Computerized Bloodstain Pattern Interpretation Circa.... 1987

Donald R. Schuessler, M. S.
Eugene Department of Public Safety
Eugene, Oregon

GEOMETRIC BLOODSTAIN PATTERN INTERPRETATION USING A COMPUTER PROGRAM

Frederick E. Wilson and
Donald R. Schuessler
Eugene Department of Police,
Fire and Emergency Services
Eugene, Oregon 97401

Geometric interpretation of human bloodstain evidence has been the subject of much investigation and experimentation. Work was first presented in 1939 with Balthazard's study on the influence of trajectory on resulting bloodstain shape. Of particular interest to individuals working in crime scene reconstruction has been the development of empirical formulae which correlate a bloodstain's width, length and orientation with its point of origin. Using methods described by Balthazard *et al.* (1939), MacDonell and Bialousz (1971, 1979), MacDonell (1982) and DeForest *et al.* (1983), a computer program has been developed which greatly simplifies the data handling and computations necessary to apply the formulae. In addition, this program can be used to represent schematically the position of a victim in a room at the instant of bloodshed, thus making the task of manual reconstruction of the point of origin unnecessary.

The computer program is primarily applicable to medium and high velocity impact patterns, such as those found in shootings and beatings. The program, by its nature, treats the crime scene like a cube, with six possible horizontal surfaces and six possible vertical surfaces. Therefore, the analysis of blood patterns on walls and floors is the primary focus of this program. Blood patterns on flat surfaces of oblique orientation can be analyzed for point of convergence with the program; however, the feature of the program which places the point of origin in three dimensions cannot be used in this circumstance. Blood patterns on items such as grass, leaves and curved surfaces are usually unsuitable input for this program. The program analysis alone gives the analyst no information about whose blood made the stain. Serological tests are typically necessary, in addition to a bloodstain pattern analysis, if the resulting reconstruction is to be meaningful to the case.

The impact angle, the angle at which a drop of blood strikes a surface, may be determined from the length and width of the resulting bloodstain (DeForest *et al.* 1983). Let A = impact angle, W = width, and L = length. Then,

$$A = \arcsin (W/L).$$

Bloodstains may be found to lie in a radially distributed pattern, with their long axes aligned parallel to the radials. If radials from all the bloodstains are traced back to a common point on the same surface, such a point is called the point of convergence. If the impact angles of several bloodstains are known, this information can be combined with the distances at which these bloodstains lie from the point of convergence to yield the distances from the bloodstained surface at which the drops of blood originated. Then, statistical interpretation can indicate the probable locations of the points of origin of the drops of blood. In general, victim location can be estimated from the results.

If a large number of bloodstains are to be examined, data handling quickly becomes a burden. This burden increases if the analyst wishes to sort out bloodstains caused by multiple blows to the victim. If the analyst wishes to obtain an averaged distance of the point of origin from the point of convergence based on several bloodstains, or a distribution of impact angles in order to eliminate questionable data points, the process again becomes unwieldy.

To facilitate a more accessible application of the above technique, the authors have developed a BASIC language program to build a database, perform the necessary calculations and display the results both numerically and graphically (Appendix 1). At this time, the program is not a sophisticated package, but only an automated approach to the same task performed manually. Planned future improvements include the capability to rotate the viewpoint of the graphics, to place a human figure in the product, to provide automatic statistics and to remove questionable data points from the database.

The program runs on a Tektronix 4052 Graphic Computing System (Tektronix, Inc., Beaverton, OR), but it could easily be rewritten for many other microcomputers.

This program has been tested on several data sets. First, it was tested against data in MacDonell and Bialousz (1979) for which it gave the same results as that text. Next, a medium velocity bloodstain pattern was created in our laboratory for the program to analyze. The program's results agreed with experimental measurements. Another agency then called upon the program to confirm manual interpretations made by its analyst. The program's results matched those of the analyst. Since its acceptance, the program has been used in relevant situations, including investigations involving a missing person, an assault and a homicide The authors continue to run cases against manual analyses, as appropriate.

To use the program, the analyst must first calculate bloodstain widths, bloodstain lengths and distances from the various points of convergence found at the crime scene. Methods for accomplishing this task are fully described in MacDonell and Bialousz (1979). Also, the locations of the points of convergence, as measured from one corner of the room, must be noted. These locations will enable the program to display the origins of the bloodstains on a perspective drawing. The analyst then enters the collected data into the program and may optionally save it on a floppy disk. Bloodstain measurements collected from six separate vertical surfaces and six separate horizontal surfaces may be entered into the program. Presently, the program can be used to place four points of origin in three dimensions, using the information from 360 bloodstains to place the points at the moment of impact. Independently derived confidence levels generally indicate a very small probability of error when numerous bloodstains are measured, which indicates that the points of origin should be placed with as many stains as possible.

Table 1 displays the results of the analysis of one bloodstain, as produced by the program. For a bloodstain 9 mm wide and 15 mm long, located 340 mm from the point of convergence, the program calculated that the blood drop hit the surface at an incident angle of 36.9° and that it originated at a point 255 mm above the surface. When 12 such bloodstains from three separate points of origin were displayed on one graph (Figure 1), the program successfully resolved the bloodstain pattern into three separate events occurring at three different points of origin. On Figure 1, the vertical axis represents the bloodstained wall, and the horizontal axis represents the distance of the point of origin from the wall. Heights are in 10-centimeter intervals, and horizontal distances from the axis of convergence are in 100-millimeter intervals. The scale of all graphs is under user control. Figure 2 represents the computed location of the

Table 1. Program Analysis of Bloodstain

Bloodstain Width	9 mm
Bloodstain Length	15 mm
Distance to Axis of Origin	340 mm

Width	Length	Distance
9 mm	15 mm	340 mm
Angle	**Tangent**	**Height**
36.8698976458	0.75	255 mm

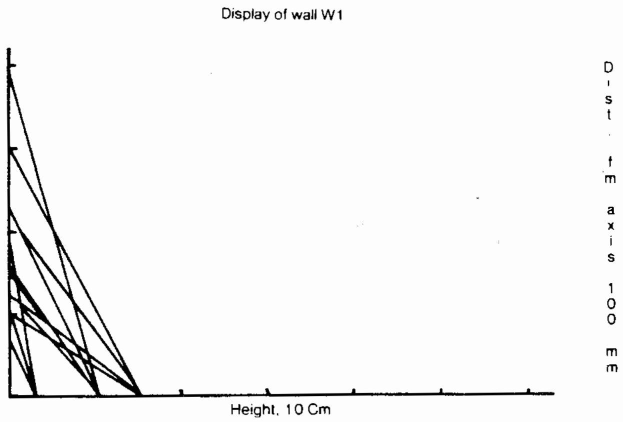

FIGURE 1. Graph of 12 bloodstains from three separate points of origin.

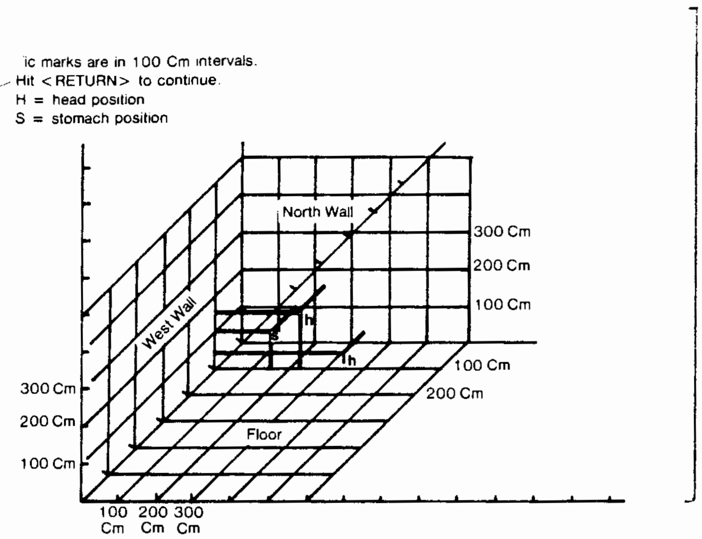

FIGURE 2. Computed location of the points of origin of three separate impact patterns sorted out by the program.

points of origin of three separate impact patterns which were sorted out by the program from the raw data. Indicated are the distances, in centimeters, of the victim's head and stomach from the north wall, west wall and floor of the crime scene.

Information used to connect the computed points of origin with specific wounds to the victim is not a feature of the computer program. This information must be established through forensic analysis. By combining examination of the victim with the results of this program, and with an examination of tissue types found in the bloodstains, the authors were able to establish in this laboratory example that the victim was shot twice in the head, once while leaning forward and once while almost prone. Further examination of the bloodstains and the victim can sometimes be used to establish the order in which the wounds occurred. In this case, the victim appears to have been shot first in the stomach while standing, since the height of the computed point of origin corresponds with the height of the victim's midsection while standing.

Once the point or points of origin of bloodstains are established, the analyst can attempt to establish a causal link between the computed points of origin and the various wounds to the victim. Once the victim's position in space is established in this way, examination may determine the angle of impact of the weapon to the victim. This information may in turn place th^ weapon at the crime scene, which may in turn place the assailant. Therefore, the automated bloodstain analysis program is just one of a spectrum of methods that may be applied sequentially or concurrently to reconstruct the sequence of events at a crime scene.

REFERENCES

Balthazard, V., Piedelievre, R., Desoille, H. and Derobert, L. (1939). Etude des gouttes de sang projete. 22nd Congres de Medecine Legale. Paris, France.

DeForest, P., Gaensslen, R. E. and Lee, H. C. (1983). Forensic Science: An Introduction to Criminalistics. McGraw-Hill, New York.

MacDonnell, H. L. (1982). Bloodstain Pattern Interpretation. Laboratory of Forensic Science, Corning, New York.

MacDonnell, H. L. and Bialousz, L. F. (1971). Flight Characteristics and Stain Patterns of Human Blood. U.S. Department of Justice, Washington, D.C.

MacDonnell, H. L. and Bialousz, L. F. (1979). Laboratory Manual for the Geometric Interpretation of Human Bloodstain Evidence. 2nd ed. Laboratory of Forensic Science, Corning, New York.