

SKIN

The use of external surface in yacht design

Maria Carola MOROZZO DELLA ROCCA^{a,1} and Giulia ZAPPIA^a

^a*Department of Architecture and Design, University of Genoa*

Abstract. Skin, external surface, coating... Those are words strictly linked to the concept of appearance, which means to be watched, to show, and sometimes to seem: a comparison between being and appearing. From a design point of view, the surface coating is, mainly, an esthetical choice. Nevertheless, sometimes that element has been due to other reasons. During the First World War, painting warships with the dazzle technique allowed them to "hide" from the enemy: the shapes and colours applied to hulls allowed them to appear in different sizes or positions compared to the actual real one. In that case, the skin assumed a vital defensive role. Even if most yachts today do not shine with peculiar external surfaces – if we closed our eyes we could imagine hulls in neutral colours, generally in one or two tones – skin however is a project element with significant potential. Ivana Porfiri commissioned Jeff Koons, acclaimed contemporary artist, to finish the external coat of the Guilty. The skin highlights shapes and formal choices of hull and superstructure, and also takes forward the link between art and yacht design, explicit by the display of art in the interiors. Another example of designed skin is LAP-1 by Francesco Paszkowski Design. Here the external coating was designed with camouflage with shades of blue, a symbolic colour for the Baglietto shipyard, responsible for building the yacht. Finally, browsing the most significant projects, the paper aims to analyse the design and use of external coatings of yachts. The skin project in a nautical context is today mainly linked to aesthetic reasons. Nevertheless, also thanks to the use of new materials, innovative painting, and covering techniques, new possibilities for skin design are envisaged. External coating, colours, textures and hull finishing could meet different and new needs in the energy and environmental field.

Keywords. Nautical design, skin, prospects, sustainability, external surface

1. The skin of boats in history: from recognisability to camouflage

It appears complex to find in history examples of external finishes on boats designed with motifs other than purely aesthetic ones. It is therefore equally complex to find evidence - historical or contemporary - of the painting or coating of hulls with particular finishes.

In the 1930s, the America's Cup yachts were the protagonists of important technological experiments and evolutions with the aim of achieving maximum speed and racing performance. It was the era of the J-class yachts, a consequence of the Universal Rule tonnage formula, which competed for the 100 Guineas Cup for eight years from 1930 to 1937. In addition to the American boats there were, especially in England, other boats that took pride in the name of J-Class, these originally belonged to the old Big Classes but then changed the sail rig and their hulls were modified to be able to run with the J-Class proper. These include Britannia, a royal yacht launched in 1893 that first belonged to the Prince of Wales Edward VII and then to King George V and was

¹Maria Carola Morozzo della Rocca, Department of Architecture and Design, University of Genoa, Stradone S.Agostino 37, 16123, Genoa, Italy; E-mail: carola.morozzo@unige.it.

converted to a J-Class in 1931 based on a Nicholson design; Astra and Candida built the first in 1928 and the second was built in 1929 by Nicholson according to the International Rating to run in the Big Class. They were converted to J-Class in 1930.

In 1934, in England, the passion for these type of boats reached its pinnacle, so much so that, motivated by the public cheering from the coast, the owners decided to paint the hulls of their boats in order to make them clearly distinguishable, so Britannia remained black, Astra became turquoise, Endeavor dark blue, Velsheda white, Shamrock blue-turquoise and Candida grey [1].

The aesthetic motivation for the painting of hulls, however, in this case stemmed from the need for greater identification and recognisability from afar of boats. The exact opposite occurs in the military.

An obvious example of the use of colour or the external coating of a means of transport for reasons that go beyond the aesthetic sense is found in the military field with the use of military camouflage as a visual technique of military deception.

It seems that the pioneers of military camouflage were the French who, during the First World War, made use of visual art artists for this purpose not only for uniforms but also for vehicles, structures, ships and planes.

From the French ploy to the present day, there have been many experiments and the basic principle on which the experiences of the various countries have focused consisted of misleading the human eye using techniques such as cancelling out shadows, the "breaking up" of human lines and equipment, cryptic mimicry² and dazzling camouflage³.

Regarding means of transport, the camouflage methods adopted are distinguished according to the specific type of vehicle to be 'hidden'. For ground vehicles, for example, the Tank adopts cryptic camouflage principles, acts to confuse its presence with the territory in which it is being used by means of chromatic textures, but also phantom principles, that is trying to appear something different from the actual reality. Ground vehicles therefore adopt principles similar to military uniforms, but adapting them to the scale of the product being camouflaged using geometric or simplified patterns, but above all by making colour the main tool useful for blending with the surrounding environment.

Regarding the Navy, until the twentieth century, naval weapons had a reduced range, therefore, the camouflage of boats was not excessively important. Paint schemes were selected for ease of maintenance or aesthetics. It was only in the early 1900s that the first principles of camouflage were introduced in the form of shades of grey of hulls in the hope that ships would vanish into the haze.

The first major change towards visual deception techniques occurred with the introduction of the dazzle technique or dazzling camouflage on the occasion of the First and Second World Wars. The dazzling camouflage, launched by the English artist Norman Wilkinson, completely changed the logic adopted previously and stemmed from the desire not to "make ships disappear", but to make them look different from themselves or smaller and/or faster, to encourage misidentification by the enemy and to make ships harder to strike.

It consisted of complex patterns of geometric shapes in contrasting colours, which interrupted and intersected each other.

² Cryptic mimicry (cryptism) consists of the assumption of shapes, colours and behaviours put in place to make them completely similar to the surrounding environment and can be of a visual, olfactory and/or auditory nature.

³ Dazzling camouflage consists of the assumption of shapes, colours and behaviours designed to confuse the observer's eye by making what is disguised appear to be something other than what it actually is.

The intention of dazzling is not to hide, but to make it difficult to estimate a target's range, speed and direction.

Dazzle was adopted by the Admiralty in the United Kingdom and later by the United States Navy. The dazzling pattern of each ship was unique to avoid making the ship classes instantly recognisable to the enemy. The result was a profusion of dazzling patterns, and the evidence of their success was mixed and maximised.

The dazzle then became a form of artistic expression in other areas, attracting the attention of prominent personalities starting from Picasso and the Cubists in general up to Andy Warhol in more recent times or was used in nautical experiments far removed from the military field such as the Guilty luxury yacht textured by the artist Jeff Koons and analysed in the following lines.

2. The colours of tradition

Traditionally and most commonly, the colours most used in small to large size yachting are light, white or creamy white. Although dark colours may meet the taste of many owners, these absorb a much higher percentage of heat than whites, with consequent less insulation from the heat of the interior spaces of the boat or more sudden heating of the walkable surfaces - it should be noted that if some hulls with dark colours are occasionally encountered, it is very rare to see a deck that is not white or wood. In addition, colours tend to fade over time, making boats with dark colours in need of more frequent restorations over time with a consequent increase in maintenance costs.

Thus, although the nautical sector has always been a field of technological experimentation and innovation for all those aspects that determine the design and construction of boats, from propulsion to hull shapes to the use of new materials for both interiors and exteriors, the same cannot be said for its skin. While technical and constructive innovations follow one after another other from year to year, the choice of external finishes of the hull and superstructures remains almost unchanged anchored to a cultural heritage that struggles to evolve or find the right reasons to do so.

An exception is the use of colours, in particular blue, by Cantieri Baglietto. The range of the renowned Varazze shipyard presents a varied colour palette, offering hulls every year that have included dark and light grey, beige, white, ice white and blue, often associated with wood or white decks and superstructures, and even shades that degrade between the hull and superstructures from white to light blue to darker blue, as in the case of Antalis, 48 m. 2007 on a project by Studio Arnaboldi. An exceptional use of colours - in particular with the inclusion of the dark blue colour - which certainly cannot be called a novelty, quite the contrary. The shipyard, which since 1854 has been one of the cornerstones of Italian and international shipbuilding, has contributed to making blue a traditional colour for pleasure boating on a par with white and wood finishes. But that's not all, Baglietto has transformed blue into its own trademark, describing the values on which the yard itself is founded through what it defines as "Blueness Baglietto"⁴.

On this subject, in 2016 Baglietto shipyard, in cooperation with the University of Genova and Gruppo Boero, started a research campaign to study the anti-aesthetical deformation of the hull sides of superyachts caused by thermal loads. After a first research on the consequences of solar radiation on yacht painted with dark colours [2] a

⁴For further information: <https://www.baglietto.com/blueness-it/>

numerical/experimental analysis has been carried out on the wave-shaped displacements caused on yacht sides by thermal loads [3].

3. Surprising finishes in contemporary yacht design

The Baglietto shipyard, a project by Francesco Paszkowski Design, is one of the yachts that make the outer skin an important part of the design of the object. Launched in 2015 for Lapo Elkann, Lap-1 takes up the military concept of cryptic camouflage, through a geometric pixel system, however, it does so without forgetting the Baglietto tradition by proposing a colour palette in shades of dark blue, blue and light blue.

Another project that takes up typical compositions of the military field to revisit them in yachting is the afore-mentioned Guilty. Launched in 2008 by Cantieri Navali Rizzardi, the yacht is designed by Ivana Porfiri. In addition to the choice of interior fittings, a combination of yacht design and modern and contemporary art that has long animated the trade press, Guilty does not go unnoticed even at first glance thanks to the particular external finish.

The squared lines of the hull and deckhouse are entirely painted in yellow, black, blue, white and pink, according to a texture created by the contemporary artist Jeff Koons that recalls the dazzle technique typical of the Second World War. The result, and perhaps also the triggering reason for such a bold stylistic choice, is the creation of a contemporary sailing manifesto. It is no coincidence that the yacht is owned by the industrialist Dakis Joannou, a collector of contemporary art considered one of the owners of the most interesting and comprehensive private collections [4].

Due to its external characteristics, the Guilty is considered by some to be the precursor of a hypothesised trend towards coloured yachts [5]. According to Linda Inga [6], the reasons for a sought-after uniqueness of the exteriors can be ascribed to a lowering of the average age of the owners and therefore a lesser link with tradition and an increasingly pushed use of the yacht and mega yacht as a marketing tool. The private luxury asset leads to a rejection of the mass product and inevitably translates into a marked, unique, recognisable from afar personalisation.

"To get an idea of how sensitive the niche market is to these needs, just look at the colour chart of a symbol of four-wheeled luxury, the Rolls Royce Phantom, and notice how the colour range is wide and not limited to "politically correct" colours. Even the protagonists of the design sector were the first to grasp the link between colour and communication for their superyachts." [6]

An example comes again from Cantieri Baglietto and is the 133 RC (now Ability), which through chameleon reflections turns from blue to red, inevitably attracting attention and emphasising the exclusivity of the product. Atlante, from the CRN shipyard, instead sports an austere grey both for the hull and for the superstructures consisting of square and geometric lines.

Furthermore, the Inoui project by Philippe Briand from 2012, launched by the Dutch Vitters shipyard, is a sailing yacht characterised by a carbon and high-tech structure that almost underlines its strong constructive characteristics through a strong bright green hull [5]. Finally, the sharp lines of the hull and painted in bright red of the Ipanema motoryacht, built by the Mondomarine shipyard in 2017 and designed by the Milanese studio Hot Lab Yacht & Design, are undoubtedly recognisable even from far away which with this project reached the position of finalist in the 2017 World Superyacht Awards in the Semidisplacement Yacht category.

4. Environmental and eco-sustainability needs

The current environmental and climatic needs also push designers and researchers in the naval and nautical fields to ask themselves what might be a concrete contribution to these problems in the sector. An example is given by the phenomenon of biofouling, that is the various forms of aquatic life which, by attaching themselves to the hull, influence both the performance and the aesthetics of the boat and which, by increasing the weight of the yacht, create more resistance with water thus forcing a greater use of fuel and, consequently, having a greater impact on the marine ecosystem. The antifouling paints and solvents used to remedy this problem, in contact with water release substances that are polluting and toxic for the ecosystem. The attention to the environment promoted at European and world level has meant that much scientific research effort has in fact focused directly on the paints and solvents used in the nautical and maritime areas, proposing new types of coatings designed to reduce aquatic pollution.

With the "paint.it" project financed by the European LIFE program of the European Climate Infrastructure and Environment Executive Agency, the Department of Enterprise Engineering (DEE) of the University of Rome Tor Vergata, together with the Azimut-Benetti Spa group, Coloribbia Consulting Srl and the Niccolò Cusano University, has developed a number of innovative non-toxic antifouling paints for naval application. In addition to the elimination of biocides, these products also contribute to reducing other causes of pollution, starting with CO₂ emissions. In fact, the use of these special paints contributes to reducing hull maintenance activities, with beneficial consequences linked to the production of energy, greenhouse gases, waste and positively impacting on the LCA [Life Cycle Assessment] of boats.⁵

An alternative to using paint products is films. The Deluxe Wrap company, for example, offers adhesive films produced by 3M that can be used for both topsides and hulls of boats. This is a coating method that in the first case is used to customise the hull and superstructures quickly and avoiding construction costs such as sanding and preparation of the base that would be necessary in case of repainting, reducing the preparatory phases to a simple cleaning of the surfaces. The films, in vinyl material, create a shield from salt and UV rays, delaying discoloration of the surfaces. Regarding the hull, the same company proposes a type of eco-friendly antifouling coating certified by Lloyd's Register of London which, in addition to having no impact on the marine ecosystem, allows easy cleaning of the hull directly in the water and contributes, where present, to slowing down the osmosis expansion phenomenon, thus reducing shipyard costs and maintenance times. The durability of the films is estimated for five years, after which the material is fully recyclable⁶.

Considering the examples just addressed as "passive" solutions, that is, through their application they reduce by a certain percentage the phenomena of emission of harmful gases, the dispersion of pollutants and reduce the maintenance times of the vehicles on which they are applied, we can imagine a use of the external skin of yachts that propose "active" solutions through which to go beyond the reduction of problems and even create a certain benefit surplus.

An interesting input in this regard comes from the Gdansk shipyard where the 80 Sunreef Power Eco catamaran, the new model of Sunreef Yachts, is under construction from 2020 [7]. The hull and superstructures are entirely covered with solar panels,

⁵ For further information: <https://www.progettopaint.it/index.html>

⁶ For further information: <https://deluxewrap.it/>

covering a total area of 200 square meters capable of producing solar energy with a capacity of 40kWp. All this is completed by a fully electric propulsion with a declared unlimited autonomy. The extended surface of the luxury catamaran offers wide and square shapes suitable to accommodate an effectively extended surface of solar panels. In the same way, this combination is made possible by the technological evolution regarding the creation of the panels themselves that appear in the project drawings and in the renderings almost painted on the surfaces of the yacht⁷.

5. Conclusions

The examples and cases provided in the discussion provide an insight into the use of external skin in nautical design which we could summarise in the following points:

- In the past, especially in the military field, external coating played a fundamental role in carrying out specific functions for which designs and compositions were developed which were subsequently taken up and reinterpreted for aesthetic purposes in other areas.
- The design and colouring of the outer skin in boating are linked to traditional precepts, in any case due to technical reasons such as overheating of the surfaces and ease of maintenance.
- To the detriment of the previous point, in particular in the medium-large yacht classes, new needs for refinement of the uniqueness of the product have promoted the use of unique paints that allow immediate recognition of the vehicle.
- Current environmental and marine ecosystem protection needs have led to the search for innovative products capable of combining owners' aesthetic needs of external finishing while reducing consumption and the dispersion of pollutants.

In yacht design, skin has played a secondary role up until now, performing a finishing function in support of the most relevant design elements such as construction materials, hull shapes, the composition of the full and empty spaces in the profile, etc.

However, the combination of aesthetic and environmental needs summarised in the last point of the list seems to be today the point of greatest interest on which to be able to pivot to hypothesise innovative uses of the external covering, targeting a new concept of use of skin which, similar to the dazzle in the military field, is able to respond to concrete and specific design needs.

Will it then be possible to take advantage of a number of innovations in the field of paints or coatings to meet the renewed needs of eco-sustainability? Will it be possible through particular types of pigments to achieve results in terms of energy efficiency due to heat absorption, with a consequent decrease in the use of heating and cooling systems and a consequent reduction in consumption? Will it be possible to take advantage of particular types of coating to extend the life cycle of boats and therefore affect their LCA? Finally, can all this be combined with or respond to the aesthetic and stylistic needs loudly requested by the owners?

⁷ Sunreef Power Eco is part of a line of catamarans, sailing and motor boats, which pursue the same green design concept. An entire section on the website is dedicated to Eco projects. For further information: <https://sunreef-yachts-eco.com/>

If today it remains difficult to provide exhaustive answers to these questions, it is however possible to hypothesise a number of innovative applications through the study and a possible future evolution of certain products currently available on the market.

Limiting ourselves to the field of paints, an interesting input comes from smart paintings. The term derives from the more generic smart material, a term attributed to advanced materials, whose common characteristic lies in the fact that, when suitably stimulated by the environment around them, they react promptly and conveniently [8]. Similarly, smart paintings refer to the paint products that change hue when subjected to changes in physical or environmental conditions.

In particular, a number of particularly interesting characteristics are: thermochromatism, that is the phenomenon whereby the colour of a substance varies as the temperature varies (in spectroscopy the phenomenon concerns the colour variations undergone by the absorption bands of certain substances); photochromatism, referring to special types of glass whose transparency, due to the relevant impurities they contain, decreases as the intensity of the light passing through them increases (the current applications include photochromic lenses for sunglasses, which are clear in low intensity light and darken in bright sunlight); piezochromic, or materials or coatings capable of changing colour when subjected to pressure.

Leader in smart pigments technology is the French company Olikromche, whose wide range of smart products includes in terms of thermochromic capacity:

- Pigments Reversible colour change (OliKrom@TSoft): the hue changes at a certain T1 temperature and returns to the original colour when the temperature returns below T1 (T1 can be determined in a range from -100 to +100°C). Some applications currently being proposed by the company are real-time monitoring of hot bearings, temperature control in the industrial sector, thermal mapping, packaging and interior decoration...
- Reversible colour change with memory effect (OliKrom@TMemory): the hue changes at a certain T1 temperature and returns to the original colour when it falls below a certain T2 temperature. The gap between T1 and T2 determines the memory effect. The applications proposed by the company include industrial maintenance control, the identification of breaks in the cold chain, control of the thermal history of specific elements, verification of appropriate storage conditions, identification of electrical components in conditions of overload, short circuit or overheating of motor parts.
- Irreversible colour change (OliKrom@TOne): the hue changes at a certain temperature that can be set in a range of between 60°C and 900°C. The process is irreversible. Some applications currently being proposed by the company are the visualisation of any temperature increase beyond a certain threshold (thermal mapping, prevention of thermal faults ...).

For photochromic pigments:

- Reversible photochromic pigments (OliKrom@hvSoft): the hue changes at a defined light intensity and returns to the original colour when this optical excitation decreases. The colour change can be induced by UV, visible light and infrareds. Proposed applications: camouflage, interactive materials that change colour with light intensity.
- Irreversible photochromic pigments (OliKrom@hvOne): the hue changes above a given light intensity. The process is irreversible. The colour change can be

induced by ultraviolet (UV), visible and infra-red (IR) light. Applications: The optical marking of industrial parts, the creation of customisable coatings.

Finally, for Piezochromic pigments:

- Reversible piezochromic pigments (OliKrom@PSoft): The hue changes at a certain pressure and returns to the original colour when the pressure decreases. Applications: visualisation of the mechanical behaviour of various materials under pressure (tensile, compressive and torsional load), material health tests.
- Irreversible piezochromic pigments (OliKrom@hvOne): The hue changes at a certain pressure. The process is irreversible. Applications: tests on non-destructive materials during production, use or maintenance (bending, breaking, wear, corrosion, cracks). Visual detection of impacts and shocks for the industrial and transport sectors⁸

In conclusion, these and other innovative materials, currently in use in different and constantly evolving fields, can provide interesting ideas for new horizons in naval and nautical design.^{9,10}.

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⁸ For further information: <https://www.olikrom.com/fr/>

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