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**THE REFURBISHMENT OF M/V ANNA MARU:
FOUR SAMPLES OF USING DURABLE WOOD PRODUCTS
IN PASSENGER SHIP INTERIOR AND EXTERIOR DESIGN**

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ABSTRACT

This study aims to identify the behavior of wood in marine environment, as well as its use in interior and exterior design of small cruise passenger ships. Cruise industry is among the most exciting and fast-growing categories in the leisure marketplace, especially in the Mediterranean region, so that there is a need for constant improvement of services and passenger comfort.

Although 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 experiences during the refurbishment of the passenger ship Anna Maru during the spring of 2016 in Psaros shipyard in Perama, Greece.

The introductory chapter is formed by specifying the vessel characteristics, its design essentials, design processes and design methods, which facilitated the successful completion of full treatment. In add-on, the problems of noise and vibrations also are mentioned, something that 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.

Key words: 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 length of 77m 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.

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

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

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

meets the 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.

Table 1. *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 ship is 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 tours in Epidaurus Theatre Festival, and a voyage to Hydra Island in the Saronic Gulf. The primary objective of the refurbishment was to preserve the original shape and style of the existing ships. All in all, many of the parts of Anna Maru were well preserved and it was necessary for it 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 focused 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 passenger ship in question. The results are shown in four different examples, including the design proposal and the method of making fixed furniture and decorative elements.

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 production and development of passenger ships. In addition to that, object of the research was also the design process of particular ship refurbishment, performing analysis of applied materials, finishing and maintenance. It did not degrade the process of ship refurbishment; rather, with its ongoing development it 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 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, it must be cost-effective and versatile.
2. The ship interior should be designed to enable circulation of passengers and crew members, and operates without excessive movement of the waves.
3. The ship must meet the security standards against fire, accidents, noise and vibration. The necessary rescue and first aid equipment 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 encountered in the operational area.
5. The fixed furniture must have structural integrity sufficiently strong to prevent any damage to the vessel itself and the passengers or cargo onboard.
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 the preliminary design stage, focus was put on 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
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. Current Situation

Anna Maru ship did not sail during the period from 2011 to 2016. The ship was found in a really poor shape. Many damages were caused by humidity and inadequate preservation.

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).

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).

The ship originally 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 forecastle, 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 found in relatively good shape. The entrance hall and reception area 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 consisted of two main parts.

1. The Purpose and Mission of the Ship: One-Day Cruise in Saronic Gulf⁸
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 goals was to create pleasant environment where passengers can spend money on the board. Passengers' 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 was performed paying special attention to maintaining as many details of the original ship as possible. The original Anna Maru plans were obtained from the archives. Hundreds of photographs showing the original structure and details of the ship were scanned and filed. All efforts were being made to save every part and every bit of wood possible.

The refurbishment of Anna Maru passenger ship was with an intention to 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 motif of the interior design was the route from the Pireus 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 the exterior design, the focus was on ergonomic principles and on furniture weight reductions. Furniture may provide a weight reduction of up to 6 tons for smaller ships with a passenger capacity of

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))

500 people. With such an appropriate choice, the shipowner can increase the cargo capacity of the ship and also reduce fuel costs. For upper deck cabins and fixed furniture, high pressure compact laminate (HPCL) with aluminium core was used. Aluminium structure actually gives more improved durability to fixed furniture, 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 compared to other materials which are used in ship design. For usage of wood, in particular, as structural material, there are two very important characteristics: 1) a relatively high hardness at low density, and 2) 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 construction material is still used in shipbuilding industry, mainly in construction and furniture fabrication. It is permeable in both directions, unlike PVC and reinforced concrete. Therefore, the construction of wooden interior provides 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 get a feeling of warmth. Wood is material that has a number of benefits, in addition to ship interior and exterior, often used in public facilities.

Proper resolution of wooden structures and appropriate choice of substrate of wooden covering in ship interior design, can result in substantial savings. Wood structures 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 are nowadays made of wood composite panels with foam core with varying 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 are 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 has remained an indispensable material for construction. Architects and trends impose new synthetic materials, but ultimately it all comes down to basic natural materials.

Due to the execution of several different interventions on the board, it was necessary to check the humidity of the existing parts made of wood. Wherever moisture could be smelt, 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 feel smooth to touch. Wood has a tendency to dry outside, but that does not guarantee dryness in the interior structure. It was needed the matter of choosing 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 renovation of a 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 reasons of its being over-exploited. So, the choice fell to wood 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 maple wood displays were selected because of its durability and flexibility.

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).

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 had been removed, a new designed parquet was fitted, with dimensions of 3x3 m. In the central part of the a dance floor podium medallion-Wind Rose Compass measuring 180x200 cm was inserted (Figure 3a, b, c). Hardwood compass rose was 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, finest soft and hardwoods were selected, including maple, teak and sapeli (sapele) (Figure 4d).



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

Generally speaking, intarsia is a woodworking technique, and as such it was enormously used in the 16th century in the European centers such as Venice, Florence, Augsburg and Antwerp, but its roots date back much further in the times of ancient Persia and Egypt. Etymologically derived from the Arabic word "tarsia" which means "insert", it 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 which was developed in the 17th century, created from elements of naturally or artificially colored veneer, of equal thickness, which (like in the collage) are prepared in motifs and glued to construct a case (usually of soft wood).

The most commonly used wood are: 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 done by machines thanks to laser cutting wood with surgical precision, and thus facilitating 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 is manufactured in the form of multi-layer plates where some of the repeats, for example, geometric patterns, which fit together by tongue and groove system. Thicknesses vary depending on the needs and wishes of the contracting authority, being from 11 to 22 mm.

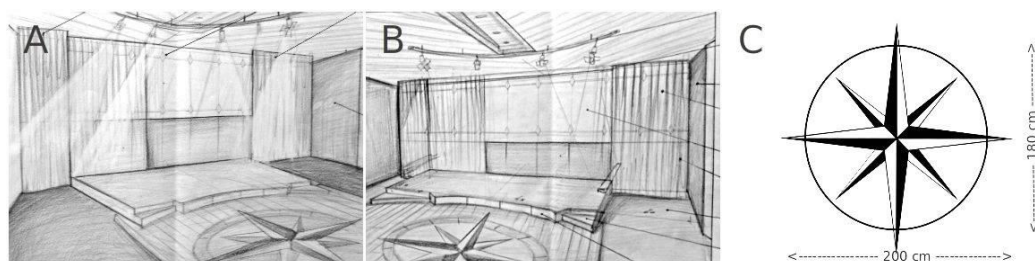


Figure 3a, b, c. Design Proposal and Wind Rose Detail Drawing in Scale. Source: Siniša Prvanov

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 were

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 was sanded mounted in a straight line by SCM wide belt sander machine (Figure 4B).

The advantages of this marquetry technique are that, when having to a buffer layer, all parts can be cut quickly and at once. 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 installation of the compass picture on the newly formed oak parquet floor. The process of varnishing is explained in more details in section 6.5.

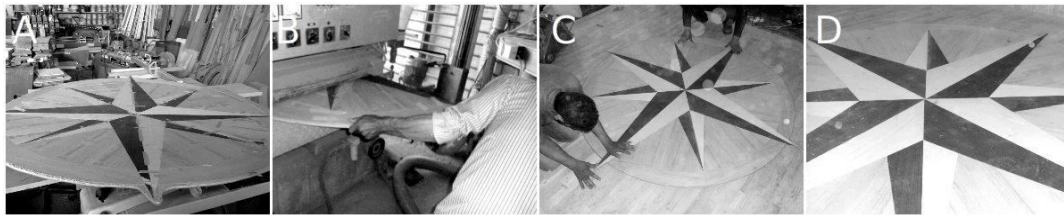


Figure 4a, b, c, d. The process of assembling hardwood veneers at the plywood base, sending, mounting and realization. Source: Siniša Prvanov

6.2. Sample 2: Interior-Wet Areas Renovation

A very important task in the renovation of the ship was also the redesign of wet areas. In addition to functional and well-appointed public areas, wet units also contribute to the comfort of passengers while they are on board. The task was to readjust of a total of eight restrooms keeping the existing infrastructure To create new cabinets for the sinks, FRP (Fiber Reinforced Plastic) laminate coated with teak veneer was used. For wall dividers and wall systems customized multi-layered wall panels thickness 50 mm were used. The panels are made from PVC-coated steel sheets on the inside, and galvanized steel sheets on the outside, with external insulation, coated with teak veneer.



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 to. 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 parts of the restroom walls were mounted with FRP sandwich structures. Wherever barrier or cabinet meets the fuselage or the countertop was associated with hull ship

construction, laminate contributed to the additional strength and stiffness of the hull. The external structure was 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

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

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/benchtot 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).

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 characteristics 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-Upper Deck 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 the existing steel fence with height of 110 cm. (Figure. 9a, b, c) was used. 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 which was realized was preparation of steel elements (arms) to hold the countertop. Care was taken that the elements would be arranged (welded) on the existing structure of the fencing at every 1.20 m. Countertop depth was defined by 30 cm (Figure 10a). The selected material for the countertop was high density polyethylene panel 10 mm thick. Since the existing fence was oval in shape, the entire surface of the countertop was composed of ten equal pieces with length of 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 counter top 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 flooding 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. A section drawing for a no drip, built up edge (Figure 10a) is shown. 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 cause 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. The type of the wood products used determines 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 from 4-6 hours.

For varnishing, once all dust was removed, the first coat of varnish was usually thinned by 25% mineral turpentine, which sealed the timber before further varnishing. For Teak and Meranti wooden parts, clear High-Gloss “Varnish Epifanes” (Pettit Marine Paint Ltd.) was used. 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 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. To reach these results, a research was conducted in the field of composite market wood products, with special emphasis on durability and safety standards, contributing to the current and future researches in the field of designing and refurbishment of small cruise ships. Regarding that, this research can be of great importance for development of future strategies for wood processing in the Mediterranean region, because the research clearly shows that composite wood products represent a new generation of products with extraordinary features, with wide area of applications and dynamic growth markets.

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