Bloodstain Pattern Analysis

Second Edition

With an Introduction to Crime Scene Reconstruction

Tom Bevel
Ross M. Gardner

CRC PRESS

Practical Aspects of Criminal and Forensic Investigations Series

Bloodstain Pattern Analysis Second Edition

With an Introduction to Crime Scene Reconstruction

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Foreword

Bloodstain Pattern Analysis: With an Introduction to Crime Scene Reconstruction, Second Edition, is a very clearly and concisely written text. In fact, it is the most complete and comprehensive handbook to date from the perspective of the investigator on the subject of bloodstain spatter analysis.

The authors have provided the reader with an articulate and practical guide to the interpretation of bloodstain patterns and crime scene analysis reconstruction. This second edition text has become the basis for standardization of blood spatter analysis. *Bloodstain Pattern Analysis: With an Introduction to Crime Scene Reconstruction* has heightened the need for universal rules that define this discipline by stressing the underlying scientific basis and how best to objectively apply this knowledge to cases in the field.

The text provides specific details on crime scene analysis and reconstruction in explaining the scientific methodology involved in the process. The authors provide an excellent historical perspective to acquaint the reader with the significant chronology of the application of this technique. The authors also provide excellent information on distinguishing crime scene analysis from behavioral analysis and discuss the considerations involved in the reconstruction of the crime. There is an entire chapter dedicated to the important subject of proper terminology to be utilized in these analyses. *Bloodstain Pattern Analysis* explains the complex mechanics of blood spatter analysis with chapters that address the dynamics of reconstruction, such as determining motion and directionality, convergence and the point of origin, evaluating impact spatter bloodstains, the characteristic patterns of blood which aid in analysis and the proper documentation of blood stains and the reconstruction of a crime. The authors have included two chapters on software applications and demonstrative evidence for court presentation. Most significant in the Second Edition is the addition of over 100 photographs, which graphically illustrate the dynamics of bloodstain patterns, practical applications, case histories and excellent appendices.

The authors bring over 50 years of practical experience to this text. Tom Bevel, my friend and colleague for many years, is a retired police Captain from Oklahoma City, Oklahoma. Bevel is the owner of TBI, a forensic edu-

cation and consulting company. He is also an associate professor in the Masters of Forensic Science program at the University of Central Oklahoma. Captain Bevel (Ret.) holds a Master's Degree in Criminal Justice and has extensive training in the area of criminal investigation both in the United States and Europe. Bevel has numerous professional affiliations and has acted as a police consultant in over 41 different states and 8 foreign countries. He has personally participated in over 3000 criminal investigations in which bloodstain spatter evidence was the issue and has testified in numerous trials as an expert witness.

Ross Gardner served for The United States Army Criminal Investigation Command (USACIDC) for over 24 years as a felony criminal investigator and is now the Chief of Police for a small suburban Atlanta Police Department. He holds a Master's Degree in Computer and Information Resource Management and has extensive training in the area of criminal investigation through the United States Military. He served as an adjunct professor for Central Texas College in the Police Science program. He is also certified as a Senior Crime Scene Analyst with the International Association of Identification and has published as a recognized expert in the field of bloodstain pattern analysis. Special Agent (Ret.) Gardner, who is a consultant in crime scene analysis, bloodstain pattern analysis, and crime scene investigation also has numerous professional affiliations. Gardner has qualified as an expert in bloodstain pattern analysis and crime scene reconstruction in both state and federal courts.

In my textbook *Practical Homicide Investigation: Tactics, Procedures, and Forensic Techniques, Third Edition*, I point out that, "Solving homicides, especially those without witnesses, is extremely more difficult to solve because your main witness, the deceased, is dead. One must develop the ability to 'absorb' the crime scene, and be able to read the uncollectible nuances of the event." The interpretation and analysis of bloodstain patterns within the crime scene oftentimes provides the investigator with the critical information to reconstruct the crime. Used properly, bloodstain pattern analysis can help establish specific events associated with the crime.

I personally believe that without practical scene experience there is a deficiency in crime scene reconstruction. Seasoned practice necessitates that the practitioner have the ability to "absorb" the crime scene, and be able to read the uncollectible nuances of the event. This is what we refer to as "scene experience" as opposed to strict "laboratory" mentality. Tom Bevel and Ross Gardner both have this "scene experience" as well as the necessary knowledge to evaluate and apply the scientific methodology to the reconstruction process.

Bloodstain Pattern Analysis: With an Introduction to Crime Scene Reconstruction, Second Edition is a masterful blend of practical scene knowledge

and the application of scientific methodology to the process of crime scene reconstruction. It is organized in such a manner to allow the reader quick and easy reference into specific areas of blood spatter.

Vernon J. Geberth, M.S., M.P.S.
Series Editor

Preface

The goal of forensics and crime scene reconstruction is simply to seek the truth. The analyst has no other agenda. In pursuing this end, we revisit what we hope is a not-too-distant past and attempt to recreate the events that unfolded. The task is anything but simple and the tools employed are all of the forensic disciplines.

Each area of forensics provides insight and a glimpse into this past. Each has its place in evaluating the aftermath of crime — the physical evidence. In the most classical sense, the majority of the forensic disciplines provide information as to the "who" of crime. Fingerprints, serology, and trace and fiber evidence allow the analyst to associate people or objects with a crime scene. Forensic pathology, on the other hand, has always been the primary link to the "what" of crime, providing insight to some of the events that occurred during the incident.

Bloodstain pattern analysis is a discipline that has certainly reawakened to its role in modern forensics as another method of illuminating the "what" of crime. Used properly, it helps establish specific events associated with violent crimes. In this capacity, bloodstain pattern analysis acts as a critical bridge between classical forensics and crime scene reconstruction.

Although certainly not a young discipline, bloodstain pattern analysis is just beginning to recognize some of the universal rules that define it. We still see aggressive discussions between analysts over what they can or cannot infer from a specific stain. More often than not these arguments consume our objectivity, leading us to a darker side of forensics, where subjective analysis reigns. To fight this tendency, our continuing goal must be to understand the discipline, its underlying scientific basis, and how best to objectively apply this knowledge to cases in the field. The investigator's mission is to always illuminate the truth, not shroud it in shadows.

The authors of this book come from two distinctly different backgrounds, although both have a high level of experience in "on scene" crime scene evaluation: one is a career civilian law enforcement officer, and the other is a retired Criminal Investigator for the U.S. Army. Both are nationally and internationally respected in their fields. Two very different roads led them to the same destination. Interestingly enough, those roads crossed outside the

city of London, at the Metropolitan Police Detective Training School. There both authors, although several years apart, attended the Scenes of Crime Officer (SOCO) course.

The English approach to crime scenes, at the very least, is one of the most methodical in the world. The SOCO course teaches students to understand and incorporate all forensic evidence in the evaluation of a crime. It places responsibility for understanding the interrelationship of that evidence on none other than a generalist, the crime scene investigator.

Perhaps then it is the SOCO course that serves as the wellspring of the authors' shared passion and belief: conduct crime scene evaluations using a holistic approach. Inherent in this thought is that case resolution is critically dependent on proper crime scene analysis. However, case resolution is not just a matter of proving someone guilty. The investigator seeks the truth, no matter what it may be. This demands a consideration of all evidence available and the correlation of such evidence in an attempt to identify reasons for contradictory results when they happen to occur.

In the criminal justice system it is not uncommon to encounter a lawyer who adamantly believes, no matter what the nature of the testimony, that the investigator established in his or her own mind the innocence or guilt of a subject before completing the crime scene evaluation. It appears incomprehensible to counsel that the investigator can take the often subjective information reported and conduct an objective investigation. Such a reaction should not surprise us, because the idea of objectivity is relatively foreign to trial law. No matter what the underlying truth, lawyers (both the prosecution and defense) highlight the information that best serves their positions and attempt to diminish that which works against them.

The crime scene analyst, however, can ill afford to pursue his or her end with the same mindset. Choosing what evidence one will or will not consider in the analysis is heresy. Unfortunately, that trap is far too easy to fall into.

Within the scene lies the evidence, which, if properly analyzed, provides everyone with an ability to define specific facts and certainly infer others. Based on the totality of this information, it may well be possible to determine the most probable events surrounding the situation. Even if one is unable to define the overall event, proper analysis still allows for the elimination of certain events, which alone adds clarity.

No single forensic discipline has the potential to provide as much clarity regarding the occurrences at a crime scene as does bloodstain pattern analysis. That cannot, however, lead to an expectation that the bloodstain evidence will stand alone. In the right hands, however, bloodstain pattern analysis is an extremely effective tool for defining the truth.

Bloodstain pattern analysis is not for the casual investigator, who intends only to graze the surface, find a quick answer, and move on. The bloodstain

pattern analyst is truly one who reconstructs crime scenes. As such, he or she must understand all the forensic disciplines. The analyst must be able to objectively apply each category of evidence to the situation, inferring as little as possible, but recognizing the whole. In this fashion, the *evidence* establishes a knowledge base from which the analyst reaches the "truth."

In part, the oath of office for a U.S. Army Criminal Investigation Special Agent states: "*I shall at all times seek diligently to discover the truth, deterred neither by fear nor prejudice*…" We dedicate this book to the men and women, analysts and investigators alike, who recognize and understand the importance of their roles as objective truth seekers.

Editor's Note

This textbook is part of a series entitled "Practical Aspects of Criminal and Forensic Investigations." This series was created by Vernon J. Geberth, New York City Police Department Lieutenant Commander (Ret.), who is an author, educator, and consultant on homicide and forensic investigations.

This series has been designed to provide contemporary, comprehensive, and pragmatic information to the practitioner involved in criminal and forensic investigations by authors who are nationally recognized experts in their respective fields.

Acknowledgments

In considering a project of this nature, it is rarely the efforts of the authors alone that ensure success. We would like to offer thanks and acknowledgment to the following individuals for their support and efforts:

Rudi Jaehser of Frankfurt, Germany, for his untiring efforts in leading Ross through the bowels of the Frankfurt University library those many late evenings.

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The International Association of Bloodstain Pattern Analysts, the Rocky Mountain Association of Bloodstain Pattern Analysts, and the Association for Crime Scene Reconstruction, for establishing an environment in which we can all grow.

There are many more individuals who may not be named here. All have contributed to this discipline in some fashion, which in turn assisted in the writing of this book. We salute them for their individual efforts, insight, and resulting research in support of bloodstain pattern analysis and crime scene reconstruction.

The Authors

Captain Tom Bevel (Ret.) is the owner of TBI, a forensic education and consulting company. He is also an associate professor in the Masters of Forensic Science program at the University of Central Oklahoma, Edmond, Oklahoma. He retired after 27 years with the Oklahoma City Police Department. His last assignment was the Commander of the Homicide, Robbery, Missing Persons, and the Unsolved Homicide units.

Captain Bevel holds a Master of Arts degree in Administration of Criminal Justice from the University of Central Oklahoma. He is a graduate of the Scenes of Crime Officer course, Hendon, England; the Technical Investigations course, Central U.S. Police Institute, Oklahoma State University at Oklahoma City; the FBI National Academy; and the Post-Graduate Medical-Legal course, London Medical College, London, England.

Captain Bevel is a Fellow of the Association for Crime Scene Reconstruction (ACSR) and the American College of Forensic Analysts; a Distinguished Member of the International Association of Bloodstain Pattern Analysts (IABPA); a Regional Representative for the International Association for Identification (IAI); a member of the Editorial Board for the *Journal of Forensic Identification*; and a member of the Southwestern Association of Forensic Scientists (SWAFS) and the American Academy of Forensic Sciences (AAFS).

Captain Bevel has served as a crime scene consultant in more than 41 U.S. states and 8 foreign countries. He has been qualified as an expert in crime scene reconstruction and bloodstain pattern analysis in both state and federal courts.

Special Agent Ross M. Gardner (Ret.) worked for the U.S. Army Criminal Investigation Command (USACIDC) as a felony criminal investigator for more than 20 years. He retired as a Command Sergeant Major and Special Agent in 1999 after serving in U.S. Army law enforcement for more than 24 years and is now the Chief of Police of a small suburban Atlanta police department.

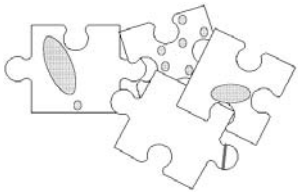
Special Agent Gardner holds a Master's degree in Computer and Information Systems Management from Webster University, a Bachelor's degree in Criminal Justice from Wayland Baptist University, and an Associate's

degree in Police Science from Central Texas College. He graduated first in his class at the Scenes of Crime Officer course, New Scotland Yard, Hendon, England. From 1988 to 1996 he served as an adjunct professor of the police science program at Central Texas College. He is a former President of the Rocky Mountain Association of Bloodstain Pattern Analysts (RMABPA) as well as the Association for Crime Scene Reconstruction (ACSR) and served as the Chairman of the Education Committee for both the RMABPA and the International Association of Bloodstain Pattern Analysts (IABPA).

Special Agent Gardner is certified by the International Association for Identification (IAI) as a Senior Crime Scene Analyst, a rating he has held for 10 years. He is an active instructor and consultant throughout the United States in crime scene analysis, bloodstain pattern analysis, and crime scene investigation, teaching to a variety of groups, from police and investigative organizations to trial counsel professional development groups. Special Agent Gardner has qualified as an expert in bloodstain pattern analysis and crime scene reconstruction in both state and federal courts.

Bloodstain Pattern Analysis: Its Function and a Historical Perspective

1



> And Cain quarreled with Abel his brother: and it came to pass, when they were in the field, that Cain rose up against Abel his brother, and slew him.
>
> And the Lord said unto Cain, Where is Abel, thy brother? And he said, I know not: Am I my brother's keeper?
>
> And the Lord said, What hast thou done? The voice of thy brother's blood crieth unto me from the ground. And now art thou cursed from the earth, which hath opened her mouth to receive thy brother's blood from thy hand. When thou tillest the ground, it shall not henceforth yield unto thee her strength; and a vagabond shalt thou be on the earth.[1]
>
> **Genesis 4:10**

Reading these passages one might wonder, was God really unaware of what transpired between Cain and Abel? Was He then convinced of the crime only by the presence of Abel's blood? This seems unlikely, given the nature of the Judeo-Christian God. Rather, it would appear that God was reminding Cain that no matter what Cain's denial, the physical evidence of the deed spoke in as strong, if not a more convincing, voice. In these few short paragraphs, we find the historical basis and very likely the first usage of bloodstain pattern analysis in a judicial setting.

The Function of Bloodstain Pattern Analysis

What is the function of bloodstain pattern analysis? Like any forensic science or discipline, bloodstain pattern analysis seeks to define the facts surrounding some incident that is in question. The examination of the physical nature of

bloodstains provides information specific to the events that occurred during the incident.

We often refer to what the analyst evaluates as the "static aftermath" of an event.[2] Dispersion, shape characteristics, volume, pattern, the number of bloodstains, and their relationship to the surrounding scene are part of this aftermath. This information provides the investigator with a window to the past. Clarity is not a guarantee, for it is possible the information present in the bloodstains will fail to illuminate any of the issues in question. Often, however, the analyst finds direct and convincing information that makes the role of the fact finder much easier.

The information we are likely to discover through an examination of the bloodstains includes:

- The direction a given droplet was traveling at the time of impact
- The angle of impact
- The probable distance from the target from which the droplet originated
- The nature of the force involved in the bloodshed and the direction from which that force was applied
- The nature of any object used in applying the force
- The approximate number of blows struck during an incident
- The relative position in the scene of the suspect, victim, or other related objects during the incident
- Sequencing of multiple events associated with an incident
- In some instances, which hand delivered the blows from a beating

The Relationship of Bloodstain Pattern Analysis to Crime Scene Reconstruction

Crime scene reconstruction demands that we evaluate all physical and testimonial evidence to derive some conclusion as to what occurred. As Geberth reminds us, for homicide investigations, case resolution hinges on "*careful and intelligent* [italics added] examination of the scene."[3] Much as does the reporter, the investigator attempts to define the who, what, when, where, how, and why of a crime to assist in reconstructing the events. There is an unfortunate problem associated with this process: there is no standard by which we can test our ultimate conclusions. An archaeologist once made an analogy about this difficulty. Discussing a dig and the conclusions drawn from it, he said, "It's something like putting together a jigsaw puzzle without having access to the boxtop. You really don't know what the picture is supposed to look like."[4] The investigator's box top is not available either. Despite

this limitation, crime scene analysis and crime scene reconstruction attempt to define the nature of actions that are so dynamic that even if we had a videotape of the incident, they might not be fully understood.

In their most classic use, the majority of forensic disciplines provide the investigator with information regarding the "who" of the crime. Blood typing, DNA evaluations, fingerprint evidence, and hair examinations help us decide who was or was not present at the scene. In this concept of "who," we also include areas such as forensic chemistry, biology, geology, and trace evidence examinations, because they help associate items to our player and to the scene. This, too, ultimately serves the function of defining the "who" of the reconstruction.

Our answers to "what," the actions that occurred during the crime, are sought most often through the application of forensic pathology. As Dr. James Luke stated: "From the standpoint of forensic pathology, the two major parameters that form the basis of any case investigation are (1) identification and documentation of the postmortem findings present, and (2) interpretation of those findings in the context of the *circumstances* [italics added] of death." [5]

In the past two decades, bloodstain pattern analysis has reawakened to its role in documenting these circumstances. Bloodstain analysis brings to the investigation the ability to define those events that could or could not have occurred during the course of bloodshed. Once identified, these facts are considered in light of all other evidence as a means of corroborating or refuting statements, confessions, or investigative theories.

Thus bloodstain pattern analysis mirrors in many ways the role of forensic pathology. Once again quoting Dr. Luke, "It is the responsibility of the forensic pathologist finally to construct a scaffolding of factual information against which witnesses' and suspects' statements can be evaluated."[6] Bloodstain evidence in this role (acting as a scaffolding or part of the lattice) cannot stand apart from other evidence.[7] Reconstruction demands that we consider all evidence. Viewed from a holistic approach, all the evidence available should lead those who view it to a preferably similar conclusion.

This concept of a generally agreed-upon conclusion should not be a foreign thought, particularly when considering bloodstain patterns. They are, after all, graphically oriented. For example, in describing a pattern transfer as "consistent with" something, any analyst should be able to point to some physical characteristic of the stain and then to the correlating item that created it. The analyst should then be able to create some generalized reproduction of the pattern using the item. If this is done, another analyst cannot simply ignore this information. Granted, we may discover a secondary method of creation, but this simply adds a responsibility to discover which is the more likely event. If a stain is observable and reproducible, it

is difficult for two analysts to rationally argue their beliefs from mutually exclusive positions. When this occurs it is very likely the result of subjective analysis on the part of one or both. Unfortunately, subjective analysis is a fact of life. To help preclude subjectivity, the analyst should attempt to achieve several things.

First, the analyst must understand all areas of forensic science and must have been directly exposed to crime scenes. Tom Griffin of the Colorado Bureau of Investigation often remarks that analysts need a "scene sense." This sense gives the analyst a more rounded perception, taking into consideration the many subtleties and interrelationships found at scenes. Evidence viewed from the confines of a white-walled laboratory is far too sterile. It leaves the viewer lacking a realistic perspective of crimes and crime scenes. It is this perspective that makes up "scene sense." As the SOCO course at the Hendon Detective Training School teaches, we gain much from viewing evidence *in situ.* This is true not only from a case perspective, but also for the long-term development of the investigator.

Do not construe the necessity for understanding these disciplines as meaning the analyst is an expert in all of them. Far from it — crime scene analysts are generalists. They have, much as does a manager, the knowledge to take the experience and expertise of the other team members and put them all together. This process is at the heart of crime scene reconstruction. As we will constantly remind the reader, it is not enough that the analyst can reconstruct the bloodstain evidence. A reconstruction that fails to consider all known evidence is no reconstruction at all.

Second, analysts must understand their discipline. Bloodstain pattern analysis is far from being a static field. Our understanding changes every day due to research and experimentation. As we base bloodstain pattern analysis on the application of physical laws to blood, there are certain universal rules we can apply. These rules are as true today as they were when first observed. Understanding these universal applications, and then seeking those areas that require further study, should be the lifetime goal of every analyst.

Historical Perspective of Bloodstain Pattern Evidence

In seeking an understanding of bloodstain pattern analysis, it is important to look at its evolution. In his 1992 book, *Blood Evidence*, Craig Lewis wrote: "The science of bloodstain pattern analysis, a field in which the only textbook in existence was written by MacDonell, was little known."[8] This viewpoint, although inaccurate, is not uncommon. Out of ignorance, authors, judges, and investigators continue to proclaim the discipline as something "new."

To those who spend time at scenes of violent crime, it seems unimaginable to ignore the presence of blood or not to ask some simple questions as to its relationship to the crime. Bloodstain pattern analysis, as we will see, is anything but new. It is only in the last several years that we have discovered some of the more important historical documents relating to bloodstain pattern analysis. The existence of these documents alters the somewhat biased view held by our investigative predecessors.

The mere presence of blood, excluding any formal analysis, has long been held as evidence of foul play. For example, in the development of early Germanic law, tribal code (private, as compared to state) was often created. One of the surviving documents of this nature is the *Sachsenspeigel*, compiled as a record of Saxon custom. A knight named Ritter Repkow wrote the document during the period 1220–1235. Common Law II, 63, Article 1-3 dealt in part with the raising of the "hue and cry" and the necessity of proving one's innocence for acting against a criminal caught in the act. He who had acted was required to prove an incontestability of the criminal's deed.[9] Examples of this proof, although not quite *beyond a reasonable doubt* included "a criminal caught red handed."[10] The *Sachsenspeigel*, with its detailed illustrations, makes reference to the criminal having been caught with blood on his hand.

The work of William Shakespeare, although not the typical reference material of the criminalist, is filled with references to blood and the prejudicial nature with which its discovery is viewed. Shakespeare's various works, written between 1582 and 1616, like those of any author, reflect the perceptions of his time. For example, in Act II, Scene II of *Macbeth*, after stabbing King Duncan, Macbeth says:

> What hands are here! Ha! they pluck out mine eyes. Will all great Neptune's ocean wash this blood Clean from my hand?[11]

Although of little concern to modern bloodstain analysis, the *Sachsenspeigel* and Shakespeare's plays do reflect the consideration of bloodstains as a basic issue, preceding the formal development of forensic science. They also reflect the prejudicial manner in which bloodstains are often viewed. An interesting artistic example of the prejudicial nature of bloodstains hangs in the Central Art Archives of Finland. The work is entitled *Fratricide*, by Akseli Gellen-Kallela (*circa* 1897). It shows a young man with a bloodied sword and clothing as his mother points to numerous stains on his clothing (Figure 1.1).

Another author whose writings reflect man's inquisitive nature with blood evidence is Sir Arthur Conan Doyle. In 1887 Doyle wrote *A Study in Scarlet,* introducing the world to his brilliant character Sherlock Holmes. In

Figure 1.1 *Fratricide* by Akseli Gellen-Kallela (1897), a painting owned by the Anteneum, the Antell Collection, and the Central Art Archives of Finland, photographed by Hannu Aaltonen. Beyond the issue of his bloody sword, the pattern transfer and blood spots on the young man's garments speak his guilt to his mother. (Photo courtesy of National Art Archives, Helsinki, Finland.)

this story, the master of deduction concerns himself not only with discovering a reliable reagent test for blood, but also within the examination of "gouts and splashes of blood, which lay all around."[12] Again, we see artistic indications that those concerned with the early investigation of crime considered the relationship of bloodstains to such crime.

Early Scientific References

Having considered several literary references, it seems appropriate to turn our attention to the scientific evaluation of bloodstain patterns. We intend to discuss some of the more critical and insightful research conducted over the last century; however, there are many references that may not be mentioned or discussed in detail. The analyst should recognize this and consider seeking these historical references for greater enlightenment.

In Germany and Austria, the universities at Kiel and Vienna appear to have been academic hotbeds of activity in bloodstain pattern analysis. Two significant authors of the time were Eduard Piotrowski and Ernst Ziemke, followed soon after by Dr. Balthazard of France.

The primary periodical in which many of the continental authors expressed themselves was the *Vierteljahresschrift für gerichtliche und offentliche Medizin* (*Quarter-Year Writings for Forensic Medicine*), published in Germany. Although much of the concern between 1850 and 1940 dealt with the identification of blood, scattered throughout these discussions are references to patterns observed at scenes.

Before proceeding, it is important to note that in German the term *Blutspritzen* was widely used by various authors. This term is translated most often as "blood sprinkles."[13] There is, however, no absolute translation and the terms sprinkle, spatter, splash, or spurt are all acceptable usage.[14] It becomes difficult, then, to always understand the specific context intended by any author. A caution is in order when considering the translations offered here.

In 1856, J. B. Lassaigne wrote "Neue Untersuchungen zur Erkennung von Blutflecken auf Eisen und Stahl" (New Examination to Differentiate Bloodspots from Iron and Steel). In the latter section of his paper, Lassaigne discusses marks that appeared similar to bloodstains but were caused by insects.[15]

Although Lassaigne made it clear he believed "crushing" of dead flies created such stains, he implied that he found such stains at scenes and associated their presence with the presence of flies. Based on the description, these stains seem similar to what we might refer to today as "fly specks." Unfortunately, the translation and overall description of Lassaigne cannot satisfy the issue. Had Lassaigne found "fly specks"? Was he then establishing a causal connection without considering the regurgitation of blood by flies at bloodstained scenes? Whatever the case, Lassaigne's observations establish his attention to detail and concern for differentiating such stains from normal bloodstains.

In 1863, John and Theodric Beck wrote "Elements of Medical Jurisprudence." The article, as reviewed by Herbert MacDonell, discussed various cases in which bloodstain pattern analysis was utilized. Specific references were made to the "situation" of wounds, and as MacDonell noted, the authors also used the term "blood sprinkles." The latter term tends to indicate a German influence, although the article originated in Philadelphia.[16]

In 1880, Dr. Henry Faulds published "On Skin-Furrows of the Hand," describing bloody fingerprints and their likely use to identify the criminal.[17]

In 1882, Professor Charles M. Tidy of London published "Legal Medicine," in which he stated:

> Few things hold so important a place as, or involve investigations of a greater nicety, than determining the precise nature of various [blood] spots or stains found on fabrics, instruments…"[18]

Perhaps one of the most impressive treatises written on the subject of bloodstain pattern analysis is *Ueber Entstehung, Form, Richtung und Ausbreitung der Blutspuren nach Hiebwunden des Kopfes* (*Concerning Origin, Shape, Direction, and Distribution of Bloodstains Following Blow Injuries to the Head*), written by Eduard Piotrowski of the University of Vienna in 1895.

Dr. Piotrowski's application of science to his observations and evaluations of bloodstains is unequaled in the known writings of the time. He reconstructed his scenes to model those in question, controlled and adjusted various variables to determine their specific effect on his experiments, and used live rabbits as victims! Although the latter issue would not sit well with many modern groups, Dr. Piotrowski recognized the dynamic nature of what he was studying.

Dr. Piotrowski considered this dynamic nature and used it as one of his variables. Calling the concept a "*complicertern morde*," he used multiple methods of attack against his study subjects (rabbits), thereby ensuring himself that he was considering all possibilities and their effects.[19]

In considering this *complicertern morde*, Dr. Piotrowski properly recognized the bodily reactions of his subjects when struck. In the following example he observed small stains "similar to dots" that radiated out from the rabbit's head, and he concluded:

> As far as their position is concerned, they spread out in a radiating pattern. The center of this outward radiating droplet [pattern] was the nostrils and mouth from which the accumulated blood was forced out… [expiratory blood].[20]

Evident to Piotrowski was the correlation between the location of the stain's tail and the direction the droplet was traveling at impact. He also recognized the causative factors of cast-off stains. He included in his evaluation of the first the effect of a parabolic arc on the resulting stain. In the latter, he isolated not only the fact that blood flung from a weapon would create a specific stain, but also correlated this with stain directionality, giving him an ability to define the direction in which the weapon was being moved.[21] In this work's concluding statement, Dr. Piotrowski commented: "… the formation, shape, and distribution of bloodstains follow specific rules and that these, allowing for many modifications considering the nature of the case, are not to be underestimated and are of great value in the judgment."[22]

In 1901 Jürgen Thorwald, writing to describe the efforts of Professor A. Florence, stated:

> [Florence] had worked out a whole system for classifying bloodstains caused by dripping, splashing, spurting, or grazing contact. Round stains, or roundish jagged stains, for example, indicate that blood fell vertically; oblong stains result from impact at various angles.[23]

Thorwald based his discussion on Florence's article "Les Taches de Sang au Laboratoire de Medicine Legale de Lyon." This article originally appeared in the *Archives de Anthropolgie Criminelle* in 1901.

In 1904, Hans Gross wrote *Handbuch für Untersuchungsrichter als System der Kriminalistik,* in which he provided a detailed discussion of not only the evaluation of bloodstains, but also their collection and documentation.[24] Gross felt bloodstains were of critical importance in the investigation and thus devoted some 30 pages of the book to his considerations of blood and bloodstain patterns in the investigative process.

In 1914, Haberda wrote "Eine besondere Form von Blutspritzen" (A Special Form of Bloodstain), discussing a specific pattern observed in airway injuries. He described such stains as droplets of various shapes that contained small air bubbles mixed with the blood. Beyond his consideration for this particular stain, Haberda offers many insightful lessons that are still applicable. Consider the following:

> The discovery of quantity, spread, form, and arrangement of bloodstains at a blood spattered crime scene can be of high importance. Evaluation requires many years of experience, usually learned little by little through practice, but never from books. Never the less, experts are often not careful enough when it comes to the necessary evaluation.
>
> Forced by precise questions of police, jurisdictional or governmental authorities, the experts sometimes answer too exclusively and draw the wrong conclusions about the bloodstains on a corpse or in the surrounding crime scene.[25]

We would agree wholeheartedly that oftentimes analysts make conclusions that are far too exclusive.

Haberda also made reference to bloody fingerprints, clothing pattern impressions, and his particular stain — the "foamy bloodstain." In describing the shapes of stains that might be encountered, Haberda wrote:

> Even though the distance of the fall, or the angle with which the blood hits the ground influences the shape of bloodstains, which are for example more or less round, bear paw like, club or bottle like…[26]

How similar to modern descriptions are Haberda's? *Round* and *bear paw* are still adjectives used to describe stains, whereas *elliptical* has replaced terms

such as *club* or *bottle-like*. There can be little doubt Haberda was observing and classifying the very characteristics we still look for today.

Ernest Ziemke is another author of interest. His work is found in *Gerichtsärztliche und polizeiärtzliche Technik,* a book edited by Theodor Lochte in 1914. Chapter 7, entitled "Die Untersuchung von Blutspuren" (The Examination of Blood Tracks), was written by Dr. Ziemke and includes 14 pages of text with numerous pictures; it details various stains and the information represented by those stains. Ziemke dealt with a wide range of issues affecting bloodstain pattern analysis.

In the chapter preamble, Dr. Ziemke states:

> Blood tracks [effects or evidence] are the most important tracks that stay behind after a crime is committed. Very often they alone have been of significant enough importance for the conviction of the suspect, and have been the focal point in a trial with only circumstantial evidence. … Their evaluation should be efficient, because during an investigation it may be hard to foresee what might be of importance later during a court trial.[27]

In discussing the search for blood, for both serological and bloodstain pattern evidence, Dr. Ziemke offers that:

> The suspect, his clothes, all items he carries, or which are in his pockets should be carefully examined for bloodstains.[28]

This is sound advice that some of the best bloodstain pattern analysts in the country continually stress and teach today. Far too often such minute traces are simply overlooked by investigators.

In discussing pattern analysis and the conclusion drawn, Dr. Ziemke comments:

> Very important conclusions can be drawn from the arrangement, location, size, and form of bloodstains. … Based on our own experience and experiments we want to point out that it is necessary to be cautious and not draw conclusions from a single or very few blood tracks. This happens quite often. … Only when a large number of bloodstains are examined and compared, is it possible to exclude errors [in logic].[29]

Dr. Ziemke provided detailed descriptions of various types of bloodstains. His terminology followed that of Piotrowski, but he added terms such as "thorn apple shaped" to refer to the bear claw stain. He acknowledged that secondary droplets (wave cast-off stains) in these instances would indicate the direction of motion of the blood droplet. He included figure examples of cast-off blood and drip patterns in which he described how to define

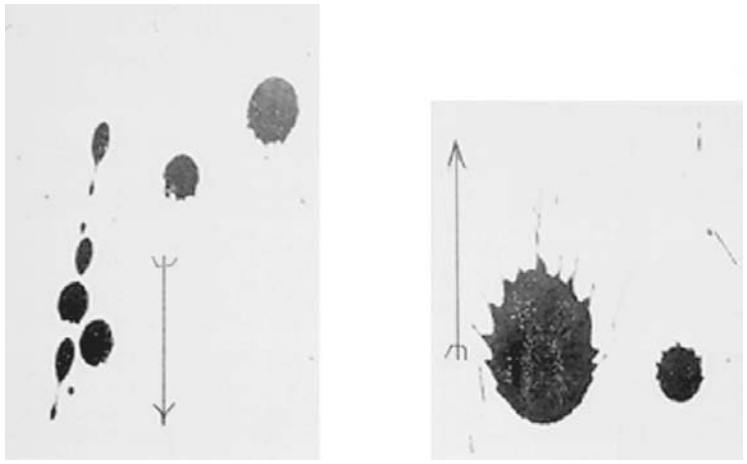


Figure 1.2 Illustrations from Dr. Ziemke's chapter (see Ref. 27) on bloodstain patterns that relate to defining directionality of the stain. The two figures (Ziemke's Figures 42 and 43) demonstrate a drip effect from walking and running. Ziemke added the arrows to show the directionality evident in the stains.

directionality. Figure 1.2 is an example of one of these illustrations. In closing his discussion of bloodstain patterns, he stated:

> When the examination of bloodstains is done efficiently and carefully, and if all possibilities are exhausted, shape, location, and the site of the bloodstain can give important details about the circumstances of the deed, eventually even be of importance for the conviction of the suspect.[30]

Dr. W. F. Hesselink, writing in 1931, considered various issues related to bloodstain analysis in his article "Blutspuren in der kriminalistischen Praxis." For example, Hesselink considered the subsequent condition of the dried stains on clothing as a manner of differentiating whether such clothing had been worn or in use since the deposit of the stains. He also considered a method of dissolving the bloodstain to determine its relative age when compared to some other stain. Hesselink eventually concluded this technique was inaccurate, indicating that the manner in which each droplet dried and coagulated would affect the results. He also considered whether a suspect would or would not be stained in a violent murder, making the following observations:

> The answer depends upon two main circumstances: one, if many bloodstains are found at the scene, and two, what instrument was used. Regarding this I did several experiments. When using the hammer, the liquid squirts in all four directions, and will also cover the suspect. If a stick is

> used, the blood squirts left and right, and the suspect might not show any blood marks. When a forward bent file is used, the blood squirts only to the front. The foreground [of an illustration] shows many spatter while only a few went towards the subject. While the suspect of a bloody murder, performed with a hammer, usually will be bloodstained, the suspect, in case of death caused by hitting with a bent file might have few or no bloodstains on the clothes.[31]

Hesselink then described the use of a pattern transfer he discovered, stating:

> In one murder, I found a blood spot on the bedroom floor. First, it did not look too informative, but when I examined it later with a very strong light, I found remarkable prints of about 14 shoe nails.[32]

Hesselink sought to define not only the nature of the stains found, but also the manner of the event creating the stains. He then correlated the information with other forensic evidence, resulting in a partial reconstruction of his scene and the crime. His recognition of the importance of bloodstain pattern analysis for this purpose is reflected in his closing statement:

> Therefore, when examining blood, the blood investigation [to identify a substance as blood] itself is not as important as the clarification of surrounding circumstances.[33]

In 1931, Henry T. F. Rhodes, a criminologist in England, member of the International Academy of Criminology, and an admirer of the great criminologist Edmund Locard, published *Some Persons Unknown*. The book was a compilation of case studies with a history of the scientific development of criminology. Although Rhodes did not discuss the use of bloodstain patterns in and of itself, he discussed in depth the development of the identification of blood in forensic investigation. He commented on the ever-increasing discrimination required by the court in terms of making identification of blood. Rhodes stated this manifested itself in the change of accepted testimony from "it looks like blood," to "yes, it is blood," to "yes, it is blood and it is human." At the time of publication the four categories of blood, which ultimately became known as the ABH/ABO grouping system, had just been discovered. Rhodes recognized this advancement as a significant investigative tool with which to primarily exclude individuals as suspects.[34]

Rhodes followed his first book with a second entitled *Clues and Crime.* Published in 1933, the theme of the book was consideration of how science assisted in the detection of crime. Rhodes did not comment himself on

bloodstain patterns but gave specific mention to the efforts of Hans Gross in bloodstain pattern analysis.[35]

In their writings it is obvious that Hesselink and Rhodes clearly viewed blood from different perspectives. Rhodes understood what Gross was pursuing in the area of bloodstain patterns, but he felt the scientific individualization through the blood grouping systems of the time was of greater significance. Hesselink, on the other hand, felt the individualization and identification was secondary and that the patterns themselves were of greater significance. Today we recognize that both were correct. The individualization of blood stains without consideration of the pattern itself or vice versa is tantamount to reading a book but skipping chapters.

In 1939, at the XXII Congress of Forensic Medicine, one of the most insightful papers relating to bloodstain pattern analysis was presented by Dr. Victor Balthazard, R. Piedelievre, Henri Desolille, and L. Derobert. Entitled "Etude des Gouttes de Sang Projecte," the proposed purpose of the research was to pinpoint characteristic elements of a bloodstain which might "give decisive hints" as to its origin.[36]

Balthazard et al. felt it necessary not only to examine the resulting spatter and stains, but also to understand the manner in which blood exits wounds, the trajectories of such blood, and the manner in which the blood droplet changed to become the resulting stain. Like Piotrowski, Balthazard recognized the importance of the dynamics involved in bloodshed and realized bloodshed could not always be mimicked under laboratory conditions. To provide more realistic data, Balthazard utilized rabbits to produce actual bleeding injuries.[37]

Balthazard's consideration of the length-to-width ratio of a stain as a function of impact angle is one of the most important contributions of his work. Analysts repeat his experiment in nearly every 40-hour bloodstain pattern analysis course taught today. In considering impact angle estimations, however, Professor Balthazard cautioned:

> In practical application, it [impact angle evaluations] should not be looked after for an illusionary accuracy. Nevertheless, this curve permits an estimate of the impact angle with an acceptable accuracy, sufficient for practical purposes.[38]

Another important consideration was determining the point of origin. Balthazard furthered the cause and process for making such estimations. His group's efforts established the basis for current "stringing" techniques. Yet, in considering the issue of the unknown parabola of the droplet, Balthazard stated:

> Practically these methods can only be applied in a limited manner. [For instance] sometimes it is necessary to find out whether a victim, at the moment he was injured, stood on his feet or was lying.[39]

Finally, Balthazard's group considered the nature of the target on which a droplet fell. They found that many deformations would be possible, given various target characteristics. In summary, Balthazard stated:

> These modifications [deformations caused by the target] are sometimes obvious, but we must constantly remember that on an apparently homogeneous target, uneven areas can occur which may cause slight disfigurations.[40]

It is likely that world events in Europe prevented further significant development of Balthazard's research. Nevertheless, his group's efforts were not completely lost. In 1941, John Gohringer, a U.S. citizen studying for his medical degree at the Institute of Forensic Medicine, University of Heidelberg, wrote as his inaugural dissertation, "Kann aus dem Bild auf verschiedenen Unterlagagen die Fallohe und Richtung des gefallenen Tropfens Ermittelt Werden?" (Is It Possible to Establish the Falling Height and Directionality of a Dropped Down Drop of Blood from the Appearance of the Stain on Various Targets?). Much of Dr. Gohringer's inspiration developed from Balthazard's research. An interesting historical note: Dr. Gohringer completed his studies in December 1941 and was subsequently held as an internee by the German government for 7 months before he was released to Vienna. He later returned to the U.S., where he practiced medicine. In 1992, Dr. Gohringer spoke before the International Association of Bloodstain Pattern Analysts (IABPA) Training Conference in Colorado Springs, and shared some of his thoughts on the history of bloodstain pattern analysis.[41]

Dr. Paul Leland Kirk, of Berkeley, California, also added immeasurably to the knowledge of bloodstain pattern analysis. Dr. Kirk, a Professor of Criminalistics and Biochemistry, was active in assisting law enforcement organizations in the U.S. from 1935 to 1967. Kirk's book, *Crime Investigation*, published in 1953, included a chapter entitled "Blood: Physical Investigation," in which he discussed the application of bloodstain pattern analysis to criminal investigations.[42]

Another source for Kirk's beliefs on the subject is his affidavit filed in the Court of Common Pleas, Criminal Branch, in the case of the *Ohio v. Samuel H. Sheppard*.[43] This document provides immense insight to his approach to bloodstain analysis.

In the Sheppard case, Dr. Kirk considered the drying times of blood and the evaluation of blood trails as evidence. He specifically sought to evaluate

plausible causes for such trails. Further, he identified a void in the bedroom of Mrs. Sheppard that others missed, which established the most likely position of the attacker. He then correlated the cast-off patterns found in the room to the position of this void. Dr. Kirk clearly utilized a whole-scene approach.*

In 1960, Dr. Jozef Radziki of Warsaw, Poland, published "Slady Krwi w Praktyce Sledczej" (Bloodstain Prints in the Practice of Technology). Although a full translation is not yet available, MacDonell had portions translated for inclusion in the IABPA library. In this work, Dr. Radziki established three basic groups of bloodstains, based on their mechanisms of creation. They are:

1. Bloodstains resulting directly from extravasation — drops, gushes, and pools of blood
2. Bloodstains resulting from the application of various instruments — spatter, cast-offs, and patterns resulting from direct contact
3. Bloodstains resulting from the wiping or removal of blood

As with previous authors, Dr. Radziki cautioned that a critical consideration were the characteristics of the target surface, because blood stains created under similar circumstances but falling to different targets might well result in dissimilar stains. Another interesting point made by Dr. Radziki included his assertion that "how" an instrument was employed would clearly affect the nature and distribution of the resulting spatter. Dr. Radziki also discussed arterial bloodstain patterns in depth.[4]

Modern Works in Bloodstain Pattern Analysis

Having dealt with a "historical" view of bloodstain pattern analysis, we arrive at a more recent history. Following Dr. Kirk's efforts throughout the 1960s was what might be considered the modern renaissance of the discipline. The number of authors writing on this subject increased dramatically, professional associations related to the field were established, and the discipline as a whole took on a far more accepted status in court.

Many proclaim Herbert MacDonell as the father of modern bloodstain pattern analysis. Whether this is accurate depends on your individual perspective. What cannot be denied is that Herbert MacDonell brought about a distinct reawakening of this discipline.

* We must make one point when considering this document. Whereas Dr. Kirk's knowledge and consideration of bloodstain analysis are unquestionable, we feel his reconstruction in the Sam Sheppard case is difficult to defend. He managed to interweave extremely subjective information into his opinion of what was or was not a fact.

In 1970, after conducting extensive research, MacDonell and Lorraine Bialousz coauthored *Flight Characteristics and Stain Patterns of Human Blood*. Because the two were working under a Law Enforcement Assistance Administration (LEAA) grant, the LEAA published the report. The LEAA document remained available for nearly 12 years before going out of print. In 1982, the revised paper was released as *Bloodstain Pattern Interpretation*. MacDonell subsequently completed a third work on the subject in 1993, entitled *Bloodstain Patterns*.

In 1983, Dr. Henry Lee, Peter Deforest, and Dr. R. E. Gaensslen wrote *Forensic Science: An Introduction to Criminalistics*.[45] Included in this work is a 12-page section dedicated to explaining bloodstain patterns.

In 1983, the IABPA was formed. The association's stated purpose is to promote the general knowledge, techniques, and understanding of bloodstain pattern evidence.*

In 1986, the *Journal of Forensic Sciences* published two papers by Peter Pizzola, Steven Roth, and Peter Deforest, entitled "Blood Droplet Dynamics — I and II." The group sought to examine the dynamics of liquid droplets in flight and photographed droplet impacts, providing a more accurate understanding of the action often referred to as "wave cast-off." In "Blood Droplet Dynamics — II," Pizzola et al. clearly demonstrated that motion in the target could mimic characteristics of an impact at an angle greater than that which occurred. Their findings are extremely important in our efforts to understand dynamic scenes of crime.[46]

In 1989, William Eckert and Stuart James published *Interpretation of Bloodstain Evidence at Crime Scenes*. Although the book received a very critical review in the *Journal of Forensic Science,* it was the first attempt in almost seven years to tackle bloodstain pattern analysis as a single reference text.

The following year, the International Association for Identification (IAI) accepted bloodstain pattern analysis as a tentative discipline, removing it as a subcategory of crime scene analysis. That same year, we wrote *Bloodstain Pattern Analysis: Theory and Practice — A Laboratory Manual*.

In 1998, James and Eckert published the second edition of *Interpretation of Bloodstain Evidence at Crime Scenes* with CRC Press, significantly adding to its value. Prior omissions were corrected and the text remains a valuable reference.

James followed this work *with Scientific and Legal Applications of Bloodstain Pattern Interpretation*. James put together an impressive group of contributors, including Alfred Carter, Ph.D., William Fischer, Carol Henderson, Paul Erwin Kish, Maria Saccoccio, and T. Pualette Sutton. The text was

* In support of this role, each year the IABPA hosts training seminars dealing with bloodstain pattern analysis and other related forensic disciplines.

directed toward trial counsel in an effort to help lawyers better understand how to apply bloodstain pattern analysis in criminal trials.

Summary

Whatever we might say of bloodstain pattern analysis, it has a rich history; one that indicates the consideration of bloodstains in solving crime predates even modern forensics. As to the issue of being a "new" discipline, the examination and consideration of bloodstain patterns and their historical acceptance in forensics is well documented. Long recognized for its ability to support the evaluation of scenes of crime, bloodstain pattern analysis serves the investigator by illuminating "what happened." It cannot tell us in all cases "who," but as Piotrowski and Hesselink discussed, the ability to define the "situation" or "circumstances" of the crime is often just as important.

Working with an understanding of all areas of forensics and with experience in evaluating crime scenes, the investigator can often use bloodstain pattern analysis to reconstruct the events surrounding a given incident. More and more, this process of crime scene reconstruction is being tested in our judicial system, but it is only through the application of quality objective analyses that the discipline can hope to serve its intended function. As analysts, our purpose must always be to guard against subjective analysis.

As we wrote in 1990, "*each day, blood from scenes of a crime cries out to investigators*." The use of proper bloodstain pattern analysis simply enhances the criminalist's ability to be an active listener to this very vocal witness.[47]

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Figure 4.25 Stain shape and impact angle. The orderly collapse of the droplet

onto the target produces characteristic shapes depending on the angle of impact.

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