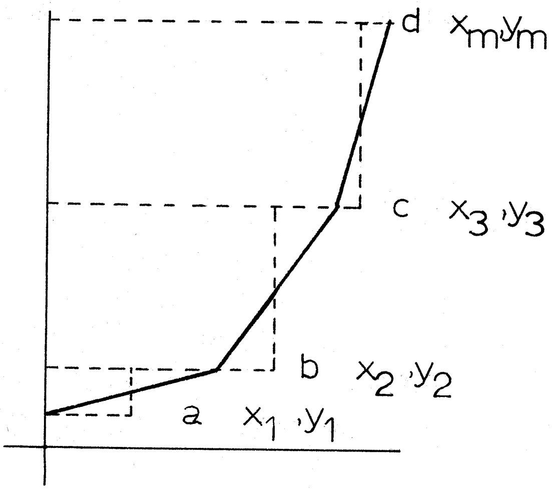
Appendix II. Computer program mathematical calculations

MC1 — $\frac{1}{2}$ STATION X-SECTION AREA (SAREA)



$$SA = \sum_{i=1}^{m-1} \left(\frac{x_i + x_{i+1}}{2}\right)\left(y_{i+1} - y_i\right)$$

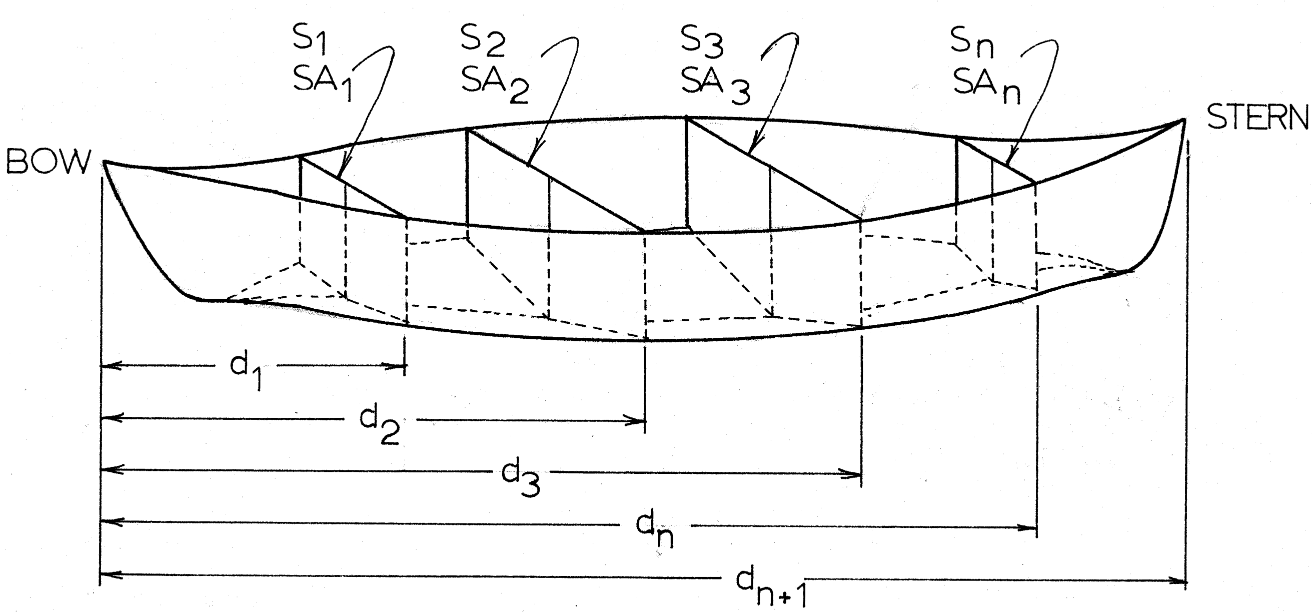
for $m > 1$

$SA = 0$ for $m = 1$

where m number of sets of x,y coordinates on x-section

Where hull is rounded and not multi-chined, greatest accuracy is obtained using as many sets of x,y coordinates as possible (up to 9 sets allowed)

MC2 — TOTAL DISPLACEMENT (DISP)



Appendix II. continued

$$D=\sum_{i=2}^{n}\left(SA_i+SA_{i-1}\right)\left(d_i-d_{i-1}\right)+SA_1\cdot d_1+SA_n\cdot d_{n+1}$$

where SA =1/2 area of cross-section
n =number of cross-section stations, d_{n+1} = total boat length (LOA)
and d =station distance from bow

Note: Areas of bow and stern cross-sections are assumed to be zero

MC3 --- $\frac{1}{2}$ CIRCUMFERENCE OF X-SECTION (CIRC)

$$C=X_m+\sum_{i=2}^{m}\sqrt{(y_i-y_{i-1})^2+(x_i-x_{i-1})^2}$$

where m = number of sets of x,y coordinates on cross-section

MC4 --- TOTAL SURFACE AREA (TSURA)

$$TSURA=C_1\cdot d_1+\sum_{i=1}^{n}(C_i+C_{i+1})(d_{i+1}-d_i)$$

where C = 1/2 circumference of cross-section,
d = station distance from bow
and n = number of stations

Appendix II. continued

MC5 --- TOTAL BOAT MOMENT (QM)

$$QM = \frac{S_1 \cdot W \cdot d_1}{2 \cdot T} + \sum_{i=2}^{n+1} \frac{S_i \cdot W}{T}\left(\frac{d_i + d_{i-1}}{2}\right)$$

where S = surface area between two stations,
W = total weight of boat,
d = station distance from bow,
T = total boat surface area,
and n = number of stations

MC6 --- FUNCTION (FUNC)

$$F = \left(-\mathrm{TAN}\,\theta \cdot d_i\right) + y_i - C \qquad \text{for } i = 1,n$$

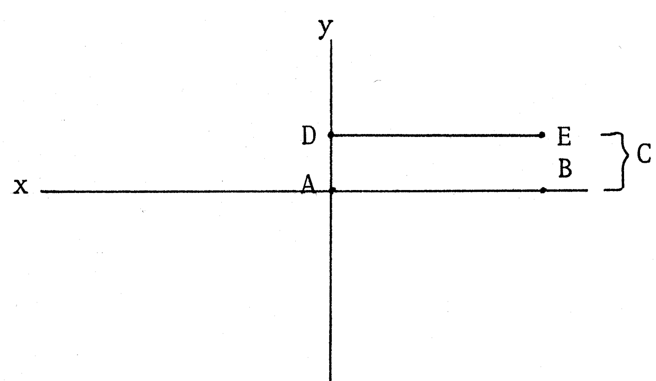
where θ = angle between datum line and waterline,
d = station distance,
c = constant,
and n = number of stations

This locates first closest hull station within ± 3 cm of longitudinal datum line.

This function is derived from the following:

a line AB on the x-axis is defined by:

1.) gx + y = 0 where g=0

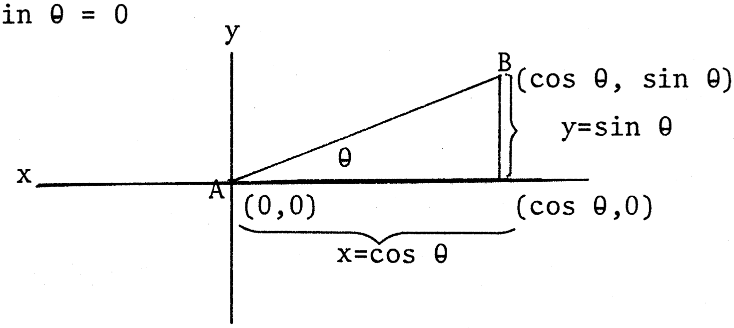


Line DE, parallel to AB is defined by:

2.) $gx + y = C$ where C is a constant

Similarly, a line AB passing through the x,y axes may be defined trigonometrically by:

3.) $g \cos \theta + \sin \theta = 0$



$$g = \frac{-\sin \theta}{\cos \theta} = -\tan \theta$$

substituting $-\tan \theta$ for g in 3.) above,

$$-\tan \theta \cos \theta + \sin \theta = 0$$

since $x = \cos \theta$ and $y = \sin \theta$,

$$-\tan \theta \, x + y = 0$$

For DE parallel to AB,

$-\tan \theta \, x + y = C$ and our function F therefore is:

$$F = -\tan \theta \, x + y - C$$

MC7 — — — UNLOADED VESSEL WATERLINE Y COORDINATES

FROM $-\text{TAN}\, \emptyset \cdot x + y = C$

$y = C + \text{TAN}\, \emptyset \cdot x$ for each station

Appendix II. continued

MC8 --- WETTED SURFACE AREA (IN SQUARE METERS)

$$WSA = \frac{TWSURA}{1000}$$

where TWSURA = total waterline surface in centimeters squared

MC9 --- VERTICAL CENTER OF GRAVITY (VCG)

$$VCG = \left[WMDIP_1 \left(\frac{\frac{y_{1,1}+y_{1,NP_1}}{2} + \frac{YB}{2}}{2} \right) + WMDIP_{n+1} \left(\frac{\frac{y_{n,1}+y_{n,NP_n}}{2} + \frac{YS}{2}}{2} \right) + \sum_{i=2}^{n} WMDIP_i \left(\frac{\frac{y_{i,1}+y_{i,NP_i}}{2} + \frac{y_{i-1,1}+y_{i-1,NP_i}}{2}}{2} \right) \right] \div TKW$$

where i = station number,
n = number of stations,
TKW = total boat weight,
NP = number of x,y coordinates for station i,
YB = y coordinate at bow,
YS = y coordinate at stern,
n+1 = total boat length

and $WMDIP_i = \frac{S}{TSURA} \cdot QW$

where S = sum of the 1/2 station circumferences times the difference of the station distances from the bow,
TSURA = total boat surface area
and QW = total unloaded boat weight

Appendix II. continued

MC10 --- LONGITUDINAL CENTER OF GRAVITY (LCG)

$$LCG = \frac{\text{TOTAL KAYAK MOMENT}}{\text{TOTAL KAYAK WEIGHT}}$$

MC11 --- LONGITUDINAL CENTER OF BUOYANCY (LCB)

$$LCB = \frac{\sum_{i=1}^{m} (SMD_i)(SV_i)}{TWD}$$

where SMD = waterline section midpoint distance from bow,
SV = waterline section volume in cm^3,
TWD = total waterline volume in cm^3,
and m = number of waterline stations

MC12 --- VERTICAL CENTER OF BUOYANCY (VCB)

$$VCB = \sum_{i=1}^{m} \frac{(SMY_i)(SV_i)}{TWD}$$

where SMY = waterline section y midpoint from hull,
SV = waterline section volume in cm^3,
TWD = total waterline volume in cm^3
and m = number of waterline sections

MC13 --- HULL SPEED IN KNOTS

$$SPEED = 1.25\sqrt{\frac{WLL}{30.48}}$$

where WLL = waterline length in cm

Appendix II. continued

MC14 --- SPEED/LENGTH RATIO AT 5 KNOTS (SLR)

$$SLR = \frac{5}{\sqrt{\frac{WLL}{30.48}}}$$ where WLL = waterline length in cm

MC15 --- FRICTIONAL RESISTANCE AT 5 KNOTS (FR)

$$FR = SPEED^{1.83} \cdot WSA \cdot C$$

where SPEED is in knots,
WSA = wetted surface area in square feet
and C is a constant that = :
.012 for craft with WLL < 12'
.011 for craft with WLL ≥ 12' and < 24'
.010 for craft with WLL ≥ 24'

MC16 --- MAXIMUM SECTION COEFFICIENT (C_m)

$$C_m = WXSA\left(X_W \cdot Y_W\right)$$

where WXSA = waterline area in cm^2 at center of gravity cross-section,
Xw = waterline beam in cm at center of gravity cross-section,
and Yw = hull to waterline distance in cm at center of gravity cross-section

MC17 --- BLOCK COEFFICIENT (C_b)

$$C_b = WDIS \times WLL \times X_W \times Y_W$$

where WDIS = displacement in ml,
WLL = waterline length in cm,
Xw = waterline beam in cm at center of gravity cross-section,
and Yw = hull to waterline distance in cm at center of gravity cross-section

Appendix II. continued

MC18 --- PRISMATIC COEFFICIENT (C.P)

The prismatic coefficient is the ratio of the immersed volume of a vessel to the product of its waterline length and immersed area of maximum section.

$$C.P = \frac{TWD}{WSA\left(\frac{WLL}{1000}\right)}$$

where TWD = total waterline displacement in liters,
WSA = waterline section area in cm^2,
and WLL = waterline length in cm

Good sailboats vary between CP's of .55 and .49. The higher the value, the more tub-like the hull; conversely, the lower the value, the finer the ends.

MC19 --- DISPLACEMENT/LENGTH RATIO (DLR)

$$DLR = \frac{BW}{(.01\,WLL)^3}$$

where BW = boat displacement in long tons (2240 lbs.),
and WLL = waterline length in feet