

The Royal Institution of Naval Architects



# Design & Construction of Super & Mega Yachts



International Conference

## Design & Construction of Super & Mega Yachts 14-15 May 2019

The Galata Museo del Mare,  
Genoa, Italy

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## 08.55-09.30 COFFEE AND REGISTRATION

## 09.30-10.05 NEW BUILDS AND THE IMPORTANCE OF THE SPECIFICATION, Claire Mckee, Sascia Sartorio, Burness Corlett Three Quays, UK

The Design and Technical Specification is the single most important document during a yacht build or refit. It can dictate the overall success of a project, whether it is the viability based on its performance or the Owner's expectations being met by reality. The way in which the client's Statement of Requirements is analysed by the Owner's Representative and Technical Advisors, then translated into the Design Brief and Technical Specification, is key. However, there is more to the process than the Design Brief and Technical Specification as they must tie into a number of other important documents and secondary specifications. In this paper, we will explore the way in which the Specification and Technical Advisors fits into the overall project management processes as well as their interconnected relationship with other important documentation. The Specification is used in tendering and is an integral part of the contractual documentation package and must be congruent with other documentation. We will therefore discuss some examples where the Technical Specification made a huge difference in the overall success of a project and how simple details can have huge knock on effects. We will show that, whilst different projects have different overall processes, the Technical Specification Contract lies at the heart of all successful ones. We will look at how technical specifications can impact on a project in one of three ways: performance, design or process and we will show how these different aspects of the technical specifications weave their way through the whole build process.

## 10.05-10.40 BUILDING TO THE REG YACHT CODES, Julian Smith, Cayman Islands Shipping Registry, UK, Carlo Vinelli, Isle of Man Ship Registry, UK

The Red Ensign Group (REG) has recently completed the development of an updated regulatory framework for yachts, entitled the 'REG Yacht Code', which entered into force on the 1st of January 2019. The Code's aim is to further develop the well-established industry standards of LY3 & PYC, combining the lessons learned from almost 20 years of regulating the large yacht sector since the first version of the Large Yacht Code was published in 1997. The revised text makes larger use of industry best practice, international standards and the IMO's overarching remit for the provision of increased 'Goal Based Standards' with the intention of allowing room for more flexibility and innovation in the design and construction of large yachts. An updated version of LY3 in 'Part A' will continue to be applicable to yachts which are 24 metres and over in load line length and do not carry more than 12 passengers. 'Part B' consists of the latest version of the PYC applicable to pleasure yachts of any size, which are in private use or engaged in trade and carry more than 12 but not more than 36 passengers. The principle changes to the Code will be presented in addition to the benefits and challenges that are associated with achieving compliance. Finally, the key technical considerations during the design and construction process when building to Parts A and B will be discussed.

## 10.40-11.15 OUT-OF-THE-BOX INTEGRATED, COLLABORATIVE, MULTI-AUTHORING, MANAGED ENVIRONMENT FOR THE DESIGN AND CONSTRUCTION OF LARGE YACHTS, Nick Danese, Stéphane Dardel, NDAR, France

Modern computational technology available to designers and builders of water-bound vehicles spans several Naval Architecture and ship building disciplines but only in rare cases are they connected, let alone integrated. This paper discusses the currently available and unique Out-Of-The-Box Integrated, Collaborative, Multi-Authoring Environment for the Design and Construction of Large Yachts composed by a number of software tools developed by different software houses, spanning 3D modelling, weight engineering, CFD, structural modelling & fatigue, seakeeping, statutory stability, CAD, etc. Following years of evolving research a practical non-linear work flow is now clearly defined in real-world terms, thereby making this innovative process available to the market segment at large. No requirements are made for specialist training and specialized staff past a run-of-the-mill Naval Architecture education for some of the people involved in the process. This contributes significantly to the ease of implementation of the individual software tools and overall process, in direct support of LEAN and AGILE business models and strategies. Moreover, the proposed work flow and business model are based on software tools already established as standards in our industry and already used by most companies in the business of design and construction of large yachts. Interactivity with the enterprise-wide environment and non-Naval Architecture activities and processes is approached from a PLM perspective by implementing a focused information managed process thanks to the creation and maintenance of unique information models tailored to each individual stakeholder and active notification of updating or absence of document composing the Work In Progress and Contractual deliverable archives.

## 10.15-11.40 COFFEE

11.40-12.15 HOME CATAMARAN: COST EFFICIENT SUPERYACHT, Albert Nazarov, Albatross Marine Design, Thailand, Jack Wijnants, AmaSea Yachts, Turkey  
The paper presents case study of 24m catamaran motor yacht project developed for live on board and long-range ocean cruising. The yacht is designed on the limit of legal 'small craft' range though due to catamaran scheme providing accommodation spaces comparable with larger superyachts. Approaches to styling are presented, with connection to seagoing shape and other functional requirements. Layout planning and functional zones specific for catamaran yachts are discussed, with attractive features for long range cruising, weekend boating and parties on board. General dimensioning of catamarans at early design stages is based on parametric study. Recommendations on performance prediction and related hull shape design issues are given, application of CFD methods for hull refinement is presented. Approaches and problems with stability assessment of catamarans are touched upon. Comparison of catamaran yachts with monohulls is provided, with discussion of pros and cons of each platform.

## 12.15-12.50 HYDROFOIL CONFIGURATIONS FOR SAILING SUPERYACHTS: HYDRODYNAMICS STABILITY AND PERFORMANCE, Jean-Baptiste Soupez, Solent University, UK

Hydrofoil-assisted racing monohulls have undergone significant development phases to refine their designs in the past decade, yet very little scientific data has reached the

public domain: an increasingly critical issue as the superyacht industry is now looking at the implementation of foils onto leisure vessels. Consequently, three contemporary configurations, namely a Dynamic Stability System, a Dali-Moustache and a Chistera foil have been towing tank tested to present the first complete characterisation of the hydrodynamic efficiency, quantification of the added dynamic stability and eventually the resulting impact on sailing performance. Furthermore, the practical considerations inherent to the design and installation of hydrofoils onto superyachts will be detailed. This paper provides a comprehensive assessment of three hydrofoil options with both technical and practical guidelines and recommendations to improve performance.

## 12.50-13.45 LUNCH

## 13.45-14.20 A NOVEL DISPLACEMENT MONOHULL/MULTIHULL SHAPE FOR IMPROVED FUEL CONSUMPTION AND HABITABILITY OF FUTURE SUPERYACHT-HYBRID, Maurizio de Giacomo, Aviomarine Tech Srl, Italy

The paper describes the hydrodynamics characteristics of a novel type of displacement hull called DYNac Hull (Dynamic Natural Air-cushion Hull), which exceeds the critical speed of the typical displacement monohull. Simulations results of 3-dimensional CFD code are compared with towing tank data and a full scale test model of 14.5 m and 9 mt. The scalability of the new design is analyzed for a range of ship lengths, and compared with reference displacement and planing hulls. The study aims to demonstrate the advantages of the design for a wide speed range up to +40 Kts. The main focus will be on substantial fuel savings due to significant reduction of hydrodynamics resistance, big advantage to apply Hybrid Propulsion and in the Next Future 100% Electric (especially small Vessels). Other important aspects such as the reduction of wave making, as well as increase of on-board space will be presented. A Project of a Superyacht of 47 mt Hybrid will be disclosed/presented, a preliminary Superyacht Trimaran and a Tender for Superyacht all with the same Technology.

## 14.20-14.55 DEVELOPING THE CONSTELLATION UNMANNED SURFACE VEHICLE PROTOTYPE, Robert Shaw, Shaw Yacht Design, New Zealand

Vessel navigation through the use of reliable nautical charts is vital to ensure safe passage. Having the ability to compliment this with the ability to see accurately both what lies beneath the water and ahead of a vessel in real time provides an added dimension of safety and certainty. Combining the high value and deep draft of modern super and mega yachts with a penchant for exploration creates a tension which can test the availability and accuracy of navigation charts. The development of a 2 metre remote and autonomous-capable surface vehicle with ultra-high resolution echo-sounder capability provides a unique solution which can open up considerable exploration capability. Having the ability to produce ultra-high resolution images and relaying these back to the mother vessel in real time enables precise seabed mapping, providing safer navigation. This paper explores the development of this remote vessel through the stages of concept development, design, manufacture and performance validation. The vessel's design development evolution is explored and assessed against operational and performance objectives. Prototype vessel performance is validated and presented to verify performance and accuracy of data collection. The resulting vessel provides unique capabilities which can enhance the safety of larger vessels by complementing contemporary navigation systems. Additionally it has the capability to deploy personal water-safety devices in situations such as a man-overboard incident.

## 14.55-15.20 COFFEE

## 15.20-15.55 MULTI-CRITERIA OPTIMIZATION AS KEY TO YACHT PERFORMANCE IMPROVEMENT, Karsten Hochkirch, Stefan Deucker, DNV GL, Germany

The paper describes the application of multi-criteria optimization to monohull and multihull yacht configurations. The paper outlines the process (involving concept exploration, formal optimization and simulations), key techniques, employed software tools and results. The analyses combined efficient low-fidelity design exploration with high-fidelity CFD simulations for accurate results. The process allows advancing unconventional designs in relatively short time exploiting the power of parallel computing and virtual prototyping. For yachts, "performance" improvement encompasses besides energy efficiency also aspects of passenger comfort. Examples, sometimes anonymized, from industry practice are used to illustrate approach and possible achievements.

## 15.55-16.30 NEW WAY TO DETERMINE THE NAVIGATION AREA AND RESTRICTIONS ON WEATHER CONDITIONS FOR HIGH-SPEED MEGA YACHTS, Oleksandr Kanifolskyi, Odessa National Maritime University, Ukraine

Several different versions of the Rules governing the navigation areas for small vessels currently exist. For example, various categories of vessels are proposed in International Standards ISO, European Union Directives and the Rules of various classification societies (GL, BV, RINA, Shipping Register of Ukraine and others). These regulatory documents contain various names of navigation areas and various values of permissible wave height characterizing the category of the vessel. Some Rules offer formulas for calculating the maximum height of a significant wave that a ship can meet in a voyage. The need to compare the existing requirements of various Rules, as well as to propose a new way of calculating permissible wave heights, which will determine the effective operation of the vessel, are actual tasks. The new way of calculation will be based on a comparison of the total energy of the wave and the kinetic energy of the vessel. The result of the calculations will be the height of significant waves at which the Mega Yacht will be able to pass the oncoming wave, when ship moving at a given speed. It is also planned to determine the values of the length and speed of a high-speed motor yacht, which are permissible at various wave heights. The results of this work will help create effective Mega Yacht projects that will be based on a preliminary determination of the ship's navigation area and weather restrictions.

## 16.30- GENERAL DISCUSSION &amp; EVENING DRINKS RECEPTION

08.55-09.25 COFFEE AND REGISTRATION

**09.25-10.00 ALTERNATIVE FUELS AND ENERGY CONVERTER TO YACHT COMFORT IMPROVEMENT, Lars Langfeldt, Stefan Deucker, DNV GL, Germany**  
Increasing interest in emission reduction and enhancement of comfort leading to development of new energy systems for the maritime market. The paper describes current developments for alternative fuels and energy converts with focus on maritime fuel cell applications. Fuel cell systems offering high efficiencies and the use of alternative fuels leading to a significant reduction of emissions to air. Due the working principals fuel cells generating less noise and vibration enhancing the comfort for passengers on board. The paper describes which combination of fuel cells and alternative fuels are suitable to be used without range restriction of the yacht or are suitable for a nearly zero emission energy supply when operating in environmental sensible areas or within the port. Criteria for this are the different energy content of the fuels and storage space needed on board of the yacht and the availability of suitable fuels and fuel cell technologies.

**10.00-10.35 DESIGN AND SIZING OF BATTERY SYSTEM FOR ELECTRIC YACHT AND FERRY, Upendra Malla, Hornblower Cruises, USA**  
The need for Zero Emission and clean energy vessels has been a major importance in the recent years. The aim of the paper is to design and size the battery system for Luxury yachts and Ferries using the Li-ion battery technology. The evolution of the battery technology in the last decade made the yacht / ferry owners to implement the battery technology to the electric vessels. This paper discusses the step by step approach for the battery system arrangement, sizing of the battery racks, selection of the cooling systems for batteries, effect on stability, cost, safety and design life of the batteries. In this paper it summarizes the cost benefit analysis of the battery system for the electric yacht / ferry when compared to a conventional diesel / hybrid propulsion system.

**10.35-11.10 PREMIUM YACHT PROPULSION FOR EXCLUSIVE PERFORMANCE, Andreas Witschel, Schottel, Germany**  
SCHOTTEL offers a wide range of main and auxiliary propulsion systems for yachts. This paper will present characteristics of different propulsion solutions: The 5-bladed controllable pitch propeller for highest propulsive efficiency for changing speed or load or the EcoPeller with best values in overall efficiency and course stability. It offers unprecedented performance and ensures that its owner benefits from low fuel consumption and thus low emissions and operating costs. Thanks to an installation flush with the hull the Pump-Jet is ideal for operation in extremely shallow waters. It can be used as maneuvering aid, additional booster or take-home device. Low-vibration and low-noise Rim Thruster enables more comfort on board.

11.10-11.35 COFFEE

**11.35-12.10 CONTROL OF WELDING DEFORMATION IN THIN PLATE, Muhammad Taha Ali, DAMEN Shipyards Galati, Romania**  
Welding is the production process to join metals. Shipbuilding industry trying to improve the welding process from last seven decades but welding in thin plate brings more nonlinear problems. Welding deformation in the thin plate is one of the critical issues in the shipbuilding especially in yachts for good outlook. Welding deformation decreases the productivity and increases the production cost for treating the welding distortion. That is why shipyards more concern in this issue because they want to deliver the ship to the client on time with minimum cost. For this reason, this thesis is focused on the different welding techniques, clamping and additional heating to control welding distortion. In shipbuilding two types of analysis are commonly used, experimental and computational analysis. Both the methods of analysis for 5mm to 8mm plates of steel and aluminium materials are used. For experimental analysis, MAG and MIG welding process is used while compiling with IACS rules and welding standards. For computational analysis, 30 model in FEM is developed to validate the analysis by temperature and residual stress measurements. Computational results and experimental measurements are validated. These measurements and modification are used to optimize the methodology to curtail the welding deformation.

**12.10-12.45 ACOUSTIC ANALYSIS AND MEASUREMENTS OF MEGA YACHTS DURING CONSTRUCTION, Mustafa Insel, Hidroteknik Nautical Design Technologies, Turkey, Ziya Saydam, Serhan Gokcay, Piri Reis University, Hidroteknik Nautical Design Technologies, Turkey, Turhan Soyaslan, C Soyaslan, Soyaslan Design, Turkey**  
Ensuring acoustic comfort on-board mega yachts is one of the challenging problems for designers. At the design stage of a mega yacht, it is possible to estimate the final sound pressure levels in each cabin using source-path-receiver methods through airborne, structure-borne and HVAC sound propagation. These methods rely on material properties of hull, internal division of cabins, furniture details, insulation material details, and HVAC system characteristics. The currently proposed approach is to test the mega yacht at four different stages during construction to verify the predictions: after the structural hull construction, after the outfitting all furniture either on shore or in the water, after completion of HVAC system, and finally during the sea trials. A newly developed yacht/ship noise prediction program (SNoPP) using source-path-receiver methodology is used at every stage to derive the absorption and transmission losses and to predict the final sea trial condition noise predictions. The current paper is describing the first stage of the acoustic measurements at the completion of hull construction for a 65 m motor yacht which has steel hull and aluminium superstructure. Both airborne and structure borne noise were generated at several different locations of the hull decks using omnidirectional loudspeakers and a tapping device respectively. Sound pressure levels were measured in source and neighbouring compartments for airborne propagation while, vibration measurements were conducted in the source deck and at every deck or bulkhead crossings for structure-borne sound propagation. The transmission losses due to structural elements were obtained and compared with the predicted values in the noise calculations.

12.45-13.40 LUNCH

**13.40-14.15 RESEARCH TO IDENTIFY TECHNOLOGIES, PROCESSES THAT WILL ENHANCE THE SUSTAINABLE AND OR LOW CARBON DESIGN, MANUFACTURE, OPERATION AND END OF LIFE OF MOTOR YACHTS OF 24 METERS AND ABOVE, Mincui Liang, Newcastle University, UK**  
Sustainability development is increasingly recognized as a serious, worldwide environmental economic and social concern in the motor yacht sector. The global orders of motor yachts take up a big superyacht market share according to the boat international global order book. However, there is no the universal definition of the sustainable superyacht or a clear process to access or predict sustainability performance of motor yachts in manufacturing, operation and end of life in order to deliver the sustainable motor yacht design. The definition of the sustainable motor yacht considers social acceptability, economic viability, and minimum environmental impact. The methodology used in this research is sustainability impact assessment which is an approach to analyze the effect of motor yachts on the economic, environmental and social aspect to optimize a design's contribution to sustainable development in the manufacture, operation, and end of life aspect of motor yachts. The aim is to develop an appropriate method for sustainability assessment to select suitable technologies for designing a sustainable motor yacht. A case study will be proposed to verify the method. The method is used to enhance sustainability performance of motor yachts in the aspect of manufacture, operation, end of life at the design stage. A 24.06 meters length sustainable superyacht has been designed for the case study and compared with existing 24.06 meters superyacht in the market in order to present insight as to how the sustainable motor yacht may look like. Last but not least, the design has been reviewed by experts in the field by Focus Group Discussions to ensure the design is acceptable.

**14.15-14.50 DEVELOPMENT OF HOVERCRAFT AS EXPLORER YACHT TENDERS, Mark Downer, Griffon Hoverwork, UK**  
Griffon Hoverwork Ltd is the world's foremost designer and builder of hovercraft with a rich history in the development of this unique vehicle since it was first conceived 50 years ago. Whilst a number of very small hovercraft have previously been found in the garages of super yachts for entertainment the more serious sea-going craft offered by Griffon have never been considered until recently. The change has come with the development of explorer yachts and the unique opportunities a hovercraft provides guests to adventure out into otherwise unreachable areas of ice, estuaries and rivers particularly where there is no infrastructure. Griffon's product development of its smaller hovercraft is based on supporting its search and rescue clients and the recent launch of the electric drive 995ED hovercraft offers exciting synergies with the requirements of the ultimate go-anywhere explorer yacht tender. The 995ED includes a number of significant technology breakthroughs not just for specialist hovercraft but also the wider light-weight marine sector including electric drive and a bonded aluminium structure. Integration of the 995ED into the mothership has challenged the team at Griffon to develop a method to allow the length and the location of lifting eyes to be economically adjusted for individual craft without a significant impact on the performance. This paper will discuss the general development of the 995ED and how it has recently been adapted for use in large explorer yachts.

14.50-15.15 COFFEE

**15.15-15.50 IMPACT OF GLASS DESIGN ON MODERN MEGA YACHTS - COMFORT AND STRENGTH ASPECTS -, Olaf Doerk, M Radon, S Semrau, DNV GL, Germany**  
Glass has significantly gained importance as an element for the design of modern cruise vessels and mega yachts. Large movable doors and windows made of glass enable transparent and clean designs with unique atmosphere. However, the trend towards large scale advanced glass solutions is accompanied by potential risks regarding both comfort as well as safety and reliability. While the former is mainly focussed on noise radiation excited by typical frequencies of the vessel itself, the latter is on the one hand related to the effects of coincident openings and on the other hand to possible partial load carrying of the glass itself. DNV GL's simulation-based procedure for noise and vibration assessment of glass windows will be described and its effects on the noise performance of the design explained. Possible countermeasures in case that the analyses reveal an unacceptable risk for violating the relevant noise limits are presented. When it comes to the structural impact of large and often coincident glass window openings beside the typical concerns regarding deformation, strength, fatigue focus is laid here on the possible benefits and the related challenges of load carrying design of the glass itself. Realistic beneficial effects on the strength and deformation behaviour are discussed based on practical experience and different case studies. Special attention is paid to the detail design of the glass bearing system which on the one hand must ensure a proper load transfer from the surrounding structure into the glass but on the other hand must avoid any direct contact between the structure and the glass itself.

**15.50-16.25 DESIGN FOR HELIDECK CERTIFICATION, Steve Beech, Safeguard Helideck Certification, UK**  
The integration of one or more helidecks within the design of modern Superyachts is becoming a more common occurrence. Whether a helideck is provided for personal use, ad-hoc operational activities or for the use of charter customers the provision of a certified helideck that has been demonstrated to be "safe by design" is a key element to ensuring the safety and efficiency of your helicopter operations. So, how can you ensure your superyacht will withstand such scrutiny? Fundamental to the safety of any helideck equipment are two elements. The equipment must be "safe by design", the subject of this paper and the equipment must be "used safely". This requires a trained crew, however a good design will place less pressure on a busy crew to make up for the shortfalls in that design. This paper aims to look at how the integration of design codes (such as the Red Ensign Group Superyacht Code) during the design process can ensure a deck that meets the designers, the owners and certification requirements. The paper will consider some of the key features relation to safe helicopter operations, with respect to certification, and will consider some of the lessons learnt from recent certification activities.

16.25- GENERAL DISCUSSION



**Design & Construction of Super & Mega Yachts**

14-15 May 2019, Galata Museo del Mare, Genoa, Italy

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