

The Special and Desirable Characteristics of Classic Swans as Offshore Yachts

Part 2

By

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Seaworthiness (Survivability)

The prior article ([Part 1](#)) dealt with Sea Kindliness (comfort), and this article ([Part 2](#)) is devoted to Seaworthiness (survivability). The reader is reminded that, as noted in Part 1, several of the S&S Swan characteristics influence both the yacht's Sea Kindliness and Seaworthiness. An attempt has been made to separate the two, and generally for the sake of clarity, some assumptions were made.

Hull Shape

There are several features of the S&S Swan hull shape which improves the yacht's ability to survive in strong winds and severe seas. These include the Swan's more balanced waterplane shape, generous fore and aft overhangs, and having the maximum beam a little aft of amidship. While in case of the more contemporary yachts (Photo 1);



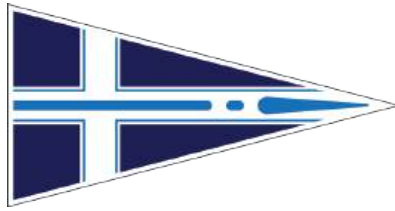
1 - Generic Modern Cruising Design

□ The effect of having imbalanced waterplanes being fuller aft on the newer yachts vs. the S&S Swans, shifts the center of flotation further aft.

□ The effect of having the maximum beam further aft on the newer yachts vs. the classic S&S Swans, tends to substantially shift the center of buoyancy aft, and especially so, in the dynamic situation, when a wave passes under the hull.

The total effect of these features when heeling or when in

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a following sea, results in a substantive shift in the center of buoyancy and flotation aft. In the case of simply heeling, on the newer yachts, there is an enormous amount of buoyancy gained aft vs. forward. Therefore, lacking relative buoyancy forward, the yacht tends to rise at the leeward stern quarter and submerge at the bow. To counteract this, often in competitive races, the newer yachts move their crews as far aft as possible to minimize the increase in bow down trim.

This bow down propensity is further exacerbated in a following sea and more often off the wind, when the wave passes under the stern, rather than break over the newer yacht's large transom, which substantially increases the buoyancy aft, thereby further driving the bow down. In total, the tendency of the newer boats vs. the S&S Swans is to trim more by the bow. As such, the newer yachts have a greater propensity to drive their bows under water (stuffing the bow). And in a worst-case scenario, this could result in the bow never emerging to the surface and putting very large stresses on the hull and rig.

Hull Construction (scantlings)

The S&S Swan line of yachts were initially based on Sparkman & Stephens standards as well as Lloyd's Rules for fiberglass hulls.

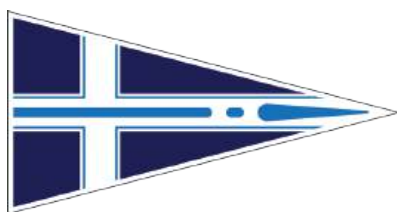
At the time fiberglass, as a construction material, was relatively new for yacht construction. The fiberglass construction technique employed was hand laid-up fiberglass, primarily mat, cloth, and roving, be it chopped strand mat or in sheet form. The percentage of resin in a laminate substantially effected the strength/flexibility of the part.

It is the laminating crew's job to evenly spread the right amount of resin, eliminate any resin starved areas, and do so before the resin begins to set. Clearly the results would vary between crews, and the diligence of a particular crew. In addition, the shop's ambient conditions (temperature/humidity) during the resin curing process adds to the method's inherent variations in the resulting mechanical properties of the hand laid-up process. It is primarily due to these variables that a semi-empirical approach was used in defining the scantling standards/rule, resulting in requirements that tended to be conservative.

It should be noted that in time more fiberglass yachts were put in service which resulted in a better understanding of the materials (newer resins, fabrics became more specialized; uni, bi, tri-axial), and laminating techniques such as vacuum bagging, and prepreg have eliminated many of the vagaries of hand laid-up construction.

In short, today we have a better understanding of the forces imposed on a hull, we are better at controlling the resulting mechanical properties of the laminate, as well as repeatability of the result. Given this accumulated knowledge the standards/rules have become more quantitative, in essence more scientifically based. Which for the S&S Swans results

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in them being even more on the conservative side of the acceptable band.

Spars/Rigging



2 - Generic S&S Swan Spars/Rigging

Historically, for spar/rigging requirements, as was the case with the hull scantlings, initially a semi-empirical approach was used. Similarly, the specifications for the spar sizes, standing and running rigging have evolved from semi-empirical to more scientifically based, and will continue to do so as we become more knowledgeable.

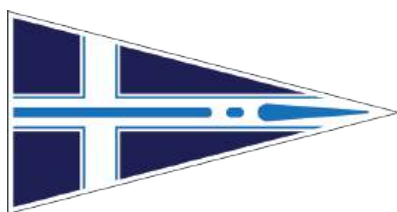
In the case of the S&S Swans, Sparkman & Stephens standards were applied for the spar and rigging sizes, which were developed from several prior standards, modified according to S&S's knowledge base. It should be borne in mind that these standards are based solely on the loads imposed by the wind, and the motions of the hull in a seaway. They do not specifically consider the loads which result from submerging the spars in the water, and at worst a 360° roll. As in the case of the scantlings, at the time, the spar/rigging requirements were relatively more conservative than those upon which newer yachts were based. Robust spars (Photo 2) minimize reliance on runners, are easier to handle, and require a smaller crew.

Appendages (Keel/Rudder)

In the case of the keel, the loads that a keel imparts at its' attachment surface to the hull, are readily quantifiable. As such the secure attachment of the fin keel to the hull has not, at least for the S&S designs been an issue. While a damaged or lost rudder would compromise the seaworthiness of the yacht. The following explains the reasons for S&S's preference for the skeg hung rudder (Photo 3).

There are several ways to affect the interface between the rudder and hull. Part 1 (Seakindliness) addressed the hy-

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3 - Typical Skeg Hung Rudder Configuration

hydrodynamic pluses and minuses of spade rudders, vs. skeg rudders, particularly as they relate to directional stability vs. maneuverability. And in the case of the S&S Swan designs it was decided that skeg hung rudders offered the best comfort and fatigue solution.

There is also the survivability component to the decision to use a skeg hung rudder, with the benefits being two-fold. The skeg being in front of the rudder adds an element of structural protection to the rudder in the case of an impact with flotsam or jetsam. In addition, while a spade rudder system and skeg/rudder system should be

designed to withstand the same stresses, the stresses considered, are for the most part typical steering stresses and not those resulting from a partial or 360° roll. It is also extremely difficult to accurately quantify the roll loads. At least in the case of the skeg hung rudder vs. the spade rudder, there is more lateral area to distribute the roll loads which would be approximately perpendicular to the appendage's surface.

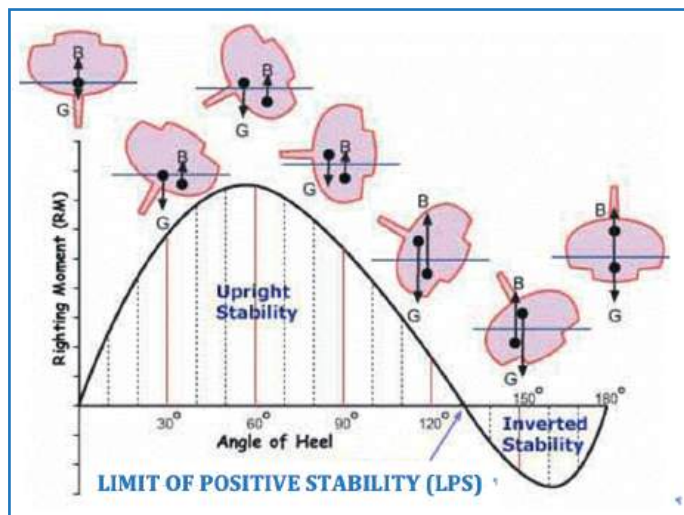
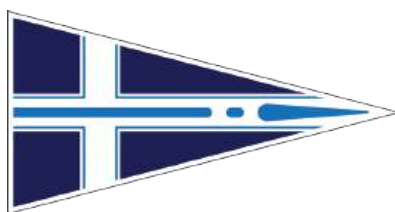
Stability

The ability of a vessel to survive a knockdown or roll where the mast is immersed in the water due to sea and/or wind conditions, is an extremely complicated dynamic event, hence extremely difficult to quantify. Consequently, over the years, a simpler static approach has been used by several regulatory agencies and racing rule authorities. While the static approach approximates the dynamic scenario, it has proven to be a generally reliable indicator of survivability, with the emphasis on generally. This static analogy typically used is referred to as the “righting moment” (or righting arm) curve.

There are two characteristics of the curve that have been of particular interest. The first being the initial stability. This is viewed as an approximate indicator of the stiffness/tenderness while under normal sailing conditions. It is determined by inclining the yacht to at least a 2° heel angle and then calculating the righting moment RM1° (righting moment at one degree heel) based on the inclining result. The yacht's sailing stiffness/tenderness goal can be adjusted in any of several ways. The amount of ballast can be changed, the maximum sail area, and/or aspect ratio of the rig can be changed as well. Typically, this is decided during the design phase.

By mathematically combining the above righting moment results with the lines plan characteristics of the yacht, righting moments over a full range of heel angles can be calculated and plotted as the righting moment curve. It is now possible

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4 - Typical Righting Moment Curve

to determine the second survival characteristic of interest, the LPS (Limit of Positive Stability). This is the angle at which, excluding the buoyancy contribution of such shapes as erections (i.e., doghouse, etc.), the yacht would have a zero righting moment. (fig. 4) In this static situation, absent any external forces, the yacht would neither right itself nor continue to roll over. This is referred to as neutral equilibrium.

However, as it took substantial forces of wind/sea to roll the yacht to the LPS heel angle, intuitively one could expect the yacht to continue to roll. Hence, the larger the LPS angle the more likelihood of surviving a knock-down

or worse rollover. The roll sensitivity of a yacht at the LPS can be understood by visualizing a cone balanced on its' tip. In this condition, without external forces, it is in neutral equilibrium. But the tiniest of tiny external forces will make the cone fall over.

As the ORA (Offshore Racing Association) considers the LPS to be a significant measure of a yacht's seaworthiness it is incorporated in the ORR (Offshore Racing Rule). The LPS of all the S&S Swan's with ORR certificates have an average value of 124.6°.

The ORR further refines specifically accounting for beam, displacement, and is ORR's STABIDX (Stability Index or Capsize Screen). Each Offshore Racing Category value for the Capsize Screen. In the case of the S&S Swans their which handily satisfies the noted below.

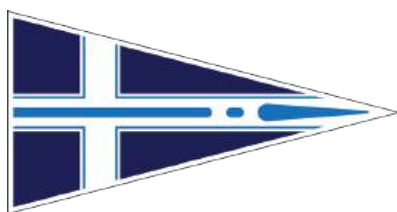
Offshore Race Category World Sailing (OSR), US (SER)	Recommended Min Stability Index (Capsize Screen)
0 (NA)	120°
1 (Ocean)	115°
2 (Ocean)	110°
3 (Coastal)	103°

Table 1

the LPS quantity by more the influences of maximum waterline length. The result ty Index or Capsize Screen). gory is assigned a minimum (Refer to Table 1). In the STABIDX average is 134.5°, most severe conditions, as

The S&S design seaworthiness features, taken in aggregate, namely hull shape, construction standards, spar & rigging standards, appendages, and stability, are the major reasons these S&S Swans have earned their reputation as good offshore yachts.

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Looking Forward (Influence of the 1979 Fastnet Race)

Tough ocean races are the ultimate empirical confirmation of seaworthiness. And one of the most severe tests of yachts was during the 1979 Fastnet Race, when many lives and yachts were lost. In response, a very thorough government inquiry was undertaken. And technical studies were initiated on both sides of the Atlantic, to determine what characteristics of a yacht help/harm their ability to survive severe conditions. This effort included having all the race participants filling out a survey with a myriad of questions.

Several significant observations came out of the study as they relate to design characteristics and in particular a better way of measuring stability. These results have influenced rating rules since, including the ORR, as illustrated in the above STABILITY section by the formulation of STABIDX.

The 1979 Fastnet Race was also a real-world test of the S&S Swan designs. As a result of the recent outstanding cooperation of the **RORC ****, the authors were able to obtain a great deal of information including the scratch sheet, and race results to mention a few. Of the 303 yachts which were recorded as starting, 13 were S&S Swans. Fortunately, the

information also includes how these 13 fared, be it finishing, or withdrawing, etc.

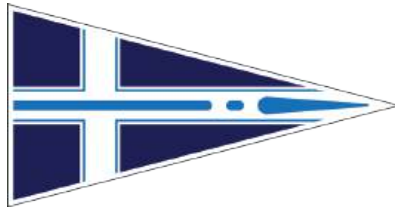


5 - Hull Shape of a Classic S&S Swan in Action

The **RORC **** information we received also provided more detailed insights into how the yachts and S&S Swan owners responded to the prevailing conditions. The authors felt that this new information would be of interest to the reader and have decided to add a **third article** to this series, titled **S&S Swans - 1979 Fastnet Race**.

And in all of this technical mumbo jumbo we should not forget the beauty of an S&S Swan close reaching (Photo 5).

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Juan Corradi is professor emeritus of sociology at New York University and an avid ocean sailor. His experience sailing with a classic Swan during 22 years was published in the book *The Voyages of Pirate. 55,000 Ocean Miles on a Classic Swan* (2019).

** The 1979 Fastnet inquiry and results are over 40 years old. Therefore, much of the documentation was not available. As such any conclusions based on the RORC information provided, should be considered indicative rather than precise.

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