

THE REFURBISHMENT OF M/V ANNA MARU

Four Samples of Using Durable Wood Products in Passenger Ship Interior and Exterior Design

Siniša Prvanov

*Bilkent University, Ankara, Turkey,
Faculty of Art, Design and Architecture,
Department of Interior Architecture and Environmental Design
sinisa.prvanov@bilkent.edu.tr*

ABSTRACT

This study aims to identify the behavior of wood in the marine environment as well as its use in interior and exterior design of small cruise passenger ships. The cruise industry is among the most exciting and fast-growing categories in the leisure marketplace, especially in Mediterranean region, so that is a need for constant improvement of services and passenger comfort. Although the wood as a building material has the most significant influence on interior design and furniture production, the material choice and building methods are first defined in the design-phase.

This study is founded on actual experience during the refurbishment of the passenger ship Anna Maru during the spring of 2016 in Psaros shipyard in Perama, Greece. The beginning chapter is formed by bringing out the vessel characteristic, design essentials, design process and design methods, which facilitated the successful completion of full treatment. In add-on, also are mentioned problems of noise and vibrations, which requires monitoring of international standards, proper usage of materials and reduction of costs. The final chapter discusses the examples of practical usage and execution of traditional wood products such as tropical hardwood, combined with the contemporary composite materials, as well as finishing techniques.

Keywords: Boat construction materials, passenger boat interior design, woodworking methods.

1. INTRODUCTION

Vessel Anna Maru¹ is a passenger ship² built in 1993 and currently sailing under the flag of Greece. Anna Maru has 77m length overall and a beam of 12m. Her gross tonnage is 1474 tons. (Table1). The original name of the ship was John P. And it joined the leading Greek cruise company "Royal Olympic Cruise Ltd.", In 2006. After a major refurbishment in 2010, the ship became the property of "Hydraiki Naval Company", Hydra, Greece.

¹ (IMO: 7809297, MMSI: 237997000) Hellenic Shipping Register 2016.

² Passenger ships-usually defined as a ship carrying more than 12 passengers-on in international voyages must comply with all relevant IMO regulations, including those in the SOLAS and Load Lines Conventions. "international voyage" means a voyage from a country to which the 1974 SOLAS Convention applies to a port outside that country, or conversely; SOLAS - International Convention for the Safety of Life at Sea. Lloyd's Register Rulefinder 2005 – Version 9.4

Table1. *m/v Anna Maru Technical Specifications. Source: Athens One Day Cruise, Hydraiki Naval Company. Greece. <http://onedaycruise.gr/>*

Flag	Greek	Capacity (In Protocol)	800 Pax
Built	Perama - Greece	Total Inside	550 (sitting)
Year of launch	1991	Total Outside	250 (sitting)
Refurbished	2016	Deck 4 - A La Carte	100 Pax (Sitting)
Length	77.45 m	Deck 4 - Grand Lounge	100 Pax (Sitting)
Breadth	12 m	Deck 3 - Main Dining	240 Pax (Sitting)
Draft	5.4 m	Deck 3 - Saloon	110 Pax (Sitting)
Maximum Speed	19 knots	All Sun Decks	250 Pax (Sitting)
Cruising Speed	16.5 knots	Crew	25
Fuel Consumption	800 l/h (cruising speed)	Engines	2 X 3750 kW
Gross Tons	1474	Air-condition	Throughout

The current owner was refurbishing Anna Maru utilizing two sources of data. The foremost is the existing Anna Maru plans that have been kept at the Ministry of Maritime Affairs, Athens. These books were very fragmentary, containing many small scale designs. The scanned Anna Maru drawings (Figure 1c), form the foundation for new drawings prepared by the Art Matters S.A.³ The studio that satisfy Coast Guard and Greek Ministry of Maritime Affairs requirements The second source was the plethora of photographs, both from the Hydraiki Naval Company and from pictures taken and provided by the crew and others.

The ship supposed to be actively employed for one-day cruising over the Aegean Sea. Planned cruises include a return to the Piraeus Port, at least five seasons in the Mediterranean, which will include serving as a tender for the foreign passengers during the classic series in Epidaurus Theatre Festival, and a voyage to Hydra Island in the Saronic Gulf. The primary objective of the refurbishment was to keep original shape and style of existing ships. In all, many of the parts of Anna Maru were well preserved and it was necessary to be incorporated into this renovation.

2. RESEARCH METHODS

2.1 Main Targets of the Research

The main purpose of this analytical research is to describe the usage of durable wood products in the marine environment. Through theoretical and field exploration, this paper wants to discuss common errors in passenger ships interior and exterior design and how to prevent them. The aim of the research is also conducted on studying environmental impact on the physical properties of tropical hardwood and composite materials and their implementation.

The first method used within this research is analysis of literature and researches in the field of passenger ships design and construction. A literature review was done in order to gain an understanding of the wood products and analysis of its components.

The second method of this research was implementation of wood products in the refurbishment of the particular passenger ship. The results are shown in four different examples, including the design proposal and the method of making fixed furniture and decorative elements.

³ Art Matters S.A. a full-service interior design firm is based in Athens, Greece, founded in 1996. <https://sinisaprvanov.wixsite.com/artmatters>

2.2 Object of the Research

The analytic-synthetic approach of this paper is to examine how the role of wood products in interior and exterior design has affected the production and development of passenger ships. Besides of that object of research also was the design process of particular ship refurbishment, performs analysis of applied materials, finishing and maintenance. It did not degrade the process of ship refurbishment, but rather, with its ongoing development has perfected different possibilities of presenting wooden products.

3. INTERIOR AND EXTERIOR DESIGN CRITERIA

3.1. Basic Criteria

The starting point for the interior renovation and the exterior of the ship Anna Maru has been defined the basic requirements pertaining to the category of the vessel, its shape, speed and the existing situation. Demands were framework to meet the demands of customers as well as technical requirements. Basic requirements that are being considered are the following:

1. The ship interior must be demountable from lightweight materials. Also, be cost-effective and versatile.
2. The ship interior should be designed to enable the circulation of passengers and crew members, and operates without excessive movement of the waves.
3. The ship had to meet security standards against fire, accidents, noise and vibration. The necessary rescue equipment and first aid must be available to the passengers and crew, or to be integrated into furniture.
4. The indoor and outdoor furniture must be sufficiently stable and not to capsize in waves that are likely to be met in the operational area.
5. The fixed furniture must have structural integrity sufficiently strong to prevent any damage to the vessel itself and passenger or cargo on board.
6. The furniture and fixture weight estimates, the calculated weights of all the boat's systems and subsystems are added together to establish a calculated lightship weight.

3.2. Safety Criteria

Some of the main problems in ship renovation are noise and vibrations. In preliminary design stage focus was on the selection and usage of proper materials to reduce levels of both factors. The rules give requirements for noise and vibration related to comfort on board ships. Reference is made to national and international standards for noise and vibration criteria related to hearing damage, speech intelligibility for safety reasons, and acceptable vibration for machinery and equipment. Environmental factors for passenger ships are defined by ISO standards:

1. ISO R717/1, "Acoustics – Rating of sound insulation in buildings and of building elements. Airborne sound insulation in buildings and interior elements".⁴

⁴ Noise: Audible air pressure fluctuations generated by ship machinery, systems or structure, i.e. In the frequency range 20 – 20 000 Hz. Passenger Ships-Passenger Accommodation Noise levels are defined in dB, (e.g. 5 dB relaxation in public, sports areas and passage ways. 5 dB relaxation near ventilation inlets and outlets).

2. ISO 4867, “Code for the measurement and reporting of shipboard vibration data”.⁵
3. ISO 2631, “Guide for the evaluation of human exposure to whole-body vibration”.⁶
4. ISO 140/4, “Acoustics – Measurements of sound insulation in buildings and of building elements”.⁷

4. BACKGROUND TO THE REFURBISHMENT OF MV ANNA MARU

4.1. Existing Situation

Anna Maru ship did not sail during the period from 2011 to 2016. The ship was caught in a really tough shape. Many damages were caused by humidity and inadequate preservation. The ship is in original condition had two decks, with a central saloon. Most fixed furniture and ornamental details were made of Cuban mahogany. All of these parts survived, as well as the forecandle, bulkhead, fixtures and hand railings. Below deck there were four crew cabins, as well as the kitchen, and storage space. The central dining room and ballroom were caught in relatively good shape. The entrance hall and reception area are required redesign and specific functional solutions.



Figure 1a, b, c. *m/v John P, Pireus Port (1994), m/v Anna Maru at the shipyard (2016), Section and plan drawing with indicated renovation areas. Source: Hydraiki Naval Company. Greece.*

4.2. The Design Statement

In the first phase of this project design statement was used to clarify the future purpose of the ship and objectives of its renovation. It was also used to determine the specific requirements of the owner and to reach a compromise solution about designing a new functional space and rational selection of materials for its development. Design Statement was consisted from two main parts.

1. The Purpose and Mission of the Ship: One-Day Cruise in Saronic Gulf⁸

⁵ Structural motion in the frequency range 1 – 100 Hz.

⁶ Basic noise and vibration quantities and units are defined in ISO 31/VII and ISO 2041. Crew Accommodation: Cabins, offices, hospitals, mess rooms, recreation rooms, and open deck areas to be used by officers and crew. Passenger Accommodation: All areas intended to be used by passengers. Public spaces: Communal indoor areas, e.g. restaurants, theaters, cinema, discos, shops, reading rooms, game rooms, gymnasiums, hobby rooms etc. Corridors, washrooms and toilets are excluded.

⁷ Building standards are defined by: 401 ISO: International Organization for Standardization, 402 IMO: International Maritime Organization, 403 IEC: (International Electrotechnical Commission. Rules for Ships, January 2011).

⁸ Saronic Gulf is a bay in central Greece. Part of the Aegean Sea, specifically its western part. The bay stretches from the west coast of the peninsula of Attica and the eastern coast of the Peloponnese. (Definitions.net, STANDS4 LLC, 2017. "saronic gulf." Accessed May 27, 2017. [http://www.definitions.net/definition/saronic gulf.](http://www.definitions.net/definition/saronic%20gulf))

2. The Owner's Design Requirements: Renovation of the main dining room, new passengers and VIP Cabins, Creating a more public outdoor area, ballroom renovation, renovation of wet areas-restrooms, new upper deck bar, wall decoration, flooring renovation (or replacement) of wooden handrails, lighting, painting and varnishing.

4.3. The Design Constraints

The main goal was to design functional interior so that owners and passengers are satisfied. One of the main purposes was to create a pleasant environment where passengers can spend money on the board. Passenger expectations are mainly safety, reliability, multiple choices and impressive design. Many shipowners employ specialized architectural firms in order to improve the space and design concept for their ships. The result can be a very effective interior that in the future may encourage passengers to repeat their experience.

The refurbishment of Anna Maru has been undertaken with a keen eye on maintaining as many details of the original ship as possible. The original Anna Maru plans have been obtained from the archives. Hundreds of photographs showing the original structure and details of the ship have been scanned and filed. All efforts are being taken to save every part and every bit of wood possible.

The refurbishment of Anna Maru passenger ship planned redesign of two public decks, with a shopping area, a buffet restaurant, an à la carte restaurant, a cafeteria in the center of each vessel and a forward cafeteria. The project also included creation of four passenger cabins on board. The theme of the interior design was the route from the Piraeus port to Saronic Islands, as the ferries will be a link between the two banks.

The main deck of a ship has capacity for 120 passengers, with a kiosk located forward. The upper deck contains a business class area for 26 passengers seated in a combination of reclining seats and a comfortable and spacious lounge area. There is also a VIP cabin.

In exterior design focus was on ergonomic principles and on furniture weight reductions. The furniture may provide a weight reduction of up to 6 tons for smaller ships with a passenger capacity of 500 people. With such a proper choice shipowner can increase the cargo capacity of the ship and also reduce fuel costs. For upper deck cabins and fixed furniture were used materials as high pressure compact laminate (HPCL) with aluminium core. Aluminium structure actually gives to fixed furniture more improved durability, as well as far less weight, unlike traditional marine furniture.

5. MATERIAL SELECTION

The sentiments on which type of material is better for boat interior design and cruising comfort, handling and safety fears are much more evenly divided between light and heavy boat supporters.

“In an age of plastics and composites, wood has not surrendered its claim on the mariner. The color and texture of the grain, the particular warmth of wood in the sun, the way a teak gunwale is shaped precisely to meet the grasping hand: these qualities of wood embody the romance of the sea. But unlike our nautical forebears, who were intimately acquainted with the properties of spruce and cedar and teak and Jarrah, many interior designers of today are not familiar with the proper means of selecting woods for marine use” (Laird, 2015).

Wood, as a structural material, has a very important characteristic in comparison with other materials which are used in ship design. For the application of wood as structural materials, especially, have two very important characteristics: - a relatively high hardness at low density - easy shaping. Wood is one of the strongest and most tenacious materials. Stronger in bending and tension than even high-tensile steel. It is highly anisotropic, and as a construction material is still used in the shipbuilding industry mainly in construction and furniture fabrication. Permeable in both directions, unlike PVC and reinforced concrete. Therefore, the construction of wooden interior gets healthy, oxygen-rich and naturally moist area that is ideal for life. The temperature in the interior of timber elements is always equal to the air temperature in the premises, and this property of wood as construction material makes us a feeling of warmth. Wood is a material that has a number of benefits, in addition to ship interior and exterior, often used in public facilities. The proper resolution of wooden structures and appropriate choice of substrate of the wooden covering in ship interior design, can achieve substantial savings. Wood constructions are applicable to almost all types of interiors - from reconstruction to the upgrade.

Thanks to innovations in technology, much lighter walls and dividers, for cabins and wet areas, today are made of wood composite panels with foam core different densities, taking into account whether they are intended for thermal insulation, sound insulation, fire protection, or all three. Polyester is also an ideal material in ship building, however, its composition is such that the parts built in the polyester often exposed to great stress due to vibration, and the kinetics of the ship, so that it is a complex process, their coating or other fixing elements to it. Due to its unique properties, wood remained an indispensable material for construction. Architects and trends impose new synthetic materials, but it all again reduced to basic natural materials.

Due to the execution of several different interventions on the board, it was necessary to check the humidity of existing parts made of wood. Wherever smelled humidity, that part had to be removed or replaced with a new one. Dry wood tends to be rough on the surface, while the fibers of moist wood are smooth to the touch. Wood has a tendency to dry outside, but that does not guarantee the dryness in the interior structure. It was needed to choose suitable tropical woods that are highly resistant to moisture. Also, their natural oils produce a dark, lustrous sheen, which is aesthetically very important. But most of these species are expensive and thus impractical for large-scale projects such as the renovation of the deck flooring and skirting profiles. Teak and mahogany were an option, especially Cuban variety, which is now very hard to find on the market for over-exploited reasons. So the choice fell on a tree secondary to quality as Ramin and Meranti (or Philippine mahogany). Some of the solutions were related to the Douglas Fir⁹ which is even stronger than steel, rigid and easy to process. For decorative applications were selected maple wood display because of its durability and flexibility.

6. EXECUTION OF THE REFURBISHMENT

6.1. Sample 1: Interior – Central Ballroom Renovation

One of the tasks of the ship interior renovation was the redesign of the central Ballroom, (Figure 2a, b, c) including the creation of a new dance floor. Since the existing parquet floor has been removed, is a new designed dimension of 3x3 m. In the central part of the dance floor is

⁹ The Douglas-Fir tree is from the evergreen conifer classification and is not actually a true fir tree at all. It grows in areas of Western North America, specifically in the temperate rainforest zones throughout Oregon, California, and Washington. The tree gets its name from botanist, David Douglas, who was the first to successfully grow the tree in England. (The Yield of Douglas Fir in the Pacific Northwest. United States Department of Agriculture. Technical Bulletin No. 201. pp.7. 2016).

inserted podium medallion-Wind Rose Compass measuring 180x200 cm (Figure 3a, b, c). Hardwood compass rose is made by using the intarsia technique combining thin veneers (0.6 mm thickness), consisting of solid hardwood placed on a plywood substrate. For the best color scheme were selected finest soft and hardwoods, including maple, teak and sapeli (sapele) (Figure 4d).



Figure 2a, b, c. *Ballroom-Existing Situation. Source: Siniša Prvanov.*

Generally intarsia is a woodworking technique, and as such its most grandiose flourish in the 16th century, in the European centers such as Venice, Florence, Augsburg and Antwerp, but its roots date back much further in time in ancient Persia and Egypt. Etymologically derived from the Arabic word "Tarsia" which means "insert" and should be distinguished from the inlay which is a decorative technique. As a technical procedure Intarsia is performed in two ways:

1) Pieces of wood by various shades of the structure are inserted into the solid wood substrate.

2) A more complicated way, it is being developed in the 17th century, created from the elements naturally or artificially colored veneer, of equal thickness, which (like the collage) prepared in motifs and glued to construct a case (usually of soft wood).

The most commonly used wood is oak, beech, ash, cherry, lime, walnut, European walnut, apple, pear, chestnut, olive, plum, maple. From sawmills spruce, larch, pine, etc. Also from exotic rosewood, wenge, iroko, teak, rosewood, eucalyptus, zebrano, iroko, duzij, mahogany, jatoba, paduk.

The process of inserting veneer pieces is performed manually, but is now increasingly used by machines thanks to laser cut wood with surgical precision, and thus facilitate the incorporation and bonding to the substrate, which is still done by hand, and this is one of the reasons for the rather high price of the parquet. Parquet with ornaments are manufactured in the form of multi-layer plates where some of the repeats, for example, geometric pattern, which fit together by tongue and groove system. Thicknesses vary depending on the needs and wishes of the contracting authority from 11 to 22 mm.

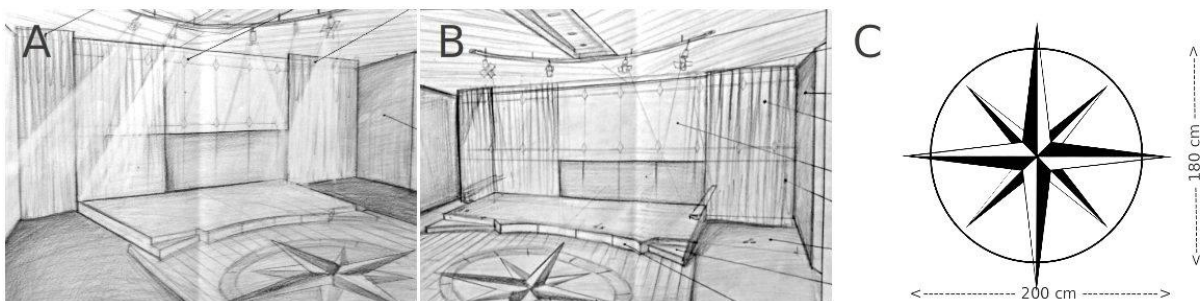


Figure 3a, b, c. *Design Proposal and Wind Rose Detail Drawing in Scale. Source: Siniša Prvanov.*

In the case of Anna Maru new ballroom, Pad Marquetry Method was used (Harry Hobbs, 1981). Several pieces of soft waste veneers were stacked together in a "pad", while a good veneer was deployed among them. To determine the position of the veneer to the final images, the parts have been attached to surface with masked tape (Figure 4a). Neighboring sleeve was placed on different layers of veneer waste, so that it does not cause direct overlap. In this way the pad was made of alternate layers of waste and good veneer, plywood and panel mounted tightly compressed during cutting. The upper layer was bonded to form cutting. This final picture has requested basis of five layers.

For this method a scroll saw was recommended, and the size of the blade was chosen in relation to the thickness of the substrate. Thereafter, the composition is sanded mounted in a straight line by SCM wide belt sander machine (Figure 4B).

The advantages of this marquetry technique are, when to build a buffer layer, all parts can be cut quickly and suddenly. The process can also be used to create multiple copies of the same image. The disadvantage of this technique is the loss of a certain amount of veneer.

The last operation was the installation of the compass picture on the newly formed oak parquet floor. The process of varnishing is explained in more detail in section 6.5.

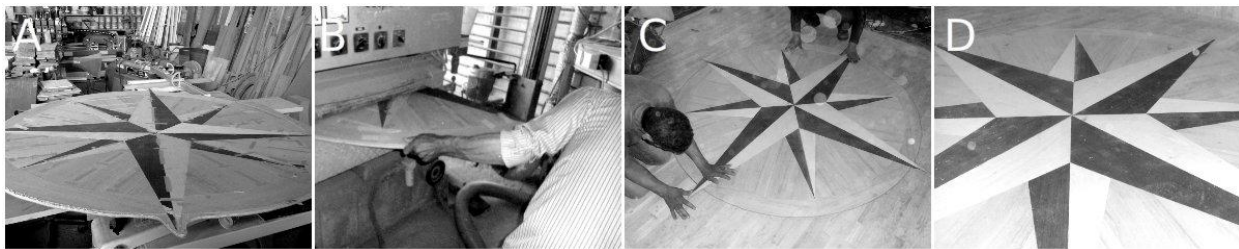


Figure 4a, b, c, d. The process of assembling hardwood veneers at the plywood base, sending, mounting and realization. Source: Siniša Prvanov.

6.2. Sample 2: Interior wet areas-Restrooms

In the world of passenger ships we often hear expressions like: High-tech laminates, Computer analyzed laminates, Aramid laminates, Carbon laminates etc. Etc. These expressions are mostly used as marketing gadgets and very few boatyards and even fewer clients know the real technical values and differences between these materials and methods.



Figure 5a, b, c. Restroom 1, Lower deck. An existing situation. Source: Siniša Prvanov.

The main factors that influence the final properties of laminates are lightweight, strength and flexibility. FRP (Fiber Reinforced Plastic) laminate has two main ingredients: Fibers and Resin. The fibers in the laminate are there to bear more of the burden which the laminate is exposed. The fibers are "defensive bridge" a laminate. The role of the resin laminate is to create a

connection between the fibers. So to speak, the adhesive holds the fibers together when they are under load. When joinery work was completed successfully, specially selected and matched teak was put together and finished in the best possible way with several layers of varnish, sanded between each layer and polished to a satin finish.

The main structural part of the restroom walls have been mounted with FRP sandwich structures. Wherever barrier or cabinet meets the fuselage or the countertop was associated with hull ship construction, laminate contributed additional strength and stiffness of the hull. The external structure is covered with teak veneer only for aesthetic reasons.



Figure 6a, b, c, d. Design proposal for renovation of restroom 1. An example of an interior panel made with Pre-Preg Carbon laminates on a Nomex sandwich and visible surface covered with a thin Teak veneer. Restrooms realization. Source: Siniša Prvanov.

6.3. Sample 3: Exterior-Upper Deck Bar and Fixed Shelving Unit

This sample describes the process of designing and creating a new deck bar that was supposed to create a new public areas ant to serve passengers. Location bar foresaw space size 6m² front of some control of the upper deck (Figure 7a, b, c). The bar is designed in the curvilinear form as the shelving unit behind. For structures of both elements was used box-shaped steel frame. For the production of shelves was used grade mixed hardwood plywood thickness 6 mm. Plywood was reinforced with fiberglass tape outside and with a shallow of resin and hardener. White color Corian®¹⁰ was used for the solid countertop and Meranti panel for the covering of front surface (Figure 8a, b, c).



Figure 7a, b, c. Upper deck existing situation. Source: Siniša Prvanov.

Meranti (Malay), a tree of many species of Shore powder from dust. The Meranti structure is similar to wood from the group Lauan and Seraya. In the trade of wood of this type

¹⁰ Corian® is the brand name for a solid surface material created by E. I. du Pont de Nemours and Company (DuPont). Its primary use is as a countertop/benchtop surface, though it has many other applications. It is composed of acrylic polymer and alumina trihydrate (ATH), a material derived from bauxite ore. Corian is the original material of this type, created by DuPont scientists in 1967. (Wikipedia, <https://en.wikipedia.org/wiki/Corian> ,Archived from the original on 3 September 2014. Retrieved June 28, 2014).

of color group, they are divided into 4 subgroups: a) white meranti (*S. assamica*, *S. braceolata*), a natural area of Malaysia and Indonesia; B) yellow meranti (*S. acuminatissima*, *S. faguetina*) with the same base; C) light blue meranti (*S. acuminata*, *S. leprosula*), spread in the area of Malaysia, Bornea and Sumatra; D) Dark-red meranti (*S. curtisii*, *S. Pauciflora*) spread over Moluccas and Filipino Islands, Malay Peninsula, Borneo, Sumatra and Celebes. Wood of some of these groups is known as Philippine mahogany. It is used in the production of veneers, plywood, furniture and interior design. Decoration and as constructional and decoration wood.

Red Meranti is a type that shipbuilders have been using for a long time in the construction of passenger ships. Moreover, it is a species that are also used in the production of quality marine experiments as well as in the production of chipboard. These are excellent outdoor products. They are distinguished by their great stamina and resistance to atmospheric influences. Meranti is in many ways similar to the original mahogany. In addition, it is much lighter than African wood species, such as Sapele, useful, and African mahogany.

Some of the technical characteristic of Meranti wood are: (e.g. Janka Hardness: 825 lbs, Density: 49 lbs/ft³, Bending Strength: MOR-17761 psi, Stiffness: MOE-2475 psi, T/R Ratio: 1.75. (Rogers, S., 2016). Source: <http://www.mcilvain.com/yesterdays-philippine-mahogany-is-todays-meranti/>



Figure 8a, b, c, d. *Proposed orthogonal plan, Shelving unit frame building and final realization.* Source: Siniša Prvanov.

6.4. Sample 4 Exterior. Public Seating Area

One of the tasks of the exterior renovation was the design and development of a new public seating area on the back side of the upper deck. For the supporting structure was used existing steel fence height of 110 cm. (Figure. 9a, b, c). The focus was on keeping the existing wooden handrail made of Mahogany wood. In this case it was necessary to use a very durable material in order to avoid technical damage during the use.



Figure 9a, b, c. *Upper Deck Back Side Rail, Existing Situation.* Source: Siniša Prvanov.

Since the existing fence length was 12.5 m, in the first stage was realized preparation of steel elements (arms) to hold the countertop. Care has been taken that the elements are arranged (welded) on the existing structure of the fencing on every 1.20 m. Countertop depth was defined

by 30 cm (Figure 10a). The selected material for the countertop was High Density Polyethylene panel thickness of 10 mm. Since the existing fence was oval in shape, the entire surface of the countertop was composed of ten equal pieces length 1.20 m (Figure 10b).

High Density Polyethylene panel is 100% Post-Consumer Recycled unless otherwise noted. Environmental attributes and excellent performance make a HDP very good choice for outdoor applications. As a substance of high density plastic, HDP requires a special adhesive that is softer than a thermoset resin. HDP material, which is thicker than the more common HPL, has the ability to add robust edge details, such as a radius or bevel. The front edge of a solid surface countertop can be shaped to any profile as soon as the top is cut to size and the saw marks are router trimmed off.

In our case, for the edge treatment “No Drip Edge” method was chosen. A typical plastic laminate post-formed top has a rise or bump at the front edge to prevent liquids from going over the edge. To accomplish the rise at the front, a strip of material had to be added, similar to a built up edge. A rabbet joint of dark red Meranti wood was cut up into the front top edge about 4 cm deep and 5 cm wide. A second piece of material was ripped out and shaped before adhering it into the rabbet with structural plastic adhesive 3M-DP8005. Pictured is a section drawing for a no drip, built up edge (Figure 10a). A Drip Groove is also recommended as a precaution.



Figure 10a, b, c, d. Upper Deck Back Side Seating Area. Design Proposal – Section Drawing and Realization. Source: Siniša Prvanov.

6.5. Finishing and Varnishing

Varnished wood brings excellent aesthetic appearance and character to any passenger ship interior and exterior. But sometimes it can also bring problems and extra work if it is to enhance the style of the vessel. Wood has to contend with the sun and sea and often with harsh chemicals such as teak deck treatments that can run or be splashed over its surface. Flaking varnish, blackened or discolored woods are common problems, but careful preparation and good application practices can overcome this, particularly with today’s sophisticated paints and varnishes.

Using modern coating technology can be created impervious spread across the wooden surface. Wood/epoxy composites are the best example of this. Type of used wood products regulate the type of varnishing or painting. Traditionally constructed passenger ships interiors use combinations of hard and soft (softer) timbers. Various species have qualities that necessitate different paints. For all types of wood preparation needs to be considered.

In the case of Anna Maru refurbishment, before of reparation of wooden floors, staircases and hardwood handrails it was necessary to remove old coatings, a common method being to burn it off. This is a very effective method, but there are points to be aware of and care to be taken. Hydro-blasting has also been used in some cases. All bare wooden parts were sanded down either by hand or mechanical methods, always sanded along the grain to remove remnants

of old paint out of the grain. Grade of paper used for sanding timber was P180 -220 and P280 – 320. For final preparation Epoxy Primer was used. Time for drying amounted to 4-6 hours.

For varnishing, once all dust was removed, the first coat of varnish was usually thinned by 25% mineral turpentine, which was sealed the timber before further varnishing. For Teak and Meranti wooden parts was used clear High-Gloss “Varnish Epifanes” (Pettit Marine Paint Ltd.). Formulated with a high solids content of Chinese Tung oil, combined with non-yellowing, modified alkyd resins and blended with a balance of UV absorbers. Varnish was applied up to ten coats with brush hand formed to preserve flagged tips for a sharper cutting edge.

7. CONCLUSION

This paper is an attempt to analyze and to show applications of durable wood products in the marine environment. Wood remains a very important element in ship design and decoration. The goal of this research was to explain the behavior of hardwood products and their possibility of combining them with new composite materials. These results conducted research in the field of composite market wood products, with special emphasis on durability and safety standards is contributing to the current and future researches in the field of designing and refurbishment of small cruise ships. Around that, this research can be of great importance in the development of future strategy development of wood processing in the Mediterranean region because they clearly showed that the composite wood products represent a new generation of products of exceptional characteristics, with wide area applications and dynamic growth markets.

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FIGURES

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