



# UNVEILING THE ART OF BLOODSTAIN PATTERNS: INVESTIGATING 2-DIMENSIONAL HORIZONTAL SURFACE STAINING

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## Introduction

- Bloodstain patterns can provide significant information relating to the types and sequence of events involved in a violent crime.
- Characteristic features used for interpreting bloodstain patterns are heavily based on their appearance on 2D vertical or 3D surfaces - suggesting that they may not be applicable solely to staining on 2D horizontal surfaces.
- Potential for loss of information value in criminal investigations involving open spaces where the majority or entirety of the bloodstain pattern is deposited on the floor.

## Purpose

This project investigates three characteristic blood stain pattern-generating activities, to determine whether or not existing conventional classification criteria are applicable for horizontal 2-dimensional patterns. Consequently making recommendations for modifying criteria based on the orientation of the deposition surface where necessary.

## Passive Drip Patterns

Bloodstain patterns formed primarily due to gravity and in the absence of other external forces (SWGSTAIN, 2009)

Participants gently squeezed a blood-soaked cloth while moving the arm around slowly and randomly to simulate an injured or weapon-wielding individual staggering around a scene.



## Exemplar Characteristics

**Arterial Projection Pattern Criteria: (ESR Standard Operating Procedures)**

1. Several larger spatter stains, ranging between 5-20mm
2. Linear or curvilinear arrangement, serpentine pattern
3. Similar gamma angles (directionality), no convergence

## Method

- Create bloodstain patterns for the three mechanisms of interest;
  - A.) Passive Drip Patterns (x 15)
  - B.) Impact Patterns (Lateral x 15, Downward x 15)
  - C.) Arterial Projection Patterns (x 15)
- Photograph and image-stitch to digitise patterns.
- Apply ABPA Method to digitally process patterns and gain quantitative stain-specific and pattern metric data.
- Compare horizontal metric data to the current conventional characteristics and make recommendations to re-define the criteria as necessary.

## Impact Spatter Patterns

Spatter bloodstain patterns that are created by an external force directly striking a source of exposed blood. (SWGSTAIN, 2009)

A novel impact mechanism was constructed utilising a rat-trap and paddle to strike a blood-soaked sponge, creating both:

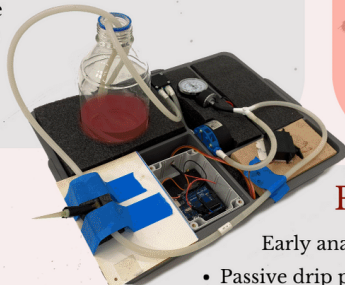
- A.) Laterally-directed impacts
- B.) Downward-directed impacts



## Arterial Projection Patterns

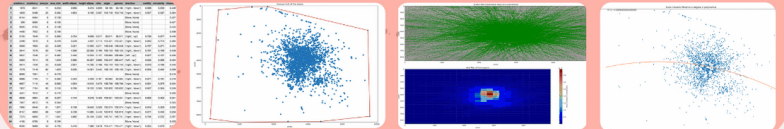
A bloodstain resulting from the projection of blood from a breach in the circulatory system (SWGSTAIN, 2009)

A brachial artery device designed by Dillon (2019) that utilizes a pump, servo motor clamp and pressure gauge was modified to project volumes of blood into free flight with pressure fluctuations to mimic a heartbeat.



## Metric Output

The Automated Bloodstain Pattern Analysis (ABPA) method developed by Rough (2023) produces metric data pertaining to both individual stains (position, size, shape, orientation, lightness) and the pattern as a whole (linearity, convergence, distribution, proportions).



## Preliminary Findings & Next Steps

Early analysis of quantitative results from the current study has suggested the following;

- Passive drip patterns current characteristics are largely **supported**; As expected, as the current characteristics are typically noted on horizontal surfaces due to the nature of the mechanism.
- Impact spatter patterns demonstrate **unsupported** characteristics; i.e Characteristic 3. "Y" or fan-shaped distribution". Our downward-directed impacts instead exhibit distinct cross-shaped stain distributions.
- Arterial Projection patterns demonstrate **unsupported** characteristics; i.e Characteristic 6. "Small spines radiating from large oval stains". Our horizontal stain shapes are almost exclusively circular as opposed to oval.

Diving deeper and analysing the data using statistical methods will allow us to assess the suitability of the current characteristics and simultaneously identify potential new additions, ultimately aiming to **benefit forensic scientists in real-world applications.**

## References

- Rough, R., Batchelor, O., Green, R., Bainbridge-Smith, A. (2023) Automating Bloodstain Pattern Analysis (Manuscript in preparation)
- Dillon, S. (2019) Investigating the Quantitative Characteristics of Drip Bloodstain Patterns & Construction of a Novel Brachial Artery Device. (Master's Thesis, The University of Auckland)
- Rough, R. (2020) ESR's Standard Operating Procedures for Bloodstain Pattern Analysis. ESR Quality Documents, Version 1.0, Section 5
- SWGSTAIN (2009) Scientific Working Group on Bloodstain Pattern Analysis: Recommended Terminology, Forensic Science Communications