Happy fall y’all! I hope you are all safe and healthy. This is the week we should all be together in Greeley, Colorado for our educational conference. Instead, we are still navigating Zoom meetings, masks, and social distancing. Hopefully this will soon be a thing of the past and we can resume life as we once knew it – together with our friends the best conference in the world.

We are saddened by the loss of two amazing contributors to bloodstain pattern analysis, Dr. Michael Taylor and Dr. Tony Raymond. The legacy they have left will live on forever and they will never be forgotten. Please visit the memorial page on the website and if you missed the memorial service for Michael, you can view it on Facebook. It was amazing.

The Executive Board and the Conference Committee continue to meet every Tuesday to discuss Association business and put the finishing touches on the Virtual Conference. If you haven’t already done so, mark your calendars for November 16th – 20th. We are still accepting abstracts if you would like to present this year. It has been great seeing everyone’s faces every week and I really hope having virtual meetings continue (maybe not EVERY week, but at least once a month). Again, I want to acknowledge Eugene Lisio, Jeremy Morris, Kacper Choromanski, and Lisa Perry for working nonstop behind the scenes to make sure this conference is successful. You guys are the best and are greatly appreciated.

Congratulations Elizabeth Pierri on your promotion to Executive Assistant Director for the NCIS Global Operations Directorate. This is an amazing accomplishment and we are so proud of you.

I hope to see you all virtually in November! If there is anything the Executive Board or I can do for you, please let us know.

Sincerely,

Celestina Rossi

President
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“The objectives of the International Association of Bloodstain Pattern Analysts are to promote education and encourage research in the discipline of bloodstain pattern analysis. The Association shall encourage the study, improve the practice, elevate the standards, and advance the cause of this discipline by promoting the standardization of bloodstain pattern analysis, training, and reporting.”

Journal of Bloodstain Pattern Analysis
Jeremiah A. Morris, Editor
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The Journal of Bloodstain Pattern Analysis is published quarterly and is the official publication of the International Association of Bloodstain Pattern Analysts. The Journal of Bloodstain Pattern Analysis is committed to the dissemination of information relevant to the Association, its members, and the discipline of bloodstain pattern analysis.

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In Memoriam

Michael (Tony) Raymond

VALE

It is with great regret that we acknowledge the death of Dr Michael (Tony) Raymond AM who passed away quietly at home with family on Sunday 23rd August, 2020. Tony played a significant role in the advancement of forensic science both nationally and internationally and we gratefully recognise his extraordinary contribution in a career spanning over four decades.

Tony graduated with a Bachelor of Science (Hons) from the University of Natal, South Africa, before completing a Graduate Certificate of Education from the University of Rhodesia, Zimbabwe, a Master of Science in forensic science from the University of Strathclyde, Scotland and a Doctorate in Philosophy: Bloodstain Pattern Analysis (BPA) from La Trobe University, Melbourne. His doctorate, titled “Trajectory Reconstruction from Bloodstains at a Crime Scene” reinforced the foundational science underpinning BPA as a forensic discipline. Notable publications from this research include “The physical properties of blood – forensic considerations” and “Oscillating blood droplets – implications for crime scene reconstruction”.

Tony began his career in Zimbabwe and was the Director of the Zimbabwe Republic Police Forensic Laboratory. He became Assistant Director at the Victoria Police Forensic Science Centre after emigrating to Australia with his young family in the early 1980’s.

Tony was the principal scientist in the landmark Royal Commission of Inquiry into the Chamberlain Convictions and the McLeod-Lindsay Inquiry; the latter having been described as a watershed case for BPA in Australia. He held the position of Director of the Forensic Services Group, later Chief Scientist of the New South Wales Police Force (NSWPF) and served as Director of the National Institute of Forensic Science (NIFS). As an Adjunct Professor at the University of Western Sydney after his retirement, Tony continued to have influence within the forensic sciences, using his expertise in both BPA and DNA to educate and encourage research master’s and PhD students.

Tony was instrumental in the establishment of a BPA Training and Education Standards Committee, which later evolved into the NIFS BPA Scientific Working Group. This group is responsible for transformational standardisation of training and reporting requirements for analysts across Australia and New Zealand. As an experienced and highly qualified practitioner himself, Tony facilitated several national BPA training events.

His further contributions include past President of the Australian and New Zealand Forensic Science Society (ANZFSS), past Chairman of...
the Senior Managers of Australia and New Zealand Forensic Laboratories (SMANZFL) network and SMANZFL International Liaison Officer, member of the Australian Academy of Forensic Sciences (AAFS) and member of the National Council as Treasurer. Tony was also a Fellow of the Australasian College of Biomedical Scientists, and an Honorary Fellow of the Australasian College of Legal and Forensic Medicine.

Dr Raymond was made a Member of the Order of Australia in 2010 for “service to forensic science in the field of law enforcement through the development of technological advances, including blood pattern analysis and DNA related identification, and through leadership and advisory roles.” He would be recognised by his peers for his work in 2014 as a recipient of the International Association of Forensic Sciences (IAFS) Adelaide medal and the Australia New Zealand Policing Advisory Agency (ANZPAA) John Harbor Phillips Award for excellence in forensic science. Tony was awarded an NSW Police Commissioner’s Commendation for DNA-related service and is also a recipient of the NSW Police Medallion for diligent and ethical service.

Tony has several presentations, journal publications and book chapters to his credit. He was an educator, mentor, and inspiring leader in bloodstain pattern analysis and the wider forensic sciences and will be sadly missed.
In Memoriam
Michael Taylor
September 18, 1953—September 1, 2020

Profound impacts and revolutionary ideas in modern bloodstain pattern analysis

Michael Taylor changed the forensic world, particularly the world of bloodstain pattern analysis, in a quiet and gentlemanly but globally significant fashion. The IABPA Distinguished Member, revered mentor, good friend, and colleague of many, passed away peacefully in his home on Tuesday, September 1st, 2020, surrounded by his loving family.

Michael was an outlier by every definition of the word, right to the very end of his earthbound chapter. In 2014 he carefully explained the probabilities of him seeing out the year, based on posterior odds and prior odds. There had been a few recorded cases, he told us, where people with this condition had made it to the two-year mark. Well, Michael made it past six. We will be forever grateful for those bonus years we and his family were able to spend with him. Michael retired as Science Leader at the Institute of Environmental Science and Research (ESR), Christchurch Science Centre, New Zealand in May, after 41 years of service.

While always searching for an objective scientific basis to explain crime scene observations, Michael’s main quest was to really understand the underlying fluid dynamics of bloodstain pattern formation. For twenty years Michael mentored and supervised postgraduate research students who had the privilege of helping him formulate the ideas and questions he had about BPA. There were many attempts at modeling the human head for BPA reconstruction. Over the years many students helped Michael to create skulls, brains, skin, arms, legs, and all manner of weird and wonderful gadgets to kick, stomp, stab, shoot, and spatter blood. All of this to advance our understanding of bloodstain pattern analysis. Then there was the steady evolution of the high-speed video capabilities, which opened up an even greater understanding of how bloodstains are formed.

Michael enjoyed many collegial relationships with collaborators, who indeed became good friends, all around the world. Of particular note was his collaboration with Bart Epstein and Terry Laber in 2007 which led to the MRFC video project: the outcomes of which are regularly used to teach BPA worldwide to this day. This research carried on for a number of months in both Christchurch and Minnesota and established a strong relationship between the three. Michael taught them what “spot-on” means and they taught Michael how to accurately drop blood from great heights and also how to shovel snow.

Michael found a new way to influence analysts when he suggested to Mark Jermy that they develop the world’s first course on the fluid mechanics of bloodstain pattern formation. Michael wove together fundamental theory and hands-on practice to get at what really makes
BPA work. Roz Rough joined the teaching team in 2015, and the course has now run 20 times in 6 countries, training 216 analysts.

Michael was awarded the IABPA Distinguished Member in 2015, which was presented to him in Christchurch, New Zealand, via video link, in a surprise ceremony attended by his family, friends, and colleagues. Over a hundred colleagues, former and current students from around the world sent congratulatory video messages, thanking him for his substantial contributions, both to forensic science and to their own lives. Such was his legendary influence, not only on the scientific frontier but on those he worked with, taught, influenced, and inspired. The influence that Michael has had, and will continue to have on the global BPA community is, simply, immeasurable.

Many scientific careers have flourished because of his belief in people. One of his favorite questions was "why not?". This true, honest leadership was the catalyst for many dissertations, MScs, and a number of PhDs - including the formation of his "Bloody Doctors", named for doing PhDs or postdocs in BPA. He was very proud of his students and the impact that we have all made in forensic science. Michael’s influence and support have deeply influenced their professional careers and personal lives. One even has a husband that he found for her!

"Let the data speak" Michael would say, never afraid to ruffle feathers in the pursuit of good science (all while being gentle, humble, kind, and having fun). He has instilled in his students and colleagues that boldness to stand up for what they believe in. For all his students, it has been an extraordinary privilege and good fortune to have the greatest mentor, MSc/Ph.D. supervisor, and friend that anyone could ever ask for. It is difficult to express in words the gratitude we feel towards Michael for everything he did for us. He taught us to ‘think’ like scientists and passed on a plethora of skills and knowledge but moreover, he set an example of how to be an impeccable human. He led with a very balanced, rational, educated, and considered (but humorous) approach. He never, ever gave up on his students, even when they gave up on themselves. To be a “student of Michael Taylor” means more than just getting a degree, it means that you will be recognized by the forensic community as having gained the Taylor philosophy and that you will pass that on to others.

Michael was also a God-fearing man. He held God at the very center of his life and especially in his final days spoke deeply of his love for God, the profound trust he had in Jesus, and the greater plans that he knew God had for him. Michael had a great sense of knowledge and wisdom that came through not only in his forensic teaching but in how he chose to live his life with God at the heart of it all. He was bold, he was bright, and had a heart after God. How blessed we are to have had a man of great faith in our midst.

Dr. Michael Taylor, The Boss, MCT, Michael, we miss you.
Call for manuscript submissions and other relevant content

The goal of the *Journal of Bloodstain Pattern Analysis* is to be the primary venue of information related to the IABPA as well as the science of bloodstain pattern analysis. The Publication Committee can gather information about the Association, upcoming training, and published papers; however, this is only a small part of the available information.

We know members of the IABPA—practitioners, instructors, and researchers—are constantly learning new things about the science. Unusual patterns are observed at scenes, training exercises create patterns with unexpected features, or research fills in knowledge gaps. We are asking IABPA members to share this information with others in the discipline by submitting it to the *Journal* for publication. There are numerous possible contributions which will be accepted:

- Images of a pattern with a brief description
- Summary of a case and lessons learned
- Results of experimentation
- Manuscripts of a research project
- Summary of published articles on a specific topic
- Review of new technology or a new product

All case reports, results of experimentation, research projects, and summary articles will go through a true blind peer review process in order to assure any content within these categories is scientifically valid and also of high quality. All material must be original content and cannot have been previously published. Any detection of plagiarism within submitted content will result in an immediate rejection of the content with no option for re-submission.

Authors of content specific to a case must have secured appropriate permission to discuss the provided details of the case within the *Journal*. The Editor reserves the right to request documentation of this permission prior to publishing the material.

If you have any questions, please don’t hesitate to reach out to the Editor or anyone on the Publication Committee.

Organizational Notices

All changes of mailing address need to be supplied by email to our Secretary Anthony Mangione ([amangione@iabpa.org](mailto:amangione@iabpa.org)). Members also need to update their contact information profiles on the [website](http://www.iabpa.org).

The fees for application of membership and yearly dues are $40.00 US each. If you have not received a dues invoice for 2019 please contact Anthony Mangione at [amangione@iabpa.org](mailto:amangione@iabpa.org). Also, apparently, non US credit cards are charging a fee above and beyond the $40.00 membership/application fee. Your credit card is charged only $40.00 US by the IABPA. Any additional fees are imposed by the credit card companies.

IABPA now accepts the following credit cards:

- Discover
- MasterCard
- American Express
- Visa
Although the current pandemic changed the look and location of our annual training conference, the Executive Board and Conference Committee are excited to meet this new challenge and offer the Association’s first ever Virtual Conference. The Conference will be run through Zoom and registration will be set up soon. Visit www.iabpa.org for regular updates.

This format provides more flexibility regarding the schedule. Instead of a single session each day which works for some time zones but not others, the Conference will be split into three different sessions – Americas (New York time zone), Europe (Paris time zone), and Asia-Pacific (Sydney time zone). The current schedule is depicted below. All times are local for the stated city.

While the details are still being worked out, the plan is for registrants to have access to all sessions, regardless of their home region. The Committee is looking into recording some presentations for short term access for registrants who could not listen to the presentations live.

Abstracts are still being accepted and a submission form is on the following pages.
The 2020 IABPA
Virtual Training Conference
16-20 November 2020

CALL FOR PRESENTATIONS

The IAPBA is pleased to announce their annual virtual conference will be held online from November 16-20, 2020. The theme of this year’s conference is, "IDEAS in BPA",

1. Presentations on various topics of BPA with respect to new research as well as case studies will be accepted. Any research should include suggested pathways of findings into casework. Case studies should include what research could further assist similar cases in the future.

2. Presentations will be limited to 30 minutes with 25 minutes for the presentation itself and 5 minutes for questions. Presentations will be delivered via ZOOM and speakers are asked to pre-record their talk or present live online.

3. Since this next conference will be available globally, speakers are asked to choose a time zone or region where their presentation will be broadcast. Further details and exact suggested time will be scheduled at a future date and every effort will be made to accommodate speaker’s schedules. Speakers are asked to be present to answer questions after any pre-recorded presentations are broadcast.

   Deadline for Abstracts: 11 October 2020
   Deadline for recorded video: 31 October 2020

4. Please note that presenters bear responsibility for all associated costs and IABPA is not able, nor accepts any liability, to reimburse presenters for attendance and/or any costs incidental to the presentation.

5. Once completed, please submit the form below to 2020abstracts@iabpa.org in order for your presentation abstract to be reviewed.
IABPA Virtual Conference 2020
Speaker Abstract Submission

Speaker Name:

Title of Presentation:

Speaker Affiliation:

Speaker Bio (min 150 characters, max 270 characters):

Presentation Abstract (min. 280 characters, max 720 characters):

Contact Email:

Presentation Format:
- [ ] Live
- [ ] Prerecorded

Preferred Region:
- [ ] Americas
- [ ] Europe
- [ ] Asia Pacific
Accuracy of Digital Ellipse Marking for Bloodstain Pattern Analysis

Eugene Liscio, P.Eng. 1, Craig C. Moore, BSc. 2

1 — ai2-3D, Woodbridge, Canada
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Abstract

This blind study looked at the accuracy of 101 individuals and how well they could mark a set of 18 digital images of perfect ellipses. The ellipses were created in a 3D modeling program thereby eliminating subjectivity due to blurred images, low resolution, extended tails, wave cast-off or other spatter stain defects. The images were 1600 x 1600 pixels and minimum number of pixels for the smallest ellipse was approximately 830 pixels while the longest ellipse was approximately 1370 pixels long. These digitally created bloodstains ranged from 5° to 90° with participant errors increasing noticeably for bloodstains greater than 70°. Bloodstains which were perfect circles (90°), were the most problematic and had errors greater than 7° although the mean error was slightly over 3°. The results of this study provide a “ground truth” for the best possible conditions an analyst may have when marking bloodstains.

Keywords — Forensic science, bloodstain pattern analysis, bloodstain ellipse, area of origin, Balthazard, CloudCompare

INTRODUCTION

Bloodstain pattern analysis relies heavily on the understanding and classification of bloodstains found at a crime scene. Analysts examine the size, shape, distribution and location of the bloodstains to try and determine things such as where an assailant may have been located or where a victim was struck. When considering impact stains, both the area of convergence and area of origin [1] may be calculated to demonstrate where the impact took place in two-dimensional or three-dimensional space. Traditional methods of stringing and newer, digital methods often involve identifying and selecting bloodstains to include in an analysis [2]. Part of this process requires that the analyst measures the width and length of each bloodstain and often, this can prove to be a difficult exercise since bloodstains are not always found in perfect form. Depending on factors such as environmental conditions and surface properties of a target surface, bloodstains may be malformed and require some knowledge to interpret the correct shape.

Marking errors resulting from incorrectly marked bloodstains (i.e. the marked shape of the ellipse does not agree with the known impact angle or true width to length ratio of the bloodstain) contribute to the overall errors in an area of origin or convergence analysis. Errors
when most problems associated with bloodstain ellipse marking have been removed.

There are two conditions that can exist for any bloodstain. Bloodstains may be circular (i.e. where a blood drop hits a surface at 90° and the length and width are equal), or they may be elliptical, with the length making up the major axis and the width, the minor axis (Figure 1). Passive blood drops such as those dripping from a bloody nose while a person is standing still, appear circular, while blood drops from a person moving (i.e. having any motion component parallel to the impacted surface) will exhibit a more elliptical shape (Figure 2).

The impact angle, which is directly related to the shape of the bloodstain, can be expressed by the equation:

\[ \theta = \sin^{-1} \sqrt{\frac{w}{l}}, \]

may be due to an analyst’s subjective interpretation which may be complicated by malformed bloodstains and estimations of where to place an accurate ellipse around an individual bloodstain. One question which has not been addressed in ellipse marking studies is performance when bloodstains are near perfect and photographs are of high quality. Thus, this study addresses a best-case scenario for analysts.
where $\theta$ is the impact angle of the bloodstain, $w$ is the width of the bloodstain (minor axis, e.g. 5 mm) and $l$ is the length of the bloodstain (major axis, e.g. 10 mm).

**History of the Impact Angle Equation**

In his 1895 text entitled, Origin, Shape Direction and Distribution of the Bloodstains following Head Wounds Caused by Blows, Eduard Piotrowski ran a series of experiments looking at bloodstain impacts. One of these experiments consisted of striking a rabbit on the floor and noting the impact patterns created on a set of temporary walls lined with paper. Different instruments were used to create the blows and subsequent strikes caused blood volumes to break free into airborne droplets. He noted that the shape of the bloodstains differed significantly and could often approximate the originating location [3].

Approximately 40 years later, four French researchers, Victor Balthazard, René Piédelièvre, Henri Desoille, and Léon Dérobert ran several experiments with rabbits. Some tests involved drops which fell from different heights, striking different textured surfaces including textiles. They incorporated oblique targets set to specific angles and utilized high speed “cinematographic” stop motion filming with rapid pulse strobe lighting to assist in their data collection [4]. Their work culminated in a research paper they presented and later published just a few months before France was engulfed in the second World War.

The research conducted by Dr. Balthazard et al. generated a ratio with the width divided by the length of a stain that strikes the surface at an angle relative to the surface. Here they were measuring outer edges of the width and length of these stains. They ran into difficulty in determining the end of extremely elongated stains such as those they created at impacts of 5°, especially as the drop fall height was increased. Part of the reason for this was because they were measuring from the leading edge of the bloodstain to the tail and not the bloodstain ellipse alone.

In his 1953 text, entitled “Crime Investigation: Physical Evidence and the Police Laboratory”, Paul L. Kirk illustrated the relationship between width and length of a bloodstain in a similar fashion. Here Dr. Kirk dripped blood from varying heights onto different angled boards of incline. These were set to specific degree slopes to create different sized/shaped stains. He too did not notice a direct trigonometric relationship between drip stain shape and the angle at which it struck the surface [5].

In 1955, Professor of Physics Dr. Conrad Rizer published “Police Mathematics – A Textbook in Applied Mathematics for Police” in which he stated that the half lengths of the ratio of width to length are found to be the sine of the impact angle between the surface and tangent to the trajectory of the bloodstain at the surface. Thus, Dr. Rizer not only states the trigonometric relationship of the width and length, but also that droplets of blood travel in a parabolic arc along their trajectory [6].

**Bloodstain Ellipse Marking Accuracy**

In 1971, Herbert Leon MacDonell and Lorraine Fiske Bialousz published a text that provided an explanation of the stringing technique used by Mr. MacDonell in the late 1960s at crime scenes [7]. The stringing technique relies on the analyst to mark the direction and impact angle of an individual bloodstain represented by a string, indicating its approximate flight path.
Virtual stringing methods and area of origin analysis brought to light by initial efforts of Dr. Fred Carter with his software program “Tracks” 1992 still depend on the marked bloodstain ellipse to calculate the impact angle [8]. Previous attempts at understanding the effect of errors on the estimated droplet trajectory began as early as 1994, when Pat Laturnus conducted a measurement survey based on a series of ten drip stains generated from an eye dropper. Each of these blood drops struck a target set to various known inclination angles. Mr. Laturnus mailed sets of photostat copies to members of the International Association of Bloodstain Pattern Analysts (IABPA) and received replies from twenty-seven individuals [9]. His findings concluded the determination of the width of the stains was very consistent amongst the participants although a significant difference in lengths was quite obvious. Part of the issue with marking real bloodstains is that the stains may often be malformed and do not have a clear elliptical outline. Thus, analysts must use subjective judgment to determine where to place the back end of the ellipse (i.e. most often where malformation occurs). The survey brought to light how different minds perceive the length of the stain differently (Figure 3).

Dr. Fred Carter's original Trajectories and later his BackTrack program [10] superimposed a thin line ellipse impression over the chosen spatter stain to greatly diminish the ambiguity of measuring an ellipse using manual stain measurement tools such as an eye loupe or caliper. Today, the ellipse overlay method and perimeter shape manipulation to best fit a bloodstain are the bases for most, if not all, computer based analytical methods.

In 2008, Dr. Mark Reynolds submitted a thesis entitled, “Bloodstain size, shape and formation: implications for the bloodstain pattern analyst” [11]. In his thesis, Dr. Reynolds ran a study on using computer assisted ellipse marking using Microsoft Excel 2003 with AutoShape tool. He found that it was possible to produce a more accurate and precise estimate of the blood droplet impact angle over manual processes available. It was also noted that the most critical refinement to the ellipse fitting method was that it allowed for the symmetrical half (trailing end of the bloodstain) to be mirrored across the width, which maintains the mathematical integrity of the ellipse during the
computer software? Posed in another, more basic form, how well can a human draw a computer ellipse using superimposed elliptical shapes over a bloodstain image? As with most measurement exercises, the understanding of errors, how they propagate and what effect they have on a final result is important to address. There are of course many reasons for why a bloodstain may be poorly marked, such as a low resolution image, malformed bloodstain, analyst bias, experience, etc. However, there are also factors related directly to how the sine function operates and having an understanding of this aids in establishing best practices in bloodstain selection and area of origin analysis.

A Sine wave is “a waveform that represents periodic oscillations in which the amplitude of displacement at each point is proportional to the sine of the phase angle of the displacement and that is visualized as a sine curve” [12]. Sine waves can have a stretched out or compressed measuring process. Although this method had been used by others, it uses the principles that Dr. Conrad Rizer first indicated, whereby the half lengths of the major and minor axes are used instead of the overall measurements (Figure 4).

**Examination of the Sine Curve from 0° to 90°**

When considering bloodstains to be used for computer reconstruction purposes, the first thing that needs to be established is how well do humans measure bloodstains through...
Thus, at impact angles closer to 90°, a large change in the θ value, creates a small change in the sine value. Stated another way, a small change in the sine value (i.e. errors in marking an ellipse) has a larger effect on the resultant impact angle for stains with an impact angle closer to 90°.

This can be exemplified in a theoretical example where a person makes a small marking error when marking a bloodstain ellipse. Assume that an analyst makes the same marking error of 1 mm (i.e. overestimation of the length) for two different bloodstains with impact angles of 15° and 88°. The 1 mm error creates resultant impact angles of 14.2° and 71.2° with errors of 0.81° and 16.8°, respectively (Figure 6). Thus, the sensitivity to errors at higher impact angles is much greater than for lower angles.

The maximum angle for any bloodstain is always 90° and it can be rather difficult to determine the direction of a drop that is close to circular. This is partly because as the length (major axis) of a bloodstain approaches equivalence with its width (minor axis), the bloodstain becomes circular. Should the original length continually decrease, the original length and width orientations are swapped, where the long axis of the stain is rearranged from vertical to horizontal. This is shown in Figure 7.

**METHOD**

A series of 18 bloodstain images were created using 3ds Max [13], which is a 3D modeling and animation program used in the film industry but also for scientific visualization. Elliptical shapes were drawn to have exact proportions of length and width that would correspond to a known impact angle. The bloodstain images were 1600 x 1600 pixels and the ellipse lengths ranged between 830 and 1370 pixels.
of angles covered by the images were from 5° (highly elliptical) to 90° (perfectly circular) in increments of 5° as shown in Figure 8.

This data set of images was made available to participants through an online link which included a data sheet, video tutorial and instructions. The software used to mark ellipses in this study was the ELlipser App [14] which can be found in the CloudCompare software [15]. CloudCompare is a point cloud processing program which is freely available online and is available for PC and Mac. This allowed participants easy access to software that would otherwise be proprietary and difficult to obtain.
In addition, participants of varying experience levels were asked to participate, and their experience level was voluntarily provided on a scale of 1 (low) to 10 (highest experience level). The average recorded experience levels of 86 participants was 5.65. The remaining participants chose not to include their experience level.

The setup process was rather simple and once the program was installed, CloudCompare would be launched and the Ellipser application would be initiated. The Ellipser App allows the user to load images and subsequently use an ellipse marking tool to mark bloodstains. Zoom and panning controls were available by using the mouse wheel and right mouse button. Once a participant was satisfied with the placement of the ellipse, they were asked to copy the value in the “theta (deg.)” field which was the reported impact angle for the ellipse.

All the data was compiled in Excel and organized by impact angle to observe the effect of marking errors to the known angles (i.e. ground truth), trends and where the greatest errors might present themselves.

RESULTS

When looking at the overall set of errors in ellipse marking, the mean errors and absolute mean errors were considered. The absolute mean errors are greater since they do not balance positive and negative values. Thus, absolute values of error give a better understanding of the overall errors without considering the direction of the actual values.

Table 1 — Summary data from ellipse marking study with Absolute Mean, Minimum and Maximum marked values and overall Range with 101 participants.

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<th>Absolute Mean</th>
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<th>Maximum Marked Angle</th>
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Above 55°, there were dozens of errors greater than 2° with some extreme values above the 7° mark. Figure 10 also gives a sense of the variation in marking as it can be noted that the range between extreme values marked for any one impact angle increases significantly closer to 90°. Similarly, this is reflected in the standard deviation of values in Figure 11 which shows the same trends of increasing standard deviation closer to 90°.

When looking at the mean absolute errors in Figure 12, the extreme spikes are “softened” and it can be noted that mean absolute errors are below 0.2° up to impact angles of 50°. The graph of Figure 14 is also quite consistent in the relationship of increasing errors to increasing
impact angle. Mean absolute errors only exceed 0.5° at impact angles of 75° or greater. The smallest mean errors were observed at impact angles of 5° to 25° with values below 0.1°.

**DISCUSSION**

As mentioned earlier, sensitivity to ellipse marking errors for impact angles which are close to circular (i.e. 90°) can cause large changes in the resultant impact angle. The results of this study show that marking errors for geometrically perfect ellipses are not static and vary depending on how circular or elliptical bloodstains appear. In cases where there are spikes in the standard deviation bar graph, (e.g. at the 55° and 75° positions), these are where participants marked ellipses with extreme errors/outliers. It is difficult to say exactly why there are spikes in the data at these particular positions other than to surmise that there is greater difficulty in marking ellipses at higher impact angles while some of the marking errors could be attributed to lack of familiarity with the ELlipser App or to the level of experience of the participants. Notably, the first stain presented in the data set was “A” with a value of 55°. It is possible that the errors at this angle were due to participants becoming familiar with the ELlipser App. However, this would not explain why there was a similar spike at 75° since this was the fourth bloodstain presented in the random sequence of images presented. Should this approach be revisited, the authors may provide participants with practice ellipses, prior to the start of the study giving participants greater operational knowhow thereby reducing the potential for marking errors.

Ellipse marking errors near 90° have a natural bias of underestimation. This can be explained...
surfaces or other spatter stain defects will all contribute to subjectivity and the potential for increased error.

These findings have generated an additional research initiative by both authors using actual bloodstains to determine what, if any further errors would appear when using computer ellipse marking methods. Testing with a large sample size of participants is recommended with real bloodstains to see if errors increase due to added subjectivity. In addition, testing the performance of automated programs and how well they can mark ellipses should be an area of study since artificial intelligence and other proposed marking schemes are naturally not far off in the near future. Ultimately, this study has shown that using a virtual ellipse marking method on a series of high quality, digitally created bloodstains, marking errors are relatively small in a range of impact angles between 5° - 75°. Errors greater than 7° may be apparent when impact angles approach 90° although the majority of errors between impact angles of 75° - 90°, were below this level. However, in each case, the effect of these errors needs to be considered with respect to the type of analysis being performed. Taking this information into the field, selecting elongated stains can reduce measuring errors and therefore minimize the error in determining the area of convergence or the 3D area of origin.

REFERENCES


7. Personal communication between MacDonell and Moore, circa 2005, Corning, NY.


Become a member of the IABPA

Prior to submitting an online Membership Application, please register [HERE](#) for our website and create your profile. This process allows members to view their membership status and access their payment history and all form submissions at any time.

There are three types of IABPA Membership for which to apply:

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<th>Member type</th>
<th>Description</th>
<th>Online Application</th>
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<tr>
<td><strong>Associate</strong></td>
<td>A member who has NOT completed an IABPA-Approved 40-hour Basic Bloodstain Pattern Analysis course but who desires to become a member of the IABPA for general interests.</td>
<td><a href="#">APPLY NOW</a> for Associate Membership</td>
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<td><strong>Provisional</strong></td>
<td>A member who has been recommended by a Full Member in good standing and who has completed a 40-hour Bloodstain Pattern Analysis course that meets the recommendations of the IABPA Education Committee*. (Course content defined by IABPA Education Committee guidelines include supervised, practical, laboratory-based practical assignments).</td>
<td><a href="#">APPLY NOW</a> for Associate Membership <a href="#">Submit a coy of your course certificate</a>.</td>
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<td><strong>Full</strong></td>
<td>A member in good standing who has held the position of Provisional Member for at least ONE YEAR, and, who has been recommended based upon efforts in the field of study of bloodstain pattern analysis.</td>
<td><a href="#">Request for Promotion to Full Membership</a></td>
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<td><strong>Distinguished</strong></td>
<td>A member who has rendered significant service to the discipline or the Association and has been awarded the designation by his or her peers*.</td>
<td><a href="#">View our current list of Distinguished Members</a>.</td>
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*Course Requirements

*Distinguished Membership status is obtained by nomination by an IABPA Member.*

To nominate a Member in good standing for Distinguished Membership, submit a Nomination Form [HERE](#).
Bloodstain Training
United States and Canada

**Advanced Bloodstain Pattern Analysis**  
October 05-09, 2020  
Institute of Police Technology and Management  
Jacksonville, Florida  
Jerry Findley  
Nancy Sulinski-Steffens

**Bloodstain Pattern Analysis**  
October 05-09, 2020  
CSI Academy of Florida  
12787 NW US Highway 441  
Alachua, FL 32615  
Kimberly Long

**Bloodstain Pattern Analysis I**  
October 12-16, 2020  
Bevel, Gardner, & Associates Inc.  
Yellowstone County Sheriff’s Office  
3165 King Ave. E.  
Billings, MT 59101

**Bloodstain Pattern Documentation Class**  
October 19-23, 2020  
Sirchie/BEVEL, GARDNER & ASSOCIATES INC.  
Youngsville, NC  
Ross M. Gardner

**Advanced Bloodstain Pattern Analysis**  
October 26-30, 2020  
Forensic Pieces  
North Palm Beach Police Department  
North Palm Beach, FL  
Jan Johnson

**Basic Bloodstain Pattern Analysis**  
November 2-6, 2020  
Graff Investigative and Forensic Training  
Grand Junction Police Department  
Grand Junction, CO  
Iris Dally Graff and Gary Graff

**Introductory Bloodstain Pattern Analysis Workshop**  
December 7-11, 2020  
Noslow Forensic Consultations, LLC  
Miami-Dade Public Safety Training Institute  
Miami, FL  
Toby Wolson

Bloodstain Training  
South America

**40 Hour Bloodstain Pattern Analysis in Brazil**  
November 9-13, 2020  
Blood Training Institute  
Rua Dep. Antonio Edu Vieira  
Florianopolis, Santa Catarina, Brazil.  
Antonio Augusto Canelas Neto
Bloodstain Training
Europe and Oceanic-Asia

Bloodstain Pattern Analysis
October 2 (and following alternate weekends)
Link Campus University
Via del Casale di S. Pio V, 44,
Roma 00165
Dr. Erebo Stirpe and Dr. Alexandra Agavrilesei

Basic Bloodstain Pattern Analysis
October 26-30, 2020
(English language instruction)
Usingen, Germany
Dr. Silke Brodbeck, MD

Basiskurs D/Basic Course
November 23-27, 2020
(German language instruction)
Usingen, Germany
Dr. Silke Brodbeck, MD

Advanced Bloodstain Pattern Analysis
October 26-30, 2020
Loci Forensics
Haverstraat 49 2153 GD Nieuw-Vennep
The Netherlands
Martin Eversdijk and René Gelderman

Visualization of Latent Bloodstain Course
November 23-27, 2020
Loci Forensics
Haverstraat 49 2153 GD Nieuw-Vennep
The Netherlands
Martin Eversdijk and René Gelderman

Bloodstain Pattern Analysis on Textile Course
December 14-18, 2020
Loci Forensics
Haverstraat 49 2153 GD Nieuw-Vennep
The Netherlands
Martin Eversdijk and René Gelderman

Did we miss something?

Although the Publication Committee works hard to find as many of the training opportunities as we can to include in the Journal, there are likely some courses which we missed. If you know of any upcoming bloodstain-related training which we did not include in the Journal, please contact the Editor or anyone on the Publication Committee so we can include it in the next issue.

Additionally, if you know of any open access, online resources which are related to bloodstain pattern analysis, please let us know. Our goal is for the Journal of Bloodstain Pattern Analysis to be a primary source of information around the world regarding bloodstain pattern analysis. You can help us meet this goal by sharing information about resources with us.
Online Resources

Bloodstain Pattern Analysis subcommittee of the Organization of Scientific Area Committees (OSAC) for Forensic Science
Development of standards and guidelines related to bloodstain pattern analysis

Bloodstain Pattern Analysis Video Collection
High speed digital video analysis of bloodstain pattern formation from common bloodletting mechanisms.

BPA-related Presentations at the 2012 Impression Pattern Evidence Symposium
Recorded webinar on presentations on approximation of blood drop trajectory, contextual bias, collection of pattern evidence from a body, reasoning and the scientific method in BPA, and developing and implementing BPA SOPs.

Bloodstain Documentation and Collection Methods
Recorded webinar on a methodology for the documentation, collection, and preservation of blood evidence.

Swipes, Wipes and Transfer Impressions
Recorded webinar on the different types of these patterns and recognizing the value of them.

Error & Uncertainty in Bloodstain Pattern Analysis
Recorded webinar on a general introduction to the concepts of error and uncertainty and how these concepts apply to quantitative and qualitative aspects of bloodstain pattern analysis.

The Sherlock Blood Spatter Analysis System
Freeware developed at Trent University to assist in processing field data and to determine the point of impact for the collected dataset.

A data set of bloodstain patterns for teaching and research in bloodstain pattern analysis: Impact beating spatters
This is a data set of sixty-one impact patterns scanned at high resolution, generated by controlled impact events corresponding to forensic beating situations. This data set is suitable for training or research purposes in the forensic discipline of bloodstain pattern analysis.

A data set of bloodstain patterns for teaching and research in bloodstain pattern analysis: Gunshot backspatters
This is a data set of gunshot backspatter patterns scanned at high resolution, generated in controlled experiments. This data set is suitable for training or research purposes in the forensic discipline of bloodstain pattern analysis.

Communicating Conclusions in Bloodstain Pattern Analysis
Recorded webinar on how principles of communication science can be applied to reporting writing and courtroom testimony. The meaning received by the audience is not always the meaning intended by the reporting analyst.

https://www.tandfonline.com/doi/abs/10.1080/00450618.2020.1805012

**Abstract**: The ability to accurately detect bloodstains is fundamental to crime scene examination; however, traditional methods can be inadequate for use on many dark-coloured surfaces commonly encountered at scenes, such as fabrics and flooring. An alternative approach may be the use of infrared (IR) photography, which is known to be effective at detecting bloodstains on fabrics and some non-porous surfaces. However, a knowledge gap exists concerning the effectiveness of IR photography for detecting bloodstains on dark-coloured floor coverings. To address this, we used a paired sampling design to assess the performance of IR photography compared with tetramethylbenzidine (TMB) and luminol for detecting bloodstains on wool and nylon carpet, linoleum, vinyl, tile and laminate flooring. We also assessed whether IR imaging would detect a substance known to create false-positive reactions with TMB and luminol. Overall, our results supported IR photography as an effective, non-destructive method compared to TMB and luminol for detecting bloodstains on dark-coloured floor coverings. To address this, we used a paired sampling design to assess the performance of IR photography compared with tetramethylbenzidine (TMB) and luminol for detecting bloodstains on wool and nylon carpet, linoleum, vinyl, tile and laminate flooring. We also assessed whether IR imaging would detect a substance known to create false-positive reactions with TMB and luminol. Overall, our results supported IR photography as an effective, non-destructive method compared to TMB and luminol for detecting bloodstains on dark-coloured floor coverings. Further, IR did not detect known false-positive samples on several surfaces. This research contributes to a growing body of literature concerning the forensic applications of IR photography and has significant operational implications for crime scene examiners.


**Abstract**: In molecular ballistics, where traces originating from the use of firearms against biological targets are investigated, “backspatter” traces are of particular importance. This biological material comprising blood and tissue from the victim is propelled back from the bullet entry site towards the direction of the shooter and can consolidate and persist on the inner and outer surfaces of the firearm, from where it can be collected and analyzed. Thus, a connection between the weapon and the victim can be established solely by molecular biological trace analysis. For the criminalistic investigation of gun-related crimes, the determination of the distance between the weapon and the victim can be of critical importance in reconstructing the circumstances of a crime. In this study, we investigated possible correlations between the shooting distance and the amount of backspatter in/on the used firearm. To this purpose, we employed a previously established skull model and performed shootings in triplicates from various distances up to 50 cm with two types of handguns (pistol and revolver). Backspatter was collected from various sampling locations, and DNA contents were quantified. A post-shooting wound channel evaluation was conducted by optical and radiological evaluation. The obtained DNA yields varied considerably between replicates from the same and from different distances. In contrast, apart from contact shots, no meaningful differences were observable in wound channel evaluations. In summary, no meaningful correlation between backspatter distribution and DNA yields, the shooting distance and the condition of the wound channel could be established.


**Annotation**: This is a summary report of the first meeting of the Terrestrial LIDAR Scanning (TLS) Working Group for
Criminal Justice Applications (TLSWG), which met on February 27 and 28 of 2020.

Abstract: Light detection and ranging (LIDAR) technology is a remote sensing technology that measures distance by illuminating a target with a laser and analyzing the reflected light. TLS scanning devices acquire complex geometric data that captures a three-dimensional representation of a scene; this technology is used in criminal justice applications, such as documenting a crime or crash scene. Although the use of this technology is increasing in criminal justice applications, no standardized, vendor agnostic guidelines are currently available for end users. The goal of the TLSWG is to develop resources that reflect consensus-based best practices that standardize and improve the use and application of TLS in crime-scene documentation and reconstruction. This will assist in establishing a minimum standard for capture, processing, analysis, visualization, presentation, and storage of TLS data in a forensic context. The objectives of the first TLSWG meeting were to brainstorm community needs and challenges and identify work products that could assist in achieving these goals. The meeting focused on 1) the identification of challenges and key community needs related to equipment procurement, calibration, and validation; 2) data capture and relevant training; and data processing, management, and reporting. TLSWG members include forensic practitioners and researchers with extensive backgrounds in crime-scene documentation and reconstruction, as well as experience in providing expert testimony on bloodstain pattern analysis and trajectory reconstruction. The working group includes representatives from federal, state, county, and local systems, as well as representation from the Crime Scene Subcommittee of the National Institute of Standards and Technology (NIST) Organization of Scientific Area Committees and the Forensic Science Research and Development Technology Working Group.


https://www.canadianscholars.ca/subjects/criminology/books/the-scientific-method-in-forensic-science

Overview: Written for the Canadian forensic science student and the professional practitioner, this timely and practical handbook provides an experience-based learning tool. This text offers an understanding of scientific method and evidence-based analysis and how they relate to forensic science and its casework—from the crime scene to the courtroom—within the Canadian context. The authors explore the paradigm shift in forensic science, highlight basic skills like scientific reasoning and literature review, as well as untangle the complexities of ethics and bias, research design, critical thought, and best practices for communication in various settings. Case examples and court testimonies are reviewed to underscore the importance of these concepts.

By blending such real-life examples with scientific concepts like validation, peer review, accountability, and transparency, The Scientific Method in Forensic Science is a fundamental read for students in introductory forensics, criminology, police studies, and anthropology.


Abstract: Bloodstain pattern analysis, one of the areas of forensic science, is performed to analyze the physical characteristics of bloodstains, including their size, shape, and distribution, to reconstruct a crime scene. A bloodstain pattern analyst should obtain through experiments and education the capabilities to both understand the generation mechanisms of bloodstains and identify the characteristics of the bloodstains.

Experiments and education about bloodstain pattern analysis are carried out by using human blood taken from subjects, animal blood (porcine or bovine) supplied from butcheries, and blood substitute products developed in other countries. However, these kinds of blood have many limitations in their application due to various problems.

The blood substitute developed in the present study is more similar to human blood than other blood substitute products developed in other countries with regard to the physical properties, including viscosity, viscoelasticity, and surface tension, as well as the drip bloodstain patterns depending on the surface and coordinate characteristics of drip stains impact angle. The blood substitute developed in the present
study is more practical, because the materials that are used in its preparation are readily available in the market and do not include chemicals that are harmful to the human body, and the blood substitute has luminol reaction functionality and pattern transfer bloodstain (bloodstain fingerprint, bloodstain footprint, etc.) dyeing functionality.


Abstract: In the context of development of standards for forensic science, particularly standards initially developed by the U.S. Organization of Scientific Area Committees for Forensic Science (OSAC), this perspective paper raises concern about the publication of vacuous standards. Vacuous standards generally state few requirements; the requirements they do state are often vague; compliance with their stated requirements can be achieved with little effort – the bar is set very low; and compliance with their stated requirements would not be sufficient to lead to scientifically valid results. This perspective paper proposes a number of requirements that we believe would be essential in order for a standard on validation of forensic-science methods to be fit for purpose.


Abstract: We investigated whether bloodstain examination and DNA typing can be performed on washed bloodstains on clothes. Blood was dropped onto T-shirts made from 100% cotton or 100% polyester. After drying, the T-shirts were hand-washed with handwashing soap, dishwashing detergent, laundry detergent, soap, or just water until the bloodstains could not be seen. After drying the T-shirts, DNA and RNA were extracted simultaneously from the bloodstained areas using commercial kits. RNA was reverse-transcribed to DNA, and then the detection of the mRNAs for HBB, ACTB, and 18S rRNA was examined. DNA was quantified via real-time PCR, and then STR typing was performed with a commercial kit. The luminol and leucomalachite green tests were used as preliminary bloodstain tests, and an immuno-chromatography kit was used to identify human bloodstains. DNA could be extracted from all washed bloodstains, but more DNA was extracted from cotton T-shirts than from polyester T-shirts. STR typing was successful for all bloodstains without issues such as PCR inhibition. In the human bloodstain identification test using mRNA, almost all bloodstains produced a Ct value for HBB and all bloodstains produced a Ct value for 18S rRNA, whereas few bloodstains produced a Ct value for ACTB. All bloodstains reacted positively to luminol, but some were negative for leucomalachite green. Most of the bloodstains did not react positively in the human bloodstain identification test using the immuno-chromatography kit. The results suggest that human bloodstain identification and DNA typing can still be performed after clothes with bloodstains are washed.
Published standards related to BPA

AAFS Standards Board (United States)

A list of recommended terms and definitions for bloodstain pattern analysis is presented. These terms and definitions address basic bloodstain pattern types and related concepts.

This document applies to the validation of procedures for bloodstain pattern analysis casework and new equipment. It also applies to the internal validation of established procedures existing within the BPA community when such procedures are being used for the first time within an agency.

This document provides requirements for establishing and maintaining a documented quality assurance program in bloodstain pattern analysis to forensic service providers. A quality assurance program is necessary to ensure the quality of the work product that comes from any forensic service provider.

This document provides minimum pre-training educational requirements for an individual currently in, or entering into, a bloodstain pattern analyst training program and the minimum training requirements that a trainee must successfully complete prior to practicing as a bloodstain pattern analyst.

This document provides guidelines for report writing in bloodstain pattern analysis (BPA). In addition, guidance is provided regarding statements to be avoided in the report.

Forensic Science Regulator (United Kingdom)

FSR-C-102, Codes of practice and conduct: bloodstain pattern analysis, Issue 1, 2015
This document provides further explanation of some of the requirements of bloodstain pattern analysis. Additionally, this document specifically relates to the classification and identification of bloodstain patterns at crime scenes and in the laboratory.
Review of the ANSI/ASB Report Writing Standard

In mid-2020, the AAFS Standards Board in the United States approved a new standard which will have a direct impact on BPA in the United States. This is ANSI/ASB Standard 031 which details the requirements for bloodstain pattern analysis reports. The standard replaces the Guidelines for Report Writing in Bloodstain Pattern Analysis which was previously published by the Scientific Working Group on Bloodstain Pattern Analysis (SWGSTAIN).

The standard is very similar to its SWGSTAIN predecessor. The standard requires the use of the previously published terminology contained in ASB TR 033 to further establish consistency in the terms used for pattern classification. The standard also includes a list and description of sections which must be included in a report. For labs which are ISO 17025 accredited, these sections will look very familiar; however, this standard does not supplant the ISO 17025 requirements for accredited laboratories.

Besides the typical sections for headers, case information, items, and methods, the standard also includes the requirement to include “limitations and assumptions” which are relevant to the work contained in the report. These limitations and assumptions can have a significant affect on the strength of any stated conclusions. The standard provides some example limitations and assumptions.

The standard also requires each report be subjected to a technical review prior to being issued. There must be documentation for this technical review. According to the website for the OSAC bloodstain subcommittee, a document is currently being drafted regarding technical reviews of bloodstain reports.

The standard also addresses the topics of unsubstantiated conclusions and the use of emotive or biased language. Neither of these are acceptable for inclusion in a bloodstain report.

The ANSI/ASB Report Writing Standard is specifically applicable to bloodstain analysts working in the United States. For analysts outside the United Standards, the standard can be used as a guide but it cannot replace specific report writing requirements in place at the local jurisdiction level.