A History and Technical Overview of The Hood Design Philosophy

TED HOOD DESIGN GROUP

The Hood Design Group was founded in 1959 by Ted Hood when he designed and built the first of many successful Robins. The first Robin demonstrated how a shallow-draft, wide-beam, deep centerboard hull concept could be extremely competitive, winning almost every race in her first season. Additional benefits of the design were an excellent load-carrying ability and a comfortable, easy motion in heavy seas. For the past 35 years, we have steadily developed this concept in over 100 designs, with a growing emphasis on the pure cruising sailor seeking both comfort and performance. We hope that the following brief synopsis will help you better understand the theory and practical applications of the Hood design philosophy.

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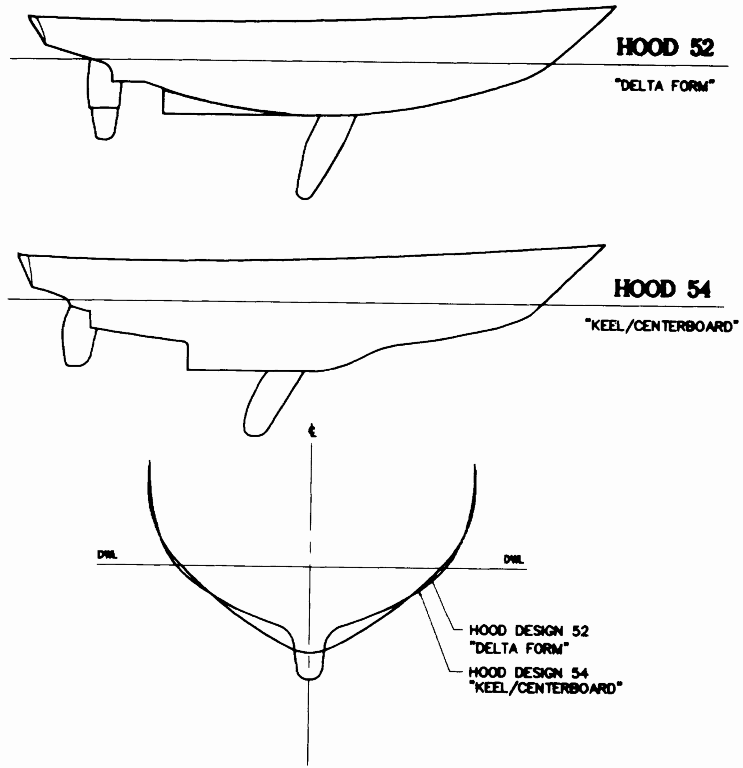
General Hull Design

The current trend in yacht design is clearly towards lighter displacement, deep-keel boats designed primarily for high performance with a lower priority on comfort and, in some instances, safety. This has been driven in part by the new generation of racing boats that are designed with a singular objective to sail around the world (or the race course) in as short a time as possible. These extreme designs have placed a tremendous burden on mast and boat builders by allowing only the narrowest margin of error in balancing safety with weight-saving construction, sometimes with tragic consequences. Oddly enough, some groups have ignored the old adage that says, "you have to finish to win the race."

The Ted Hood Design Group stands firm in the face of this trend by offering a unique design alternative that emphasizes comfort and safety without giving up respectable performance characteristics. Today, the average cruising sailor wants to sail quickly from point to point and feel pride at the wheel when passing other boats of similar size. At the same time, they want to be self-sufficient for longer passages and retain valuable creature comforts. Before focusing on these benefits to the cruising sailor, let's first talk about performance.

Since 1959, Hood designs have consistently proven to be competitive on the race course. Some of these boats were designed primarily as racing boats under the old I.O.R. rule, while other boats were successful as racer/cruisers. With the advent of the I.M.S. rule over the past decade, we have put a greater emphasis on cruising requirements, both above and below the waterline, while at the same time striving to keep each boat competitive. For example, in each of the four Newport/Marion-Bermuda races from 1989-1992, a Hood designed "cruising machine" finished first in class, in each case proving itself in a variety of wind conditions.

In looking at why a relatively heavy Hood design performs well, we need to focus on five important design characteristics: 1.) Stability, 2.) Wetted Surface, 3.) Prismatic Coefficient, 4.) Appendages, and 5.) Rig Design.

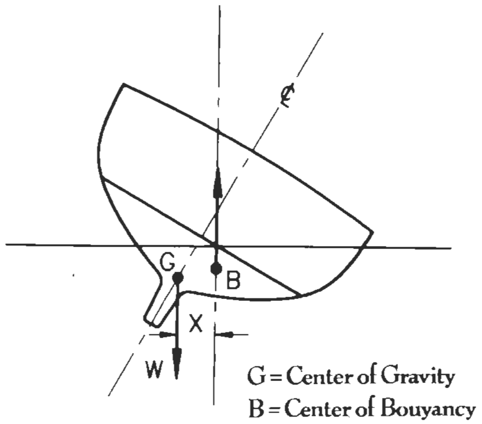


Stability

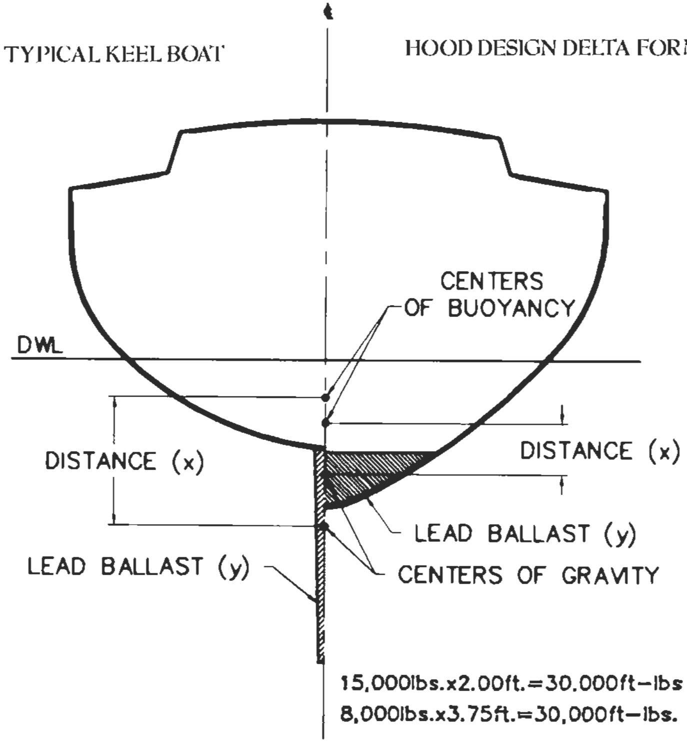
Over the years, we have designed several moderate displacement keel boats, including the record-breaking circumnavigator, "AMERICAN PROMISE," and a string of accomplished "ROBINS." However, the majority of our designs have incorporated a hull form with relatively heavy displacement, wide beam and a centerboard with shoal draft to provide many advantages for the cruising sailor that we will cover later.

We have further developed two variations on this theme in the form of the classic keel/centerboard hull with a centerboard raised into a short keel; and the more extreme shoal-draft "delta form" with a deeper, delta-shaped hull and no keel extension. The latter was developed to satisfy those sailors who have specific draft restrictions at home or at preferred cruising grounds.

A question we most often hear is, "How can a shallow draft hull possibly have enough stability to perform in heavy winds?" We have shown the cross-section of our more extreme "delta form" design as compared to that of a typical light to moderate displacement keel boat to demonstrate how a shallow-draft Hood design can provide stability to support a powerful sail plan and remain safe for extended offshore use. Note that the center of gravity of the lead ballast is only marginally higher than the deep lead keel because of a much deeper hull profile. Because of the greater hull



Righting Moment = Weight(W) x Righting Arm (X)



Ballast Moment = Distance $_{(x)}$ × Ballast $_{(y)}$ - Moment

Comparison of Righting Moments: 43'- 47'

Boat Type	Designer	Hull Configuration	Draft* (Ft.)	Righting* Moment (Ft.-Lbs.)
Hinckley 43	McCurdy & Rhodes	Keel/Centerboard	4.6	1276
Seguin 44	Sparkman & Stephens	Keel	6.4	1427
Alden 45	Alden	Keel	5.6	1598
Swan 44	Frers	Keel	7.5	1869
Frers 45	Frers	Keel	8.3	1891
Tripp 47	Tripp	Keel	9.0	1915
Little Harbor 43	Hood	Centerboard ("delta form")	4.1	2050
Beneteau 456	Beneteau	Shoal Keel	6.6	2058
J-44	Johnstone	Wing Keel	6.4	2141
Baltic 46	Petersen	Keel	7.5	2236
Little Harbor 44	Hood	Keel/Centerboard	5.5	2291
Bristol 45.5	Hood	Keel/Centerboard	5.5	2297

Comparison of Righting Moments: 50'- 54'

Boat Type	Designer	Hull Configuration	Draft* (Ft.)	Righting* Moment (Ft.-Lbs.)
Hinckley 51	McCurdy & Rhodes	Keel/Centerboard	5.8	2611
Alden 54	Alden	Keel/Centerboard	5.7	2823
Beneteau 53	Beneteau	Keel	8.1	2850
Swan 51	Frers	Keel	8.9	3115
Little Harbor 50	Hood	Keel/Centerboard	6.0	3125
Little Harbor 52	Hood	Centerboard ("delta form")	4.6	3216

*Data obtained from certified IMS measurement certificates.

displacement (or buoyancy), we are able to specify considerably more lead to compensate for this difference in ballast height. The amount of ballast multiplied by the distance of ballast below the hull's center of buoyancy equals the "ballast moment," a key component affecting the overall "righting moment" or force required to heel a boat at a given angle.

In comparing these hull sections you will also note that Hood designs have more beam than a typical keel boat of the same length. As the boat heels, up to 20 or 25 degrees in a stiff breeze, this extra beam on the leeward side provides additional buoyancy, or "form stability," that also affects the overall righting moment by moving the center of buoyancy outboard more rapidly as the boat heels, thereby increasing the righting arm.

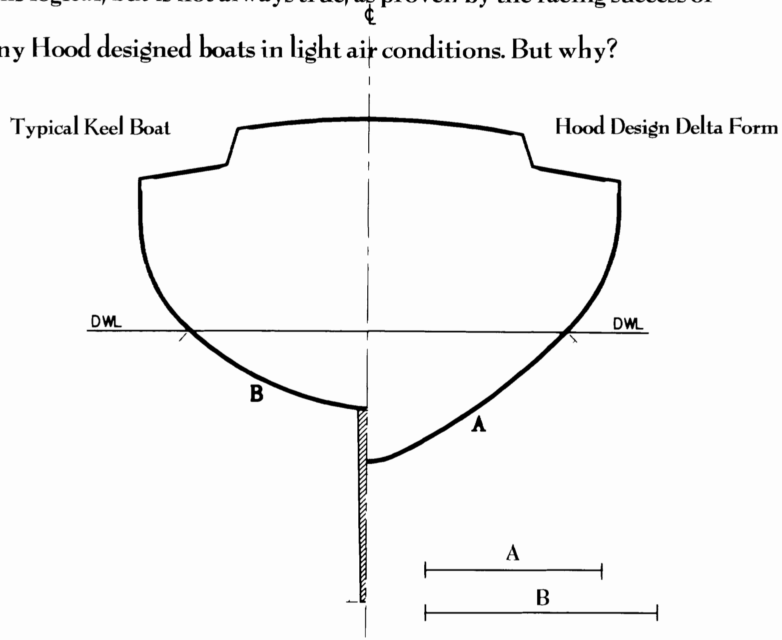
Generally, a higher righting moment implies a relatively "stiffer" boat able to carry more sail area and/or perform better in heavy winds.

We have shown a chart of measured righting moments for various Hood designs as compared to other well-known keel/centerboard and full-keel designs in the 44-46' and 50-52' ranges (see previous page).

In summary, a heavier displacement hull with generous beam can carry considerably more ballast, although not as deep as a conventional deep-keel design, and still retain the same stability characteristics as a deep-draft design.

Wetted Surface

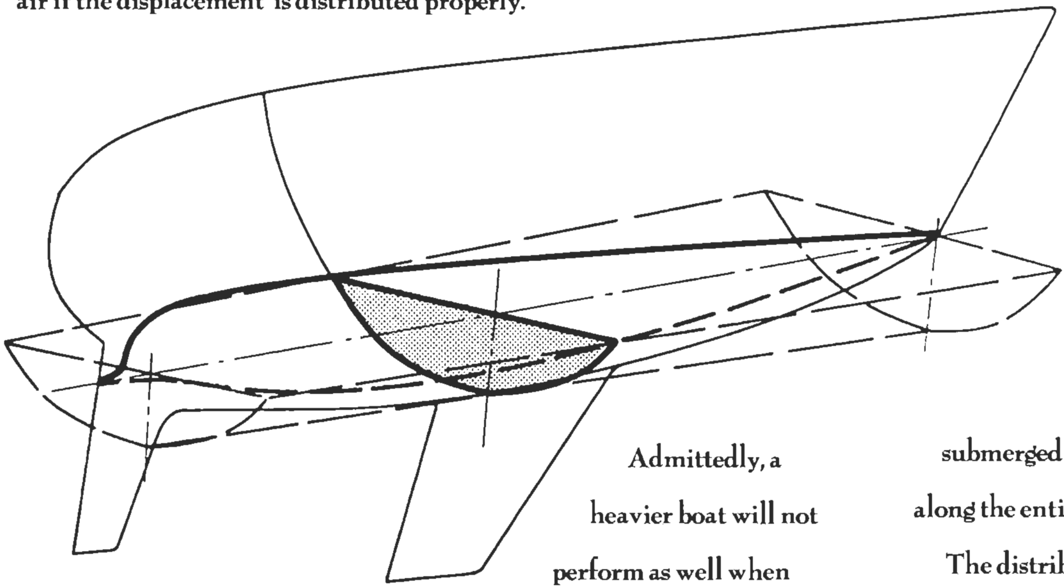
Another common question that we often hear regarding performance is, "How can a heavier displacement boat move in light air? After all, a boat must be light to move well in less than 8-10 knots of breeze." This seems logical, but is not always true, as proven by the racing success of many Hood designed boats in light air conditions. But why?



Girth Measurement Comparison

There are three forms of resistance to a hull moving through the water: wave-making, form, and frictional. In light winds, when a boat is moving well below maximum speed, the overriding component of resistance is skin friction of the water along the hull surface because there is less turbulent flow. Therefore we strive to shape our heavier displacement hull in such a way that minimizes the wetted surface area below the waterline. A racing rowing shell has a hull section that is completely circular because that shape provides the least wetted surface for a given displacement. While our designs accentuate hull depth and waterline beam for stability reasons, as explained previously, our rounded "V" sections follow the same goals of maximizing displacement (i.e. cruising amenities and interior volume) with a minimum hull surface area.

Comparing a cross-section of each hull once again, we have noted how a shallow-draft, heavy displacement hull has a smaller "chain girth" measurement. That is, the distance measured on an imaginary string running from the waterline to the bottom of the keel is shorter, meaning that when averaged out over the length of the hull, the wetted surface is comparable or less than a light displacement hull. In this manner, a heavier displacement hull can maintain fast, "straightline" speed in light air if the displacement is distributed properly.



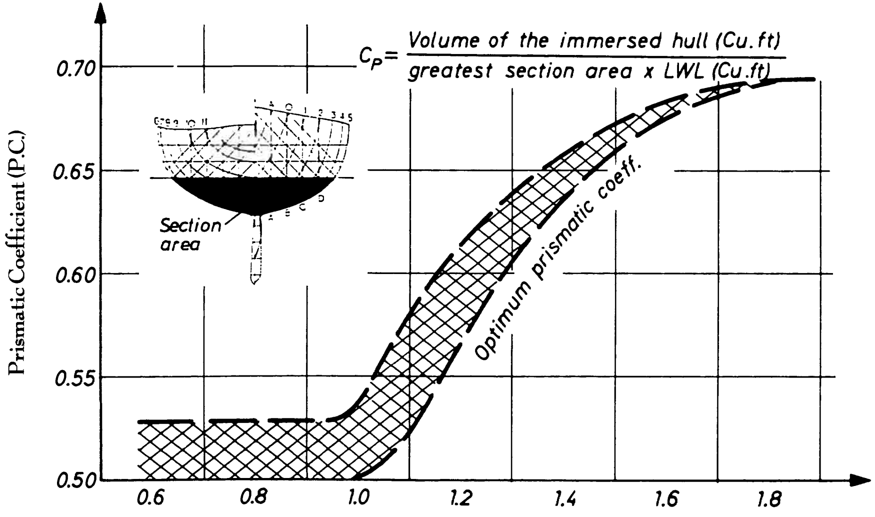
Admittedly, a heavier boat will not perform as well when short-tacking up a narrow channel because of the longer time needed to accelerate. In heavy air sailing downwind, a lighter boat will certainly surf more easily. But for the average cruising sailor looking to make a fast passage in safety and comfort, these qualities are not a high priority because the typical wind conditions under which we sail is less than twenty knots.

Prismatic Coefficient

The prismatic coefficient (P.C.) is a technical term used to define how displacement is distributed along a hull, or how fine or full the ends of the hull are. Typical sailboats have a range of .45-.60 with a maximum theoretical number of 1.00 possible only for a submerged cylinder (e.g., a barge) with equal distribution of volume along the entire length.

The distribution of displacement, or P.C., has a great effect on the wave-making component of resistance of a hull through the water. Every boat (sail or power) has an optimum P.C. for a given hull speed (see graph next page). For example, a powerboat designed for high speeds has a light displacement hull with relatively fuller ends and a P.C. in the .70 range. However, when this boat is operated at lower speeds (below planing), a large wave develops and the boat operates far less efficiently because of the increased drag. In much the same way, a light displacement sailboat with a relatively higher P.C. can plane or surf downwind much more easily in a stiff breeze, but at lower boat speeds in light to moderate wind, the lighter boat will develop more wave-making resistance.

This phenomenon is greatly accentuated when one adds weight to a sailboat originally designed to be light. For example, many former stripped-out racing boats have been modified for cruising, only to discover that light air performance is considerably diminished. A sailboat originally designed with greater displacement and lower prismatic will be much less sensitive to added weight, because the P.C. stays more constant as the hull is immersed and the increase in displacement as a percent of total is less. This is an important consideration to the cruising sailor who needs to load onboard thousands of pounds in extra gear and provisions for any kind of

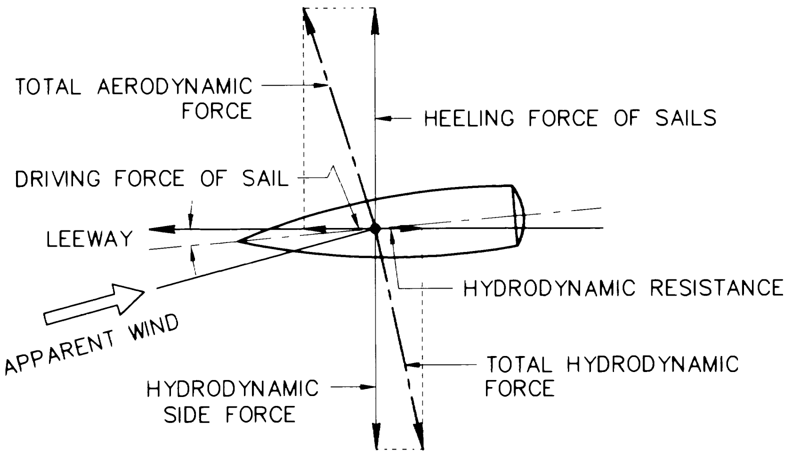


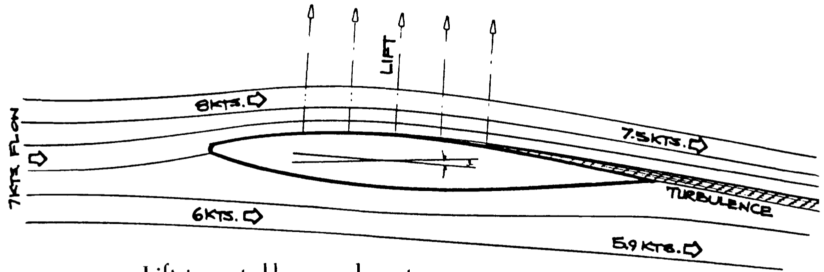
BOAT SPEED / √L
Optimal P.C. for a given boat, speed

extended voyage. Our designs typically have a P.C. in the range of .54-.55 to optimize performance in 8-15 knots of wind where Boat Speed / √L rarely exceeds 1.2.

Appendages - Centerboards and Rudders

A discussion on performance of Hood designs cannot be complete without looking closely at centerboard and rudder configurations. The general theory of sailing demonstrates that the wind over the sails creates a force that pushes the boat both forward and to leeward when sailing upwind(see below). The resistance to leeway, or slipping sideways, is determined by the total profile area, or lateral plane, below the waterline and the shape of the hull and appendages.

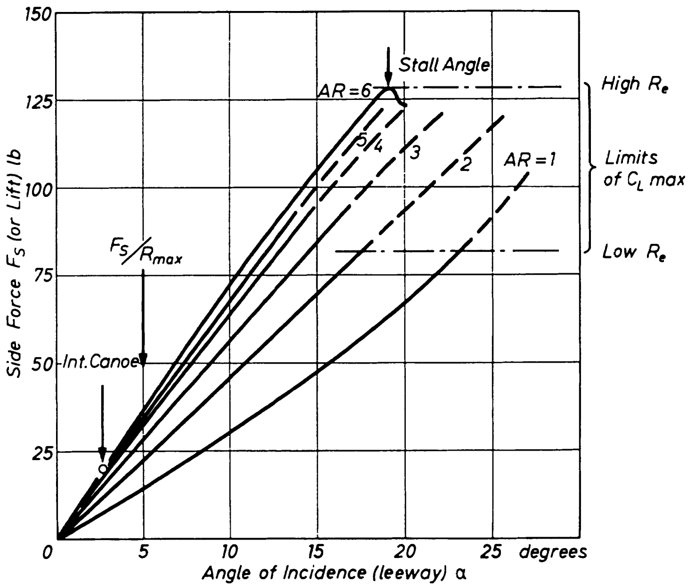




Lift generated by an underwater appendage moving through the water.

It has been proven in one-design dinghies and the new America's Cup Class that a thin keel or centerboard is faster. In fact, some classes have strict rules against modifying them below a minimum thickness. In addition, designers have learned that deeper, narrow (fore and aft) appendages are a more efficient foil, or "wing," for developing a lifting force to windward. A good analogy to this can be seen in the long, narrow wing designs of gliders capable of producing tremendous lift at lower speeds. Experiments have proven that a higher aspect ratio appendage produces more lift for a given area than a more square profile (see next page).

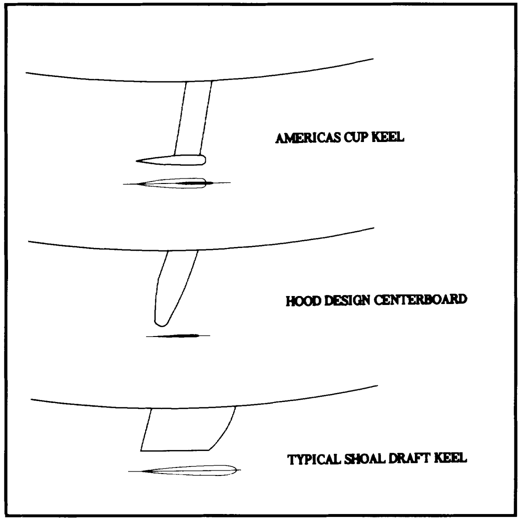
A typical racing boat today confirms this trend towards deep, narrow appendages. However, a sailboat with a fixed, deep-draft keel with ten feet of draft has limited appeal to any cruising sailor. A common solution for a cruiser/racer is to reduce the draft of the keel, make it thicker or longer fore and aft to provide volume for lead, and/or add wings or bulbs to the bottom to lower the center of gravity of the lead. This is a compromise that greatly reduces the upwind performance of the boat.



Lift produced by an appendage of 4 sq. ft. with various aspect ratios (AR).

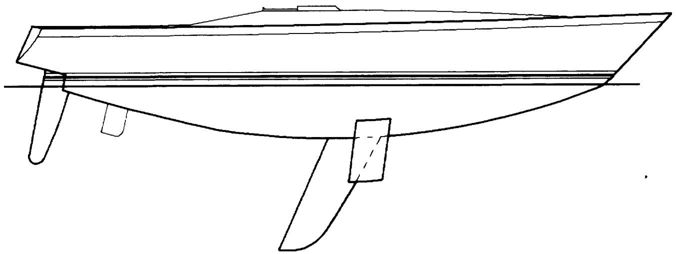
NOTE: THE HIGHEST ASPECT RATIO OF 5 GENERATES THE GREATEST LIFT.

A Hood designed keel/centerboard or "delta form" hull has all internal lead ballast so that the centerboard is not heavy and can be easily raised with a simple and reliable manual winch. There is no restriction to the depth, width or thickness of the centerboard since it can be raised in shallow waters and does not have to have volume for lead ballast. We are free to optimize the section shape and aspect ratio of the centerboard to provide the maximum amount of lift.



Keel/Appendage Comparison

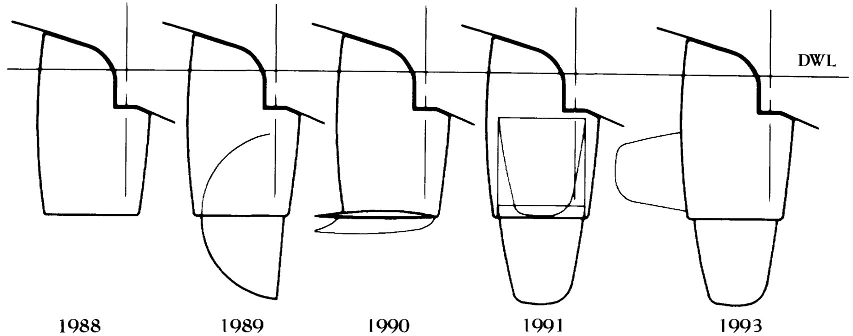
There have also been great efforts made to improve the transition between the hull and the keel or centerboard so that the water flow remains smooth when sailing upwind. This is most evident in the recent race boat designs where the keel is extremely narrow, both fore and aft, in the section where it meets the hull. Again, this is fine for the extreme racing sailor, but difficult and costly on a typical cruising boat because of the engineering and construction challenge of supporting a heavy keel



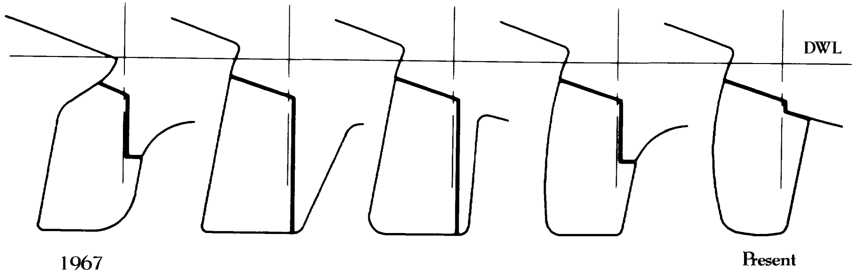
Forty Foot Race Boat, "Nike"

on such a small area. Our centerboard designs, particularly the "delta form" version, provide this clean transition without engineering concerns.

We have experimented with all types of centerboards and foil arrangements over the years in an effort to improve upwind performance. The most unusual design was the 40' race boat pictured above that



Retractable Rudder Development



Balanced Rudder Development

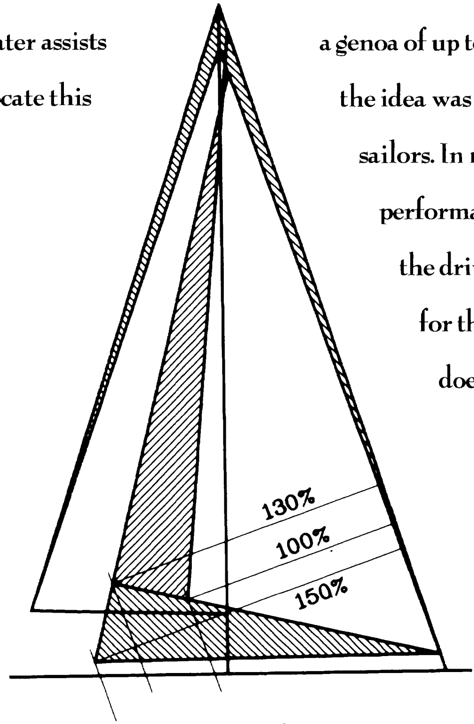
featured the usual main centerboard, along with one centerboard aft and twin asymmetrical daggerboards on each side of the hull that were alternately raised and lowered on each tack. This, of course, is not practical for the cruising sailor and we typically specify one main center-board and a second, smaller centerboard aft (for boats over 75 feet) to improve tracking in extreme downwind conditions.

The Ted Hood Design Group has also experimented with many different rudder configurations over the years. As with keels and centerboards, naval architects have discovered that a deep, high-aspect rudder is far superior in that it stalls less and hence turns more easily, providing additional lift when sailing upwind. Our challenge with the more extreme shallow-draft, "delta form" hull has been to provide the qualities of a deep rudder but have a fixed draft less than the hull depth so that a hard grounding would not damage the steering system. In some earlier designs, we developed a retractable rudder whereby a lower section was raised into an upper section like a daggerboard. This was not ideal, as the system was still subject to damage if one forgot to raise the rudder in shallow waters. We recently solved this problem by allowing the lower section to swing up more like a centerboard to prevent serious damage on grounding (see previous page). This has been successfully introduced on the Sequin 49 and Little Harbor 52/60 designs.

We have also experimented much with skeg-hung rudders and fully balanced "spade" rudders. A "balanced" rudder is designed so that a portion of the total rudder area (ideally 13.5%) is ahead of the rudder post so that as the rudder is turned, the flow of water assists the helmsman in operating the steering system. We advocate this design because the load on the steering system is reduced, the helmsman has more control, and the flow of water is not interrupted by a fixed skeg.

Rig Design

The design of the rig has a direct impact on the performance of any sailboat as the sails provide the "horsepower" to move the hull through the water. In the absence of any racing rules, the Hood Design Group advocates a tall, efficient, high-aspect sail plan that can be supported by a hull and ballast plan that provides a respectable righting moment.



150% Racing Genoa and 130% Genoa vs. 100% High Clew Tall Rig

In addition to minimizing wetted surface, we maximize sail area so that the ratio for sail area to wetted surface is extremely high—another key factor in determining light air performance. Under the old racing rules, a genoa of up to 150% overlap was allowed without penalty. Somehow, the idea was adopted that large genoas were also good for cruising sailors. In reality, reducing a genoa size to 130% has little effect on performance because the forward one-third of the sail is providing the drive. A 130% genoa with a higher clew improves visibility for the helmsman and is easier to furl because the genoa car does not move as far forward when reefing.

In some cases, depending on the owner and intended use, we recommend adding to the standard rig height and using only a 100% genoa for ease of handling the sail when tacking and improved visibility from the helm location. The loss of sail area is offset by the longer, more valuable luff length of both the main and genoa.

Rig design can have a great impact on the perception of stability. For example, a yacht with a relatively poor righting moment could be hopelessly under rigged for lighter winds, yet feel "stiff" in a breeze simply because there is not much there to heel the boat. We advocate a relatively powerful sail plan for all winds, supported by a stable hull, that can be easily reefed as the wind increases.

Performance

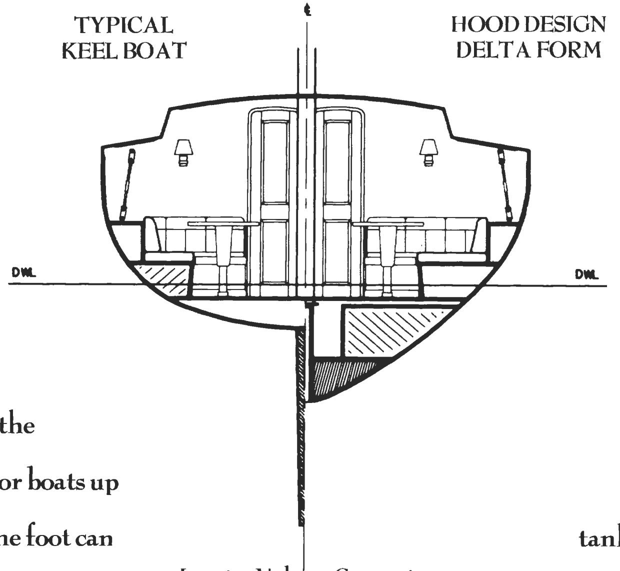
We have now reviewed five key characteristics of a Hood design that help ensure good performance. There are, of course, many finer points for the designer to consider in balancing speed with comfort, safety, and affordability. There are also many more details controlled by the builder, such as lightweight construction materials or the use of flush-mounted hardware below the waterline, that have an effect on performance.

We have talked so far about "performance" strictly in terms of speed potential, which is primarily what most sailors relate to. From our years of experience in designing all types of yachts, we have developed what we feel is a much more practical definition of "performance" as in the equation below: In this section we will look at how Hood design characteristics affect each of these five additional variables.

Performance = Speed x Comfort x Payload x Range x Safety x Integrity

The same hull design characteristics that we outlined previously have a strong impact on the general use and safety of the complete boat. For example, the typical shoal draft of each Hood design allows the owner to visit cruising grounds inaccessible by most boats of the same size; in fact, this ability is as much a motivation for (as opposed to a by-product of) the Hood design concept. A desire by many owners for even less draft inspired the "delta form" hull form that draws under five feet for boats up to 60 feet in length. A reduction in draft of only one foot can open up a whole new world for the cruising sailor to explore, whether it be the Caribbean, European waters or the Pacific.

After looking at how relatively greater beam and displacement contribute to performance via stability and low-wetted surface, let's look at how these features can produce an even greater benefit. First, displacement and beam directly translate into more interior hull volume. This provides substantially more space for interior accommodations and the long list of machinery and equipment required to be comfortable onboard. Substantial water and fuel tankage can all be below floor level so that all space under seats and berths is reserved for storage (pictured at left).



Interior Volume Comparison

This additional joinerwork, equipment and tankage is extra weight that the buoyant hull is designed to carry without affecting the overall performance. The increase in cruising range and self-sufficiency is of great value.

Second, the heavier displacement hull will have a much easier motion in heavy seas. A light, flatter bottom hull tends to pound into seas with a quick, uncomfortable motion in large waves. The rounded V-sections of

Comparison of Stability Index: 43'- 47'

Boat Type	Designer	Hull Configuration	IMS Draft * (Ft.)	Stability Index*
J-44	Johnstone	Wing Keel	6.4	111.1
Beneteau 456	Beneteau	Shoal Keel	6.6	113.1
Little Harbor 43	Hood	Centerboard ("delta form")	4.1	122.7
Frers 45	Frers	Keel	8.3	122.7
Hinckley 43	McCurdy & Rhodes	Keel/Centerboard	4.6	122.9
Baltic 46	Petersen	Keel	7.5	123.2
Tripp 47	Tripp	Keel	9.0	124.5
Alden 45	Alden	Keel	5.6	125.0
Bristol 45.5	Hood	Keel/Centerboard	5.5	126.1
Seguin 44	Sparkman & Stephens	Keel	6.4	127.8
Swan 44	Frers	Keel	7.5	135.8
Little Harbor 44	Hood	Keel/Centerboard	5.5	137.5

Comparison of Stability Index: 50'- 54'

Boat Type	Designer	Hull Configuration	IMS Draft * (Ft.)	Stability Index*
Alden 54	Alden	Keel/Centerboard	5.7	110.8
Beneteau 53	Beneteau	Keel	8.1	112.5
Little Harbor 52	Hood	Centerboard ("delta form")	4.6	121.9
Hinckley 51	McCurdy & Rhodes	Keel/Centerboard	5.8	123.6
Swan 51	Frers	Keel	8.9	125.5
Little Harbor 50	Hood	Keel/Centerboard	6.0	126.2

*Data obtained from certified IMS measurement certificates.

the Hood design allow it to push through large seas without as sudden a motion.

Third, the "inertia," or mass of ballast, interior weight and tall rig have been proven to increase capsize resistance as compared to a light boat as reported in a study completed after the 1979 Fastnet Race disaster. In theory, a lighter boat can be rolled over with less resistance, while a heavier boat rolls slower and has time to recover between waves.

The "limit of positive stability" of a yacht is a calculation by computer models of the maximum angle a boat will heel before capsizing. This is determined without consideration of inertia factors and, as currently calculated, does not take into account the buoyancy of the cabin house as compared to a flush-deck design. Nevertheless, in 1992 the ORC special regulations governing the design parameters acceptable for offshore racing introduced a "Stability Index." This index takes a yacht's "limit of positive stability" and combines it with a "capsize screen value" and "size value" essentially measuring a yacht's ability to recover from a capsize due to a wave rollover or wind knockdown. The calculated values of various designs are shown on a comparison chart (see previous page). As shown, the capsize resistance of Hood designs compares favorably to many other well-known and respected designs.

Of course, a large part of an owner's comfort and safety is dependent on how easily the yacht can be operated. We devote considerable time in designing a deck layout so that, in most cases, one person can operate all systems without leaving the helm. Sail handling systems developed by Ted Hood and others have greatly improved the operational safety of most yachts. Access in and out of a mid-cockpit is made easy, in part because the deep hull allows the floor to be lower, which in turn allows for a much lower profile cockpit. In fact, in 1967 we were the first to design a mid-cockpit yacht under 60' in length with full walk-around headroom below.

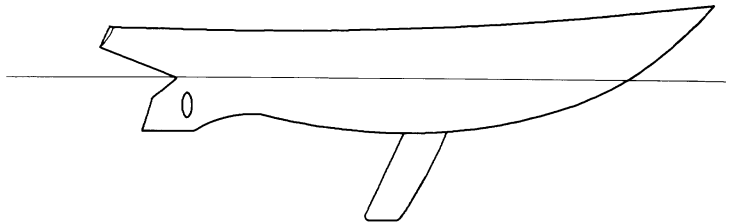
Comfort also includes many other important variables, such as adequate light and ventilation, "real" size berths and a multitude of fine design details that are carefully checked for proper ergonomics. Indeed, we spend many hours refining the interior and deck layouts of each boat to make the absolute best use of a given volume and provide access to all possible storage areas.

Finally, the integrity of a yacht is also an important factor that contributes to overall performance. A construction standard must be established that calls for the best materials and workmanship in order to provide greater value and reliability. Structural problems, deck leaks, and broken equipment are just some of the many concerns of a boat owner. As designers, we draw from our own experiences and accept responsibility for developing a proper specification and helping to select the right builder for a given project.

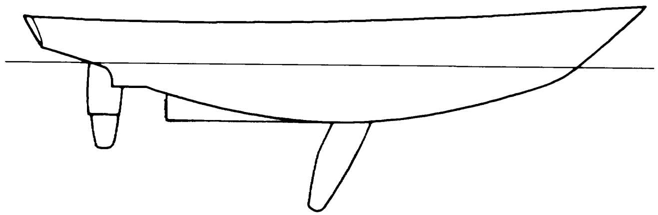
Summary

The Hood design philosophy of a relatively heavy displacement, wide, shoal-draft, centerboard hull is not new (see illustration). Our concept has evolved over time since Ted Hood designed his first boat in 1959.

We design our boats to provide a unique balance between pure "speed" and other important variables such as "payload," the ability to carry more



"Robin": 1968 Newport - Bermuda Race Winner



"Freestyle": 1992 Newport - Bermuda Race Winner

interior volume and creature comforts. The old clipper ships of the 1800's were designed much the same way in an effort to move as much cargo as possible, yet still arrive in port ahead of the competition. Interestingly enough, the basic hull shapes of those great ships have remarkable similarities to our current hull designs, although they performed poorly upwind because of their square rigs, narrow hulls and lack of underwater appendages.

A yacht's displacement is not just it's weight on a scale. Archimedes taught us long ago that it is also a measurement of the volume of water displaced which in turn translates into interior volume. Unfortunately, while most yachts are sold on perceived value related to length, the actual construction costs are more or less proportional to displacement, consequently, price per pound should be a primary factor in comparing relative value - all else being equal, of course.

We strongly believe that the most important role for an owner in any design project is to communicate his or her desires, lifestyle and intended use to the designer in the beginning to ensure ultimate satisfaction with the finished yacht. All too often, the design of a yacht is centered around a particular function that may be used only a very small percentage of the time yet significantly compromises the entire yacht during most other times. As designers, our goal is to see that an owner's desires and priorities are identified and properly addressed in the finished yacht.

We fully recognize that our designs are not for everyone. For those with a primary focus on speed, such as deep water racers, there are certainly better alternatives. However, we feel that our "performance equation" best exemplifies our balanced approach to yacht design.

The Ted Hood Design Group is proud of the variety of boats designed and built throughout the world during the last 35 years. The owners of many of these yachts have distinguished themselves on the race course or cruised remote areas of the world with great comfort and safety. We look forward to the future as we further refine our design concept to meet the challenges of each unique project.

Significant Race Results for Hood Designs Since 1959

- **1959** — 40' ROBIN first Hood design; winner of numerous races in first season
- **1962** — 12' NEFERTITI America's Cup contender
- **1964** — 47' INDIGO Winner, TransAtlantic Race
- **1964** — 12-METER NEFERTITI America's Cup contender
- **1967** — 52' ROBIN Winner, Cygnet Cup (NYYC)
- **1968** — 52' ROBIN First overall, Newport-Bermuda Race
- **1970** — 54' ROBIN Winner, Cygnet Cup (NYYC)
- **1972** — 40' DYNAMITE Winner, Canada's Cup
- **1973** — 36' ROBIN Third, One-Ton Worlds • Third, SORC
- **1974** — 36' ROBIN First, SORC • Cygnet Cup (NYYC)
- **1975** — 40' ROBIN First in class, SORC • Winner, Trans-Atlantic Race • Top U.S. Admiral's Cup
- **1976** — 36' ABINO ROBIN First in class, Newport-Bermuda
- **1977** — 12-METER INDEPENDENCE America's Cup contender
- **1979** — 36' ROBIN Third, SORC • Cygnet Cup (NYYC)
- **1983** — 36' ROBIN Third, SORC • Cygnet Cup (NYYC)
- **1986** — 60' AMERICAN PROMISE World Record, Solo Circumnavigation
- **1986** — 38' PURITAN First overall, Newport-Bermuda Race
- **1989** — 54' CHASSEUR First in class, Marion-Bermuda Race
- **1990** — 54' CHASSEUR First in class, Newport-Bermuda Race
- **1991** — 58' INTEGRITY First in class, Marion-Bermuda Race
- **1992** — 52' FREESTYLE First overall, Newport-Bermuda Race

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