



16th International Symposium on Boat & Ship Archaeology

– Zadar, Croatia

– 26 September – 1 October 2021

Sailing through History *Reading the Past – Imagining the Future*

BOOK OF ABSTRACTS

16th International Symposium on Boat & Ship Archaeology

Sailing through History

Reading the Past - Imagining the Future

BOOK OF ABSTRACTS

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Nautical archaeology is a multidisciplinary and interdisciplinary field of study which expands our understanding of the past through the historical interpretation of boat and ship remains. In recent decades the discipline has faced huge changes due to the development of new tools, particularly 3D technologies, which have had a strong impact on the procedures of documentation, interpretation and reconstruction. These more efficient and precise tools have been adapted for the study of boats and ships, and are now widely adopted into the community of nautical archaeologists. This technology has had important consequences on archaeological analyses, improving speed, precision, reliability, and cost effectiveness.

However, the central issue is to determine whether these new tools help us propose new research questions to obtain a better understanding of boats and ships, and ultimately decide whether they lead to more relevant historical interpretations. The main theme of ISBSA 16 is *Reading the Past - Imagining the Future*, and its core aim is to reflect on the results of traditional methods and tools while considering new possibilities provided through the implementation of modern computer technology. Also, as technology is adopted in nautical archaeology, we must consider which methodological standard procedures or analytical practices remain relevant in future excavations.

As in previous symposia, the endeavour is to interrogate the methods of the discipline, and to investigate the adoption of new technologies in the field of boat and ship archaeology. The question is how can we best adapt them to the requirements of historical questioning and the interpretation of ship and boat remains.

Entitled "Sailing through History", the 16th ISBSA intends also to continue the experiences gained during the previous editions, grouped under the following themes:

- Ship construction
- Recent discoveries
- Nautical ethnography
- Experimental nautical archaeology
- Research methods.

Within the topics listed above, we are also reconsidering the foundations of the methodological paradigms of nautical archaeology (documentation, analysis and interpretation), particularly with regard to dialogue with historical, iconographic and ethnographic sources.

PROGRAMME

Sunday, 26 September _____

Murter, Island of Murter

Lateen Sail Regatta (transfer from Zadar at 10:00)

Monday, 27 September _____

University of Zadar

- 8:00 – 11:00 — Registration of the participants
- 9:00 – 9:30 — **Welcome speeches**
- 9:30 – 10:30 — **Keynote talks**
- 10:30 – 11:00 — Coffee break
- 11:00 – 12:35 — **Session 1 – Main theme I (chair: Irena Radić Rossi)**
- Poster presentations
 - Pat Tanner, *The significance of archaeological source data*
 - Aoife Daly, Alicia Van Ham-Meert, Paloma Fernandez Diaz-Maroto, *New analytical methods for ship timber provenance analysis – win some, lose some*
 - Marta Domínguez-Delmás, Sara Rich, Nigel Nayling, *Dendroarchaeology of shipwrecks in the Iberian Peninsula: 10 years of research and advances*
 - Nigel Nayling, *Tradition and Revolution? A Personal Reflection*
 - Mateusz Polakowski, Pat Tanner, Giulia Boetto, Vincent Dumas, Pierre Poveda, Henri Bernard-Maugiron, Gilles Chauma, *Past and Present of the Marsala Punic Ship: From construction to exhibition*
- 12:35 – 14:30 — Lunch
- 14:00 – 16:00 — Registration of the participants
- 14:30 – 16:05 — **Session 2 – Main theme II (chair: André van Holk)**
- Poster presentations
 - Mauro Bondioli, Mariangela Nicolardi, Irena Radić Rossi, *Historical Written Sources on Shipbuilding and the Archaeological Study of a Mediterranean Post-Medieval Shipwreck: the Gagliana grossa case study*
 - Wouter Waldus, *17th century turf shipping in the Dutch Zuyderzee area: historical maritime archaeology*
 - Julie Satchell, *The potential of digitised historic archives for the interpretation of shipwrecks: Examining the Flower of Ugie, wrecked 1852*

- Andri Evripidou, Stella Demesticha, *Visualizing shipbuilding features through textual evidence: the case of the 19th century Aegean brigs*
- John McCarthy, *Ship Shapes: Digitising Historic Ship Models*

16:05 – 16:35 — Coffee break

16:35 – 18:05 — **Session 3 – Main theme III (chair: Pierre Poveda)**

- Poster presentations
- David Gal, Hadas Saaroni, Deborah Cvikel, *Method for mapping potential ancient sailing mobility: new meaning to the term ‘favourable winds’*
- Smiljko Rudan, Šimun Sviličić, Albert Zamarin, Davor Bolf, Irena Radić Rossi, *Numerical modelling of flooding of an ancient ship*
- Nathan Helfman, *The keelson: An engineering-archaeological analysis of a milestone in medieval maritime architecture*
- Mick de Ruyter, Enrique Aragon, John McCarthy, *Finding lost dhows in Qatar: Re-imaging the al Jassasiya petroglyphs*
- Fredrik Leijonhufvud, *Developing a craft perspective on the interpretation and reconstruction of boats*

19:30 — **Museum of Ancient Glass:**

Welcome Reception

Opening of the exhibition ***To sail is necessary; Eastern Adriatic Traditional Ships and Boats***, models by Luciano Keber

Guided visit to the Museum of Ancient Glass

Tuesday, 28 September —————

University of Zadar

8:00 – 11:00 — Registration of the participants

9:00 – 18:00 — **Online poster presentations in SpatialChat**

9:00 – 10:35 — **Session 4 – Ship construction I (chair: Beat Arnold)**

- Poster presentations
- Ekaterina Kashina, Aleksandr Shutikhun, Aleksandr Okorokov, Evgeniy Gak, *Visible and invisible water transport components of the East European Plain and the Trans-Urals in Prehistory*
- Timm Weski, *A Bronze Age Logboat from the Starnberger See near the Roseninsel, Bavaria, Germany*
- Terje Planke, Svein Erik Øya, *Reconstructing the pattern of Iron Age and vernacular boats*

- Stella Demesticha, Carlos de Juan, *The Mazotos Shipwreck: preliminary results of the hull investigation*
- 10:00 – 11:00 — **SpatialChat poster presentations**
- Implementation of modern computer technology in understanding ship's construction and performance
 - Photogrammetry and remote sensing: recording and presentation to public
- 10:35 – 11:05 — Coffee break
- 11:05 – 12:40 — **Session 5 – Ship construction II (chair: Giulia Boetto)**
- Poster presentations
 - Emmanuel Nantet, *The Caesarea Shipwreck: The Remains of a Large Early Imperial Ship in the Eastern Mediterranean*
 - Dušana Romanović, Katarina Batur, Irena Radić Rossi, Nikola Budimir, *Reinterpretation of the third sewn boat from the ancient port of Zaton in the vicinity of ancient Nin (Aenona), Croatia*
 - Massimo Capulli, *The columns shipwreck of Kamarina (II AD). New data from the Kaukana project (Sicily)*
 - Maayan Cohen, Deborah Cvikel, *New Insights into the Ma'agan Mikhael B Shipwreck, Israel*
- 12:40 – 14:30 — Lunch
- 14:00 – 16:00 — Registration of the participants
- 14:30 – 16:05 — **Session 6 – Ship construction III (chair: Jerzy Litwin)**
- Poster presentations
 - Jeroen Vermeersch, *Ships and shipping in medieval Flanders, the case of Hulst*
 - Staffan von Arbin, *A 13th-century shipwreck with 'cog' features, investigated off Skeppstad, western Sweden*
 - Morten Ravn, *A 14th-century Boat-Find from Vordingborg Castle, Denmark*
 - Niklas Eriksson, *The late medieval Bellevue Ship – new findings concerning the oldest wreck in Dalarö harbour, Stockholm Archipelago*
- 16:00 – 17:00 — **SpatialChat poster presentations**
- Audit research
 - Iconography, historical sources and material culture
- 16:05 – 16:35 — Coffee break
- 16:35 – 18:10 — **Session 7 – Ship construction IV (chair: Wouter Waldus)**
- Poster presentations
 - Mike Belasus, Jens Auer, Konstantinos Alexiou, *The Jasmund 7 'Mukran' wreck A mid-16th century carvel built ship off the Island of Rügen, North Germany*

- Thijs Coenen, Alice Overmeer, Heidi Vink, *An early lapstrake-and-carvel ship fragment from Terschelling, the Netherlands*
 - Sarah Fawsitt, Marja-Liisa Petrelius Grue, Hilde Vangstad, *Bispevika 8 - Homemade? An early 16th century carvel ship found in Oslo harbour*
 - Fred Hocker, *Taking a palace to sea: the great cabin on Vasa (1628)*
- 19:00 — **Guided visit to the Forum and the Archaeological Museum Zadar**
- 20:00 — Public talk at the University of Zadar:
Bridget Buxton, "Titanic in 2021"

Wednesday, 29 September

Trokut Center for Entrepreneurship and New Technologies

- 8:00 – 9:30 — Bus transfer from Zadar to Šibenik
- 10:00 – 11:25 — **Session 8 – Ship construction V (chair: Jens Auer)**
- Poster presentations
 - José L. Casabán, Irena Radić Rossi, *Recording, analysis, and interpretation of the hull remains of Santo Hieronimo (1576), a vessel from the merchant fleet of the Maritime Republic of Ragusa*
 - Kroum Batchvarov, *Ottoman ships of the Black Sea*
 - Dragomir Garbov, *A nearly intact bombarde from the Western Black Sea*
 - José Manuel Matés Luque, *Yesterday's watercraft, tomorrow's watercraft. Recording the 20th century timber watercraft abandoned on the riverbanks of the Basque intertidal estuaries*
- 11:25 – 11:55 — Coffe break
- 11:55 – 13:20 — **Session 9 – Inland navigation (chair: Eric Rieth)**
- Poster presentations
 - Wojciech Borkowski, Michal Grabowski, Waldemar Ossowski, *The Czarsk Ship Excavation of the large Vistula River vessel from Medieval Times*
 - Petr Sorokin, *Cargo ship from Lake Onega and the Late Medieval shipbuilding tradition in Northern Russia*
 - Tomasz Bednarz, *Shipwrecks of flat-bottom vessels used in local transport in the Gulf of Gdańsk from the 16th to the 19th century*
 - Robert Domzal, *Boats from the Silesian coal mine*
- 13:20 – 13:40 — **Presentation of sponsors Niteh Ltd. and Viakornel - 3Design and prototype development studio**

- 13:40 – 15:00 — Lunch
- 15:00 – 18:00 — **Visit to the St. James Cathedral, Šibenik City Museum and the fortresses**
- 18:30 – 20:00 — Bus transfer from Šibenik to Zadar

Thursday, 30 September ---

Croatian National Theatre Zadar

- 9:00 – 18:00 — **Online poster presentations in SpatialChat**
- 9:00 – 10:50 — **Session 10 – Recent discoveries I (chair: Mladen Pešić)**
- Poster presentations
 - Alberto Bravo-Morata Rodríguez, Timmy Gambin, *The Phoenician Shipwreck off Xlendi Bay, Gozo – initial observations, size and shipbuilding technologies used*
 - Franck Goddio, Alexander Belov, David Honoré, *Shipwreck 5 from Thonis-Heracleion, Egypt*
 - Igor Miholjek, Pavle Dugonjić, Giulia Boetto, Anton Divić, Vincent Dumas, Pierre Poveda, Ivan Vidulić, *The Late Hellenistic shipwreck from the Bay of Paržine, island of Ilovik (Kvarner, Croatia)*
 - Klaudia Bartolić Sirotić, Gaetano Benčić, Giulia Boetto, Anton Divić, Ida Koncani Uhač, Davor Munda, Marko Uhač, *A newly-discovered Roman sewn boat from Poreč, Istria (Croatia)*
 - Irena Radić Rossi, David G. Ruff, *Second scuttled ship of Trstenik, Kaštel Sućurac, Croatia: Preliminary report*
- 10:00 – 11:00 — **SpatialChat poster presentations**
- Ethnography: Shipyards, fishing villages & local community
 - Ethnography: Ships and logboats
- 10:50 – 11:20 — Coffee break
- 11:20 – 12:45 — **Session 11 – Recent discoveries II (chair: Carlo Beltrame)**
- Ilija Danković, Anton Divić, Goran Stojić, Ljubomir Jevtović, Mladen Jovičić, Bebina Milovanović, Snežana Nikolić, Nemanja Mrđić, Ivan Bogdanović, *A preliminary report on newly discovered fluvial vessels from Kostolac, Serbia*
 - Laurent Grimbert, Marc Guyon, *Villeneuve-d'Ornon (Gironde, France) - A shipwreck from the early Middle Ages*
 - Maili Roio, *The Peeter wreck as an example of exchange and interaction in the Middle Ages*

- Alessandro Ghidoni, *Metal fastenings in the western Indian Ocean during the medieval period: New data from the Islamic site of al-Balid (10th–16th centuries), Oman*

12:45 – 14:30 — Lunch

14:30 – 16:00 — **Session 12 – Recent discoveries III (chair: Katarina Batur)**

- José Bettencourt, Patrícia Carvalho, Mónica Ponce, Tiago Nunes, Gonçalo Lopes, Tiago Silva, Inês Amélia, *An extraordinary find? Boa Vista 5, a new early modern ship discovered in Lisbon waterfront (Portugal)*
- Daniel Peter Dalicsek, *The shipwrecks of Gothenburg: Nine wrecks from the Royal Mast Harbour*
- Jim Hansson, *A unique ship wreck found with a unique cargo-of osmund iron*
- Daniel Zwick, *An early 17th-century 'half-carvel' construction in the North Frisian Wadden Sea: The Japsand wreckage near Hallig Hooge, Germany*

16:00 – 17:00 — **SpatialChat poster presentations**

- Early modern period shipbuilding
- Recent discoveries in Croatia

16:00 – 16:30 — Coffee break

16:30 – 18:00 — **Session 13 – Recent discoveries / Reconstruction I (chair: José Bettencourt)**

- André van Holk, Alice Overmeer, *Waste disposal in the Netherlands as reflected in shipwrecks of the former Zuiderzee*
- Pierre Poveda, Giulia Boetto, Sergey Olkhovskiy, *The Late Hellenistic military ship of Phanagoria (Taman Peninsula, Black Sea): new data for the reconstruction of the ship*
- Elisa Costa, Carlo Beltrame, *Virtual reconstruction of the Roman Shipwreck Grado I from archive and legacy data*
- Anton Divić, Giulia Boetto, Kruno Zubčić, *Digital reconstruction hypothesis of the Roman-era fluvial barge from Kamensko, Croatia*

18:00 – 19:00 — **Next ISBSA Discussion**

20:30 — **Gala Dinner**

Friday, 1 October

Croatian National Theatre Zadar

9:00 – 10:30 — **Session 14 – Reconstruction II (chair: Pat Tunner)**

- Julian Whitewright, *The Sutton Hoo Ship Reconstruction: Recording the Reconstruction*
- Jens Auer, Massimiliano Ditta, *Visualising a “Big Ship”. The reconstruction of a 12th century cargo vessel found in the harbour of Wismar*
- Tori Falck, Sven Ahrens, Sarah Fawsitt, Terje Planke, Christian Rodum, Lars Stålegård, Hilde Vangstad, *Reconstructions. Between facts and choices. Methods and results viewed from the late 16th century Barcode 6 boat*
- Chiara Zazzaro, Agni Mochtar, Ahmad Ginanjar Purnawibawa, Shinatria Adhityatama, *Toward a Virtual Reconstruction of the Punjulharjo Boat in Rembang, Indonesia: 3D Photogrammetry and Analysis of the Hull*

10:30 – 11:00 — Coffee break

11:00 – 12:25 — **Session 15 – Iconography and Ethnography (chair: Julie Satchell)**

- Aleydis Van de Moortel, *The Adoption of the Sail in the Early Bronze Age Aegean (ca. 2500/2400 – 2200/2150 BCE) and its Impact on Later Minoan, Aeginetan, and Mycenaean Seafaring*
- Ita Praničević Borovac, *Ship Graffiti of the Eastern Adriatic Coast*
- Katarina Dellaporta, *Sailing through Lepanto’s history: Reading the Ships of the greatest naval battle of XVIth century in the Mediterranean from unknown Greek iconography*
- Ziad M. Morsy, Mai Ghanem, Sarah Wagdy, *Stuck on the Nile bank: preliminary results on recording and analysis of the last surviving traditional wooden fishing sailboat and its community*

12:25 – 14:30 — Lunch

14:30 – 16:00 — **Session 16 – Ethnography (chair: Nigel Nayling)**

- Lucy Blue, John P. Cooper, Alessandro Ghidoni, *Conceiving shell; conceiving frame: switching and blurring in the building of the ngwanda, Zanzibar, Tanzania*
- John P. Cooper, Alessandro Ghidoni, Chiara Zazzaro, Shadi Kalantar, *Contextualising the ‘baggāra/ameleh’, sewn fishing boat of the Persian Gulf coast, Iran*
- Joana Baço, Gonçalo Correia Lopes, *The dugout canoe from São Tomé and Príncipe. The results of an archaeo-anthropological mission*
- Brad Duncan, *Strange Craft in the Murray River - Characterizing the Archaeological Signatures of River Vessel in Australia’s Largest River System*

16:00 – 17:00 — **Closing Session**

18:30 — **Night in the port (carousel of Lateen sail rigged boats)**

Saturday, 2 October ---

- Sailing in front of Zadar in the Lateen sail rigged boats (optional)
- Post Conference Excursions (optional)

LIST OF POSTERS

(in alphabetical order of first author's surname)

Rita Auriemma, Alessio Calantropio, Filiberto Chiabrande, Luigi Coluccia, *Photogrammetric techniques for 3D underwater record of the Late-Imperial Torre Santa Sabina's shipwreck*

Manuel Berenguel, Emmanuel Nantet, *A Hellenistic Shipyard on the Telephos Frieze: A Representation of the Shipwright's Toolkit*

Hélène Botcazou, *Boats of Corsica: a study of several maritime Ex-Voto*

Geke Burger, Rik Lettany, *The Scheurak SO1 Shipwreck in the Maritime Cultural Landscape of the Early Modern Netherlands, 1550-1650*

Kostas Damianidis, Gelina Harlaftis, Spyros Vosinakis, Eleni Bintsi, Georgios Tzavaras, Vasiliki Nikolakopoulou, Nikolaos Politopoulos, Alexis Tourtas, *3D digital study of the historic ship-model "Aris" from the 19th century - VHSS*

Nesreen El-Galy, *Ancient Egyptian ship & boat models between theory & simulation*

Timmy Gambin, Alberto Bravo-Morata Rodríguez, *The remote sensing survey off Malta - approaches to the mapping of an island's territorial waters*

Déjla Garmi, Emmanuel Nantet, *The sails of the Lyon Mummy*

Aya Mohamed Helmy, *Shipyards in Egypt between antiquity, nowadays, and the future*

Anita Jelić, Mladen Pešić, *Condura Croatica - A Revision of the Structural Drawings*

Grgo Jerat, Smiljko Rudan, Albert Zamarin, Irena Radić Rossi, *Uncertainty in the reconstruction of the ancient ship hull and its impact on sailing characteristics*

Maja Kaleb, *Potkamenica Bay Shipwreck, Croatia*

Tea Katunarić Kirjakov, *Using 3D technology for documentation and interpretation of newly discovered shipwrecks and underwater sites near by islands of Šćedro and Hvar, Croatia*

Maria Ktori, *Paphos harbour and vernacular shipbuilding in Cyprus: proposing a new approach on examining its condition in the Middle Ages (12th-16th century)*

Paweł Litwinienko, *The digital reconstruction of the P3 wreck hull*

Yomna Mohamed Awad, *Fishing boat in El Max, Historical and Ethnographic study*

Constantinos Nicolaou, Stella Demesticha, Kostas Damianidis, Irene Katsouri, Massimiliano Secci, Georgios Tzavaras, Marina Faka, Dante Abate, *Documenting a 20th century wooden vessel at risk: the Agios Spyridon project*

Mariangela Nicolardi, Mauro Bondioli, Irena Radić Rossi, *The Contribution of Historical Sources in the Reconstruction of the Nin 1 Original Hull Form*

Andrea Podestà, Rita Auriemma, Fernando Zongolo, *The Galea Magna Shipwreck. Archaeological Evidences and Archival Sources of a Venetian War Galley of 1598*

Mario Radaljac, *St Nicholas' Bay on the Island Pag, Croatia*

Eric Rieth, Marine Sadania, Hervé Alfonsi, *The Sanguinaires C wreck, Corsica : an early 16th century clinker ship of Atlantic or Northern origin*

Janusz Różycki, *The P1 wreck – 40 years after the discovery*

Graham Scott, Robert MacKintosh, Paolo Croce, Toby Gane, Hefin Meara, *An ROV revolution? Using the new generation of low-cost battery powered ROVs for subsea archaeological work*

Lucy Semaan, Sergio el Kesrouwani, *The Modern Shipwrecks Project - Lebanon*

Stefanos Spanos, *Ship representations on Mycenaean pottery. The rare depiction of a shipwreck from Koukounaries on Paros*

Dino Taras, Ines Šelendić, *18th century wreck in the bay of St Nicholas, Island of Pag, Croatia*

Darina Tully, *Reed and Rush Bundle Rafts in Ireland – Ethnographic and Experimental Nautical Archaeology*

Marko Uhač, Ida Koncani Uhač, *Last Austro-Hungarian Navy Rettungskutter I Kl*

Sarah Wagdy, Ziad Morsy, Mai Ghanem, Yomna Mohamed Awad, *Traditional boats of the Egyptian coastal lakes (Manzala, Burullus and Edku) documental project (TBCL-EGY)*

Krzysztof Zamoscinski, *Expanded logboats in the world – the ethnological perspective*

PAPERS

The dugout canoe from São Tomé and Príncipe. The results of an archaeo-anthropological mission

The aim of the paper is to show the results of a research mission (in the scope of CONCHA* project) carried out in early 2020 before the global pandemic Covid-19. In a scenario far from our world, we went to collect the traces of wooden construction on the islands of São Tomé and Príncipe. A tradition to be ended either because the trees have retreated from the coast and it is increasingly difficult to find the right species, or because the youngest do not wish to learn this art, or even because fiberglass stands out as more durable, safe and stable material. The work carried out here deals with the study of Santomean canoes, seeking to document and understand their manufacturing process, from the cutting of the tree to its use over the water. It is, therefore, a work related to ethnography, maritime and nautical archaeology. This symbiosis resulted from the need to register traditions, lifestyles and vessels that are rapidly disappearing. It is in this context that this study appears: analytical and comparative of a forgotten island reality that struggles daily to survive and stay afloat.

* CONCHA Project, “The construction of early modern global Cities and oceanic networks in the Atlantic: An approach via Ocean’s Cultural Heritage”, <http://www.cham.fcsh.unl.pt/ext/concha/project.html>

**Klaudia Bartolić Sirotić¹, Gaetano Benčić¹, Giulia Boetto², Anton Divić²,
Ida Koncani Uhač³, Davor Munda¹ & Marko Uhač⁴**

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³ Archaeological Museum of Istria, Pula, Croatia

⁴ Ministry of Culture, Directorate for Protection of Cultural Heritage, Conservation Department in Pula, Pula, Croatia

A newly-discovered Roman sewn boat from Poreč, Istria (Croatia)

The paper will provide results of a preliminary study of a new Roman sewn boat discovered in March 2020 in Poreč (Istria, Croatia) during preventive archaeological works adjacent to the Porta da Mar, along the southern waterfront of the harbour of the Roman Parentium. Stones of different shape and size covered the shipwreck that lies at the base of a quay made of large worked stone blocks. Many fragments of ceramics and amphorae testify to the use of the port until late Antiquity, when other structures and a medieval tower were built on the quay. The shipwreck, preserved in a total length of 5.7 m, shares similar architectural characteristics with others sewn boats dated to the Roman Imperial Period found in Istria (Pula) and in Dalmatia (Caska and Zaton) and confirms the widespread use of the sewing technique in North-Eastern Adriatic shipbuilding.

The excavation and study were led by the Museum of the Poreč Territory in collaboration with the Centre Camille Jullian (Aix-Marseille University, CNRS), the Archaeological Museum of Istria and the Directorate for Protection of Cultural Heritage of Croatia.

Ottoman Ships of the Black Sea

Between 2015 and 2017 in the process of gathering data for reconstruction of the quaternary paleo-landscapes of the Bulgarian shelf, human response to Pleistocene and Holocene water level changes and to enhance the existing sea level curves for the Black Sea, the Black Sea Maritime Archaeological Project located more than 60 shipwrecks.

High-resolution video and photographic surveys were used to create three-dimensional scalable models of the vessels from which constructional and design details can be extracted. The time span of the finds is from the 5th century BCE to the 20th century CE, but the largest group of the shipwrecks dates to the Ottoman period and are likely of local, Black Sea origin. A total of 38 wrecks belong to this group and twenty-two of them are of sailing ships. The state of preservation varies among the wrecks. Some are fragmentary, some are too deeply covered by the sediment to extract sufficient information for analysis, but most are lying exposed and in fairly good state of preservation. A few of the ships still have masts standing, for others, the spars, though fallen, are easily identifiable and measurable. These wrecks present unique opportunity to study masting of Ottoman vessels with details of rigging that are quite different from Western traditions. Ships are single or two-masted and at least one appears to have been an armed vessel as testified by the presence of gunports.

The vessels exhibit characteristics that place them in a common building tradition, but within this tradition there are significant variations in detail of rigging, deck arrangement, decoration and proportions. This paper presents new shipbuilding information and discusses the common characteristics and variations within the hulls and rigging of Ottoman sailing ships in the Black Sea.

Shipwrecks of flat-bottom vessels used in local transport in the Gulf of Gdańsk from the 16th to the 19th century

Until now, in the Gulf of Gdańsk five shipwrecks of flat-bottom vessels have been discovered and archeologically examined. They were used to reload goods, transport the cargo between the ports within this area or operated as inland means of transport used for timber floating down the Vistula River. This paper aims at characterizing the structure of shipwrecks, their provenance, chronology, and functions.

The most interesting vessel among this group is the F53.15 shipwreck, identified as the remains of the 17th century reloading ship, discovered with its cargo of quern stones and lead ingots. The vessel of 80-last load capacity was made after 1632, of pine wood (planking) and oak wood (floor timbers) from within the Gdańsk Pomerania.

The paper will also refer to the F53.9 shipwreck, the remains of a flat-bottom vessel of inland ship structural features, possibly used to reload goods. The earliest date indicating the ship's construction is 1854. The wood used to build the ship comes from the centre or upper Vistula river basin.

Another vessel is the F53.12 shipwreck, the remains of the flat-bottom vessel made of pine and oak wood, operating as a reloading ship, or used in local freight shipping. The ship was built after 1869, of wood originating from the north-eastern part of Poland.

Next ship is the F32.9 shipwreck which constitutes the remains of a flat-bottom vessel used in local transport within the ports of the Gulf of Gdańsk. Most probably, the ship was built and used in the second half of the 18th century.

The last flat-bottom vessel is the F53.20 shipwreck with structural features indicating the remains of an inland ship built after 1547. The planking was V-shape chamfered for the sealing with moss. The sealing was tightened with wooden stripes, and these were fitted to the planking with iron clamps.

The *Jasmund 7 ‘Mukran’* wreck. A mid-16th century carvel built ship off the Island of Rügen, North Germany

The *Jasmund 7 “Mukran”* wreck is one of the earliest carvel built ships found in Germany. GDR navy divers discovered it in 1982. Since then a number of attempts were undertaken to document the ship’s remains in shallow water off the island of Rügen in the Baltic Sea (Springmann 1997/Förster 1999).

Ship’s weaponry found in the vicinity of the site and traces of fire within the remains may relate the wreck to a hostile encounter between a joined squadron of Danish vessels and ships from the Hanse town of Lübeck on one side and Swedish ships on the other in 1565 during the Nordic Seven Years’ War (1563-1570).

In a joint campaign of the State Archaeology Service of Mecklenburg – West Pomerania, the German Maritime Museum and the University of Southern Denmark’s Maritime Archaeology Program during the summers of 2016 and 2017 it was finally possible to carry out a detailed investigation and recording of the ship’s remains and artefacts recovered from the site in previous years. Further, an extensive dendrochronological analysis provided vital data for the interpretation of the construction.

The wreck represents an important source of information on the ways of adapting flush outer planking in North European shipbuilding.

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An extraordinary find? Boa Vista 5, a new early-modern ship discovered in Lisbon waterfront (Portugal)

Discovered in August 2020 and excavated until February 2021, Boa Vista 5 is the best-preserved ship ever found in the riverside area of Lisbon. The remains are 23 m long and 17 m in width, from the bow to the stern and from the keel to the level of a deck. The wreck was found in the limits of an anchorage used since Roman times, abandoned on the beach in the intertidal area, sometime in the last quarter of the 17th century. The location and the presence of coconuts between and under the ballast suggests an operational area in the Atlantic, probably on the Brazilian routes, being a rare example of a merchant ship of this period.

In this paper we intend to present the context, the documentation procedures and a first analysis of the ship's construction features. The vessel presents a composite keel, a frame-first construction with scarves between the floor timbers and the futtocks, carvel planking, and an unusual transversal ceiling covering the space between the keelson and the first stringer. The mast step is a unique timber, fixed to the keelson with scarves. The hold was arranged in compartments. The fasteners are all in iron.

Assuming the hypothesis that Boa Vista 5 was built in the Iberian Peninsula kingdoms, it is an important context for the review the available sources on later 17th century ship construction for the Atlantic.

Conceiving shell; conceiving frame: switching and blurring in the building of the *ngwanda*, Zanzibar, Tanzania

How do the academic notions such as frame- and shell-conceived construction play out in practice? How does a builder visualise, plan and execute the construction of a vessel? And how can this process inform our understanding of how hulls might be conceived and completed more generally?

This paper is the result of conversations with, and observations of, the builders of the carvel-built *ngwanda*, the most popular plank-based craft found today on Zanzibar and coastal Tanzanian generally. It focuses, conventionally, on aspects of the vessel's construction, from method and sequence to the materials and tools used. Equally conventionally, it documents examples of the type via construction drawings, naval-lines plans and 3D photogrammetry.

Less conventionally, the paper explores builders' approaches and rationales in establishing the overall shape of the *ngwanda*, as well as exploring the ongoing dialectic between shell and frame that results in the completed hull. The degree of agency expressed through the decisions made is also explored by examining variations within type that provide insights into the individual shipwrights' varying choices, even from build to build.

Finally, interviews with builders and fishermen provide further context to the *ngwanda*, which is used both as a fishing and leisure boat. The craft is a relatively recent innovation, and represents a prime example of how coastal communities adapt to newly available technologies.

The paper draws upon data collected primarily during fieldwork conducted in 2018 at Kinazini, a suburb of Stone Town, Zanzibar, supplemented by observations made during fieldwork conducted in 2019–20 at Bagamoyo, mainland Tanzania. It is part of a wider programme of documentation of watercraft heritage in Tanzania, a region where vernacular building is widespread, but where recording had previously been limited.

Historical Written Sources on Shipbuilding and the Archaeological Study of a Mediterranean Post-Medieval Shipwreck: the *Gagliana grossa* case study

During the excavation campaigns (2012-2020) conducted on the late 16th century shipwreck of *Gagliana grossa* (islet of Gnalić, Croatia), the problems relating to the documentation, interpretation and graphical representation of the hull structural elements were addressed. Being a Renaissance wreck of Venetian origin, it seemed appropriate to combine the archaeological data with iconography, archival documents, and contemporary written sources on shipbuilding. The research aimed at understanding the construction techniques, historically contextualizing the architectural design, filling the gaps in the archaeological remains, and, finally, moving towards the reconstruction of the original hull shape. This type of approach has become common in the archaeological studies on medieval and post-medieval shipwrecks of Mediterranean and non-Mediterranean origin. It will certainly evolve in the future, especially in conjunction with the development of 3D graphic technologies. Modern virtual tools help the archaeologist to make the reconstructive hypotheses more attractive, realistic, and credible, but, at the same time, blur ‘the line between fact and fiction.’ The tendency to apply written sources on shipbuilding in archaeological contexts has not yet developed a shared methodology and still requires theoretical assessment, as today archaeological paradigms are still in force. In fact, justifiable doubts about the use of historical sources on shipbuilding in archaeological reconstructive hypotheses were raised in 1976, at the first Symposium held in Greenwich on *Sources and Techniques in Boat Archaeology*. Furthermore, part of the scientific community remains sceptical about the legitimacy of recovering the conceptual processes underlying the ship’s design as reconstructed from the archaeological evidence, a kind of psycho-archaeological approach that would perhaps best belong to cognitive archaeology. With regard to these issues, in the framework of the NEREAS Project (IP 2020-02-3420), this paper aims to illustrate the results achieved by the team of experts collaborating in the research of the shipwreck of *Gagliana grossa*.

The Czersk Ship. Excavation of the large Vistula River vessel from Medieval Times

During the summer of 2018, remains of a wooden shipwreck were excavated and recovered from an old river bed in Czersk (Masovian Voivodeship, Poland). The recovered wreck is one of the largest and best-preserved examples of sailing vessels, used on Vistula River for grain shipping, in a pre-industrial era. The story of the wreck has started almost 30 years ago. During the deepening of a small pond, located a few kilometres from Vistula River's bed, the local workers accidentally began to recover old, oak timbers. The recovered elements, including part of the stempost, were finally reported to the authorities, which led to the first archaeological excavations in 2009. Drainage of the pond revealed almost 30 m long wreck of a flat-bottomed barge. The vessel was in a good condition, preserved on its port side up to the gunwale and with almost intact stern section.

At that time, the recovery was limited by a lack of appropriate conservation facility. None of the existing facilities in Poland was able to proceed conservation of such long shipwreck timbers. In 2018, by the efforts of State Archaeological Museum in Warsaw, in cooperation with University of Gdansk and Archcom Company, the wreck of Czersk Ship could have been raised and properly maintained with the aim for its further exhibition.

This presentation shows the results of an archaeological campaign conducted in 2018 – 2019 when the wreck was fully recovered and documented. With the use of three-dimensional recording methods, including photogrammetry and structural light scanning, elements of the Czersk Ship could have been examined in the highest level of details and resulted in better understanding of its construction as well as shipbuilding techniques used in old times on Vistula river.

The Phoenician Shipwreck off Xlendi Bay, Gozo - initial observations, size and shipbuilding technologies used

In 2007, during an offshore remote sensing survey aimed at mapping Malta's Underwater Cultural Heritage, a small anomaly was noted in the sonar data. Since then, a team led by the University of Malta has been studying what turned out to be an extremely important discovery.

Found at a depth of 110 m off Xlendi Bay in Gozo (Malta), the Phoenician shipwreck consists of an intact and well-preserved mixed cargo of amphorae & stone grinding stones datable to the 7th century BC. The cargo is shedding new light on the economic history and trade networks of the Central Mediterranean during the Archaic period. In addition to the archaeological benefits - including the study of hitherto unknown ceramic typologies - a wide variety of scientific tests done in the post excavation phases are being conducted. This shipwreck presents other challenges and opportunities regarding methodologies and accessibility.

This paper focuses on a particular aspect of the site - the ship itself. Using the limited evidence available so far, we will present aspects related to the ship's size, the wood used for its construction as well as construction techniques. The authors will also present avenues for future research and the potential impact of this on a better understanding of Phoenician ships and shipbuilding.

The columns Shipwreck of Kamarina (II AD). New data from the Kaukana project (Sicily)

Known to the authorities since 1973, the Columns Shipwreck (175-200 AD) has been the subject of a series of surveys in the 1970s. Excavation campaigns, however, only took place a few years later, in particular in 1989 and 1996, which allowed the excavation of almost the entire site.

The ship carried two monolithic columns, semi-processed and just over 6 m long, made of Numid yellow marble. Other goods added to this main cargo, namely blocks of grey marble and compact sandstone, as well as African amphorae.

The research carried out during the last two years (2019-2020) has made it possible to extend the excavation and to follow the eastern side well beyond the limits assumed. Upper sections of the frames were identified and documented. In addition, the entire hull was documented again, also using the new techniques available (Structure from motion).

The hull, preserved for about 15 m in length, was built according to the “shell first” system, where the planks are firmly connected in this case by a double order of mortise and tenons, arranged in a staggered manner on two parallel rows, in such a way that the joint does not present a solution of continuity.

This research is part of the Kaukana Project that was born from the partnership between the Department of Humanities and Cultural Heritage of the University of Udine and the Sea Superintendence of the Sicily Region, with the support of Institute of Nautical Archaeology. It aimed at the diachronic reconstruction of the submerged and coastal landscape of the Ragusa province (Sicily).

The paper will present the new data of the columns shipwreck and its relationship with Kamarina colony in the context of maritime trade.

Recording, analysis, and interpretation of the hull remains of *Santo Hieronimo* (1576), a vessel from the merchant fleet of the Maritime Republic of Ragusa

Following the discovery of the remains of *Santo Hieronimo* in the early 1970s near the Island of Šipan (Croatia), the Maritime Museum of Dubrovnik carried out the rescue excavation of the wreck under the direction of Anica Kisić. The pioneering work initiated by the Maritime Museum of Dubrovnik led to the preliminary interpretation of hull remains and recovered artefacts. Ten years later, the research conducted at the National Archive of Dubrovnik resulted in the identification of the wreck. The archaeological study of the remains of *Santo Hieronimo* continued in 2014, with a series of systematic surveys and excavation campaigns, carried out as part of the Archaeology of Adriatic Shipbuilding and Seafaring Project (AdriaS). The aim of the project was the interdisciplinary study and interpretation of the archaeological and historical record of shipbuilding and seafaring in the Eastern Adriatic.

This paper presents the latest results of the archaeological excavation, recording, and interpretation of the hull features, dimensions, and assembly of *Santo Hieronimo* to understand the design and construction of the post-medieval vessels that sailed the Adriatic Sea. In addition, this study aims to identify design and technological transfers between Adriatic, Mediterranean, and Atlantic shipbuilding traditions through the comparative analysis of the archaeological remains of *Santo Hieronimo* and contemporary 16th-century vessels. Finally, the paper also provides an evaluation of the digital techniques, especially underwater photogrammetry, applied to the recording and interpretation of the hull remains of *Santo Hieronimo* since 2014.

New Insights into the Ma'agan Mikhael B Shipwreck, Israel

The Ma'agan Mikhael B shipwreck found off the Mediterranean coast of Israel and dated to the mid-7th–mid-8th centuries CE, has so far been excavated for six seasons, from 2016 to 2019, by the Leon Recanati Institute for Maritime Studies at the University of Haifa.

Its remains are 19.6 m long from bow to stern, and its maximum width is 4.9 m. Among the well-preserved wooden hull components found to date are the keel, endposts, aprons, sternson, framing timbers, hull planks, central longitudinal timbers, stringers, bulkheads and a mast-step assembly. The ship was built to a high standard, as shown by the expertise evident in design, selection of wood species, construction and details of the carpentry. This is confirmed by the remains of the sail, which is made of high-quality sheep's wool.

The most significant find is a hook-shaped masthead with sheaves, which is characteristic of lateen-rigged vessels. It is unique, being the only known example of this type of fitting of its period found in context. The organic finds and fired clay bricks found on board reveal a sailing route that included Egypt, Israel, Turkey and Cyprus.

It appears that the Ma'agan Mikhael B was a 23 m-long lateen-rigged merchantman, with a beam of 6.9 m and a displacement of 120 tons at a draught of 1.7 m. Based on its construction details – no planking edge-fasteners of any type, and planks butt-jointed at frame stations to form strakes – it is suggested that the ship was built to a 'frame-based' concept. The hull remains constitute firm evidence that the transition in ship construction was complete in the eastern Mediterranean in the second half of the 1st millennium CE.

An early lapstrake-and-carvel ship fragment from Terschelling, the Netherlands

During a long, stormy night on February 12th, 2020, a large ship fragment appeared on the North Sea shore of the Dutch island of Terschelling. The morning after, locals found the shipwreck, and pulled it apart with their four-wheel drives. The remaining parts were documented by the authors through drawing and photogrammetry. The timbers turned out to have belonged to an interesting ship, of which the hull was partly clinker-built and partly carvel-built.

The fragment measured 9 m in length and 4 m in height. It consisted of nine strakes and twenty futtocks. The six lower strakes were lapstrake laid and interconnected with rivets as well as small wooden treenails. The three upmost strakes were flush laid. During the assemblage, the latter had been temporarily fastened by clamps, which were removed when the frames were inserted. The remaining nail holes were filled with square wooden plugs, so-called *spijkerpennen*. The ship was thus built entirely shell-first.

The combination of a lapstrake hull in the underwater ship and flush strakes above the waterline had not yet been found in the Netherlands before. A few examples are known from Germany and Scandinavia. The term 'half-carvel' is often used for ships built in this way, but it is not sure whether this was a common term at the time and should therefore be used with caution.

The Terschelling shipwreck was dated AD 1546 (springtime), and is the earliest example of this building method in Europe. Thus this interesting ship part originates from a period of change, in which transition from clinker to carvel hull construction took place. This paper will present the latest results of the research. The wreck will be compared to similar finds from Northwest Europe, in order to place it in a wider context of European shipbuilding traditions.

Contextualising the *baggāra/ameleh*, sewn fishing boat of the Persian Gulf coast, Iran

Small fishing boats of sewn construction and with bitumen coatings were to be found until recently along the Persian Gulf coast of Iran's west Hormuzgan province, largely deployed in beach-seining activities: they have gradually disappeared over recent decades as alternative fiberglass technologies have become available. As demand for the vessels has diminished, knowledge and skills around their construction and use has likewise faded. It remains today within the memories of a dwindling number of older users.

Recent published work by some of the authors of this paper has documented the structure of one variety of these craft held in the collection of Qatar Museums (QM), where they are recorded as *baggāras* (Arabic بَرَاقِب, pl. رِيَقِاقِب or تَارَاقِب). The present paper augments this scholarship by placing the vessels within their original Iranian social and environmental contexts. It is based on ethnographic survey work conducted in person and virtually (due to Covid-19 restrictions) between 2020 and 2021, during which members of coastal communities with memories of, and other connections to, these vessels were interviewed about their naming, construction, materials, coatings, distribution and use, as well as the cause of their decline and disappearance.

The *baggāra/ameleh* is also known along the west Hormuzgan coast as *amela* (هلماع) and, perhaps, *shash* (شاش). Those vessels surviving in the QM collection are rare examples of a wider western Indian Ocean, but also unique to recorded scholarship in their stitching-together of both garboards and the keel in a single sewing action; their use of bitumen as a coating is also unique to the ethnographic record of regional sewn boats—while redolent of much more ancient practices. In all these respects, the *baggāra/ameleh*, is a highly significant vessel.

Virtual reconstruction of the Roman Shipwreck Grado I from archive and legacy data

Digital technologies support documentation and studies to increase and enhance knowledge about shipwrecks and maritime archaeology, allowing innovative archaeological reconstruction and research, and, furthermore, permitting the accessibility of the shipwreck to the public. As an action of the Interreg Italy-Croatia *UnderwaterMuse* project, that promotes a new kind of accessibility to a wider public through a digital approach of the underwater archaeological sites of the Adriatic Sea, the paper presents a 3D virtual model of the Roman shipwreck Grado I from archival and heterogeneous data, that could be studied and visualized with innovative solution and technologies. The wreck was discovered in 1986 and underwent numerous excavation campaigns which have seen the complete recovery of the cargo and the hull; a large part of the hull was covered by the amphoras and a section of the starboard side of the ship remained up to the height of the deck, that permit the reconstruction of a wide portion of the hull. The meticulous study of the hull and the cargo provided an opportunity to experiment the use of the documentation to reconstruct the entire shipwreck and provide to study and disseminate a complete visualization of an already investigated site which is no longer accessible.

First, we have processed the data realized during the excavation, from 1990 to 1999, to obtain the 3D model of the *in situ* shipwreck; then, starting from *in situ* wooden elements and from the results of the study of the original hull lines realized in 2000, we have reconstruct the original shape of the boat and cargo, restoring the missing parts of the boats from research carried out on archaeological and iconographic comparisons from this period. We are able to calculate the dimensions and the tonnage, to understand the original disposition of the amphoras in one or two levels and to calculate the displacement and stability conditions.

The shipwrecks of Gothenburg: nine wrecks from the Royal Mast Harbour

Since its founding exactly 400 years ago, in 1621, Gothenburg's history has been connected to transport: first the East India Company and then VOLVO. For a city of such great maritime importance, there were only two shipwrecks discovered in its waters before, the last one in 2001.

In 2019-2020 nine shipwrecks were excavated and lifted in the city centre during the archaeological mitigation for a large-scale railroad construction project. The wrecks date from the late-17th to the mid-19th century and range in size from 5 to 25 m.

Through their function and construction this new collection of wrecks displays not only shipbuilding history, but the city's social and economic development.

The older vessels provide evidence for Dutch shipbuilding techniques, as the town was first settled by Dutch and German citizens. The later 18th and 19th-century wrecks then showcase the Nordic clinker boatbuilding, as the population changed. The variety in the collection provides not only possible new types, but individual vessels that serve as evidence for boat variants only known from ethnographic records or from successive types. The excellent preservation conditions enabled details to be documented that are traces from the sailors and boat builders of Gothenburg.

Beside the boatbuilding technology, the wrecks also tell of the economy that drove the town; lighters that unloaded the cargo of the East Indiamen, fishing boats and bulk carriers for timber or grain.

The excavations finished in November 2020 and the complete recording of the 1387 ship timbers is ongoing. In late-2021 the last remaining area of the harbour will be excavated with the possibility of another three shipwrecks of 17th-century date.

This paper introduces the excavation and the shipwrecks and discusses these in the wider social and maritime historical context of Gothenburg.

New analytical methods for ship timber provenance analysis – win some, lose some

During the last few years, the TIMBER research team have been exploring new methods to refine the identification of the origin of the timber in shipwrecks. While tree-ring analysis has proven a highly reliable tool through the use of ‘dendroprovenance’, we wished to address gaps that appear in that technique. Could other techniques refine, for example, the precision of the dendroprovenance result, or point to timber sources for which we do not (yet) have dendrochronological datasets?

We explored two approaches, Strontium isotopic analysis and ancient DNA. Strontium is taken up in plants from the soil, and the $^{87}\text{Sr}/^{86}\text{Sr}$ ratio is derived ultimately from the bedrock. Identifying this ratio in the timber should allow identification of the geology on which the tree grew. However, ship timbers preserved underwater absorb the water’s Sr, or they might even exchange Sr with the water in which they are immersed, and the main challenge for this study was to examine if this ‘contaminant’ could be removed, so that the tree’s original Sr chemistry could be measured.

DNA is in all living organisms, and mapping of the genome of living oaks in Europe has shown a clear geographical distribution of haplotypes, east to west, across the continent. We know that DNA is a good tool for examining provenance, but it depends heavily on the preservation of the aDNA. In this talk we will present the results of these experiments and suggest how we might apply these new methods in future enquiry into past procurement of timber for shipbuilding.

These questions have been examined in the project TIMBER (Northern Europe’s timber resource - chronology, origin and exploitation) which received funding from the European Research Council (ERC) under the European Union’s Horizon 2020 research and innovation programme (grant agreement No. 677152).

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A preliminary report on newly discovered fluvial vessels from Kostolac, Serbia

This paper will present the results of a preliminary study of a group of four fluvial vessels recently discovered in the vicinity of Roman Viminacium in modern-day Serbia, dated between the Late Iron Age and Late Medieval Period. The remains of four vessels were discovered in March 2020 during regular mining activity at the Drmno open-air coal mine near the town of Kostolac in Serbia, at four kilometers distance from the contemporary course of the Danube. Archaeologists from the Belgrade Institute of Archaeology working as resident researchers at the nearby Viminacium Archaeological Park were immediately alerted and surveyed the scene, subsequently joined by members of the Centre Camille Jullian research laboratory for further studies and analyses of the remains.

Four different vessels were identified among the wooden remains well preserved under six meters of clay-like sediment: two dugouts, a single plank belonging to a flat-bottomed vessel, and a well preserved flat-bottomed planked barge. The discovery, taking place just two days before the introduction of the state of emergency in Serbia due to the 2020 sanitary crisis, was followed by hasty rescue excavation, documentation, and extraction of the shipwrecks and their transportation to the nearby Archaeological Park for further conservation.

While focusing on the architectural characteristics and nautical capabilities of the discovered vessels, this paper will also present preliminary conclusions on the context of their discovery in relation to the archaeological topography of the region, as well as with the naval construction and navigation practices within the Middle Danube zone of transport geography.

Sailing through Lepanto's history. Reading the Ships of the greatest naval battle of XVIth century in the Mediterranean from unknown Greek iconography

450 years ago in 1571, the naval battle that defined the history of the Mediterranean but also the last one that took place entirely with galleys took place in Nafpaktos, Lepanto in western Greece coast.

On the other hand, different and new types of ships were used with the one and only purpose of imposing themselves on conflicts at sea, such as by indicative means: the large-scale galley of the western naval tradition, galeaza, or galee grosse, which was a mixed sailing warship, the galliots, faster and more flexible, lightly equipped and efficient in coastal operations, the smaller rowing warships such as warships bergantins, used to protect the sides and sterns of blocked galleys on the battle line and finally the lantern galley, a warship of Mediterranean concept with the same outline on a larger scale than the galley.

The representation of the 1571 Lepanto's naval battle was one of the most popular subjects of western painting from the 16th to the 18th century, giving the triggering event to a number of iconographic representations related to engravings, tapestry, wood carvings, silver sculpture etc.

This paper attempts to define the distinctive features of the groups and types of ships that participated in the last great naval battle with galleys of the Mediterranean through unknown depictions of the Lepanto's naval battle from Greek museums and collections.

The Mazotos Shipwreck: Preliminary results of the hull investigation

The 4th century BC shipwreck that was found at -44m off the south coast of Cyprus, near the village of Mazotos, is a coherent wreck-site of an ancient merchantman. Most of its main cargo, wine amphorae from the island of Chios in the Aegean, was still *in situ* when it was discovered. Archaeological investigations at the site have been carried out since 2007 by the University of Cyprus, in collaboration with the Department of Antiquities and the Cyprus University of Technology. After seven excavation seasons, a good part of the hull has been unburied, mainly at the fore part of the ship. The starboard side is the best preserved one, and its exposed sections include part of the keel and eight strakes, with six frames and a stringer still *in situ*.

The excavation of the amphora cargo over the hull progresses slowly, given its considerable volume and the site's depth. Thanks to the extensive and successful use of photogrammetry, however, the documentation of the timbers was achieved with very good accuracy. Evidence thus far suggests that it was a round bottom ship, fastened with pegged mortise and tenons. Some 'archaic' features, such as the trapezoidal cross section frames and the framing pattern, as well as the presence of tetrahedral openings, open the question of the ship's broader technological and cultural context, and underscore the contribution of this project to our knowledge for shipbuilding traditions in the eastern Mediterranean during the Classical period.

Finding lost dhows in Qatar: Re-imaging the al Jassasiya petroglyphs

The assemblage of rock carvings of boats and ships at al Jassasiya, Qatar, has previously been interpreted in the light of watercraft types still found in the region into the twentieth century, even though some glyphs been dated to around the late eighteenth century. By using photogrammetry to extrude the shallow relief and network analysis to compare the shapes throughout the site, it can be shown that several of the watercraft represented accord with dhow types that became extinct in the nineteenth century. Most glyphs at the site have been interpreted as pearling vessels or common types used for coastal haulage as they are carved on a small rise inshore from an anchorage frequently used as shelter by pearling fleets. Several glyphs have stern extensions in shallow relief that appear not to represent common pearling types and are more like fighting craft used in the region in the eighteenth century. The methods of this project show how the shallow relief of these carvings is meaningful, prompting a reassessment of rock carvings and their traditionally two-dimensional illustrations. The identification of two-dimensional and three-dimensional depictions of watercraft in rock art, graffiti, models and other iconography is often a subjective process based on comparative analysis. The method of using high-resolution three-dimensional digital models of petroglyphs compared with similar types using network analysis moves interpretation towards more objective repeatability. This study demonstrates that the potential of the watercraft carvings at al Jassasiya is greater than allowed by two-dimensional representations and shows how extinct types might be identified and interpreted beyond a narrow pearling narrative.

Visualising a “Big Ship”. The reconstruction of a 12th century cargo vessel found in the harbour of Wismar

At the ISBSA 15 in Marseille the authors presented the preliminary results of the excavation of a Medieval cargo vessel, built from oak and pine sourced from western Sweden in the period 1184-90 AD. The wreck was recovered as a result of the expansion of the port of Wismar in Mecklenburg-Western Pomerania in Northern Germany. As the project was still in an early stage, the presentation mainly focussed on the construction of the ship, which was built in the Nordic clinker tradition.

Since then, the full documentation of the wreck has been completed and the timbers are currently undergoing conservation treatment.

In order to analyse and compare the hull-shape, a digital reconstruction has been carried out in Rhinoceros3D, using a three-dimensional scan of the as-found model of the wreck as a basis. Lines extracted from the model were integrated with data from comparative sites for the lofting of the hull. The digital fairing process was controlled and verified using three-dimensional scans of the internal timbers.

This paper discusses the methodology used for the archaeological reconstruction and presents the results of the hull analysis. Finally, the Wismar ship is compared with contemporary ship finds with a view to explore its place in the development of the sailing cargo vessel in the 12th and 13th Century.

Digital reconstruction hypothesis of the Roman-era fluvial barge from Kamensko, Croatia

The Kamensko shipwreck, as presented on the ISBSA 15 in Marseille, is that of a Roman-era fluvial barge well preserved on the riverbed of the Kupa under the cargo of bricks it was transporting on its last voyage. Excavated between 2015 and 2018 by a joint team from the Centre Camille Jullian (CCJ) and the Croatian Conservation Institute (HRZ), it is the first fluvial shipwreck to be systematically studied in Croatia.

This paper will present a digital 3D reconstruction hypothesis of the barge's hull shape and structure, its propulsion and direction systems as well as its cargo disposition, with the special emphasis placed on the processes and methodological approaches behind the final result. The 3D reconstruction hypothesis, created in Rhinoceros 3D software within the framework of a PhD project of one of the co-authors, was conceived on the basis of substantial fieldwork documentation, photogrammetric recording and 3D plans of the remains, as well as through pertinent archaeological and iconographic parallels. Besides "bringing to life" the shipwreck after two millennia, the reconstruction hypothesis served as a model for hydrostatical experimentation and analyses of barge's navigation performances in relationship with its nautical space, tackling the issues of the barge's hydrostatic stability, draught, displacement, capacity, construction sequence, and carrying out other pertinent studies whose results will be presented in this paper.

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Dendroarchaeology of shipwrecks in the Iberian Peninsula: 10 years of research and advances

In the Iberian Peninsula, tree-ring research on shipwrecks started in the 2000s by the authors with the aim to gain knowledge about timber supply (selection of trees and species for particular elements in the ship; use of local vs. imported timber) and the evolution of shipbuilding along the Iberian-Atlantic coast during the Early Modern Period. Here we compile the results and observations gathered in the period 2009-2019 through dendrochronological analysis on 25 shipwreck assemblages found in the Iberian Peninsula and elsewhere, predominantly thought to belong to Iberian-built/commissioned ships. Only three of these shipwrecks correspond to ships identified *a priori* (*Triunfante*, *Magdalena*, and *Bayonnaise* – the latter a French-built ship), providing a known ship history, including date and location of construction. The rest (Barceloneta I, Ribadeo, San Sebastián, Matagrana, Mortella III, Punta Restelos, Arade I, Ria de Aveiro F and G, Barreiros, Belinho, Delta I, II and III, Cee I and II, Yarmouth Roads, Newport, Emmanuel Point II and III, Highbourne Cay and San Esteban) have relative dates ranging from the 15th to the 18th centuries based on historical information, construction features and/or archaeological context. Combined archaeological, historical and dendrochronological research has led to the identification of four wrecks as ships built in Italian shipyards, allowing inferences to be made about their supply. Our results demonstrate an almost-exclusive use of deciduous oak (*Quercus* subg. *Quercus*) in hull and framing elements until the mid-18th century, and suggest a transition from differentiated selection of trees based on growth rates in the 15th century associated with traditional woodworking techniques towards an indifferent selection of growth rates in subsequent centuries due to availability of raw materials and technological advances. Reflections about key lessons learned are presented, and this diachronic selection of trees is discussed in the context of shipbuilding and seafaring in the Early Modern Period.

Boats from the Silesian coal mine

We are used to perceiving wrecks to be the objects found underwater or in the proximity of waterways. In January and April 2013 two unique boats were discovered in the layer of silt in a 200-year-old adit in the area of Zabrze (Silesia, southern Poland). They lay in a disused gallery of the adit about 22 m underground. The boats are similar in size: 5 metres in length and less than a metre in width. They had been made from the Douglas fir wood and were not used to transport the coal, as one might assume, but to carry the miners, tools and materials, possibly also for inspections of the mine site. Vessels of this kind might have been used in mining from the middle of the 19th century until the second half of the 20th century. Despite numerous distortions, the condition of the boats can be considered to be good.

Why did these vessels occur at such depth under the ground? At the end of the 18th century the construction of the Main Key Hereditary Adit began. It served as a drainage adit and as an underground water canal between Zabrze and Królewska Huta in Upper Silesia at the same time. It is one of the longest hereditary adits in Europe and the longest hydrotechnical construction in European coal mining. It is presumably one of the oldest galleries carved out in coal in the world.

Author discusses the circumstances of the discovery of the boats, their construction and their utility details. Both artefacts are the property of the Coal Mining Museum in Zabrze. The National Maritime Museum in Gdańsk is now preserving the objects, which is not an easy task considering the combination of wood and metal. Part of the research revealing the inner construction details is conducted with the use of a special digital radiography lamp. 3D models were made with the Artec Eva optical scanner.

Strange craft in the Murray River - characterizing the archaeological signatures of river vessel in Australia's largest river system

Recent research undertaken in the Murray River in South Eastern Australia has revealed a range of river craft whose structural designs have not previously been documented (either archaeologically or historically). The vessels, predominantly large scale barges used in the wool, wheat and timber trades, have vastly different construction techniques to those used in Oceanic regions, and designs that appear to be unique to the region. Based on site inspections, oral histories with traditional boatbuilders, and analysis of remnant vessels, this paper outlines ongoing investigations to characterise the archaeological signatures of these remnant hulks and wrecks, and the ethnographic practices associated with these highly unusual watercraft. The origins of these local construction techniques are also being investigated to further explore whether these craft are being based on imported international designs or demonstrate the rise of a unique class of Australian vernacular boatbuilding. Undertaken as part of a wider project to investigate riverine heritage in NSW and other State river systems (NSW Rivers and Waterways Cultural Landscapes Project), this paper provides insights into the long forgotten vessels and shipbuilding practices of Australia largest industrial waterway system.

The late medieval Bellevue Ship – new findings concerning the oldest wreck in Dalarö harbour, Stockholm Archipelago

The Dalarö area is famous for its many shipwrecks. One of the lesser known is the Bellevue Ship that was discovered already in the 1960s and which is named after a nearby hotel. Between 1985 and 1993 the large clinker-built ship was surveyed by a group of diving amateur archaeologists. Despite serious efforts from the group, the age, type, and origin of the ship to a large extent has remained unknown.

During the past few years some additional fieldwork and research has been carried out at the site. This has included wood sampling for dendrochronological analysis, creation of a new site plan and re-evaluation of previous work. Altogether this has provided new insights regarding the ships architecture, its overall dimensions and its age.

This presentation will summarize this research and emphasize how iconographical sources can enrich our knowledge and form the departure for analysis and interpretation of ship remains. I will argue that the Bellevue Ship was built around the turn of the 15th century and represents one of the largest clinker-built vessels of its day, and that it was originally equipped with a forecastle. Another important result of the survey is that it sheds some new light on the activities in the Dalarö area before the 17th century, which is sparsely revealed from written sources.

Visualizing shipbuilding features through textual evidence: The case of the 19th century Aegean brigs

During the 19th century, while seaborne trade networks were growing in the Mediterranean, several Aegean islands along with some mainland harbours maintained active shipyards to meet the increasing demand for merchantmen, mostly brigs. The most dynamic shipbuilding center of the region was in Ermoupoli, the capital of the island of Syros. Illustrations of brigs on paintings of that era are common and historical sources provide abundant information on shipbuilding. Material evidence, however, is limited in ships' parts exhibited in museums. No Greek brig has been excavated thus far, so there is a serious gap in our knowledge of 19th century Aegean ship's architecture.

The lack of ships and shipwrecks of the period could be partly counterbalanced by the wealth of textual evidence. Shipbuilding contracts, a valuable source for the socio-economic conditions of the shipbuilding industry, contain detailed descriptions of ship's components with their measurements and positioning in each ship. Such information provide unique insights into the conception and materialisation phase of shipbuilding's *chaîne opératoire*, which is not otherwise preserved in the historical or archaeological record. To investigate this argument further, ten contracts for brigs built between 1832 to 1857 in Ermoupoli's shipyards were analysed. The processes and data included in them were tabularized, and were then used for the digital partial reconstruction of each one of the specific brigs in a 3D environment (using AutoCAD and Rhinoceros softwares)

This paper discusses the results of this experimental reconstructions, with an emphasis on the challenges faced during archival sources' examination, the decisive role of the digital tools in their technical analysis and the importance of visualization for the study of nautical heritage.

Reconstructions. Between facts and choices. Methods and results viewed from the late 16th century Barcode 6 boat.

One of the less obvious outcomes of the systematic usage of digital recording of archaeological ship-finds is the increased capacity for sharing and communicating the results. At the Norwegian Maritime Museum, this positive feature has become noticeable, increasing cooperation between different fields of expertise, e.g. archaeologists, ethnologists, boat builders and technical conservators. Throughout the workflow, the data, accumulated during excavation and documentation, is processed differently by each specialist according to their specific requirements.

Within the limits of contract archaeology, the ability to build reconstructions is normally beyond the scope of these projects. Being able to work with reconstructions has been rewarding on many levels and has added to our knowledge on both methodological issues, and not least on shipbuilding itself.

In this paper we would like to present the making of three different reconstructions of the same vessel: the scale model, the floating hypothesis, and the exhibition of the reconstructed original material. Reconstructions produce different representations of the find. These representations, although based on the same material, will demonstrate deviations from each other. This paves the way for interesting discussions on both methodological and theoretical levels. Some choices are made based on objective facts, while others rest heavily on subjective interpretations or even unconscious notions.

The example used in the discussion is a late 16th century small cargo vessel, the Barcode 6. The boat was excavated in the harbour of Oslo in 2008, and its technical features will be presented. Focusing on the reconstructions we would like to investigate how and why discrepancies occur, and thereby also discuss possible consequences both for the characteristics of the shape of the hull, sailing capabilities and cargo capacities. The discussion will work as a critical examination of the methods in use, as seen from the viewpoints of the archaeologist, the ethnologist, and the boatbuilder.

Bispevika 8 – Homemade? An early 16th century carvel ship found in Oslo harbour

In 2015 the wreck Bispevika 8 was found in the Renaissance era harbour of Oslo, amongst 37 other 16th Century (+/-20 years) wrecks. While some of the other wrecks had carvel elements, they were primarily clinker-built vessels. Bispevika 8 was the only vessel found with an entirely carvel construction. Although only the lower, aft section of the wreck was preserved, it still provides an interesting perspective on the introduction of carvel construction to Scandinavia. The trees used to build the ship were felled between 1534-39 AD, making Bispevika 8 the earliest carvel wreck found in Norway, and one of the oldest Northern Dutch flush wrecks found anywhere.

The construction elements of Bispevika 08 strongly suggest a Northern Dutch influence. Dendrochronological analysis of the ship's planking revealed a provenance in southern Norway. This alone would not raise any eyebrows as Norway exported timber on a large scale in the 16th century; however, analysis of the caulking material has revealed that the caulking was not gathered in the Netherlands. Three potential regions were suggested, the south-eastern coast of Sweden, the eastern Baltic, and southern Norway.

Bispevika 8 has undergone thorough documentation, making it an excellent source to assess early carvel construction in Northern Europe, and Scandinavia specifically. Bispevika 8 raises the possibility of a locally constructed carvel ship. A ship, feasibly built not for the purpose of war but for trade, sparking debate about the reasons for the introduction of carvel construction into Scandinavia. But is the remaining evidence robust enough to determine that such an early Dutch-influenced ship could have been constructed in Norway? Based on the historical context, the archaeological documentation, and the scientific analysis we will try to ascertain the wrecks intended usage, and furthermore its origin.

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Method for mapping potential ancient sailing mobility: new meaning to the term 'favourable winds'

A new method has been developed for measuring potential sailing mobility of loose footed single square sail merchant ships in the ancient Mediterranean, with the objective of mapping potential sailing mobility in the central and eastern Mediterranean basins. This method is applicable to both direct open water sailing passages and to coastal-breeze driven sailing. Many previous quantitative works have evaluated sailing passages using averaged wind as input, losing information on the intra- and inter-diurnal variability of the winds in the Mediterranean. Their sole measure of mobility has been a representation of sailing speed on direct crossings. Moreover, these Mediterranean studies have not considered the difference between technological and practical mobility, which is driven by human factors, for instance, the choice of whether to sail or to wait for better conditions.

The proposed method uses meteorological resources at high spatial and temporal resolutions, with the premise of exploiting the recurring wind variabilities and patterns which are key to mobility, especially on routes contrary to the prevailing winds. The underlying methodology converts meteorological 'big data' to 'big data' of hundreds of thousands of simulated sailing passages. The latter providing for statistical analysis of potential sailing mobility. Inclusion of criteria-based human factors – e.g. the preferences of the mariners of the period, provides realistic measures of mobility, representing not only sailing speed, but also waiting time and the probability of conducting feasible passages at given times of the year. Sailings of the replica ship *Ma'agan Mikhael II* supported the development of the method with valuable input of ship performance.

One of the aims of the study is to publish a mapping of potential sailing mobility in support of studies of Mediterranean maritime space. This new method provides deeper insight into potential sailing mobility and the understanding of seafaring in the Mediterranean.

A nearly intact *bombarde* from the Western Black Sea

Due to the paucity of source material and therefore scholarly interest, the nautical archaeology of the Western Black Sea in the Golden Age of Sail is still poorly understood. Only lately did this *status quo* begin to change as more and more archaeological evidence is coming to light, sparking focused research on the various topics defining this age of maritime globalisation. One of the most potent of these topics is the profound change in local maritime culture and seafaring practice induced by the gradual re-admittance of European mariners into this remotest and most conservative part of the Mediterranean World. While it is still too early to address the topic in full, studying individual channels of influence in the form of archaeological remains of European sailing ships, has strong potential for building up the empirical database required for future studies.

The proposed paper will discuss ongoing work on a nearly intact shipwreck identified and recorded by the Black Sea Maritime Archaeology Project. The site lies on Bulgaria's continental shelf on the verge of the anoxic zone. It represents the extraordinarily well preserved coherent remains of a 22-metre-long wooden sailing ship. The evidence for the hull and the particular style of polacre-ketch rig allow for interpreting the site as an early 19th century *bombarde* of potentially Provençal origin.

One of the work horses of the Western Mediterranean, in the late 18th and 19th centuries *bombardes* were built in the hundreds. Owned and sailed by Marseille merchants, such vessels would have appeared on the Black Sea as early as 1788 raising a Russian flag. For a discrete period they would have been a regular sight along the Western Black Sea coast, carrying apart from their valuable cargoes the deeper meaning of a symbol of change. To the knowledge of this author the shipwreck to be discussed in the proposed paper is the only example of its kind in the archaeological record to date.

Metal fastenings in the western Indian Ocean during the medieval period: new data from the Islamic site of al-Balid (10th–16th centuries), Oman

The prevailing conceptualization of western Indian Ocean boatbuilding has been, for decades, that metal fastenings were either introduced or influenced by Europeans during the 16th century CE. The lack of archaeological evidence for watercraft in the region, along with historical references to boats fastened with fibre cordage, led early scholars to assume that medieval western Indian Ocean vessels were exclusively sewn.

However, archaeological discoveries such as the nailed planks of Quseir al-Qadim (12th–15th centuries) on the Red Sea coast of Egypt, and a shipwreck from Kerala, southwest India (10–13th century), have provided evidence that challenged the assumption that all western Indian Ocean vessels were sewn before the 16th century. Unfortunately, the implications of these finds have been mostly unexplored.

Recently discovered ship timbers from the Islamic port of al-Balid, Oman, displaying both sewing and oblique nails, provide the only evidence of a nail-construction technique in Arabia in the medieval period, and yield further data on the introduction of iron fastenings in the region.

This paper examines these sets of evidence, focussing primarily on the al-Balid timbers, to describe the forms of nailed-plank technology in the medieval Indian Ocean, identifying three different techniques. These are contextualized within the broader Indian Ocean to provide insights into the origin of these nailed vessels, while discussing which boatbuilding traditions might have influenced the use of nails in the western Indian Ocean.

Lastly, this paper argues that the introduction of metal fastenings is a complex topic that cannot be expressed in terms of simplistic absolutes and assumptions found in the early scholarship, and that nailed vessels were probably more common than previously assumed.

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Shipwreck 5 from Thonis-Heracleion, Egypt

The site of Thonis-Heracleion located in the Nile's Delta probably contains more than a hundred of ancient ships most of which date to the Late (664–332 BC) and Ptolemaic (332–31 BC) Periods. Shipwreck 5 was excavated by IEASM in 2019. The ceramic evidence and small finds from the ship allows dating it to the first half of the 4th century BC. It is possible that the ship took fire and sank during a military conflict. Approximately one half of its original hull was preserved and was deposited inside a larger and earlier ship of a 'baris' type.

The preserved portion of the hull makes 7 by 3 meters while the original length of the ship may be estimated at 14-15 m. The hull's remains were in good state of preservation and included a section of a keel, a short section of a fore/afterfoot, 23 strakes of the planking, two stringers and 26 frames. The ship was constructed mainly of coniferous wood species. The keel was almost square in section and had modest dimensions. It had no rabbet and was scarfed to the end-posts. The planking was assembled with pegged mortise-and-tenon joints and the frames were nailed to the planking with double-clenched iron nails driven through wooden pegs. Ship 5 belonged to a typical shell-based construction with primary strength of the hull provided by planking with its dense distribution of M&T joints of considerable size. Some frames and stringers were fabricated from reused planks. In the bilge area many remains of ropes were discovered. The ship was either transporting the ropes or it was involved in mooring procedures within the harbour.

The particular interest of Ship 5 is that it had no ligatures in its construction. Latter feature was quite characteristic of archaic Greek shipbuilding preceding the Graeco-Roman type of construction relying on M&T joints, the latter best attested by the Kyrenia shipwreck from Cyprus (295-285 BC).

Villeneuve-d'Ornon (Gironde, France). A shipwreck from the early Middle Ages

The wreck of Villeneuve-d'Ornon was discovered in 2013 during an archaeological diagnosis carried out by Inrap (Institute of Preventive Archaeological Research) on the banks of the Garonne, a little upstream from Bordeaux. A first phase of excavation of the boat by Inrap took place in the second half of 2019, but the observations and the complete removal of the boat could not then be completed due to technical and meteorological constraints. The resumption of the operation is currently being studied.

The 2019 excavation confirmed the remarkable state of preservation of the wreck, which is preserved over a length of 11.20 m, a width of 5.90 m and a height of 1.60 m. Only part of the stern is missing, over an estimated length of 3 or 4 m, which would return a boat with an initial length of around 15 m. All the structural elements have been precisely observed (keel, planking, mast step, beam...) as well as the connections between the elements, mainly by treenails but many nails are also present.

The architectural analysis leads for the time being to restore a very robust boat (numerous and tight frames) adapted to the transport of goods whose nature remains, for the moment, undetermined. The presence of a keel is evidence of the ability to leave the river Garonne framework and carry out coastal shipping. Several radiocarbon dates enable us to place the boat between the second half of the 6th and first half of the 7th centuries.

A unique shipwreck found with a unique cargo

In December 2017 a ship wreck was found in the Stockholm archipelago. The wreck is unusually well preserved for a ship built with clinker technique. It also has its cargo still in place. There are a little over 30 barrels visible, mostly containing so called osmund iron. No similar wreck has ever before been found in Swedish waters.

The date of the ship is based on dendro. It date's the wreck to 1540's (provenance Stockholm) and has been repaired in the 1550's (provenance, south of Finland).

The wreck has three masts (the main mast still standing in its original place) and all it's the rigging seems to be intact at the site. It seems that the wreck is almost totally intact so it's a unique ship wreck in many ways.

Iron exports was then, and still is, one of Sweden's most important exports but the knowledge of historic cargo ships, the trade routes and the quality of the iron is almost unknown. This ship is one of the most important finds to date and can tell us much more about how the iron was transported, how export was organized and what kind of ships were constructed for iron cargo. We can also reconstruct the rig of a three masted clinker built cargo ship which will give us more knowledge about how a big cargo ship sailed.

Based on the archaeological surveys this paper discusses the ship wreck, its construction, the rigging and the cargo and the possibilities for further study of the history of the Swedish iron industry through a ship wreck still fully equipped and comparable to a time capsule from 1550.

The keelson: An engineering-archaeological analysis of a milestone in medieval maritime architecture

J.R. Steffy remarked, when analysing the shell-first construction, that ‘the keelson would only serve its purpose hundreds of years later’. The thousand years of the first millennium CE bear witness to a slow but deliberate revolution-evolution in marine architecture and propulsion. Wooden ship hull architecture morphed from robust edge-joined planks to skeletal framed-based ships whose frames were joined to a single back-bone keel. Their skins were composed of longitudinal strakes nailed to the frames. During this same period square sails were being replaced by settee and triangular lateen sails. However, these hull and sail innovations engendered their own unique challenges: frame-based ships required extensive longitudinal reinforcement while triangular sails, heading up-wind, resulted in slide-slippage and heeling. Two representative shipwrecks stand out in their structural uniqueness: the Tantara B (9th century CE) and the Serçe Limanı (11th century CE). Both ships, less than 20 meters in length, possessed frame structures nailed and bolted between a keel and a massive keelson. This structural archetype appeared anomalous given that marine architectural principles clearly demonstrate that in wooden ships of this length a keelson is redundant. Upon employing structural Finite Element Analysis (FEA) Computerized Fluid Dynamics (CFD) accompanied by laboratory validation, it was demonstrated that the Serçe Limanı maintained a high degree of structural integrity which was not influenced by the addition of the keelson: the keelson was not a longitudinal reinforcer. This finding contradicted the assumptions previously published in archaeological literature. The keelson did, however, enable both the lengthening and thickening of the keel, which when applying CFD simulations, it was demonstrated that the modified keel contributed to the significant reduction of side-slippage caused by upwind sailing characteristic lateen sails. This research was inspired by P. Pomey’s commentary that ‘...the nailing or bolting of frames to the keel, and eventually to the keelson, needs further study [and] cannot be interpreted simply...’.

Taking a palace to sea: the great cabin on *Vasa* (1628)

The great cabin on a capital warship was not simply the accommodation for the highest ranking officer on board, but also served as a formal reception space for visitors, an embassy, and a stage set for political theatre. Its location, configuration and decoration were intended to establish the power relationships between people entering it, and most importantly, to serve as the symbolic seat of the sovereign's power. On *Vasa*, these functions are emphasized by how the space is configured and decorated, using costly imported materials and the highest quality workmanship, carried out by the joiners from the royal palace rather than the navy's carpenters. They created a royal interior, the only one to survive from the reign of Gustav II Adolf, to emphasize the ship's political function. This paper will present the results of a comprehensive project carried out to document the structure, furnishings and decoration of the great cabin, and place the reconstruction of the interior into the broader context of warship interiors and the social organization of space.

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Visible and invisible water transport components of the East European Plain and the Trans-Urals in Prehistory

So far, the only Prehistoric logboat recorded in the territory of the European part of Russia is dated to the Bronze Age by ¹⁴C (1800-1700 cal BC), as verified in the course of our study, funded by the Russian Foundation of Basic Research (project no. 19-09-00301). Other logboat finds in Russia date in the range from the Late Medieval Period to the 19th c. AD. Based on the ethnographical data of Siberian indigenous peoples and written sources of the Early Modern period from the area of Northern Russia, the presence of birch bark canoes and skin boats in the past can be hypothetically recognized.

The unique find of the ceramic birch bark canoe model comes from a collective burial of Bronze Age Forest hunter-gatherer-fishers in Central Russia and dates to around 2200-2000 cal BC. By construction, the canoe reminds one of Native American designs and according to proportions could represent a boat for two persons, about 6 m long.

Mesolithic, Neolithic, and Early Bronze Age paddle finds come both from the East European Plain and the Middle Trans-Urals. Some of them were definitely used for canoes or skin boats, as they have light weight and moderate length. This contribution discusses their dimensions and decoration patterns, and concentrates also on the unique group of the Trans-Uralic items shaped to assemble either the one-blade or the double-blade paddle. Some Trans-Uralic peatbog wooden items which presumably could have been canoe or skin boat frame details are discussed also.

As a result, a much more comprehensive picture of forest-zone Prehistoric water transport has emerged after re-analyzing old and recent archaeological finds and establishing their relevance with the ethnographical data.

Developing a craft perspective on the interpretation and reconstruction of boats

In my PhD project, I explore how a boat builder's interpretation of boats can enhance research that aims to reconstruct boat building skills and knowledge from an older tradition. In this contribution, I discuss methods for surveying and reconstructing boats and ships with a craft perspective. I am in the process of evaluating the differences in outcomes between conventional analogue methods for documentation and digital photogrammetry when read and seen from the perspective of a skilled boatbuilder. With experience from surveys of Nordic clinker boats, I can pinpoint specific examples from the use of photogrammetry versus the use of analogue tools. The advantages and possible shortcomings of digital methods need to be considered to reach good practice in the survey. The current case study focuses on a local type of Nordic clinker boat tradition, boats from the Stockholm Archipelago, partly built with hewed planking. This tradition was discontinued in the late 1800s. The absence of living tradition bearers means that the craft tradition is broken, but traces of it can be deciphered from the few remaining boats. Both theoretical insights and practical experience are crucial in the survey in order to interpret craft objects from the past. The boat builder's perspective on surveys and reconstruction of boats can therefore contribute to maritime archaeological research. However, even if the craftsman-researcher is highly skilled, artefacts have limitations as sources of craft knowledge, which must be considered in the interpretation process. To interpret a boat built in an older tradition, one needs to be aware of one's own traditions and prejudices, and that one's perspective will always differ from that of boat builders from the past.

Yesterday's watercraft, tomorrow's watercraft. Recording the 20th century timber watercraft abandoned on the riverbanks of the Basque intertidal estuaries

As archaeologists, we tend to focus on old watercraft to understand past societies. By recording such watercraft, we aim to understand the people who built and used them and, sometimes, died in them.

As Basque archaeologists, we have realized that many timber watercrafts are abandoned on the riverbanks of estuaries. They are a rich source of information to understand not only the 20th century ship and boatbuilding construction - whose last watercraft are disappearing as they are replaced by fiberglass and metal ones - but also older ships and boats, since they represent the last steps in ship and boatbuilding which have their roots in the Middle Ages.

For the last few years, we have started recording the estuaries, focusing on any type of watercraft abandoned there. This is not an easy task as they are muddy places where one also must work with the tides, a risky environment making the recording a bit more difficult.

During December 2019 and February 2020, we managed to record the remains of at least ten different watercrafts. They are two boats, a barge and seven fishing ships. Some are almost complete whilst other are just small parts. During summer 2021 we aim to record some new ones and finish with the recording of other which were partially recorded in the 2020-2021 campaign.

It is important to record them now, as they are still accessible with relatively complete structure. If we allow time and environment to attack them before they are properly recorded, one day they will collapse and disappear; then, it will be too late to record anything. If this happens, what will future archaeologists say about us? We had the opportunity, but we did nothing. Let us hope that our effort is not in vain.

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Ship shapes: digitising historic ship models

This recently completed PhD project undertaken in the Maritime Archaeology Program at Flinders University in South Australia involved gathering of spatial data for large Dutch merchant ships of the 17th and 18th century and the conversion of that data into a common spatial format. The project explored spatial data from iconography, shipbuilding manuals, contemporary ship models and shipwreck surveys for new insights into ship design during this period. A large proportion of the known scale models of this type and period have been digitised in partnership with museums across Europe. Digital reconstructions of ships were created from 3D scans of wrecks within their wider landscapes and a number of virtual reality experiences were created to facilitate the dissemination of accurate maritime archaeological data and museum collections to the public.

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The Late Hellenistic shipwreck from the Bay of Paržine, island of Ilovik (Kvarner, Croatia)

The Ilovik-Paržine shipwreck was discovered in 2016 in the Bay of Paržine, island of Ilovik, and inspected in 2017 by the Department for Underwater Archaeology of the Croatian Conservation Institute. The first inspection confirmed a very interesting site, as well as an exceptionally conserved ship's structure, despite the remains were laying in shallow water, covered only by a thin layer of sand, and exposed to the anchors of the numerous pleasure boats mooring in the bay. In 2018, the Croatian Conservation Institute and the Centre Camille Jullian (Aix Marseille University, CNRS), in collaboration with the Special Police of the Ministry of the Interior from Kovčanje, and the Lošinj Museum, decided to mutually investigate the shipwreck in the frame of a multi-year and interdisciplinary research programme.

After three excavation campaigns, the team identified the stern, part of the hull bottom covered by stone ballast, and a part of the ship's bow lying detached from the main deposit. The research revealed a very unique ship structure showing a wineglass cross section typical of Hellenistic ships, and a straight or concave stem creating an asymmetrical longitudinal profile. The Ilovik-Paržine shipwreck was also particularly interesting due to its mixed cargo including tree trunks, and late Greco-Italic or early Lamboglia 2 amphorae dating to the last journey of the ship, that is to the end of the 2nd century BCE. Other ship equipment's findings, such as a small bronze female figurine representing the tutelary divinity of the ship, are also of particular interest.

This paper presents the project, the research methods and the main results obtained.

Stuck on the Nile bank: preliminary results on recording and analysis of the last surviving traditional wooden fishing sailboat and its community

The Egyptian riverine cultural heritage has formed the country's identity for centuries. Despite the value and uniqueness of this heritage and its traditions, these traditions do not get the attention of maritime archaeologists/ethnographers as its counterparts in the Gulf and the Indian Ocean. Coupled with several social, economic, and environmental factors which affected the Egyptian riverine community during the 19th and 20th centuries, which led to a drastic decline in the numbers of traditional wooden sailboats on the Nile and the vanishing of 200-year-old traditions. Thus, the need for a rescue project to record the remaining fragments of these traditions.

This paper will discuss preliminary results of the “Egyptian Traditional Riverine Tangible and Intangible Heritage Rescue Project (TradEGY)”, funded by the Honor Frost Foundation. These preliminary results including, the outcomes of the surveys and documentation of the last surviving wooden fishing boat on the Nile, which dates back to the early 20th century.

The paper will also include presentation of one of the oldest Nilotic fishing communities, their lives, fishing techniques, and how they preserved their tangible and intangible heritage until today. It will include the story of the community's life cycle, which was intertwined with their boats and fishing gear, and how these objects were retired and repurposed, insuring its preservation until now. In addition, this paper will discuss how 3D technologies would help interpret and visualize the boat when it was being used.

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The Caesarea shipwreck: the remains of a large early Imperial ship in the Eastern Mediterranean

The Caesarea shipwreck provides significant information about large ships that have hardly been evidenced archaeologically. The find comprises one of the very few early imperial hulls that have been excavated and studied in the Eastern Mediterranean. Lying in the northern anchorage of Caesarea, Israel, excavation of the vessel is made difficult due to sediment input, the coast's propensity for storms, and the widespread Roman architectural debris on the shore. The first exploration of the wreck carried out in the 1980s was limited to a few parts of the hull. Despite the damage wrought to her since then, the extensive underwater excavation led by the University of Haifa in the two seasons of 2017–2018 has documented the entirety of the remaining hull.

The presentation will detail the hull plan, including the mortise-and-tenon fastening system, and will display the cross sections of what remains of the hold. A systematic tree species analysis of all main timbers and numerous pegs and tenons has been carried out. The data allows us to determine the architectural type of the ship and to rank her tonnage among the highest category, due to the thick size of her timbers and short room-and-space. Our analysis of the wreck relies on a dendrochronological analysis of all sections of the planks and frames, providing a shifting chronology subsequently fixed with ¹⁴C analysis.

Numerous literary, papyrological, and iconographic sources provide new information on the large Roman vessels sailing in the Eastern Mediterranean, which includes the ship at Caesarea. However, the absence of merchandise in the hull does not allow us to determine her cargo. Nevertheless, the location of the wreck outside the prestigious harbour built by Herod highlights the economic importance of the northern anchorage that has been thus far neglected.

Tradition and Revolution? A Personal Reflection

Based on an archaeological career spanning almost 50 years, this paper seeks to reflect on the central theme of this ISBSA conference and consider how over the last half-century archaeological methods of documentation and analysis, particularly within the sphere of nautical archaeology, have undergone considerable adaptation and, in the last 20 years, arguably, a digital revolution. This paper takes an unashamedly personal perspective drawing on the author's archaeological experience including terrestrial excavations in the coastal province of Cornwall in his teens, the Orkney Islands off the north coast of Scotland; Salango in the coastal province of Manabi, Ecuador, excavation and specialist engagement with the Roman and later port and City of London, review of waterlogged timber documentation undertaken in the late 1980's for whole of the United Kingdom, and decades of research and rescue excavation in that most productive of coastal zones, the Severn Estuary (Barland's Farm, Caldicot, Magor Pill, Newport). As a specialist and advisor, direct involvement in more recent nautical excavation and post-excavation projects has focused on medieval (Aberwr'ach, Doel Cogs, Mortar Wreck, Newport) and early modern shipwrecks (Belinho 1, Drogheda, Emanuel Point II and III, Gresham (Prince's Channel), Highbourne Cay, Invincible, Mortella III, Ribadeo, *Sea Venture*, Swash Channel, Yarmouth Roads). The intention is, through reflection on this personal research journey, to consider some of the core questions which the conference theme seeks to address and contribute towards their debate. What are the key research questions in nautical archaeology? Have these remained constant or have they developed as our sub-discipline has matured? Does a "tradition" really exist within nautical archaeology and has there been a revolution which threatens it? What new opportunities or 'threats' lie on the maritime horizon in terms of methodological, technological or theoretical developments?

Reconstructing the pattern of Iron Age - and vernacular boats

It is a strong history of effect (Wirkungsgeschichte) between the Viking ships of the 9th century AD and the vernacular boats from the Scandinavian coastline 1000 years later. The core of the technology shows a remarkable continuity with shell built, lapstrake hull clinkered with iron rivets, ribs, oarlocks, and oars etc. At the same time, there are some important differences in the concepts of the planking and the shape of the hulls from different epochs. Through investigating *the pattern* of different boat types, we can get closer to reading the intentions materialized into the archaeological boats and thereby getting a more precise discussion and reconstruction of the shape and function of each boat. The concept of *patterns* gives attention to the fragments as parts of a whole structure, not as individual functions.

Our presentation will reveal how such patterns can be identified in different vernacular types of boats from Norway. Each pattern, we have documented by combining practical skills and 3D computer technology, is unique. The use of materials, in the combination with the strake diagram relate to tools, the technology and procedures of work. This way, the pattern defines possibilities and limitations for the shape of the hull and the qualities of the boat in usage.

Inspired by our analysis of tradition, we have identified different characteristics of the hulls of archaeological boat finds from the Iron Age in Northern Europe. Each pattern has its own limitations and possibilities for giving the shape of the hull and thereby different characteristics to the type. In this process we base our knowledge and research process on a combination of boatbuilding, cardboard models and drawings and 3D computer modelling. We will conclude the paper by presenting the pattern and the shape of our reconstruction of the third Gokstadboat, excavated in 1880.

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Past and Present of the Marsala Punic Ship: From construction to exhibition

The Marsala Punic Ship, dating to the 3rd century BCE, is one of the few excavated shipwrecks that provides information about Punic shipbuilding techniques. Excavated by Honor Frost between 1971-4, conserved with PEG between 1975-8, it is currently housed in the Regional Archaeological Museum Lilibeo in Marsala. In 2018, a new collaborative project supported by the Museum and the Honor Frost Foundation (HFF) assembled ship archaeologists from the Centre Camille Jullian (Aix Marseille University, CNRS) and the University of Southampton with conservators from the Arc-Nucléart restoration laboratory of Grenoble (France). The project goals were to assess the ship's state of conservation using a Faro Focus5 (S-series) laser scanner and photogrammetry in combination with physio-chemical analyses. Examination of archival data in connection with the ongoing HFF Trinacria Sounding Project (TSP) was used to compare the ship's current shape to earlier interpretations. The digital documentation of the ship before an intervention begins will assist in the formulation of a conservation strategy including a better supporting the Punic Ship structure and help the museum create engaging public displays. This paper presents the recent work conducted to revisit, reframe, and reinterpret the archaeological remains of the Marsala Punic Ship.

The Late Hellenistic military ship of Phanagoria (Taman Painsinsula, Black Sea): New data for the reconstruction of the ship

The ship was discovered in 2012 during the exploration of the ancient harbour structures of the ancient settlement of Phanagoria by the underwater department of the Phanagorian expedition of the Institute of Archaeology of the Russian Academy of Sciences (IA RAS). The remains measured nearly 16 m in length, and the port side on which the ship rested was preserved up to the caprail.

In 2014, a bronze casing decorated with a crescent accompanied by a five-rayed star, was found 1.5 m to the west of the keel extremity. This symbol on the bronze casing gave arguments for identifying the ship with a military unit associated to the uprising of Phanagoria against Mithridates VI Eupator in 63 BCE.

In 2019, the Centre Camille Jullian (Aix Marseille University, CNRS) joined the IA RAS in Phanagoria. The ship was entirely re-opened and the team completed the study of the ship structure, and of some timbers previously recovered thus collecting important evidences for the general interpretation and reconstruction of the ship.

This paper presents the recent work conducted to re-examine and reinterpret the remains, and to reconstruct the original shape of the ship of Phanagoria.

Ship Graffiti of the Eastern Adriatic Coast

On the coastal and island area of Dalmatia there are over 30 sites with graffiti depicting ships. Since many of them have more than one, and often several drawings, their total number exceeds one hundred. Each one is unique. Only few drawings date back to antiquity; there are a dozen sites with drawings from the Middle Ages, and most of the graffiti were done between the 16th and 20th century. The drawings made by charcoal, carved on the plaster or stone surfaces of the walls vary in quality, ranging from clumsy sketches to detailed representations of parts of ships and their equipment.

The question remains what is their purpose and meaning. Most of the drawings are found on the walls of sacral buildings, whether small churches or cathedrals, suggesting their votive or devotional character. Even if we cannot reconstruct the process of their creation, what we can read from them is the description of the vessels shown in the drawings, the shape of the ships, the number of masts and oars, the type of sails etc. These drawings are primary historical sources. They are documents of time and traces of human communication through the images.

Second scuttled ship of Trstenik, Kaštel Sućurac, Croatia: Preliminary report

In the small bay in front of residential houses in Trstenik, at the eastern end of Kaštel Sućurac, the remains of an economic complex from Roman times can be seen in the shallow sea. Traces of human activity in this place date back to the 1st century BC. Underwater research started in 2002 with the recovery of a large perforated dolium, and continued over the next five years. In 2006, the well-preserved remains of a ship, scuttled and used to reinforce the operational waterfront, were discovered in the western part of the site. The ship was researched in 2012, 2015 and 2020.

In 2020, while cleaning the bow of the ship at the eastern end of the trench, one extremity of another ship was discovered, consisting of keel or post, two stringers, four frames and several planks. Given the limited time, the remains of the second ship were quickly recorded and protected on the seabed, pending future work. Then, during the cleaning of a wooden structure composed of planks and poles forming part of the operational waterfront, the remains of a third scuttled ship were found at the western end of the trench. Unlike the previous two ships, which lay in an east-west direction, the third ship is oriented in the north-south direction and follows the wooden coastal structure that turns to the north. The paper presents the preliminary results of research carried out on another ship at Trstenik.

Morten Ravn

Viking Ship Museum in Roskilde, Denmark

A 14th-century Boat-Find from Vordingborg Castle, Denmark

In 2012 the remains of a well-preserved 14th century rowing boat, c. 5.5 m long and 1.3 m wide, were un-earthed while restoring the moat at Vordingborg Castle, Denmark. This paper presents the excavation and documentation of the boat-find, as well as the recently (2019-2020) conducted model reconstruction and dendrochronological and metallurgical investigations. The paper concludes with a discussion of the written evidence of using small rowing boats, comparable to the Vordingborg Boat, in a military context in the 12th-14th centuries Southern Scandinavia.

The Peeter wreck as an example of exchange and interaction in the Middle Ages

In May 2015, during construction works in Tallinn in Estonia, the medieval shipwreck was found inside the sediments of the former seabed. The wreck was at the depth of approximately three meters from the ground. The so called “Peeter wreck” from 14th century, has preserved as a complete site. This is a medieval merchant ship, a cog with rich find material. Many everyday items made of metal, wood, birch bark, leather, textile, clay and stone, have been found both inside and around the ship. The ship was built after AD 1296.

Similarity of the tree-ring series with the East Pomeranian oak chronology gives a basis to assume that the oaks used to build this ship were grown anywhere in east Poland or even in the region eastward of it. It is difficult to establish when the ship went aground but the preliminary study of pottery suggests that it happened around the second quarter of 14th century. The wreck, pottery, stone and other artefacts show a very broad geographical background.

The presentation will provide an overview of the research results, used 3D documentation and will demonstrate the Peeter wreck as an example of exchange and interaction in the Middle Ages.

Reinterpretation of the third sewn boat from the ancient port of Zaton in the vicinity of ancient Nin (*Aenona*), Croatia

The port of Zaton in the vicinity of the city of Nin, Croatia, was an ancient port of the municipium Aenona, in the province of Dalmatia. Intense port activity was recorded from the middle of the 1st century until the end of the 3rd century AD. It appears that it tapered off, ceasing about the beginning to the mid-4th century AD. The remains of a large breakwater are visible in the marine environment. At the inner (eastern) side of this structure, three sewn boats were probably scuttled, and left in shallow waters. The research campaigns in 1966 and 1982 resulted in the discovery of the boats Zaton 1 and 2. The boats were recovered in 1979 and 1987. As the hull remains were not recorded *in situ*, the data crucial to their interpretation was irretrievably lost.

This presentation deals with the boat Zaton 3, which still lies on the seabed. It was discovered in 2002, when it was cleaned and recorded within the capabilities of the team present at the site. Through joint efforts of the Archaeological Museum Zadar and the University of Zadar, the site was revisited in September 2019. The boat was found in a good state of preservation, with a length of 6.5 m and an almost entirely preserved keel. The paper presents the construction features of the hull, encompassing the massive keelson/mast step, with mortise to accommodate the mast.

The 2019 excavation campaign supplemented documentation from the earlier research, and yielded reinterpretation of the hull remains. Considering the six thoroughly recorded sewn boats from Classical Antiquity in Istria and Dalmatia (one in Poreč, two in Pula and three in Caska), the third sewn boat from Zaton provides additional knowledge on the construction and sewing techniques used in the Adriatic at the beginning of the first millennium. It is particularly noteworthy that the Histrian and Liburnian prehistoric shipbuilding techniques survived well into the period when mortise-and-tenon built ships sailed the Adriatic.

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Numerical modelling of flooding of an ancient ship

Ancient ships were capable of long-distance sailing while withstanding storms and heavy seas. At the same time, they were built of wood, therefore did not have a large structural safety margin in the case of collision or grounding. Wood behaves as a linear elastic material which suddenly ruptures. Due to that fact, even if these ships were not particularly large and were not sailing fast, so their kinetic energy was limited, they were indeed sensitive to structural damage which might lead to flooding. Flooding is the process of filling the ship's internal space with fluid through openings in bulkheads, decks, and other elements of the ship's structure. If flooding is excessive, it certainly leads to the sinking of the vessel.

The paper examines the topology of an ancient ship in an attempt to simulate the flooding process for several damage scenarios. A fluid-structure interaction analysis model is generated, modelling the ship as a rigid body floating freely in a fluid domain. Damage is modelled by removing supposedly damaged finite elements. The sequence and timing of flooding is observed. The scope of the paper is to compare the effect of different damage scenarios on the flooding sequence up to the loss of ship stability. The analysis estimates the time available to the crew in the case of flooding for each scenario. The research is carried out in the framework of the NEREAS Project (IP 2020-02-3420).

The potential of digitised historic archives for the interpretation of shipwrecks: examining the *Flower of Ugie*, wrecked 1852

The rapid digitisation and online availability of historical documents and archives related to ships is fast-changing the pace and scope of research, leading to an increased depth of interpretation of wrecks and a more nuanced understanding of their wider social significance and impact.

Between 2004 - 2011 archaeological investigation and research of the *Flower of Ugie*, a 350 ton sailing barque wrecked in 1852 in the Eastern Solent, UK, revealed initial details of the ships a 14-year career sailing the globe, trading across oceans and between continents, swapping sailing routes and cargoes depending on demand driven by economic and social circumstances.

Since this date a range of newly digitised records and archives have become available; this exceptionally detailed historical material is now available at the click of a button. These sources have provided information that has shed light on specifics of the ship's components and repairs, ports of call, incidents during voyages, time spent in port loading and unloading, cargoes imported and exported, and the role of merchants and owners.

Through such sources we now have a more in-depth understanding of the physical seabed remains of the *Flower of Ugie* and the impact of its career as both enabling and reflecting the multiscalar process of colonialism, capitalism and globalisation that were driving cultural transformation in this period.

While the historical sources used are not themselves new, the method of identifying and researching them has required technology for the digitisation, online presentation and rapid searching of archives, which is revolutionising access to data. Further growth in the availability of digital archives will further transform our ability to interpret ships and their roles in the complex web of international networks.

Cargo ship from Lake Onega and the Late Medieval shipbuilding tradition in Northern Russia

The wooden shipwreck was discovered on the southern coast of Lake Onega in 2018. The ship's bottom, eight floor timbers, and part of a side are well preserved. The flat bottom, made up of five boards up to 23 cm thick, had length 20.6 m, width 1.7 m. The largest frame was 5.8 m long. Part of the side had seven planks up to 6 cm thick, with dimensions of 11.4 x 1.05 m. The planks of the bottom were connected with wooden nails and iron bars, and the sides in clinker in the technique of sewing with the help of vitsa. The sealing of the seams i.e. caulking strakes was done with moss, fixed with laths and iron sintels. The reconstructed dimensions of the ship are about 22 m in length and up to 7 m width. The height of it reached over 1.5 m.

According to the dendrochronological analysis of wood, the ship dates from the second quarter of the 17th century (Zhavoronkov 2018). It belongs to the cargo ships used for lake and sea voyages. Judging by the size of the vessel, it can be interpreted as a *Lodia*. Parts of this type of ship have been found on the end of water way from Vologda to the White Sea. Some design features of the wreck have analogies among medieval boat details from Novgorod. Its location in the Baltic Sea basin shows that the ship could have been used, among other things, for trading operations in the Baltic Sea, known from written sources of the 17th century. The Sewn boat from Stockholm (Skeepargatan), dating from the late 17th – early 18th century and interpreted as Russian, had also some technological similarities to the find from Lake Onega. The development of traditional North Russian shipbuilding in the Baltic and White Sea regions during the medieval period becomes clearer as a result of the study of the shipwreck from Onega.

The significance of archaeological source data

From experience gained on projects such as the Newport Medieval Ship, Bremen Cog re-analysis, Poole Logboat analysis, and the Sutton Hoo digital reconstruction, all archaeology is contingent on the source data and everything stems from that. That source data, by its nature can be difficult to understand, and the study of ship remains often begins with the recording of seemingly trivial details such as the thickness of planks, the number and size of nails, or the direction of an adze stroke. Achieving a detailed understanding of both the object and the processes is predicated on the quality of the underlying source data.

Past reconstruction projects may have used the source data, but it is not always possible to understand or interrogate how that source data has been used or interpreted, due to the lack of published paradata. Consequently, the technology used to record site data is not a secondary concern but is central to the activity of site archaeology. We have an obligation to bridge the gap between the exclusive knowledge of the excavator and the published record, a mode of data capture and record that is devoid of interpretation, or where interpretation is inevitable, paradata is used to explain the human processes of understanding and interpretation of the data objects.

This presentation examines the development of methods employed in the surveying of an archaeological excavation site, in essence the capture and recording of the raw primary data from the site or artefact. Just as a site has stratigraphy, ships also have a stratigraphy in themselves, which must be carefully recorded. The rapid advances in both hardware and post-processing software means it is now possible to easily capture high volume and high-quality 3D data. This form of digital data should go a long way towards bridging the gap between the exclusive knowledge of the excavator and the published record, allowing lots of people to use the data in new and novel ways, and this raises the question: as archaeologists should we all be doing this?

The Adoption of the sail in the Early Bronze Age Aegean (ca. 2500/2400 – 2200/2150 BCE) and its impact on later Minoan, Aeginetan and Mycenaean seafaring

In this paper, the adoption of the sail in the Bronze Age Aegean will be considered within its broader historical context. It still is widely reported in the literature that the Minoans were the first people in the Aegean to adopt the sail, and that this happened towards the end of the Early Bronze Age. However, new evidence firmly places the appearance of the sail in this region several centuries earlier. Moreover, the earliest evidence for this new technology does not come from Crete but from islands in the Central Aegean, and there are strong indications that it was introduced by seafarers from the East Aegean. New studies also indicate that Minoan Crete adopted the sail later than previously thought. The earliest depictions of sailing technology on Crete date not to the Early Bronze Age but to an early phase of the Middle Bronze Age, ca. 1900 BCE.

This paper will place the first adoption of the sail in the Aegean within the context of the expanding Anatolian Trade Network, which linked the Aegean with Mesopotamia and the East Mediterranean. It is proposed that this trade network may have brought sailing technology, and possibly new shipbuilding technology as well, first to the western Anatolian coast and its offshore islands, and then to other areas of the Aegean. These new maritime technologies would have a major impact on the history of the Aegean in the Middle and Late Bronze Ages, as they facilitated the rise of Minoan, Aeginetan, and Mycenaean trade networks and control over the seas.

Waste disposal in the Netherlands as reflected in shipwrecks of the former Zuiderzee

The province of Flevoland in the Netherlands is known as the largest graveyard of shipwrecks on land in the world. In this province, which is reclaimed from the Zuiderzee between 1942 and 1968, over 450 shipwrecks have been found, during the drainage and cultivation of the land. Of all these shipwrecks, a total of nine could be identified as vessels carrying a cargo of waste. Only one dated from the second quarter of the 17th century; the other eight wrecks all date to from the 19th century.

One of these wrecks was found in 1973 at lot ZP 5/6, when a drainage ditch was further expanded. It was partially excavated in 1982, but was back in the spotlights in 2019 as part of a training project for students and volunteers in archaeology. It was an 18 m-long barge-like vessel, loaded with a cargo that at first sight seemed to be household waste. However, analysis of the composition of the cargo showed a completely different picture. The XRF spectrometer measured a high percentage of lead, but zero phosphate. The larger components were mainly coal and slag, and only 4% consisted of archaeological material as pottery, glass, bone and leather. This is not the typical household waste, but rather resembles waste from light industries.

This may shift the prevailing picture of waste disposal and transport in the Netherlands. On the one hand there were the heavily urbanized parts of the western Netherlands which struggled with their surplus of waste (mainly human excrements, farmyard manure, street waste, waste from cesspits, hearth ash and waste from agricultural products). On the other hand, there were agricultural areas, especially poor sandy soils and the exploited peat areas in the North, which were in need of manure. The only way those bulk cargoes of manure could be profitably transported was by ship.

In this paper we will explain the different cargo composition of the waste transporters found in the Netherlands, and look into the historical context of waste disposal and transport. The ship at lot ZP 5/6 and its cargo will play an explicit role in this.

Ships and shipping in medieval Flanders, the case of Hulst

This paper reveals the results of a research which started in 2011 and has been going on and off during the past years and is now in its concluding phase. It is part of a PhD project at the university of Ghent (Belgium) that focusses on the ships and shipping in late medieval Flanders (Belgium).

During a watching brief in the Dutch town of Hulst in 2011 several remains of shipwrecks have been found as part of the medieval harbour quay. In just a few days the structures had to be recorded. No funding was present for further dendrochronological study, for the analysis of the caulking or for an in-depth study of the construction. Only in the years to follow budget was made available to study these finds in more detail. These re-used ship timbers represent four different ships with various construction features, dates and places of origin. They date between first quarter of the 13th century and the early 14th century and have their origin either in the Low Countries or the Baltic.

For the first time a trade link was thought to be found between this modest town at the river Scheldt and the Baltic since two wrecks could be linked to the region of Lübeck (Hulst 2, c. 1223) and Gdansk (Hulst 3, c. 1302-1315). Repairs on the former vessel showed that it had repairs done in southern Scandinavia.

At a second glance the ship timbers might represent the growing number of recycled ship timbers known in the Scheldt estuary during the late medieval period and might even be linked to the ship graveyard where the Doel cogs were found. Hence these boats could have traded with Antwerp rather than with Hulst.

In this paper the research since 2011 will be presented and comparisons will be made with similar wrecks in the Low Countries and the Baltic and an insight will be given into the framework of recycling ship timbers in late medieval Flanders.

A 13th-century shipwreck with ‘cog’ features, investigated off Skeppstad, western Sweden

During an aerial survey of filamentous algae distribution along the Swedish west coast in the summer of 2008, a distinct ship-shaped feature was observed in shallow water in the Jorefjorden estuary, approximately 100 km north of Gothenburg. A subsequent archaeological diving inspection, conducted in 2009, revealed a wooden shipwreck, 17.4 m long and 5.5 m wide.

Dendrochronological analysis suggests that the vessel in question was built in the early 1260s from oak trees originating in the Ardennes. This implies that the timber used for its construction was floated down the river Meuse, and that it was either built somewhere along the river or further downstream in the Rhine–Meuse–Scheldt delta, which today constitutes the southern part of the Netherlands.

Minor investigations of the wreck site in 2012 and 2013 have shown that the vessel was built in the lapstrake fashion, with a straight stem and sternpost and massive through-beams. However, since the bottom section of the wreck is missing, it has not been possible to determine whether it was flush-laid, as is the case in contemporaneous ‘cogs’ and other bottom-based vessels, or clinker-built like the rest of the hull. The missing bottom section is presumably also the reason why so few artefacts were found during excavation, and that no traces of a cargo were identified.

Investigations have thus shown that the Skeppstad wreck is clearly an exponent of the so-called Ummelandfahrt, that is, the hazardous circumnavigation of the Skaw (Cape Skagen), which allegedly commenced during this period due to the partial sanding-up of the Limfjord strait. The purpose of this contribution is 1) to present some of the preliminary archaeological findings, made during investigations of the wreck site, and 2) to briefly discuss these findings in relation to Ummeland voyaging more specifically.

17th century turf shipping in the Dutch Zuyderzee area: historical maritime archaeology

In this presentation I'll discuss the results of the excavation of a peat transport vessel found in the polder of the former Zuyderzee and dated 1638-1664 AD. The 20 m long cargo ship contained a large amount of peat bricks, combustible destined for Amsterdam. The find will be interpreted in the context of the large scale peat extractions in the north of the country and within the maritime transport landscape of the Zuyderzee. Based on the elaborate inventory found in the wreck, the biography of the skipper can be reconstructed. This shipwreck offers convincing evidence of the importance of inland shipping for the remarkable socioeconomic developments during the Dutch Golden Age.

A Bronze Age Logboat from the Starnberger See near the Roseninsel, Bavaria, Germany

In 1986 a logboat of 13.34 m length was discovered near the Roseninsel in the Starnberger See. After its documentation under water it was handed over to the Archäologische Staatssammlung München in 1989, where it was conserved with PEG. The logboat, dendrodated to 900 BC, had not sunk in upright position, but had listed to starboard. Therefore the portside, the bow and about two-thirds of the upperparts of the starboard side are missing. Though a drawing had been made, it proved to be insufficient. Therefore a 3-D-documentation became necessary. With the help of these data it was possible to place the hull into its suggested floating condition. It showed that the balk at the stern was originally above the waterline or just below. On the inside of the block, which forms the “transom”, a step was cut on starboard. Together with the balk the shape of the stern is unique. Unfortunately, the centre of the trunk at the bow could not be identified, therefore the original shape of it could not be reconstructed. But with the help of the 3-D data the reconstruction of original breadth and depth in the aft part of the vessel was possible. Inside the hull there were several toolmarks. Oblong grooves were carved into the inside of the trunk. Further there are particularly in the block at the stern several auger holes whose intention remains open. Another auger hole at the bow indicates, that it was crowned by some kind of decoration. In the starboard side there are several large, oval holes of unknown function. Perhaps they may be regarded as a hint for forward-facing or push rowing, though this technique has not yet been recorded from prehistoric times in Central Europe. Since there were no bulk goods like salt to be transported across the Starnberger See, it could have been a warrior or ceremonial vessel.

The Sutton Hoo Ship Reconstruction: Recording the Reconstruction

The early seventh century AD Anglo-Saxon ship burial from Sutton Hoo in Suffolk, England, is one of the richest and most important ship burials from early-medieval northwest Europe. The imprint of the 27m long ship, left behind in the soil, attests to a large clinker-built vessel fit to contain a royal burial. While the general nature of the ship has been understood since its excavation, the detail of the vessel has not been fully investigated from an experimental archaeological perspective. An ongoing project seeks to undertake the full-scale reconstruction of the ship in order to better understand its use, performance, and deposition. Phase One of this project was concerned with 3D digital reconstruction and hydrostatic testing of the hull, prior to full-scale physical reconstruction. This work was published in early 2020 signalling the completion of the opening phase of the project.

Focus has now shifted to the full-scale reconstruction of the ship (Phase Two). But the opportunities for digital methodologies to assist in answering new research questions continues. In particular, the project aims to record and track the individual vessel components as they are created, and the parent logs that they are created from. This, in conjunction with repeat 3D recording of the emerging ship structure, and timber sampling to create a dendrochronological resource, will create an unparalleled record of an experimental ship reconstruction across all stages. This will allow the project to undertake analytical comparison of the Phase One digital reconstruction, with the full-scale built ship from Phase Two, and eventually to identify changes to hull shape as a result of use in the sea-trials that will comprise Phase Three. This paper provides an update on the project so far, explains the methodological detail and choices underpinning the recording system, and summarises the initial results of this process.

Toward a virtual reconstruction of the Punjulharjo Boat in Rembang, Indonesia: 3D photogrammetry and analysis of the hull

The Punjulharjo boat is the most complete wooden boat built using the South-east Asian lashed-lug technology found to date. The seventh-century AD boat was found in 2008 and is currently displayed *in situ* after being treated in a lengthy conservation process. The Punjulharjo boat offers an invaluable evidence for understanding ancient boatbuilding technologies in the region and to help in the interpretation of previous incomplete finds and future discoveries.

The proposed paper presents the preliminary results of the first 3D photogrammetry of the boat, conducted with the aim to analyse and examine in detail the characteristics of the hull from a renewed perspective. The 3D model obtained from the photogrammetry was combined with *in situ* observations and close examination of the hull, as well as with results from previous archaeological investigations of the boat.

Over a decade the boat condition has been altered from when it was initially unearthed, the present research contributed to understand the current state of the boat, and to explain hull changes occurred during the depositional process and after the restoration. Such analysis of the hull also aims at a future hypothetical digital reconstruction of the boat.

The research also assesses the reliability of the approach in general, applied to the study of ancient and contemporary ships and boats in Indonesia, where the documentation method is mostly still rudimentary, to propose future plans for this research.

An early 17th-century ,half-carvel' construction in the North Frisian Wadden Sea: The Japsand wreckage near Hallig Hooge, Germany

In February 2017 an articulated slab of mixed lapstrake and carvel planking was discovered east of Japsand, an outer shoal of the island of Hooge in Germany. In May another slab of evidently the same wreck was discovered at a distance of 400 m. With a *terminus post quem* of 1609 it is the second oldest so-called ,half-carvel' construction hitherto known after the Åkroken wreck of 1577 from the Swedish town of Sundsvall. Half carvel constructions are mainly linked to Sweden and occurred between the 16th to the mid 20th century, but similar constructions are also known from Denmark, Norway and northern Germany. In contrast to most Scandinavian half-carvels, this wreck is built entirely of oak, which originated from a singular source in southern Sweden or northern Germany. Both the timber selection and way of construction indicate a rural origin, which is consistent to the type's preconceived perception. The find location in an inhospitable and dangerous part of the Wadden Sea – bereft of natural harbours and sheltered anchorages – and the wreck's fragmentary state suggests a violent loss, which may have been linked to a natural disaster like the historic storm floods of 1625 or 1634, which depopulated the North Frisian Islands.

The location of the wreckage in the intertidal zone posed an additional challenge, as it was only accessible at low tide after traversing nearly two kilometres of tidal mudflats and creeks. The circumstances required a fast recording methodology, as newly discovered wrecks are swiftly reclaimed by the sea in this part of the world. It included an extensive photo-documentation for the creation of a SfM-photomosaic, *in situ* recording, and dendro-sampling. Another critical factor was the involvement of the island community, which local knowledge proved of vital importance for the reporting of new archaeological sites and the logistical support on site.

POSTERS

Photogrammetric techniques for 3-d underwater record of the Late-Imperial Torre Santa Sabina's shipwreck

The possibility offered nowadays by the adoption of digital photogrammetry techniques allows one to virtually reconstruct the surveyed underwater assets to make it accessible also remotely, via visualization and dissemination platforms (online or offline). In order to improve the study of the documented cultural heritage artefacts and sites, it is crucial to adopt the right photogrammetric principles to achieve 3D metric products that are consistent and coherent with the real object of the survey. This paper is related to the photogrammetric survey of the late-imperial era roman shipwreck, located in Baia dei Camerini, Torre Santa Sabina (BR), Italy, in the framework of the project UnderwaterMuse (Italia-Croatia 2014-2020 Cooperation Programme).

An integrated topographic and photogrammetric (underwater and UAV) survey has been conducted, and in the present research the last advancements in the underwater photogrammetry data acquisition and processing will be addressed in combination with the UAV achievable products.

The application of virtual reality and augmented reality will be exploited to provide 3D reconstructions and immersive virtual tours capable of enabling virtual fruition of the heritage (both naturalistic and cultural). These reconstructions could be exploited in Museums, MPA's visit centers, all the regional network of the places of culture but also directly in situ, through interactive fruition systems of the underwater archaeological heritage, based on simple underwater tablets, connected to an aerial for the reading of data recorded on tags placed near the archaeological finds.

A Hellenistic Shipyard on the Telephos Frieze: A Representation of the Shipwright's Toolkit

The Telephos frieze of the Great Altar of Pergamon (panels 5 & 6) on display in the Pergamon Museum, Berlin, contains important information on boat construction, tools, and working practices within a Hellenistic shipyard. The scene depicts the building of a small boat for Auge, the mother of the hero Telephos. It has been primarily discussed by Hellenistic sculpture experts and classical historians but not by scholars of ship archaeology in any detail. The small boat or skiff on the Pergamon Altar differs from the majority of textual sources on the myth of Telephos recounting that King Aleus sent his daughter Auge in a chest away to sea.

This boat is shown in the process of being built and at an important moment of its construction, just before the final completion of the set-up of the frames. The scene thus affords a rare representation of shell-first construction, confirming observations from earlier work on shipwrecks. However, the panel on the frieze is damaged so that some parts of the tools and the craftsmen's arms are missing. An understanding of the technical aspects displayed on this scene is only possible with a comparative examination of tools from shipwrecks found in the past few decades and a rigorous study of other visual representations. A comparison with these different sources offers exceptional insight into Hellenistic shipbuilding. Our focus will be on the specialized tools employed by trained workmen in their construction of a small boat: the bow saw, bow-drill, two-handled adze, mallet, and chisel. In addition to identifying each implement of this boatbuilding toolkit, we explore their precise function in ship construction, providing valuable documentation that will allow for further experimentation in nautical archaeology.

Boats of Corsica: a study of several maritime Ex-Voto

Located at the very heart of the Western Mediterranean, Corsica island is well integrated into the maritime network routes. Very active harbours and ports are originally genovese citadels more open toward the sea than the mountains inland. We know little about the ships sailing along those shores. Their waters are generally too shallow and the bays too narrow to allow ships of significant tonnage to approach. We set aside the modest but useful *latini*, *gondole*, *scafi*, *schivi*, *barcelle*, *vilucce*, *saette*, *corazelli*, *piatte*, *gozzi*, *bovi*. Nowadays few exemplaries of the *traditi* “*felouque*” from Bonifacio are surviving, all made by the shipyards of Ajaccio. The last one closed 40 years ago. In this article we will present some of this coasters and little fishing boats sailing in Corsican waters between the 19th and the 20th centuries. We aim to present a new typology of this boats known from historical and iconographical sources in order to describe their characteristics and identify the adaptations to the Corsican environment and to the local societies that built them. We will rely on new iconographical sources of the maritime *Ex-Voto* preserved in the island’s chapels, and examined during a 2018 survey. A Maritime *Ex-voto* (coming from the latin *Ex Voto Suscepto*) can be a painting, or an object in relation to a maritime event, given to a sanctuary as a reward to God or a Saint. The donor generally survived to a misfortune or an accident. He depicts it and sometimes describes the events in a dedication. The paintings can be a great source of information for the architectural details of the ship, the maritime routes, or the emergency procedures followed during extreme weather conditions.

This study was carried out within the research framework of the author’s recently defended PhD, with the collaboration of the LA3M laboratory (Aix-Marseille University, France) and the IPSO FACTO Company. This work was co-directed by Nicolas Faucherre (CNRS-AMU) and Eric Rieth (CNRS, Paris 1 Panthéon-Sorbonne).

The Scheurrak SO1 shipwreck in the Maritime Cultural Landscape of the Early Modern Netherlands, 1550-1650

In 1984 a well-preserved merchantman dating back to the late 16th century was discovered off the coast of Texel (the Netherlands). During subsequent excavations, over 3000 finds were recovered. A cargo of grain links the ship to the Baltic grain trade. Construction features indicate that the ship was built ‘Dutch Flush’. Many aspects of the site were studied over the past 25 years, yet a holistic and interdisciplinary interpretation is still absent. The University of Leiden was assigned by the Cultural Heritage Agency of the Netherlands to conduct a combined archaeological and historical research to fill this hiatus.

The project comprises two doctoral studies (both 2020-2024). A first study, titled “Innovative in a conservative sector: ‘Dutch Flush’ in a European perspective, 1550-1650”, will focus on the ship’s construction. By comparing Scheurrak SO1’s construction in both a European contemporary and regional diachronic perspective, it aims to further determine characteristics of Dutch shipbuilding in a period of technological transition. By elaborating these findings within the larger context of the ‘maritime cultural landscape’, this research intends to understand why the Dutch were able to become highly successful shipbuilders with a rather conservative shipbuilding technique.

A second study, titled ‘The Material Culture and the Dutch Baltic trade, 1550-1650’, is embedded in the historical discipline and studies the objects found at the wreck site as a reflection of the Dutch early modern society during the era of the Baltic trade. Besides, this research aims to place the ship in a broader historical context and its maritime cultural landscape. In order to achieve this, the study of the archaeological finds is combined with thorough archival and literature research. The output will be a comprehensive historical study on the Scheurrak SO1 shipwreck on the interface between maritime history and archaeology.

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3D digital study of the historic ship-model ‘Aris’ from the 19th century – VHSS

The 3D representation and study of a historic ship-model of the brig “Aris” was undertaken during the implementation of the project “VIRTUAL HISTORIC SAILING SHIPS-VHSS” by the Institute for Mediterranean Studies (IMS) of the Foundation for Research and Technology Hellas (FORTH) and the Department of Product and Systems Design Engineering of the University of the Aegean.

The project is focusing on the creation of 3D digital models of 19th century sailing vessels based on original data including 3D physical scaled models, drawings, old photographs, technical descriptions and other contemporary artifacts.

The physical 3D ship-model of “Aris” is in the permanent exhibition of the Benaki Museum / Athens. The model was donated to the Museum in 1933 by the descendants of the Admiral Andreas Miaoulis (1769-1835) and according to the records it was probably built during the lifetime of the Admiral. It has a length of 64.7 cm and it is planked on the starboard side and unplanked on the port side. Parts of the inside structure of the model are visible and directly related to the structure of the real ship. The model represents the hull of the brig “Aris” built around 1813 in the shipyards of the island of Hydra. “Aris” became the flagship of the Greek fleet during the Greek War of Independence (1821-1830) and unregistered some time before 1834.

The digital 3D recording of the model together with other sources like contemporary descriptions, painting of the ship and its figurehead (National Historic Museum / Athens) offer a corpus of information that allows us to create a virtual reconstruction of the historic brig “Aris”. The reconstructed model will be used as a basis for the development of interactive virtual and mixed reality applications for demonstrating its construction process and simulating its sailing.

Ancient Egyptian ship & boat models - Between theory & simulation

The vessel models discovered inside ancient Egyptian tombs can be potentially rewarding sources of information as three-dimensional proxies for their full-sized counterparts. While tomb paintings may show a great amount of detail, generally, the cross-section of the vessel is unseen. Consequently, ship and boat models are significant for the three-dimensional evidence they contain. The question is, can models be related to full-size vessels and give information about their design and development? This relies upon the extent to which we can be confident that the ancient Egyptians were accurately miniaturizing objects for use as “ex-votos”. Clearly, if they did then the rich variety of vessel models found in tombs can be used to augment the sparse nautical archaeological evidence from Egypt. Yet this translation from model and tomb painting to real-world vessel is by no means as straightforward as it might first appear.

My research focuses on documenting, observing, and testing Egyptian vessel models using naval architectural software. In this presentation I will aim to address the role that vessel models can play in order to better understand and envision ancient Egyptian ships and boats through case studies on three groups of models from the Old, Middle and New Kingdoms tombs. To what extent are the techniques from the science of naval architecture helpful for the analysis and interpretation of the ancient Egyptian shipbuilding industry?

The analysis revealed that full-sized versions of all of the vessel models in my corpus could have effectively sailed on the Nile. Interestingly, the models and iconographic evidence from the tested groups have the same hull lines and flat bottom. It appears that while the modeler created these models approximately to scale, the draught is much shorter than would be expected. This is also demonstrated in the experimental work on full-scaled versions of these models, which indicated that the flat-bottomed vessels could not have functioned well in the water. By increasing the draft line to create a more rounded hull bottom, followed by the re-examination of their hydrostatics and stability, it has been shown that increasing the draft length results in a stable hull with the ability to resist short waves characteristic of the Nile. It is, therefore, clear that while boat models are in certain ways accurate representations of ancient vessels, they are also compromised as a source of evidence by other more practical considerations: in this case, perhaps the need to stand the model on a flat surface, or to present it – as is also the case in the tomb paintings – as floating on the waters of the Nile.

The remote sensing survey off Malta - approaches to the mapping of an island's territorial waters

Side Scan Sonar as a technique for surveying is a well-known & established method, commonly known to be used with a “towed system configuration”, operated from a boat, which tows the device and controls the survey. In archaeology, this technique can be used in different kind of surveys, such as “blind” surveys, documentation of specific areas or sites with known remains which are non-accessible, etc.

The Malta Shipwreck Project, conducted by the University of Malta is aimed at surveying Malta's territorial waters, in order to create a map of archaeological remains located on the seabed. Since 2018, this work is executed using an Autonomous Underwater Vehicle (AUV). Its main payload is an Edgetech dual-frequency (600/1600 Khz) Side Scan Sonar. Due to the capabilities of this particular AUV (stability and battery autonomy), it is able to produce images that are of much higher definition than traditional towed systems. Another advantage is the doing away with long turns associated with working with a “towed fish”.

In the results obtained from the surveys conducted with the AUV, various kinds of information are obtained (kind of seabed, bathymetry, presence of anomalies, trawling signs, geological formations, etc.). These are useful for fields of research that go beyond the realm of archaeology.

In this poster we will highlight the methodology established by the UM's team, with the aim of being able to document a site in detail from the discovery until verification stages. Using a combination of approaches the team is able to obtain various deliverables that range from large maps of the seabed to very detailed high-resolution imagery of archaeological targets. Such information guides the last stage of recording which is the recording of the site as a 3D photogrammetric model.

The Sails of the Lyon Mummy

The textiles of the mummy preserved in the Musée des Confluences, Lyon, present new perspectives for the study of sails in Hellenistic and Roman Egypt. The remains of a forty-year-old man were wrapped in textiles that appear to have belonged to at least three different sails, one of which was made of cotton. The first results published under Jean-Claude Goyon's supervision in 1987 detailed seven layers of shrouds that included padding textiles. In a selective study, Jean Rougé identified the remains of a sail and one brail-ring. Linen fabrics were recognized during this first examination, which was to be expected in an Egyptian funerary context. Our new investigation has revealed the presence of hemp strings and a yellow wool strand, the latter find proving to be unanticipated. Even though wool was more suitable for dyeing in antiquity, it was forbidden for religious ritualistic use in Egypt.

In our presentation we will provide a reappraisal of these fabrics, focusing in particular on the padded textiles that were not part of the first study by Goyon due to their poor state of preservation. These fragments include a four-meter-long strip punctuated with small hemp strings fastening the brail-rings. Two of the three sails appear to have been similar to those represented in various iconographical sources. Our study also presents the first examination of a hieroglyphic inscription and remains of paint.

This review offers new insight into the manufacture and technical features of ancient sails of the 1st century CE. The presence of specific signs of wear, multiple repairs, as well as their final use as a shroud shed new light on the value and significance of ship sails in antiquity and their afterlife when reused.

Shipyards in Egypt between antiquity, nowadays, and the future

Sea and seafaring had played an extensive role in building civilizations in the Mediterranean region; therefore, it is required to study the Mediterranean ships. However, ships have always been studied as machines, but it is not common to study shipyards where ships were built and repaired. Studying shipyards reveals evidence that supports the studying of ship construction and building techniques. Shipyards indeed reflect both the materialistic aspect represented in used tools and material, and the cultural aspect represented in laborers and builders. Many of the archaeological excavations around the Mediterranean generally, and in Egypt specifically revealed indications of shipyards, which will be shown through the poster to illustrate the main features of shipyards and also, the differences and similarities between these features through history.

As the primary theme of the symposium is sailing through history, this poster aims to present shipyards in Egypt in antiquity, and nowadays, in addition to their future outlook. Ethnographic research is the main methodology used in this study to define the characteristics of nowadays shipyards, as well as the archaeological and historical evidence to read the past of shipyards and imagine their future.

***Condura Croatica* – A Revision of the Structural Drawings**

Two early Croatian wooden boats of the *Condura Croatica* type were discovered at the mouth of the Nin cove in 1966 and 1968. These boats are late eleventh or early twelfth century vessels and are unique examples of the maritime tradition of the medieval period early Croatian rulers. In 1974 the boats were extracted from their marine environment, followed by the conservation and reconstruction of one of the boats and the exhibition of both at the Museum of Nin Antiquities, a division of the Archaeological Museum of Zadar. As time passed, however, significant degradation processes were observed of the wooden elements of these boats. The University of Zadar worked with the University of Tel Aviv in 2008 and the Texas A&M University in 2010 to analyse samples of the wood: it was determined that a range of chemical and physical processes, and the inadequate conditions in which the boats were kept, was causing the destruction of the wooden structure. Based on these insights a comprehensive conservation-restoration procedure was initiated in 2016. The project is funded through the Ministry of Culture and Media and carried out by specialists of the International Centre for Underwater Archaeology in Zadar. During the cleaning of the frames it was observed that a gap filling mixture was present at a thickness of up to five centimetres between the planking and frames. Bearing in mind the possible spreading out of the boat's planking that may have come about during the sinking of the vessels, the effects of the seawater, and the possible dimensional changes that occurred during the process of the impregnation and drying of the wooden material, there is an evident need to revise the structural drawings. With the aid of new digital imaging and the production of the lines of the boats on the basis of these images, we will endeavour to ascertain if the current state of the *Condura Croatica* boats is consistent with their original form.

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Uncertainty in the reconstruction of the ancient ship hull and its impact on sailing characteristics

Reconstruction of the original form of the hull of an ancient ship is often made based upon a limited amount of evidence. Commonly, only parts of the ship's hull and cargo are found on the shipwreck site. Due to the absence of information, it is inevitable that each reconstruction relies on assumptions to fill in missing data. The resulting hull form is, therefore, just one of many possible hull forms. The reconstructed ship's sailing abilities, cargo space, displacement, and other ship characteristics, such as structural arrangement and scantlings, are directly related to the assumptions made during the reconstruction process.

In the framework of the NEREAS Project (HRZZ IP-2020-02-3420), we examined the effect of variations of the hull form on resulting ship characteristics, namely resistance and stability. The Kyrenia ship reconstruction was chosen as the study case. The Kyrenia reconstructed hull form was altered by reducing and enlarging the ship's beam by 5% and 10% respectively. The Holtrop method was used to estimate the resistance of different hull forms, and the effect on ship's speed was examined. Furthermore, the application of the Holtrop method was validated by a state-of-the-art Computational Fluid Dynamics calculation. Finally, stability of the ship in the case of each of the developed hull forms was examined. Further research may include variations of the structural arrangement and structural elements scantlings and joints resulting from the differences in the reconstructed form of the ship's hull.

Potkamenica Bay Shipwreck, Croatia

Archaeological excavations were carried out at the site of the shipwreck in Potkamenica Bay in 2020. The main goal when implementing this program was the research and documentation, although the most important was the protection of the ship structure threatened by further devastation. Besides the employees of the ICUA Zadar, the members of the UPA Rostrum Split participated in the project. In just 5 working days, 4 archaeological probes were opened at the position where it was determined that the ship structure was the best preserved. The excavation exposed a keel, measuring six metre in length with an interesting joint—an elaborate hook scarf, 35 partially preserved planks, and nine futtocks. The planks, which formed the ship's outer shell strakes, were joined with a system of mortise and tenon joints with a practically uniformed spacing of approximately 17 - 20 cm. The frames were inserted after the fabrication of the planking (shell-first construction), and the discovered futtocks were joined with large trenails. Along with traces of burning on some parts of the structure (the futtocks and part of the outer planking), we also identified traces of pitch that was used to improve the impermeability of the constantly submerged parts of ship's hull. According to the preliminary analysis of ceramic materials, the shipwreck dates to the end of the 4th or the very beginning of the 5th century.

In addition to the classic design documentation of the floor plan and profile, about 1000 photos were taken for the purpose of rendering an orthophoto mosaic and a 3D model. Documenting of the ship's remains would not be possible without the use of modern technology. In just 5 working days, the shipwreck was fully excavated and documented, followed by weeks of processing the collected information.

Using 3D technology for documentation and interpretation of newly discovered shipwrecks and underwater sites near the islands of Šćedro and Hvar, Croatia

The island of Hvar and the small, isolated island of Šćedro adjacent to it are situated in the middle of the Eastern Adriatic Coast. They are located on the most significant navigation route in the Eastern Adriatic. Both islands were inhabited from prehistoric to present times due to fertile plains, sources of fresh water and protected and safe coves. The only connection with other islands and the mainland were through maritime routes. Therefore, there are numerous archaeological underwater sites around those islands that have been recorded and explored for more than 200 years. In the last few years, thanks to great collaboration with the local population, divers, and fishermen, several new sites of intact shipwrecks were discovered. These include two shipwrecks with cargo of amphoras from the Roman Republican period located near the island of Šćedro, a Late Roman shipwreck with ballast stones, and the cargo of a boat from 16/17th century located in the Stari Grad Bay on the island of Hvar. The shipwrecks were recorded using 3D technology. More than 4500 photographs were shot and processed to obtain precise 3D model of the sites. 3D models were analysed in detail regarding the typology, determination and amount of the cargo, shape, dimensions and dating of the vessel, circumstances of the wreckage, as well as their interaction with terrestrial and submerged sites on the islands such as pier and villa maritime on the island of Šćedro and the Hellenistic and Roman port of Pharos/Pharia on the island of Hvar. All those locations were also documented by 3D scanning. In addition to the precise documentation of those sites, 3D models assist in the development of guidelines for future excavations as well as site protection and VR presentation.

Paphos harbour and vernacular shipbuilding in Cyprus: proposing a new approach on examining its condition in the Middle Ages (12th-16th century)

Paphos harbour was notoriously famous in medieval sources as a poor choice for a vessel to dock at. Ongoing silting, persisting for many centuries, earthquakes, and overall neglect to repair its installations, had rendered it useless to large vessels. The occasional accounts of such vessels using the harbour make one question the actual situation at the only large haven in western Cyprus. The author collected and reviewed written sources (12th - 20th century), and the available archaeological data. These were juxtaposed with late 19th -early 20th century photographs presenting traditional wooden vessels docked at the harbour, to investigate harbour conditions, navigability issues and how the two may have affected seaborne trade. The present paper draws data from two ongoing projects, on settlement systems in Paphos region (12th - 17th century) and the Intangible Maritime Cultural Heritage Project respectively. The two distinct datasets provided a multidisciplinary basis to gauge the deterioration mentioned in sources, creating thus a new layer of information to understand cycles of development and decline of coastal settlements in western Cyprus.

The digital reconstruction of the P3 wreck hull

The P3 wreck was discovered in the submerged remains of the medieval harbour in Puck Lagoon, Poland in 1979, one of the four lapstrake vessels found at the site. It was recorded underwater and salvaged in 1990; the individual planks and other timbers were then passed on to conservation in the National Maritime Museum in Gdańsk. The wreck is a clinker vessel, built accordingly to the Slavic shipbuilding tradition and interpreted as a cargo ship, dated dendrochronologically to the 1150s. Almost half of the hull is preserved, including the stem. Taking into consideration the scarcity of such well-preserved finds in the Southern Baltic, the P3 wreck remains an important source of our knowledge on the maritime tradition of the region in the times before Hanza.

Following the procedures developed and used for the digital reconstruction of another Puck harbour wreck, the longship P2, the timbers of the P3 cargo vessel were documented in 3D using the Faro Arm recording device. With the use of field documentation this allowed digital reassembly of the individual timbers into the wreck as it was originally found. On that basis a reconstruction of the complete hull was prepared and tested for hydrostatic properties.

Fishing boats in El Max. Historical and Ethnographic study

El Max is located in the west of Alexandria governorate, Egypt. Its name reflects the name of one of the taxes which was collected from ships in this area.

El Max was actually a fishermen's community located around the freshwater Mahmoudiya canal, which was dug in 1820 by order of the governor Muhammad Ali in order to bring water from the Nile to Alexandria and also to be the route for cargo ships. It is a sub-canal from the Nile River which goes through Alexandria, ending in the Mediterranean Sea. In this area, the waters of the Nile are mixed with sea water, resulting in a different marine environment.

The canal was named in the past after Sultan Mahmoud II, Sultan of Istanbul, as Egypt was at that time part of the Ottoman Empire. The canal played an important role in navigation during the 19th century.

When the canal closed to navigation, a group of fishermen took up residence on the quayside, creating small nests, with their numbers increasing as the fishermen started to turn these spots into homes. These changes happened during many generations of fishermen. The homes that hugged the waterway, lined by boats at the entrances to the homes, became a wonderful sight. Perhaps the most distinctive scenes in that region are the gatherings of fishermen on boats to weave nets and prepare them for fishing. The daily life of the residents was limited to fishing, as well as storing and selling fish.

A few months ago, the government decided to remove all houses which are located on the canal as part of a national project, so the researchers worked to document the site through visits, capture photos, and do several interviews with fishermen there to record the development of boats, fishing, and navigation methods before the site was demolished.

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Documenting a 20th century wooden vessel at risk: the Agios Spyridon project

Agios Spyridon was a 24-m long wooden vessel, built in 1950 in Crete. It was registered in Cyprus in 1954 and was used as a fishing trawler until 2004, when it was withdrawn according to EU Fishing Policy. The boat was preserved as a monument of the local cultural heritage. This plan was never materialized, however, and in 2018 the Municipal Council of Polis Chrysochous / CY decided that the vessel, which had remained out of the sea for 15 years without any maintenance, should be destroyed for safety and aesthetic reasons. Despite all efforts to the contrary, the loss of the monument was unavoidable. In order to mitigate the consequences, the Maritime Archaeological Research Laboratory of the University of Cyprus (MARELab), in collaboration with the Cyprus Institute and with the support of the Honor Frost Foundation, initiated a project of controlled destruction and detailed recording, in 2019, the first of its kind in the eastern Mediterranean.

Following a rescue excavation approach, every phase of the vessel's dismantling was fully recorded, using both conventional and digital methods: a 3D model was produced with photogrammetry and laser scanning, whereas 2D architectural drawings were also used for the analysis of the structural elements of the hull. The project also included activities for raising public awareness of the importance of historic ships and vernacular shipbuilding, and critical parts, such as the engine and the fishing gear, were preserved for further study and a possible future exhibition.

This paper is a preliminary report of this multifaceted project, and discusses the main phases of the project, all related with the protection and preservation of Maritime Cultural Heritage of the recent past. Methodological and logistic challenges are also discussed, with a focus on the potential of digital tools for a comprehensive recording of ships at risk.

The Contribution of historical sources in the reconstruction of the *Nin 1* original hull form

The ships *Nin 1* and *Nin 2* were discovered in the late 1960s in Nin, north of Zadar. They were recovered in 1974, and tentatively dated to the 11th century AD. In the late 1990s two vessels inspired by the archaeological finds were built, but their construction process did not fully consider all of the archaeologically recovered ship characteristics, leaving the modern vessels as something less than replicas of the ships excavated at Nin.

Reconstruction of the original form of a medieval wreck is a complex hypothetical process, in which the quality and quantity of the archaeological data considerably affects the reliability of the final result. However, every wreck presents problems of structural distortion and fragmentation that must be solved in some way to arrive at a coherent and convincing result. For this reason, the reconstruction process is inevitably subject to methodologies of study, interpretations and choices which, in any case, can never lead to a single and incontrovertible solution.

In general, the difference between these methodologies lies in the type of approach to the object of research and the criteria for the analysis. In many cases the archaeological data relating to a wreck are analyzed with an approach and methodology strictly connected to the criteria of modern naval engineering to obtain an optimal and measurable hull form in terms of efficiency and sailing performance. The main purpose of this method is to discover the technological level reached in the geo-cultural area at the time of the ship's construction.

The aim of our poster, realized in the framework of the NEREAS Project (IP 2020-02-3420), is to illustrate a different approach to the problem, using written and iconographic sources on medieval and late medieval shipbuilding. In other words, we intend to contextualize the wreck from the historical-technical point of view and to formulate a hypothesis regarding the design system and tools used by the builder to conceive the forms and to outline the structures of the hull.

The Galea Magna shipwreck. Archaeological evidences and archival sources of a Venetian war galley of 1598

The underwater archaeological site of Torre S. Sabina (Carovigno, Brindisi) is the setting of a pilot intervention within the UnderwaterMuse Project, due to the quality and variety of the contexts in the bay. It is a “super-site”, with stratifications of events that are also significant indicators of the evolution of the coastal landscape: cargos and hulls, but also remains of quarries and settlements.

One of the main goals of the last campaign 2020 was to ascertain the identification of various finds brought to the light during the previous ones, since 1998, hypothetically attributed to a Venetian ship; the accurate researches in the Venetian archives and the study of the recovered artifacts allowed us to recognize this finds as the scattered remains of the Galea Magna, that sank at the entrance of the bay on the 1st January 1598.

The archaeological material from the shipwreck includes Venetian glazed pottery fragments, silver coins, glass fragments, weapons, artillery projectiles, iron helmets and metallic finds. It allows making some assumption about soldiers' personal equipment (Fanti della Serenissima) and life on board. Between the artifacts there are a long rifle, identified as a “archibuglio da posta” and 23 helmets, “borgognotte” and a “bacinello”. The identification of the shipwreck was confirmed thanks to the correspondence of the Venetian ambassador in Naples, Giovan Carlo Scaramelli, with the Senate of the Republic of Venice. The diverse studies have now been completed and allow us to reconstruct the route from the harbour of Canea to Torre Santa Sabina, to understand the reasons of its sinking and to achieve several information about navigation and life on board Venetian War Gallies of the late 16th century.

St Nicholas' Bay on the Island of Pag, Croatia

St Nicholas' Bay is situated in the Gulf of Pag, south of St Nicholas' Cape and the so called Gate of Pag. Thanks to its position, the bay is sheltered from strong north-eastern wind (Cro. *bura*), and partially also from the winds from southern and western directions.

Just after rounding the Cape to enter St Nicholas' Bay there is a small 15th century church of St Nicholas. The Statute of Pag (1433) mentions this church as the place where the communal fee for wine trade should be paid. The site was active from the 15th to the beginning of the 20th century.

A small commune of Pag entered the Venetian *Stato del Mar* in 1409, and through large saltpans and intense salt production received extra financial support. After the building of New Pag, the maritime activities and trade probably intensified. Large amounts of archaeological material in St Nicholas' Bay, dating from the 15th to the 17th century, support that presumption.

Due to the geomorphology of the Gulf of Pag and climatic characteristics of St Nicholas' Bay, we can assume that the Bay was used as the safe harbour and/or the place for quarantine. This conclusion is supported by the historical sources, and by the recent discovery of well-preserved ship remains dated to the 18th century. This poster will illustrate the history of St Nicholas' Bay and describe the discovery of the 18th century ship.

The Sanguinaires C wreck, Corsica: an early XVIth century clinker ship of Atlantic or Northern origin

Discovered in 2005, the Sanguinaires C wreck is located at a depth of 19 m, near the Sanguinaires Islands in the Gulf of Ajaccio (Corsica). After two test excavations carried out by Hervé Alfonsi (ARASM), the results led to the development of a multiannual excavation led by H. Alfonsi and Marine Sadania (DRASSM) in collaboration with Éric Rieth (CNRS), whose initial data is the subject of this poster. The wreck is characterized by a stone mound (dolomitic limestone) 17.40 m long, 12.40 m wide and 2.80 m high covering the architectural remains of the hull. Two millstones and two iron anchors are associated with the wreck. A secondary cargo of Pisan and Ligurian ceramics dating from the early 16th century has been unearthed. Excavation of the architectural remains, limited to the forward and aft ends of the keel, has brought to light several main features. The most important one, in the Mediterranean context, concerns the clinker structure of the planking assembled by means of iron rivets driven in from the outside of the hull and riveted to quadrangular iron roves. The watertightness between the clinker planking is achieved by luting made of horsehair and/or sheep's wool. This clinker planking is combined with a strong transverse framework. The frames (floor timbers and futtocks) are arranged on the keel with a small room and space. Several crotches are fixed to the keel by means of iron pins driven in with a lost point from the underside of the keel. The ceiling is covered by a movable protective flooring on which the stones cargo rests.

The clinker architecture of this large transport ship, whose Atlantic or Northern origin remains unknown at the present stage of excavation, represents an archaeological *unicum* in the Mediterranean and an archaeological site of first importance for the knowledge of the history of 16th century naval architecture.

The P1 wreck – 40 years after the discovery

In 1979 during the survey of the remains of the submerged medieval harbour in Puck Lagoon a wreck of a lapstrake vessel was found. In 1983 the excavation has begun and documentation of approximately one third of the wreck was prepared. The timbers were radiocarbon dated on 1240s. The political situation in Poland in the late 1980s and 1990s did not allow to continue the research. In 1999 remains of the wreck had been covered with bags filled with sand.

In 2019 the team of archaeologists from the NMM in Gdańsk had returned to the site for surveying the state of preservation of the construction and for securing the site *in situ*. During the works a photogrammetric documentation was prepared, while the remains of the wreck were covered with geotextile. The survey allowed to evaluate the state of preservation as well as post-deposit processes that took place in 40 years since the discovery. The performed photogrammetry combined with the 1980s documentation allows the attempt to reconstruct the vessel.

An ROV revolution? Using the new generation of low-cost battery powered ROVs for subsea archaeological work

A new type of very low-cost remotely operated vehicle (ROV) has been introduced in the last few years, benefitting from advances in drone and battery technology. Substituting high capacity LIPO batteries for surface power whilst still retaining useful performance, these subsea vehicles are easy to deploy, pilot and maintain. For their size and cost they offer impressive inspection and survey capabilities, including photogrammetry, imaging sonar and acoustic positioning, at a fraction of the cost of similar small ROVs of more traditional design. They also offer opportunities to carry out survey at deeper depths, more efficiently and with less risk than deploying archaeologist divers. Furthermore, imminent advances in low-latency satellite broadband services may enable remote participation in subsea archaeological survey work carried out by these vehicles, as well as facilitating new forms of live client and public engagement.

Using examples of subsea archaeological survey linked to heritage protection carried out in the last three years for UK public bodies Historic England and Historic Environment Scotland, including surveys of a Spanish post-medieval wreck site and a 19th century clipper, this paper will explore the pros and cons of using a 100m depth rated ROV of this type for archaeological work and the opportunities that could be developed from it. It will also consider whether the future relationship between the use of divers and the use of ROVs for subsea archaeology generally will echo the way in which these respective capabilities have been developed in other marine sectors, such as oil and gas and offshore wind/renewables.

Although we are not able to make a definite commitment at this stage, we are potentially able to demonstrate remote interaction between the worldwide conference audience and the ROV during the presentation by means of sharing a live ROV video/sonar stream and two-way ROV pilot audio feed over the internet, whilst an operational or training dive is being undertaken in the UK.

The Modern Shipwrecks Project - Lebanon

The poster serves to inform the audience of the 'Modern Shipwreck Project' (MSP) which is being undertaken in Lebanon by the Honor Frost Foundation's Lebanon team. It will also introduce the relatively newly formed HFF Lebanon team.

The MSP entails performing ground-truthing dives on wreck sites, predominately modern, located offshore across the Lebanese coastline as part of the HFF Modern Shipwreck Database Project in Lebanon. The sites' locations are acquired through different sources, including data from online sources, charts, divers, as well as results from remote sensing surveys performed in the past.

The wrecks mostly consist of 20th century cargo ships and some military vessels that date back to the Lebanese Civil War (1975-1990), WWII and WWI. Although many of these ships are not strictly considered as archaeology according to the national legislation, they certainly hold historic value. Our goal is to be able to help preserve these sites and share them with the public, so that the past is not forgotten, and these sites can be appreciated and valued. The poster will include images and 3D models of wreck sites, as well as snippets of the database, maps, and the team in action.

The ground-truthing phase of the project is done through diver-based visual surveys to verify the presence or absence of wrecks, document and record the finds, and extract as much information as possible to help determine the identity of the sunken remains. The data produced from this project allows us to determine and assess the locations of possible cultural heritage sites, bringing them to light, and aid in future efforts to preserve them. Due to the lack of monitoring and implementation of protective measures, shipwrecks are prone to looting and damaging by sport divers and fishing activity. Therefore, a clear assessment of such a part of Lebanon's submerged cultural heritage is needed.

Ship representations on Mycenaean pottery. The rare depiction of a shipwreck from Koukounaries on Paros

The fall of the Mycenaean palaces marked a radical change in the geopolitical map of prehistoric Greece. The excavations showed that immediately after the destruction of the Mycenaean centers on mainland Greece, a group of Mycenaean refugees fled to Paros, where they occupied a hill that they turned into a Mycenaean acropolis. A period of prosperity followed, as various finds have shown, such as ivory, rock crystal, bronze, painted pottery from the Late Helladic III C Middle period.

A deep bowl (skyphos) from this period from Koukounaries offers a rare representation of a ship. A band runs around the edge on the inside. Outside, a ship is depicted upside down. It is a rare depiction of a Mycenaean shipwreck. The ship of Paros can be compared to the representation of a ship from Skyros and a second representation of a ship from Tragana. The bow is curved like on these two ships. The sail is billowed by the wind. The depiction is more reminiscent of a shipwreck scene like that on the north wall of the great temple of Medinet Habu.

Finds from Koukounaries on Paros show that the collapse of the Mycenaean palaces on the mainland was followed by a period of prosperity based on the revival of the arts and commerce. Luxury finds from Paros show that Koukounaries had important overseas connections with the Cyclades Islands, which are at the crossroads of sea trade with Asia Minor, Egypt, Syria, Cyprus and Crete.

18th century wreck in the bay of St Nicholas, Island of Pag, Croatia

Excavations in St Nicholas Bay had started in 2017 when local divers informed curators of Archaeological museum Zadar about pottery fragments on the bottom of the bay, from the shallows down to 20 m depth. The first campaign focused on mapping and collecting the archaeological material, as well as establishing the wider area of the site. Archaeological survey revealed underwater remains of a breakwater or a pier which protected the little bay from northwestern wind. The campaign in 2019 brought out evidence of ship's construction in the shallow part of the submerged site, with 12 m² of wreck excavated, cleaned and documented. Because of time and budget constraints, the construction was covered and reburied for the next year's campaign.

In 2020 excavation at the bay of St Nicholas had the main focus on the ship's construction. By the end of the campaign, the entire wreck was unearthed, measuring 17 m in length and over 3 m in width. The keel is preserved in its entire length, with numerous floor timbers and futtocks, as well as outer planking and limber boards. The area around the wreck and its edges have scattered wooden forms which display man-made oblique edges – these resemble short stakes and were probably a part of the protection of planking and limber boards from the weight of the cargo. Samples of wood have been gathered for ¹⁴C and dendrochronological dating, as well as samples for xyological determination of wood and wooden forms surrounding the ship's construction.

The poster's aim is to present this new find in the bay of St Nicholas and will show the results and analysis of samples collected, as well as a basic analysis of the ship's construction.

Reed and Rush Bundle Rafts in Ireland – Ethnographic and Experimental Nautical Archaeology

Well into the 20th century, primitive boats constructed of reeds and rushes persisted in use in the midland regions of Ireland. While there is little photographic evidence, some descriptions of various bundle rafts were collected by 19th Century antiquarians and later by The Irish Folklore Commission (1935-1971). There were simple wading and swimming aids, round coracle type craft, and larger rectangular rafts. All of these bundle type rafts relied on the buoyancy of the material rather than hull displacement, and larger rafts seem to have been built around some form of framework.

The most widely known of the bundle rush craft was the *Cliath Thulca* or 'flood raft', used to navigate the 'Callows', a flood plain area of the River Shannon. A number of replicas of the *Cliath Thulca* have been built. These replicas are quite elaborate and have mainly used modern techniques in their construction. It has been thought by many that reed or rush bundle rafts were generally of a simpler construction, with smaller dimensions. Reconstruction of some of these bundle rush rafts was recently undertaken using information sourced mainly from literary descriptions and ethnographic research.

The *Cliath Thulca* and other reed and rush bundle rafts were considered a temporary or seasonal craft, mainly due to their buoyancy limitations and the finite structural integrity of the bundles of reeds and rushes. With little skill needed in their construction, and an unlimited source of building material available, rafts of reeds or rushes could be replaced and built rapidly when required.

Reed boats are usually associated with warmer climates, but water reeds, rushes and bulrushes (*Phragmites Australis*, *Juncus Effuses*, *Schoenoplectus Lacustris*) thrive in damp temperate climates. Construction of bundle rafts of the type found in Ireland require fewer skills and resources than that of skin boats or dug-outs, and as such are likely to have been more numerous. They may therefore be worthy of more focussed study as a form of ancient transport for local mobility in Ireland and the wider Northern European inland waterways.

Last Austro-Hungarian Navy *Rettungskutter I Kl.*

Many ships on the Adriatic still sail without a proper understanding of their cultural and historical importance. A real pearl of maritime history was recently discovered in such circumstances: the last example of a wooden boat of the Austro-Hungarian Navy.

It is a type of *Rettungskutter I Kl.* - a lifeboat of the 1st class - whose specific purpose was the ability to launch quickly from the mother warship and sail in bad hydro-meteorological conditions, with the aim of rescuing an individual man at sea or resolving other emergencies. Some of the larger warships of the Austro-Hungarian Navy had one *Rettungskutter* / lifeboat on board. The boat is 9 m long, and its hull is built with double planking. The construction system enabled the boat to be stored on the deck of the ship without any fear that the wood would dry out and its hull would therefore cease to be watertight. Under the side benches and below the bow and stern deck, air boxes were installed, which allowed the boat to float even when it was full of water. It's construction dates back to the turn of the 19th century. The technical characteristics and design of the boat was based on tradition of lifeboats built in northern Europe.

Traditional boats of the Egyptian coastal lakes (Manzala, Burullus and Edku) documental project (TBCL-EGY)

The archaeologists of ships and boats and maritime ethnographers did not turn their attention to the traditional Egyptian maritime heritage of some of the coastal lakes except within the past decades of the present century. Furthermore, they gave partial attention to some Traditional boats, which are still in use in the Burullus and Manzala lakes, without studying other traditional boats in the same lakes. In addition to this partial interest in some boats but not others, the studies conducted on these boats are incomplete. Unfortunately, some of these boats are on the verge of disappearing completely and others were abandoned. Additionally, other lakes, such as Lake Edku, did not receive any attention; many of these unstudied lakes have lost most of their traditional maritime heritage and boats. Hence, there is an urgent need to implement a documental project to preserve what remains of the traditional Egyptian maritime heritage of these previously mentioned coastal lakes and their traditional boats. This project was recently approved to be funded by the Honor Frost Foundation.

This poster will provide a presentation of the Egyptian coastal lake communities and the tangible cultural heritage represented by their traditional boats of various types and equipment. Moreover, this research will shed light on the latest results of the preliminary fieldwork of the project's team in these lakes and the documentation methodology of some types of these boats, which includes 3D digital technology, particularly photogrammetry. Also, the research will illustrate the effects of using 3D digital technology, on the documentation procedures and the historical, and technical interpretations of some of these boats.

Expanded logboats in the world - the ethnological perspective

Contemporary expanded logboats arouse interest of many archaeologists. For them they are helpful for interpretations of archaeological finds, but also sometimes for formulating hypotheses concerning their place in a regional boatbuilding tradition and their influence on its development. At the same time archaeologist researching north-European finds usually limit themselves to placing them only in northern Euro-Asiatic area of distribution of those expanded logboats. They rarely express awareness of wider distribution of this technique of building logboats, particularly the existence of the parallel southern range along Asiatic Sea coasts. Author would like to change this perspective.

The article will be a look on the expanded logboats from ethnological point of view. The author will try to record every available information on their occurrence in the contemporary world and in old written sources as well as archaeological sources. It will describe techniques of expanding logboats. The attention will be focused on the similarities and the differences in application of this technique depending on a place of its occurrence. Using the created map of ranges of occurrence, it will research their relation to the maritime and river routs and possible contacts among communities using this technique, so in consequence a possibility of migration of the concept of the expanding logboat. The article will also explore the possibility of creating this technical solution independently in different places. Finally, the author will consider the influence of the created picture on existing interpretations and hypothesis. The author will use ethnohistorical and ethnogeographical methods in his research. Moreover, he will support his research with his own experiences gained during the building of an expanded logboat in Estonia in 2000 and he will use photographic material recorded there.

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ORGANIZERS

University of Zadar

The University of Zadar was founded in name in 2002, but it is known for its centuries-old university tradition. It originated with the higher education institution *Studium generale*, founded by the order of Dominicans in 1396, later known as *Universitas Iadertina*. That institution was active from 1396 to 1553, consisting of two faculties, the lower and higher-level studies of Philosophy and Theology, and offering the highest levels of university degrees, including the doctorate.

Today, the University of Zadar is the largest integrated University in the Republic of Croatia, featuring 25 university departments. With a total number of 6000 students, the University performs studies on three levels: undergraduate, graduate, and postgraduate, with activities at four separate research centres.

Department of Archaeology

The Department of Archaeology, established in 1956 within the Faculty of Philosophy, is one of the oldest departments at the University of Zadar. The Department was founded on the legacy of archaeological excavation performed by pioneers of Croatian archaeology and the abundance of archaeological sites in Northern Dalmatia.

With respect to coastal, maritime, and underwater archaeology, the Department has executed research activities on some of the most remarkable terrestrial and underwater sites along the Adriatic coast. In the past fifteen years, the Department has sponsored numerous excavations focusing on Adriatic seafaring, naval architecture, and coastal settlements, establishing fruitful collaboration with numerous international universities and organizations. In addition to the 16th International Symposium on Boat and Ship Archaeology, the Department of Archaeology has hosted important international archaeological conferences, including the 13th Annual Meeting of the European Association of Archaeologists (EAA) in 2007, and the 2011 International Congress on Underwater Archaeology (IKU-WA 4) conference entitled Managing the Underwater Archaeological Heritage.

<https://www.unizd.hr/eng/>

International Centre for Underwater Archaeology in Zadar

The International Centre for Underwater Archaeology in Zadar (ICUA Zadar) was established in 2007 within the Croatian Conservation Institute. In 2009 ICUA Zadar became an independent public institution and gained the status of UNESCO Category 2 Centre.

The main purpose of ICUA Zadar is to carry out educational activities in the fields of exploration, conservation, and restoration of underwater cultural heritage. The Centre is active in promoting the ratification and implementation of the UNESCO Convention on the protection of the underwater cultural heritage (2001) by developing and sharing good practices and supporting capacity-building, training, and knowledge exchange on regional and international levels.

It is tasked with the missions of developing international professional and research collaboration and education in the field of underwater archaeology while presenting and popularising underwater cultural heritage among the public at large.

<http://icua.hr/en/>

Archaeological Museum Zadar

The Archaeological Museum Zadar was established in November 1832 as part of a general museum of natural goods, industrial products, and antiquities. It became an autonomous institution in 1880. In 1974, the Archaeological Museum moved to the purpose-built premises in front of the ancient Forum, where it stands to this day. The Museum of Nin Antiquities, located in the nearby historical town of Nin, is a part of the Archaeological Museum in Zadar. The Museum also manages St. Donat's church in Zadar.

The Archaeological Museum in Zadar collects, keeps, studies, and displays archaeological items mostly from northern Dalmatia. Today it is a modern institution with well-equipped restoration workshops, depots, research departments and a library. Since its founding – almost 200 years now – the Archaeological Museum has been relentlessly accomplishing its mission: preserving the identity of the area and community it belongs to and cooperates with.

There are more than 100,000 various items displayed in Zadar's Archaeological Museum from all cultural and historical periods. The Museum features three permanent exhibitions:

The permanent prehistoric exhibition, created in 1975 and located on the second floor. Items from historical and cultural periods ranging from the Old and New Stone Ages and the Copper, Bronze and Iron Ages to the end of prehistory are displayed in chronological order, covering the time span from approximately 40,000 BC to the beginning of antiquity and recorded history.

The permanent exhibition of Roman Antiquity, created in 2014 and located on the first floor. Chronologically, this exhibition spans the time from the arrival of the Romans in the 1st century BC to the Migration Period in the 6th century AD.

The permanent medieval (Old Croatian) exhibition, created in 1974 and located on the ground floor. This exhibit presents the archaeological evidence from Zadar and its surroundings from the arrival of the Slavs/Croats to these parts in the early 7th century to the Croatian dynasty in the early 12th century.

Each collection contains numerous valuable items from all over northern Dalmatia, Zadar's archipelago, and the islands of Rab and Pag that illustrate the everyday life, spirituality, and artistic achievements of various cultures.

<https://amzd.hr/en/>

Museum of Ancient Glass, Zadar

The Museum of Ancient Glass in Zadar, located in a renewed historic Cosmacendi palace from the second half of the 19th century, is a specialized archeological museum and a center of study of ancient, primarily Roman-era glass finds. The permanent museum display contains over two thousand glass objects which illustrate the everyday use of glass in households, the importance of glass in the production of cosmetic and medicinal substances, and the use of glass containers in funerary rites. The production of glass jewelry and trade exchange is presented over a relatively broad chronological range from the 1st to 4th centuries AD.

In the Museum there are two glass-working workshops and a glass-blowing workshop for making glass objects. The possibility of direct access to the process of making various glass items, as well as direct communication with glass masters, is certainly one of the most important and attractive offerings in the museum.

<https://www.mas-zadar.hr/en>

City of Zadar

The City of Zadar is a local public authority with 13 administrative departments. The city itself is situated on the Adriatic coast and counts more than 70,000 inhabitants. The administrative area of the City of Zadar includes the town of Zadar and four nearby settlements, as well as eight islands. Fields of interest which are under the jurisdiction of the City include: culture, sports, social welfare, education, spatial planning and construction, and other works in accordance with special laws. Its mission is responsible and efficient management of public affairs as well as transparent work in accordance with the interests and needs of its citizens.

The City of Zadar is founder of four local cultural institutions: the Zadar City Library, the Research Library of Zadar, the Zadar Concert Office, and the Croatian National Theatre of Zadar. With these institutions the City of Zadar co-organizes many influential local festivals with international character. The Department for Culture and Sports provides administrative and organizational support for many of these festivals. Moreover, the City of Zadar is an active participant in the field of transnational and cross-border cooperation, with a long tradition of cooperation with numerous foreign local governments and international organizations.

<https://www.grad-zadar.hr/>

City of Šibenik

The city of Šibenik is the oldest Croatian town on the Adriatic coast and is the cultural, educational, administrative, and economic center in Šibenik-Knin County. The administrative area of the city encompasses 405 square kilometers with a population of 46,000 inhabitants. The city government conducts all executive tasks for local authorities. In its framework of ten administrative departments, 130 employees take care of the economy, entrepreneurship, protection of the natural environment, culture, sports, spatial planning and building, communal infrastructure, and other functions. The city of Šibenik has founded 19 companies and institutions which have special importance for further development and advancement of the local community. Independently or through related institutions, it is the host of various cultural, scientific, and other events of international importance. Šibenik is a required destination for visitors from all around the world. The city of Šibenik has signed charters of town twinning and friendship with seven European and nine Croatian cities.

<https://www.sibenik.hr/>

PARTNERS

NEREAS Project (Numerical Reconstruction in the Archaeology of Seafaring, HRZZ, IP-2020-02-3420)

NEREAS Project is an interdisciplinary research project in which the use of modern engineering tools brings new scientific insights into the archeology of seafaring. Ships are structures whose behavior due to the action of different loads can be predicted by computer simulations, using the finite element method. However, the application of such tools in maritime archeology is very limited. The NEREAS project seeks to capitalize on the experience of the international team in the effort to focus on a range of research questions, and clearly demonstrate the scientific justification and significance of the application of modern engineering methods in the analysis of marine structures and events of the past.

<http://nereasproject.org/en/>

Ministry of Culture and Media of the Republic of Croatia

The Ministry of Culture and Media performs administrative and other tasks in the field of culture that are related to the following: development and improvement of culture, cultural and artistic creation, cultural life and activities; foundation of institutions and other legal entities in the field of culture; promotion of cultural relationships with other countries and international institutions; fostering the development of cultural and creative industries; normative and administrative tasks in the field of media; professional and administrative tasks for the Croatian Commission for UNESCO; fostering programmes aimed at meeting the cultural needs of the Croatian people in other countries; provision of financial, material and other prerequisites for the performance and development of cultural activities, especially museum, gallery, library, archive, theatre, music, music and theatre, publishing, visual art and audio-visual activities.

<https://min-kulture.gov.hr/en>

Novena Ltd. – Digital Media Studio

Novena d.o.o. is a Digital Media Studio based in Zagreb, Croatia. Over the last 30 years Novena has acquired a wealth of experience in developing multimedia presentations of tourist locations – cities, provinces, museums, exhibitions and cultural and natural heritage sites. Our team of experts has been creating innovative multimedia solutions for clients in Croatia and abroad. Our moto from the beginning is “steady development and growth” with continuous monitoring and adopting the latest technologies. What we do is consultancy and design of multimedia projects; design of digital media; design and production of printed materials; application programming (AR, VR, 360 VR); design and web design; creating web applications; making games; 3D modelling and animation and photo, video and audio production.

<https://novena.hr/>

Terra travel Ltd.

Terra Travel Agency is located in Zadar, at the central part of the Adriatic coast in Croatia. From establishment to today, we keep growing every year, by expanding our offers and collaborating with different Croatian and international partners, including participation in different international tourism fairs and events such as ‘World Travel Market’ in London, ‘ITB Berlin’ in Berlin and others. Our motto ‘the best service in Zadar’ describes our quality offers, including: accommodation in different types of private apartments or hotels; guided Zadar city tour in different languages; trips and excursions to national parks and other destinations of high interest; different types of active vacations (rafting, paintball, mountaineering, jeep safari, etc.); one or multiple day sailing trips with skipper provided; boat trip transfer services (car, VIP transfer, van, coach); special trips and excursions (on request); rent-a-car, rent-a-scooter, rent-a-bike, rent-a-boat, and various culinary experiences. Terra Travel monitors the needs of the local community, supporting sports (Zadar is considered the birthplace of Croatian basketball), schools, different projects and non-profit organizations.

<https://www.terratravel.hr/>

Croatian National Theatre Zadar

The history of Croatian theater in Zadar extends for almost a whole millennium. The very beginnings of Croatian drama and theater are related to Zadar. The first Croatian medieval liturgical dramas and ritual played here in Latin from the 11th century, marking the origin of Croatian theater. For centuries, the theatrical life of Zadar took place on two planes: one of Croatian and the other of Italian speech. The capital of Dalmatia got its first real theater in 1783. By the decision of the Zadar Municipal Assembly in April 1992, the Croatian Theater House was constituted. By the decision of the City Council on November 19, 2009, the Croatian Theater House changed its name to the Croatian National Theater.

<https://www.hnk-zadar.hr/en>

Foka Ltd.

Foka diving center is located in the holiday camping site Šimuni on Pag island. For many years, in addition to diving courses, they offer trips to beautiful locations such as the underwater cave on Premuda, gorgonians on Maun and an impressive ancient shipwreck with over 400 amphoraes of the Lamboglia 2 type at the Letavica site. If you want an attractive, fun, but also safe dive, Foka Center is the right choice for you.

<https://www.foka.hr/index.php/en/>

Šibenik City Museum

Šibenik City Museum (Šibenik, Croatia) was established in 1925. It is a modern complex museum with an extensive collection of archaeological, historic, ethnographic and art objects from Šibenik and its county. The museum's ongoing mission is to collect, research, evaluate and exhibit as many aspects of historic heritage as possible, through exhibitions, publications, workshops, and social media. The Museum is located in the former Duke's Palace, which dates back to the 13th century.

<http://www.muzej-sibenik.hr>

Fortress of Culture Šibenik

The Public Institution Fortress of Culture Šibenik was founded in June 2016. The institution today manages two revitalized Šibenik Fortresses, St. Michael's and Barone Fortress, including their contents. Fortress of Culture is also a partner in the Revitalization project of St. John's Fortress area, and will manage the site after project completion. From May 2021, Fortress of Culture has also managed House of Arts Arsen, a new city stage for music and stage events, cinema screenings, plays, exhibitions - a venue that is in fact a renovated former cinema.

<https://www.tvrdjava-kulture.hr/en/>

ARS NAUTICA Institute for Maritime Heritage

ARS NAUTICA Institute for Maritime Heritage is a non-profit NGO founded in 2017 and registered with the competent government offices of the Zadar County in Biograd na Moru (Croatia). Its main objectives are the research, protection, enhancement, promotion, conservation and sustainable use of the European cultural and historical maritime heritage, both tangible and intangible. Its members include academics, students, scholars or simple enthusiasts of the naval and maritime subject, and prominent figures from the world of culture.

<https://www.facebook.com/ars.nautica.institute/>

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MARITIM Ltd. is a private company founded 30 years ago with representatives in the areas of medical diagnostics and chemical analytics. The company sources instruments and reagents for our clients, which include public health institutions, forensic laboratories, the food industry, and the Croatian national program for detecting colorectal cancer. The company also provides services and consulting to its clients.

<https://www.maritim.si/>

Zadar City Tourist Board

Zadar is located in the heart of the Croatian coast; the city is characterized by exceptional beauty and rich history that has left a visible mark. This Dalmatian gem has a lot to offer; each year the city is becoming a more and more desirable destination for people from all corners of the world. The main purpose of the Zadar City Tourist Board is promoting and suggesting tourist offers in the city, including accommodation, local gourmet delicacies, cultural monuments and a variety of excursion programs, combining the beauty of the past with all the amenities that the modern traveler expects.

<https://zadar.travel>

OIKON Ltd. – Institute of Applied Ecology

OIKON Ltd. – Institute of Applied Ecology is a leading licensed and accredited consulting company / research institute in the field of applied ecology in Croatia and the region. Oikon was founded in 1997 in Zagreb, Croatia. The company offers services in the areas of nature and environment protection, industrial ecology, renewable energy, natural resource management, ecological modeling, landscape analysis and design, geographic information systems (GIS), remote sensing, information and communications technology (ICT), environmental law, policy and economics, feasibility studies, and program and project management. It is independently operated and privately owned and has the official status of a scientific institute. In Croatia, it is officially licensed for activities in the fields of environmental and nature protection, geodesy, protection and conservation of cultural properties, as well as development of forest management plans. Oikon is a major provider of environmental impact assessments (EIA), environmental management plans (EMP) and appropriate assessments in regards to the ecological network / NATURA2000 in Croatia, for all kinds of developments in both terrestrial and marine environments.

<https://oikon.hr>

Maritime High School Zadar

Maritime High School Zadar is situated on the Zadar peninsula, next to the Land Gate in a port called Foša. The school was founded in 1957 with the aim to raise and educate students. Graduates gain a general education while acquiring professional competencies in the areas of transportation, logistics, and mechanical engineering.

<http://www.ss-pomorska-zd.skole.hr/>

Zadar County

Zadar County is one of seven Croatian littoral counties situated at the very centre of the Adriatic coast. Geographically, it includes the northern Dalmatian coast and the hinterland of Ravni Kotari and Bukovica. Zadar County therefore has a key position in linking the northern and southern parts of Croatia. There are 6 towns and 28 municipalities in Zadar County, with 179.186 inhabitants (according to the 2011 census). The largest city and administrative centre of the county is Zadar- 3.000 years old, and currently the fifth largest city in Croatia. Zadar is also the educational and economic centre of the region. Three millennia of history are evident in the city's cultural heritage, which has contributed significantly to the understanding of Croatian history as a whole. The University of Zadar testifies to that, as it was established as a successor to the Dominican University founded in 1396. The total area of the county consists half of land and half of sea. That is an undeniable indicator of the maritime importance of the region, primarily in economic terms. Two national parks, three natural parks, and numerous protected natural areas surround Zadar County. Due to its natural and cultural richness, the main economic developments in Zadar County relate to tourism and its complementary activities.

<https://www.zadarska-zupanija.hr/>

Pakoštane Municipality

The Municipality of Pakoštane is situated in the heart of Dalmatia in Zadar County. It consists of four settlements with 4123 inhabitants – Pakoštane, Drage, Vrana, and Vrgada Island. The Municipality of Pakoštane boasts outstanding natural and cultural heritage and a rich tourist tradition. Notable among many archaeological sites in the region is a submerged Neolithic settlement discovered in the Pakoštane Roman harbour in Janice Cove. In the vicinity of Pakoštane is the Lake Vrana Nature Park, designated as an ornithological reserve in 1983 and distinguished by its wealth of living bird species. The area in and around Lake Vrana is the ideal place for anyone who loves the great outdoors, and there are plentiful cycling opportunities. One of the most important monuments of the Turks period in all of Croatia is the well-preserved Han of Jusufpaša Mašković (*caravanserai*) in Vrana, built in 1644. The renovation of the Maškovića han (Heritage Hotel) and the economic revitalization of Vrana received significant funding from the European Union.

<https://www.opcina-pakostane.hr/>

Via Kornel - 3Design and prototype development studio

Via Kornel is a technology company from Rijeka specializing in advanced 3D modelling, 3D reconstruction, 3D visualization, design and technical documentation, prototype development and model optimization for 3D printing or Computer Numerical Control (CNC) processing. During many years of continuous work, first as a team of independent experts, and now in the form of a specialized technological company for 3D technologies, we are able to develop and implement projects in multiple fields, including 3D modelling of ship structures and ship equipment, 3D reconstruction of historic vessels, and 3D documentation of traditional wooden ships and vessels, to include development of hull shapes and ship lines drawings. Additionally, Via Kornel provides services for optimization and refinement of 3D models with the application and use of 3D scanning technologies and photogrammetry. We are also able to optimize and prepare models for production using 3D printing technology (PLA, PETG & SLA technology) as well as model development using CNC machining (CNC laser engraving and cutting, CNC carving) and casting using silicone or fiberglass moulds.

<https://viakornel.com/?lang=en>

Niteh Ltd.

Niteh focuses on the design, development, production, and marketing of components to optimize production processes. Through many years of experience in various segments of production and technology, we successfully market technological solutions for a wide range of processes. Niteh's flagship programs are developed and supplemented based on the needs and wishes of our end users. In addition to individual components, we have the capability to upgrade and align entire systems in manufacturing, processing, and assembly processes. We offer solutions for all three production processes: production of raw materials, production of parts, and assembly. Niteh is a long-term partner with manufacturers of machine tools, process automation systems, cutting tools and equipment, measuring devices, and devices for monitoring the quality and marking of machined parts. Our partners are renowned manufacturers on a global level, and through the constant development of new products and technologies we have an impact on increasing their productivity and quality.

<https://niteh.hr/homepage-3>

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