DIGITAL TECHNOLOGY FOR NAUTICAL HERITAGE

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INTRODUCTION

The nautical heritage is widespread throughout Europe. Historic boats distinguish our coasts and are preserved, restored and enhanced in different ways depending on their national and, even more, local origin. In Italy, the historic boat recovery represents a niche reality; nevertheless, it is essential as it aims to conserve a precious part of the national heritage. The latter is a varied and strongly peculiar heritage that constitutes the foundations of the nautical sector, a driving force for the national economy. Therefore, the protection, conservation and restoration of historical boats have significant consequences for the territory and the social fabric. Nowadays, new technologies and the increasingly widespread digitalization offer new opportunities in this sector. The paper aims to show how digital technologies can positively influence the branch, from a cultural point of view, in the diffusion and valorization of the existing nautical heritage and as a practical tool representing a valid help for designers in every phase of the restoration project.

NAUTICAL HERITAGE IN ITALY

Italian nautical heritage is rich and varied. It is composed of sailing and motorboats, yachts and racing boats. These vessels are generally made of wood but can also be of metal or mixed materials. They conserve historical and cultural knowledge, proving the age from which they came (Figure 1). Traditional boats are part of the Italian nautical heritage too. These generally originate as work boats and constitute a part of the heritage closest to the country's poorest, popular and traditional culture. The former (yachts and racing boats) are precious testimonies of particular technical innovations, style or construction, or their participation in historical events or nautical competitions. On the other hand, traditional boats represent the popular maritime essence of the country. All of them can be considered the spokesperson of maritime customs and the relationship between man and the sea in our territory.

To safeguard and maintain the vessels of nautical heritage that have survived is of vital importance for the preservation of all those values responsible for the birth and definition of our community's maritime culture. Values on which the current know-how of the national nautical and naval sector is based. For example, many traditional boats, although nowadays drastically reduced in number, navigate around Italian coasts, characterising each area through typical peculiarities. Among these, the gozzo (Figure 2) is the boat par excellence for the multiple uses for which it was used (fishing, transport, walking, etc.) throughout the Mediterranean. With its many variations, it has characterised the Spanish, French, Italian, Croatian, Tunisian, Maltese and other coastlines.

Figure 1. Historic Yachts moored in the port of Viareggio, Tuscany (IT) during the Vele Storiche Viareggio event in 2019 (credits: G. Zappia).

Figure 2. Gozzi moored in the port of Genoa, Liguria (IT) during the Ocean Race event in 2023 (credits: G. Zappia).

In the years when the gozzo was widespread, it mirrored the society, economic possibilities, resources, availability of raw materials and geomorphological attributes of a coastline, and from its characteristics, it was possible to distinguish the territory of origin, the shipyard, and even the hand of the shipwright[1].
Since its foundation in 2019, the Federazione Italiana Barche Storiche (FIBaS) has been the body that brings together all the associations involved in preserving and enhancing historic boats, becoming the Italian reference point for the sector. In the definition of Historical Nautical Heritage contained in its charter, FIBaS emphasises that nautical heritage includes not only all the artefacts that make up the material part (boats and parts of them) but also all the trades and know-how associated with the construction, navigation, use and maintenance of these vessels[2]. That is commonly referred to as intangible heritage.

CRITICAL ISSUES

A survey conducted between 2017 and 2018 revealed that the number of Italian historic seagoing vessels is between 2900 and 3700[3]. Only a few of these vessels – less than 200 – are preserved by museums. The others almost all belong to associations and are privately owned.
In Italy around the 1960s, the advent of composite materials, which resulted in a dramatic increase in the construction of fibreglass units, led to a strong cultural detachment from the origins of boating that lasted about twenty years. During this period, many yachts were lost, generally replaced by the more fashionable boats made initially of marine plywood and later of fibreglass. Similarly, work boats, considered old, were replaced by more easily maintained and therefore useful vessels.
In the early 1980s, there was a return of interest in the boats of the past. From there began a slow revival of the traditional values and know-how that enabled owners of historic boats to preserve and maintain them. Therefore, ship-owners played a key role in discovering and preserving hulls that would otherwise have been lost. A role they maintain to these days. However, this characteristic severely limits - when it does not eliminate it - the usability of boats to most people, effectively making them a ‘niche’ heritage and distancing them from people in both a physical and cultural sense.
Although it is nowadays well-known and acknowledged that vessels of the past are to be considered part of our heritage[4], scientific research has defined it as invisible or submerged as it is not fully recognisable and usable[5]. Sure enough, it appears to be taken for granted that when visiting a maritime museum, the objects shown are part of a heritage to be preserved and maintained. Such a judgement most often derives not from the objects themselves but from the place they are. In other words, the place indicates the historical and cultural value. This won’t happen when faced with a historical boat moored in a harbour or on a beach. The contextualising element that immediately allows us to categorise the boat as an object of value is missing here.
In conclusion, the current level of awareness of nautical heritage does not allow a broad and widespread recognition of heritage assets. This results in two critical issues, which are the focus of this paper. The first and most obvious is the potential loss of historical boats, and with them, the loss of those intangible assets that we have seen to be fundamental in outlining the cultural values of a territory and a community. The second, directly related to the first, concerns the conservation and maintenance of historic boats. Explaining the latter more in detail, the lack of widespread recognition of the boat as a heritage asset has meant that over time, a common strategy for its conservation has never been developed, as is the case with other types of heritage (art, architecture, etc.). Consequently, the maintenance and restoration of these boats have always been entrusted to individual professionals or nautical construction experts without the aid of a shared guideline at least on a national level. To summarize finally, we have on the one hand the risk of oblivion of tangible and intangible assets

related to the nautical heritage, and on the other hand the lack of a shared strategy for its recovery and conservation (Figure 3).

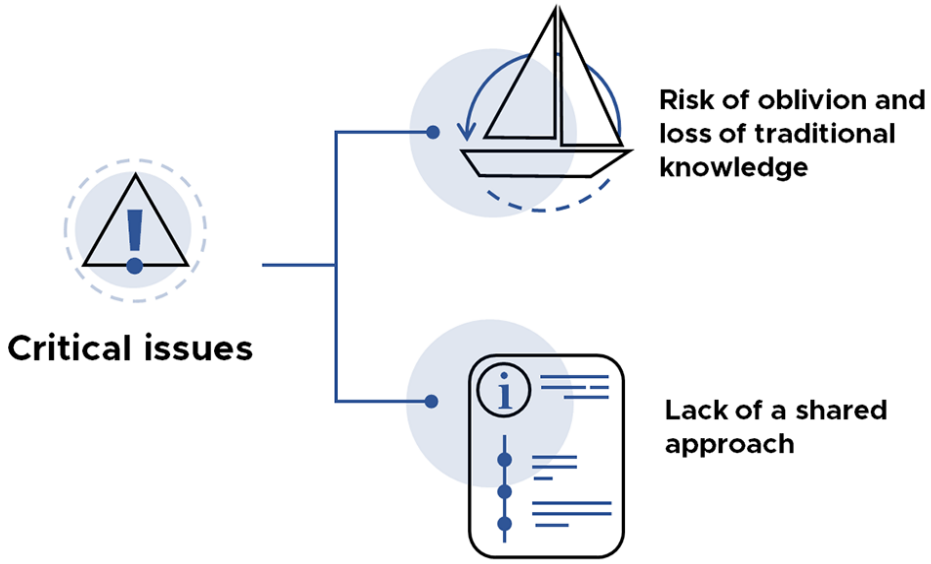

Figure 3. Diagram of the critical issues in the field of nautical heritage (credits: C. Tacchella, G. Zappia).

STRATEGIES FOR NAUTICAL HERITAGE CONSERVATION

For several years, the University of Genoa has been addressing these critical issues. One of the first strategies to prevent the risk of oblivion has been the promotion of greater knowledge of the nautical heritage by the majority of people. To achieve this, several research lines have been activated. First of all, the creation of an online catalogue of the existing nautical heritage[6]. Another line of research, which responds directly to the second critical issue, concerns conservation and restoration. The latter activity is anything but simple. It is a project for which a special sensitivity to nautical history and culture is required, as well as the ability to research, study, and coordinate many elements that fully define the design of a historic nautical cultural asset. Therefore, nautical restoration projects require a specific professional figure capable of having a holistic vision of every aspect. This vision makes it possible to preserve the historical value of the boat and, at the same time, guarantee its seaworthiness requirements through innovative and sustainable solutions.

During the nautical restoration process, the designer must, first of all, consider the historical and cultural value of the boat, and together with it, analyse the boat's condition; consider the owner's wishes (as we have seen in Italy, a large part of the heritage is held by private owners who are therefore the first promoters of boat preservation); consider future use, as many work boats are converted to pleasure use; and finally, consider the navigability and safety requirements at sea given by current regulations.

Today, nautical designers have two tools, originating from scientific research, at their disposal for maintaining control of a project that is as complex from a methodological and procedural point of view as it is from a more strictly operational point of view. *The guidelines for the nautical restoration process*[7], together with the criteria of the *conscious approach to restoration*[8], provide the designer with a guide to nautical restoration that follows the entire restoration process: from the research and survey phases to the design phase, up to precise indications regarding the choice of types of intervention. Lastly, another tool that offers a wide range of possibilities and that could assist the

designer in multiple stages of the nautical restoration process - from the research to the design phase, from customer engagement to asset enhancement - is digital technology.

DIGITAL TECHNOLOGY IN NAUTICAL RESTORATION: CASE STUDIES

Nowadays, digital technologies have proved their usefulness in the different fields of cultural and historical areas. Museums have diffusely incorporated digital technologies to provide immersive and innovative experiences to the public, engaging visitors in various ways.[9] Researchers and scholars use technology to improve their studies, present the outcomes, and preserve and spread information and the intangible part of knowledge.[10] It is not only a means of preserving and spreading information. Thanks to new devices and software, digital technologies are used to study different aspects of the past, allowing virtual simulations, three-dimensional models, renderings, and calculations. That could permit a better understanding of finds and historical objects in the so-called virtual cultural heritage, as already proved in the archaeological context.[11] The application of digital technology can also help for preserving physical heritage. Indeed, technological and analytic tools can provide digital surveys, acquire information about the subject condition and support to plan the interventions to the point of individuating problems, such as infiltrations or structural failures, ideate and design solutions, and prevent further damages. Considering these and other aspects[12], it becomes clear how cultural heritage can take advantage of digital technologies, from the preservation and diffusion of documents in digital archives and databases, as well as communications and diffusion of knowledge on modern platforms and devices, to the study of conditions of physical heritage, and their documentation thanks to virtual three-dimensional models.

All these benefits could be valid for nautical restoration. Nevertheless, as seen before, this field is still based on manual and traditional techniques, representing a niche both for restoration and nautical design branches and the risk of oblivion for what concerns both tangible and intangible heritage. However, digital technologies are starting to permeate this world, showing the significant opportunities offered to a nautical designer in charge of a conservation process. In particular, they can be a precious aid in the research and project phases (Figure 4).

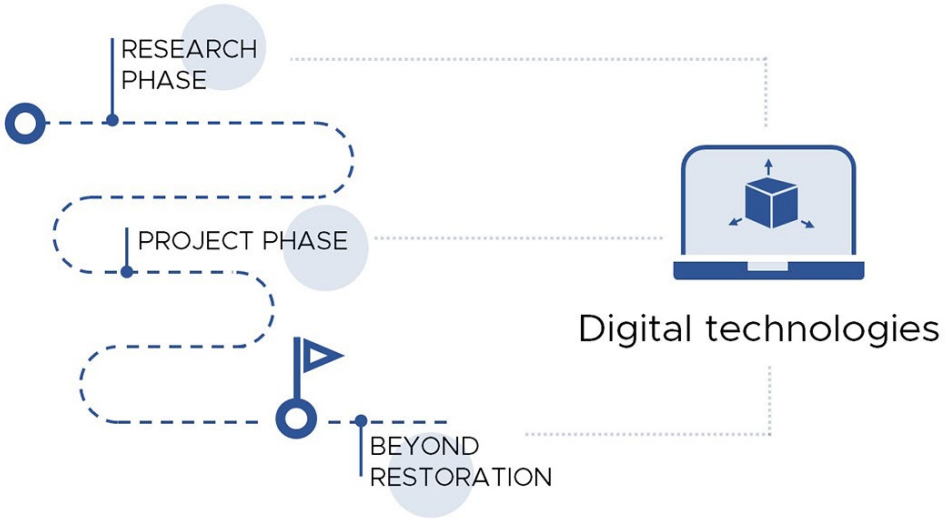

Figure 4. Diagram of the main phases of nautical restoration process in which digital technologies could represent a support (credits: C. Tacchella, G. Zappia).

Research Phase

The first step in nautical restoration is the research phase. That means acquiring as much information as possible about the vessel, regarding her history and conditions. Concerning historical research, technology can help to identify documents, pictures, archives or even persons and associations that may have played a role in vessel's life. However, it is during the survey that technology represents an innovative solution. In this step, the vessel is carefully analysed, measuring all its parts and recording all details. Nowadays, there are different tools for digital survey, where the result is a virtual copy of the boat. Two methods have been tested through some case studies by the Architecture and Design Department of the University of Genova, photogrammetry and laser scanners. Photogrammetry was applied to the case study of the sloop *Bigrin*, a 17-meter-long ship built in 1960 (Figure 5). The digital scan was made by taking several pictures from different stations all around the ship until all portions were photographed. In this way, the whole hull could be assembled in the virtual space as a puzzle of pictures. The framings have to be partially overlapping, meaning that after taking a picture, the next one should contain a portion already present in the previous snapshot so that the software can place them in the correct position. The outcome was a point cloud, elaborated through the software 3D-Zephyr. The rough result obtained included some geometrical points describing the background; thus, one of the first steps was to "clean" the file, deleting the visual noise. The file contained several blue rectangles placed around the hull; these marks corresponded to each picture, showing the camera position. Thanks to them, it is possible to appreciate the groups of snapshots corresponding to each station and the regular space interval from one station to the other. A 3D model was obtained elaborating on the point cloud.

Figure 5. Digital survey through photogrammetry of Bigrin (left), the resulting point cloud and mesh (right). Study conducted during the project "Ricostruzione disegni e modelli imbarcazione Bigrin e strategie per la valorizzazione", Department of Architecture and Design, UNIGE (2019).

In the second case study, the technique tested was the Laser scanner (LiDAR). The subject of the survey was *Ancilla*, a 11-meter-long vessel launched in 1928 and used to transport people on Lake Maggiore (Figure 6). The scanning was conducted by framing the whole boat with a tablet equipped with a camera. Using the LiDAR, the scan consists of a continuous shooting, including every part of

the hull. The distance between the hull and the lens should not considerably change, or the camera could not recognize some portions already scanned and overlap the section. Indeed, a laser scanner works by emitting a ray that, after hitting the first object met, comes back; the software calculates the time taken by the ray to go and come back, and, knowing the speed, understands the distance, thus the position of the point hit by the laser. Being a non-stop operation and requiring a certain precision in holding the device, the laser scanner proved to be a good choice for smaller hulls to avoid a too-long operation time. With LiDAR technology, it is possible to use different devices; in this test, the choice was to use free software, Scaniverse, downloaded to a personal device. That meant not providing expensive equipment, as a total station would have been, and reducing the costs. The results were good enough for the purpose, which was to obtain a point cloud describing the general shape of the hull. Then, it was elaborated on Rhinoceros.

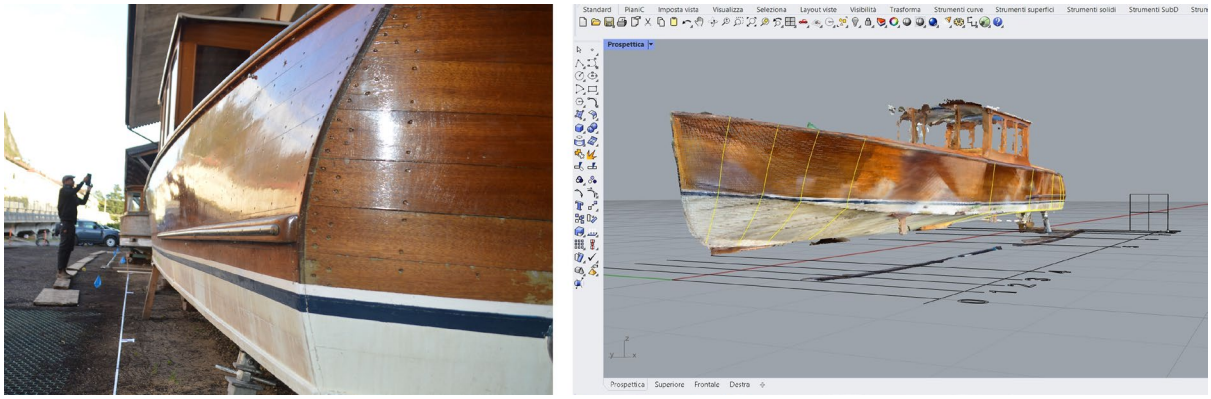

Figure 6. Digital survey through laser scanner of Ancilla (left); the resulting point cloud (right) (credits: C. Tacchella).

There are different advantages to choosing a digital survey. Firstly, digital technologies reduce the survey time compared to manual operation, where the designer has to take all the measurements using manual tools, such as meters or plumb lines. Differently, thanks to digital surveys, a digital copy can be obtained instead of a series of numbers to elaborate. Moreover, the digital copy can be analysed in the virtual space wherever and whenever, thanks to a detachment from the real object. Furthermore, it is possible to compare the vessel to the original design, as done in the *Bigrin* case study. By doing this, it was possible to understand the changes that occurred during the time, noticing that the profile of the current state of the bow profile was no longer the same as the original drawing. Moreover, by doing a digital scan of the outside and inside, the result is a copy of the whole vessel. By having it done, the virtual model can be sectioned; the sectioned part can be projected on a virtual layer, obtaining a 2D drawing. This technique provides all the sections needed and, thus, the plans of the current state. Another significant part of the survey is to map damages or missing parts to understand what and where interventions are needed. Once again, having a digital copy makes the operations easier since it allows the use of layers and graphic techniques to represent all the aspects of the physical conditions. In another case study, *Bruma*, a 16,5-meter long sailing ship designed by the Camper&Nicholson Shipyards, was scanned through the laser scanner method, and the model obtained was used to map the hull condition (Figure 7). The profile 2D drawings were elaborated to show the visible damages besides the thickness of the hull; the 3D model was enriched with the inner structures in different colours to show which ones required interventions.

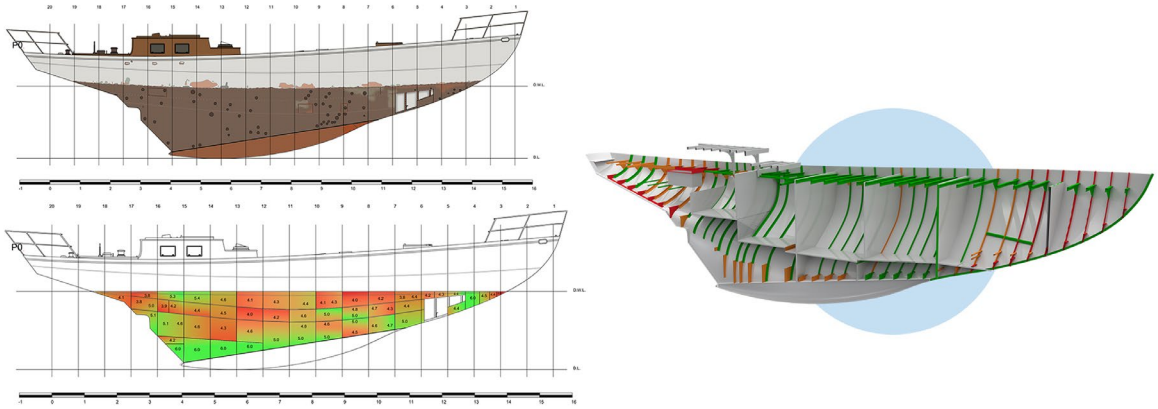

Figure 7. Digital drawings and 3D model mapping the damages and conditions of the vessel. Study conducted during the course Disegno Industriale 2.2 (2023-24), Master degree in Vessel & Yacht design, Department of Architecture and Design, UNIGE (credits: F. Bellotti, S. Ciufetti, P. Maccarini, S. Salvai).

Project Phase

The digital copy can be modified, scaled, and easily shared; it also represents the basis for other studies and digital elements. That means that the virtual copy can be useful for the project phase, where it is fundamental for the designer to identify the interventions and to communicate them and the final result to the stakeholders. Having a 3D model helps the designer in the project decisions since it allows to test different solutions and their impact in advance, before operating on the vessel. Moreover, doing virtual simulations and renderings increases the communication effectiveness with the stakeholders. The value of this operation can be clear by looking at the renderings obtained during the work on the case study of *Ancilla* (Figure 8).

Figure 8. Picture of Ancilla before the restoration (above) and renderings showing two different projects (below). Study conducted during the course Disegno Industriale 2.2 (2022-23), Master degree in Ship and Yacht design, Department of Architecture and Design, UNIGE (credits: S. Borsi, V. Fioravanti, D. V. Jimenez, P. Marini, S. Turato, O. Giordano, V. Malagnini, S. Navisse, A. Vitali).

There, two projects were aiming to very different solutions: in one the vessel was thought to be placed in a museum, removing a part of the planks to show the traditional and local way of shipbuilding; in the second project, *Ancilla* was made sail again. Comparing the renderings and drawings created makes understandable at first sight the different results of the two restorations, making clear how powerful these elaborations can be.

BEYOND RESTORATION: DOCUMENTATION, PRESERVATION AND DISSEMINATION

Digital technologies can also offer advantages beyond restoration projects. Firstly, the initial virtual model provided by the digital survey becomes a historical reference basis, freezing the asset before the recovery work. That means that at any moment in future, it will be possible to know exactly how the vessel was before the interventions. Moreover, this first scanner added to subsequent modelling becomes a testimony to the recovery process by documenting the project stages, including the final result. This is again an important part of preserving the history of ships.

Secondly, once the restoration is over, digital technology can still be a help in preserving historic vessels. Indeed, by repeating the scan at intervals and comparing the results obtained with the previous ones, it is possible to monitor conditions over time, identifying any structural failure or change, and preventing further damage. This technique is already in use by some naval museums, such as at Vasa Museum in Stockholm; there, the Seventeenth-century *Vasa* is periodically scanned using laser scanner technology, and the point clouds are compared to the previous ones so to identify any movement of the structure, leading the future operations for her preservation.

Finally, digital technology already proved helpful for preserving nautical heritage in general. Indeed, digital documentation goes beyond the limits of space and time, improving the conservation and dissemination of intangible knowledge. Indeed, data and information inserted in the digital world, being in an archive or database, will be accessible to a wider public, saying everyone who has internet access and a device to surf the net, and ensuring its potentially eternal preservation.[13]

NOTES

[1] Giovanni Panella. *Gozzi, pescatori e marinai. Storie del Mediterraneo* (Fano: La Nave di Carta, 2021).
[2] "Statuto FIBaS", Federazione Italiana Barche Storiche, accessed August 28, 2024, https://www.fibas.it/wp-content/uploads/2020/01/Statuto-FIBaS.pdf
[3] Maria Carola Morozzo della Rocca. *Per un Portale del Nautica Heritage. Ricerca, azioni e proiezioni* (Genova: GUP Genova University Press, 2018).
[4] Legislative Decree No. 42/2004 Codice dei Beni Culturali e del Paesaggio in Italy regulates the maintenance of all assets considered of value for the memory of the national community. In Article 10.4 (i) 'ships and floating vessels of artistic, historical or ethno-anthropological interest' are included in the definition of cultural heritage. However, the Code has not proved to be an effective tool for safeguarding this particular heritage. For more details: Guido Rosato. *"*La tutela e il restauro delle imbarcazioni storiche e l'attività delle soprintendenze per i beni storici artistici e etnoantropologici della Liguria", in *Yachts Restoration. Stato dell'arte, problematiche e prospettive,* ed. Maria Carola Morozzo della Rocca (Torino: Allemandi & C., 2014), 34-41.
[5] Giovanna Tagliasco and Giulia Zappia. "Hidden heritage. Strategie per la valorizzazione di patrimoni invisibili," in *100 anni dal Bauhaus. Le prospettive della ricerca in design,* ed. Giuseppe Di Bucchianico et al. (Ascoli Piceno: Società Italiana di Design, 2020), 374–381.
[6] Maria Carola Morozzo della Rocca. *Per un Portale del Nautica Heritage. Ricerca, azioni e proiezioni* (Genova: GUP Genova University Press, 2018).
[7] Giulia Zappia. *Restauro nautico e design. Strumento e metodi per il recupero delle imbarcazioni storiche* (Genova: Genova University Press, 2020).
[8] Leonardo Bortolami. *Imbarcazioni in legno, il restauro consapevole. Progettare e realizzare un intervento efficace* (Verona: Il Frangente, 2018).
[9] Loïc Tallon and K. Walker. *Digital Technologies and the Museum Experience Handheld Guides and Other Media* (Plymouth: AltaMira Press, 2008).
[10] Ian Milligan. *The Transformation of Historical Research in the Digital Age* (Cambridge: Cambridge University Press, 2022).
[11] Donald H. Sanders. *From Photography to 3D Models and Beyond: Visualizations in Archaeology* (Oxford: Archaeopress Publishing Limited, 2023).
[12] Alfonso Ippolito and Michela Cigola. *Handbook of Research on Emerging Technologies for Digital Preservation and Information Modeling* (Hershey: Information Science Reference, 2016).
[13] The paper is the result of the common reflection of the authors, but the following are to be attributed: 'NAUTICAL HERITAGE IN ITALY', 'CRITICAL ISSUES' and 'STRATEGIES FOR NAUTICAL HERITAGE CONSERVATION' are to be ascribed to G. Zappia, 'DIGITAL TECHNOLOGY IN NAUTICAL RESTORATION: CASE STUDIES' and 'BEYOND RESTORATION: DOCUMENTATION, PRESERVATION AND DISSEMINATION' are to be ascribed to C. Tacchella. This publication was realised thanks to PRA 2022 'DESIGN FOR THE TERRITORY' and PRA 2023 'STUDIO DI METODOLOGIE INNOVATIVE PER IL PROGETTO DI RESTAURO NAUTICO' funding from the DAD - Architecture and Design Department of the Polytechnic School of the University of Genoa.

BIBLIOGRAPHY

Bortolami, Leonardo. *Imbarcazioni in legno, il restauro consapevole. Progettare e realizzare un intervento efficace*. Verona: Il Frangente, 2018.
Federazione Italiana Barche Storiche, "Statuto FIBaS". Accessed August 28, 2024. https://www.fibas.it/wp-content/uploads/2020/01/Statuto-FIBaS.pdf
Ippolito, Alfonso, and M. Cigola. *Handbook of Research on Emerging Technologies for Digital Preservation and Information Modeling*. Hershey: Information Science Reference, 2016.
Milligan, Ian. *The Transformation of Historical Research in the Digital Age*. Cambridge: Cambridge University Press, 2022.
Morozzo della Rocca, Maria C. *Per un Portale del Nautical Heritage. Ricerca Azioni e proiezioni.* Genova: Genova University Press, 2018.
Panella, Giovanni. *Gozzi, pescatori e marinai. Storie del Mediterraneo.* Fano: La Nave di Carta, 2021.
Sanders, Donald H. *From Photography to 3D Models and Beyond: Visualizations in Archaeology*. Oxford: Archaeopress Publishing Limited, 2023.
Rosato, Guido. *"*La tutela e il restauro delle imbarcazioni storiche e l'attività delle soprintendenze per i beni storici artistici e etnoantropologici della Liguria". In *Yachts Restoration. Stato dell'arte, problematiche e prospettive,* edited by Maria Carola Morozzo della Rocca, 34-41. Torino: Allemandi & C., 2014.
Tallon, Loïc, and K. Walker. *Digital Technologies and the Museum Experience Handheld Guides and Other Media*. Plymouth: AltaMira Press, 2008.

Tagliasco, Giovanna, and Giulia Zappia. “Hidden heritage. Strategie per la valorizzazione di patrimoni invisibili.” In *100 anni dal Bauhaus. Le prospettive della ricerca in design,* edited by Giuseppe Di Bucchianico, Raffaella Fagnoni, Lucia Pietroni, Daniela Piscitelli and Raimonda Riccini, 374–381. Ascoli Piceno: Società Italiana di Design, 2020.

Zappia, Giulia. *Restauro nautico e design. Strumento e metodi per il recupero delle imbarcazioni storiche.* Genova: Genova University Press, 2020.