Article 2.2

Formulae and Variables

A formula of the form

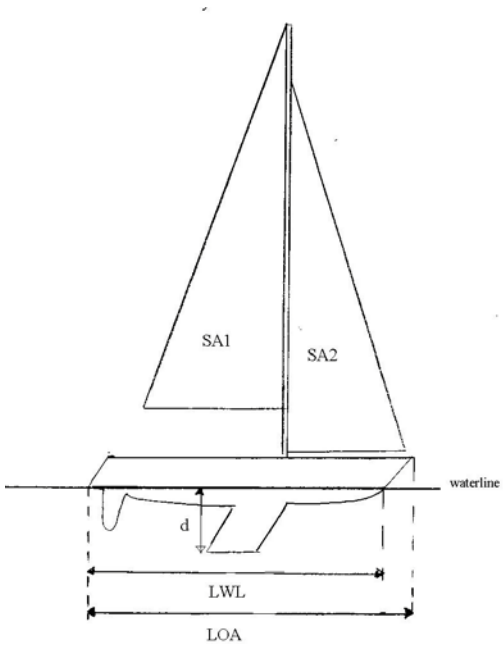
$$HN = (a_0 + a_1 X_1 + a_2 X_2 ..... + a_n X_n) f_q$$

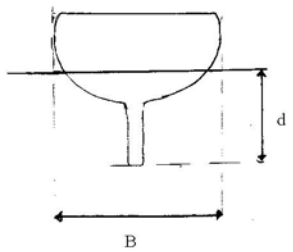
has been shown to be an effective model for HN = handicap number. The $\{X_i\}$ are functions of boat measurements, but the best form of these is neither obvious or straightforward. Qualitative factors, such as engine/propeller type, age and type of sails, construction type etc., may be accounted for and generally it is best that such factors are accommodated by multiplicative terms, symbolised here by f_q.

Basic boat measurements are depicted in the schematic below.

Basic variables

LOA = overall length	*D* = displacement
LWL = waterline length	*SA*1 = area of mainsail
d = draft	*SA*2 = area of largest foresail
B = beam	*SA* = *SA*1 + *SA*2





Such boat measurements are readily to hand for the majority of boat owners - they are found in boat brochures/manuals or in online archives. It must be remembered that for such handicap formulae to be used easily by sailing clubs, getting the data must be simple, as well as application of the algorithm.

There are a number of functions of these basic variables that are well known indicators of performance potential.

For example, the maximum hull speed of a boat sailing by displacement (as opposed to planing, for example) is proportional to the square root of waterline length (LWL). Specifically, $V = 2.42\sqrt{LWL}$, where V is in knots and LWL in metres. This is the reason for some modern cruiser-races having a rather more vertical bow profile than in traditional design, in an attempt to increase speed whilst not increasing overall boat length.

The *power-to-weight ratio* is another popular performance reference (often quoted by magazine reviews). Some yachting literature will refer to this as $\frac{SA}{D}$, which is potentially misleading. First, 'D' is in effect $D^{2/3}$ and 'SA' is often not the actual sail area, but the area of the main and foresail "triangles", which is essentially about rig dimensions.

Such ratios are 'dimensionless' in that the units of measurement effectively disappear. SA is a 'square' unit of measurement, and so is $D^{2/3}$. It is possible therefore for a small boat to have the same power-to weight ratio as a large boat.

Handicap formulae tend to have a mix of variables. Some in units that represent size (e.g. $\sqrt{LWL}$) and some that are not a direct reflection of size (e.g. $\frac{SA}{D^{2/3}}$).

There are two key difficulties to be addressed in the task of producing a handicap model. One is the high degree of correlation between boat measurements e.g. in general, the longer a boat, the larger the sail area, and this is a statistical problem (See Article 3.1). The other issue is that of determining the best functions of the basic measurements (from a very large number of possibilities) to be the $\{X_i\}$. There is no magic process for this - it relies on knowledge of boat design, experience and some experimentation.