JASON E. FOOSE, PS

the HP 35s calculator

A Field Surveyor's Companion

Part 9—Intersections

We can calculate anything and everything under the sun or the dismal grey Cleveland skies of FirstEnergy Stadium, however, a decision to set aside previously fixed local survey legal subdivision corners must be supported by evidence that goes beyond mere demonstration of technical error, reasonable discrepancies between former and new measurement, and less than strict adherence to restoration and subdivision rules. Were (we) obliged to open the question as to the location of a particular tract or tracts over technical differences or reasonable discrepancies, controversies would constantly arise, and resurveys and readjudication would be interminable. The law gives these activities repose.

"Oh, what's this pile of meadow muffins?" you say. Well, save the dismal grey non-Superbowl rubbish, it is a direct quote from the summary of Chapter III section 137 of the 2009 BLM Manual of Instruction located on page 74. The instructions to establish the center of section in the vacuum of title known as the public domain are clearly acknowledged as being out of character in the fruited and colorful non-federal arena. Where States like Colorado have provided the Manual of Instruction as a statutory reference (CRS 38-51-103.1) they cite *"such professional land surveyor shall proceed according to the applicable rules contained in the current "Manual of Instructions for the Survey of the Public Lands of the United States" published by the United States…"* rather than *"Place the center one-quarter corner in accordance with Chapter III Section 114 of the Manual of Instruction"*. The States and their Honorable Courts understand that the Manual contains a set of instructions

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defining the act of subdividing lands gestating within the prenatal title of a sovereign. The fabric of the non-federal arena is on the other hand a series of bona fide conveyances referencing protracted division lines within a section. The weight of conveyancing coupled with occupation and local surveys is wholeheartedly acknowledged in numerous places throughout the 2009 Manual. So, before you open up to page 68 and intersect those straight lines to fire another salvo into the center quarter, remember that retracement surveying is an evaluation of evidence, not a pop quiz in geometry class. Consequently "intersection" is a tool not an answer!

Please do not hesitate to send any comments, concerns, questions, or criticism to *rls43185@gmail.com*

This Month's Program

Program L: Intersections includes routines for Direction/Direction, Direction/Distance, and Distance/Distance. The program operates by assuming a base line from the first point to the second point. Direction/Distance and Distance/Distance naturally have 2 solutions. The preferential solution may be defined as being left or right of the line facing the second point.

This month we will focus on Azimuth/Azimuth(Direction/Direction) and create the curve referenced in the AREA program installment. The Direction/Distance and Distance/Distance examples will follow next month. I encourage all readers to try the routines preemptively and send feedback. I promise a speedy response and I'll do my best to include your comments in the next installment. I think the good folks of the campus bookstore bevy refer to that as "an interactive reader experience".

Example Data and Running The Program

We will reference our previous data set as follows:

PNT	NORTH	EAST
1	4,680.20	4,917.12
3	5,267.15	5,517.46
4	5,267.06	5,186.98
5	5,000.00	5,000.00
1-5	N 14°31'45" E	330.36
3-4	S 89°59'04" W	330.48

If you have carried coordinates through from the compass rule adjustment article you may find insignificant differences in solutions as noted in the last month's area listing. The source of the error is the difference between hand entering coordinates to two decimal places versus the computed (adjusted) values that are carried out to the full 12 digit precision of the HP 35s. This is a great example toward accepting tolerance in measurement through the assessment of the source data. The amount of these differences is insignificant, however the reason they exist must be identified before considering the impact. I will be reporting will the 2 decimal coordinates listed above.

KEYSTROKE STEPS	RESULTANT DISPLAY	ACTION
XEQ yX ENTER	Y-reg : X-reg : INTERSECTIONS	Executes program {L} and displays program annunciator. note: the "L" key is between the square root and reciprocal keys. It is the "Y" raised to "X" function key.
R/S	Y-reg: X-reg: RCL POINT	Annunciator/reminder. RCL input to follow.
R/S	Y-reg: J? X-reg: default value	Prompt for first point number.
1 R/S	Y-reg : (1)= X-reg : 4,680.20 i 4,917.12	Display point info for review.
R/S	"RUNNING" then Y-reg : X-reg : RCL POINT	Annunciator/reminder. RCL input to follow.
R/S	Y-reg: J? X-reg: default value	Prompt for second point number.
3 R/S	Y-reg : (3)= X-reg : 5,267.15 i 5,517.46	Display point info for review.
R/S	"RUNNING" then Y-reg : X-reg : AZ-AZ PRESS 0	Prompt for Azimuth/Azimuth intersection. Directly press 0 R/S to proceed to AZ-AZ or hit any key(except zero) R/S to continue menu choices.
0 R/S	Y-reg : X-reg : 1ST AZIMUTH	Annunciator/reminder. Azimuth input to follow.
R/S	Y-reg : A? X-reg : default value	Prompt for azimuth in decimal degrees from 1ST point. The objective is to intersect lines 1-5 with 3-4 to create the P.I. of the curve used in the previous AREA routine. The inverse can be computed beforehand as found on the data table. Line 1-5 bears N14°31'45"E and is converted to14.5292 decimal degrees. The northeast quadrant bearing is a direct expression of azimuth.
14.3145 YLS 8 R/S	"RUNNING" then Y-reg : X-reg : 2ND AZIMUTH	Annunciator/reminder. Azimuth input to follow.
R/S	Y-reg : A? X-reg : default value	Prompt for azimuth in decimal degrees from 2nd point. Line 3-4 is in the southwest quadrant. Convert to decimal degrees (89.9844) and add 180°. Azimuth=269.9844
89.5904 YLS 8 180 + R/S	"RUNNING" then Y-reg : X-reg : STORE POINT	The "RUNNING" may take a minute then annunciator for point storage.
R/S	Y-reg : J? X-reg : default value	Prompt for point number.
6 R/S	Y-reg : (6)= X-reg : 5,267.03 i 5,069.20	Display point info for review.
R/S		Return to program top.

Program Listing

NOTES: The algebraic symbology for multiplication * and division / are used during EQN entry. L118 begins with +/- to make "2" negative. The negative sign will be displayed a fuzz higher than a minus sign.

L001	LBL L
L002	SF 10
L003	EQN "INTERSECTIONS"
L004	XEQ J001
L005	EQN [REGY,REGX] ▶Y
L006	EQN (J) ▶L
L007	XEQ J001
L008	EQN [REGY,REGX] ▶Z
L009	EQN (J)▶K
L010	1
L011	SF 10
L012	EQN "AZ-AZ PRESS 0"
L013	x=0?
L014	GTO L022
L015	1
L016	EQN "DS-DS PRESS 0"
L017	x=0?
L018	GTO L086
L019	EQN "AZ-DS"
L020	GTO L112
L021	STOP
L022	CF 10
L023	EQN Z-Y▶T
L024	EQN Z-Y▶U
L025	FIX 4
L026	SF 10
L027	EQN "1ST AZIMUTH"
L028	CF 10
L029	INPUT A
L030	RCL A
L031	STO M
L032	1
L033	XEQ R001
L034	x<>y

L035	EQN [REGY,REGX] ▶V
L036	RCL U
L037	RCL V
L038	x (multiplication)
L039	RCL U
L040	ABS
L041	RCL V
L042	ABS
L043	x (multiplication)
L044	÷ (division)
L045	ABS
L046	ACOS
L047	STO W
L048	SF 10
L049	EQN "2ND AZIMUTH"
L050	INPUT A
L051	1
L052	XEQ R001
L053	x<>y
L054	EQN [REGY,REGX] ▶R
L055	RCL T
L056	RCL R
L057	x (multiplication)
L058	RCL T
L059	ABS
L060	RCL R
L061	ABS
L062	x (multiplication)
L063	÷ (division)
L064	ABS
L065	ACOS
L066	STO S
L067	EQN 180-W-S▶P
L068	EQN ABS(U)*(SIN(S)/SIN(P))▶O
L069	RCL M
L070	RCL O
L071	XEQ R001
L072	XEQ P001
L073	x<>y
L074	XEQ C001
L075	RCL L
L076	+ (add)
L077	SF 10
L078	EQN "STORE PNT"
L079	FIX 0
L080	INPUT J
L081	x<>y
L082	STO(J)
L083	FIX 2
L084	VIEW (J)
L085	GTO L001
L086	EQN "DIST-DIST"
L087	EQN "1ST DIST"
L088	INPUT D
L089	CF 10
L090	EQN D▶U
L091	SF 10
L092	EQN "2ND DIST"
L093	INPUT D
L094	CF 10
L095	EQN RCL D▶V
L096	CF 10
L097	EQN K-L▶Y
L098	EQN ABS(Y)▶W
L099	EQN ACOS((SQ(W)+SQ(U)-SQ(V))/(2*W*U))▶Z
L100	FIX 4
L101	EQN K-L
L102	ARG
L103	RCL Z
L104	SF 10
L105	EQN "-LT OR +RT"
L106	RCL U
L107	x<>y
L108	XEQ C001
L109	RCL L
L110	+ (add)
L111	GTO L077
L112	EQN "AZ FRM 1ST PNT"
L113	INPUT A
L114	EQN "DIST 2ND PNT"
L115	INPUT D
L116	CF 10
L117	EQN ((ARG(K-L)-A)▶U
L118	EQN -2*ABS(K-L)*COS(U)▶V
L119	EQN ABS(V)▶V
L120	EQN SQ(ABS(K-L))-SQ(D)▶W
L121	EQN (SQ(V)-(4*W)▶R
L122	EQN SQRT(R)▶R
L123	EQN (V+R)/2▶S
L124	EQN (V-R)/2▶T
L125	SF 10
L126	EQN "DIST A-AZ PNT"
L127	RCL T
L128	STOP
L129	EQN "DIST B-AZ PNT"
L130	RCL S
L131	STOP
L132	EQN "SAVE A=0 B=1"
L133	x≠0?
L134	GTO L139
L135	RCL T
L136	RCL A
L137	XEQ C001
L138	GTO L142
L139	RCL S
L140	RCL A
L141	XEQ C001
L142	RCL L
L143	+ (add)
L144	EQN "STORE PNT"
L145	FIX 0
L146	INPUT J
L147	x<>y
L148	FIX 2
L149	STO(J)
L150	VIEW(J)
L151	STOP
L152	GTO L001
L151	RTN

Jason Foose is the County Surveyor of Mohave County Arizona. He originally hails from The Connecticut Western Reserve Township 3, Range XIV West of Ellicott's Line Surveyed in 1785 but now resides in Township 21 North, Range 17 West of the Gila & Salt River Base Line and Meridian.