

Assessing yacht coatings

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One of the most important elements of a mega-yacht is its visual impact. A large part of this impact is attributable to the appearance of the final coating finish of the external hull.

For many years the assessment of the hull and superstructure coating has been based around terms such as “Super/Mega-yacht standard”.

This paper sets out to explore what this means and offers some suggestions and a proposal as to how the assessment of yacht finishes can be standardised and made more objective.

The paper will first consider the current approaches adopted and then look at the present work of the ISO standards committee and finally suggest a proposal that may have some merit.

1. Introduction

Over the last 5-10 years the increasing demand for Super-yachts (Mega-yachts) has seen substantial demand being placed on yacht builders and maintenance facilities around the world but in particular Europe. The resulting facilities and skills shortages have led to a considerable number of new entrants into the market place for new build and maintenance work. In addition both owners and yards have increased demand for coating inspection/advice.

The coating work is generally focussed on three separate activities:

- New build application

- Crew maintenance and wash down

- Regular re-coating at designated repair/overhaul intervals.

The result is a range of capabilities at new build and repair and maintenance that is resulting in many Super-yachts suffering from coating problems of one form or another.

Studies (1) have shown that typically faults in coating work can be broken down into a number of categories:

- Poor vessel design

- Poor product selection

- Poor product

- Poor management processes

- Poor preparation/application

- Poor maintenance

- Poor repair

- Poor climate/environment control

- Poor worker skill

Not all of these are in the control of one entity, in fact the designer, the yard, the owner, the paint supplier, the contractor, the paint inspector, the crew and the maintenance facility all contribute in one way or another to either the success or

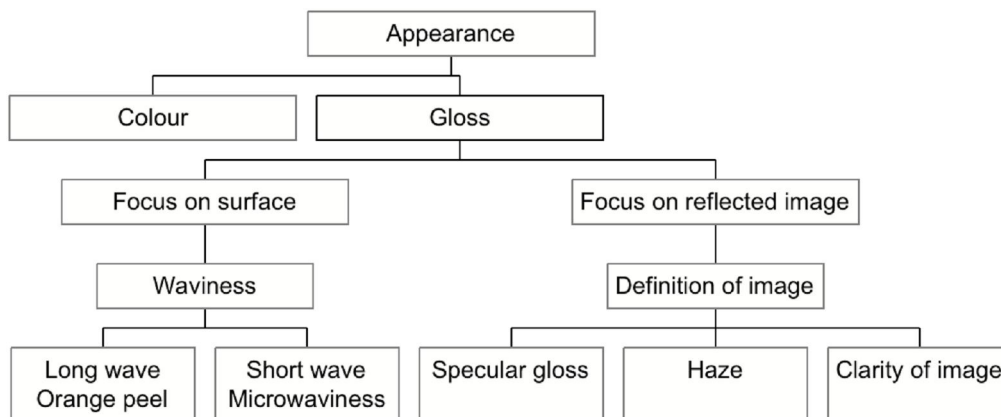
poor performance of the coating resulting in a failure to reach Super-yacht standards.

Before discussing possible solutions for Super-yachts there is perhaps a need to discuss what makes a surface appear visually pleasing.

2. Visual appearance of surfaces

The appearance of a surface can be characterised by a number of factors and these are summarised in Figure 1.

Figure 1 Surface Appearance

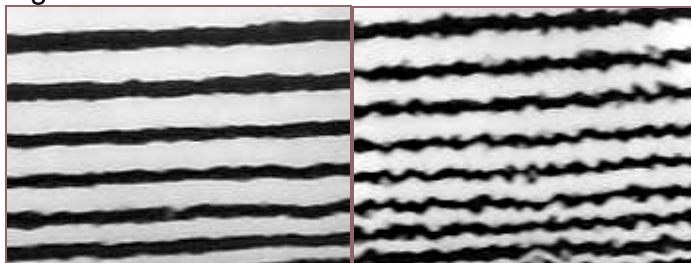


Quality of visual appearance is ultimately dictated by the uniformity of the surface that is being observed. The question though is to what standard has that uniformity to be achieved.

Thus there is a surface focus caused by surface effects and the reflected image effects. It is not the intent of this paper to discuss all the factors that influence the appearance of a surface, but a few simple examples may help the reader to understand some of the key issues involved.

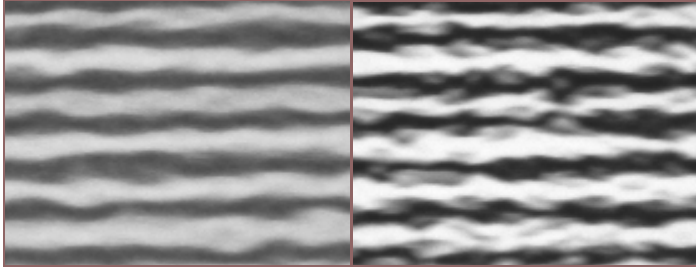
Examples of some surface effects and reflected image effects and how they can interact are shown in Figures 2 and 3 below.

Figure 2 Focus on surface



Waviness (short and long waves)

Figure 3 Focus on reflected image



DOI and contrast

So a surface of uniform appearance is one where the values of the elements that make up appearance are consistent over the whole surface. This may be easy to achieve over small areas such as a car body panel but is not so easy on a yacht which may be in excess of 60m in length with surfaces at a variety of angles from horizontal to vertical and when the surface may be viewed from close up or at a distance.

Therefore the standard to which the surface is assessed should be defined.

The factors that influence appearance are:

- First time coating or touch up
- Substrate type and quality
- Orientation of surface
- Concave or convex surface
- Application process stability
- Lighting and environment
- Human observer

As can be seen in Figure 1, appearance is a function of waviness and definition of image (DOI) and colour.

Waviness is defined by the orange peel effect, which is a surface effect and Reflection, is indicated by the Definition of Image (DOI), which is a reflected light effect.

Waviness is itself dictated by the coating surface structure and size and can be Long Wave, Short Wave or a combination of both when areas are repaired.

Appearance can change with observer distance and lighting conditions or angle and for a yacht this is a real problem as the need is for both good long wave and short wave characteristics and the lighting conditions can vary considerably during a given 24hr period let alone the build time of the yacht.

3. Resolution of light

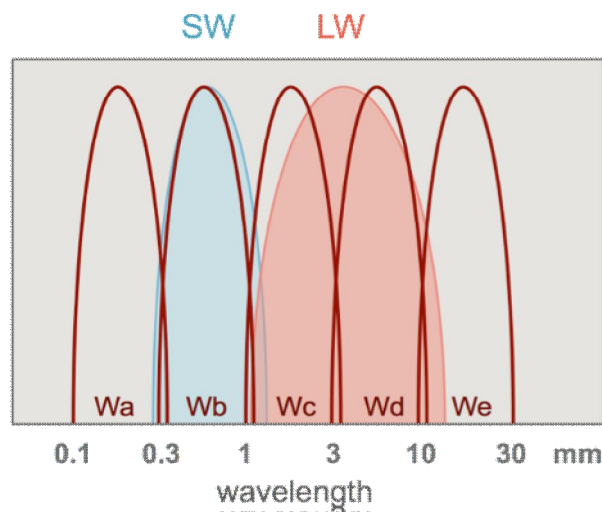
The human eye can resolve longer wavelength light from a distance of about 3m (long wavelength [LW] taken to mean 1mm – 100mm). At shorter distances, say

40cm, the human eye can resolve shorter wavelengths [SW] of the order 0.1mm – 30mm.

When the wavelength of the light is below 0.1mm, then the measure becomes one of dullness rather than brilliance.

The eye of course processes all this information, while the use of instruments allows the wavelengths received to be analysed and categorised in different bands (typically 5 band widths from short to long see Figure 4). Instruments also allow for a consistent interpretation of the surface in an objective manner.

Figure 5 Separation of wavelengths into 5 ranges.

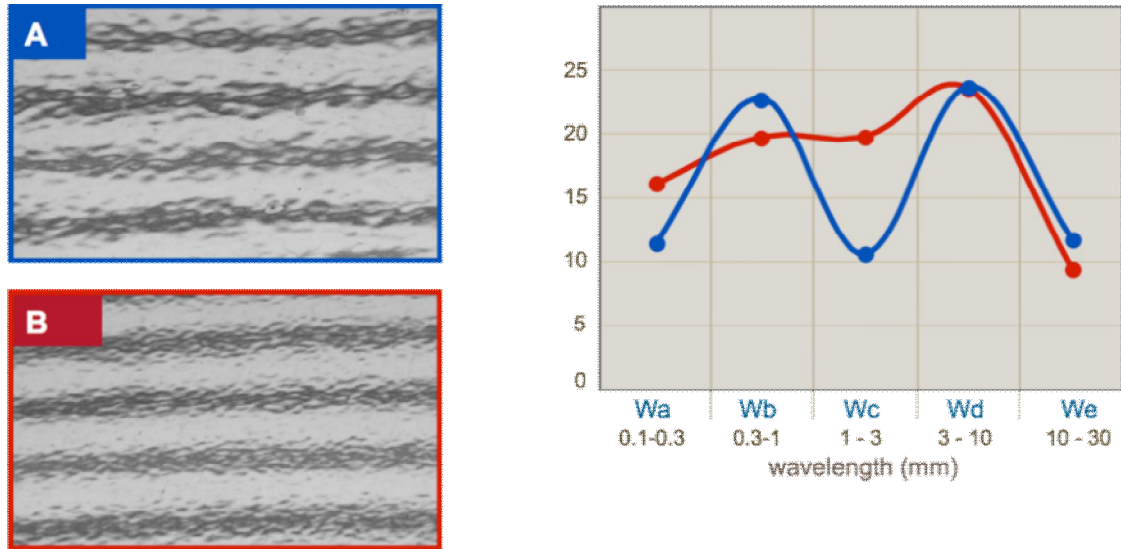


However it is not only the presence of long and short wavelengths that influence appearance. The ratio in which they appear can have considerable impact on the appearance as can other factors such as:

- Contrast
- Sharpness
- DOI

The structure of the coating can influence the Definition of Image. If the structure scatters light then this can reduce contrast, while smaller structures can cause distortion of the outlines of the image. Thus the profile of surface can be analysed and differences in appearance quantified (Figure 5).

Figure 5 Surface appearance profiling



Thus if a surface can be judged by an owner or a yard as acceptable in appearance it can be subjected to some measurements that would enable a profile of it to be built up. It is of course not quite as simple as this, but the overview serves to illustrate the point, that profiling could offer a solution and it is one that is used in the motor industry.

4. Metallic paints

In a continuous drive to be different and to innovate, both designers and owners are often looking for elements of uniqueness for their design/yacht. In terms of coatings this can mean darker colours (blues and greys), even matt finishes as opposed to high gloss. However increasingly owners are asking for metallic paint either in part or in total for the yacht.

These products work by changing the reflected light angle using a combination of:

- Absorption pigments
- Interference pigments
- Metallic pigments

The way in which these pigments are introduced into the paint formulation enables them to combine to give the desired effect.

The introduction of metallic paint would impact of course and add to the factors that influence appearance by the introduction of concepts such as graininess and sparkle.

For metallic paints, light conditions become even more critical and for some even the angle of viewing can be critical.

5.0 Super yacht standards

So what is an acceptable Super-yacht appearance standard for coating finishes? At the present time, it can be argued that a Super-yacht appearance standard is whatever the owners representative is willing to accept or what the yard is able to sell, within the cost and time budgets of the project.

Consequently, the standard can be open to subjective decision-making and opinion, with an ultimate compromise often based on attrition of one party or another.

In the field there are a number of methods by which owners/yards attempt to agree on the required Super-yacht standard for a particular project. The following methods/techniques are predominantly in use:

- Subjective assessment by eye based on a 3rd party assessment
- Use of reference panels/mock ups
- Photographic referencing
- Basic measurements
- Use of measured reference vessels

The fact that a problem exists is reflected by a proposed ISO standard [3], which will apply to non-metallic coatings.

Each of these approaches has its strengths and weaknesses and all are in regular use. The best way to assess them would be to compare their needs to those as laid out in the proposed ISO standard. This will identify strengths and weaknesses in the current approach and the limitation of the ISO standard.

6.0 Assessing coatings

There are number of issues to consider in assessing coatings:

- Method of measurement and definition of acceptable measured values
- Cosmetic appearance
- Colour and type of coating (e.g. light vs. dark colours, metallic and non-metallic)
- Experience of assessor
- Expectations of owner
- Capability of yard/contractor

In an attempt to minimise the variability and then produce a number of options to try to establish benchmarks in one or another, they may make reference to:

- Measured values or
- Optical references (e.g. mock ups, reference vessels, photographs).

7.0 Measured values

7.1 Paint standards

One noteworthy attempt has been made to try and define some standards [2]. In this paper a very important distinction was made between:

Technical Quality, the measurable attributes of the application,

As distinct to

Cosmetic Quality (appearance) of the application.

Technical Quality is objective and can be properly assessed and measured. In simple terms Technical Quality can be answered by a positive response to the questions:

Was the scheme applied in accordance to the manufacturers guidelines?

Was the scheme specified using a functional paint specification approach?

These two elements together create a TQI (Technical Quality Index).

If the answer is negative then the failings in Technical Quality may or may not manifest themselves in the assessment of Cosmetic Quality (if they do not, which sometimes is the case, then a decision has to be made as to the acceptability of the final result, Technical Quality notwithstanding).

For example Technical Quality can be poor in control of dry film thickness (DFT) with either too high a dft or too low a dft. To what extent that may show in the cosmetic appearance will vary, to what extent it may impact on the in service performance of the coating (say dft, which can influence the life of the finish) could be evaluated and may prove to be negligible in some cases.

Technical Quality should be defined in the form of a Functional Paint specification. This is a specification that takes into account the build process, the tools and techniques available and the in service performance requirements. Regrettably, all too often a generic paint specification is developed that enables little assessment on the technical merit of the various options and often results in a decision based on price, rumour of past successes or failures, without a real sound basis for performance.

As Technical Quality can be well defined (that is not to say it always is), this paper will not discuss the make up of the TQI, but it cannot be ignored in a final assessment of the yacht coatings.

The focus is rather on the Cosmetic quality (Cosmetic Quality Index – CQI), in the form of questions such as:

Does it look acceptable?

Is it as good as the last yacht?

Is the owner happy with it?

Reference 2 correctly identified that many of these issues are subjective and difficult to measure and identified the following visual aspects:

- Gloss
- Fairness
- Dustfall
- Surface Texture

The paper argued that these are the factors that most influence the optical cosmetic quality of the finish and went further to quantify them and the findings can be summarised in the following table which was put forward as a proposal to the industry in the conclusion of the paper.

| Cosmetic standard for Super Yachts | | | |
|------------------------------------|--|-------------------|--------------------|
| Property | Suggested min/max value | Method | Next step |
| Gloss | 90% at 60 ⁰ (vertical) 87% at 60 ⁰ (horizontal) | Gloss meter | n.a |
| Dust | Max 8 particles per sq decimetre, max 0.3mm diameter per particle. | Visual microscope | n.a. |
| Surface texture | Reference panel | Visual comparison | Electronic mapping |
| Fairness | To be judged through application of show coat | Visual judgement | Electronic mapping |
| Sags/runs | Not allowed unless considered acceptable by owners rep. | | |

7.2 ISO draft standard TC 8/SC 12

The draft standard entitled Large Yachts – Coatings – Measurement and analysis of the visual appearance (Ref 3). Identifies the following cosmetic issues:

- Gloss
- Colour difference
- Appearance

Fairness
Other superficial defects
Gel coat defects
Film thickness

In doing so it references other appropriate ISO standards and sets out some useful terms and definitions to ensure that everyone involved speaks the same language.

Immediately it can be seen that the list of factors that impact on appearance has increased and it is interesting that an item of Technical Quality has emerged on the list, namely film thickness. This would appear then to confuse Cosmetic Quality issues with Technical Quality issues.

In reviewing the draft then the following observations can be made:

Gloss to be measured using a gloss meter
Colour difference to be measured using a spectrometer
Appearance (orange peel) DOI, to be assessed using a wave scan.

Work is still on going to cover the other aspects of:

Fairness
Superficial defects
Gel coat defects
Film thickness

7.3 Other available technologies

With the advent of laser scanning (Ref 4), then the issue of fairness control could be developed in an objective format without the reliance of a subjective judgement based on observations on a show coat, or possibly the use of a metal baton.

Improved fairing should help improve the TQI and the CQI to enhance overall appearance and reduce filler consumption and make the process easier. Thus there are strides being made across many aspects of the Cosmetic Quality issues to remove the subjective element, with a view of making the processes more objective.

The reality however, is that even if the Technical Quality Index is correct and the measurable elements of the Cosmetic Quality Index are correct and in accordance with measurements, the results may not look pleasing to the eye. This would imply that more work needs to be done to better define the standards so that the objective values agreed at the start of a contract do align with the subjective requirements in terms of Cosmetic Quality.

Once that is done, then a profile of the acceptable values of TQI and CQI could be developed for any yacht project. The remainder of this paper sets out a proposal for the CQI format, and the TQI would follow a similar format.

8.0 Proposal

To date discussion has focussed on one standard and that is the Super-yacht standard. The implication to yards and owners is that as long as the subjective element of this remains, then there is no really clear point at which a decision could be made to say that the finish that is presented meets the standard or if it fails by how much it fails and for what reasons.

The danger is that “beauty is left to the eye of the beholder” and no two people may agree as to what the standard is.

It is clear that the important factors in assessing the cosmetic quality of a Super yacht finish include but are not limited to:

- Gloss
- Colour measurement (initial and over time)
- Definition of Image (DOI)
- Dust inclusions
- Fairness
- Gel coat defects
- Other surface defects

In addition these can be enhanced by factors such as:

- Tension (ratio of short to long wave light reflected)
- Hardness of surface (propensity to mark and scuff)
- Haze (cloudiness)

Of course finally the TQI requirements must also be met.

Finally not withstanding how all the others are determined and measured the visual appearance cannot be ignored, as it is the most critical, and ultimately subjective.

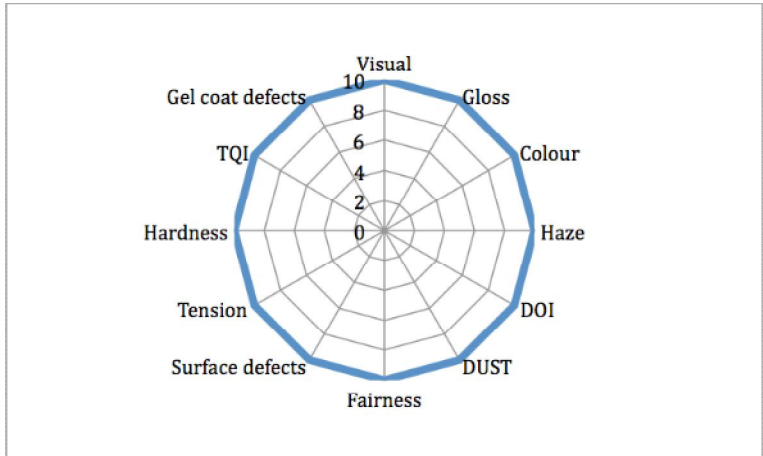
In theory it is possible (but unlikely) that all other elements of TQI and CQI are not achieved but the vessel finish may be accepted based on the visual appearance.

8.1 Reference vessel

The simplest method of establishing the standard required for a particular Super-yacht, would be to take a prospective owner and show him a selection of yachts (this is how the car industry sets about establishing its acceptable cosmetic quality). The owner having selected a suitable reference vessel can then have the vessel analysed and a profile of the vessel can be built up and that would create a standard for that particular owner and that particular yacht, which may be different to another owner and another yacht.

If this assessment could be undertaken then the various measurements could be combined on a scale that could represent a CQI profile as below:

Figure 6 CQI Profile of a reference yacht



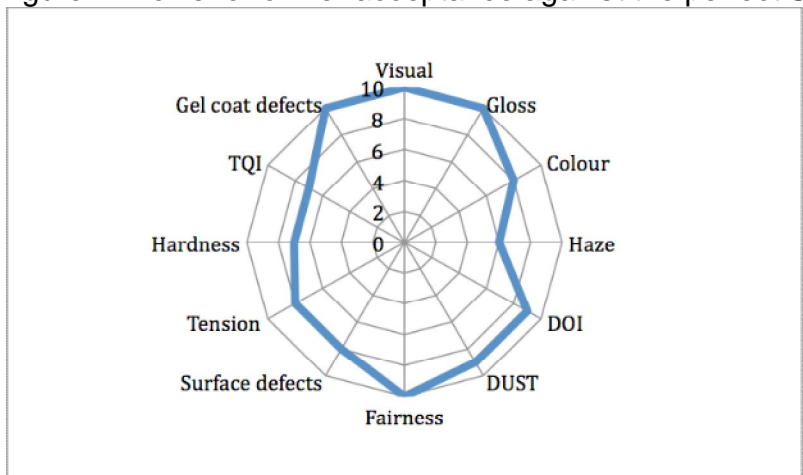
The perfect Super-yacht finish could be denoted on a scale of 0 to 10, where 10 represents complete adherence to the requirements (including the subjective visual confirmation). And 0 would be the absolute failure to meet any acceptable standard. Thus if all of the 12 elements detailed for assessment achieved the perfect result then the Yacht would have been coated and finished to the Perfect 12 Standard, covering both TQI and CQI elements.

The scale is then in effect re-set by project based on the reference vessel or mock up so that 10 indicates complete fulfilment of the requirements (the implication is that the visual element will always have to be achieve a 10). Thus it could be said that both the paper in reference 2 and the ISO standard are setting the parameters acceptable for a perfect 10 score on some of the 12 elements outlined above.

8.2 Owner profile

An owner who has selected a reference yacht can then have a profile built up that may appear as shown in Figure 7:

Figure 7 Profile for owner acceptance against the perfect Super - yacht



For this profile each element can be quantified using appropriate instrumentation and used as the Super-yacht standard profile for the contract in hand.

Over time, the yacht builder/contractor could compile a library of these profiles and to each profile a cost can be attached.

Therefore the proposal offers a gradation to reach level 10, with the implication being that reduced levels of any aspect would result in reduced cost but likely to be at cost to the visual appearance.

This type of approach therefore offers an opportunity to set measurable parameters for each level from the Perfect 12 standard down to what ever level a yard or owner may wish, with the implication that as you move away from the Perfect 12 standard, then costs will reduce and visual appearance may or may not be compromised depending on the interaction of the various effects and the scale itself. Yet the visual requirements would still be met.

The implication here is that the visual standard would always be a 10, but how that value of 10 is reached can vary considerably.

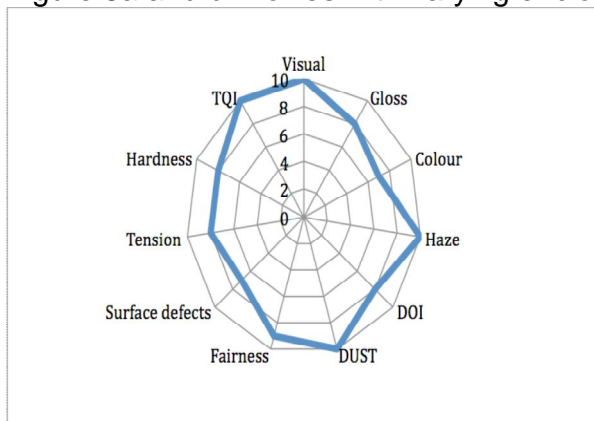
The assessment of the standard for a particular yacht could be made in two ways:

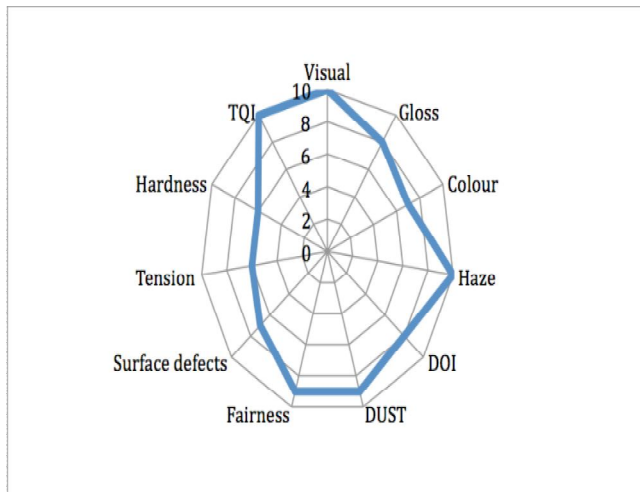
- That the requirement for each of the 12 elements must be met or
- The total enclosed area needs to be met as long as visual appearance is not compromised (probably unlikely).

For the scale assessment then readings and values obtained in the assessment must meet those specified by the reference yacht, while for the area assessment deviations could be accepted as long as the enclosed area is achieved (i.e. the standard may be exceeded in some areas but not met in others, as), as long as the visual requirement is met.

For example Figure 8a shows an enclosed area of 103, while Figure 8b gives an enclosed area of 110 but with excellent gloss and DOI.

Figure 8a and b Profiles with varying enclosed areas.





The important thing here is that the system offers a gradation for both yard and owner, if the vessel is specified to the Perfect 12 standard, then the finish and cost associated with it are such as to provide the perfect finish (Both TQI and CQI, based on current knowledge and methods). If the owner or yard wish to pull back from the Perfect 12 standard then the option is to either define each element on the linear scale or to define an enclosed area or a combination of both based on some reference vessel or a mock up then that can be done.

8.3 Visibility assessment

The final visual assessment can still exert great influence there are however opportunities to mitigate some of this influence, certainly one route would be to divide the visual impact into four broad categories:

- High visibility
- Medium visibility
- Low visibility
- No visibility

The high visibility areas are those where there can be no compromise on the finish and are visible to guests and passers by.

Medium visibility would take into account those areas that have limited visibility to passengers e.g. lockers

Low visibility areas are those that are not on display at all (perhaps inside a motor housing).

Finally no visibility areas are those that will be covered by linings or decking or other materials.

Thus for the no visibility areas the TQI is paramount, while for the high visibility areas the CQI is the critical element.

9.0 Conclusions

A working standard for yacht finishes remains elusive, although previous proposals and the ISO draft text go a long way toward quantifying some key elements, there has not been a method proposed onto which the Technical and Cosmetic aspects of a finish for a Super-yacht can judged against in a consistent manner.

The proposal set out here, may offer a route for consideration and is under continuous development. It is slowly being applied to appropriate projects with an initial focus on the TQI elements and the use of increasingly complex instrumentation for the CQI elements.

Perhaps beauty will always remain in the eye of the beholder, but it may be possible to define that beauty on a project-by-project basis and give all parties an opportunity to work to an agreed standard.

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