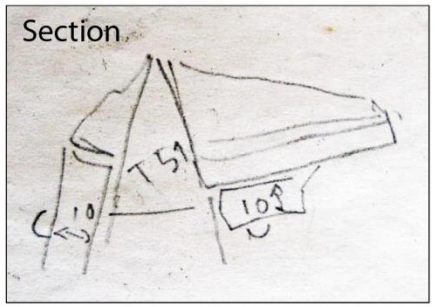
Sided = 37-42 cm

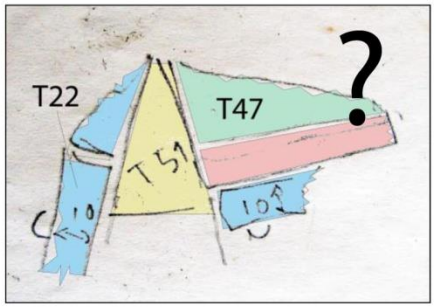
Molded = abt. 8 cm

Length Preserved = 1.34 m exposed

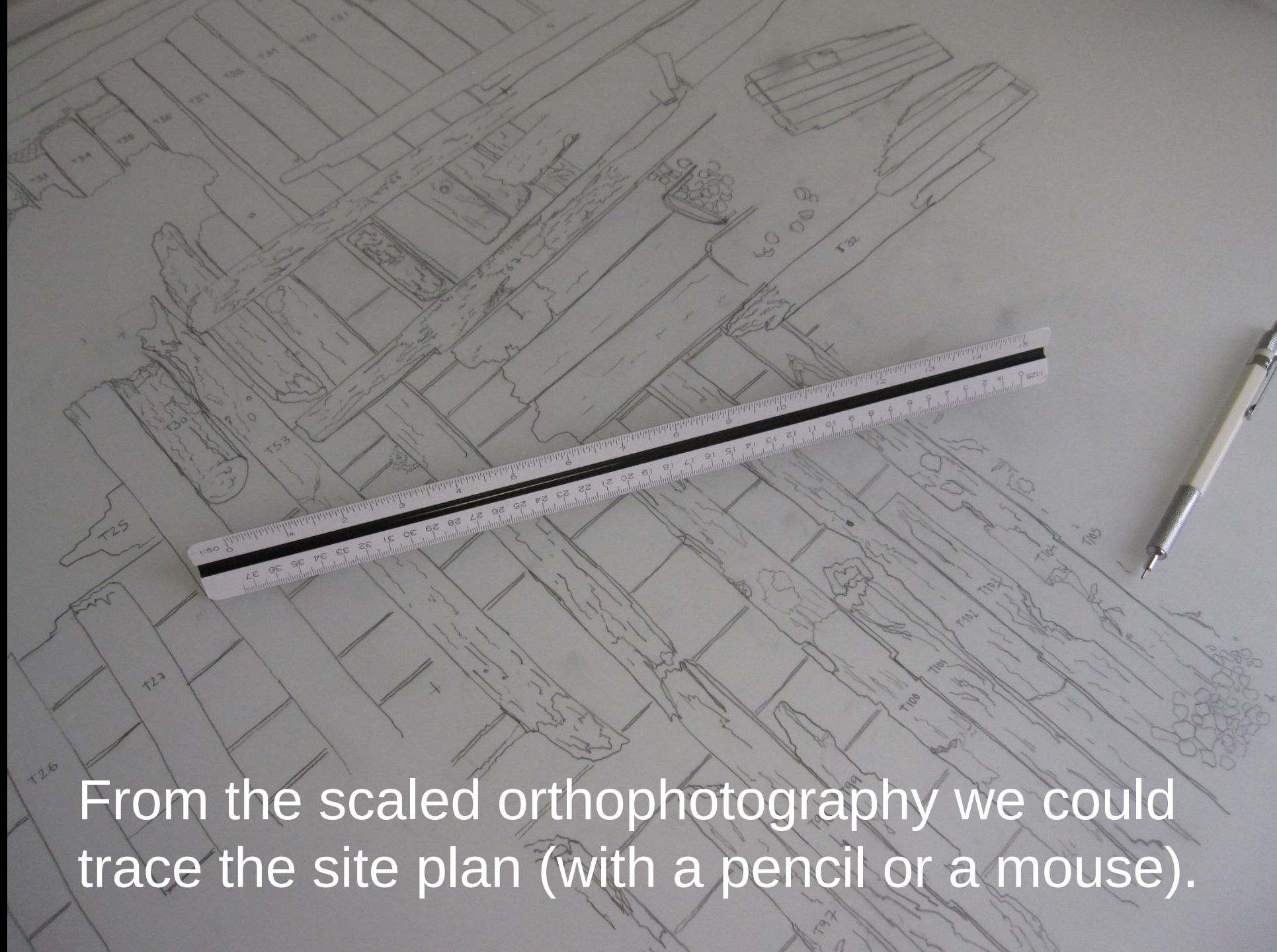
Very eroded.





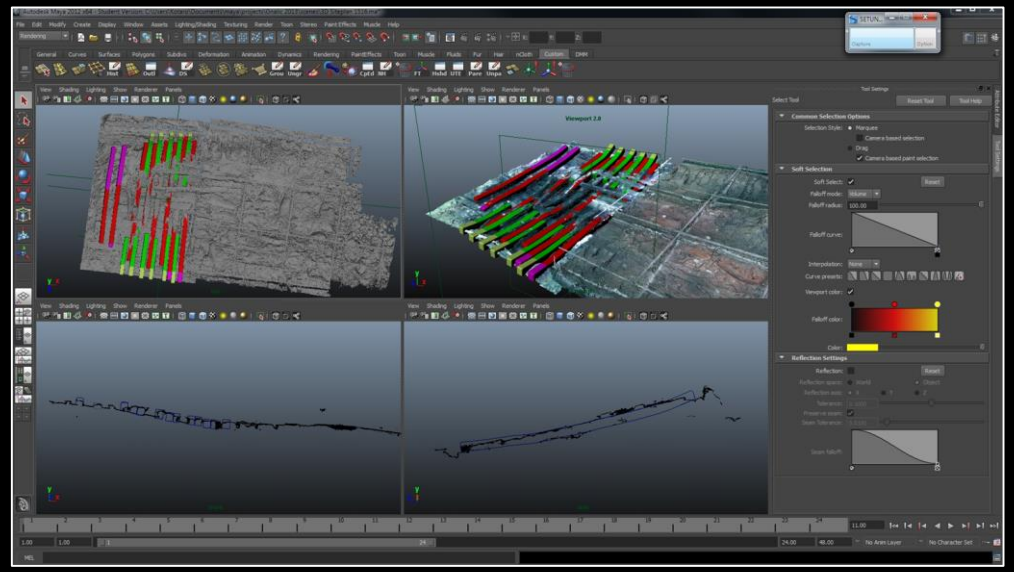


This timber is difficult to record because there are many concretions around it. When we have a laboratory where it can be taken, it should be brought up and recorded.

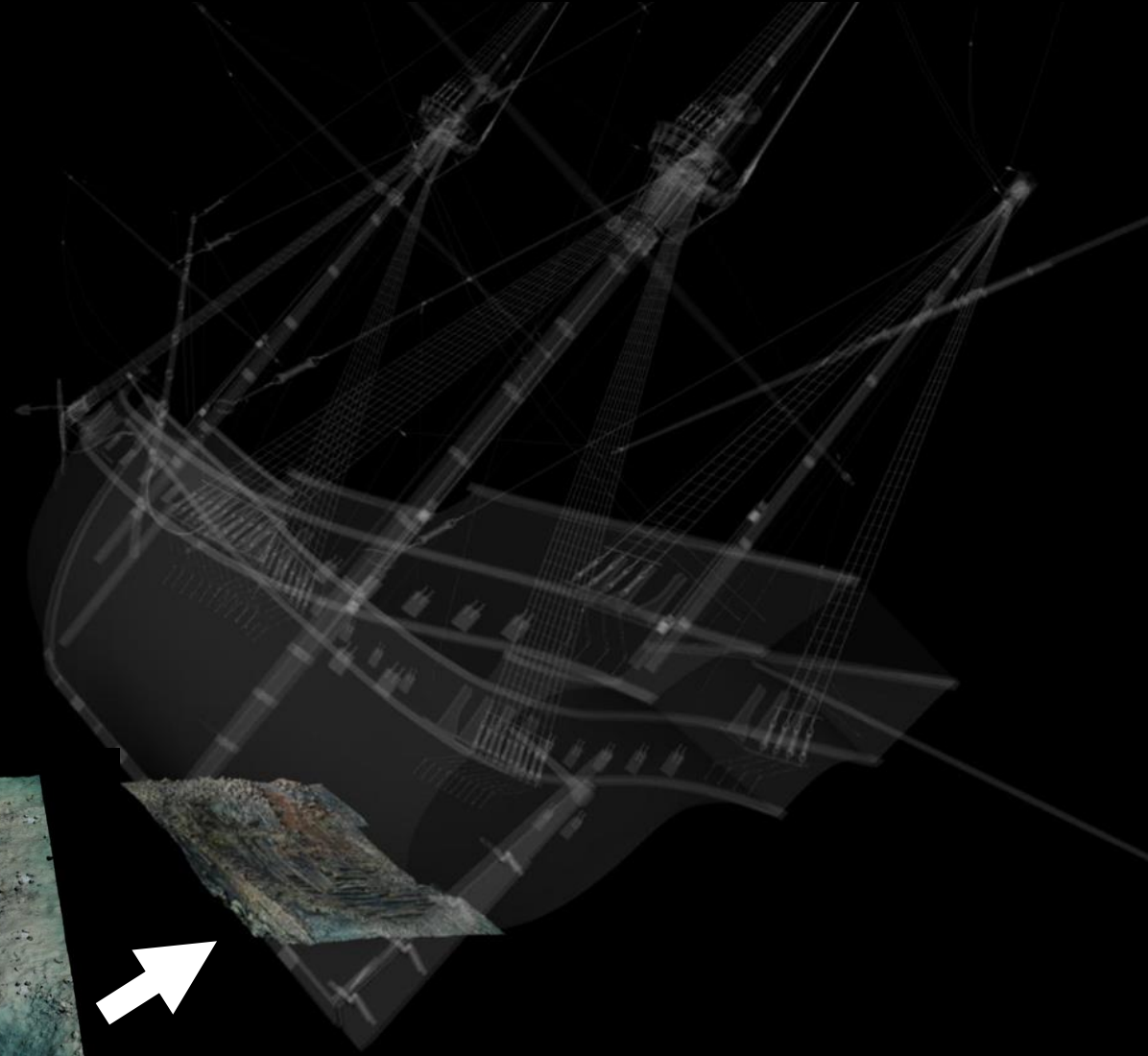


From the scaled orthophotography we could trace the site plan (with a pencil or a mouse).

Each timber was analyzed separately.



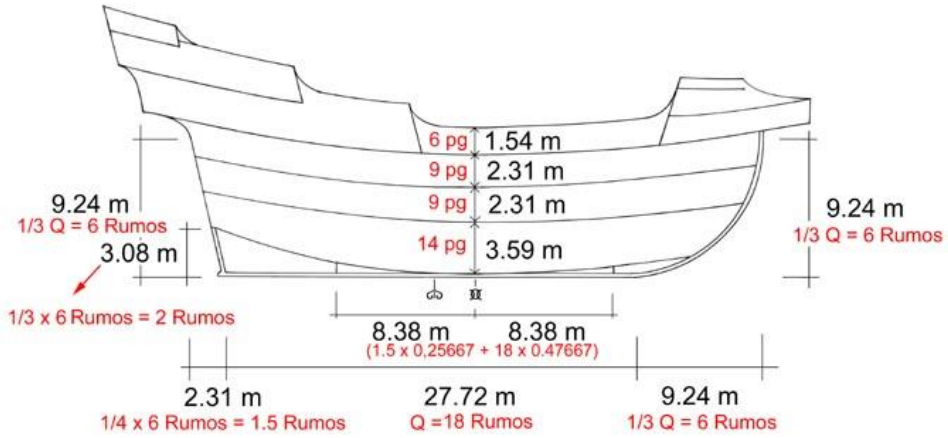
The goal is to reconstruct a ship from its remains.

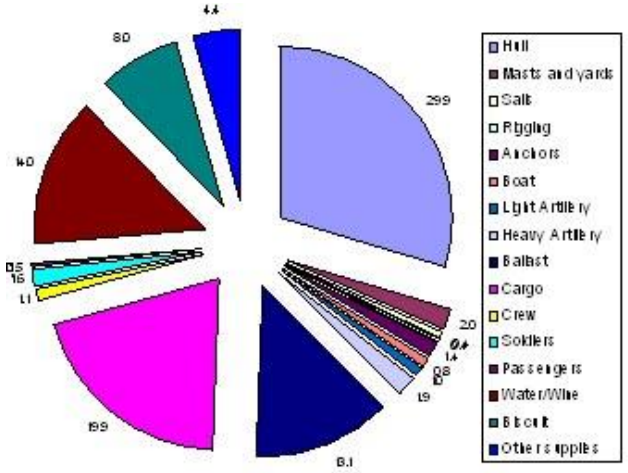


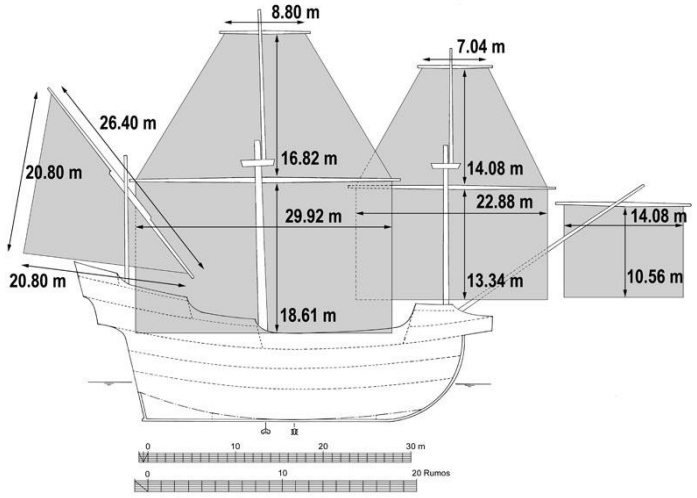
Kotaro Yamafune

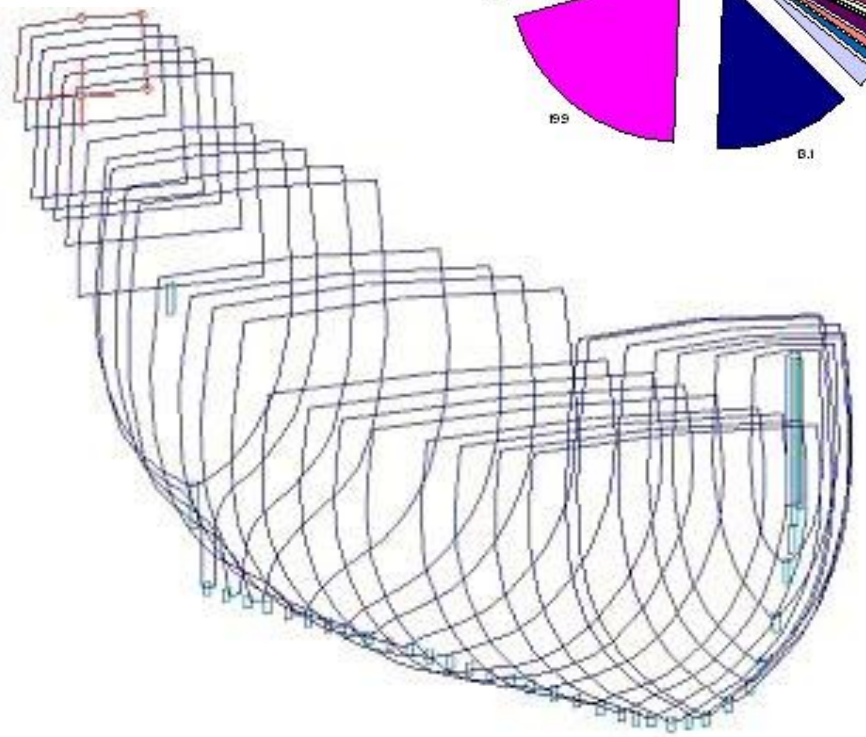
Cody Leuschner
Bruce Gooch's class

Lines drawings, materials and weights, intact stability calculations, sailing characteristics, polar diagram.

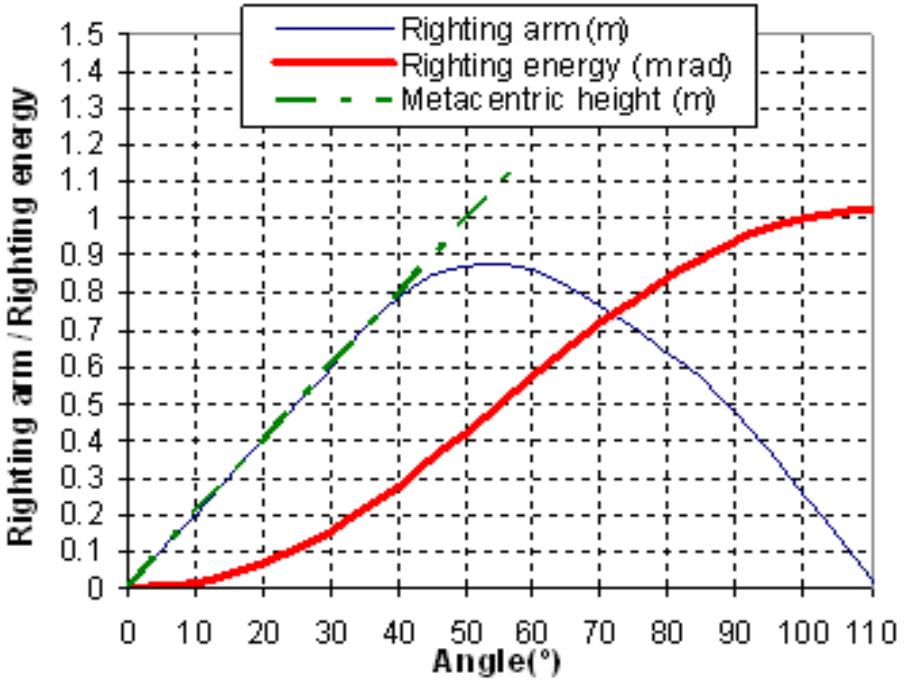


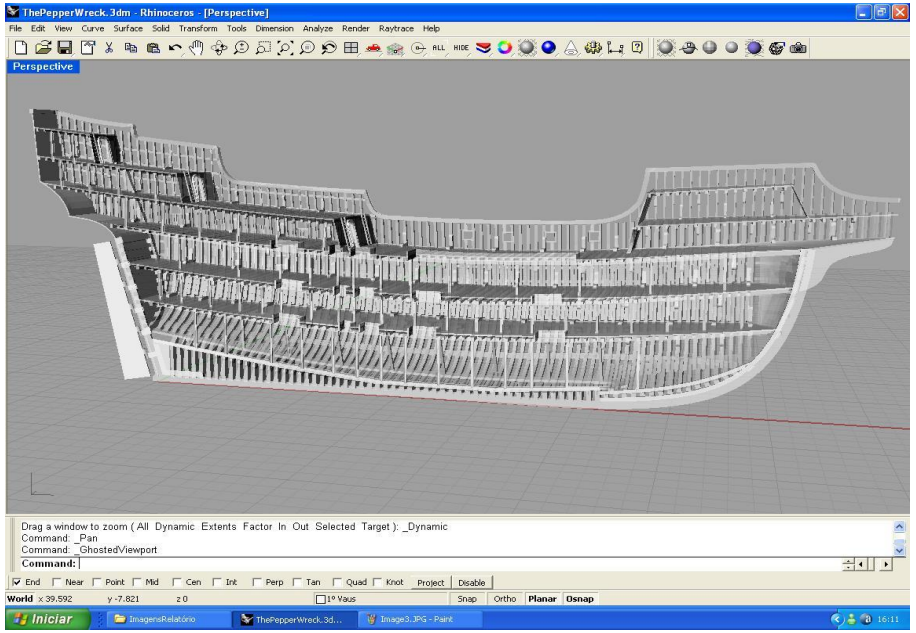


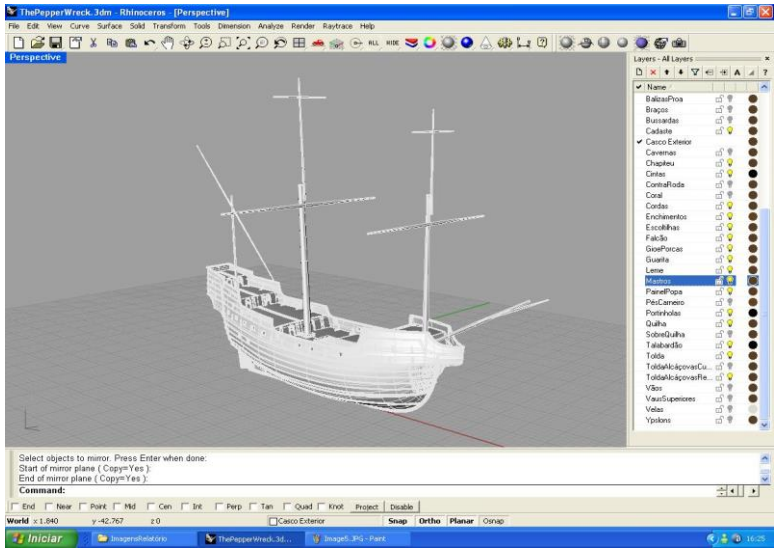


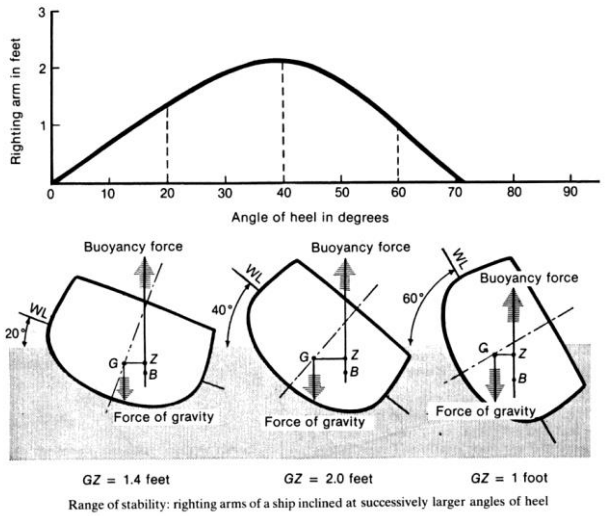


Nuno Fonseca

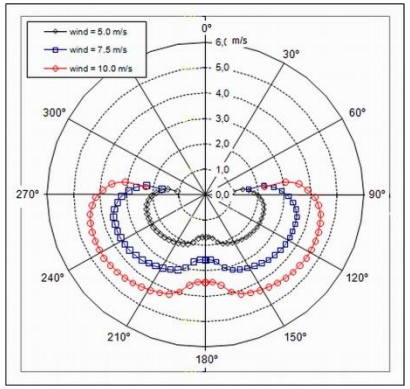






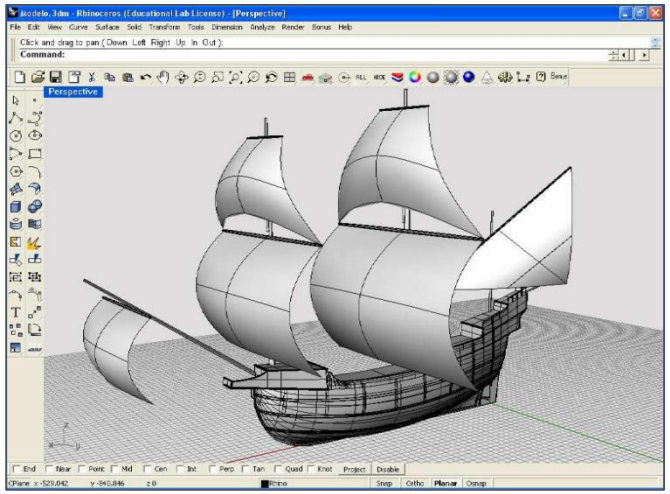


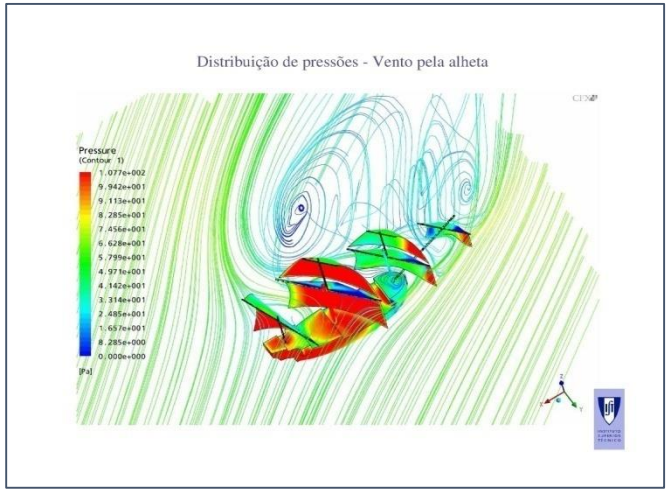
Range of stability: righting arms of a ship inclined at successively larger angles of heel

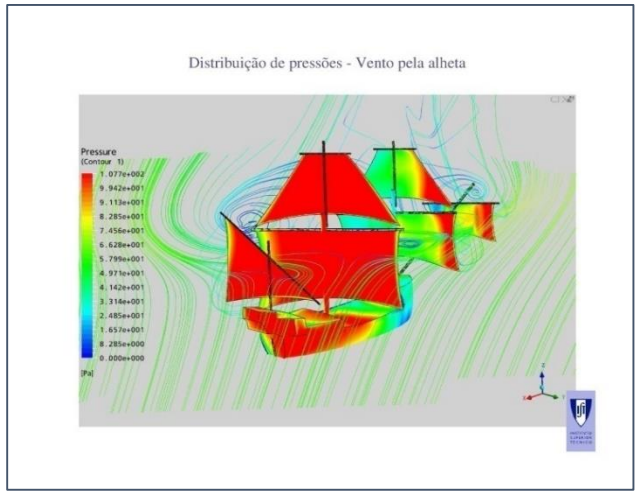


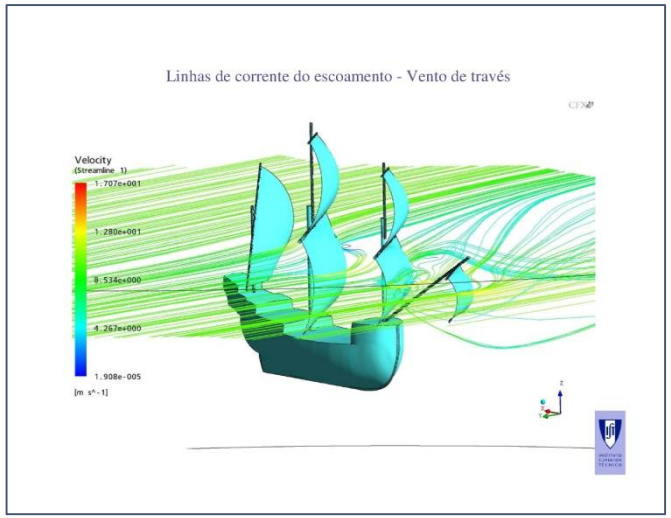
Performance under sail

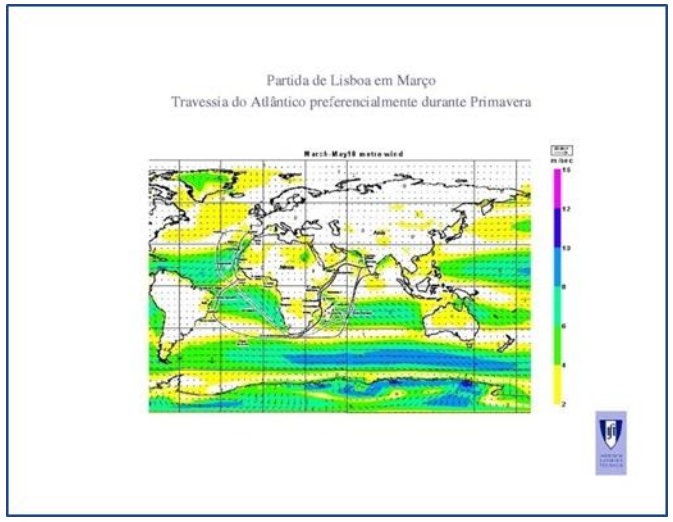
Nuno Fonseca, IST, SAEN

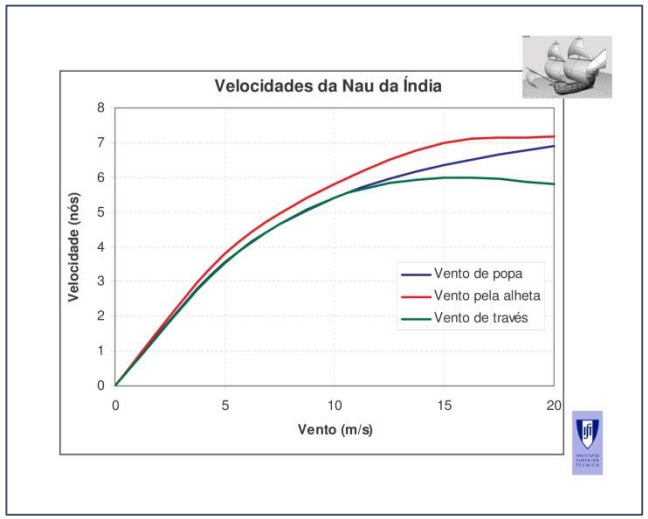












3. Conserving is perhaps the most complex task because the UNESCO Convention for the Underwater Cultural Heritage makes a strong case for the protection of archaeological sites in situ.

That entails the development of a number of tools that either don't exist or are too expensive to be used:

a. Finding the sites and rigorously limiting the area where cultural remains are spread;

b. Characterizing the sites, mostly with non-intrusive technology (limited trenching and sub-bottom profiling);

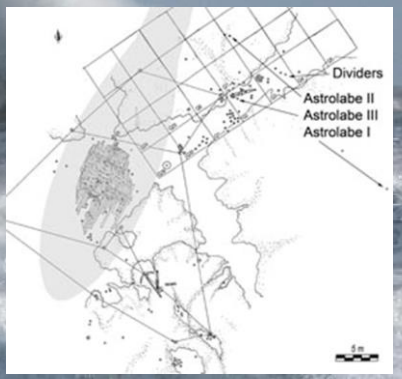
c. Developing diagnostic tools and procedures (involving biology, chemistry, geology, etc.) to assess the site's stability;

d. Developing prognostics (what happens if we don't touch, what happens if we cover the site, etc.);

e. Developing mitigation procedures and techniques;

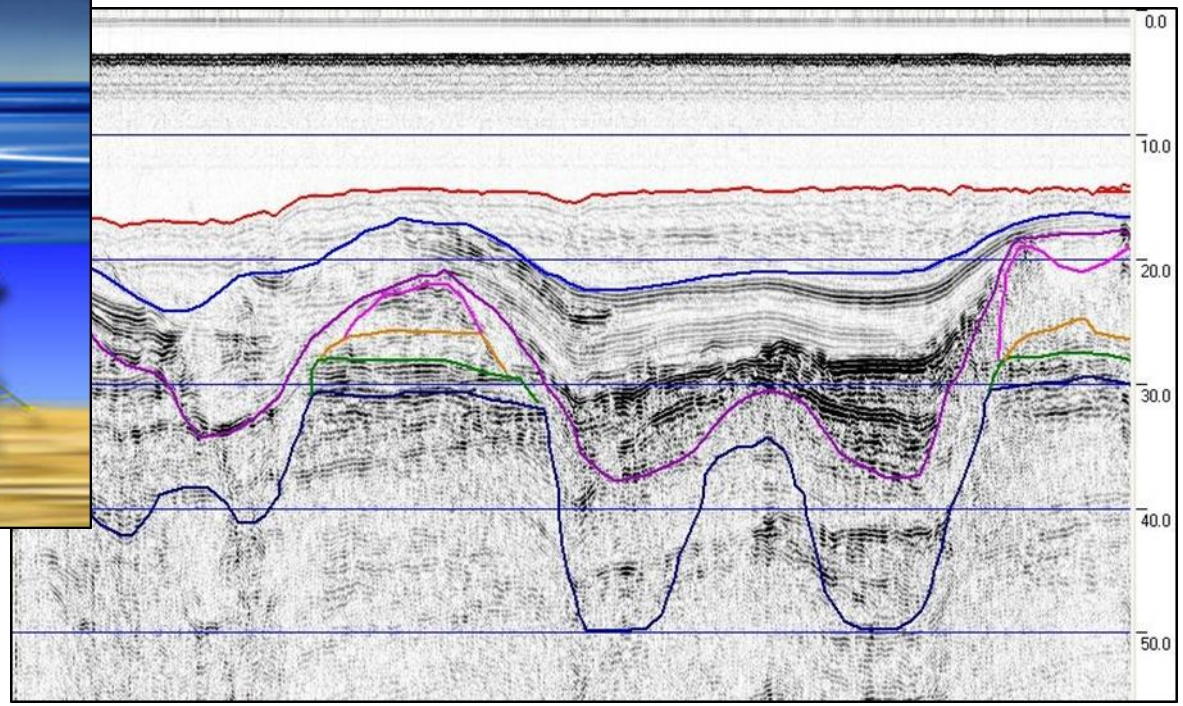
f. Develop assessment tools to monitor the in situ sites periodically.

a. Finding the sites and limiting the area where cultural remains are spread



b. Characterizing the sites, mostly with non-intrusive technology (limited trenching and sub-bottom profiling);

c. Developing diagnostic tools and procedures (involving biology, chemistry, geology, etc.) to assess the site's stability;

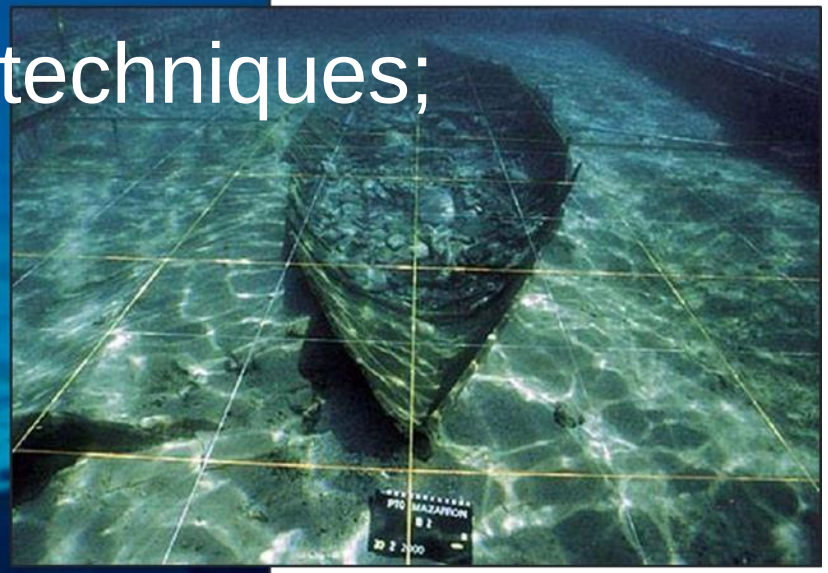


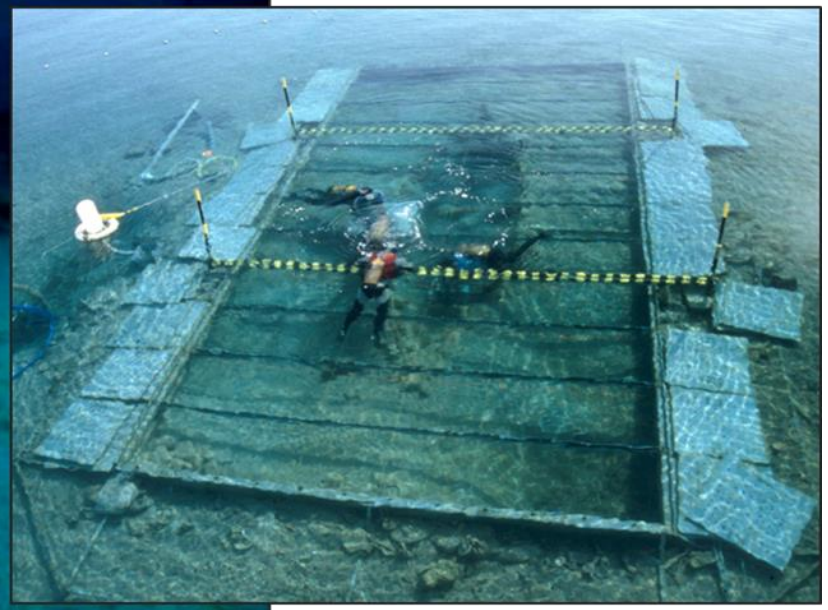
d. Developing prognostics (what happens if we don't touch, what happens if we cover the site, etc.);

Anthropic factors include looting, dredging, trawling, etc.

We catch 160 million tons of fish each year; 25% of the world fisheries are illegal; there are around 2 million decked fishing boats (84k in the EU); they discard 84k tons of nets every year; most shipwrecks 500 m and above have nets over them; artifacts turn up every day in fish markets: there is a market for archaeological artifacts and one for paleontological materials.

e. Developing mitigation procedures and techniques;





f. Develop assessment tools to monitor the sites periodically.

4. Divulgation is undoubtedly the most important task.

It may involve several types and levels of outreach:

a. Through archaeological reports and peer reviewed papers;

b. Through magazine articles for the great public;

c. Through internet videos and television shows;

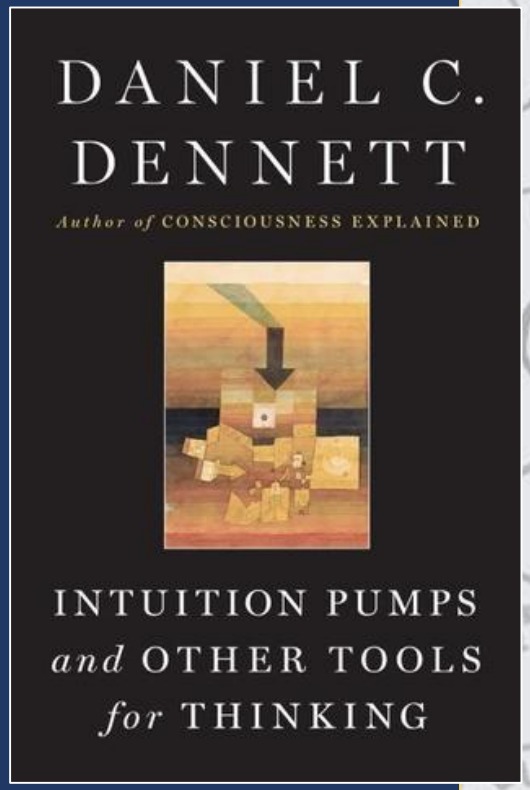
d. Through computer animations and computer models that allow the public to experience these sites;

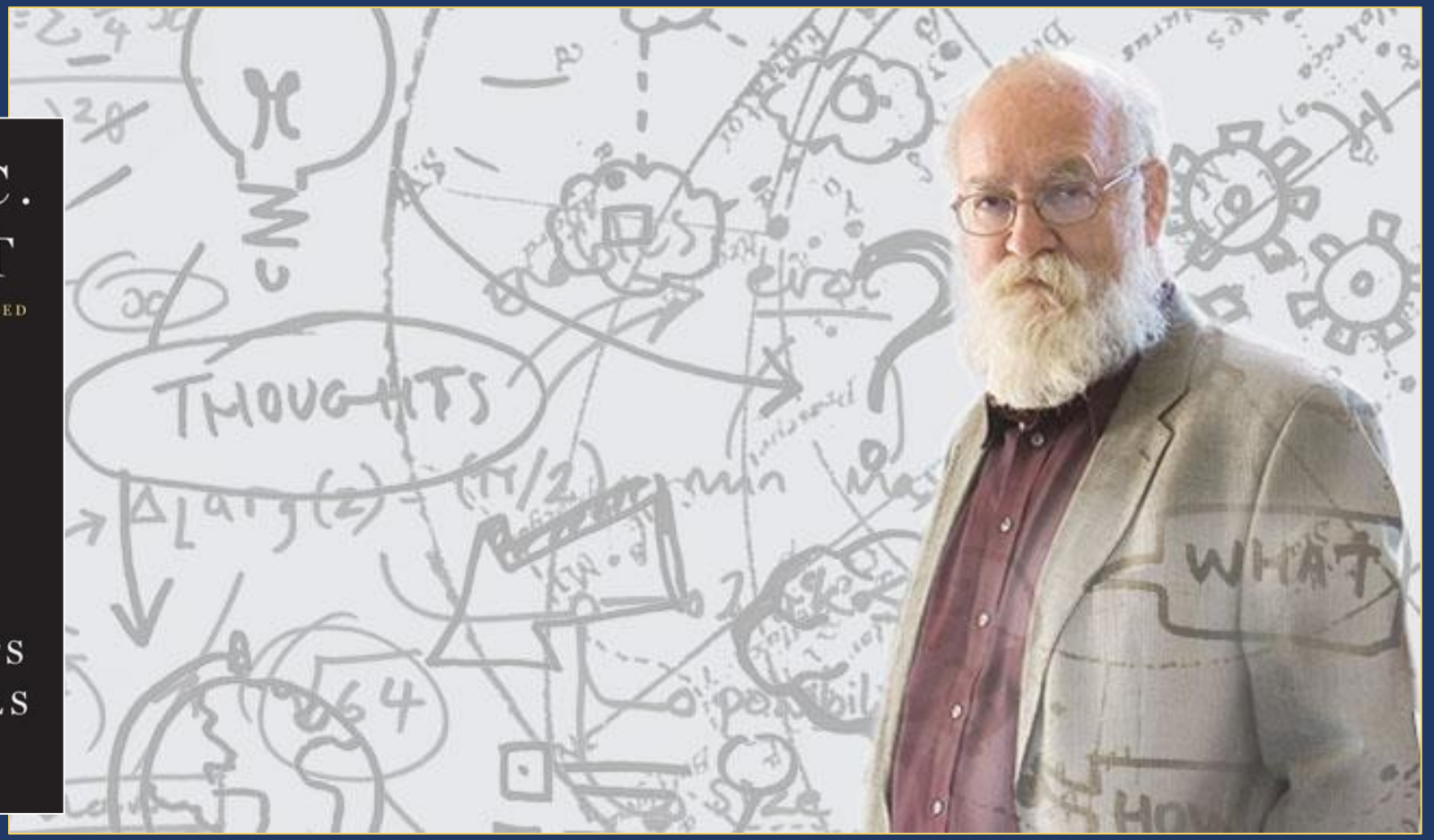
e. Through augmented reality, that allows the visitors to question the sites and understand them better;

f. Through the involvement of sections of the public and the creation of fora and the development of public archaeology projects: these may entail educated reconstruction of shipwrecks and computer modeling of intact stability, mechanisms of collapse, seakeeping, etc.

g. Through the creation of learning environments and serious games.

What is the social value of archaeology?! It provides the world with thinking tools! “We cannot do much carpentry with our bare hands, and we cannot do much thinking with our bare brains.”

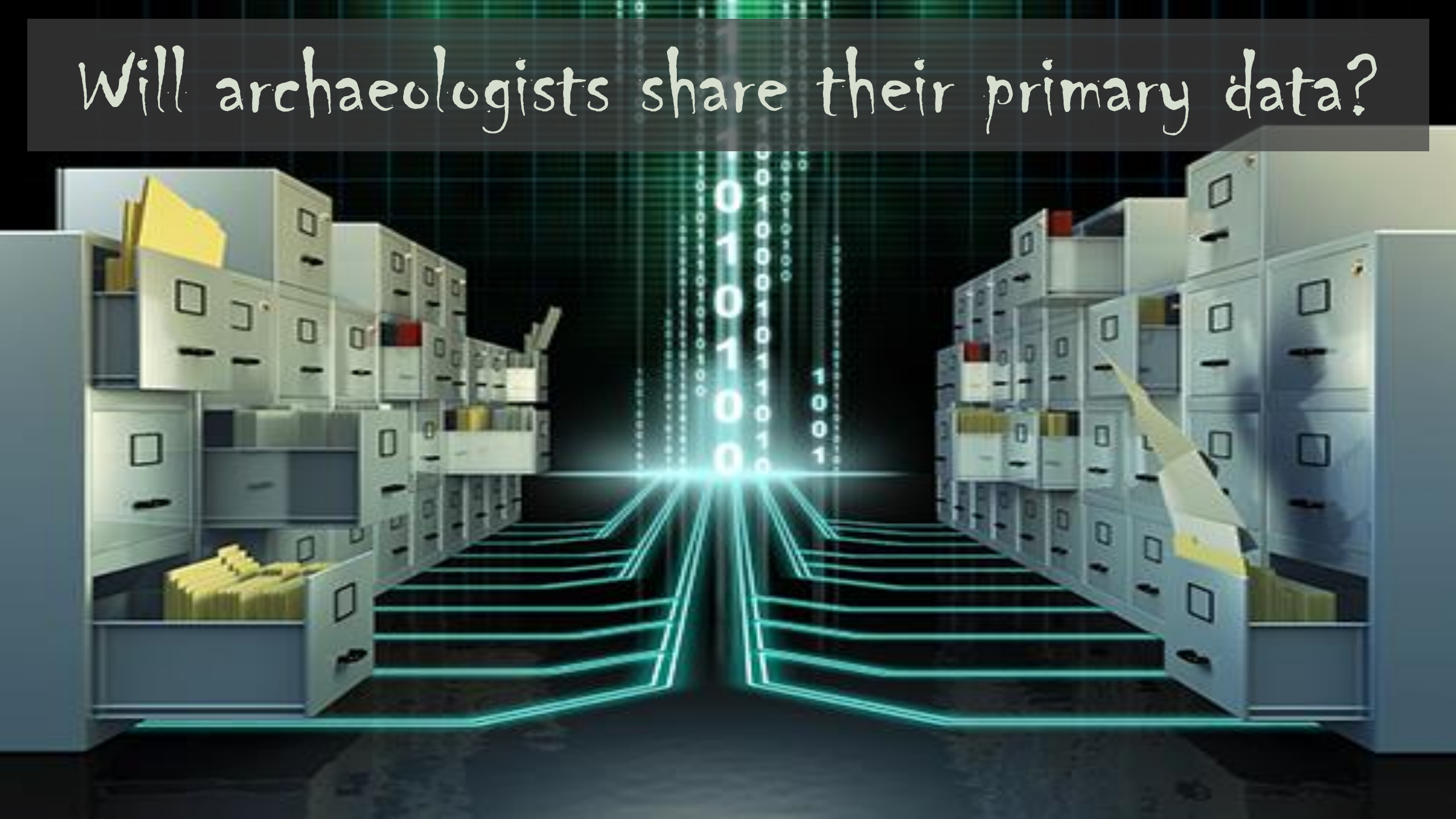




Will archaeologists start publishing their excavations?

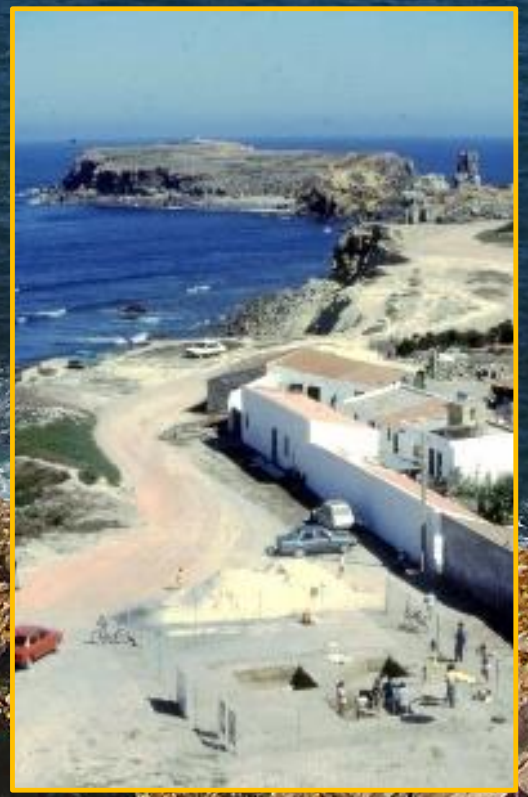
Archaeologists probably publish around 25% of the sites they dig (e.g. Stoddart and Malone 2001; Atwood 2007; Boardman 2009; Owen 2009; Bass 2011). Treasure hunters fill the niche created by archaeologists and cater to the interested public.

Will archaeologists share their primary data?

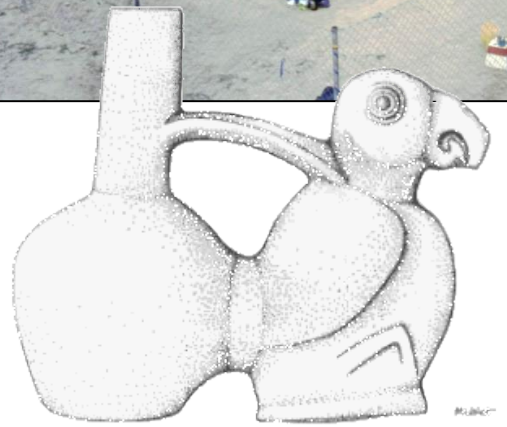


“…our past provides apps that we upload to our necktops.”

San Pedro de Alcantara
(1784)



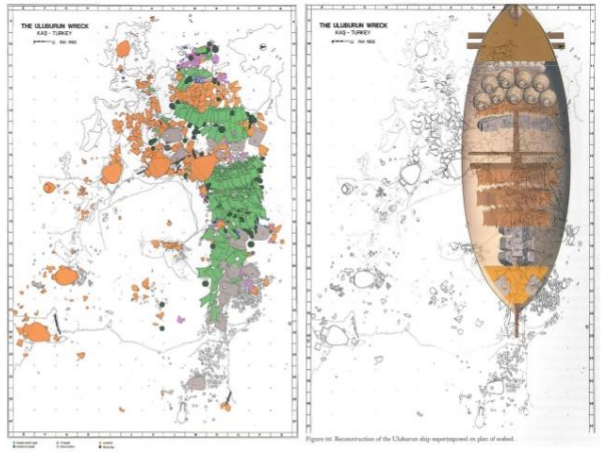
San Pedro de Alcantara (1784) transported Fernando Tupac Amaru Bastidas, the son of José Condorcanqui (Tupac Amaru II) who was forced to witness the execution of his parents and died in exile in Spain.



Outreach: technology is changing everything,

starting with museums:

Questions?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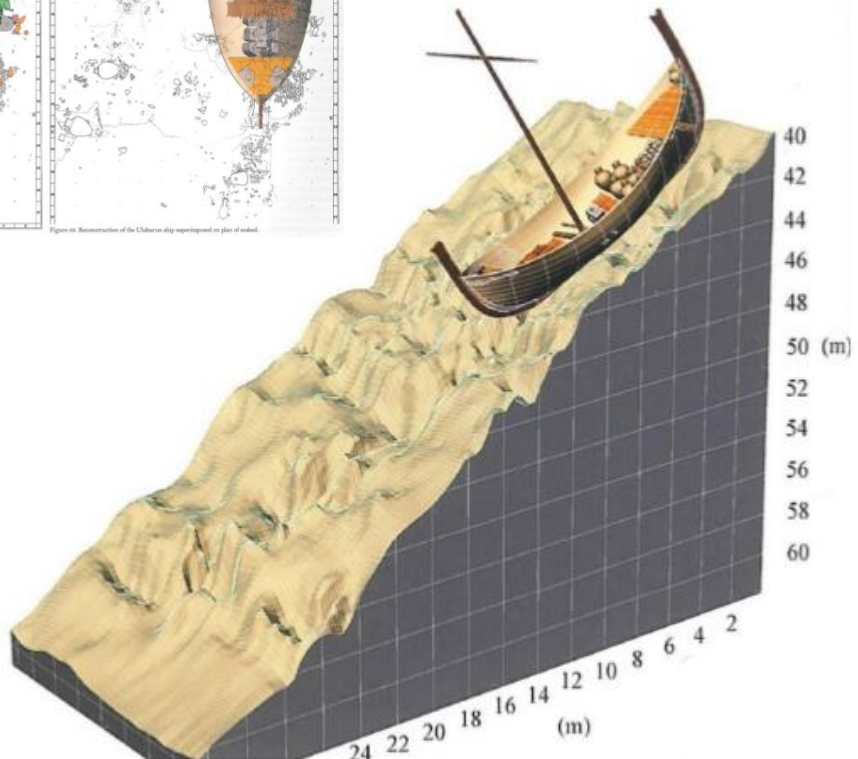
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