Yacht Racing Handicap Systems
Jim Teeters 12/2000

The Kamasutra lists 9 different categories of union between man and woman. In offshore racing there are at least as many handicap systems: PHRF, IMS, AMERICAP, Ratings Plus, ORC Club, Portsmouth Yardstick, IRM, IRC, and countless one design classes. They all have their adherents who are only too happy to praise the virtues of their chosen rule and disparage the others. And, just like in the Kamasutra, the whole thing can be quite confusing.

The goal of any boat handicap system is to provide an equal opportunity to all the members of its fleet to win races. Equal opportunity does not guarantee equal results. There are always differences in boat preparation, sailing skills, tactics, and luck that can determine the winners. Moreover, any rule has its own shortcomings or biases. This article will try to present the basics of handicapping boats and explain the principal features of the major rules available in the United States. The reader should come away with a better understanding of the racing options out there and which ones might be most attractive to him.

The systems currently in use tend to fall into one of the following 2 categories:

1. Those that attempt to handicap boats by observing actual performance.
2. Those that take measurements and use formulas to predict performance.

These are two very different philosophical viewpoints. The former, the observational, is intended to fairly handicap any and all boats. Race results are reviewed and ratings adjusted so that all boats have a reasonable chance at winning. Handicappers of observational systems must attempt to separate the inherent speed of a boat from the skills of the sailors, who could easily make a design look better or worse than it actually is.

The second approach, the predictive, takes measurements of those parameters that are thought to be important (length, weight, sail area, stability…) and uses formulas to assign ratings. Accurately predicting sail boat performance is quite complex and no set of measurements and formulas can be expected to treat all boats fairly, although that often is the stated goal.

In reality, these two approaches are just the extremes of a continuum of handicapping. There is no reason why you can't mix in a little of both: formulas moderated with a bit of the human touch. Either way, the rule is going to create some kind of rating that is used to give slow boats and fast boats equal chances of winning.

How do rules do this? They measure **elapsed time**, the clock difference between start and finish, and then make adjustments to get **corrected time.** The boat with the fastest corrected time wins. One method of adjustments is to predict a seconds/mile delta. This delta is multiplied by the number of miles raced, then added to the elapsed time to calculate the corrected time. For example, lets say that the rule has determined that boat A is faster than boat B by 10 sec/mile. If boat A finishes a 10 mile race in 2 hours, then boat B would be given a handicap delta of 10 miles multiplied by 10 sec/mile, which equals 100 seconds. For boat B to beat boat A, she would need to complete the race in 2 hours - 1 minute - and 40 seconds. This procedure is called **time-on-distance**. The distance of the race is used to compute the time deltas. It is customary in large fleets to assign each boat a rating; the deltas that boats owe each other are just the differences in ratings. In the above example, boat A could have a rating of 100 and boat B 110.

A rule that uses a single time-on-distance rating for each boat will not be able to incorporate the fact that in different wind strengths or courses, the actual performance deltas between boats will vary. If boat A owes B 10 sec/mi in 10 knots of wind on a windward/leeward course, who is to say what she owes in 20 knots or on a reach? The actual delta might even change sign with boat B owing time to boat A. Single rating systems cannot expect to be fair in any given race, but over the course of a season, as conditions average out, they should do a much better job. There are multiple rating systems that address this deficiency. More on them later.

An interesting alternative to time-on-distance is what is called **time-on-time**. The rating assigned to each boat is a factor, not a delta. The elapsed time is multiplied by the factor to calculate corrected time. Let's say boat A above had a rating factor of 1.00 and finished the course in 2 hours. Her corrected time would be 2x1.00 or 2 hours. Suppose boat B had a rating factor of .9863 and finished in the same 2 hours - 1 minute - 40 seconds (2.02778 hours). Her corrected time would be 2.02778x.9863 or exactly 2 hours. The boats have the same corrected time and would be tied. If boat B had finished 1 second earlier or had a smaller rating factor she would have won. Where time-on-distance says the <u>time delta</u> between 2 boats is always the same per mile, time-on-time says that the <u>time ratio</u> is always the same. If the same 10-mile race took 4 hours for boat A to complete (low wind, all upwind, adverse current), she would still owe boat B 100 seconds under time-on-distance. With time on time, boat B would need to finish within 4/.9863, or 4 hours - 3 minutes - 20 seconds, to tie. I.e., boat B now receives 200 seconds from boat B.

In this example, the time-on-time method looks very attractive because it incorporates some of the effects that wind, course and current have on performance. And indeed, time-on-time is quite popular in locales that have strong tides. But suppose the wind quits in the middle of a race. All the boats

just sit there. Under time-on-distance this has no effect. It is as if there were a half time show in the middle of the race. However, under time-on-time, the clock is ticking away and the slower boats are earning corrected time credit even though nothing is happening.

You might think that some combination of time-on-distance and time-on-time would be even better, and that is what some of the rules do. More on this later.

For any rating system to be successful, it must tailor its methods to the needs of the sailors who will use it. Just like rating systems, the sailing population seems to fall into 2 broad categories:

1. Those that want the rule to treat their existing boat fairly. This sailor does not want to make big modifications to his boat to fit the rule; the rule should change to fit his boat.
2. Those who want to design and optimize their boats against a rule. They don't want the rule to change every year. After all, how do you shoot a moving target?

For sure, categorizing people into 1 of 2 types is very simplistic and ignores a lot of other viewpoints that differentiate sailors and what they are looking for. However, it does serve as a model to help us understand whom a rating rule is best serving.

So who are the major handicap systems in the US and how do they develop and implement their ratings?

PHRF - This is currently the most popular rule in the US. It is a purely "observational" rule although IMS predictions are often used as a guide to rating new boats. It is implemented locally. A handicap committee periodically reviews the observed performance of each boat and assigns a rating. Boats that are modified are re-rated. The committee has available a national database of ratings that serves as a check to help separate the influence of crew skill.

Local control is a great asset of PHRF. Ratings can be tuned to local conditions. There is someone around who can explain the system and listen to complaints about ratings. This is important because the rating process is subjective and can appear to be political. And besides, we all like to blame the rule makers when we don't win.

Certificates are maintained for each boat. These contain the principal dimensions of the rig and hull, the weight, propeller type, etc. This is not enough data for a measurement rule, but it does serve to identify the boat configuration. For example, if an owner decides to change his sailplan, the handicap committee will track the change and use a guideline for assigning rating

adjustments for changes in boat configuration. There are handicappers who fit formulas to the certificate data, but PHRF is really an observational rule where boats that win too often are likely to hit with faster ratings. This makes it hard to design against the rule. One way to improve your chances is to find a stock boat that is not popular among the better racers and may have an attractive rating for a top-notch crew.

PHRF can have difficulty in rating new designs and may assign a conservative rating until such a boat has shown on the water what she can do. Standard production boats are easier to handicap because they often have a “history” of observed performance. Typically, PHRF uses single ratings, time-on-distance or time-on-time, with no variation for course or wind speed. This means that it is blind to crossovers in relative performance, as explained above. Some of the more sophisticated PHRF associations have developed multiple ratings to apply to different races. RATINGS PLUS, described below, is an attempt to help in that area.

PHRF is a very simple system to understand and is quite inexpensive. It is easy to know how you are doing on the race course. In time-on-distance, just take the time difference at a mark and compare it to the rating delta multiplied by the number of miles raced so far. If racing time-on-time, multiply each boats elapsed mark time by their handicaps and compare. In the author’s opinion, the rule is most appropriate for the casual racer on up to the serious racer who wants a simple rule and is not interested in “tweaking” the design configuration of his boat, i.e., the type 1 sailor above.

IMS - This is a pure measurement rule, a predictive system using detailed measurements of hull, appendages, rig, sails, flotation and stability. It incorporates simple physics into a computer code, the velocity prediction program (VPP), to translate those measurements into speeds. IMS is the most rational, scientific handicapping system yet devised and was intended to fairly handicap a diverse fleet of designs. It does a reasonable job of predicting relative performance between boats and is highly accurate at predicting speed differences due to wind and course changes. This permits choosing ratings that fit the race conditions.

IMS, as is the case in any measurement rule, has some degree of type-forming and is open to optimization. By intent, no credit is given for such things as unfair hull shapes, bad keel and rudder design, etc. The formulas that predict the aero and hydrodynamic characteristics of boats are, at best, only as good as the technical data on which they are based. However, IMS is a “living” rule that is being regularly improved with new research and development.

At the grand prix level, where IMS boats are highly optimized, the designs have type-formed into boats that have clean lines, perform well and are fun to race.

Boats in the cruiser/racer class receive a system of credits as compensation for the compromises inherent in a boat designed to cruise as well as race.

The measurement process of IMS is relatively expensive. Scoring is more complex because the rule makes full use of one of its greatest assets: the flexibility to use different rated speeds for different course and wind conditions. The higher levels of racing use what is called Performance Curve Scoring. The race committee picks the course content to be used. The VPP "sails" each boat over that course for a standard range of wind speeds. Boat speeds are usually expressed as seconds per mile. In theory, the race committee could pick a wind speed, evaluate each curve to get a sec/mile rating and use standard time-on-distance methods. In practice, the IMS uses an elegant concept that relieves the race committee from the onerous responsibility of picking the wind, and thereby the winner. Why not compute the average seconds per mile for each boat, interpolate each boat's performance curve at that sec/mile to get the average wind it must have been sailing at. The boat with the fastest average wind, termed implied wind, is the winner. Expressed differently, the guy that wins is the one that sailed so fast (or smartly) that it appears that he had the greatest wind. In fact, if the race committee provides a scratch sheet with sec/mile ratings for all the boats at each of the standard wind speeds, then it is easy for a competitor to interpolate by hand and see how he is doing at any mark, much the way described for PHRF above.

Interestingly, this performance curve scoring is a combination of time-on-time and time-on-distance. A longer race or a slower one both give greater time allowances. In a relatively new development, IMS is offering Performance Line Scoring, a simplification first implemented by AMERICAP. The curve of sec/mile vs. wind speed is replaced by a straight-line approximation. This is even easier to evaluate on the race course. In fact, using a little high school algebra, the IMS recasts the straight line formula as A x elapsed time + B x distance, trivial to compute and a clear expression of the time-on-time and time-on-distance elements.

IMS works best for boats that are well designed and are not penalized by biases in its VPP. It appeals to owners who do not like the subjective aspect of observational rules like PHRF. Yes, understanding and using the system requires more effort on the part of both rule administrators and competitors. However, it ultimately provides the most accurate scoring with variations in wind speed and direction. At the grand prix level, it allows owners to organize teams of designers, builders and sailors that seek ways to optimize against the VPP. In the cruiser/racer class, it provides sufficient accuracy to permit a wide diversity of boats to race fairly.

AMERICAP - This was intended by US Sailing as a simplified version of IMS, targeted for the cruiser/racer. It uses IMS style measurements or boat lines

provided by the designer, a secret VPP, and performance line scoring that can easily be evaluated while racing. Once a production boat has been measured, subsequent boats need not do so. A noteworthy difference from IMS is that AMERICAP utilizes experience-related formulas to counteract the biases in its VPP.

AMERICAP is relatively inexpensive, once a sister boat has been measured. The rule is appropriate for the sailor who wants a measurement rule that has simple scoring and is more tolerant of non-optimal designs. Pick a boat that already has an IMS or AMERICAP certificate and save

RATINGS PLUS is a service that US Sailing offers to local PHRF committees. It uses a VPP to predict changes in performance with changes in course content or wind speed. These changes are added to the base ratings to produce new ratings for specific course/wind scenarios. Since the VPP is only required to give performance deltas, it can use a very simple representation of the hull, appendages and rig. In fact, it creates these using only the data on a PHRF certificate.

RATINGS PLUS is clearly a blend, a mix of the observational and the predictive. It should appeal to PHRF sailors who would like more equitable ratings when the course and wind content are substantially different from the norm. Scoring can be either time-on-distance or time-on-time.

ORC Club is a relatively new offering from the Offshore Racing Council, the organization that maintains the IMS rule. In fact, ORC Club is an “entry level” version of IMS. Boats need not be measured. A quick and jiffy (inexpensive) VPP model of the boat is crafted by identifying similar boats and developing representative offsets files. If there is no stability information, and estimation is used. ORC Club uses performance line scoring. As its name suggests, the rule is targeted for the more casual, club sailor who would prefer something akin to a measurement rule.

IRC is popular in Britain and France. It is a mix of observational and measurement. The measurements, which include weighing boats, are relatively simple and inexpensive. What the rule does with those measurements is a secret. IRC is a single number system that typically uses time-on-time. Its appeal is likely very similar to that of PHRF in the United States: low cost and simplicity. Because it does use measurements, it is open to design optimization, at least until the “secret process” closes the loopholes that arise.

IRM is intended as a rule for grand prix type sailing. The formulas are public and it is anticipated that the sailors will aggressively seek to beat the rule. The boats will likely type form rapidly. Like IRC, this is a single number system with time-on-time scoring that can be converted to a time-on-distance format. IRM

has not really caught on yet and only time will tell if it ever develops a sizable fleet.

So there you have it: time-on-time vs. time-on-distance, single vs. multiple-rating scoring, simple vs. complex, cheap vs. expensive, any good boat vs. optimized design, casual vs. intense vs. very very intense. We are clearly in period of many options for offshore handicapping. Even more rules and rating services compete for sailors.

Finding the right rule for you and your boat is much like a marriage. There is no such thing as perfection. You need to review the pros and cons with a cool, rationale intellect, yet go with your gut instinct and what looks attractive. There can be a wonderful honeymoon of great racing (winning more than your share) or an abrupt disenchantment (losing more than…) The rule needs to fit your pocketbook as well as your outlook on sailing and the commitment to racing you are willing to make. In the end, you must be willing to accept the flaws in your choice, adapt your expectations to what is realistic, and work with the volunteers who run it. Finally, embrace your rule with loving arms, for an unfair rating (yours) makes for great bar talk.