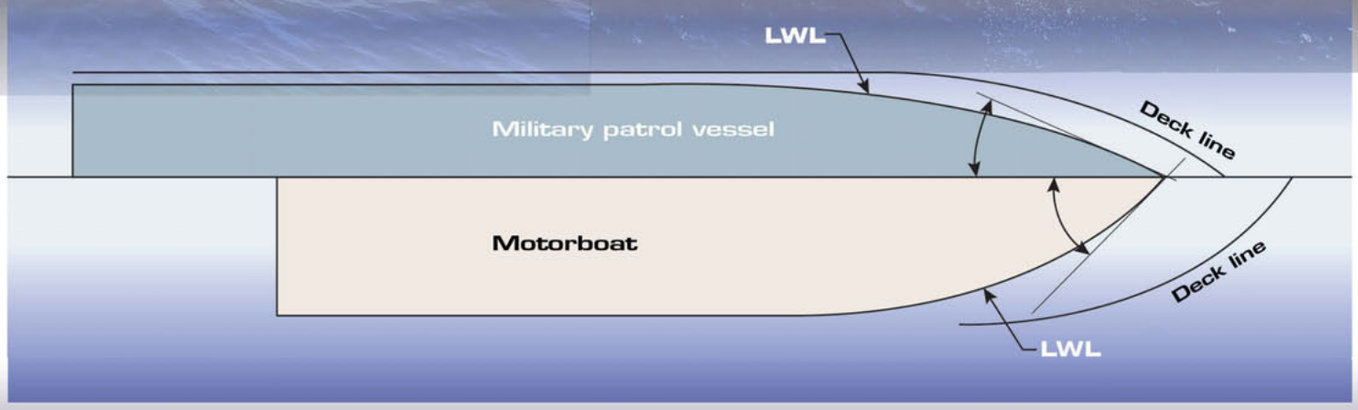
THE HULL

BEHIND THE SUCCESS OF VITRUVIUS®

by Andrea Mancini

There's no doubt about it: the Vitruvius® series, the new Perini Navi motoryachts already built or currently under construction with the glorious Picchiotti brand name, are certainly a success from both the commercial and image viewpoint, a success sealed by the many acknowledgements obtained by the first yacht of the series, Exuma 50. But these yachts are also an excellent example of a new trend in pleasure craft large and small: a new way of thinking that no longer wants high power on board, or at least not solely that. In fact there are yachties and owners who are seeking first and foremost a more efficient boat. Translated into less vague terms, this means a yacht that burns less fuel, pollutes less, sails well and is

Figure 02 – Comparison of the waterlines of the long, narrow hull of a military patrol vessel (top) and the stockier hull of a motorboat (bottom). As may be seen, the military vessel has a semi-angle of entrance that is half the size of the motorboat's; consequently, in displacing or semi-displacing sailing, wave-making at the bow will be reduced, together with drag. Above and left, Exuma.



The hull behind the success of Vitruvius

seakindly even in heavy weather. But what's the secret concealed behind this success? Philippe Briand, who designed the hulls for the whole Vitruvius® series, believes that "the lines of the hull are the DNA of a yacht and they determine her efficiency, consumption, her behaviour under way." And you can't fault his argument! It's no accident that the normally submerged part of the hull is also called "quick work", to distinguish it from the part in full view above the waterline, the topside, that does not determine the behaviour of the vessel and was once known as "upper works". So the essence of the Vitruvius® series lies in the new forms of hull designed for yachts of 30 to 70 metres, as may be seen from table 01 which shows the characteristics of some of these designs. But new, more efficient forms of hull aren't the only novelty: they have been coupled with other measures such as reduced superstructures and lighter displacement, again with the aim of maximising overall efficiency.

PICCHIOTTI	LOA	LWL	B	Δ	V max	LWL/B	LWL/∇1/3
Explorer 44 m	44 m	43.5	8.6	277	17	5.06	6.73
Explorer 50 m (Exuma)	50 m	48.9	9.5	400	17	5.15	6.69
Ex 55 m Ice class (Galileo G)	55 m	54.25	10.35	675	15.5	5.24	6.24
Explorer 73 m	73 m	71.9	13.2	1700	16.5	5.45	6.07

Table 01 – Characterstics of some Vitruvius series yachts. Over and above the absolute dimensions it is interesting to note that with these hulls the geometric ratios LWL/B (between waterline length LWL and beam B) and LWL/∇1/3 (between waterline length LWL and volume of displacement ∇) are very similar, indicating extreme resemblance of the forms.

To continue with the hull of Vitruvius® series yachts: taut and streamlined, near-vertical

Figure 01 – Hull and superstructure of the Picchiotti Explorer 55 m Ice Class during construction. As with all the Vitruvius series yachts the hull is taut and streamlined with near-vertical stem, narrow forward sections, maximum beam aft of amidships, reduced displacement and low superstructures: in some ways it's closer to a latest generation racing sailboat than a classic motoryacht.

stem, narrow forward sections, maximum beam aft of amidships and reduced displacement, in some ways it's closer to a latest generation racing sailboat than a classic motoryacht (figure 01). Unsurprisingly, the work of Philippe Briand himself, a famous sailboat designer whose yachts have also raced in the America's Cup. He calls it the BOS Hull (Briand Optimised Stretched Hull). But what do these features actually mean? Let's go into detail. The vertical stem maximises length on the waterline, improving the hydrodynamic efficiency of the hull. In point of fact, the length of the vessel, together with the high Length/Beam ratio which is always greater than 5 for Vitruvius® series yachts, and more generally together with greater fineness in the hull forms, mean that in relation to LOA higher speeds in displacing sailing can be achieved. This is rather like Columbus's egg, something well known to naval architects. It is not by chance that military vessels – displacing ships which also need to be fast – have always been long and narrow. But the foregoing may be better understood by analysing two design parameters:

- ❑ semi-angle of entrance at the waterline;
- ❑ critical speed.

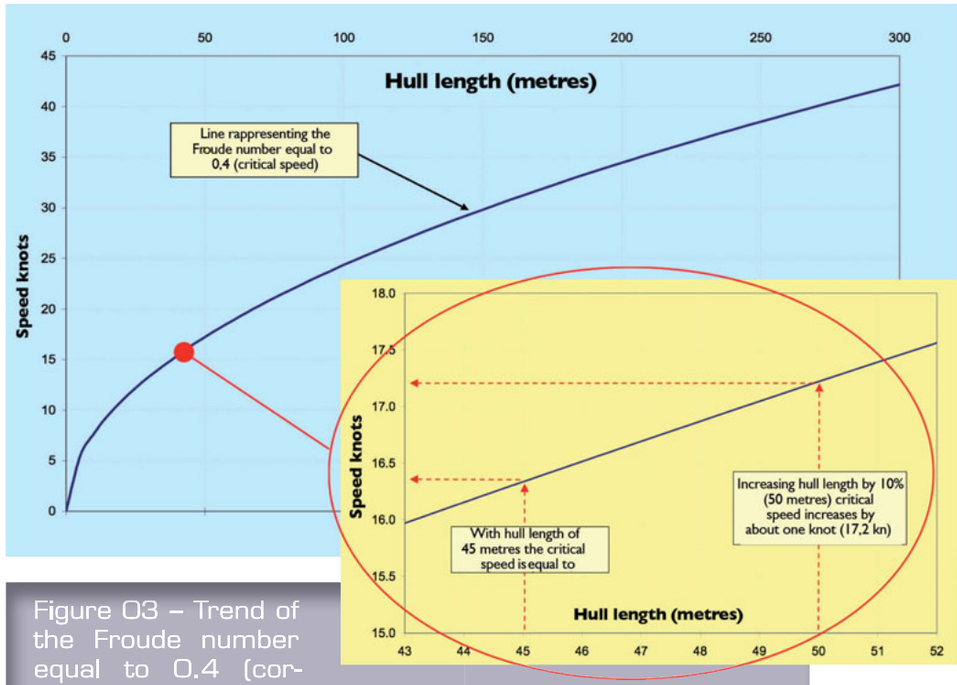


Figure 03 – Trend of the Froude number equal to 0.4 (corresponding to critical speed) in function of the speed and length of the hull: if for example, other conditions being equal, we increase the length of a 45 metre vessel by 10%, bringing it to 50 metres like the M/Y "Exuma", we increase speed by almost 1 knot with almost the same power.

We'll begin with the first, the semi-angle of entrance at the waterline, a parameter that supplies a direct indication of wave-making drag at the bow as the hull proceeds. As may be easily intuited, a narrow and long hull means that the forms at the bow can be extremely fine, generating less wave-making (and therefore less drag) in comparison with fuller forms (figure 02). These considerations are of course valid only for displacing or semi-displacing sailing.

Critical speed is the speed at which the hull creates a transverse wave as long as the hull itself. On exceeding this speed, which is the limit of so-called displacing sailing, the vessel creates a wave longer than itself and – in words far from scientific but efficacious

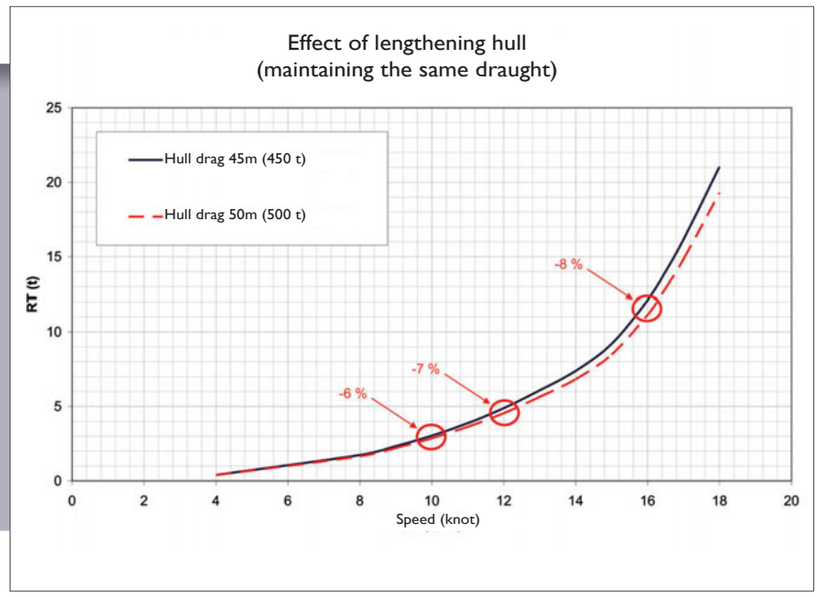
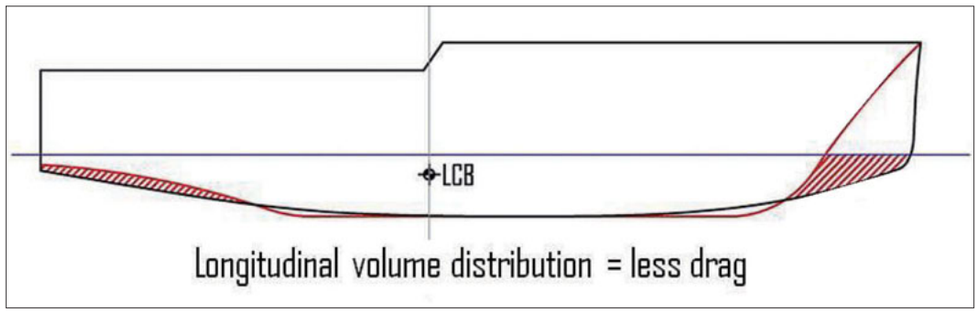


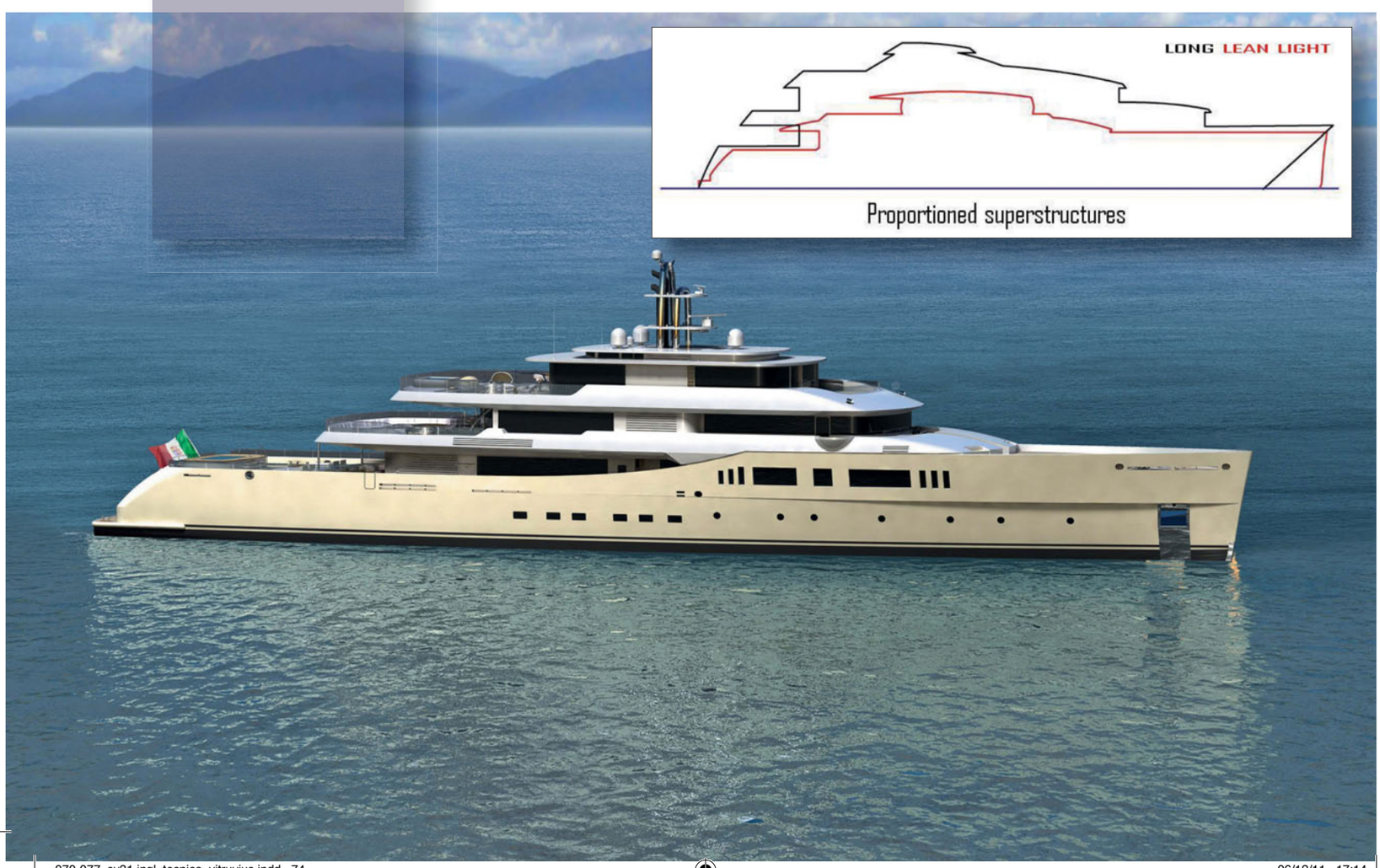
Figure 04 – Hydrodynamic drag of a hull whose forms are similar to that of the Vitruvius® series yachts: It's only by the lengthening deriving from absence of rakes, bringing waterline length from 45 to 50 metres while maintaining beam and draught unaltered – the hull is actually "stretched" – that a diminution of drag is obtained: 7% at 12 knots which becomes 8% at 16 knots on approaching critical speed.

The hull behind the success of Vitruvius



– "sits" down by the stern on the wave it has produced. Consequently the drag due to wave-making begins suddenly to increase. But this critical speed, or to put it better the wave-making caused by a hull in movement, is a function of the speed/hull length ratio: other conditions being equal, a longer vessel may be faster while maintaining wave-making drag practically unaltered, therefore with a minimum increase of power due solely to the increase of other hydrodynamic drag factors such as, for example, water friction or resistance produced by hull appendages. Or less power will be needed to achieve the same speed. This is explained in technical terms by saying that the Froude number is maintained unaltered, a number that is no other than the speed and hull length ratio (a ratio which, expressed in other terms, is also called relative velocity).
In figure 03, (preceding page) the trend of the Froude number equal to 0.4 is represented (corresponding to critical speed) in function of the speed and length of the hull, and illustrates what we have dealt with so far. Obviously critical speed should be understood not as a precise speed but as the speed at which the phenomenon, which involves a more

Figure 05 – The hulls of the Vitruvius® series have a more uniform longitudinal distribution of immersed volumes that permits better establishment of the waterlines (Image Philippe Briand LtdTM).



extensive rage of speeds, takes on the maximum value. So if the nominal critical speed, corresponding to FN = 0.4 is equal, as in the example to 16.3 knots for a length of 45 metres and 17.2 knots for a length of 50 metres, the same range of speed extends for a further plus or minus 1-2 knots.

And the yachts of the Vitruvius® series well illustrate the foregoing. For example the Vitruvius 50m, being practically devoid of rake at stem and stern, has a waterline length almost the same as its length overall, a waterline length which turns out to be about 10% longer than other yachts of similar overall sizes (table 02).

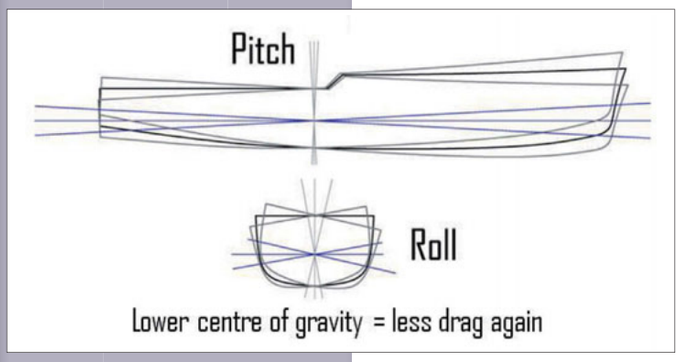
	LOA	LWL	B	Δ	LWL/B	LWL/∇1/3
Yacht Mariù	49.9 m	41.7 m	9.5 m	500 t	4.39	5.30
Yacht Tribù	50.7 m	46 m	9.25 m	620 t	4.97	5.44
Yacht Deniky	52.3 m	46.9 m	9 m	687 t	5.21	5.36
Picchiotti Explorer (Exuma)	50 m	48.9 m	9.5 m	400 t	5.15	6.69

Table 02 – The hull of the Vitruvius 50 (Exuma) compared with the hulls of other famous recently built yachts. The data clearly show that with equal overall lengths (LOA) the hull of the Vitruvius 50m (Exuma) has a longer waterline length (LWL) and less displacement (Δ), factors that determine a greater relative length LWL/∇1/3 (ratio of waterline length LWL and volume of displacement ∇). With the increase of this latter parameter, which represents the distribution of hull volume in function of length, there is a decrease of wave drag, especially in correspondence to critical speed. It's only by the lengthening deriving from absence of rakes, bringing waterline length from 45 to 50 metres while maintaining beam and draught unaltered – the hull is actually "stretched" – that a diminution of drag is obtained: 7% at 12 knots which becomes 8% at 16 knots on approaching critical speed which, for a length of 50 metres, is equal to 17.2 knots (figure 04).

Over and above the vertical stem, with consequent sharpening of the forms of the bow and increase in LWL, in the Vitruvius® series of yachts other design choices were made with view, as we said, to reducing wave-making and the related hydrodynamic drag. These also included solutions more typical of the sailboat world, such as having maximum beam aft of amidships and a more uniform longitudinal distribution of immersed volumes, the latter resulting in better establishment of the waterlines (figure 05). All these measures should contribute to further diminishing the hull's hydrodynamic drag.

Another important aspect introduced in Vitruvius® series yachts is the reduced extension of the superstructures which, as in sailboats, have a low profile so that the silhouette of these yachts is dominated by the majestic volume of the hull (figure 06). But it's not just an aesthetic choice. Reduced superstructures mean less aerodynamic drag, less weight, a lower centre of gravity and therefore less pitching and rolling under way (figure 07), all elements that contribute to further increasing the yacht's overall efficiency. Once again taking the Vitruvius 50 metre as an example and comparing its overall weight, i.e. displacement, with that of other same-size yachts, it is no accident that it turns out to be 20-40% less, as shown in table 02. All these choices, which obviously might interact positively or negatively with one another, were then reciprocally balanced through long work of study and design which concluded with experimental tank tests on a model (figure 08). It was thus possible to obtain a hull of

Figures 06 and 07 – Another important aspect introduced in Vitruvius® series yachts is the reduced extension of the superstructures which, as well as aesthetically characterising the silhouette of the yacht, results in less aerodynamic drag, less weight, a lower centre of gravity and therefore less pitching and rolling under way (Images Philippe Briand LtdTM).



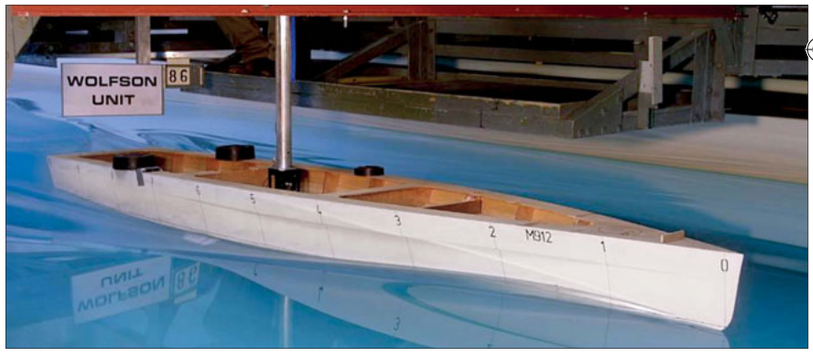


Figure 08 – All the design choices, which obviously might interact positively or negatively with one another, were then reciprocally balanced through long work of study and design which concluded with experimental tank tests on a model (Image Philippe Briand LtdTM).

The hull behind the success of Vitruvius

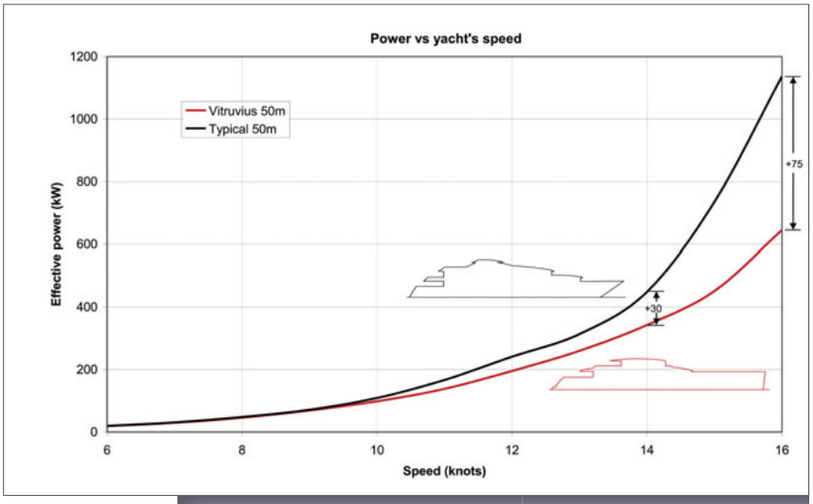
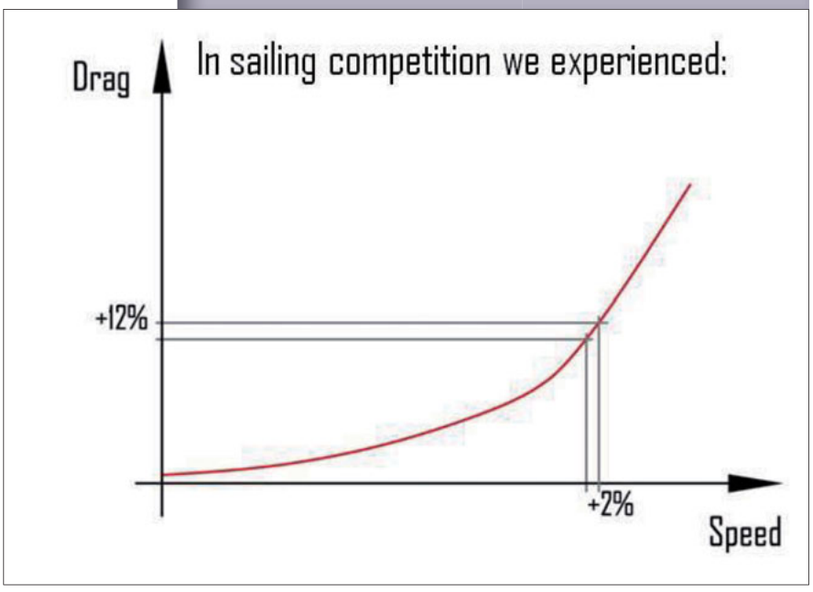


Figure 09 – Long work of design and experimental testing resulted in a hull of greater overall efficiency in comparison with typical yachts of the same size (Image Philippe Briand LtdTM).
Figure 10 – On approaching critical speed, going even slightly faster means employing much more power, because hydrodynamic drag increases notably with small increases in speed (Image Philippe Briand LtdTM).



greater overall efficiency in comparison with typical yachts of the same size, as shown in figure 09. But these keen forms with a sharp vertical stem also carry the advantage of improving seakeeping: firstly because at least in part they aid the so called "wave piercing" effect, whereas a traditionally shaped hull tends to follow the movements of the waves. Together with the very long hull or, to put it better, with the high L/B ratio, this feature means that speed can be kept up even with a sea running. These forms actually limit pitching and heaving (the vertical movement generated by waves) and above all limit the impacts of slamming.

These impacts produce very high and concentrated stresses on the forward part of the hull, and even more so if the surfaces in this zone are horizontal or sub-horizontal to the impact with the water, as in the case of the classic bow. It may therefore be intuited that hulls with slender bows, which morphologically have almost vertical surfaces for a considerable portion, undergo slamming impacts that are limited in extent and frequency. To put it tritely we could say they suffer a lot less in heavy weather. It also becomes clear why a boat with a traditional bow has to reduce speed when there's a sea running. But yachts with characteristics like the ones we've just described have a further and not inconsiderable advantage: in comparison with boats of the same size and performance, they cost substantially less to build and run.

Having less superstructures to build means less materials, less furnishings, less plant and reduced overall weight. You can therefore install smaller engines, also in virtue of the greater hydrodynamic efficiency of the hull, a consequence of its length. In a word, you spend less - saving as much as 20-30% - which is an important aspect even when talking about a luxury item. And we can also talk about running costs: hulls that are more hydrodynamically efficient make for lower fuel consumption. In brief, we can also start talking about a reduced environmental impact yacht, especially if we point out other technical and design solutions aimed at limiting consumption and pollution, such as onboard waste treatment, engines with reduced and controlled emissions, eco-sustainable antifouling paint and so on. And it is precisely the eye to environmental sustainability in the yachting and luxury field that is another winning card in the Vitruvius® series of yachts, starting with the type of craft itself: an explorer, meaning a vessel built to go round the world, but unhurriedly, exactly as explorers do. Moreover, if we're talking about the environmental sustainability of a means of transport we can't forget about pollution produced by the propulsive system, which is all the more the faster we go. Well, doing 12 knots with a 50 metre boat means sailing at a speed at which hydrodynamic drag is still very slight, so fuel consumption will be very low. If the boat has also been specifically designed to be more efficient at this speed, as in the case of the hulls of the Vitruvius® series of yachts, it will burn less fuel and pollute even less. Table 03 shows how such consumption may be half of what a yacht of the same size requires.

Figure 11 – In recent years, with increasing frequency, we've been seeing big new yachts with increasingly longer and narrower hulls, where waterline length tends to be equal to or in certain cases even greater than length overall, as in the case of the 72 metre megayacht "Predator", launched in 2008. One of the many yachts with the stem inclined aft (Reverse-Bow).

	Anno	LOA	HP tot.	V max (kn)	Auton.	Consumo
Yacht Mariù	2003	49.9 m	4520	17.5	4600 nm	26 l/nm a 14 nodi
Yacht Tribù	2007	50.7 m	2468	15	4000 nm	25 l/nm a 13 nodi
Yacht Deniky	2007	52.3 m	2816	15.5	4500 nm	26 l/nm a 13 nodi
Explorer 50 m (Ex.)	2010	50 m	2650	17	6500 nm	12 l/nm16.5 l/nm a 12/14 nodi

Table 03 – Exuma's installed power and consumption compared with other famous recently built yachts. Exuma's installed power is more or less the same as that of Tribù and Deniky, but Exuma has a higher top speed by about two knots. Whereas in comparison with Mariù, which can reach the same top speed, Exuma has about 40% less power installed. Furthermore, fuel consumption at cruising speed is 30-50% less, depending on speed. On the other hand, having exceeded certain speeds, going even faster means having to employ a great deal more power, as shown in figure 10. But in concluding this reflection a consideration springs to mind: vertical stems with fine bow sections, streamlined and slender waterlines, high L/B ratios, low superstructures of limited extension, large decks and open spaces: let's face it, all this is possible only because we're talking about huge yachts where there's certainly no lack of space aboard. Consequently there is no longer the limitation of full hull shapes and a classic two or three deck layout that rises to a considerable percentage of ship length, because there is no longer the problem of having to find the space necessary for the interiors. The very dimensions of the hull guarantee sufficient volumes for cabins, saloons, technical rooms and relaxation areas, meaning everything that characterises a big luxury yacht. Indeed when there are no longer regulatory or financial limitations to determining the dimensions of a yacht, or when length actually becomes an element of distinction and characterisation, we get the recent trend for big yachts with increasingly longer hulls where the waterline length tends to be equal to or in certain cases even greater than length overall: what is gained is speed, efficiency, seakeeping and comfort (figure 11). Obviously the features described in this article are not exclusive to yachts of the Vitruvius® series. Indeed, as we've just mentioned, these characteristics are part of a trend that has been spreading in recent years in the big yacht sector, but not only. This however doesn't mean that any old yacht is a good one just because it's narrow and long or has a vertical stem. In fact if it is true that a good design is first and foremost a good compromise, all its features must be well balanced and reciprocally weighed. So it can't be by chance that Philippe Briand and his staff chose the Vitruvian Man as symbol of their idea of a yacht, probably convinced that they've achieved a perfect balance of forms and proportions, precisely a "Vitruvian equilibrium". Any exaggeration here? For further information please contact: http://www.vitruviusyachts.com - http://www.perininavi.it

QUALE CARENA DIETRO IL SUCCESSO DEL VITRUVIUS®

di Andrea Mancini

Non c'è che dire: gli yacht della serie Vitruvius®, i nuovi MY di Perini Navi già costruiti o in costruzione con il glorioso marchio Picchiotti, sicuramente costituiscono un successo sia dal punto di vista commerciale che di immagine, un successo sigillato dai tanti riconoscimenti ottenuti dal primo yacht della serie Vitruvius®, "Exuma 50". Ma questi yacht rappresentano anche un ottimo esempio di una nuova tendenza presente nel diporto nautico, grande o piccolo che sia, una tendenza, un nuovo modo di pensare che non vuole più tanti cavalli a bordo, o perlomeno non solo quelli. Ci sono infatti diportisti e armatori che vogliono prima di tutto yacht più efficienti che, tradotto in termini meno vaghi, significa yacht che consumano meno, che inquinano di meno, che navighino bene e siano confortevoli anche in condizioni meteo-marine difficili. Ma quale è il segreto che si nasconde dietro a questo successo? Philippe Briand,

Figura 11 - In questi ultimi anni, sempre con maggiore frequenza, abbiamo visto nuovi e grandi yacht con carene sempre più lunghe e sempre più strette, ed in cui la lunghezza al galleggiamento tende ad essere uguale o, in certi casi, addirittura maggiore della lunghezza fuori tutto, come nel caso del MegaYacht di 72 m "Predator", varato nel 2008, uno dei tanti yacht con il dritto di prua inclinato verso poppa (Bow Riverse Yacht).

ta appositamente studiata per essere più efficiente a queste velocità, come nel caso delle carene degli yacht della serie Vitruvius®, si consumerà e si inquinerà ancor meno. La tabella 3 mostra come tali consumi possano arrivare ad essere la metà rispetto a yacht delle stesse dimensioni.

	Anno	LOA	HP tot	V max (kn)	Auton.	Consumo
Yacht Mariù	2003	49.9 m	4520	17.5	4600 nm	26 l/nm a 14 nodi
Yacht Tribù	2007	50.7 m	2468	15	4000 nm	25 l/nm a 13 nodi
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Explorer 50 m (Ex.)	2010	50 m	2650	17	6500 nm	12 l/nm16.5 l/nm a 12/14 nodi

Tabella 3 - Potenza installata a bordo e consumi dell'Exuma messi a confronto con altri famosi e recenti yacht. La potenza installata sull'Exuma e più o meno uguale a quella installata a bordo del Tribù e del Deniky, ma l'Exuma ha una velocità massima maggiore di circa due nodi, mentre rispetto al Mariù che può raggiungere la stessa velocità massima l'Exuma ha circa il 40% di potenza in meno installata. Inoltre i consumi alle velocità di crociera sono inferiori del 30-50% a seconda della velocità. D'altronde superate certe velocità andare ancora più veloci, anche se di poco, significa dover spendere tanti cavalli in più, come mostra la figura 10.

Concludendo questa riflessione viene però spontanea una considerazione: prue verticali con sezioni di prora affinate, linee d'acqua filanti e snelle, rapporti L/B elevati, sovrastrutture basse e con una estensione limitata, grandi ponti e spazi all'aperto: diciamocelo chiaramente, tutto ciò è possibile solo perché stiamo parlando di grandi yacht dove lo spazio a bordo non manca di certo. Di conseguenza non si è più vincolati a forme di carena piene ed ad un'impostazione classica a due o tre ponti estesi per una notevole percentuale della lunghezza nave, perché non si ha più il problema di dover trovare gli spazi necessari per gli interni in quanto le dimensioni stesse dello scafo garantiscono volumi a sufficienza per contenere alloggi, saloni, spazi tecnici e zone relax, cioè tutto ciò che caratterizza un grande yacht di lusso. Anzi, nel momento in cui non ho più vincoli normativi o economici nel determinare le dimensioni dello yacht o, addirittura, la lunghezza diventa un elemento di distinzione e caratterizzazione, ecco nascere la tendenza di questi anni ad avere grandi yacht con carene sempre più lunghe in cui la lunghezza al galleggiamento tende ad essere uguale o, in certi casi, addirittura maggiore della lunghezza fuori tutto: si guadagna in velocità, efficienza, tenuta al mare, comfort (figura 11).

Ovviamente le caratteristiche che abbiamo descritto nell'articolo non sono prerogativa solo degli yacht della serie Vitruvius®. Anzi come abbiamo appena accennato, tali caratteristiche fanno parte di una tendenza che si sta diffondendo in questi anni per i grandi yacht, e non solo. Ma ciò non vuol dire che qualsiasi yacht, solo perché è stretto e lungo, o perché ha la prua verticale, sia un buon yacht. Infatti, se è vero che un buon progetto è prima di tutto un buon compromesso, tutte le sue caratteristiche dovranno essere ben bilanciate ed equilibrate tra loro. E allora non sarà stato un caso se Philippe Briand ed il suo staff abbiano scelto l'uomo vitruviano come simbolo della loro idea di yacht: probabilmente sono convinti di aver raggiunto un equilibrio perfetto delle forme e delle proporzioni, un "equilibrio vitruviano", appunto. Avranno esagerato?

Per maggiori informazioni: http: www.vitruviusyachts.com - http: www.perininavi.it