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Computer Aided Anal. Limitations

Computer Aided Analysis: Capabilities and Limitations

Part I

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In what fashion should the bloodstain pattern analyst view the computer? Should we expect a computer to conduct the analysis, that is to reason through the data and decide upon a solution? Is technology an adequate replacement for the human analyst? The intent of this article is to consider such questions and the overall value of computer technology in supporting bloodstain pattern analysis.

To deal effectively with this issue, we first need to dispel a myth relating to computers. In the past ten years while developing methods for dealing with computer crime scenes and computer generated evidence, I've become aware through my own education of a basic myth about using computer technology. People often view computers as a panacea for everything. They seem to believe we can automate any action and the resulting information, solution or whatever will be better. I must admit I held this belief myself when I bought my first computer, but through time and trial learned it's not particularly true.

In part we seem to predicate this myth on a more serious misconception regarding computers, that is that computers think. Certainly were it true that a computer "thinks", as we use the term to describe our own brain activity, then such a reasoning ability combined with the additional precision computers give us would make any resulting analysis better than a strictly human analysis.

The question is, can the computer think? Often referred to as Strong AI (Artificial Intelligence), the thinking computer is the idea that future computers can mimic human brain activity. The academic world still hotly debates whether this is possible or not. Current machines give us solutions, but do so based on human algorithms which tell the computer when it has achieved a solution. We, on the other hand, appear not to need such coding; we arrive intuitively at solutions. After evaluating everything before us we seem to "know" when the solution is reached, no one has to tell us. Advocates of Strong AI believe computers will conduct such abstract thinking, deriving solutions where no preset solution exists.

With regard to thinking machines I tend to accept the more conservative position such as that held by Roger Penrose of Oxford University. In his book *The Emperor's New Mind*, Penrose effectively argues that computers as machines cannot engage in abstract thinking as humans do. It is not that Penrose doubts the utility or versatility of computers, he simply draws a distinct line between thinking and computing.[1]

So how does this "thinking" argument affect our discipline? It demands we at least consider how we use and accept computers within bloodstain analysis. Imagine for a moment a given analyst being cross examined by a defense attorney. In this instance imagine also that our defense attorney has purchased one of the available software packages used in bloodstain analysis. The analyst testifies to some specific conclusion, which of course is based on both a holistic approach to the evidence and the analyst's experience and knowledge. Does anyone doubt for a moment the defense attorney wouldn't attack the human conclusion, based upon a discrepancy indicated by the defense's use of the bloodstain analysis software. Their attack is likely to start as, "But the computer says.....".

In this fashion the defense presents the software and the technology as the "expert". To accept this position is to also accept that the human analyst is unnecessary, that the computer's solution can stand on its own, without need for further evaluation. The position in effect expects the computer and software to "think" through a distinctly abstract problem. It's not hard to foresee this situation occurring in bloodstain pattern analysis. Anyone to include lawyers, no matter how misguided or misinformed, can plug data into a computer and get "a" result.

Penrose's position, however, demands that we accept the computer as an aid to the analysis process. As with any other tool, the computer is a means by which the human becomes more effective. The solutions we derive about the case or pattern being evaluated still require the application of trained human talent. Despite attempts at neural networks and other AI advances, the world has yet to see a true thinking machine.

Lacking "thinking machines", what is the role of the computer in bloodstain pattern analysis? Currently three basic functions exist: training, computer aided analysis, and demonstrative support of analysis and reconstruction. Each area has strong potential for the long term benefit of our discipline, but they also have what to me are clear limitations. In Part I of this article we'll confine ourselves to the first two areas.

<u>As a Training Tool: Expert Systems and Teaching Programs</u>

We've already seen several uses of automation for teaching bloodstain analysis. The first true teaching program was ***DROPLETS***. Developed by Dr. Alfred Carter for courses taught for Carleton University and the Royal Canadian Mounted Police, ***DROPLETS*** simulated flight paths of blood drops, striking a vertical wall.[2]

DROPLETS eventually grew into the program ***TRACKS***. Developed and coded by Dr. Carter through Forensic Computing of Ottawa Inc. (FCO), ***TRACKS*** is "a computer program designed as a teaching tool to allow users to become familiar with the behavior of droplets in flight and the resultant droplet stains."[3]

TRACKS allows the user to adjust various factors, to include volume, speed, direction and elevation of the impacting droplet. ***TRACKS*** is not an analysis tool; that is, it does not take crime scene information and assist the analyst in deciding issues about droplets or stains found at the crime scene. Rather, as a training tool, it teaches basic concepts of droplet behavior to students. I had occasion to use ***TRACKS*** effectively while teaching a basic course in Helsinki in 1993. Using this program, students found it easier to understand changes in droplet behavior due to increases in volume size and speed.

Another important teaching tool in automation is the Expert System. Properly used it provides a means of cataloging basic knowledge of a given expert for future reference. Typically an expert system leads the user through a set of structured questions which, based upon the user's responses, apply the expert's rules for solving the problem. It is as if the user could directly contact and "ask" the expert. The expert's knowledge reinforces that of the user's and helps overcome specific knowledge gaps.

I know of only one discussion to create an expert system for bloodstain pattern analysis. During the IABPA Training Conference in Dallas in 1989, I had occasion to share a dinner conversation with Bart Epstein. During the discussion, Bart indicated that a group had offered to develop an expert system using Bart's knowledge. At the time, Bart was not confident of how the field would use the program and up to now I've heard nothing indicating he went ahead with the project.

Of course, developing an expert system is no simple matter. First, the expert must establish the actual manner in which they think out the problem. This information becomes the Inference Engine and sets up rules for attacking a given problem. The Inference Engine works with a Knowledge Base. This knowledge base is both academic knowledge of the subject matter and the expert's "rules of thumb and private knowledge attained through experience" which of course provide the student with the expert's insight.[4]

Although no easy project to undertake, imagine the utility of a "Ask Herb", "Ask Tom", or "Ask Judy" type of program. Students gain the advantage of ready reference to the accepted experts in the field, from which they gain specific knowledge and increase their own abilities. An expert system if sufficiently planned out, might also serve in a semi-analysis role which is the next area of discussion.

Computer Aided Analysis: Making the Analyst More Effective

Although computers certainly cannot think in an abstract fashion as humans do, they are effective tools for dealing with large amounts of data and conducting difficult calculations. This of course, is something we as humans are not quite as good at. This capability is clearly supportive of bloodstain pattern analysis. Often, to accomplish an in depth analysis of a scene, we need to conduct impact angle and point of origin calculations. In the past we accomplished this primarily by stringing the scene or through a stubby pencil process. Software advancements now make stringing a thing of the past.

Eckert and James' book *Interpretation of Bloodstain Evidence At Crime Scenes* details one of the first documented programs for analyzing bloodstains at crime scenes. Apparently developed in the mid-eighties by Don Schuessler and Frederick Wilson, the program used standard impact angle and point of origin calculations. The user could display results either numerically or graphically. As Schuessler and Wilson wrote, the program is an "automated approach to [conducting] the same task performed manually."[5] Their intent was to simplify the handling of data, ease the computations and eliminate the overall burden faced by the analyst.

Although the authors discussed possible future enhancements, I've never seen a working version in use, nor heard any direct comments regarding its utility. A word of caution for anyone interested in reviving the program. The code (in Basic) found in Appendix C of Eckert and James' book requires major rewriting to conform to current Basic language programming commands.

As discussed previously, Dr. Carter of Carleton University began developing software to assist him in instruction. This naturally led to an effort by Dr. Carter to provide the analyst with a true analysis tool. ***TRAJECTORIES*** was the second such "analysis" program.

In a presentation to the IABPA at the annual conference in 1989, Dr. Carter and Ed Podworny in discussing ***TRAJECTORIES*** wrote "... if the investigator can examine the spot produced by the blood droplet and estimate reasonable values for the impact parameters it is possible to reconstruct, by calculation, the path followed by the droplet... ***TRAJECTORIES*** was created to perform such calculations."[6] ***TRAJECTORIES,*** using actual data from the crime scene, allows the investigator to establish a probable point of origin(s).

Dr. Carter improved upon ***TRAJECTORIES*** and eventually released it through Forensic Computing of Ottawa as ***BACKTRACK***, a full function program that allows for point of origin calculations on vertical surfaces. ***BACKTRACK*** employs actual flight path (parabola) calculations, which require estimates of blood droplet volume and consideration of gravity and air resistance factors.

Shortly after its release, FCO released another program, ***BACKTRACK/STRINGS***. FCO scaled this version down somewhat, changing the manner in which it handles the point of origin algorithm. It has all of the primary functions of ***BACKTRACK***, but utilizes a strings approach to determining flight paths in lieu of the parabola approach used in ***BACKTRACK***.

In running ***BACKTRACK/STRINGS,*** the analyst measures data regarding the stains present at the crime scene. This includes identifying the stain's coordinate position, width and length, and the glancing angle. Once entered for each stain, the analyst moves to a top view and chooses string paths that converge. The chosen lines of convergence provide the computer with an averaged CPx and CPy (convergence point). The analyst then moves to the side view and again considering the paths, chooses an appropriate CPz. Generally the analyst does this by lowering the cursor and choosing a point below the paths of the strings. Once chosen, the analyst then saves these convergence points, and the software creates a graphical representation of the probable point of origin.

Let me point out two specific issues in this process with regard to our consideration of the computer's role. First, it is the analyst and not the computer that chooses the converging lines in the top view. These lines establish a CPx and CPy. The computer cannot distinguish appropriate convergence points from incidental points. Incidental points do occur, particularly when two stain lines originate close together. Such lines may cross each other millimeters from the target and converge with the remaining lines at a more normal convergence point. This situation is typically a result of some minor aberration in a measurement by the analyst. It is usually the result of error which of course we know, but the computer does not.

The second point is that when deciding upon the CPz, again it is the analyst who chooses where to place the cursor in the side view. If twelve stain lines show a general convergence 40 cm above the floor of the target area and one stain line causes a path much lower, the analyst is likely to ignore the single errant line. There are no absolute rules we can apply to an algorithm to allow the computer this decision. It is one based on observation, knowledge and intuition.

Another software program available for computer aided analysis is ***NO MORE STRINGS***. Developed by Miller Forensic Software of San Jose, California, ***NO MORE STRINGS*** offers the analyst a viable method of documenting, analyzing, and presenting bloodstain information. Richard and Victoria Miller began ***NO MORE STRINGS*** five years ago, when they recognized a need for an easier method than working with strings. Richard and Victoria's son Dan provided the programming skills, as he was working towards a software engineering degree at the time.

Originally, ***NO MORE STRINGS*** used standard triangulation techniques, but Dan Miller later transitioned to vector analysis. Version 3 accepts data from the analyst, who provides impact angle measurement data, coordinate information, and an angle of travel (a concept synonymous with Dr. Carter's gamma angle, but measured in a different fashion). The program draws straight line paths for each bloodstain, then using vector analysis finds the point of closest approach for each path. With this line to line comparison, ***NO MORE STRINGS*** offers the user "data analysis tools to evaluate these relationships [one stain line's position from another] and lets the user determine which are valid for the origin being evaluated."[7]

After providing stain data, the general approach to analysis with ***NO MORE STRINGS*** is to move to the graphical view of the stains. Remember, the program compares each stain and its path against every other stain and path, resulting in a series of colored dots. The dots represent the point of origin and not the droplet. As a result of this comparison procedure there are as Miller Forensics points out "(n x(n-1)) dots on the screen, where 'n' is the number of stains in the data set. Six stains produce 30 point of origin dots (6 x(6-1))."[8]

In this graphics view, dots widely off-line or out of range with the main cluster of dots may indicate errors or stains unrelated to the specific event being examined. The program backs up the graphical evaluation with two data analysis functions. The first "Data Trace Back" compares each stain line against the others and lists the variance. Miller Forensic suggests the analyst scrutinize any listing showing repeated variances of 30-35%.

The second function is the "Data Analysis Utility". As Miller Forensic explains: "the utility also compares stain data in pairs, but in a different way. It successively deletes each stain from the remaining stain data before performing the comparison. It's as if you deleted the stain from the data, compared its data with the remaining data, added it back in, deleted the second stain, compared the data, added it back in, etc. through all of the stains in the data set. This gives the user instant feedback as to the suitability of each bloodstain in the data set."[9] Through these functions the analyst attempts to optimize the location of the point of origin of the stains, tightening the cluster of dots.

It's important to note that although ***NO MORE STRINGS*** offers the 30-35% variance figure as a starting point for excluding data as being unrelated to the event, they still view this decision as belonging to the analyst. They clearly caution the user that optimizing the data in any given instance remains a judgment call based on experience.[10]

Analysis Limitations

As should be evident, both ***NO MORE STRINGS*** and ***BACKTRACK*** allow the analyst to more efficiently locate the point of origin of a given event(s). The computer handles the data and calculations in a precise manner, eliminating human math errors and some of the subjectivity inherent in the stubby pencil routines of the past. But does a more efficient mathematical process mean a more precise definition of the true point of origin?

The answer is not really. In a classic stringing technique, one might limit the point of origin to a ten or twelve inch area, in which the strings appear to cross each other, but rarely has the need existed to define this location to an absolute point. The nature of events that create spatter in and of themselves make defining this "point" a moot issue. Events are dynamic and rarely static. To state an event occurred at a precise XYZ position in space is almost ludicrous!

Unlike the stringing technique, however, the computer provides us with a very precise point in three-dimensional space. ***BACKTRACK*** graphically depicts this XYZ point, while ***NO MORE STRINGS*** shows a graphic cluster of dots and then gives us the XYZ point in text. Without an understanding of basic bloodstain dynamics, someone evaluating this information could easily assume the computer had narrowed the event down to this precise location. As trained analysts, we recognize these points as idealized and based on the averages contained in the data. They do not place the event in an absolute location with absolute accuracy.

To illustrate this point I ran several tests using both ***NO MORE STRINGS*** and ***BACKTRACK/STRINGS***. My standards were examples from a basic course used to teach students the tangent formula. As such, I originally documented only the distance of the event from the target for each. Obviously, I limited the comparison to this figure and not a complete XYZ coordinate position, but this figure alone makes the point. The results are as follows:

Standard #	Actual Event Distance	Backtrack/Strings Calc. Distance	No More Strings Calc. Distance
A1	56 cm	46 cm	42 cm
A3	66 cm	52 cm	44 cm
A4	31 cm	34 cm	31 cm
S1	31 cm	32 cm	23 cm
S2	46 cm	39 cm	42 cm
S3	155 cm	151 cm	149 cm

Note that each program effectively places the point of origin within twenty centimeters of the actual creation distance or distance from the target. The minor discrepancies evident may in part be due to the particular stains chosen and the manner of measurement used. Remember also that the creation events of the standards were themselves dynamic and thus not limited to an exact point of impact.

Nevertheless, both programs provide an accurate estimate of the actual point of origin of the events. Despite the mathematical precision the computer brings to the situation, it is just as obvious that the computed points of origin are not more accurate. Are they more easily computed? Yes. But are they more absolute in their accuracy of defining the event? No. Mere placement of a decimal point in a mathematical calculation does not eliminate the level of uncertainty that will always exist in these situations.

Conclusions

No matter how objective the computer may be in conducting precise calculations, it cannot think or reason through an abstract problem. As we discussed, the computer eliminates many of the human errors possible in the calculation process, but it cannot apply considerations from the evaluation of the evidence to define its solution. Current programs give us an effective method of documenting, evaluating, and representing crime scene data. They are almost indispensable as tools for those serious about the future of bloodstain analysis. They do not, however, eliminate the need for the trained analyst. Nor have any of the software creators intended this. Schuessler, Carter and Miller all indicate that software is not a *replacement for* but rather a *tool of* the bloodstain analyst. As Dr. Carter writes "The choice of which stains to use for the analysis, the choice of which intersections in the top view, and the choice of which strings to use in the side view analysis for CPz, these are properly choices that must be made by the analyst based on his or her experience."[11]

The computer cannot see the crime scene. It cannot identify signs of staging or recognize disturbed evidence. Its solution relies upon the ability of the user to provide it with "good" data. It is the analyst who chooses this data. Of course, the analyst must be able to discern why a stain belongs with a particular group, or why they may exclude it from that group. This decision is based on the stains relationship to other evidence and not solely upon its failure to meet an arbitrary variance level. We can't throw evidence away simply because it doesn't make for a neat package! Even then a computed solution, tidy or otherwise, is itself a part of the overall problem. The solution is one more thing the analyst must consider with all other evidence. Without someone trained to understand what good data really is, software is as ineffective as the untrained analyst. One computer sentiment that is certainly true is: garbage in, garbage out!

In the past ten years we have seen outstanding efforts to bring automation abilities into the forefront of bloodstain analysis. The efforts of Forensic Computing of Ottawa and Miller Forensic Software make it possible for the analyst to use automation in capturing, evaluating and representing the analyst's work. The utility this brings to the investigative process cannot be understated. In terms of training analysts, perhaps we have not fully captured or used automation to its full extent. But even that is changing. ***TRACKS*** is in use in the field and as our general comfort level in the discipline increases we are likely to see someone develop an expert system or similar teaching tool. Our concern should be not to limit the use of these tools , but certainly to ensure trained analysts use them. They will never replace the crime scene analyst, they simply make the analyst better.

Authors Note: In Part II of this article I 'll consider a more controversial issue, the use of automation as demonstrative evidence in court.

1 Penrose, Roger, *The Emperor's New Mind: Concerning Computers, Minds, and the Laws of Physics*, Oxford University Press, NY, 1989, pg. 5.

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3 Carter, Alfred L. Ph.D., *Tracks User Manual*, Forensic Computing of Ottawa Inc., Ottawa, Ontario, 1992, pg. 2.

4 Williams, Brian K. and O'Leary T.J., *Computers and Information Systems*, The Benjamin Cummings Publishing Company Inc. Redwood City, CA, 1989, pp. 479-480.

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6 Podworny, Edward J. and Carter, Alfred L. Ph.D., "Computer Modeling of the Trajectories of Blood Droplets and Bloodstain Pattern Analysis With a PC Computer", presentation to the IABPA 2nd Annual Training Conference, Nov. 30, 1989, Dallas Texas.

7 Miller, Victoria, personal communication, 13 March 1995.

8 Miller Forensic Software, "How to Use the No More Strings Demo Disk", pg. 5.

9 ibid., pg. 4.

10 ibid., pg. 5.

11 Carter, Alfred L. Ph.D., personal communication, 18 July 1995.