TRAVERSE ERROR ANALYSIS

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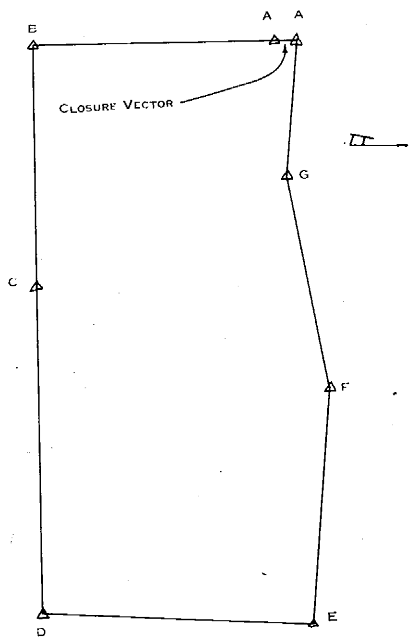
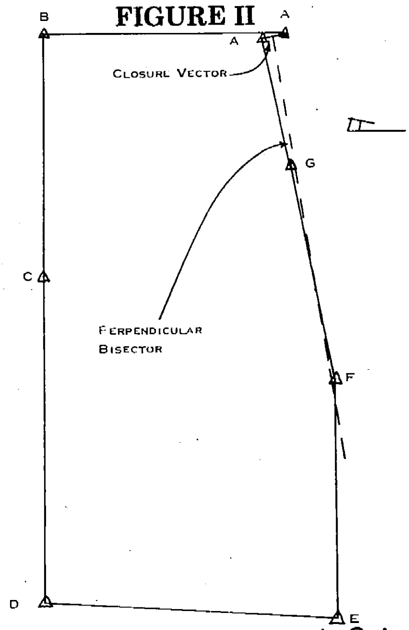
Abstract: Development, illustrations and a method are given for identifying the magnitude, direction and location of errors and combinations of errors in a traverse loop.

FIGURE I



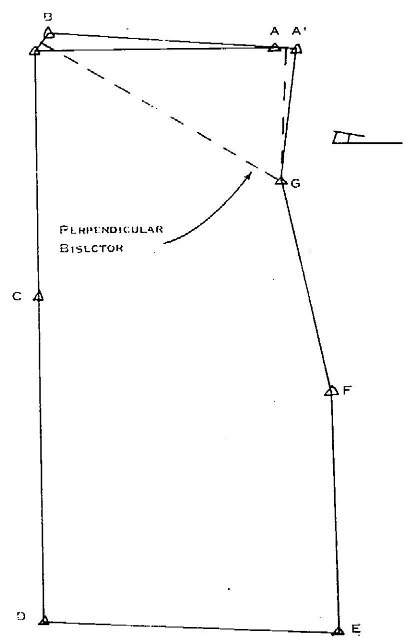
Error in Distance. AB too short or DE too long. Its magnitude is the same as AA'.

FIGURE II



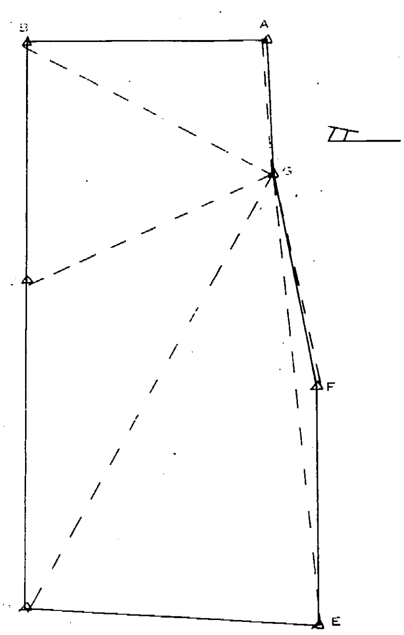
Error in angle G or F. If at angle G, its magnitude is the same as one-half angle AGA'. If at angle F, its magnitude is the same as one-half angle AFA'.

FIGURE III



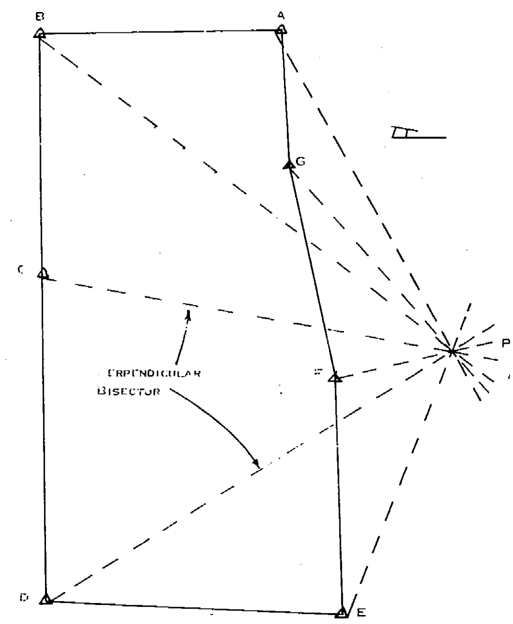
Angular error at G. Magnitude one-half angle AGA' or one-half angle AGA'.

FIGURE IV



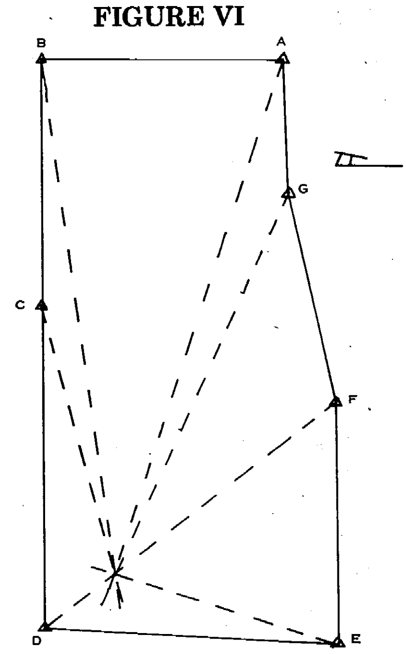
Angle G has an angular error.

FIGURE V



Combined distance and angular error. Distance error in line FG, magnitude GG'. Angular error at F, magnitude one-half FPF'.

FIGURE VI



Angular errors at angles F and D. Magnitude not determined.

All surveyors know (should know) that if only one error is made in a traverse loop, its magnitude, direction and location can often be determined by some simple computations and a plot using the closure vector.

Through an idea about improving this method and through experimentation, a way to identify the magnitude, direction and location of a combination of two errors was recently discovered.

The information originally available was that if a distance error was made on only one of the traverse lines and no angular errors were made, then inspection of the closure vector could yield the magnitude, direction and location of the error. The magnitude and direction were given by the closure vector itself and the error could be located by identifying the traverse line parallel to the closure vector. If there were more than one traverse line parallel to the closure vector, the error could be in any one or combination of these lines. See Figure 1. Also if an angular error was made at only one of the traverse points and no distance errors were made, then again inspection of the closure vector could yield the magnitude, direction and location of the error. The location of the error could be determined by constructing the perpendicular bisector of the closure vector. It would pass through the traverse point where the error was made. See Figure II. If more than one traverse point fell on or near the perpendicular bisector of the closure vector, the error could be in any one or combination of these points. If the point could be identified, the magnitude and direction of the error could be determined by computing one-half the angle centered at this point turning between the two sets of coordinates at the closure point.

The idea for improvement of this method was that if another closure was computed with a different point of beginning, then the perpendicular bisector of the closure vector would also pass through the traverse point where an angular error was made. The perpendicular bisectors of closure vectors at two traverse points would intersect at only one of the traverse points, therefore positively identifying where the angular error was made. See Figure III.

While performing these computations, it was realized that a complete recomputation of the traverse starting at point B was not necessary. All that was needed was to compute B' using the point A' already computed, the angle measured at A and the distance A-B. In fact, since a computer was being used, with the addition of a few cards the computations were continued the rest of the way around the traverse obtaining a double set of coordinates for each point. The traverse and the perpendicular bisectors of the closure vectors were then plotted. The result, reproduced in Figure IV, was dramatic. Only one set of traverse points is plotted. This result was expected. The surprise came when the procedure was repeated introducing a distance error as well as an angular error. This result is reproduced in Figure V. It was a surprise to see the perpendicular bisectors to the closure vectors all intersect at a point different from any of the traverse points. It was then that serious investigation and experimentation began, resulting in a method of identifying the magnitude, direction and location of some combinations of errors.

The resulting method is summarized in the table below. The perpendicular bisector or closure vector will be called a normal.

TRAVERSE ERROR ANALYSIS*

Situation	Most Likely Analysis	Solution
1. Precision within limitations.	1. No analysis necessary.	1. No analysis necessary.
2. Normals Parallel or near parallel.	2. Distance error(s)	2.
a. Parallel or near parallel to one or more traverse lines.	a. Error in this line (lines).	a. Check this distance (s).
b. Not parallel or near parallel to one or more traverse lines.	b. Two or more distance errors not parallel.	b. Check all distance (s).
3. Normals intersect at or near one traverse point. See Figure IV.	3. Angular error at this traverse point.	3. Check this angle.
4. Normals intersect at or near a point on a straight line between two traverse points. See Figure VI.	4. Angular errors at these two traverse points.	4. Check these angles.
5. Normals intersect at a point not near one of the traverse points.	5. More than one error.	5.
a. One normal is perpendicular to one or more traverse lines. See Figure V.	a. This traverse line has a distance error and the traverse point projecting the normal has an angular error.	a. Check this distance check this angle.
b. Otherwise	b. Too many errors for analysis.	b. Resurvey traverse.

**To utilize this table beyond Step 1, a double set of coordinates for each point must be computed. This is done using a measured angle for each traverse point and a measured distance for each traverse line and computing around the traverse twice. See the sample computations given below for Figure IV. Then the traverse (one set of points only) and the perpendicular bisectors of the closure vectors (normals) are plotted. It is recommended that a computer be used for the computations and plot due to the precision required for meaningful results.*

SAMPLE COMPUTATIONS

Point	Inside Angle	AZ	Dist	LAT	DEP
A				10000.0000	10000.0000
		180°	1000		
B	90°			9000.0000	10000.0000
		90	1000		
C	180°			9000.0000	11000.0000
		90°	1347.88		
D	93°15′			9000.0000	12347.8800
		363°15′	1223.08		
E	86°0′30″			10221.1129	12417.2198
		269°15′30″	982.2		
F	68°53′			10208.3991	11435.1021
		258°8′30″	905		
G	188°31′14″			10022.4284	10549.4160
		266°39′44″	549.87		
A′	92°20′16″			9990.4137	10000.4788
		179°	1000		
B′	90°			8990.5660	10017.9312
		89°	1000		
C′	180°			9008.0184	11017.7789
		89°	1347.88		
D′	93°15′			9031.5421	12365.4536
		2°15′	1223.08		
E′	86°0′30″			10253.6792	12413.4715
		268°15′30″	982.2		
F′	168°53′			10223.8271	11431.7253
		257°8′30″	905		
G′				10022.4273	10549.4197

Precaution: None of the above is mathematically proven in this paper. Analysis techniques were determined from many computer plots with various combinations of errors programmed.

This method of analysis is definitely not intended to be used for office closure of survey traverses. Suggested solutions must be field checked because multiple errors can result in a plot that could be interpreted as a single or double error.

Thanks goes out to Kenneth Bourassa, President of Techni Data Computer Services for computer time used for this research.

SHARE YOUR DISCOVERIES

Editor's Note: Our thanks to Mr. Bassham for the second excellent article he has provided us in the past six months. We feel that other surveyors must be doing experimentation and work which, like Mr. Bassham's, richly deserves to be shared with others in the profession. We would be proud to print articles describing such discoveries; if you lack the time or interest in writing, just drop us a line describing the work and we'll interview you, write it up outselves, submit it to you for checking before we publish it.