In the November, 2008 issue of The American Surveyor magazine article “Hidden Point Offset” written by Shawn Billings, LS was given a detailed explanation of the procedure that he offers to use to calculate hidden point’s coordinates. While his method is acceptable I believe that a same problem can be solved much quicker and easier by employing the following method:

Let’s say, a tree, pole or other vertical obstruction is blocking a view to the property monument and we want to find coordinates of that monument without an additional traverse point (please see Fig.1).
Using tape or string containing a knot we can install 3 temporary spikes at equal dimensions (radius) from the monument thus putting these spikes on the circle with radius point located exactly at the subject monument and making sure that the spikes are clearly visible from the instrument.
The next step is to obtain the side shots to the spikes. When points are downloaded to Auto-Cad or other graphic software we can simply construct a circle by using Draw Circle through 3 points.
Once a circle is drawn we can easily obtain coordinates of its center from the drawing.

However, in an unlikely case when no computer graphic software is used, then the center of the circle’s coordinates can be calculated as follows:

The equation of the circle is:

$$(n-N)^2 + (e-E)^2 = r^2$$

Where n and e are coordinates of the points on the circle, r is the radius of the circle and N & E are the coordinates of the center of the circle. N, E and r will be unknowns if string containing a knot was used to maintain equal dimensions from the monument to the spikes instead of using a tape.

Since there are 3 points, we will have 3 sets of the coordinates.

The circle will be described by 3 independent equations as follows:

- $(n_1-N)^2 + (e_1-E)^2 = r^2$ or $n_1^2-2n_1N+N^2+e_1^2-2e_1E+E^2=r^2$ (1)
- $(n_2-N)^2 + (e_2-E)^2 = r^2$ or $n_2^2-2n_2N+N^2+e_2^2-2e_2E+E^2=r^2$ (2)
- $(n_3-N)^2 + (e_3-E)^2 = r^2$ or $n_3^2-2n_3N+N^2+e_3^2-2e_3E+E^2=r^2$ (3)

In order to solve these equations first step is to subtract third equation from first and second equations:

$$\frac{n_1^2-2n_1N+N^2+e_1^2-2e_1E+E^2=r^2}{n_3^2-2n_3N+N^2+e_3^2-2e_3E+E^2=r^2} = n_1^2-n_3^2-2n_1N+2n_3N+e_1^2-e_3^2-2e_1E+2e_3E=0 \quad (4)$$

$$\frac{n_2^2-2n_2N+N^2+e_2^2-2e_2E+E^2=r^2}{n_3^2-2n_3N+N^2+e_3^2-2e_3E+E^2=r^2} = n_2^2-n_3^2-2n_2N+2n_3N+e_2^2-e_3^2-2e_2E+2e_3E=0 \quad (5)$$

We can simplify equations (4) and (5) as follows:

$$n_1^2-n_3^2-2n_1N+2n_3N+e_1^2-e_3^2-2e_1E+2e_3E=0 \quad (4)$$

$n_1^2-n_3^2+e_1^2-e_3^2 = A_1$
$n_3 - n_1 = B_1$
$e_3 - e_1 = C_1$

$$A_1 + 2NB_1 + 2EC_1 = 0$$

$$n_2^2-n_3^2-2n_2N+2n_3N+e_2^2-e_3^2-2e_2E+2e_3E=0 \quad (5)$$

$n_2^2 - n_3^2 + e_2^2 - e_3^2 = A_2$
$n_3 - n_2 = B_2$
$e_3 - e_2 = C_2$

So equations (4) and (5) can de expressed as follows:

$A_1 + 2NB_1 + 2EC_1 = 0$ (4)
$A_2 + 2NB_2 + 2EC_2 = 0$ (5)

$A_1/2B_1 + N + EC_1/B_1 = 0$ (4)
$A_2/2B_2 + N + EC_2/B_2 = 0$ (5)

Let's solve this problem using coordinates of the points 1, 2, 3 as shown on Fig, 1.

$n_1 = 100$; $e_1 = 0$;
$n_2 = 200$; $e_2 = 100$;
$n_3 = 138.26834324$; $e_3 = 192.38795325$;

$A_1 = n_1^2 - n_3^2 + e_1^2 - e_3^2 = 100^2 - 138.26834324^2 + 0^2 - 192.38795325^2 = -9109.827587 - 37013.14254 = -46,131.25929806$
$B_1 = n_3 - n_1 = 138.26834324 - 100 = 38.26834324$
$C_1 = e_3 - e_1 = 192.38795325 - 0 = 192.38795325$

$A_2 = n_2^2 - n_3^2 + e_2^2 - e_3^2 = 200^2 - 138.26834324^2 + 100^2 - 192.38795325^2 = -6,131.25929806$
$B_2 = n_3 - n_2 = 138.268343243244 - 200 = -61.73165676$
$C_2 = e_3 - e_2 = 192.38795325 - 100 = 92.38795325$

$A_1/2B_1 = -602.73394916$
$C_1/B_1 = 5.02733949$
$A_2/2B_2 = 49.66057627$
$C_2/B_2 = -1.49660576$

$49.66057627 + N + (-1.49660576)*E = 0$ (5)

$-602.73394916 + N + 5.02733949*E = 0$ (4)

Subtract (4) from (5)

$49.66057627 + 602.73394916 = 6.52394525 * E$, and solve foe E;

E = 100.00

N = $-49.66057627 + (1.49660576)*100 =$ **100.00**

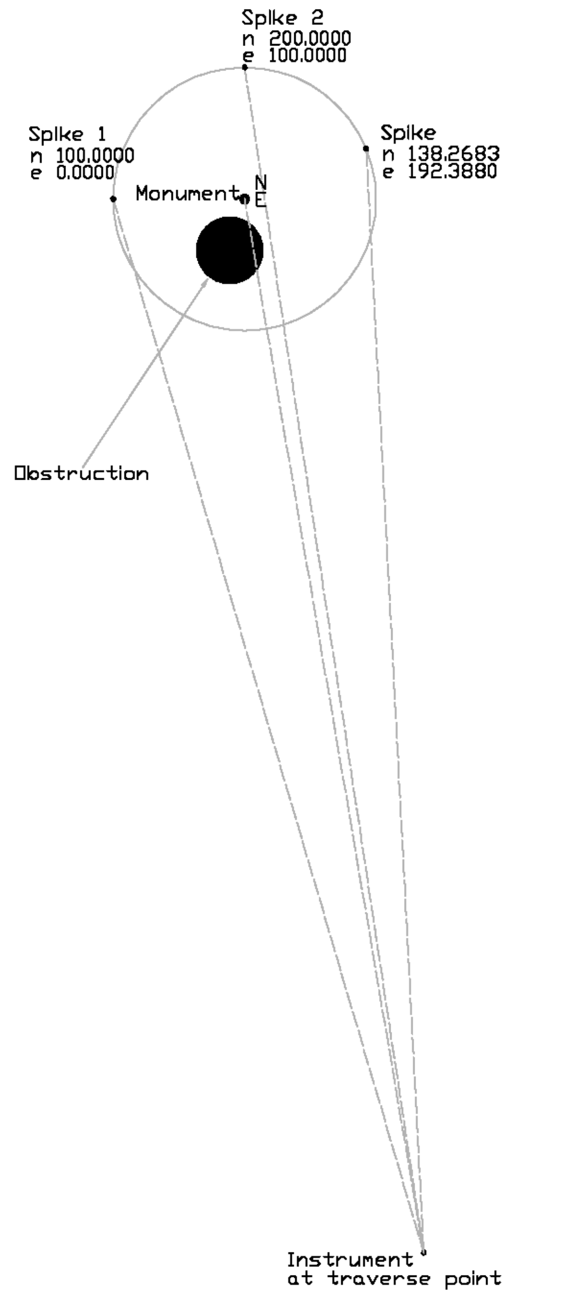
Calculated coordinates of the center of the circle:

N=100.00
E=100.00

In order to find out an elevation of the monument we can simply stretch a string with the line level on it and measure h using a tape, (please see Fig. 2)
Monument Elevation = Spike Elevation + h.

This method of finding elevation is acceptable for topographic survey since accuracy of the monument elevation will be comparable with the accuracy of the elevation of the spike(s) obtained by the side shot.

Albert Avanesyan P.S., P.E.



Spike 2
n 200.0000
e 100.0000
Spike 1
n 100.0000
e 0.0000
Spike
n 138.2683
e 192.3880
Monument
N
E
Obstruction
Instrument
at traverse point

Fig. 1

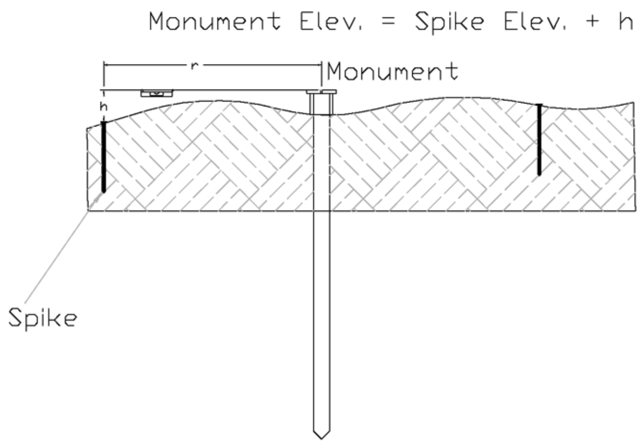


Fig. 2