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Traverse Calculations

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IWORDS ACADEMY
School for the smarties

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- **www.youtube.com/@IwordsShotsEmpire**

Traverse Calculations

- Determine Angular Misclosure
- Balance Angular Misclosure
- Determine Directions of Sides
- Latitudes and Departures
- Determine Linear Misclosure
- Adjust Linear Misclosure
- Determine Area Enclosed

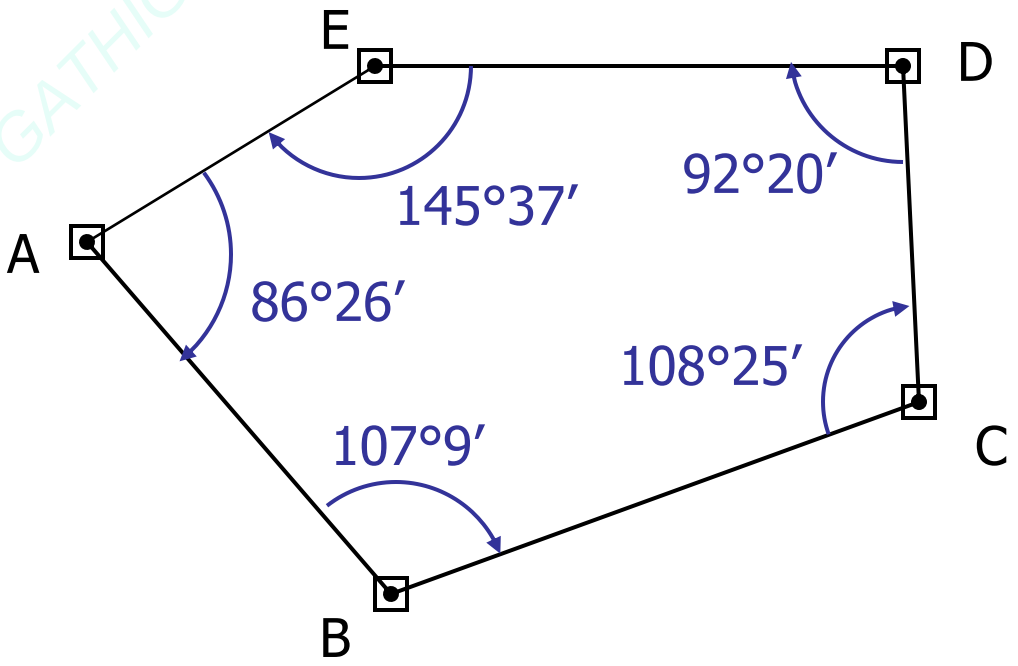
Angular Misclosure

- Total = (n-2)(180)
- n = 5, Total = 540°

86°26′
+ 107°09′
+ 108°25′
+ 92°20′
+ 145°37′
= 539°57′

Misclosure = -3′

Acceptable?



Balance Angular Error

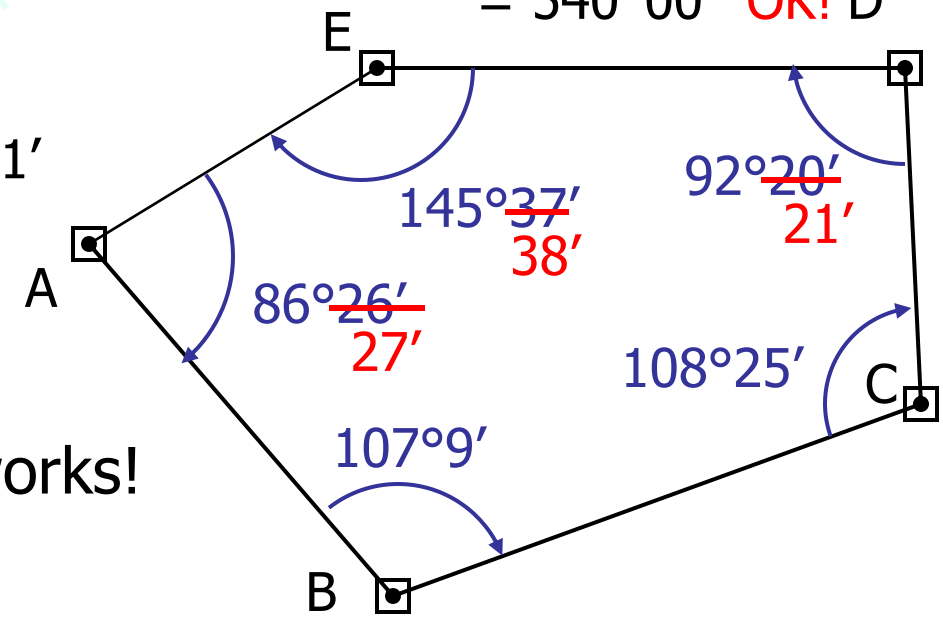
- Contribution to Error
  - Angles not consistent – more work
    - Assign contribution - C
    - Correction = C*(-error/ΣC)
    - Say angle A, B turned twice; C,D, E 4 times
      - A & B are twice as likely to contribute to error
        $C_A = C_B = 2$, $C_C = C_D = C_E = 1$, $\Sigma C = 7$
      - Correction = C*(3′/7) = 26″*C
      - $Corr_A = Corr_B = 51''$, $Corr_C = Corr_D = Corr_E = 26''$
  - Much easier if all angles contribute equally

Balancing Angular Error

- Assuming all work is consistent
  - E = error, n = number of angles
  - Correction = -E/n
  - Reflect precision
    - C = -(-3′)/5 = 36″
    - Work recorded to 1′
    - Adjust 3 by 1′
    - Shortest shots
    - Add 1′ to A, E, D
  - Check that total works!

$$
\begin{aligned}
&86°27′\\
+\ &107°09′\\
+\ &108°25′\\
+\ &92°21′\\
+\ &145°38′\\
\hline
=\ &540°00′
\end{aligned}
$$

OK! D



Determine Directions of Sides

- Use Adjusted Angles
- $Az_{BC} = BackAz_{AB} + ABC$

$AZ_{AB} = 141°45'$

$AZ_{BC} = 321°45' + 107°9' = 68°54'$

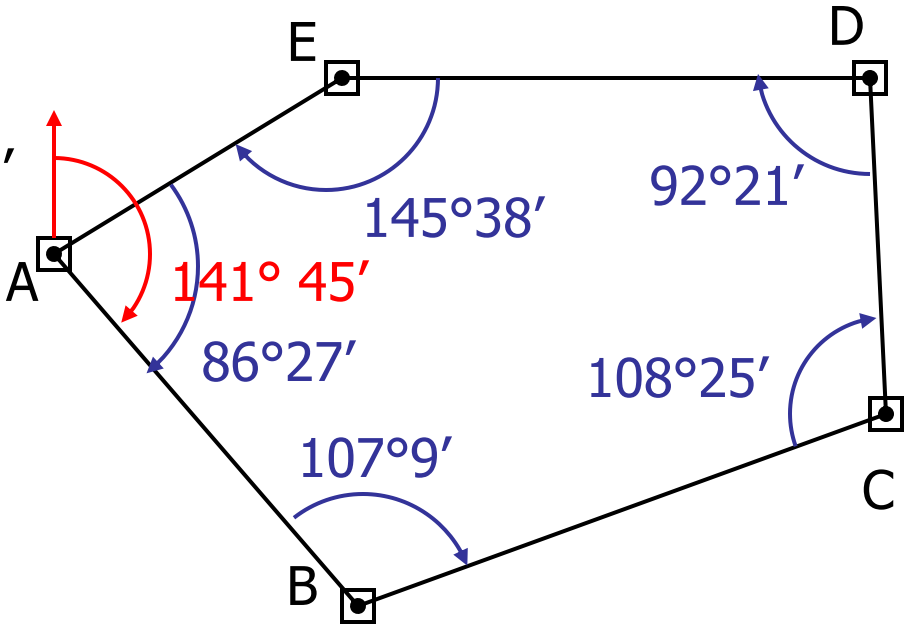
$AZ_{CD} = 248°54' + 108°25' = 357°19'$

$AZ_{DE} = 177°19' + 92°21' = 269°40'$

$AZ_{EA} = 89°40' + 145°38' = 235°18'$

Check that last angle!

$AZ_{AB} = 55°18' + 86°27' = 141°45'$



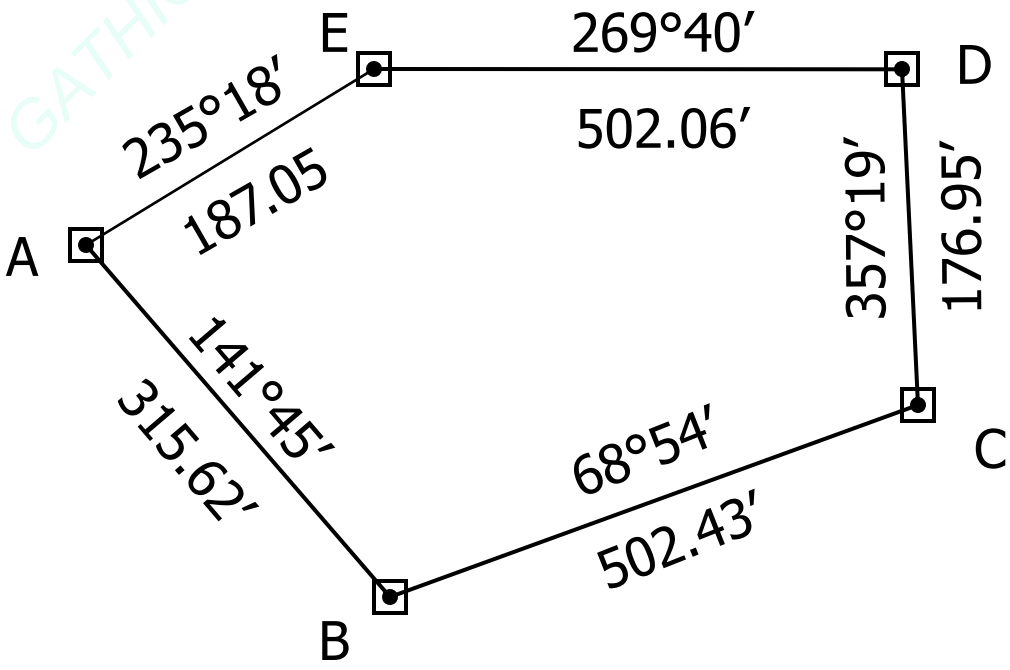
Latitudes and Departures

- Latitude = Length*Cos(Az or Bearing Angle)
- Departure = Length*Sin(Az or B.A.)

Lat_{AB} = 315.65 Cos(141°45′)
= -247.86

Dep_{AB} = 315.65 Sin(141°45′)
= 195.40

Check your calculator:
polar -> rectangular key!

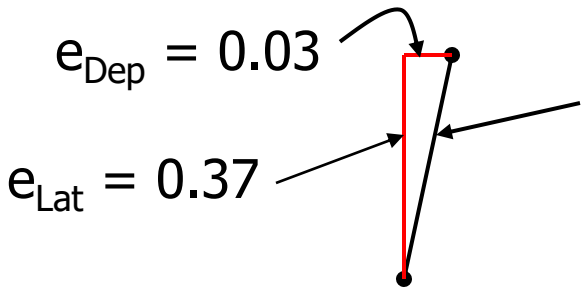


Latitudes and Departures

Side	Length	Azimuth	Latitude	Departure
AB	315.62	141°45′	-247.86	195.40
BC	502.43	68°54′	180.87	468.74
CD	176.95	357°19′	176.76	-8.28
DE	502.06	269°40′	-2.92	-502.05
EA	187.05	235°18′	-106.48	-153.78
	1684.11		0.37	0.03

Determine Linear Misclosure

- You should end up where you started
  - Sum of Lat's = 0
  - Sum of Dep's = 0
- Linear Misclosure (error)
  - A line connects starting and ending point
  - Linear error = length of line



$$e_{Lin} = \sqrt{e_{Lat}^2 + e_{Dep}^2}$$

$$= \sqrt{0.36^2 + 0.03^2} = 0.37$$

Relative Error

- Is the linear error acceptable?
- Relative Error
  - Relates error to total distance surveyed
  - Expressed as 1/xxxx

$$RE = \frac{e_{Lin}}{\Sigma Length} = \frac{0.37}{1684.11} = \frac{1}{4550}$$

Adjust Linear Error

- Transit rule
  - When angles are more accurate than distances
  - Proportion L error based on total N-S distance
  - Proportion Dep error based on total E-W distance
- Compass Rule – more common
  - Assumes angles are as accurate as distances
  - Proportion both errors based on total distance
- Least-Squares
  - Uses square roots of sums of Lats and Deps
  - Typically requires computer program

Adjust Linear Error

- Compass Rule
  - Proportion Lat, Dep error to length of side

$$\Delta Lat = Length \cdot \left(\frac{-e_{Lat}}{\Sigma Lengths} \right) \qquad \Delta Dep = Length \cdot \left(\frac{-e_{Dep}}{\Sigma Lengths} \right)$$

$$\Delta Lat_{AB} = 315.62 \cdot \left(\frac{-0.36}{1684.11} \right) = -0.07$$

$$\Delta Dep_{AB} = 315.62 \cdot \left(\frac{-0.03}{1684.11} \right) = -0.006 \approx -0.01$$

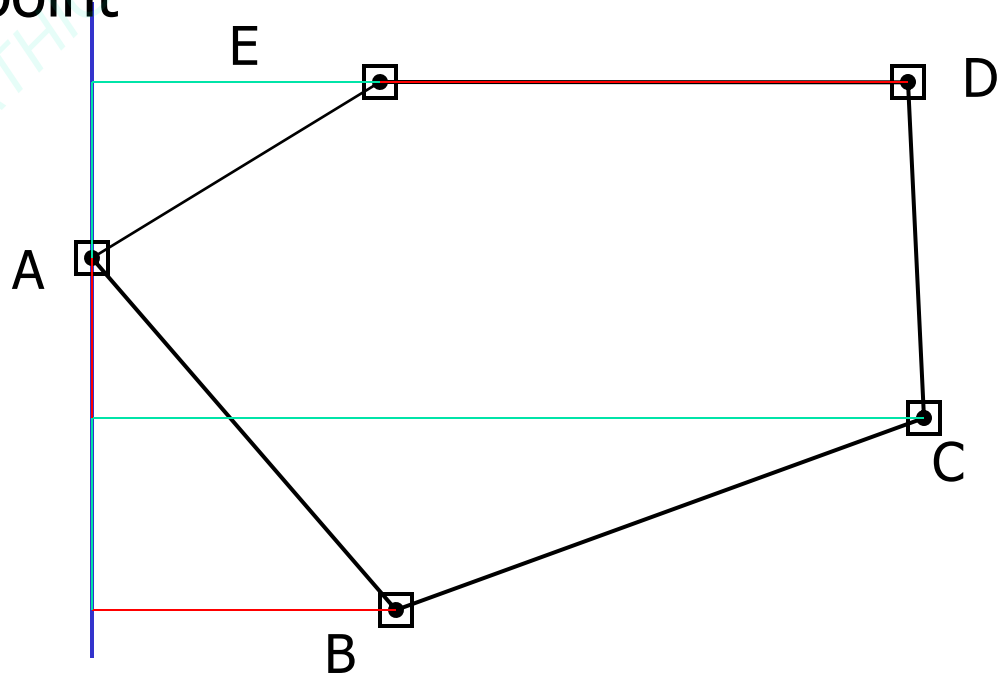
Adjusting Lat's and Dep's

Side	Length	Lat	ΔLat	Adj'd Lat	Dep	ΔDep	Adj'd Dep
AB	315.62	-247.86	-.07	-247.93	195.40	-.01	195.39
BC	502.43	180.87	-.11	180.76	468.74	-.01	468.73
CD	176.95	176.76	-.04	176.72	-8.28	0	-8.28
DE	502.06	-2.92	-.11	-3.03	-502.05	-.01	-502.06
EA	187.05	-106.48	-.04	-106.52	-153.78	0	-153.78
	1684.11	0.37		0.00	0.03		0.00

Area by DMD

Double Meridian Distance

- Use adjusted Lat's and Dep's
- Meridian through west point
- Use Lat, Dep to define triangles, trapezoids
- Note formulas
  - A = ½bh
  - A = ½b(h_1+h_2)
- DMD – double area



Area by DMD

- Process follows around the boundary
  - $DMD_{BC} = DMD_{AB} + Dep_{AB} + Dep_{BC}$
  - Multiply DMD * Lat for each side
  - Add up = Double area
  - Divide total by 2

Areas by DMD

Side	Adj'd Lat	Adj'd Dep	DMD	DMD x LAt
AB	-247.93	195.39	195.39	-48,443
BC	180.76	468.73	859.51	155,365
CD	176.72	-8.28	1319.96	233,263
DE	-3.03	-502.06	809.62	-2,453
EA	-106.52	-153.78	153.78	-16,381
	0.00	0.00		321,352

Area = 321,352/2 = 160,676 s.f./43,560 = 3.69 acres

Coordinates

- Assign an origin W and S of point A
- N $Coord_B$ = N $Coord_A$ + Lat_{AB}
- E $Coord_B$ = E $Coord_A$ + Dep_{AB}
- Area by Coordinates
  - Multiply E $Coord_A$ * N $Coord_B$, repeat, add
  - Multiply E $Coord_B$ * N $Coord_A$, repeat, add
  - 2A = Difference of sums

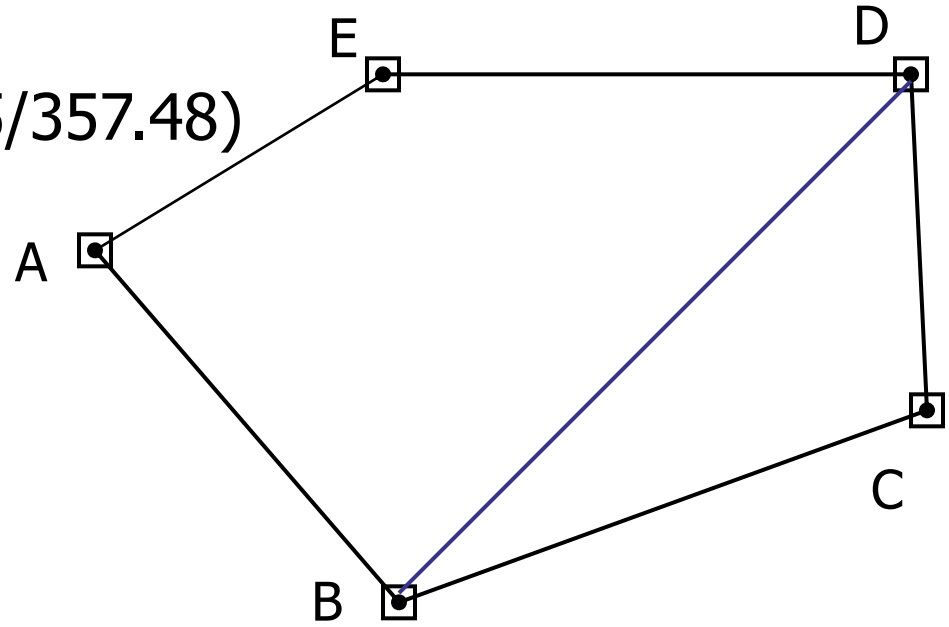
Coordinates

Side	Adj'd Lat	Adj'd Dep	Point	N	E	Up	Down
			A	300.00	100.00	5,207	
AB	-247.93	195.39	B	52.07	295.39	68,776	88,617
BC	180.76	468.73	C	232.83	764.12	312,945	39,788
CD	176.72	-8.28	D	409.55	755.84	307,264	175,982
DE	-3.03	-502.06	E	406.52	253.78	76,134	103,936
EA	-106.52	-153.78	A	300.00	100.00		40,652
						770,326	448,975

Area = (770,326 – 448,975)/2 = 160,676 s.f. /43,560 = 3.69 acres

Why Use Coordinates?

- What line connects B and D?
  - Lat = $N_D - N_B = 409.55 - 52.07 = 357.48$
  - Dep = $E_D - E_B = 755.84 - 295.39 = 460.45$
  - $L = (357.48^2 + 460.45^2)^{½}$
    $= 582.93$
  - $Az = Tan^{-1}(460.45/357.48)$
    $= 52°10'30"$



REF

- FUNDAMENTAL OF SURVEYING
- SURVEY HANDBOOK
- SURVEYING MADE EASY NOTES
- SURVEYING BANNISTER
- MY NOTES

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