

# Arq. en Aguas Profundas I

Especialización en Patrimonio Cultural Sumergido  
Cohorte 2021

## Introducción



Universidad  
**Externado**  
de Colombia

Filipe Castro  
Bogotá, April 2021



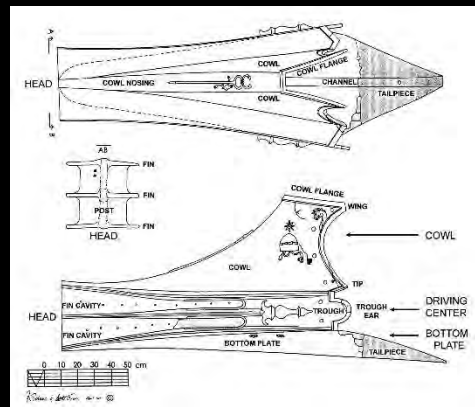
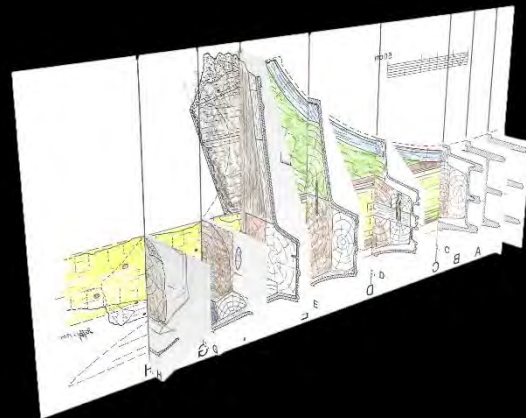
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SOCIAIS E HUMANAS  
UNIVERSIDADE NOVA DE LISBOA



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

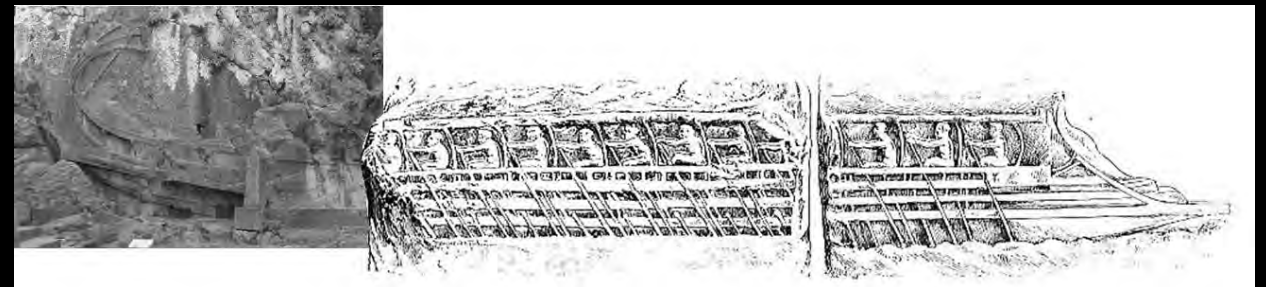
Nobody knows what an Athenian trireme looked like.

All we have is a ram (190 BCE)...



...a few timbers preserved inside it...

...and some sculptures:



Maritime archaeology is concerned with the study of seafaring and maritime cultural landscapes.





Piraeus has been an important harbor for the best part of the last 25 centuries.

We study shipwrecks to try to understand the people that built and sailed them, and the world in which they sailed. The history of warship design is largely unknown to us...



...but we are also interested in the everyday lives of the peoples that manned and inhabited the ships.



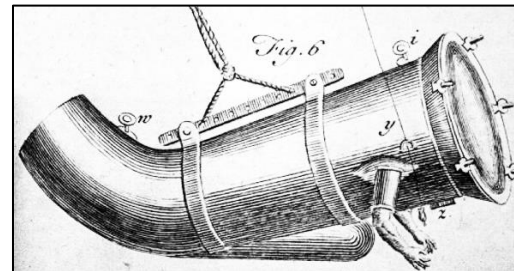
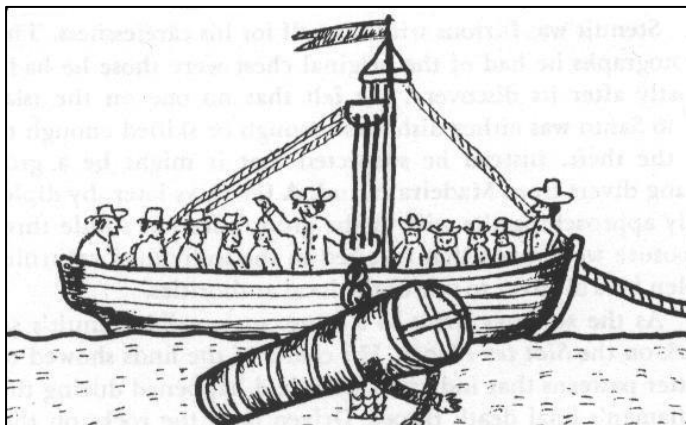
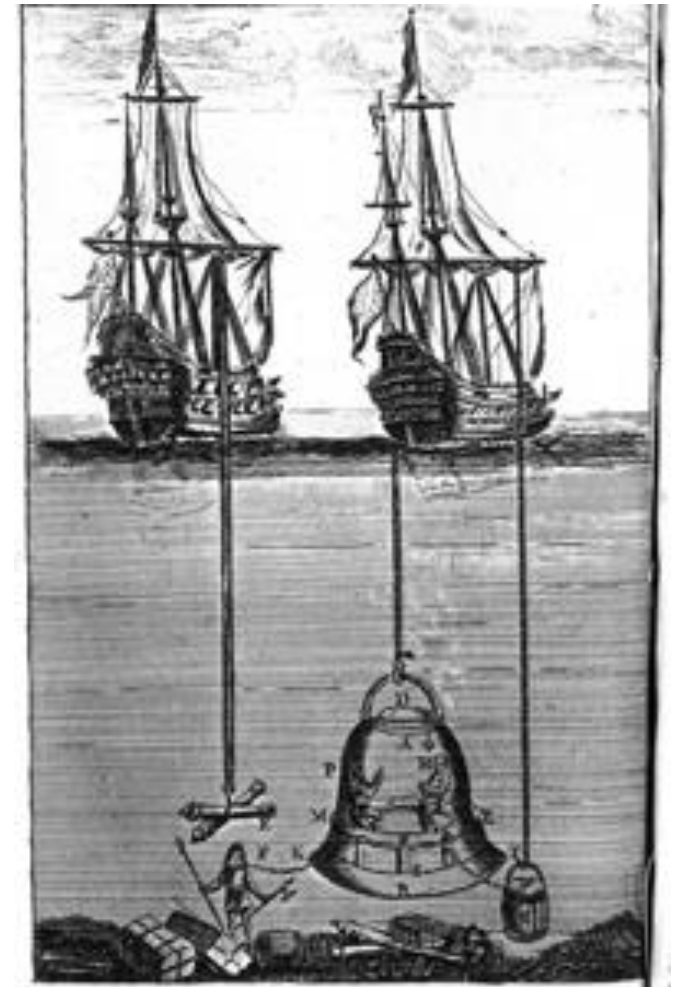


Archaeologists rarely try to work beneath air / nitrox diving depths.





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



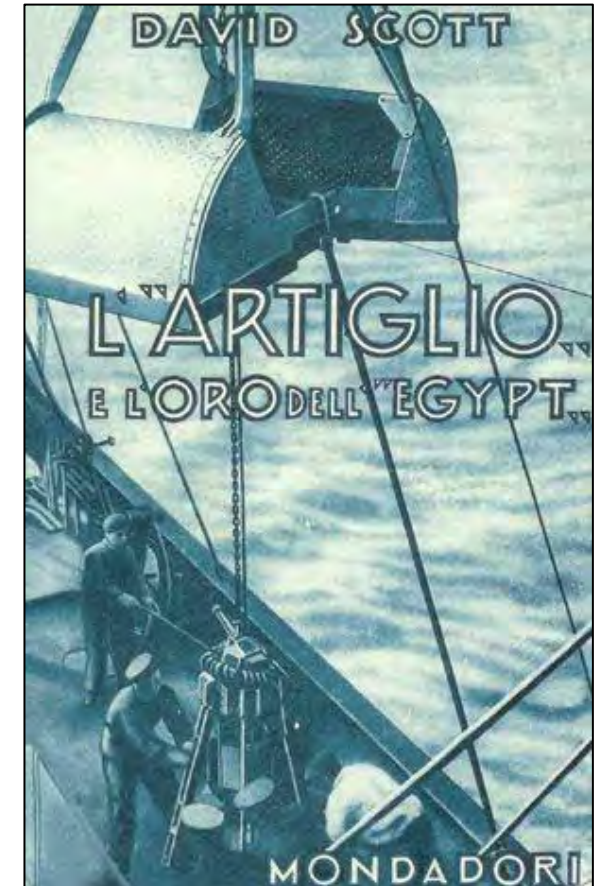
The depths of operation of salvage companies increased steadily during the 20<sup>th</sup> century, and after the treasure hunting boom of the 1960s, treasure hunting companies started looking into cargos sunken in deep water.



*Harrisburg telegraph.* (Harrisburg, Pa.),  
19 July 1916.



Sorima's salvage of the gold of  
*Egypt*, 1930.



Treasure hunters have more resources, as their money is in the pockets of the investors, not on the bottom of the sea.

**WANTED** Thomas Thompson  
Alison Antekeier

Wanted for Contempt of Court  
**614-469-5540**

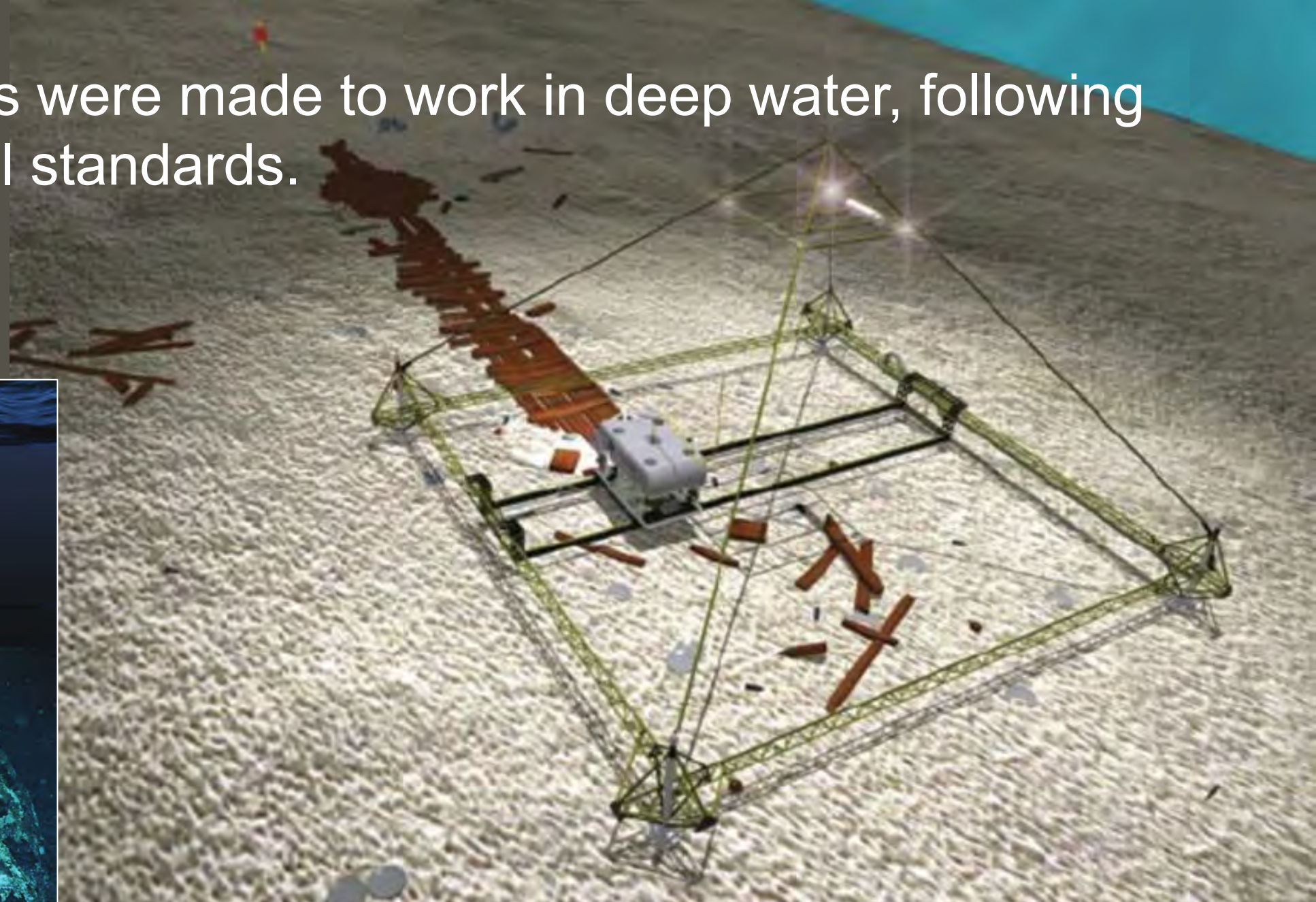
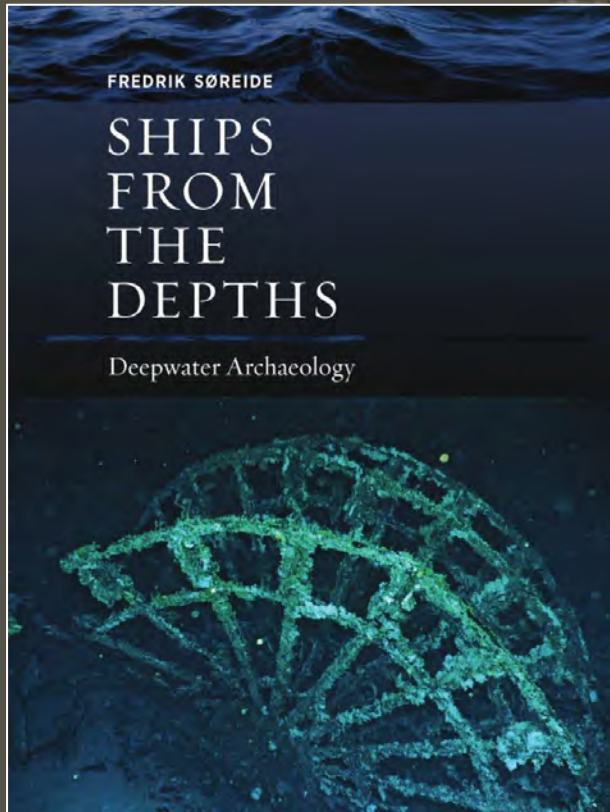
U.S. MARSHALS

070425 CLEARCHANNEL

In 20107 Greg Stemm recovered  
17 tons of silver coins from a  
Spanish shipwreck c. 1100 m deep.



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

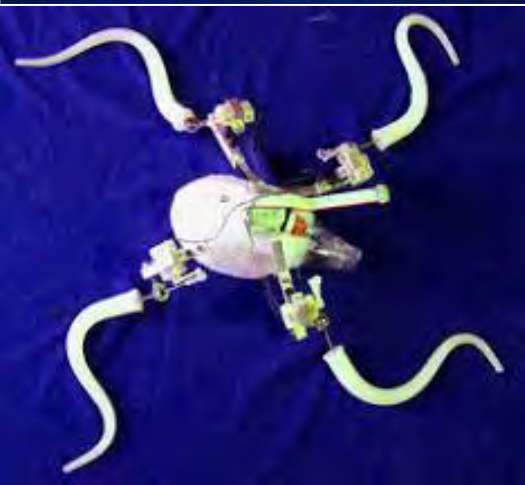


Ormen Lange, Norway, 2003

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

Archaeologists work within a 19<sup>th</sup> century paradigm, and what we do can be roughly divided into four main activities:

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



Although it is expensive, research in archaeology can be justified by its social value. And if marine robots can do archaeology, they can do anything.

Low depth 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.

# 1

Surveying requires an array of remote sensing tools:

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



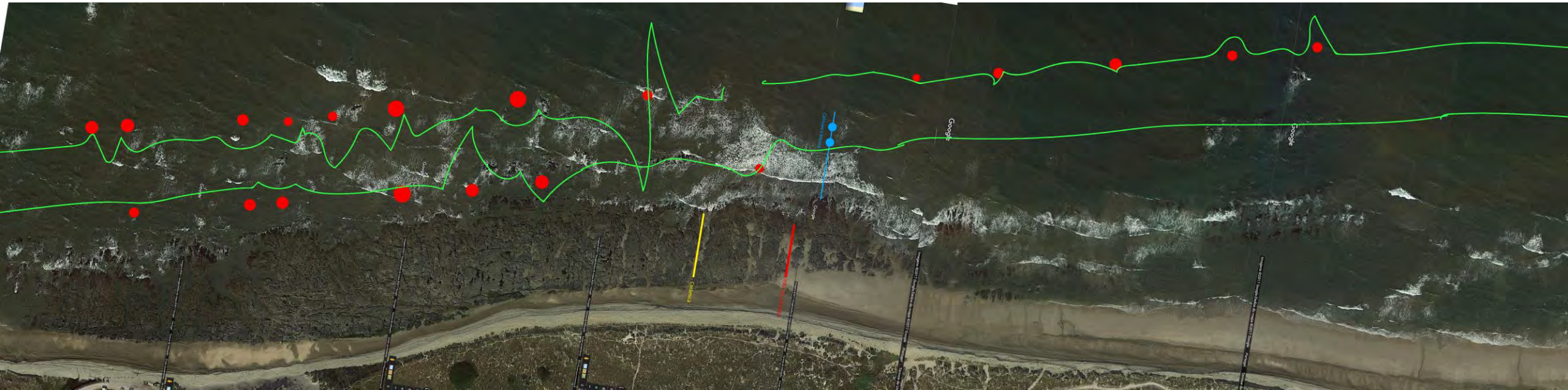
Ground truthing generally requires diving or the use of ROVs.

Besides cost, survey problems include:

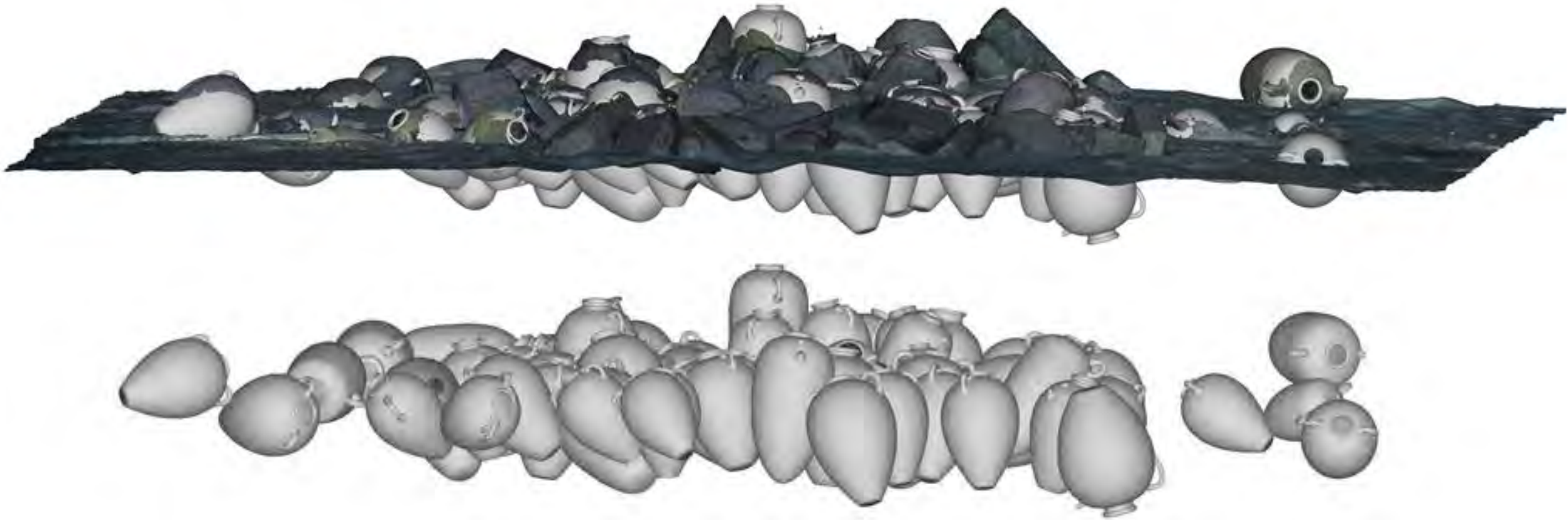
- a. AUV payload;
- b. AUV autonomy;
- c. AUV stability (pitch, roll, and yaw control);
- d. AUV path control;
- e. Communications (data migration).

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 Xiendi 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 out.



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

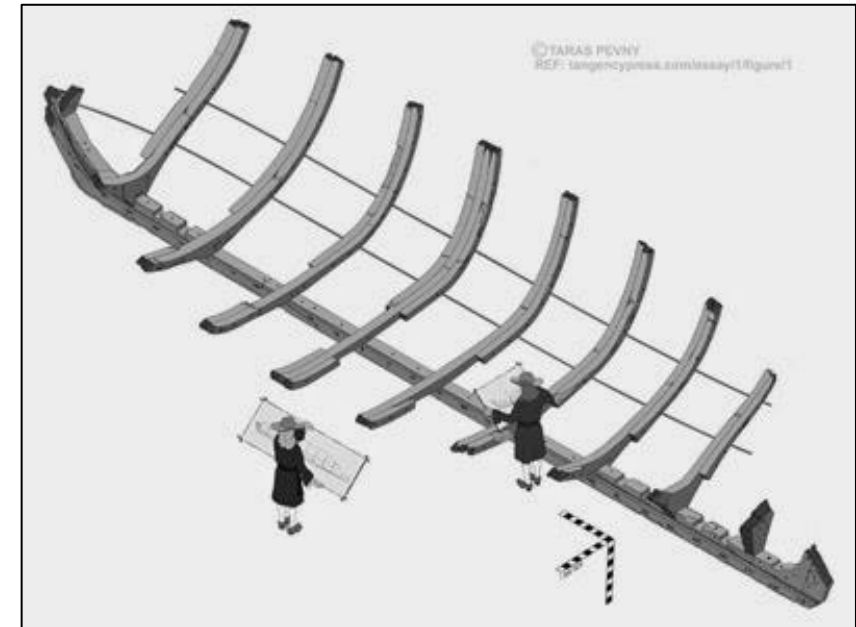




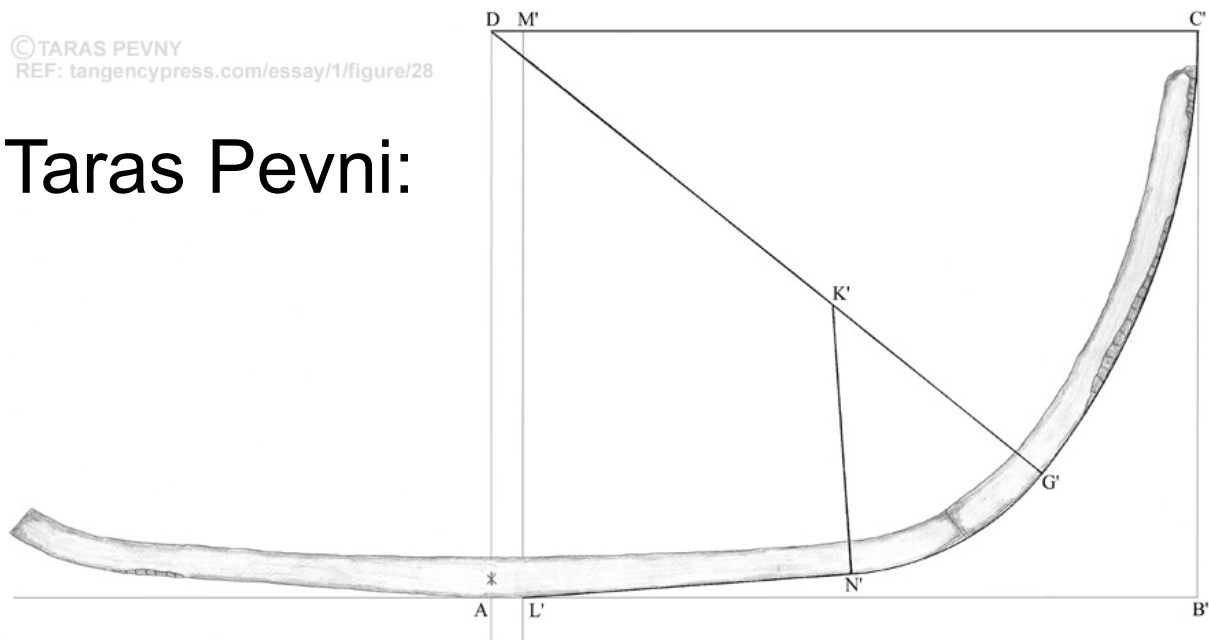




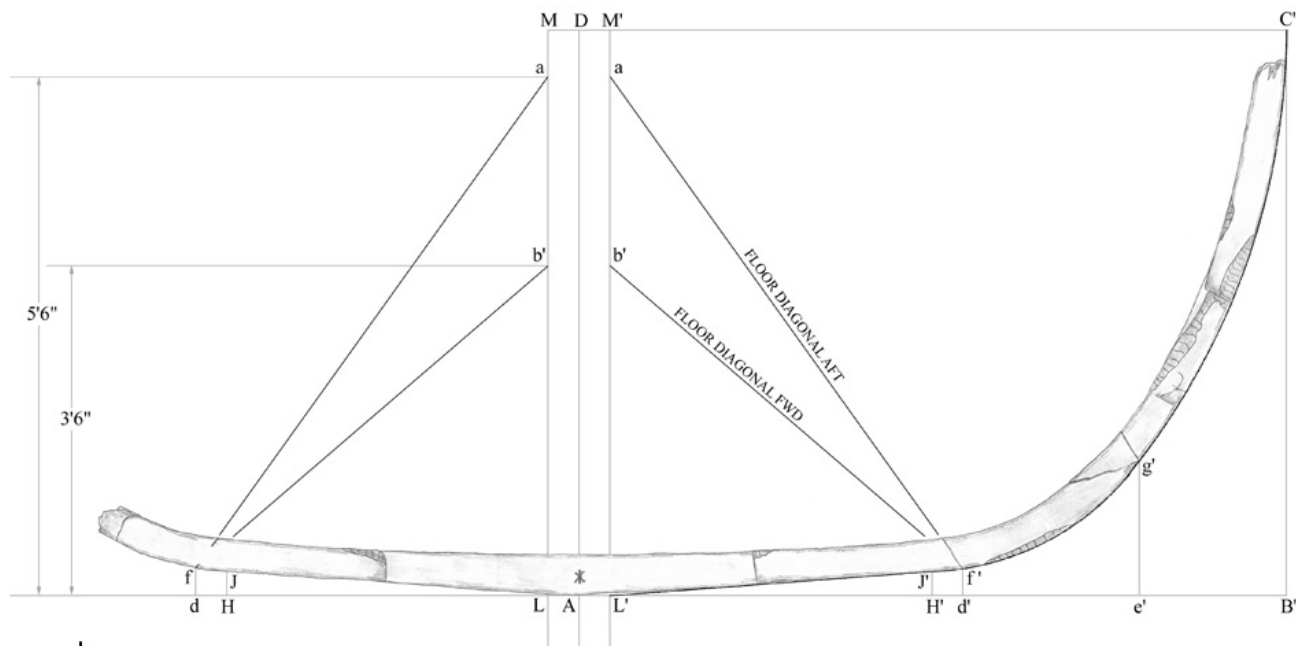
The hull was disassembled, each timber recorded separately, cleaned, and reassembled before conservation treatment started.



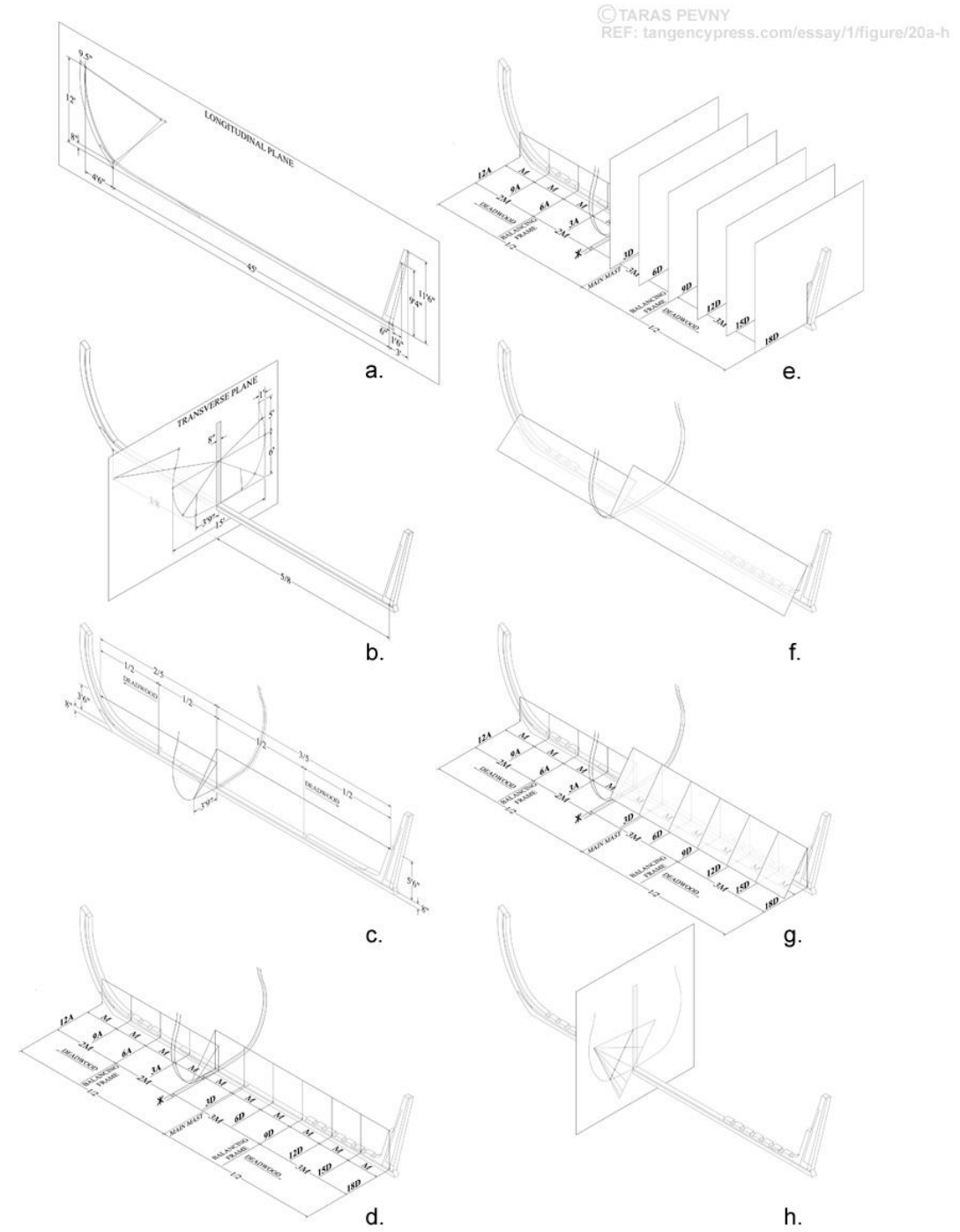
# Taras Pevni:



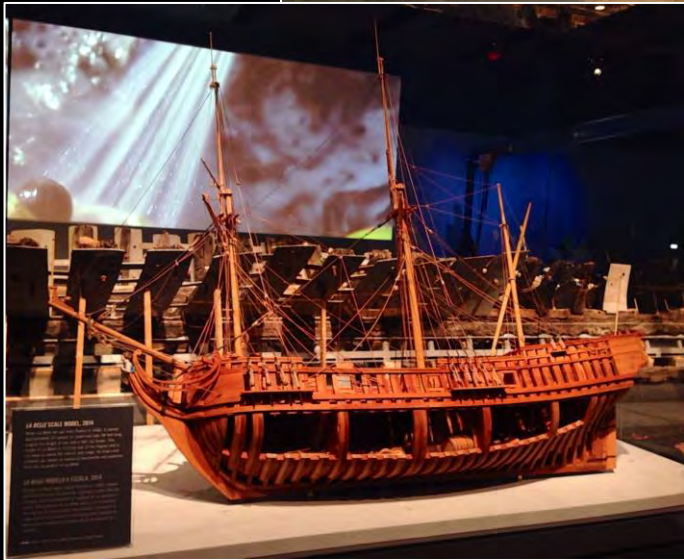
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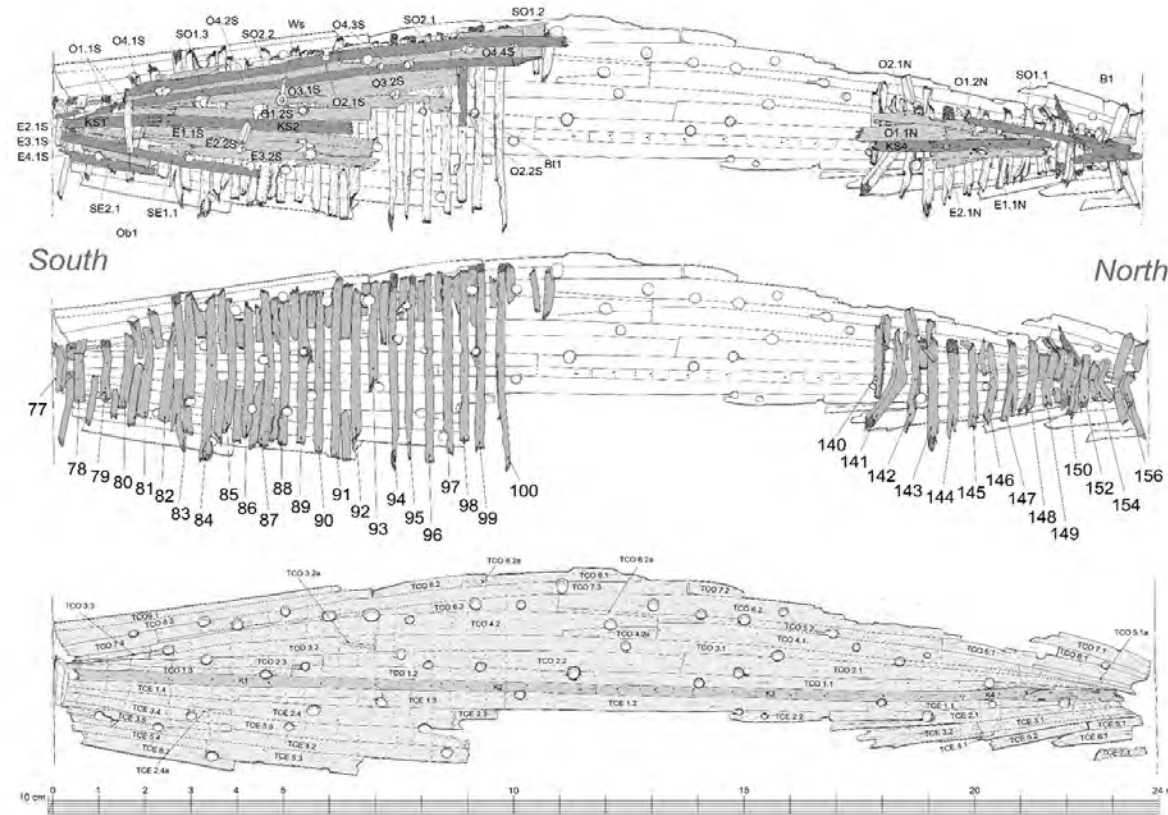
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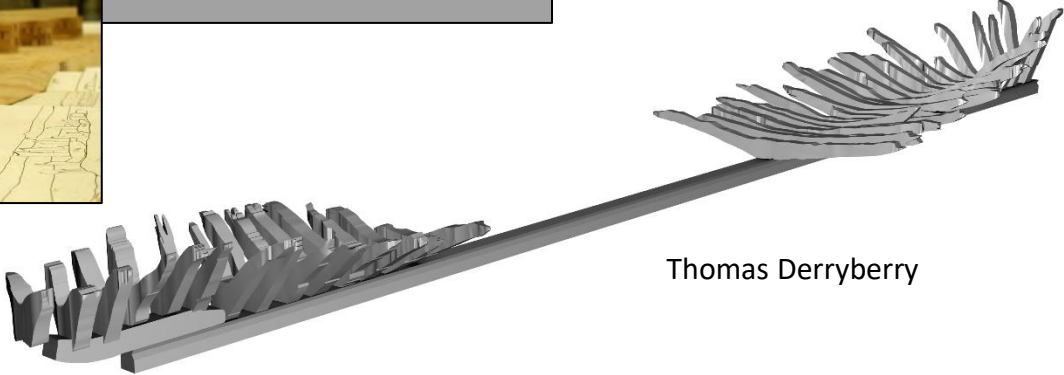
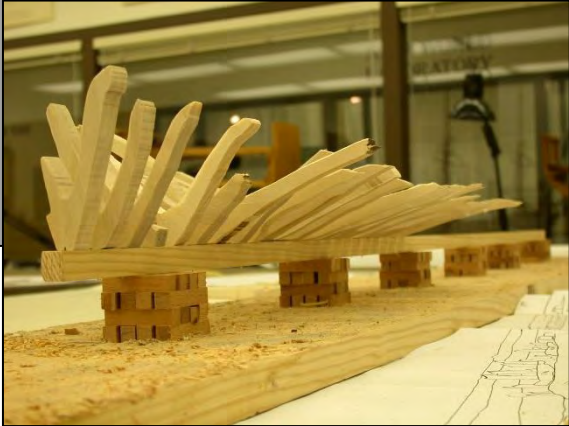
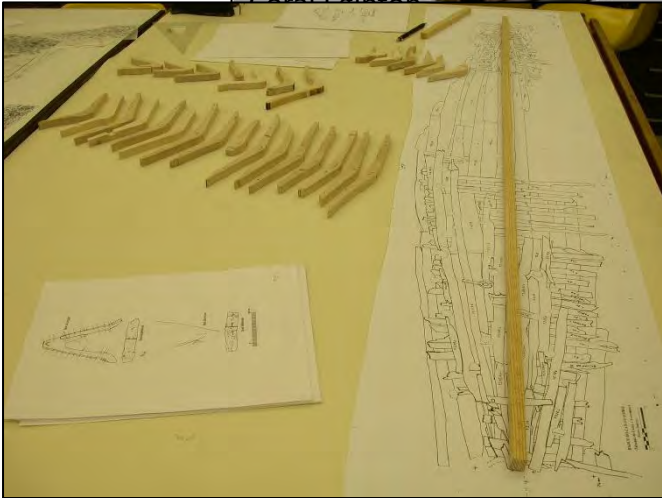
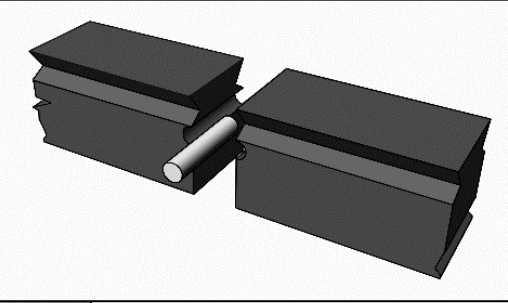
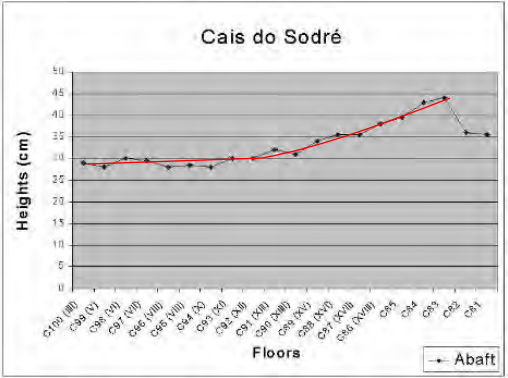
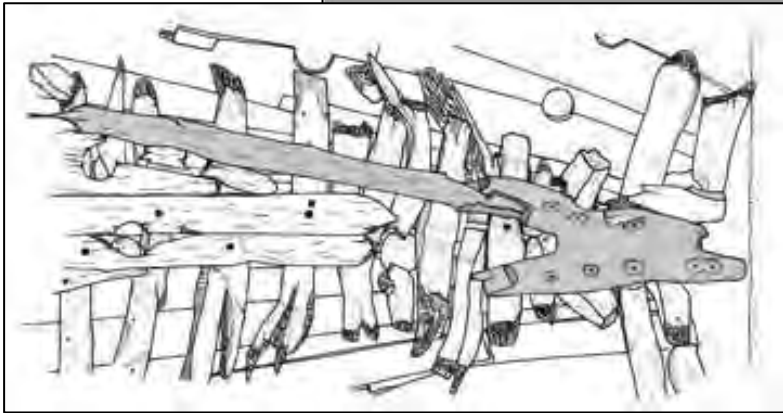
After conservation the hull was exposed in Austin, at the Bullock Texas State History Museum, and an attempt to reconstruct the ship and its rigging was made.



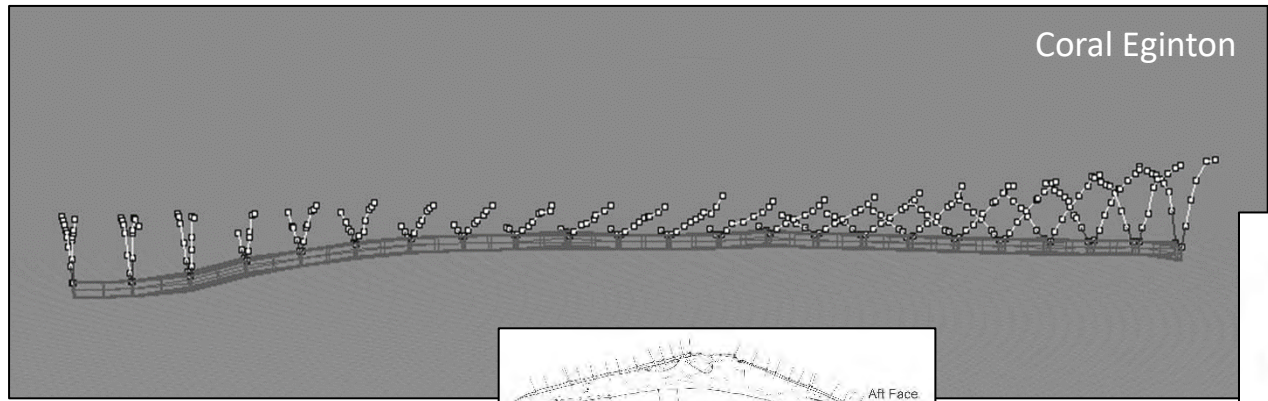
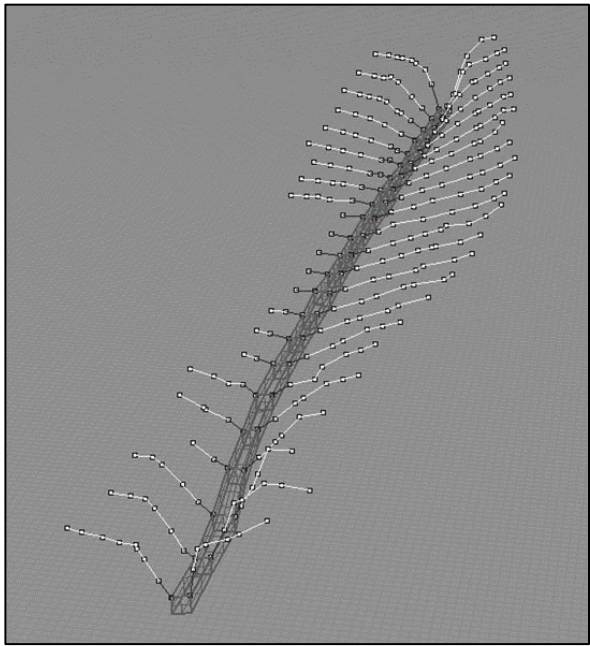
The excavation process is always the same: **map**, **dig**, **clean**, **tag**, **record** (sketch, measure, and draw plans and **sections**), and **cover**.



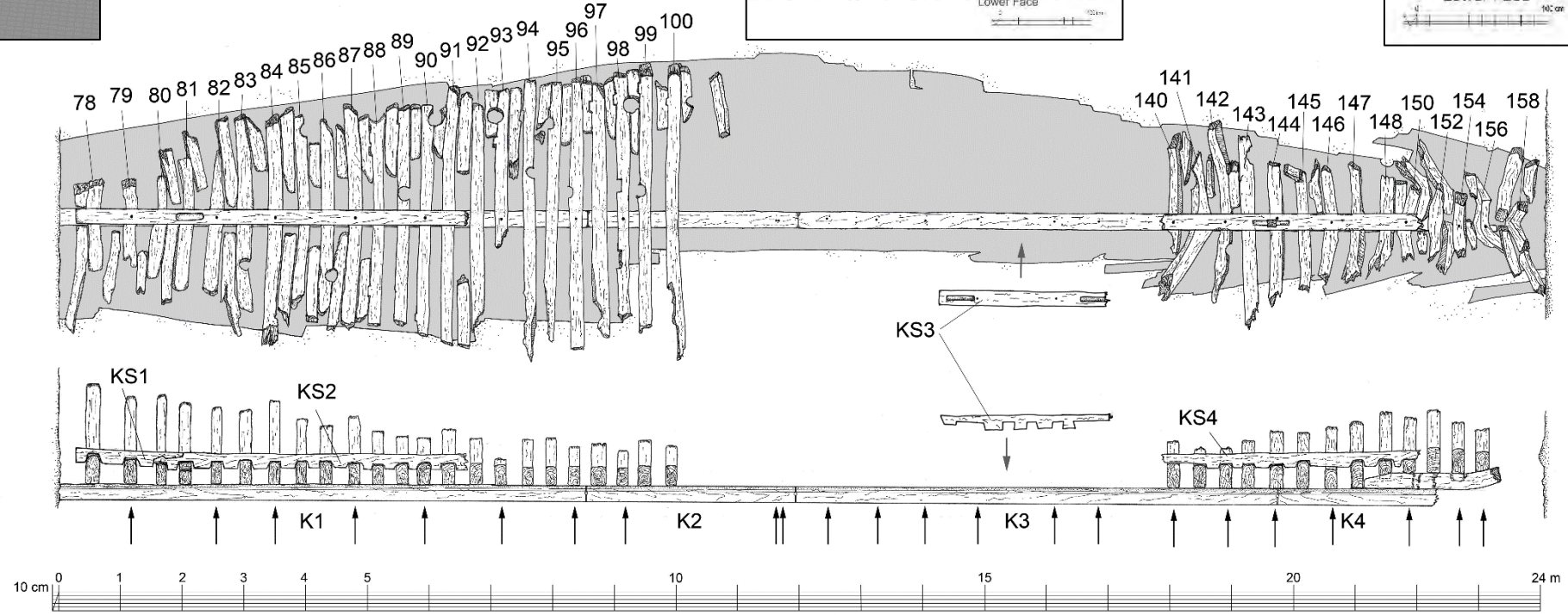
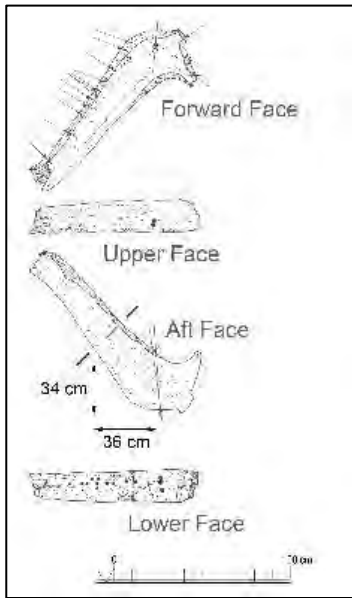
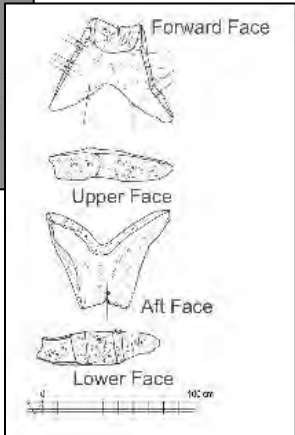
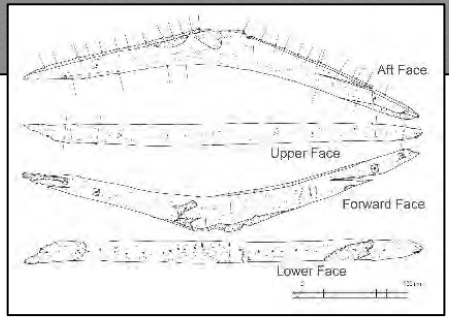
Cais do Sodré shipwreck, Lisbon (C14 dated to c. 1500)

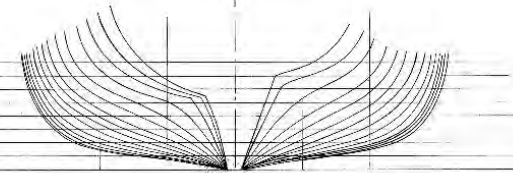
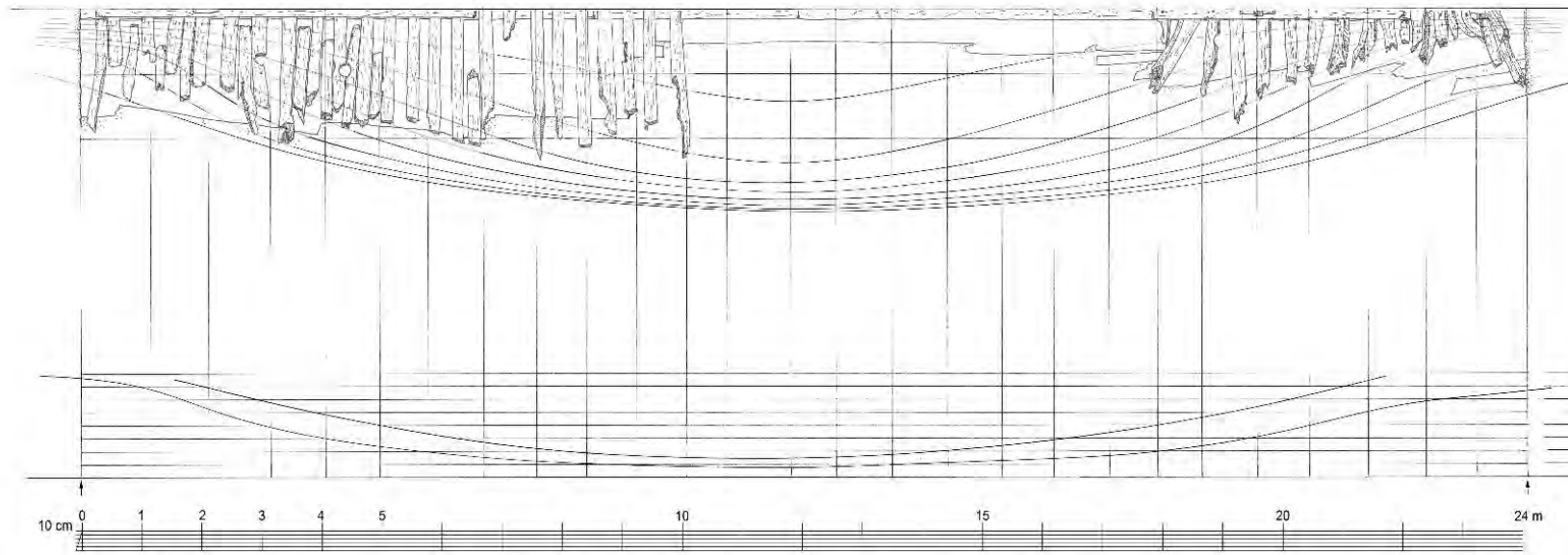
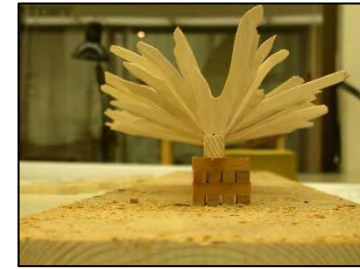
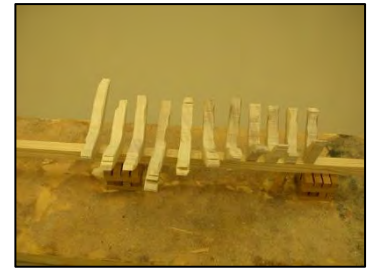
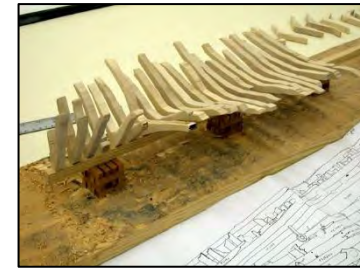
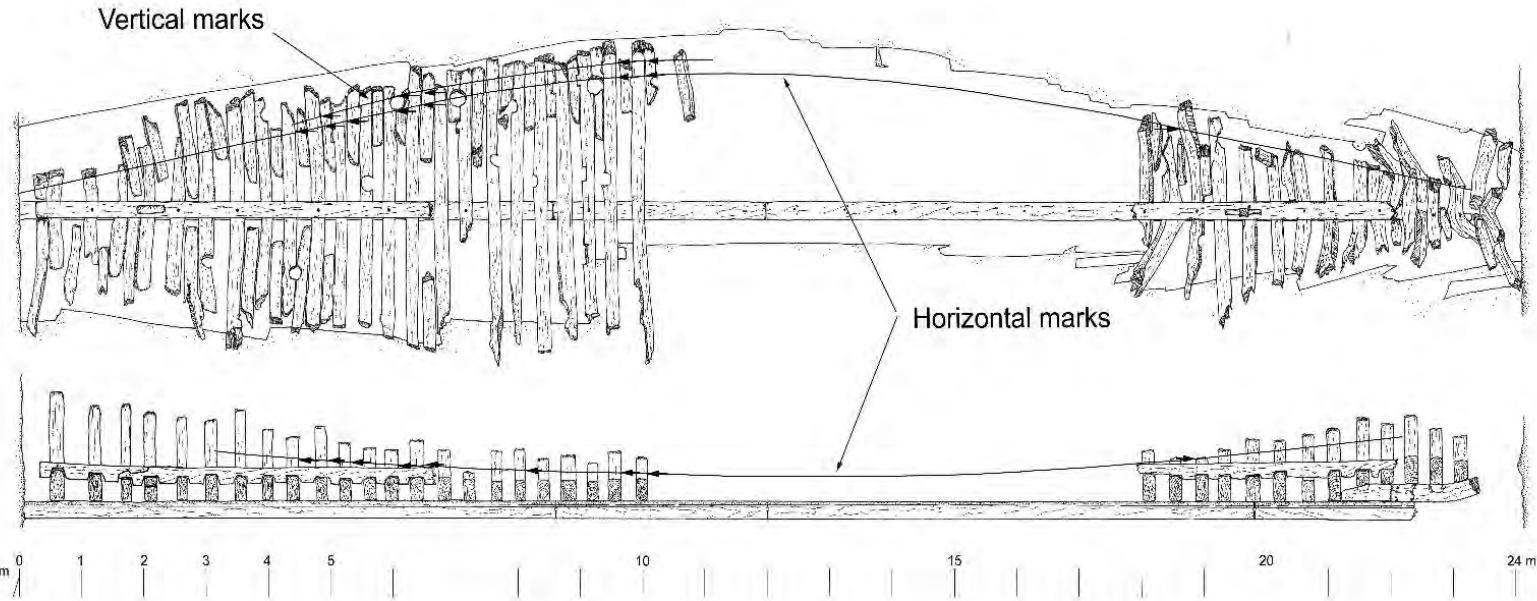


Thomas Derryberry

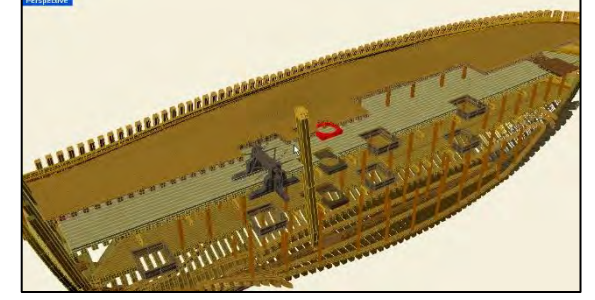
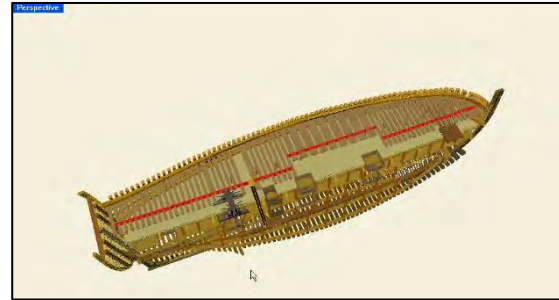
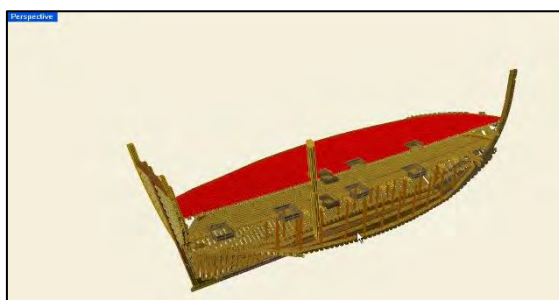
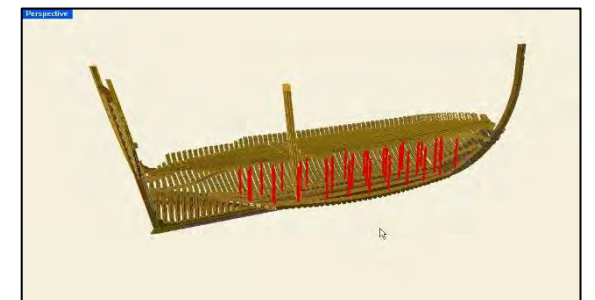
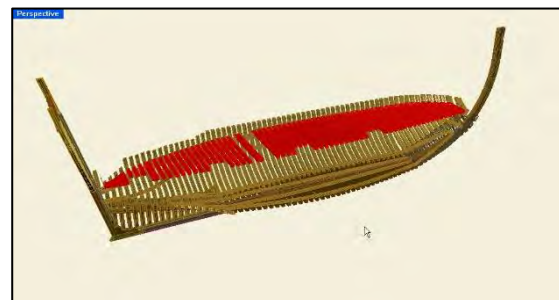
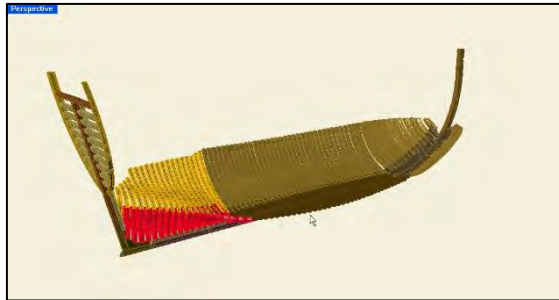
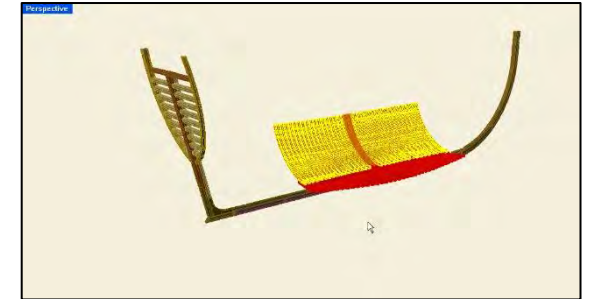
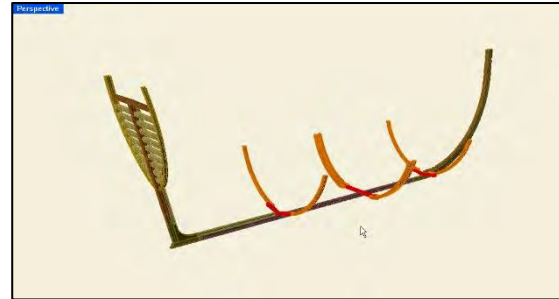
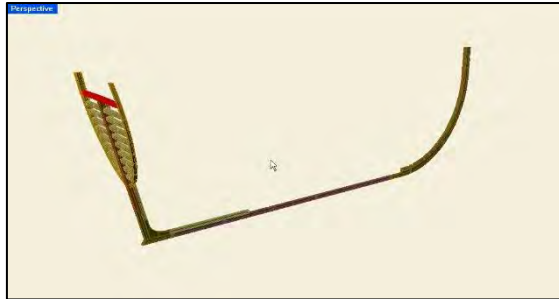


Coral Eginton



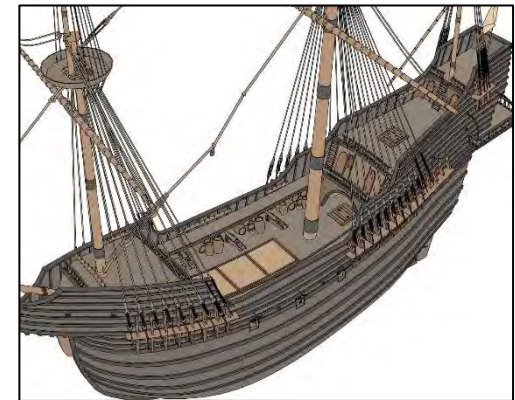
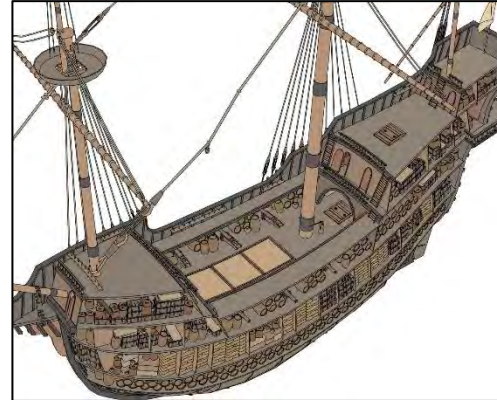
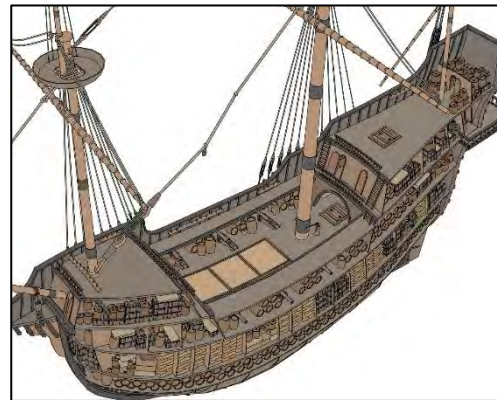
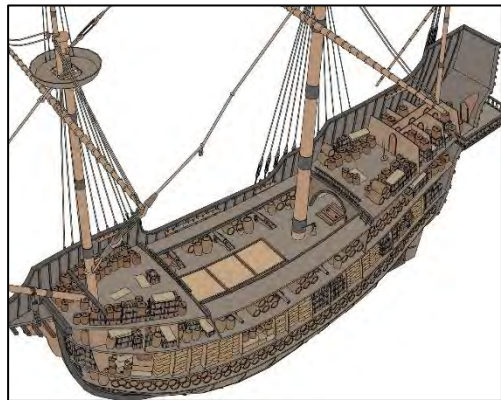
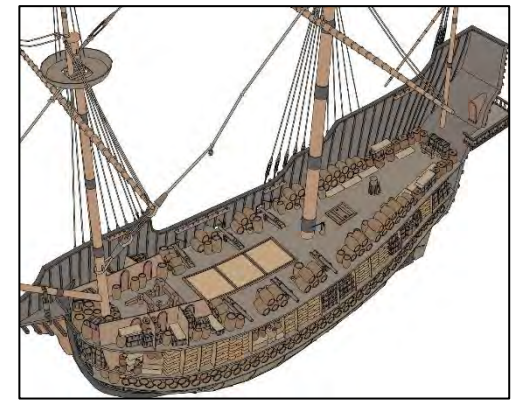
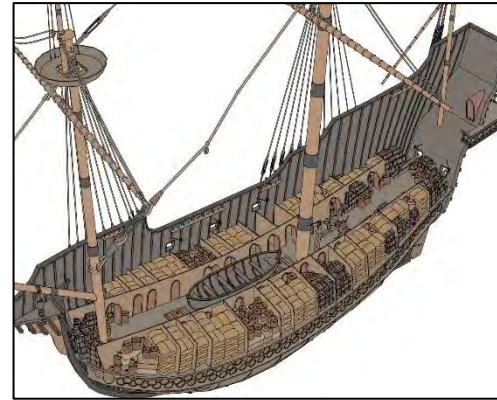
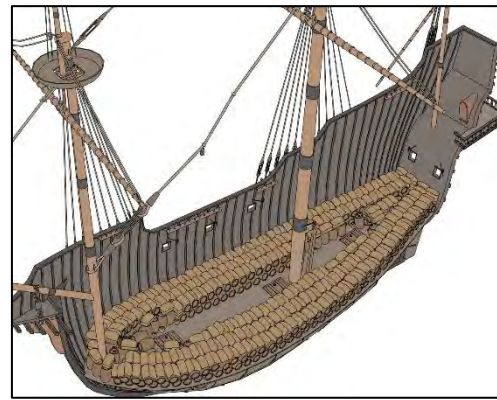
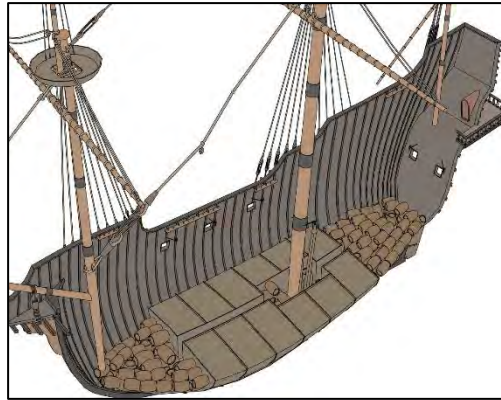


Ships have a stratigraphy in themselves: they were built following a traditionally established construction sequence.





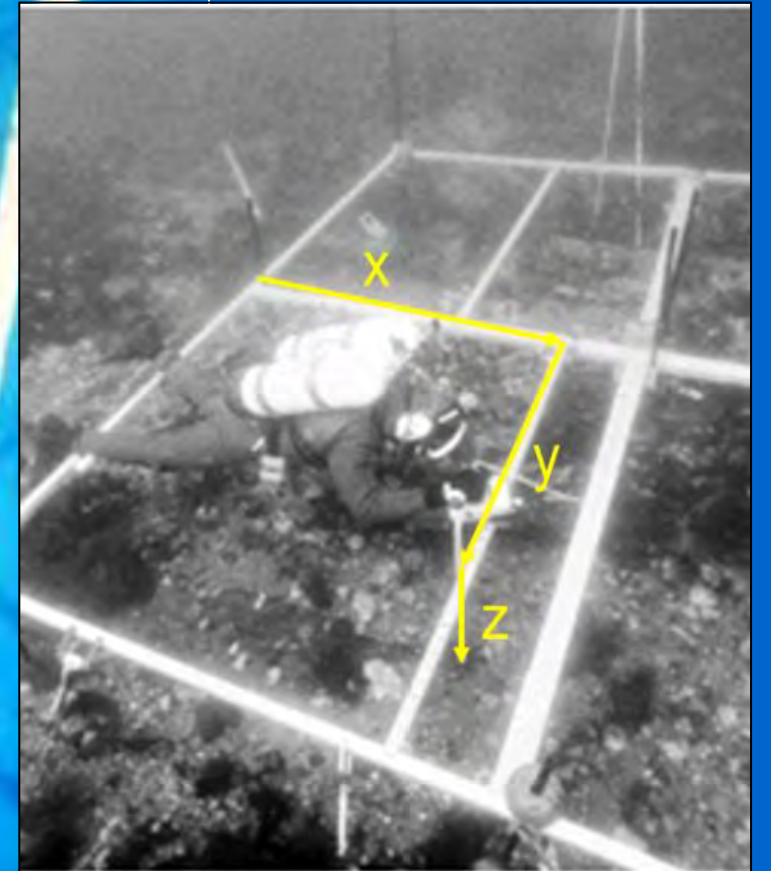
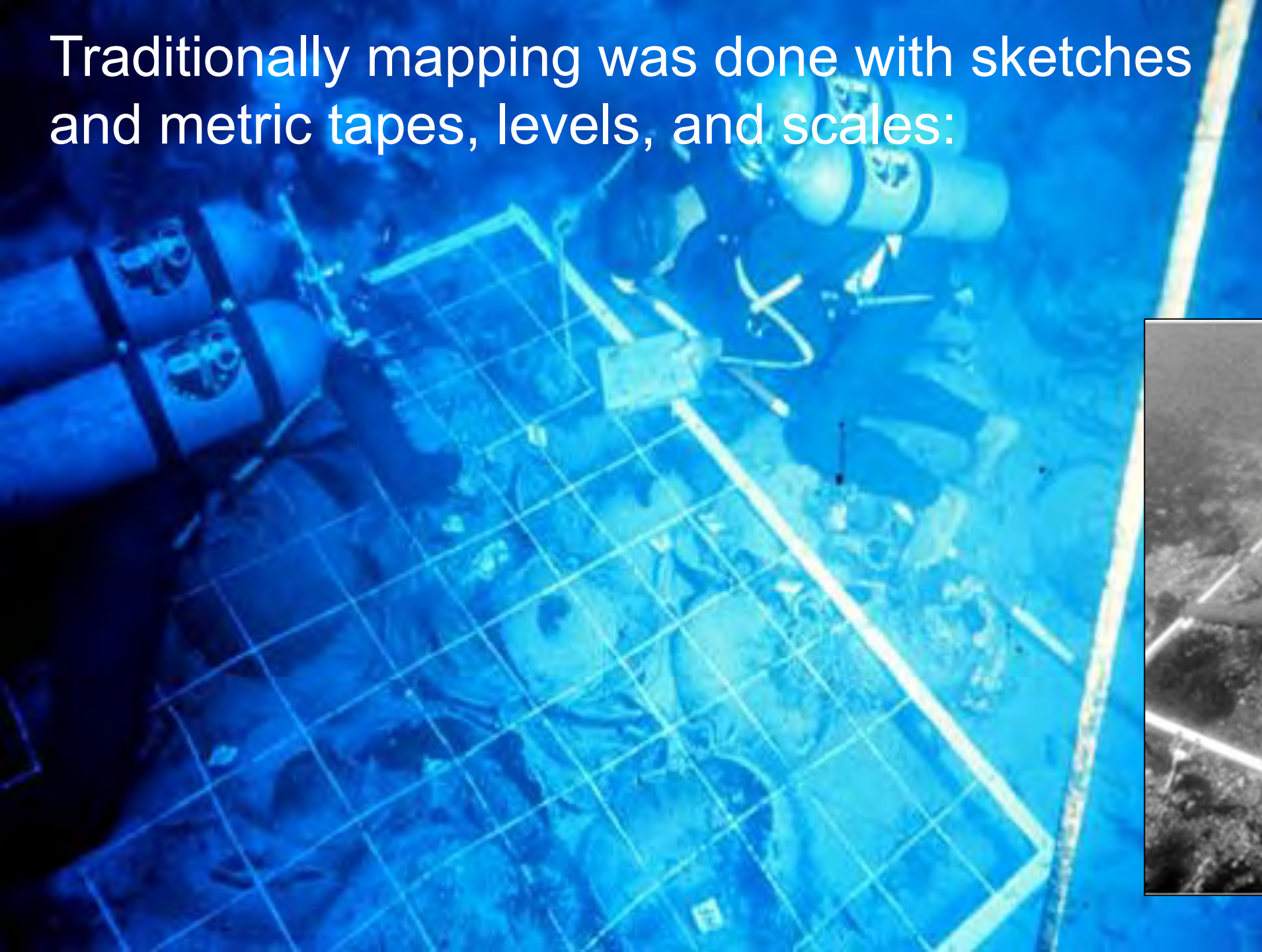
We want to reconstruct them, populate them, and understand the world in which they sailed:



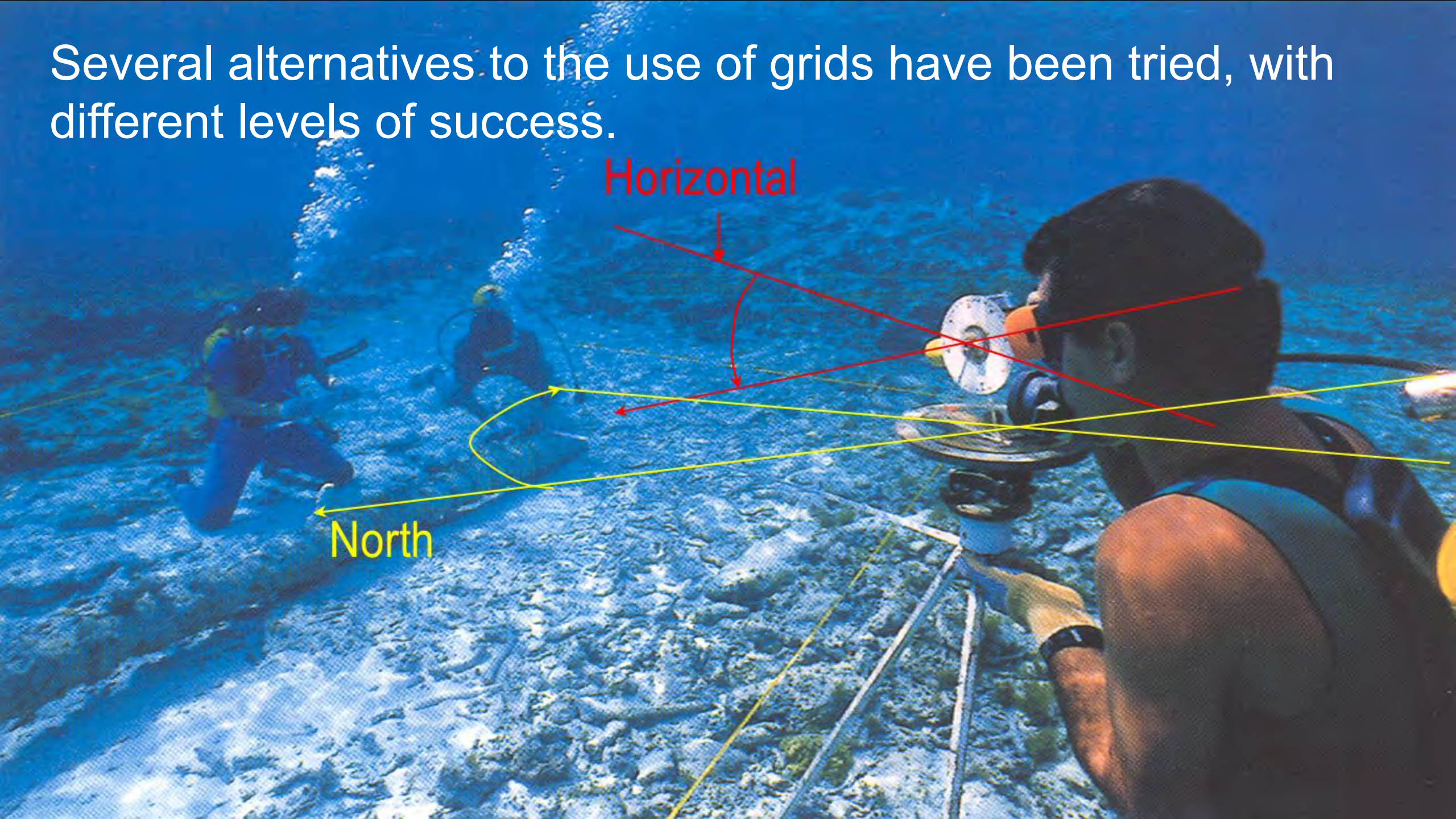


Cody Leuschner  
Bruce Gooch's student

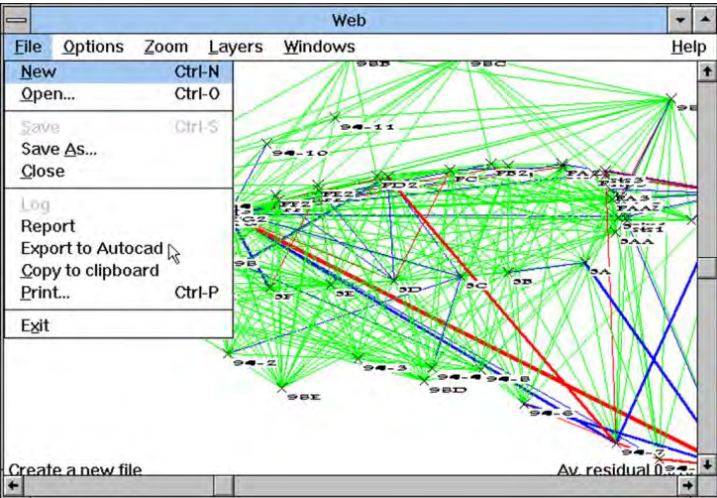
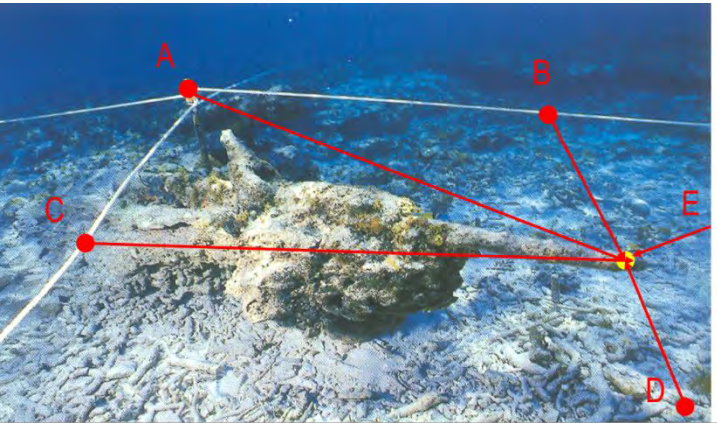
Traditionally mapping was done with sketches and metric tapes, levels, and scales:



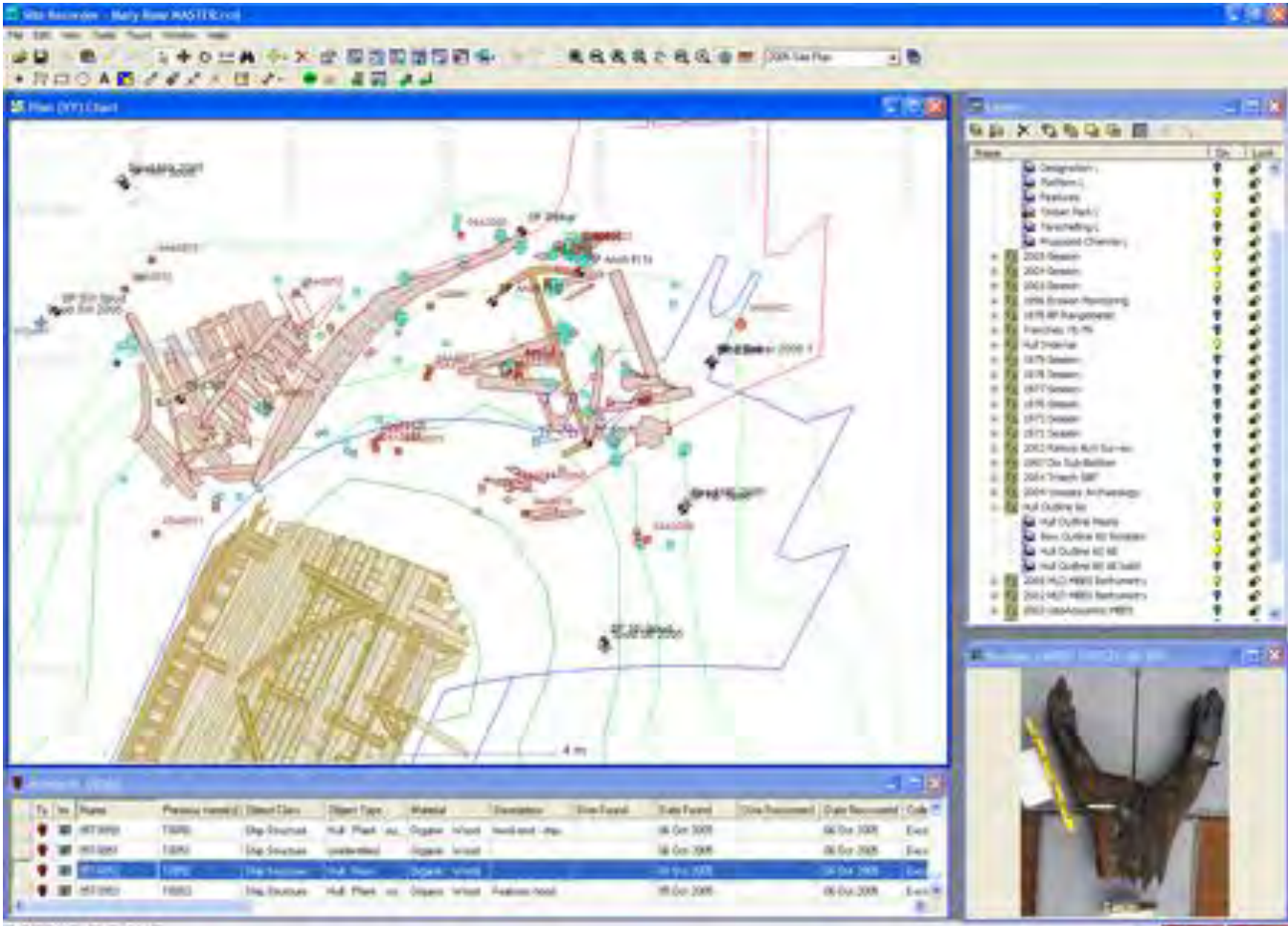
Several alternatives to the use of grids have been tried, with different levels of success.



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



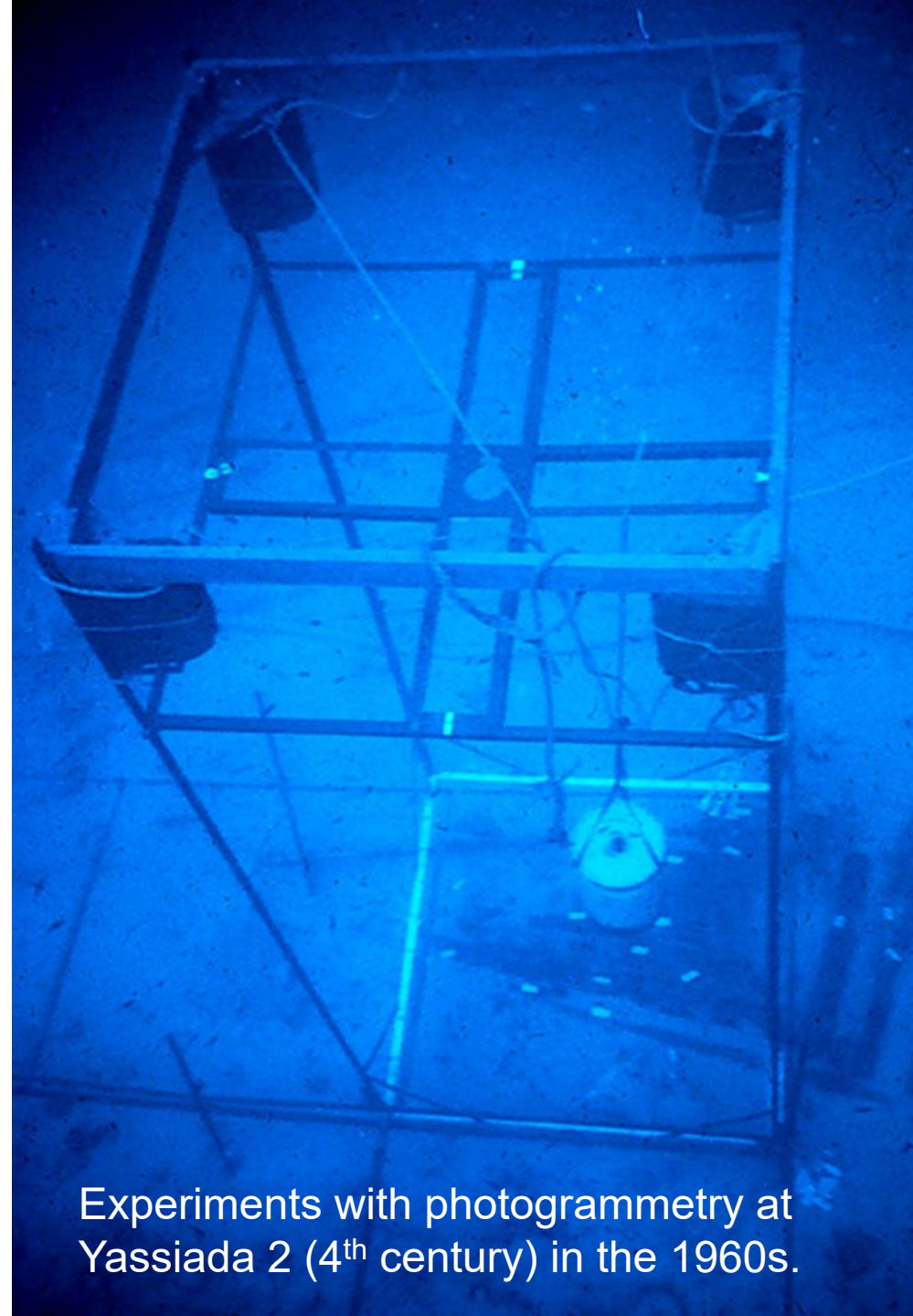
3H Consulting Site Recorder Software

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



Photogrammetry has been around since the 19<sup>th</sup> 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 (4<sup>th</sup> century) in the 1960s.

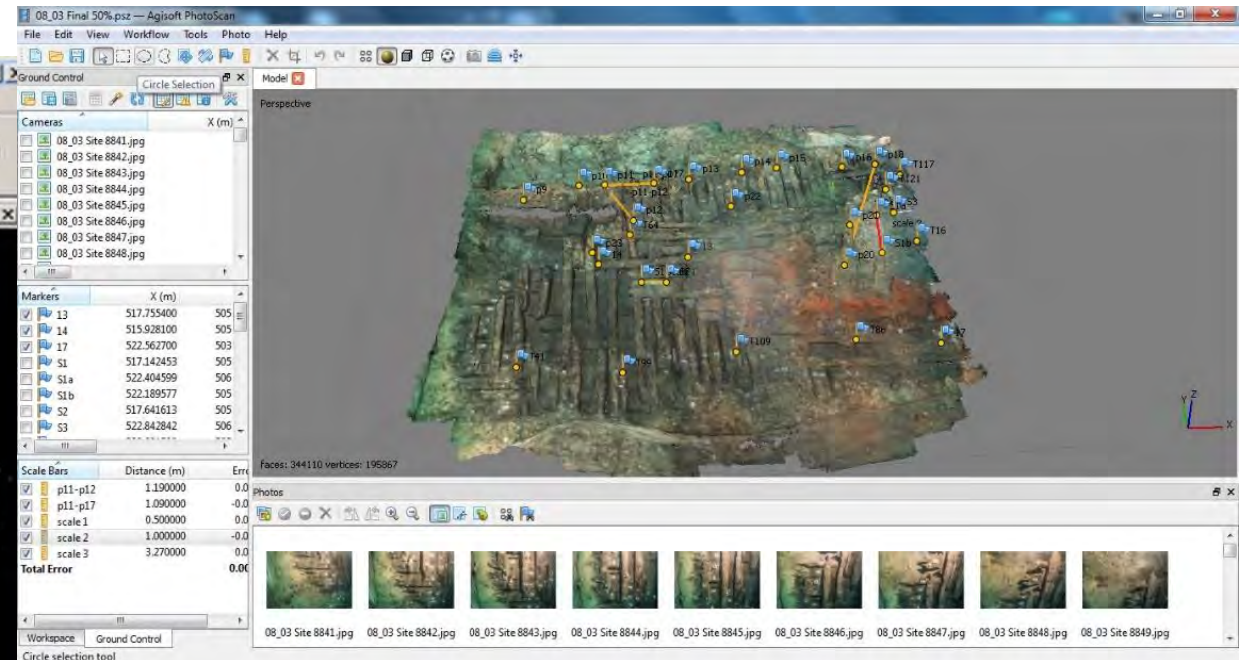
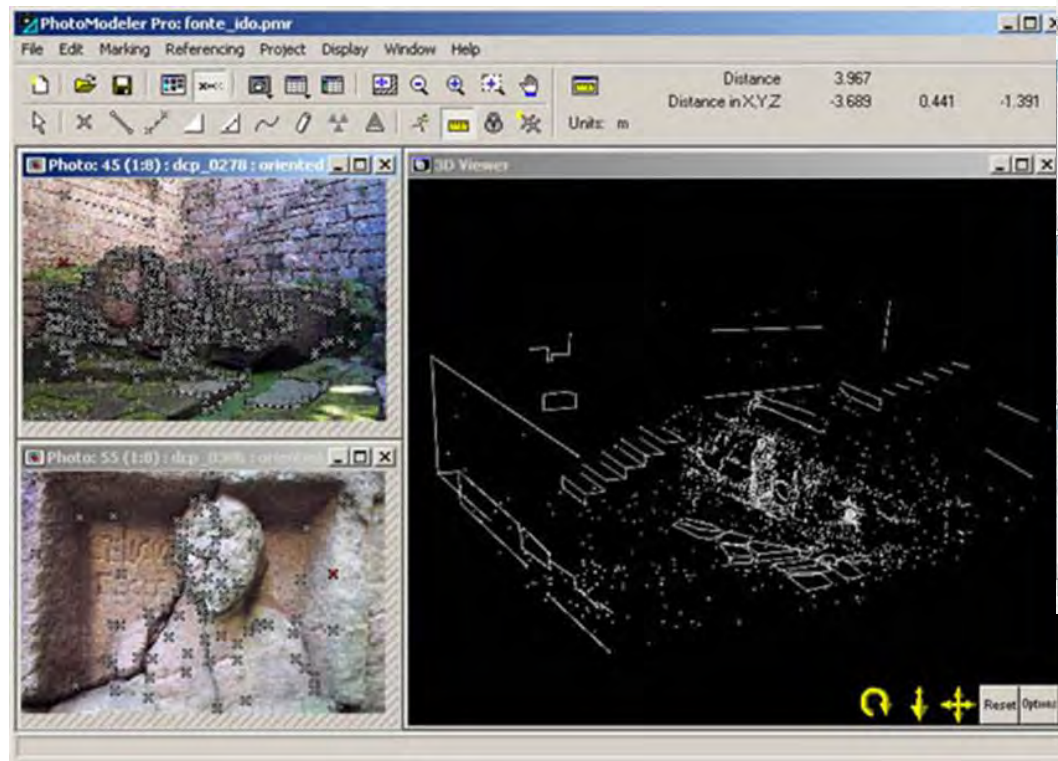
Marine robotics brought about the possibility of making images – photography or video – with remotely operated or autonomous vehicles.





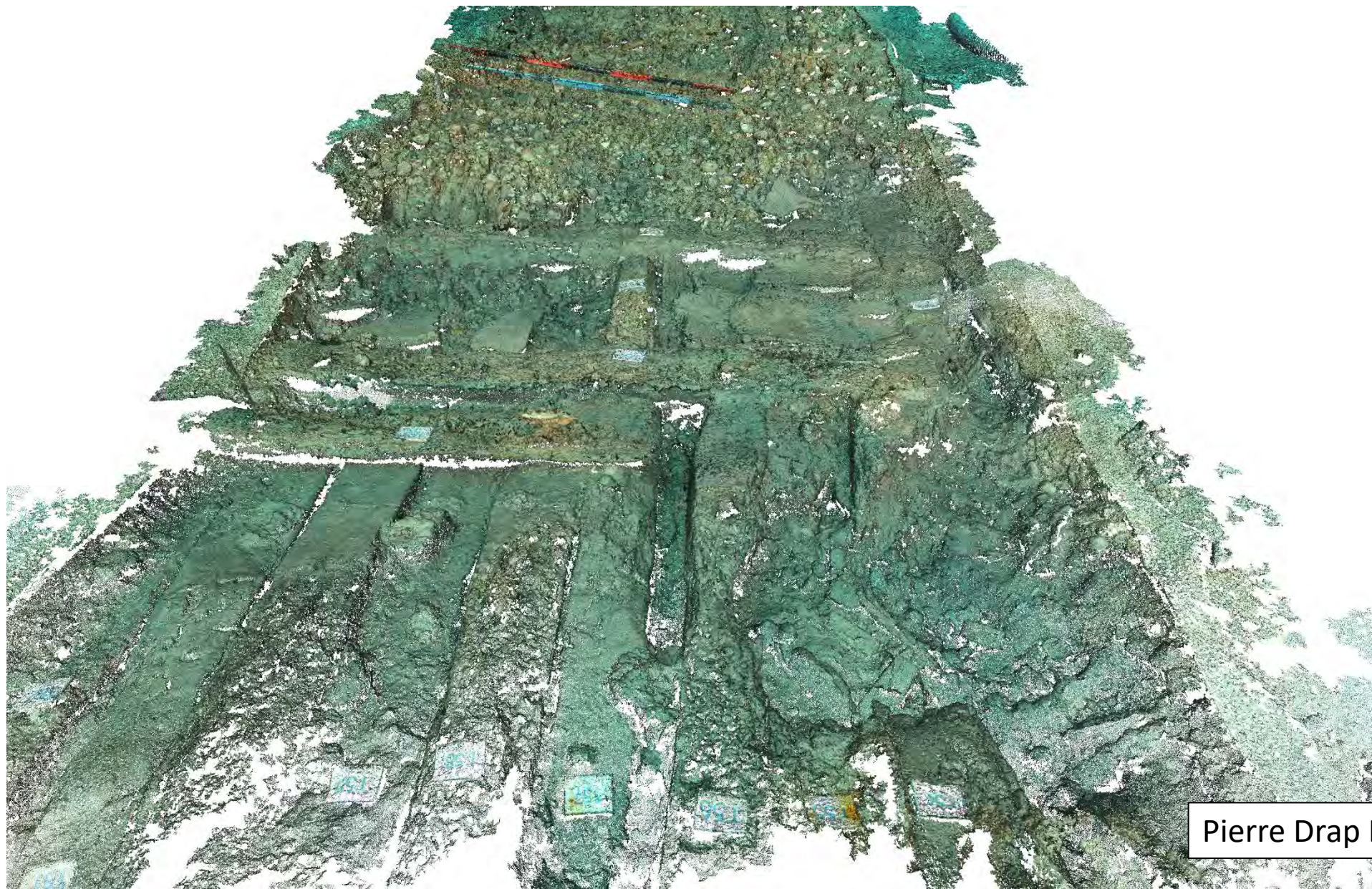
Photogrammetry software made it possible to transform large batches of pictures into tridimensional color meshes of points or into large orthogonal, scaled photos.

### PhotoModeler

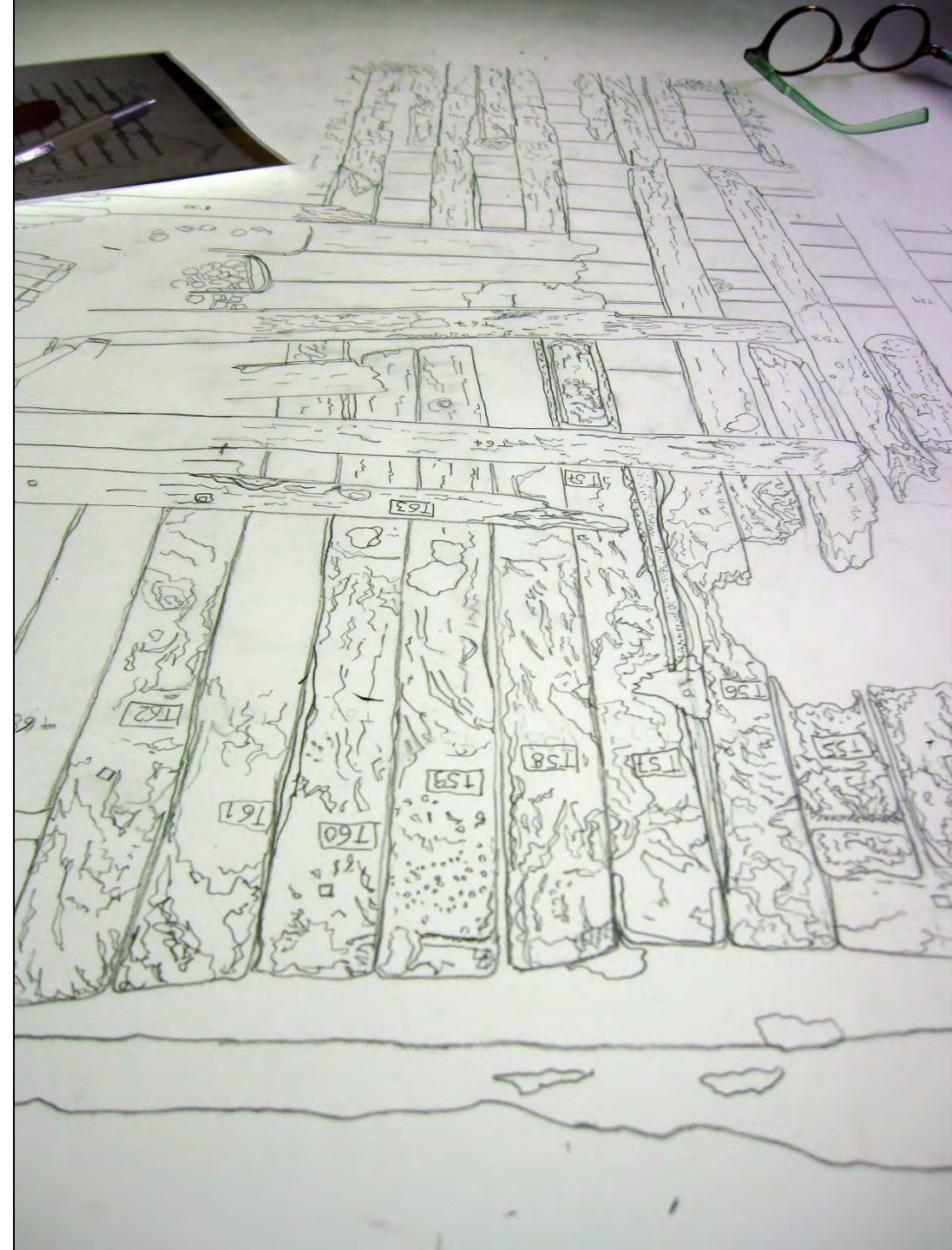


PhotoScan

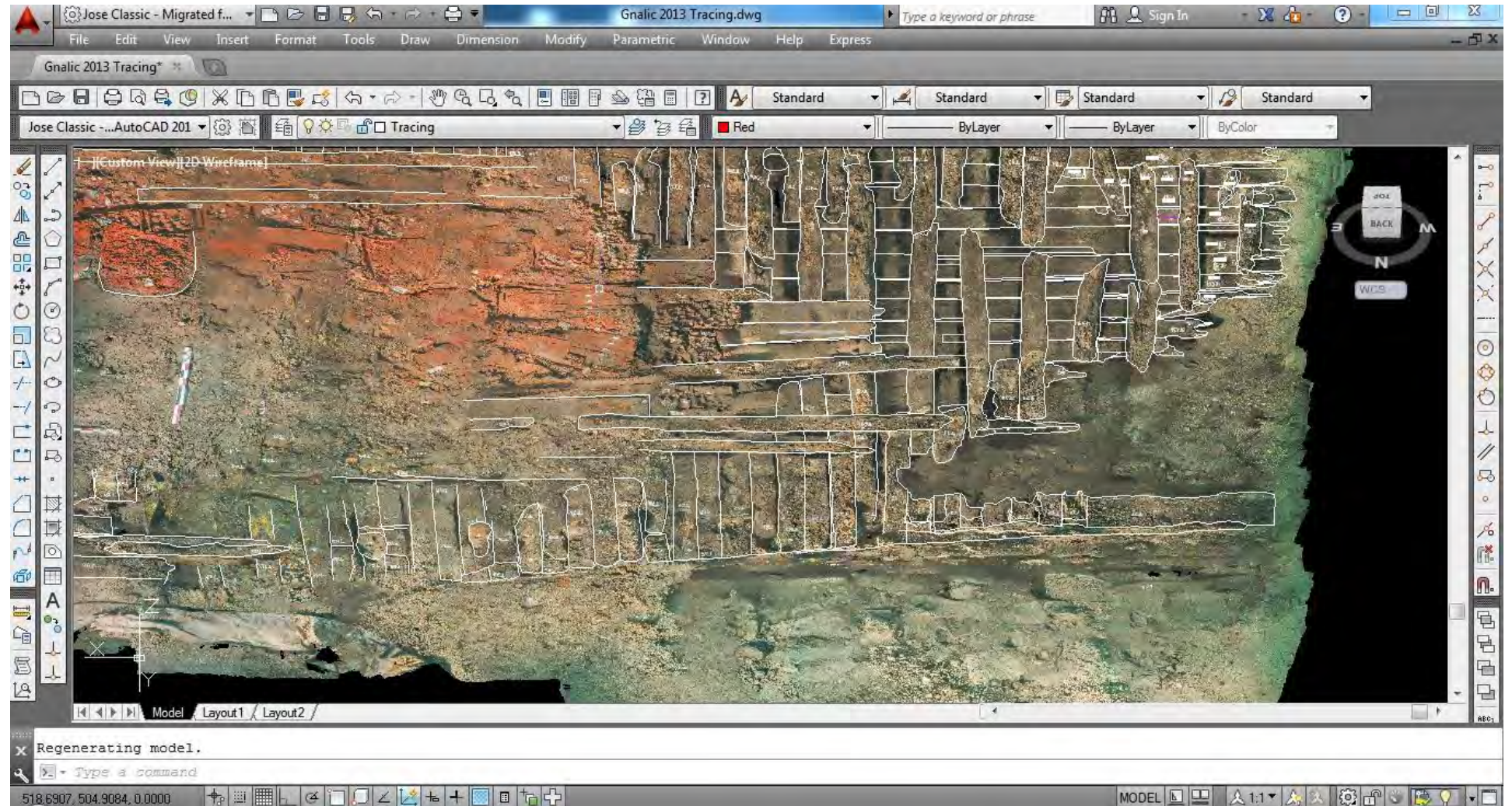
From scaled meshes of points, archaeologists make their site plans.



...sometimes by hand.

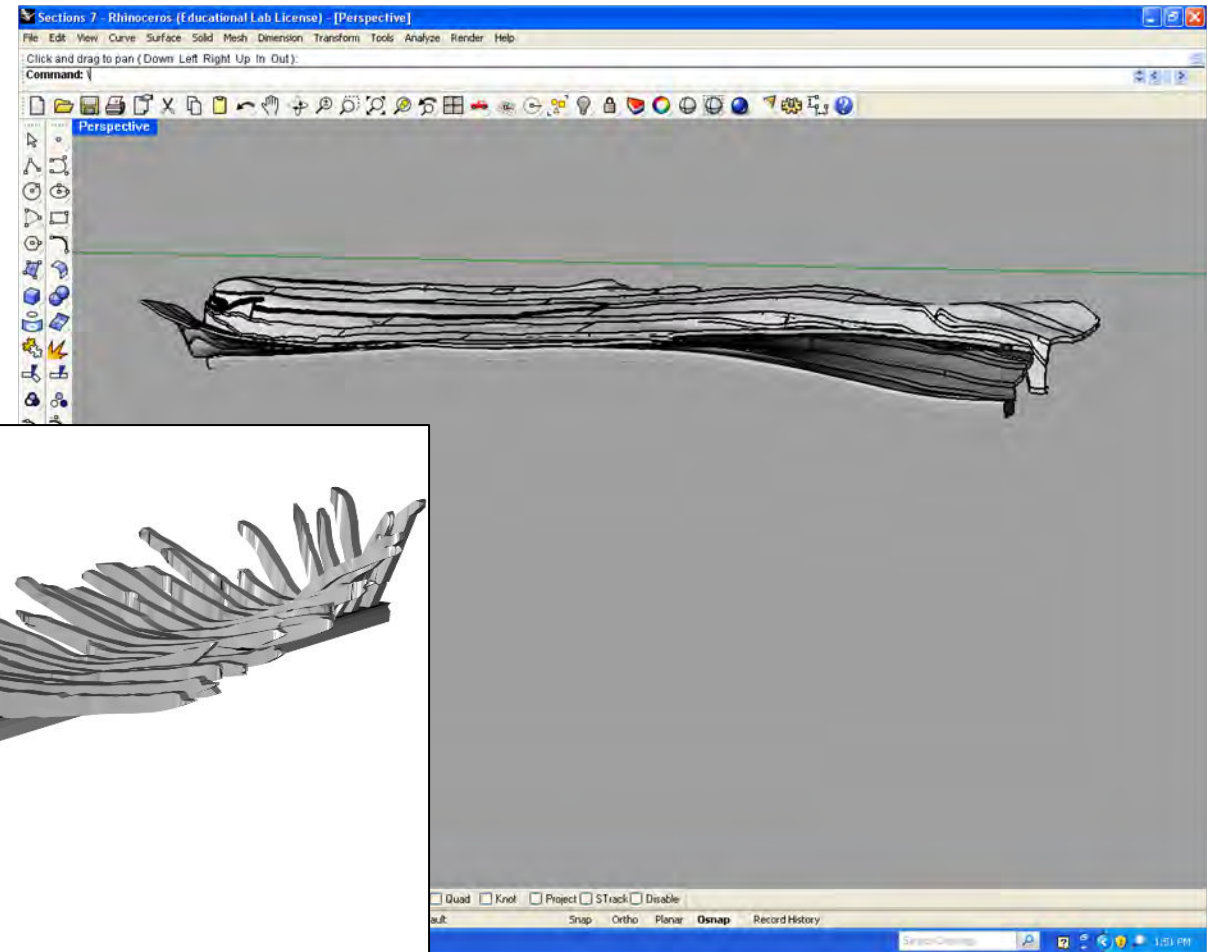
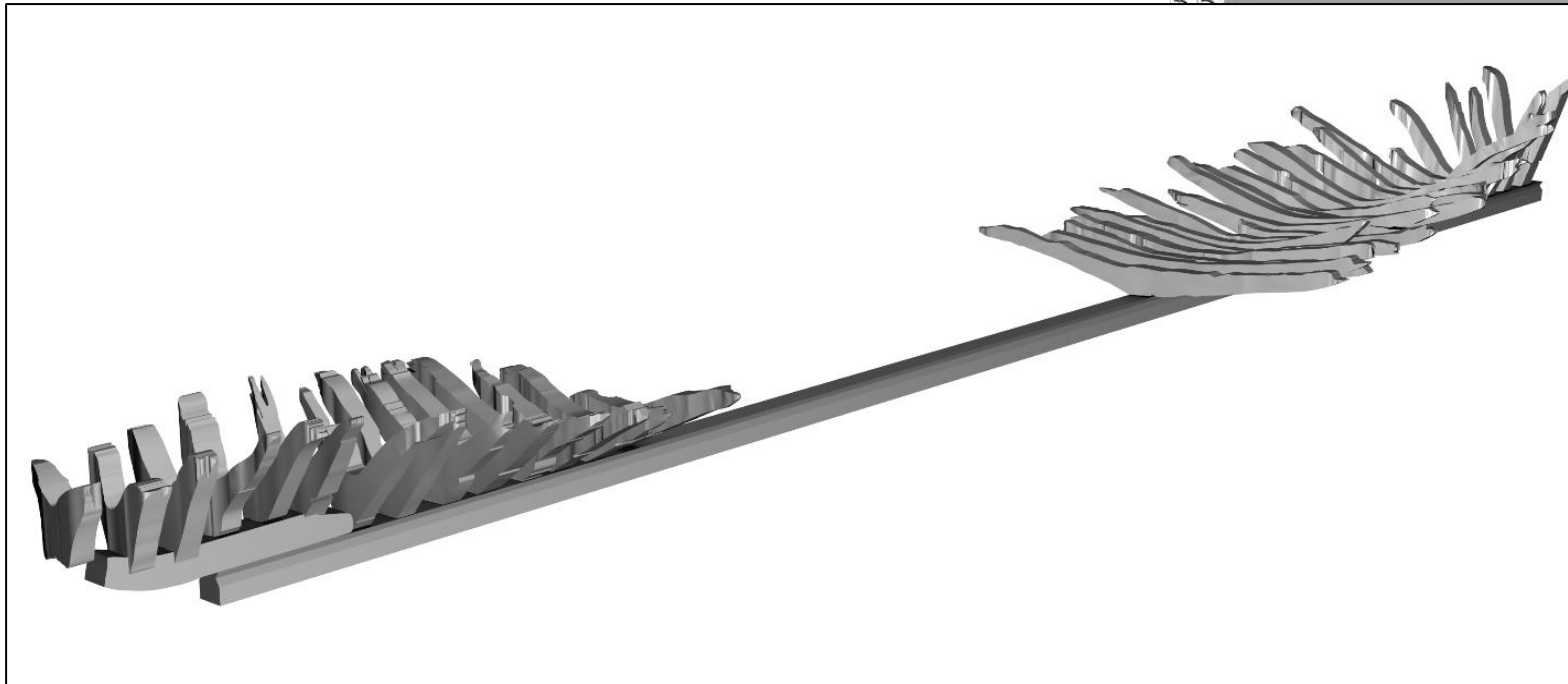


...sometimes using off the shelf drafting software, such as *AutoCAD* (2D), *Adobe Illustrator*, *Corel Draw*, or *Inkscape* (open source), more often using **GIS**.



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

Thomas Derryberry



Coral Eginton

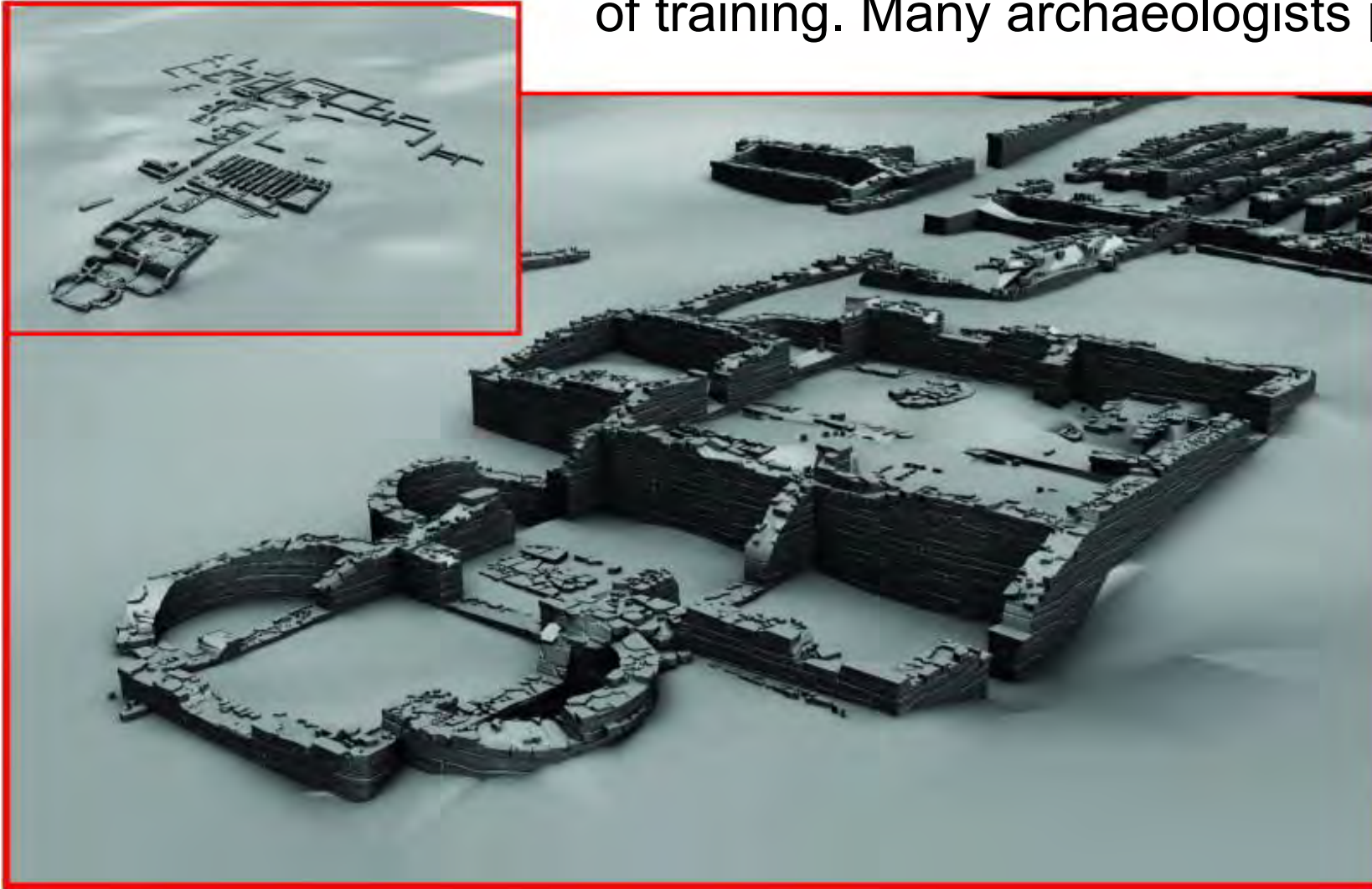


Again there are many software packages available, although the best require a level of mastery that is time consuming to acquire.

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



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



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



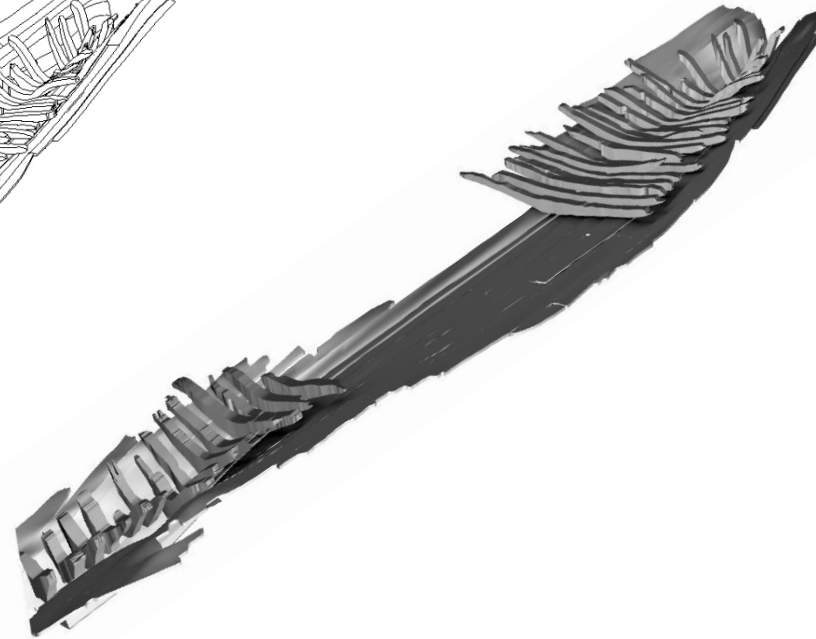
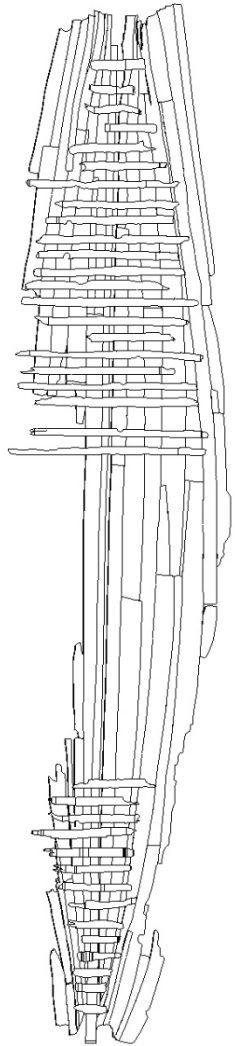
Recorded with FARO Arm,  
assembled in Rhinoceros, and  
printed.



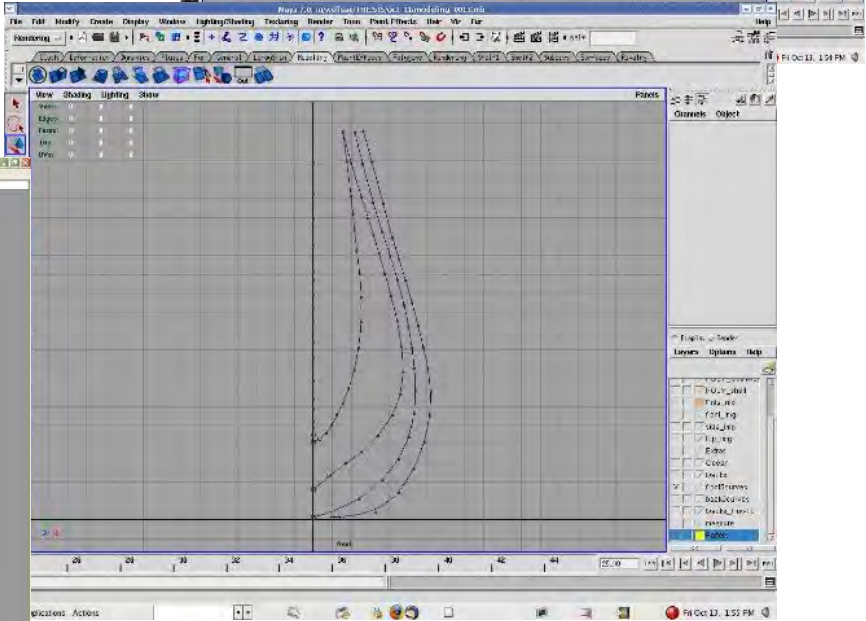
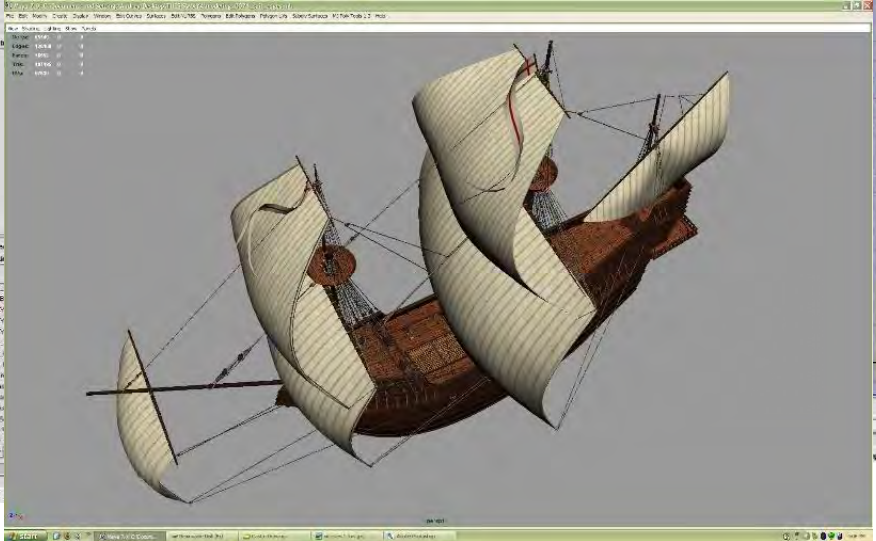
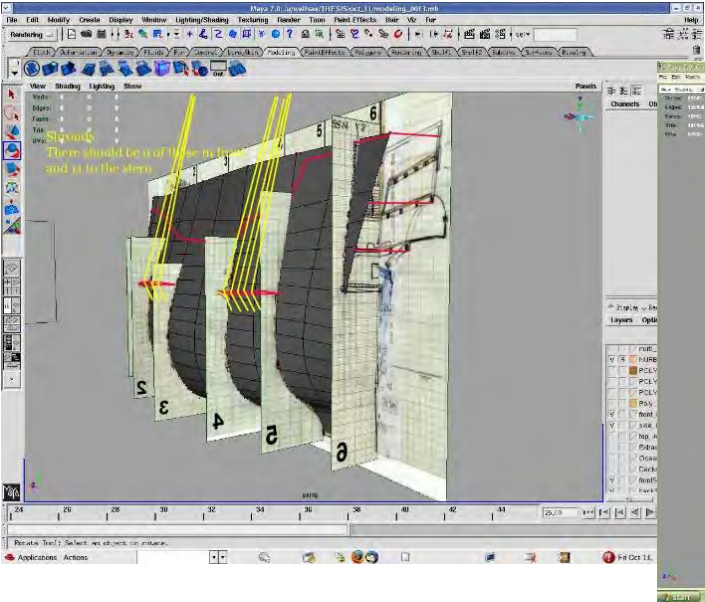
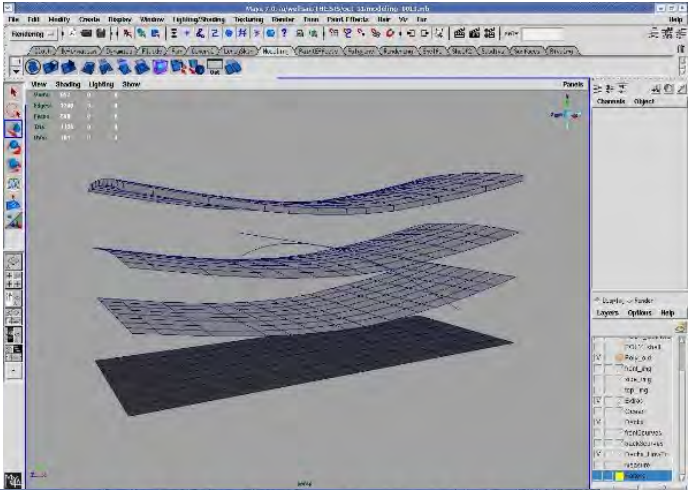
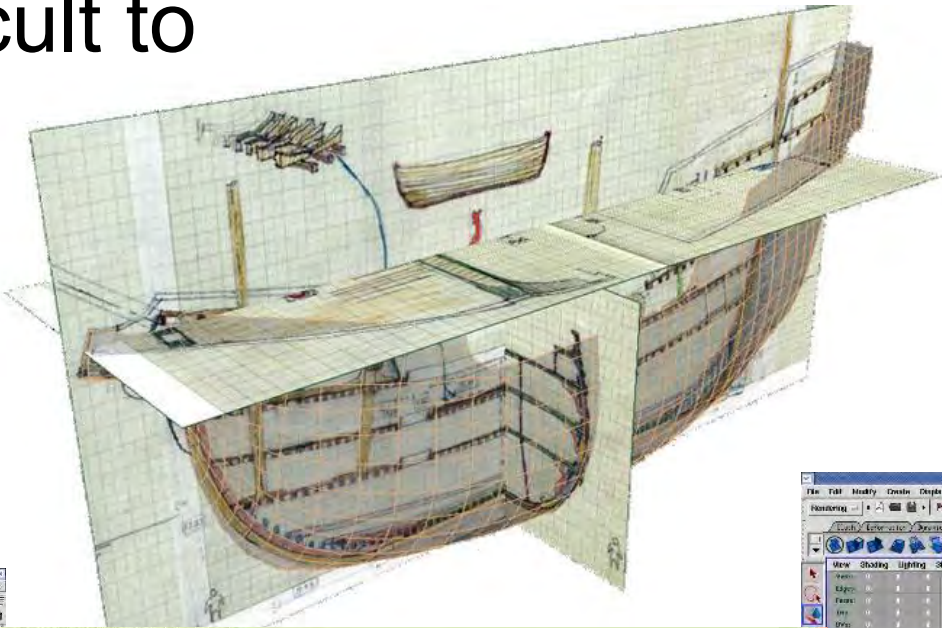
Toby Jones



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

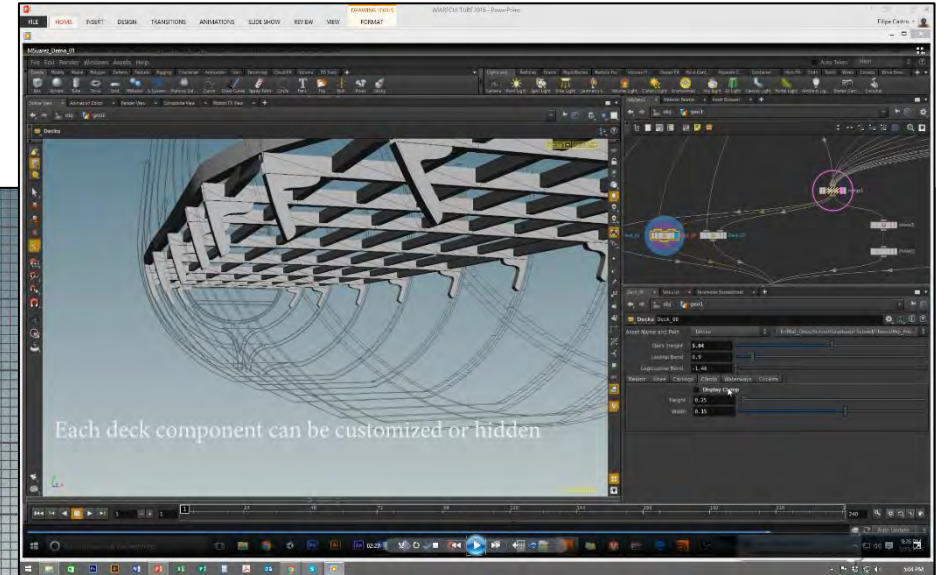
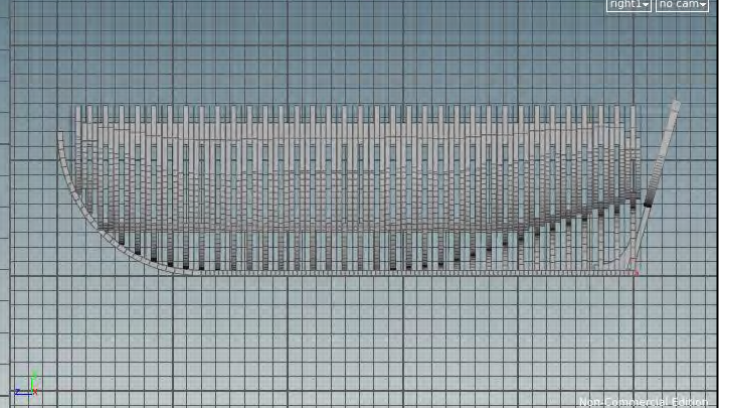
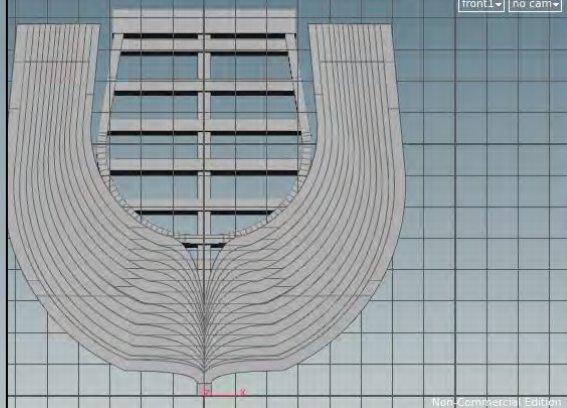
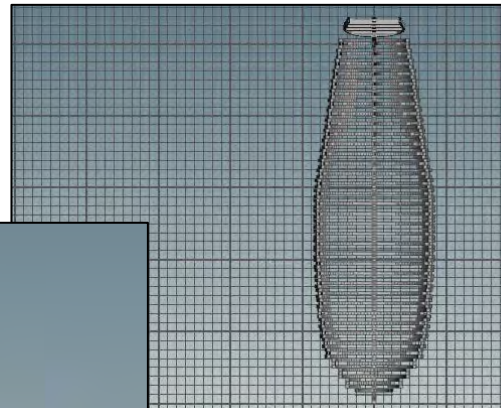
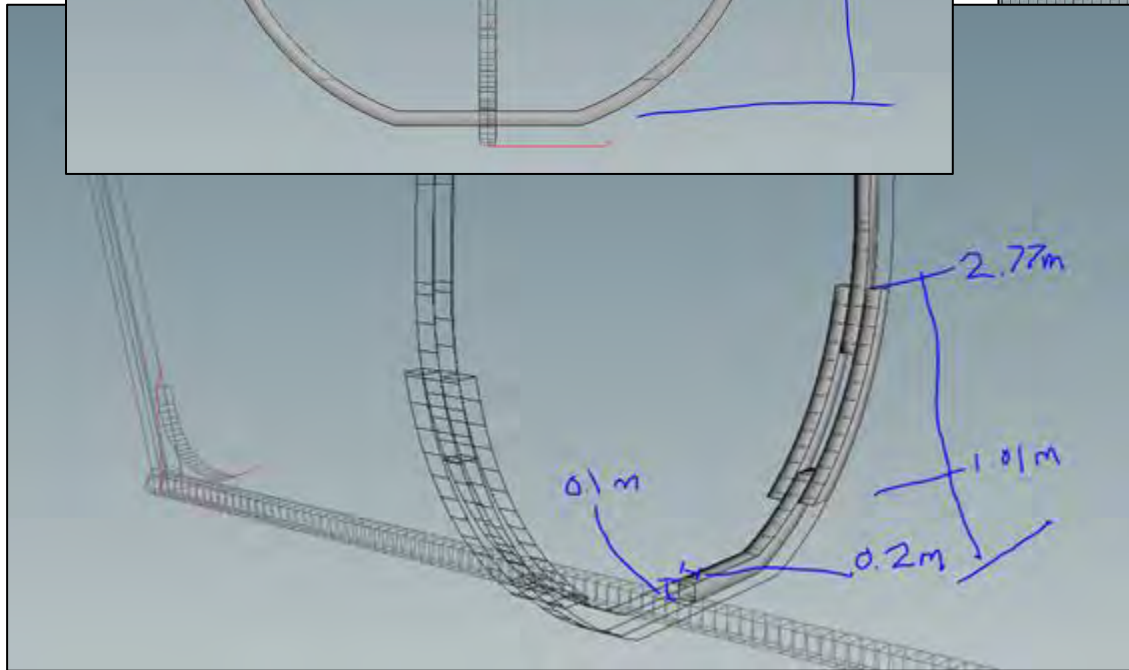
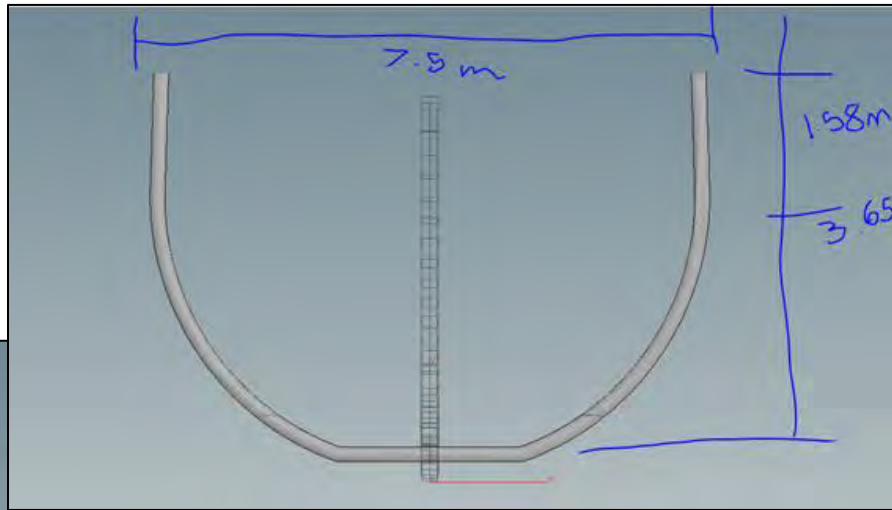


Autodesk Maya is a powerful software but difficult to master.



Audrey Wells

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



Matt Suarez  
*Andre Thoma's idea*

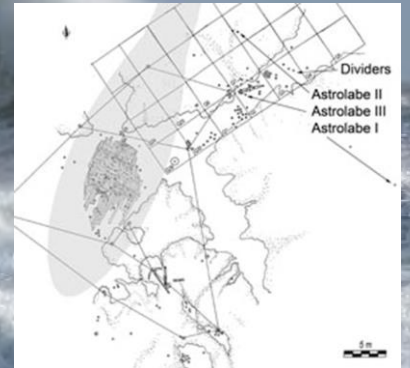
# 3

- 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.

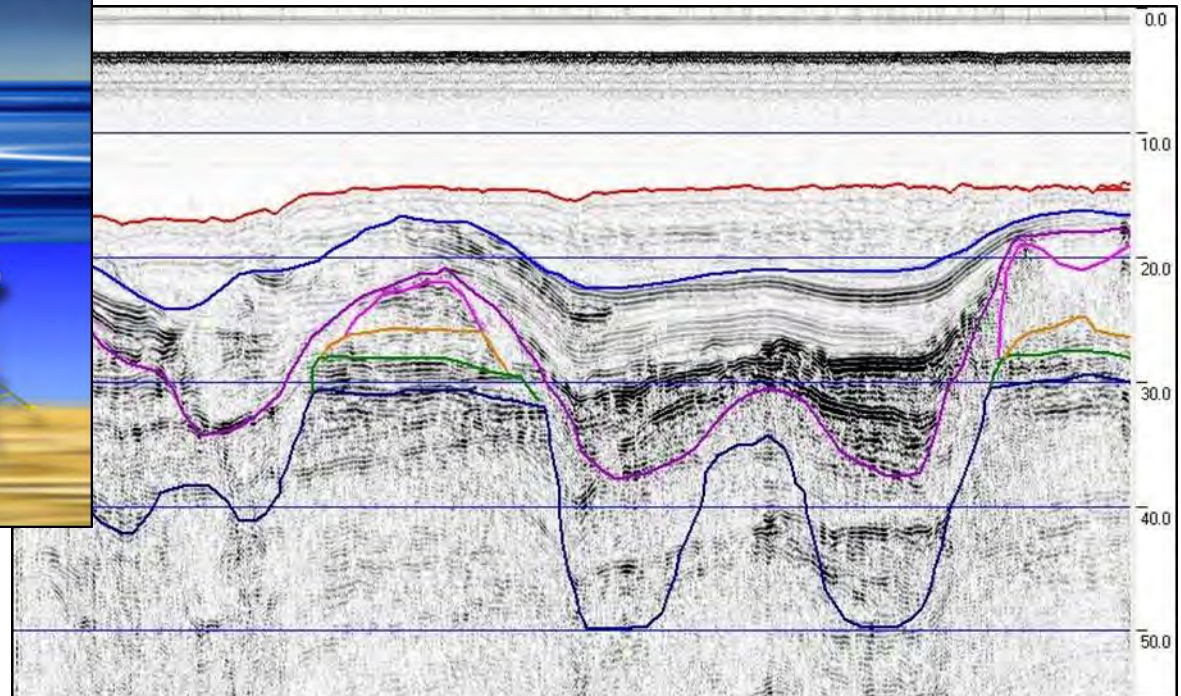
a. Finding the sites and limiting the area where cultural remains are spread



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;



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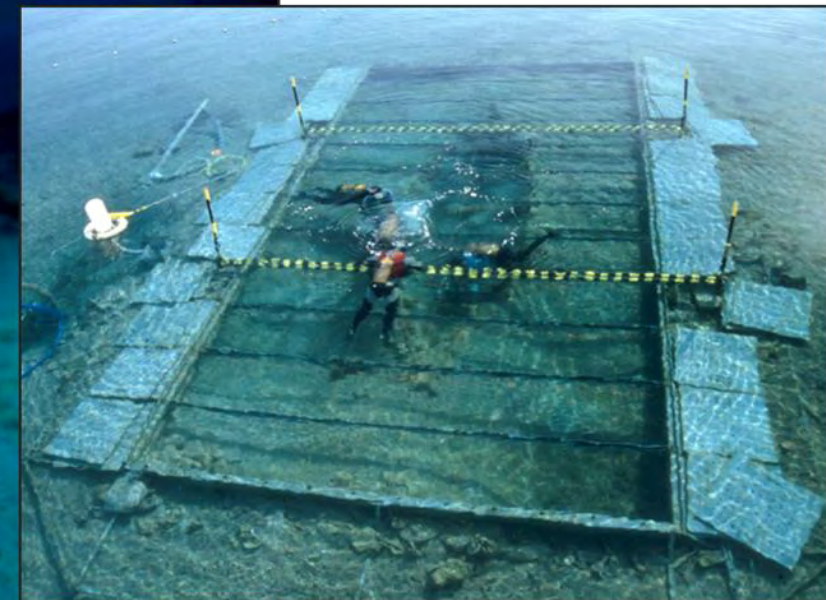
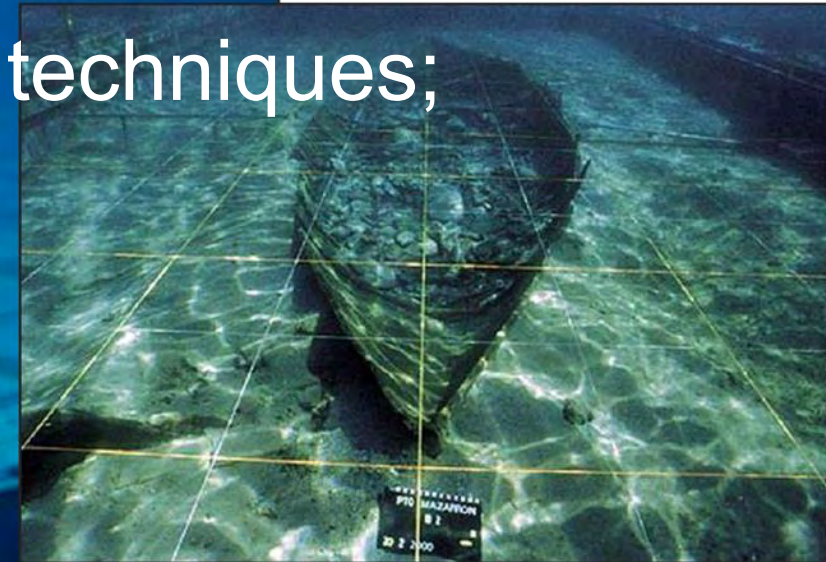
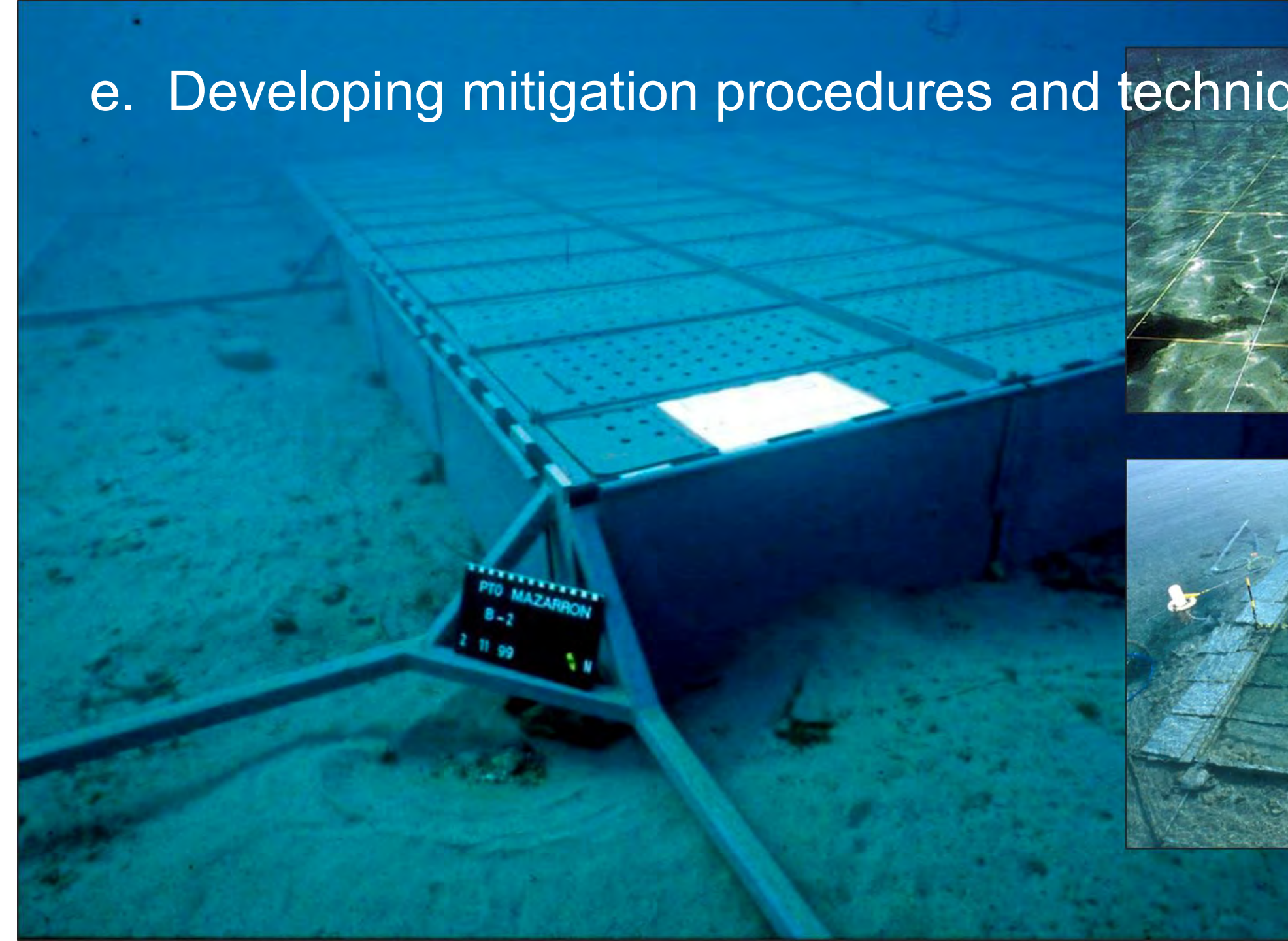


**Anthropic factors include looting, dredging, trawling, etc.**

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

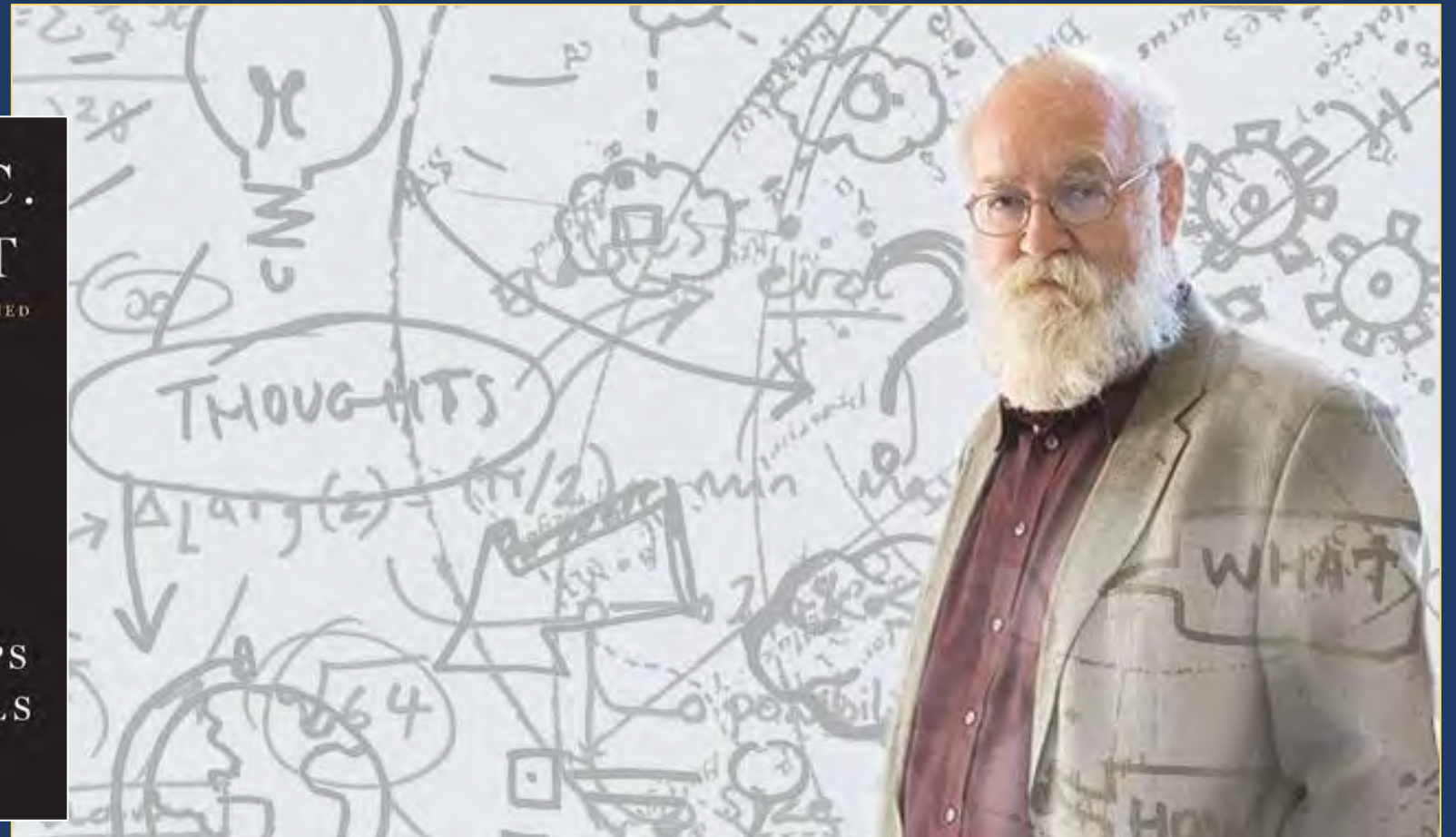
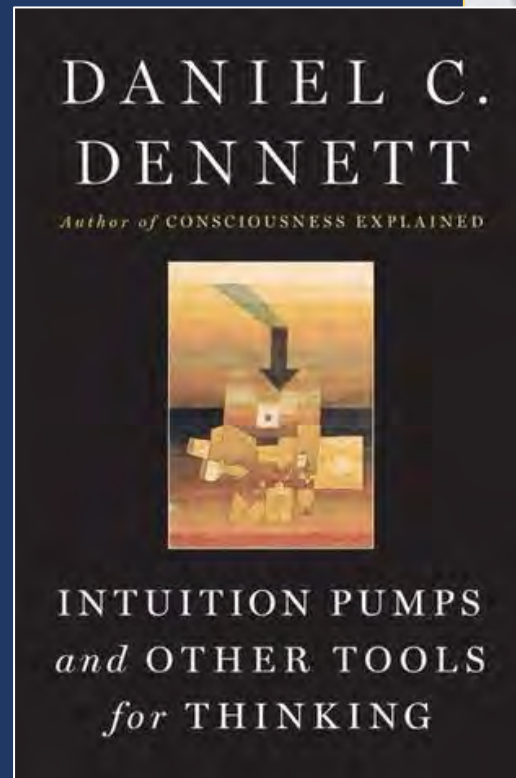
- Divulcation is undoubtedly the most important task.


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?



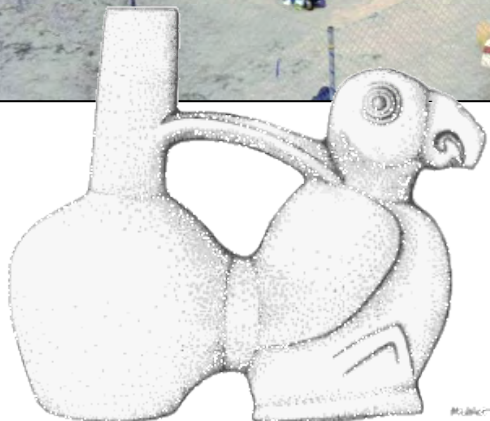
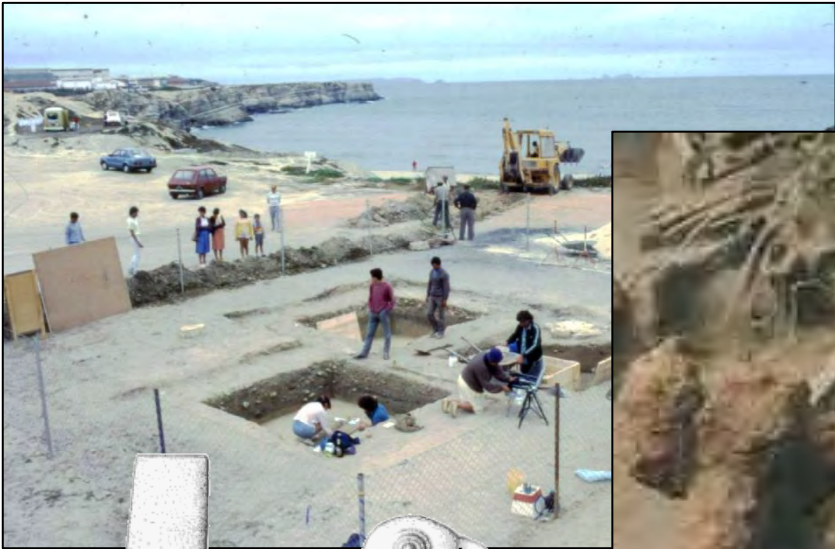
“...our past provides apps that we upload to our necktops.”

*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?

