SPECIAL ARTICLE

THREE SURVEY PROBLEMS

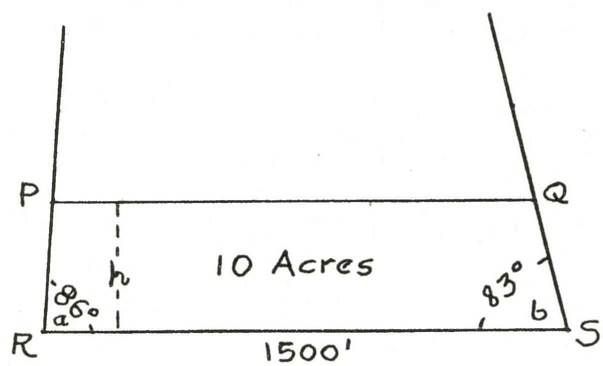
by A.C. McEwen *

The solution to the following problems, though by no means original, are not treated in the textbooks normally brought to the attention of the O. L. S. student. Problem 1 is very common in ordinary practice where it is often solved by trial and error. The remaining problems are of frequent occurrence where a co-ordinate system is used.

PROBLEM 1

Given: RS = 1500', a = 86°, b = 83°

Required: To cut off an area of 10 acres with a line PQ, drawn parallel to RS



Solution:

$$\text{Area} = \frac{PQ + RS}{2}h$$

$$2\,\text{Area} = \left(2RS - h(\cot a + \cot b)\right)h$$

$$h^2(\cot a + \cot b) - 2RSh + 2\,\text{Area} = 0$$

$$0.1927114h^2 - 3000h + 871200 = 0$$

Solving by quadratic formula gives h = 296.03'

From which PQ, PR and QS can be easily obtained.

Note: Another method would be to produce PR and QS to intersection and to proportion the areas and the squares of the sides of the two similar triangles. But this involves unwieldy computation where, as in this instance, angles a and b are fairly close to 90°

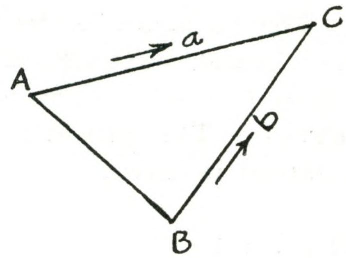
PROBLEM 2

Given: Plane Co-ordinates of A and B (Easting and Northing)

$E_A = 6897.82 \qquad N_A = 7120.48$

$E_B = 7357.44 \qquad N_B = 6734.81$

a = Bearing AC = 75°, b = Bearing BC = 30°



Required: Co-ordinates of C

Note: One method of solution would be to obtain length and bearing of AB from difference in co-ordinates, then solve Δ ABC by sine law and, finally, compute the co-ordinates of C. A much simpler solution is possible with the "short cotangent formula", the proof of which is rather long for inclusion here but which gives:-

$$E_C = \frac{E_A \cot a - E_B \cot b - N_A + N_B}{\cot a - \cot b}$$

$$N_C = \cot a\,(E_C - E_A) + N_A \text{ or } N_C = \cot b\,(E_C - E_B) + N_B$$

Solution:

$E_A \cot a = 6897.82 \times .2679492 = 1848.26$

$E_B \cot b = 7357.44 \times 1.7320508 = \underline{12743.46}$

$E_A \cot a - E_B \cot b = -10895.20$

$- N_A \qquad \underline{7120.48}$

$= -18015.68$

$+ N_B \qquad \underline{6734.81}$

$= -11280.87$

$\cot a - \cot b = -1.4641016$

$$E_C = \frac{-11280.87}{-1.4641016} = \underline{\underline{7704.98}}$$

$\cot a\,(E_C - E_A) = 216.28$

$+ N_A \qquad \underline{7120.48}$

$N_C = \underline{\underline{7336.76}}$

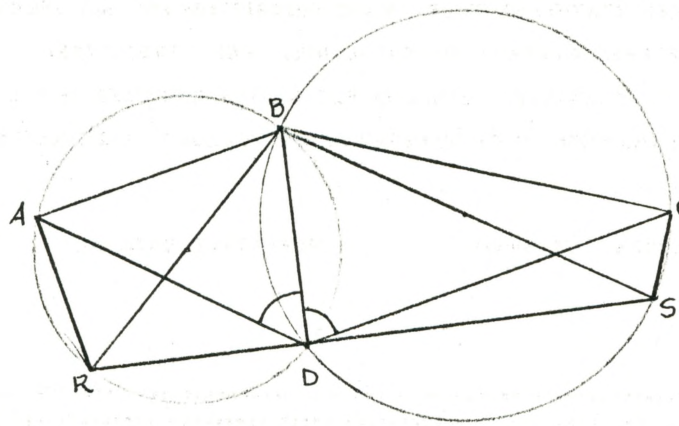
When using this formula care must be taken to use the correct quadrantal sign for the cotangents of the bearings.

PROBLEM 3

Given: The relationship between three points, A, B and C, Angles ADB and BDC

Required: Position of D

Note: This is the resection or three-point problem, for which there are several methods of solution. The method suggested here is easier to remember than some others. $\triangle$ s ABD and BCD must be well-conditioned or the solution will be weak.



Solution: D lies at the intersection of two circles which pass respectively through the points A, B & D and B, C and D. From B draw the diameter of each circle.

By construction $\angle BDR = \angle BDS = 90^{\circ} = \angle BAR = \angle BCS$

$\angle ARB = \angle ADB$ $\quad\quad$ $AR = AB \cot ADB$

$\angle BSC = \angle BDC$ $\quad\quad$ $CS = BC \cot BDC$

Solve for bearing of RS by "missing course" method

Bearing BD = bearing RS $\pm$ 90°

$\triangle$s ABD and BCD can now be solved by the sine law or, if the plane co-ordinates of A, B and C are known, the co-ordinates of D can be computed directly by the cotangent formula given in Problem 2.

* *A.C. McEwen, O.L.S., D.L.S., A.R.I.C.S., is the author of the report on "The Survey of the Seychelles Archipelago" published in the April issue of "The Ontario Land Surveyor".*