THE SHADOW YACHT - TOY BOX OF THE SEA

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SUMMARY

Despite the ever increasing size of large yachts, space is always at a premium. The seemingly endless list of equipment that these vessels are required to carry rapidly turns even the largest vessel into a spatial design challenge – from jetskis, speedboats and sports cars to hidden helicopter garages and mini submarines launching beneath the hull. Given that the cost per square foot for this vessel type is at an extreme premium, it is becoming increasingly common for owners to adopt the use of a shadow yacht to carry their 'toys' and free-up valuable space on board the mother ship. This paper will discuss the ideal technical requirements for such a vessel and will present a number of possible design solutions.

1. INTRODUCTION

In recent years a number of yacht owners have opted for a 'shadow yacht' in order to carry their extensive range of 'toys', and free-up valuable space on board their yacht.

One of the most well-known shadow yachts is the 66 metre 'Golden Shadow' which, since 1994 has supported the 76 metre 'Golden Odyssey' and is believed to have pioneered the shadow concept. As well as having an impressive toy-carrying capability ranging from small inflatables to a high performance race boat and a Cessna 208 seaplane, Golden Shadow is also fitted out with full 'back-of-house' facilities to support Golden Odyssey. These facilities include a large galley, walk-in refrigerators, waste management systems and water-makers, allowing an endurance of up to 3 weeks before having to re-supply.

Since Golden Shadow first appeared on the scene, the shadow yacht market has proven increasingly popular with yacht owners as they continue to realise the benefits that a shadow yacht can offer. Many existing shadow yachts have been developed as conversions of retired supply ships or research vessels. The original layouts of these vessels lend themselves well to the launch, recovery and stowage of large and heavy items, making them a practical and financially attractive option for converting into a 'toy box'.

However, with yachts becoming larger and styling becoming less conventional in recent years, many owners are considering new-build shadow yachts over conversions. This offers the flexibility of a bespoke design which can be styled to complement the main vessel, and can be based around an owner's personal requirement for toy-handling and yacht support. It is important to note that a shadow yacht should not become a superyacht itself, primarily based on the considerable difference in cost between a luxury yacht and a vessel finished to a more 'commercial' standard. It is considered that a typical shadow yacht should be finished to a high commercial standard, with only a minimal level of luxury finish for dedicated owner occupied spaces.

There is no doubt that shadow yachts offer many advantages in terms of through-life yacht support. This paper will start by discussing the main benefits of a new-build shadow yacht, and will go on to discuss trends in superyacht size. Recommendations will also be provided on whether an owner seeking a new-build yacht may be able to reap the benefits of a new-build shadow yacht for little or no additional cost. Various design considerations and two potential design solutions for bespoke shadow yachts are presented towards the end of the paper.

Throughout the remainder of this paper an owner's main vessel shall be referred to as the 'yacht', the shadow vessel shall be referred to as the 'shadow' and all speedboats, helicopters, cars and similar toys shall be referred to as the 'tenders'.

2. THE BENEFITS OF A SHADOW YACHT

As well as acting as a storage facility for a wide range of tenders, a yacht and shadow combination provides an owner with numerous benefits including:

Spatial benefits:

- A shadow will eliminate the need for garage facilities and helicopter handling facilities onboard a new-build yacht, and will therefore free up a large amount of space for saloons, pools, offices, accommodation and leisure spaces, or alternatively, allow the owner to specify a yacht of reduced length and cost.

- A shadow will eliminate the need for large side shell openings and complex handling systems onboard a new-build yacht.

It should be noted that although a shadow would carry the majority of the owner's tenders, the yacht would still be required, as a minimum, to carry a rescue boat and/or small tender(s) on deck for emergency situations or short excursions, but not necessarily in an enclosed garage.

Operational benefits:

- For long-range voyages and delivery trips (e.g. transatlantic) a shadow can provide high levels of support to the yacht by;

  – Providing immediate aid in emergencies,

  - Providing additional security and reducing potential risk of pirate attacks,
  - Providing additional 'back-of-house' facilities,
  - Providing fuel bunkering facilities via replenishment at sea (RAS),
  - Carrying additional provisions, spares and equipment for the yacht.

- For short-range voyages (e.g. island-hopping) a shadow can arrive at the destination a few hours in advance of the yacht, and provide support by;

  - Reserving prime anchorings,
  - Unloading tenders ready for the owner to use when the yacht arrives,
  - Collecting provisions for the yacht from the shore before the yacht arrives.

- By designing a shadow to use the same machinery and equipment as the yacht, spares could be carried onboard and be readily available for either the yacht or the shadow to use as required.

- Tenders can be maintained and repaired onboard the shadow.

- A larger pool of crew across vessels would allow a rotation system to be achieved, giving greater flexibility in terms of hours of work and rest.

Financial benefits:

- While long term operating costs for one large yacht may be expected to be lower than operating costs for two vessels (i.e. a yacht and a shadow), it is possible that by opting for a yacht and shadow combination there may be the opportunity for potential savings in initial build costs. This assumes that the shadow design is kept to a commercial finish and does not develop into a luxury yacht itself.

- The use of a shadow may give rise to a smaller yacht which operates under LY2 rather than SOLAS. Associated operating costs would then be considerably reduced.

Other benefits;

- Given that a shadow may provide the option of reducing length and cost of the yacht, there may also be a reduction in build time, and the possibility of smaller yards being able to tender for the build contract.

- The use of a shadow can improve the overall aesthetics of a yacht by reducing the number of side shell openings and interruptions to the styling of the lines.

3. TRENDS IN SUPERYACHT DESIGN

3.1 TRENDS IN SUPERYACHT SIZE

The standard definition of a superyacht is a vessel of 24 metres in length and above. On this basis, the statistics on global trends in superyacht size [1] show that at the beginning of 2008 there were 916 superyachts on order or in build, with a total combined length of 34.6 kilometres. This gives an average length of 37.8 metres. On average the increase in length of superyachts has been approximately 1 metre per year over the past decade. Further analysis of the current market shows that the largest growth area is at the larger end of the scale, with the greatest percentage increase in orders and builds since 2007 being in the 61 to 76 metre market.

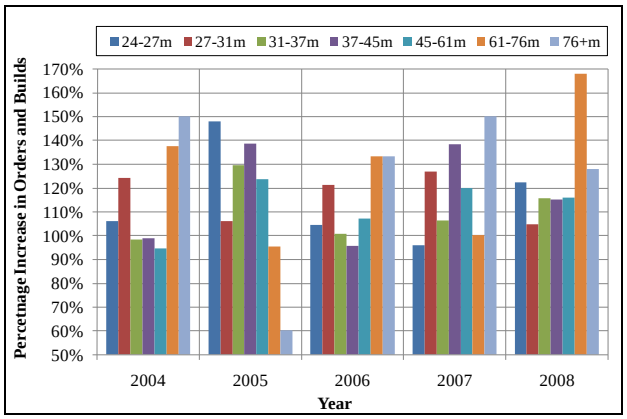

Figure 1: Recent Growth in Yacht Orders by Length

As is well known in the industry, there has also been an increase in the number of yachts greater than 100 metres in length which is creating its own set of problems. The development of marinas and ports appears to be lagging behind the trend towards larger yachts. This is not only resulting in a shortage of berths, but also means that the largest of these 'gigayachts' are now so long that they cannot fit in many marinas. These yachts must anchor either outside of the marina or moor alongside commercial wharfs.

With the increase in length there is an obvious increase in build cost. Figure 2 illustrates the relationship between vessel length and cost-per-metre. The build cost of a 70 metre yacht is around US$1.45M per metre, but for a 130 metre yacht the cost is 30% higher at around US$1.9M per metre. The shaded area in Figure 2 allows for potential variations in outfit quality which will greatly affect the overall cost.

The common demand for yachts to house extensive tender collections often leads to a large proportion of internal spaces and usable deck areas being given up solely to the storage of tenders.

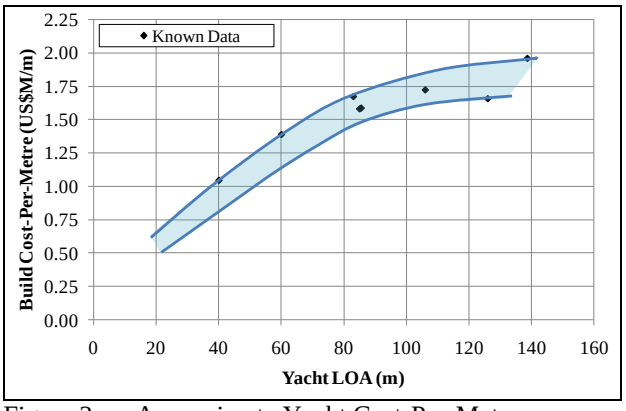

Figure 2: Approximate Yacht Cost-Per-Metre

Figure 3 shows a full width garage onboard the 138 metre yacht, 'Rising Sun', with approximate dimensions of 15 metres in length and 18 metres in beam. This gives a garage area of approximately 270 square metres (2900 square feet). Based on the cost-per-metre data presented in Figure 2, an approximate price for the length of yacht dedicated to tenders alone is around US$28.5M (at US$1.9M per metre), and it should be noted that this is not the only garage space aboard the yacht!

Figure 3: Tender Garage on the 138 metre Yacht, 'Rising Sun' – photo courtesy of www.SuperYachtTimes.com

Figures 4 and 5 also illustrate how much space is given up to tenders onboard another well-known yacht, the 114 metre 'Le Grand Bleu'. This vessel is capable of carrying a 68' Sunseeker and a 72' Baltic sailing yacht alongside her two helipads. An estimated 32 metres of length is dedicated to these tenders, equating to a cost of around US$56M for storage of tenders alone on the aft deck (at US$1.75M per metre).

It should be noted that the figures presented above have been obtained through a simplified analysis of garage space value based solely on length. No allowances have been made for the fact that the volume of the yacht is a function of the length cubed, and therefore the addition of length for a garage adds more than just garage volume.

Section 3.2 presents an analysis of the value of yacht areas, and discusses how through the use of a yacht and shadow combination, potential cost savings might be made.

Figure 4: The 114 metre Yacht, 'Le Grand Bleu' – photo courtesy of www.webshots.com

Figure 5: Tenders Onboard 'Le Grand Bleu' – photo courtesy of www.eventective.com

3.2 POTENTIAL COST REDUCTIONS

3.2 (a) Prime Real Estate

Many yacht owners may be unaware that they own some of the most expensive pieces of real estate in the world. The average cost per square foot for the range of yachts considered in Section 3.2 (b) of this paper has been calculated as approximately US$3,570 per square foot, ranking superyachts 6th in a table of the world's most expensive residential real estate! [2]

Location	**US$/sq.ft**
Monaco	5,478
London	4,792
Cap Ferrat (Prime Cote d'Azur)	4,544
Courchevel (Prime Alps)	3,684
New York	3,620
Superyachts!	***3,570***
Moscow	1,829
Tokyo	1,768
Hong Kong	1,725
Sydney	1,587
Paris	1,494

Figure 6: Average Cost per Square Foot of World's Most Expensive Residential Real Estate

It is common practice that all areas on board a yacht are finished to the same level of quality, irrespective of whether they are leisure spaces, engineering spaces or tender garages. Additionally, much of the equipment employed in these areas is generally required to have a high quality yacht finish which further increases vessel cost. It could be argued that with the cost per square foot at such an extreme premium, this is an unnecessary practice resulting in unnecessary cost.

Wherever possible, owners should be provided with solutions which minimise both cost and the amount of prime internal area given up to garage space, and maximise the amount of space which can be used in a far more desirable capacity as living space. Tenders, tender-handling capabilities and garage spaces can all be removed from the yacht onto a commercially finished shadow where cost of engineering spaces and tender garages will be significantly lower.

One solution may be to determine the length of superyacht that an owner can afford, and suggest that with a reduced length yacht of standard proportion and form without garages, it may be possible to reduce cost such that a separate shadow of high standard commercial finish can also be acquired. The following section presents a discussion of the value of yacht garage spaces based on a range of existing superyachts, and provides guidance to identify whether the acquisition of a separate shadow could potentially lead to savings in build cost.

3.2 (b) Typical Trends in Yacht Garage Space

In order to quantify how much 'prime real estate' is typically given up to garages, general arrangements for a range of superyachts have been assessed. Only conventional monohull designs within the length range 40-120 metres have been considered in the analysis, and it should be noted that the figures presented for garage area also include areas on deck which have been given up to exclusively accommodate tenders.

The first stage of the analysis was to measure the total length of all of the tenders that each yacht would commonly carry. As may be expected, the total length of tenders varies greatly from yacht to yacht, and it is almost impossible to fit a reasonable trend-line through the data points. Consequently the analysis was revised to focus on the area given up to garage space on each vessel.

A plot of garage area against vessel length (Figure 7) demonstrates a well correlated trend-line running through the majority of data points. There are some highlighted points which lie above and below the trend-line, but these can be explained due to differences in vessel capability. The points above the line represent vessels which have a helicopter stowage facility rather than a 'touch-and-go' helipad, or have sacrificed an unusually large amount of living space to accommodate a larger number of tenders. The points below the line are all yachts with very high levels of accommodation and fewer requirements for a large range of tenders.

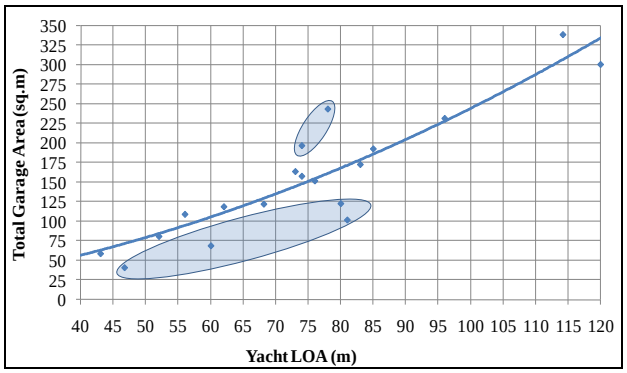

Figure 7: Total Garage Area for Some Existing Motor Yacht Designs

The data presented in Figure 7 was used as a starting point to identify whether an owner may be able to justify having a shadow in order to reduce yacht build costs. By using the cost-per-metre data presented in Figure 2 for conventional monohull motor yachts, the effective garage value can be determined. However, as the data presented in Figure 7 is based on area, it must be converted into an 'effective garage length'. To do this, each of the data values has been divided by the corresponding vessel beam. As all of the vessels in the analysis are of similar proportions and form (i.e. similar length-beam ratios), the data points presented in Figure 8 also demonstrate a well correlated trend line.

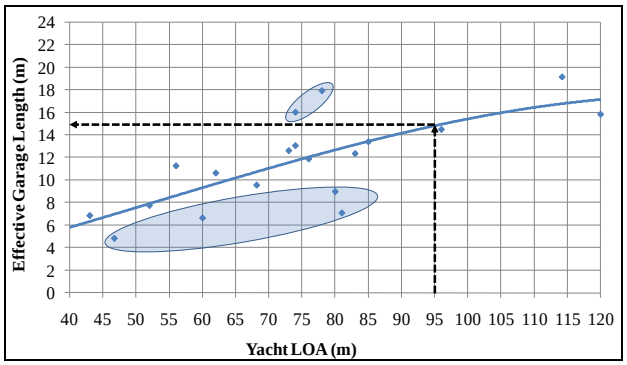

Figure 8: Effective Garage Length for Some Existing Motor Yacht Designs

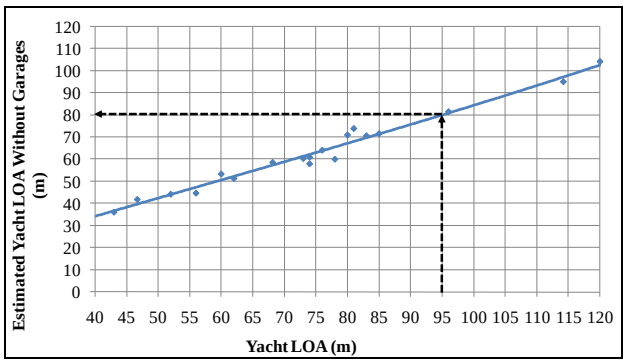

Figure 9: Estimated Yacht Length Without Garages vs Yacht Length With Garages

The effective garage length can therefore be considered as the length by which a yacht could be reduced if all garage spaces were removed. Figure 8 suggests that for a 95 metre yacht, approximately 15 metres would typically be given up to garage space. Figure 9 demonstrates that there is a consistent trend across the range of lengths analysed.

Based on the data presented above, this length saving can be translated into a cost saving as shown in Figure 10. This chart demonstrates that if an owner can afford a conventional yacht of 95 metres (including garage space) then it may be financially beneficial to offer an alternative solution whereby the owner acquires an 80 metre yacht, and saves approximately US$35M to put towards a separate shadow. But can a suitable shadow be built for the money that is saved? To answer this, the cost of building a shadow must be considered as well as the minimum practical size for such a vessel.

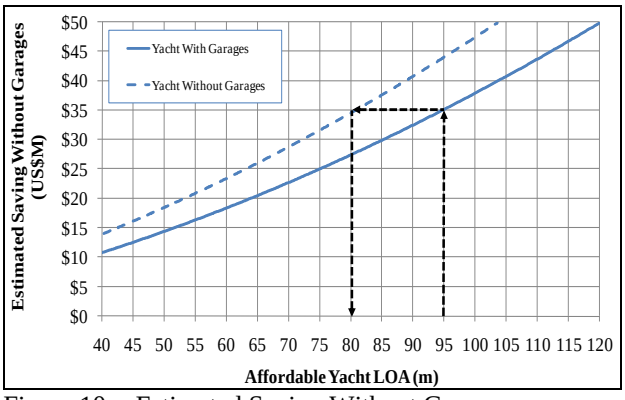

Figure 10: Estimated Saving Without Garages

3.2 (c) Shadow Vessel Costs

In recent years BMT Nigel Gee has been involved with a number of shadow designs, from 'conventional' medium-speed monohulls to 'high-specification', high-speed catamarans. Further details of these two different types of shadow are discussed in Sections 5.1 and 5.2.

Cost estimations for each of these shadow types are presented in Figure 11 for a range of lengths from 40 metres to 75 metres, and are based on new-build vessels of high commercial finish. It should be noted that the cost of these vessels is heavily affected by the required standard of finish. Although shadows may generally still be considered as yachts, a full yacht finish would raise the cost of a vessel substantially. In BMT's experience an optimum shadow design should be based around a high commercial finish with only minimal levels (if any) of owner occupied spaces finished to a yacht standard.

From Figure 11 it can be seen that for the US$35M saving discussed in Section 3.2 (b) a conventional shadow vessel of around 55 to 62 metres could be acquired (depending on standard of fit-out). This is considered to be a reasonable length for a conventional monohull shadow. Alternatively, the chart suggests that a high-specification shadow of around 45 metres could be acquired, but as discussed in Section 3.2 (d), 45 metres could be considered too small for a high-specification multihull. Consequently, it is considered that an owner seeking a 95 metre new-build yacht could be presented with two options:

- Opt for a conventional 95 metre yacht with typical garage facilities, or, for approximately the same cost,
- Opt for a conventional 80 metre yacht without garage facilities, and enjoy the benefits of a conventional 55 metre new-build shadow.

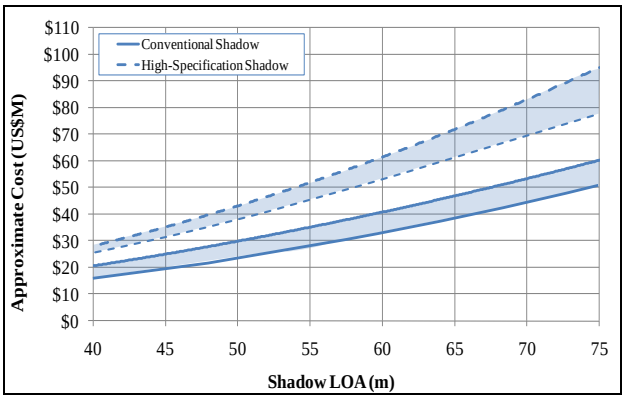

Figure 11: Approximate Shadow Vessel Costs

The shaded regions in Figure 11 have been provided to demonstrate that for the same price, an owner may be able to obtain a longer shadow with greater tender capacity, by specifying less complex handling and stowage systems, a minimal level of owner accommodation and lower speed capabilities, for example.

For the remainder of this paper, it is assumed that an owner wishing to acquire a new-build vessel would specify state-of-the-art handling capabilities and a small area of owner accommodation, as described by the upper limits of the shaded regions in Figure 11.

3.2 (d) Shadow Vessel Size

This section provides some guidance on when a shadow vessel is considered to be too small to offer any significant benefit. BMT is currently involved in the development of conventional monohull shadows of around 50 metres and upwards. There are also a number of conventional shadows in existence of around 50-70 metres. The size of a shadow is driven largely by owners' requirements, but it should be noted that while vessels below 50 metres may be able to provide many of the benefits listed in Section 2, it is considered that only vessels above 50 metres would realistically be able to provide sufficient tender carrying capacity. Furthermore, by limiting the payload capacity through having a smaller vessel, the resale value will also be reduced. A shorter vessel will also operate at a higher Froude

number and may therefore be unable to reasonably meet or exceed the speed of the yacht.

With regard to a high-specification shadow, BMT considers that the ideal hullform for such a vessel would be a catamaran. This is primarily due to the high-speed potential of multihull craft and their large deck areas in comparison to monohulls of similar length.

Another important consideration is the vessel's seakeeping ability. For smaller shadows the seakeeping will be a limiting operational factor, particularly in comparison to a larger yacht that it may be supporting. For a catamaran, wet deck clearance is the limiting factor in large seas. A minimum practical length of approximately 55 metres is suggested for a catamaran in order to provide a sufficient level of yacht support.

Based on these assumptions of limiting vessel size and the estimated cost data presented in Section 3.2 (c), some guidance has been compiled to identify whether an owner seeking a new-build yacht may be able to realise the benefits of a shadow for little or no additional cost.

3.2 (e) Guidance on Shadow Length Selection

With reference to Figure 12, the following guidance has been provided to determine if there are any potential savings in build cost by opting for a shadow vessel:

- Determine what length of yacht (with garage space) the owner desires.
- Identify the corresponding potential cost savings offered by the removal of garage space.
- Check if the savings in build cost are sufficient to allow a conventional shadow or a high-specification shadow to be built with no additional outlay.
- Identify the length of shadow that can be built with the cost saving.
- If the cost saving does not exceed the cost of a shadow, then some additional outlay will be required to acquire a yacht and shadow combination.

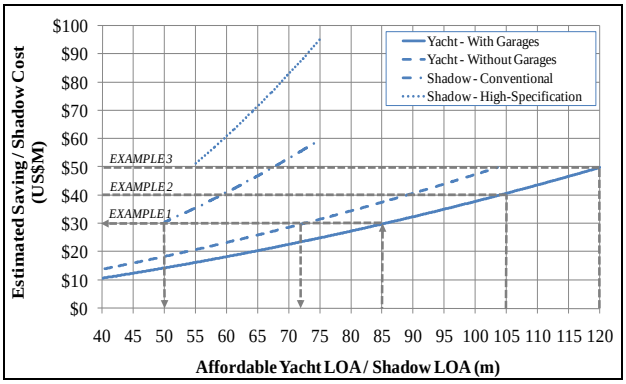

Figure 12: Guidance on Shadow Length Selection

Example 1 – A yacht owner enquires about a conventional 85 metre monohull motor yacht with tender-carrying capabilities. Figure 12 suggests that by excluding garage spaces from the yacht, a 72 metre yacht of standard proportions and form could be built instead, saving the owner approximately US$30M. With this saving the owner could then acquire a 50 metre conventional shadow.

Example 2 – A yacht owner enquires about a conventional 105 metre monohull motor yacht with tender-carrying capabilities. Figure 12 suggests that by excluding the garage spaces from the yacht, an 89 metre yacht of standard proportions and form could be built instead, saving approximately US$40M with which the owner could acquire a 60 metre conventional shadow.

Example 3 – A yacht owner enquires about a conventional 120 metre monohull motor yacht with tender-carrying capabilities. Figure 12 suggests that by excluding the garage spaces from the yacht, a 104 metre yacht of standard proportions and form could be built instead, saving approximately US$50M with which the owner could acquire a 68 metre conventional shadow or a 55 metre high-specification shadow. With some additional outlay, the owner may wish to acquire a larger high-specification shadow.

The analysis suggests that the largest savings can be realised at the top-end of the yacht market. For owners who can afford the larger yachts (i.e. greater than 85 metres) it may be possible to acquire a shadow with no additional expenditure. For owners seeking smaller yachts (i.e. less than 85 metres) there may be additional costs involved in acquiring a shadow.

4. SHADOW DESIGN CONSIDERATIONS

4.1 TECHNICAL REQUIREMENTS

It is difficult to quantify typical requirements for shadow payload capacity as individual requirements will vary greatly from one owner to another. However, as with any vessel it is of vital importance to maximise the payload carrying capacity as much as possible in terms of space and weight.

It is equally important to ensure that any items that must be carried on the shadow can be launched, recovered and moved around the vessel as required. Such requirements may require some complex handling systems which could include retractable helicopter garages, stern and side shell doors, bomb-bay doors, vehicle access ramps, deck cranes, boom cranes, overhead gantry (X-Y) cranes, winches, elevators and so on.

Furthermore, it is desirable that a shadow should be capable of exceeding the speed of the yacht such that it can arrive at the destination in advance. This factor will also have an impact on the optimum length of a shadow,

as it becomes difficult to meet when the shadow is significantly smaller than the yacht.

It must also be assumed that the shadow should exceed, or at least equal the range and endurance capabilities of the yacht to ensure that it can provide the required level of support at all times.

4.2 REGULATORY REQUIREMENTS

The regulatory requirements for shadows can be discussed under the two main areas of Flag and Class. In both cases it would be logical to operate a yacht's shadow under the same regulatory regime as the yacht itself.

The majority of large yachts less than 3000 GRT and carrying less than 12 passengers are built to the MCA Large Yacht Code (LY2). Above this tonnage and passenger number threshold full SOLAS must be applied. As a shadow will generally have the ability to carry only a small number of passengers, building to the LY2 code is considered to be the best option.

One less obvious benefit of employing a shadow is that the design of the yacht itself can then be kept within the LY2 framework, avoiding the need to achieve full SOLAS compliance. It is then likely that considerable cost savings can be made as well as allowing greater freedom in the design.

Additionally, shadows can help to alleviate the impact on design of newer regulations. For example, the International Labour Organization (ILO) has recently produced the Marine Labour Convention (MLC 2006) which has been developed to ensure that crews are provided with adequate working conditions. This convention will have a significant impact on the space and volume of a yacht taken up by crew accommodation. A shadow could minimise this impact by providing 'off-yacht' crew accommodation. This would also allow greater flexibility in providing improved leisure facilities for the crew onboard the shadow, and give greater flexibility for complying with requirements for hours of work and rest.

5. SHADOW DESIGN PROPOSALS

5.1 'CONVENTIONAL' SHADOW

As discussed in Section 3.2(d), it is considered that around 50 metres is the minimum length for a monohull shadow, giving a considerable level of tender-carrying capability whilst remaining at the lower end of the cost scale (approximately US$30M for a commercially finished new-build vessel). A typical set of principal particulars and tender-carrying capabilities are presented in Figure 13 and Figure 14, and a typical general arrangement is presented in Figure 15.

Length Overall	50.0	metres
Length Waterline	47.0	metres
Beam Overall	13.0	metres
Draught Maximum	3.5	metres
Approximate Deadweight	300	tonnes
Approximate Full Load	1200	tonnes
Maximum Speed	14.5	knots
Cruise Speed	13.0	knots
Range at 13 knots	3500	n.miles

Figure 13: Principal Particulars for a Conventional Monohull Shadow

Tender	Launch & Recovery
1 x Helicopter (6-8 passengers, approximate weight of 5 tonnes)	Stored in retractable deck hangar
1 x Large Tender (13.0m) 1 x Small Tenders (9.0m) 1 x Hovercraft (6.0m)	Stored in main garage Launched / recovered by boom crane
2 x Large Jet Skis (3.0m) 2 x Small Jet Skis (2.0m) 3 x Motor Bikes (2.5m)	Loaded / unloaded by side door

Figure 14: Typical Tender-Handling Capabilities for a Conventional Monohull Shadow

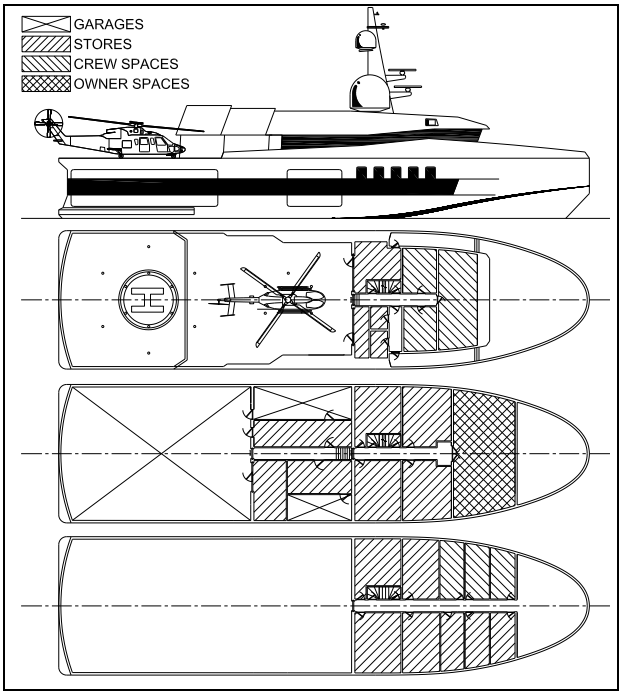

Figure 15: General Arrangement for a Conventional Monohull Shadow

5.2 'HIGH-SPECIFICATION' SHADOW

As discussed in Section 3.2(d), it is considered that around 55 metres is the minimum length for a catamaran shadow. In order to demonstrate the higher end of the shadow market the data presented below is based on a 70 metre catamaran shadow, giving an impressive level of tender-carrying capability and even a considerable amount of owner space, with two VIP/owner cabins, an

office and a large saloon. One key benefit of a high-specification catamaran shadow is the impressive speed capability, ensuring that the shadow can exceed the speed of the yacht and provide all of the operational benefits discussed in Section 2. A further key benefit of a catamaran shadow is the exceptional helicopter handling capabilities owing to the large flight deck area.

At approximately US$82M for a new-build vessel, the additional speed capabilities and owner accommodation come at a considerably higher cost in comparison to a more conventional monohull shadow. A typical set of principal particulars and tender-carrying capabilities are presented in Figure 16 and Figure 17, and a typical general arrangement is presented in Figure 19.

Length Overall	70.0	metres
Length Waterline	67.0	metres
Beam Overall	17.5	metres
Draught Maximum	4.5	metres
Approximate Deadweight	400	tonnes
Approximate Full Load	1250	tonnes
Maximum Speed	29.0	knots
Short-Range Cruise Speed	25.0	knots
Long-Range Cruise Speed	18.0	knots
Range at 25 knots	1500	n.miles
Range at 18 knots	3500	n.miles

Figure 16: Principal Particulars for a High-Specification Catamaran Shadow

Tender	Launch & Recovery
1 x Helicopter (6-8 passengers, approximate weight of 5tonnes)	Stored in deck hangar (plus capacity to land a second helicopter)
1 x Landing Craft (9.0m) 1 x Powerboat (13.0m) 1 x Large Tender (13.0m) 1 x Small Tender (9.0m) 1 x Hovercraft (6.0 m) 2 x Large Jet Skis (3.0m) 2 x Small Jet Skis (2.0m)	Stored in main garage Launched / recovered by X-Y crane through bomb-bay doors
2 x Quad Bikes (2.0m) 4 x Motor Bikes (2.5m) 4 x Moped (2.0m) 1 x Hummer (5.5m)	Stored in vehicle garage Loaded / unloaded by side door

Figure 17: Typical Tender-Handling Capabilities for a High-Specification Catamaran Shadow

Figure 18: Potential Catamaran Shadow – image courtesy of Bjorn Johansson Design

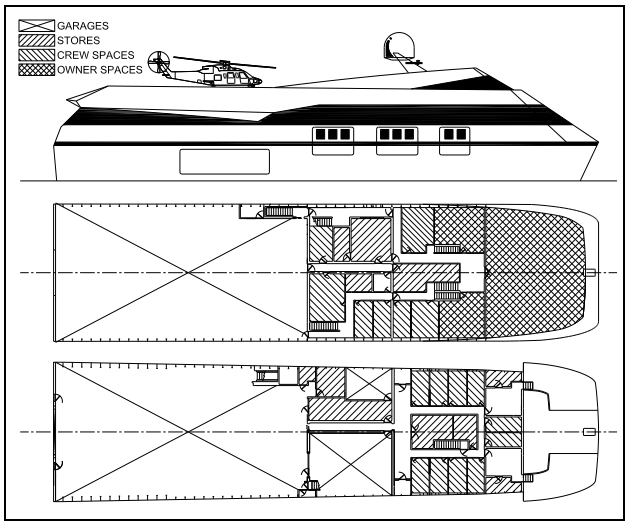

Figure 19: General Arrangement for a High-Specification Catamaran Shadow

For the conventional shadow described above and the high-specification shadow described below, other small tenders such as sailing dinghies, canoes and bicycles may also be carried but have not been listed.

6. CONCLUSIONS

This paper has explored a number of aspects relating to the operational benefits of using a shadow yacht. Additionally the costs of building such a vessel have been presented together with the possible savings that could be made by adopting a shadow yacht and subsequently reducing the size of the main yacht.

It has been illustrated that for a new-build yacht design of 85 metres and above it may be possible, with no additional increase in build cost, to acquire a new-build shadow by removing the garage spaces from the yacht.

The minimum length of a shadow yacht has been discussed and it is suggested that a vessel of at least 50 metres will provide sufficient operational support to the yacht as well as reasonable speed and payload capabilities.

Designs for a conventional medium-speed monohull and a high-specification high-speed catamaran have been presented. It has been illustrated that the catamaran offers significant advantages in respect of matching the speed capability of a shadow to that of the yacht.

It is hoped that based on the information presented in this paper, yacht designers and yacht brokers can present prospective owners with an alternative solution which meets, and in some cases exceeds their initial specifications for little or no additional cost.

9. DISCLAIMER

The costs presented in this paper are approximate figures based on past and current data and may vary considerably depending on future market conditions. The financial savings presented are indicative and are provided solely as an approximation of potential cost savings.

10. REFERENCES

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11. AUTHORS' BIOGRAPHIES

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