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Visual Pleasantness in Interior Yacht Design: A Case Study of the Pleasure-Based Approach Application

Massimo Di Nicolantonio, Giuseppe Di Bucchianico, Stefania Camplone, and Andrea Vallicelli

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3.1 Introduction

The quality of the environment is closely related to the control and availability of natural light and possible views. In the field of yachting, however, the design solution of the hulls and the internal environments often makes the relation between the availability of natural light and views inside the boat especially critical. Anyway, the demands of representation and sociality required by final users needs the introduction of new systems of windows, terraces, and new layouts, to relate the interior of the boats with the deck, attributing new meanings within the social idea of “going out to sea.” This is how the small portholes, with the original function of air environments, can aspire to become large openings for dialog with sky and sea. However, the unstable horizon of the boat and the dynamic changing nature of views and natural light generate very difficult conditions with regard to the control of the factors which can help determine the good size of domestic interiors and their relationship with the environment.
3.2 New Ideas of “Transparency” in Yacht Design

In recent years, the yachting industry has had an unprecedented expansion and evolution. Technological development has been complemented by experimental research of new layout solutions, new product concepts, and new morphologies, where the methodologies, techniques, and tools of the project have responded with unprecedented dynamism, research, and solutions that guarantee the improvement of each performance, putting the end user at the center of the whole creative process. Today it is known that yachts are not only for transportation, for competition, or for exploration, but increasingly assume the role of status symbols, places of representation with high social value. It is therefore inevitable that the spaces on board need substantial, technical, and functional changes. Referring to the range of the sailing yachts of medium and large size, the attention of yacht designers today takes care of both the pleasure of sailing conditions and the living conditions, changing spatiality, and shapes. Actually, to obtain the best organization of the interior living spaces, the designers tend to preserve the most typical layouts, to introduce new materials and advanced technologies, to improve the performance values of the boat, and make new ways of living the boat possible.

The new technological solutions improve the operating conditions of the crew, so it is possible to reduce the number of crew members and to reduce the crew area. It is now possible to create larger external living spaces, separated and organized better to increase the levels of comfort and hospitality. One of the most significant innovations is related to the research about the interiors “transparency.” The interiors are no longer small, dark, cramped, protective. The interiors tend to “open-up” to the surrounding environment, giving new social meaning to the idea of “going out to sea.” The small portholes, originally designed to ventilate the interior, now become large openings, so the crew can really dialog with the sea and the sky from the interiors of the boat. Hulls and decks structures are cut from large windows. The walls can be more transparent, and the crew can live in dialog with the sea and nature. New physical and visual relationships between the interior and exterior of the boat are established, through the inclusion of unpublished terraces and openings.

In this context of technological innovation and space control experimentation, this new visual attractiveness represents an interesting and strategic project proposal, both referring to the “views” and the possibility for the crew to relate visually from the surrounding natural environment, both reported to control the quantity and quality of natural light that invests on a daily basis the inside of the boats, which often must be shielded in order to obtain acceptable levels of visual comfort.

3.3 Verify and Assess the Visual Pleasantness on Board

The visual comfort in any indoor environment is the result of several factors. The natural and artificial lighting, the colors, the views, the shape of the space, which must be carefully related to each other in order to produce well-being and not malaise. Most of these aspects are derived directly from the sizing, the shape, and positioning of any openings to the outside.

The research was conducted with an initial investigation of the general nature on the subject of visual comfort through natural and artificial lighting and through the use of
color and its effects on humans, also investigating those activities the user is going to do into these specific environments.

The study was preliminary and extremely useful for defining the research objectives, and to obtain qualitative data on the attractiveness of the apertures toward the outside and the colors in the living area of the yacht.

The first issue was the choice of the size of a 15 m sailing yacht, due to the fact that the interior layout of this type of boat can be considered a good compromise between a marine space and architectural civil space. The smallest sailing yachts have internal spaces similar to cockpits. On the contrary, the environment of this type of boat can be compared to those of the civil architecture, which lead to a different spatial perception from that of the interior of a boat.

The second issue was the choice to conduct the experiment on the living area, because it is the common and the most experienced space of the yacht. This particular environment, defined “square,” represents the social area of the yacht, generated by the union of the saloon and the kitchen. Thus it is possible to prepare and eat food, while relaxing or making conversation, often also in special spatial conditions (a boat tilted, in continuous movement, etc.).

3.4 The Pleasure-Based Approach

The research is part of the most famous experiments in applied ergonomics that make reference to the pleasure-based approach (PBA). The designers use this methodology to know the needs and desires of the target audience through tests made with specific groups of individuals at all stages of design.

In particular, the articulation of the experimental phases refers to the SeQUAM* (Bandini Buti, 1997), sensorial quality assessment method, with some modifications due to the specific contexts of use.

The objectives are

- To create approval rating indexes associated with the objective aspects of the product, to point out the satisfaction ranges for each parameter from which the guidelines of pleasantness will result
- To define guidelines of pleasantness for designers
- To formulate design specifications about object pleasantness and every individual parameter
- To obtain transmittable and certain data, based on certainty basis and applicable to the design, making predictive assessments related to objective parameters

The method involves that the operative scheme will be repeated thrice during the sequential survey:

- Survey on the present
- Innovation survey
- Prototype check

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* The SeQUAM method (Method for sensory quality assessment evaluation) was developed by L. Bandini Buti and L. Bonapace, since 1992, as part of a project for FIAT Auto aimed at increasing the levels of pleasantness perceived by users during eye contact, touch, and body parts and components of motor vehicles.
In the first phase (survey on the present), objects selected from those offered by the market will be investigated, which are particularly interesting to analyze for aspects of attractiveness. The purpose of the first phase is to derive quantitative assessments on the appreciation of the members of the stimuli and to guide the design of experimental maquettes necessary for a systematic study of the individual component of agreeableness.

The advantages to investigate the series products are:

- To allow rapid retrieval of samples to be tested
- To be able to test all the variables because the object is finished and is functioning

The disadvantages are:

- That the object can recall the interviewee stereotypes which are difficult to eliminate (e.g., known or mythical objects, or objects that are better known than others, etc.)
- It is only possible to test common and not innovative parameters

This first phase investigates by using the observation matrixes M1 and M2. The establishment of pleasantness criteria inserted into the matrixes, combined with the reading of the results, allows the research group to obtain useful data for the design of maquettes to be included in the test of pleasantness in phase 2.

Phase 2 (innovation survey), starts from the indications of pleasantness obtained during phase 1. It refers to those solutions which are currently in production and are therefore significant for today, but do not say anything about innovative trends, especially if it is taken into account that what is offered by the market has been conceived a long time before. It is therefore necessary to introduce a stage in the investigation that analyzes objects specially designed for the research, which should allow us to:

- Investigate parameters that in the first phase showed trends that should be deepened
- Analyze trends emerged from the survey but not verified due to a lack of suitable objects
- Investigate innovative trends

This second phase involves the design, the construction, and the test of a homogeneous series of maquettes which lead the survey of the subjective response related to the changes of individual components in “low noise” situations, that is not polluted by past prejudices. The series of maquettes can be used to check the performance’s limits related to the variability of the components investigated by evaluating models with features also esasperated (e.g., grips of excessively large size or excessively small).

The advantages to investigate maquettes are:

- To analyze very well the individual parameters by comparing maquettes, equal in all ways except for the variation of the parameter
- The time required for the development of this phase is not much longer than that of the previous phase, because it requires the development of projects, and the execution of models
The disadvantages are

- Timing and costs of production enforce that the research can be made generally by using maquettes just not working.

The innovation survey is conducted by a test subject in a representative group of potential users. The results of the tests crossed to the results of the matrixes allow us to obtain guidelines based on reliable data for the realization of a concept.

In the first two phases, the research is carried out in conditions that should enable us to get the maximum information with content development time, as required by the logic of production marketing.

Under experimental conditions, the subjects pay attention only to the objects themselves, which must be used in the presence of observers. In a real condition of use, subjects pay attention only to the results of their actions.

The final and third phase of SeQUAM is called “verification on the prototype.”

It requires us to carry out research on working prototypes that have all the characteristics of the finished product and which are included in the correct environment, from the functional point of view, and from that formal point of view, and last, that can be used in real conditions by potential users.

In this case the third phase did not take place.

### 3.4.1 Application of M1 and M2 Matrixes

In this case study, to carry out the “analysis on the current” in a structured way, the research developed two matrixes or cards classification.

The matrix M1 refers to the “analysis of the views” and is a table that organizes the “elements” and “criteria” to analyze the views to the outside.

In particular, among the “elements” are considered some aspects of identification of the vessels analyzed, and especially the vertical and horizontal elements having the ability to control the stimuli coming from the outside. They are the four “directions” in which apertures are inserted (at the bow, to the stern, aft to the bulwarks, on the ceiling).

The “criteria” have been shown: position of the openings/transparent surfaces, with which you can benefit from the view posture (standing, sitting, half-lying, lying), and finally what kind of view of return openings (circumscribed, elongated, fragmented, overview).

The use of the matrix M1 has allowed us to analyze a sample sufficiently significant of boats.

The matrix M2 refers to the “analysis of the use of colors” and it is a table that organizes the “elements” and “criteria” to analyze the use of color in the living spaces of the yachts.

In particular, among the “elements” are considered some aspects of the yachts analyzed identifiers (name, images of the square) and especially the opaque surfaces of the living area such as the deck, the sides, the bulkheads, and the top.

Among the “criteria,” however, have been shown, each part has its own color with high gloss levels, those characterized by colors that convey similar feelings, and those colors that convey different sensations.

Also in this case the use of the matrix M2 has allowed us to analyze and systematize the data referring to a significant sample of yachts.

This phase of the research has had the aim of obtaining qualitative data on the attractiveness of the views to the outside, and the colors, related to the living area of a sailing boat.
3.4.2 Investigation with Maquettes and Render Scenes

An evaluation test was designed to investigate the “new tendencies.” For the experiment a questionnaire was used accompanied by some “maquettes,” in respect of which, the judgment of pleasantness was asked for.

The variables evaluated (and on which were carried out maquette/render scenes) were considered with respect to (1) placement of transparent surfaces; (2) posture of the individual for the views; (3) kind of fruition views; and (4) dyes for coloring matt surfaces.

The sample was composed of 26 members, divided into three age groups between 21 and 65 years, 13 of them with experience in sailing and 13 with no experience of sailing.

In particular, users had to answer a questionnaire based on some cards containing render scenes describing an “environment type,” of which we must make a judgment. The reproduced scenes on each card are different only for the feature that is intended to be investigated.

The ratings of pleasantness judgments were expressed using a simple rating scale (1: not pleasant; 10: very pleasant), with the possibility to indicate intermediate values. Each judgment of pleasantness expressed in numerical form (quantitative assessment) was also required to be associated with an explicit “motivation” (qualitative judgment).

The scenes for which we asked to give the judgments of pleasantness were 61, divided into 8 tabs. Each tab on the back reported two questions to answer. Assuming an average rating for each scene of 15 s, a minute and a half to meet every couple of questions, and adding about 5 or 6 min to fill out the Getting Started tab and be informed on the tasks to be performed, it was previously calculated that the overall average length of the test was about 40–45 min, a time short enough to hold the attention and get answers that were instinctive enough, and at the same time sufficiently long enough to avoid a hasty completion of the questionnaire.

Even the conducting of the trial was designed in detail, describing in detail the activities and roles of the researcher to obtain sufficiently objective results. The test was carried out in the laboratory.

3.5 Data Analysis and Guidelines

The results have been organized in respect of two aspects.

The first aspect concerns the system of guidelines for the awareness design of portholes in the living nautical spaces, and the guidelines for the usage of colors.

The second consists of a further study that reported the possible control systems of the quality and quantity of light through natural apertures which could be transparent or translucent.

The data collected were allowed to organize guidelines in respect to placement of the apertures (and the respective openings that allow it), postures to enjoy the apertures, and the type of use of the views.

The data collected were allowed to organize, in general, that the requirements relating to internal living spaces for sailing boats of similar size to those analyzed are attributable to the following concepts: highest availability of free surfaces on the sides;
convertibility, mobility, and flexibility in the use of equipment and furnishings to allow variability in exhibition set up environments; maximum spaciousness, and maximum usability views.

The same comparison was conducted with respect to the use of colors. In this case, the guidelines have been organized with respect to dyes to color the side surfaces of matt colors for opaque surfaces at the bottom (deck); colors for opaque surfaces at the top (top).

The requirements related to the use of the colors were: transformability (the possibility to change the colors also instantly depending on the prevailing activities) and high gloss.

### 3.6 Daylight Control Systems

Another interesting study of the research has focused on the identification of possible smart systems to control the quality and quantity of natural light that passes transparently or translucently into the yachts. Our attention was focused on the identification of a useful smart system for screening:

- To control the amount of natural light that penetrates inside at certain times of the day and according to specific conditions and changing orientation of the yacht relative to the position of the sun (mostly because of the so-called “greenhouse effect”)
- To choose the quality of natural light, even filtered through special screening systems that can help to determine new shades for specific environmental conditions and activities

The research has been focused on chromogenic devices that also allow you to greatly reduce the energy consumption for cooling and lighting the indoor environment. In marine applications, the control of the solar factor referred to in the transparent or translucent parts is very important for maintaining microclimate comfort, as well as to provide specific visual effects, high levels of security and privacy that may differ when related to internal and external factors regarding the yacht.

The control of “natural light” or “sunlight” depends on the type of yacht, the weather, the seasons, the different times of the day, and on the characteristics of use. The use of chromogenic materials is more effective than the use of traditional solar shading systems such as blinds, curtains, drapes, and many others. The systems chromogenic materials are characterized by the ability to modify the optical properties with a reversible effect, following the application of an electrical stimulus, heat, or light. According to their behavior we identify four types of chromogenic materials: liquid crystals, electrochemical, photochromic, and thermochromic. In this case the chromogenic and photochromic devices proved potentially more effective compared to the specific conditions of use. In particular, these devices that are sensitive to environmental parameters and placed in special “smart windows” react with the gradual and reversible change of color when exposed to light stimuli of varying intensity (UV exposure). With the same technology it is also possible to control the tint of the light, turning the transparent surface into a real color filter.
3.7 Concept Design: A Study Case of PBA Approach in 15 m Sailing Yacht Interiors

The system of guidelines that referred to the design of the apertures to the outside has allowed a deepening in terms of the design of possible responses. The starting point of view, related with the innovative relationship between interior and exterior spaces of the sailing yacht, through the combination of the data produced by research and the new concept referring to the relationship between the product and the marine environment, has had great influence on the final concept. At last, the solution was found, through two ways of action:

- New interior concept
- New exterior concept

With reference to the interiors the choice has been to reconfigure the living area, through the use of large apertures on both sides of the hull and on the deck of the yacht. This choice, obtained with the adoption of smart materials and control systems of the intensity of natural light and with the aid of the control systems of the staining, allows us to optimize the relationship with the natural environment.

New technological and formal solutions have been found for the exterior design that could highlight the innovation represented by large apertures. The first step was to redesign a structural framework that would guarantee the stability of the entire system under the effect of stress to which a yacht is constantly subject. Second, it is necessary to rethink the yacht starting with the elements that characterize the morphological forms of the hull.

All the design choices implemented have allowed the research group to develop the project of a boat with extremely innovative solutions in morphological, structural, and distributive terms. All the solutions allowed, especially in the middle of the square, a visual relationship with the external environment, characterized as extremely flexible, instantly reconfigurable, and really unusual for the sailing yacht industry.

3.7.1 Design of Apertures toward the Outside

The first insight of the concept took care of the design and reconfiguration of an original deck layout, thanks to an original design of topsides related to the introduction of these great apertures.

At the same time new solutions for a new internal layout were found, related to the choice of introducing great apertures on the top and on the sides, and introducing the new technology of the chromogenic panels, with the purpose of obtaining these large apertures and color variations of sensory character.

The correct height of the washboard has allowed the insertion of these large portholes in the hull, which acquire a great architectural value, due to their size, and due to the fact that the entire system is redesigned on the outer side, so unusual and original, enhancing the form and function through the use of views. The final result has been a new and original design of the hull profile, strongly characterized by the system of architectural openings embedded in a dynamic way (Figure 3.1).

3.7.2 The New Concept Design of the Hull Structures

The inclusion of a large number of apertures into the deck and into the hull of the sailing yacht led the designers to analyze the functioning of the structures of the entire boat.
As known, the sailing boat is by nature subject to a number of high stresses that are absorbed by a complex system of structural stiffening of the body. In this case, the stress increase is due to the inclusion of large apertures. It has therefore become necessary to optimize the structural system of the floor plates and transversal beams. The structural grid has been reinforced with the right number of beams that serve the dual function of supporting the chromogenic panels. The reinforcement system increases its mechanical performance with the use of the bulkheads in a carbon single-skin laminated with vinyl ester resin, which can block the movement of the structural reference cage. The rigidity of the cage is also increased through the right dimensioning of the high current, placed in the vicinity of the top side line of the hull, and the low current, which also absolve the dual function of support and base for the coupling of the chromogenic panels inside. The construction material is carbon fiber, resin laminated and the structural omega and at the hull with vinylester resin, and subsequently worked with the system of the vacuum bag to clear any possible delamination problems. The entire system of hull lamination is based on a sandwich with a honeycomb core and internal and external layers of carbon fiber material.

3.7.3 Design Solutions “to Live” the Living Area

The two last insights involved the insertion of two sitting systems in the living area and the transformation system of the living area into a dining area.

In the first chase, the concept proposal was the insertion of two symmetrical and linear components, equipped with low seats inside.
This sitting system puts the user in a position to take advantage of the space in different ways, depending on the different useful functions and criteria of the management system of the apertures outside, in the hull, and on the deck. This new solution introduces a new way of feeling the outside context, and creating a new type of relationship between the user and the internal living space, like a scenic surrounding (Figure 3.2).

In the second case, as the square is a multifunctional environment concept, it is possible to transform the living area into a hybrid space involving the function of dining through a mechanism that moves a folding table in the forward bulkhead. The table, with characteristics of modularity, can accommodate a minimum of two guests to a maximum of six guests, according to the organization of the general layout.

### 3.8 Conclusions

This research aimed to investigate how the PBA could give reliable data on subjective aspects of the project, so far left only to the individual sensitivity and culture of the designers.

The PBA looks at design for the individual. What could be considered quality for one final users could be considered the opposite for many other final users.

Numerous methods to transfer subjective aspects into the projects have been studied, such as the SeQUAM, which has been used in this research to investigate the issue of visual pleasantness as a way of attractiveness.
Such a study was conducted in the field of sailing yachts, considered a key sector of Italian industry.

A first result of the research was to identify the most subjective aspects that could generate healthy sight in the living area of the boat resulting in the criteria that were used to analyze a number of case studies on the market today by using the principles of SeQUAM, given us by the results of matrices M1 and M2. It is true that in this way it was possible to design and implement a questionnaire, which allowed us to investigate aspects of visual attractiveness. The test was administered to a representative set of potential users. The results were extrapolated to the guidelines and requirements for the design of a 15 m sailing yacht concept.

The design requirements of the yacht had to immediately deal with those problems related to the structural nature of the hull, along with those concerning the external layout, and then those related to the distribution and organization of the external and internal living areas, where the different activities based on different needs were considered. The first result is a concept which has several innovative ideas and can potentially be engineered according to a PBA to the project.

The methodological approach of this research can be considered a starting point for further developments and insights, not only in a yachting living space, but in any interior housing.

**Credits**

Here, we have detailed the results achieved in a master’s degree thesis “Yacht Design: PBA pleasure-based approach” (Advisor: Professor G. Di Bucchianico, PhD; co-advisor: Professor M. Di Nicolantonio; technical consultants: S. Camplone, A. Vallicelli; candidate: F.P. Salvemini), developed in the “Interior Design of Sustainable Living” Degree Laboratory, at the Department of Architecture of the University of Chieti-Pescara (Italy). All the images reported in this chapter are taken from the abovementioned MSc thesis.

This chapter can be considered the consequence of common discussion and collective review among authors. In particular, the writing of the various sections can be attributed to Giuseppe Di Bucchianico (Section 3.1), Andrea Vallicelli (Section 3.2), Stefania Camplone (Sections 3.3 through 3.5), and Massimo Di Nicolantonio (Sections 3.6 through 3.8).

**Reference**
