A Preliminary Study of Map360 Area of Origin Tools

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ABSTRACT

Bloodstain pattern analysts have benefitted for more than 20 years from digital software for area of origin (AO) analysis using digital photographs, and more recently, laser scanner data. As more software options for AO analysis become available on the market, it is important to be able to evaluate the different software packages so that workflows are understood and each software package is tested against a ground truth in order to establish potential errors and limitations. In this study, a preliminary validation of the Map360 software was conducted using the area of origin tool within the software and the results were compared to multiple known impact locations. Five different impact patterns were created with an impact rig at varied positions (18 cm-50 cm) from the front wall target projecting onto single and multiple walls. The Map360 software had a 9.6 cm average deviation combing data from all five impacts. The maximum deviation was 15 cm on a single surface target, when the known impact location was 50 cm from the target wall. These results fall within the researcher's acceptable error range of 20 cm which has also been quoted in past studies. Future testing with more complex scenarios, greater distances for impact locations, and blind participants should be performed to have a better understanding of the limitations of this software.

INTRODUCTION

Prior to the usage of software, area of origin (AO) analysis was manually done at the scene by using the stringing method where strings were attached to the stains to visualize the AO location. In the late 1990s, one of the first software packages created specifically for area of origin (AO) analysis was developed by Dr. Fred Carter called BackTrack [1]. This program utilized digital images of bloodstains within an impact pattern and utilized manual measurements to appropriately scale the resulting images. The user digitally marked ellipses which eventually provided a set of straight-line trajectories leading back to the approximate impact location; this was accomplished by using trigonometry and directional analysis [2]. BackTrack was used by bloodstain pattern analysts for many years, although it eventually became unsupported and no longer commercially available.

There are currently several software programs available that assist analysts in performing AO analysis with modern tools such as the laser scanner, allowing the analysis to be done within the point cloud back at the office instead of spending hours on-scene conducting the analysis. Software such as HemoSpat [3], FARO Zone 3D [4], and HemoVision [5] are commercially available for analysts to use in AO analysis. Each of these software programs have supporting peer-reviewed studies available in forensic journals. HemoSpat was initially released in 2006 and is one of the most used software programs. This program works with photographs of select bloodstains within an impact pattern which are manually measured for position. In the past, it was only possible to measure one bloodstain per photograph; however, more recently, HemoSpat allows for multiple bloodstains to be measured within a single image, reducing the overall time to photograph and measure each bloodstain. HemoSpat has the ability to view the results in 3D, however, it does not integrate directly with 3D laser scanner data, although it is possible to export the results of the analysis and combine them with point cloud data in an external program.

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FARO Zone 3D is a software package released in early 2016 and used originally for creating forensic diagrams from total station and laser scanner data. FARO Zone 3D has grown to allow the user to perform different types of analyses such as momentum analysis, bullet trajectory analysis, and BPA, to name a few. FARO Zone 3D has had extensive validation for both AO analysis and more recently, the Path Volume Envelope (PVE) analysis of cast-off patterns [6] [7]. The software can be used with or without laser scanner data to help with the visualization of bloodstain analysis results within the context of a scene containing bloodstains.

HemoVision became commercially available in 2022 and is dedicated to AO analysis using computer vision techniques coupled with automatic and semi-automatic features for ellipse marking and digital image perspective correction. This software package has several validation studies that have tested the accuracy of the algorithms and the software's performance on the analysis of impact patterns [8]. HemoVision utilizes structure from motion (SFM) to automate the image placement that can be tedious in other software packages. The software requires only photographs and manual measurements, the results of which are subsequently visualized fully in 3D. The latest version of HemoVision has point cloud integration such that BPA results can be overlayed and visualized on top of laser scanner data.

Map360, a Leica Geosystems product, is a forensic mapping software, similar to FARO Zone 3D, used by public safety professionals around the world. The software allows the importation of many different 2D and 3D data sources such as total station data and laser scanner data so that forensic diagrams can be completed and different types of forensic analyses can be performed. The BPA tool in Map360 was first released in version 3.1 of the software on January 15, 2020. This coincided with the release of a whitepaper study by Leica Geosystems using the Map360 BPA tools which analyzed the AO of several impact patterns generated in a controlled setting utilizing liquid defibrinated sheep blood. The errors of the calculated AOs were found to be similar in range with those generated with other computer aided AO calculations. The maximum absolute errors for the X, Y, and Z axes were 5.4 cm, 17.2 cm, and 10.4 cm, respectively; calculated from a single radiating impact pattern on a flat surface [9]. Note that the Y axis was chosen as the vertical axis and the Z axis, the distance from the front wall.

Typical Digital AO Analysis Workflow

As mentioned above, there exist several digital software solutions available for performing an AO analysis and in general, they operate similarly. In all cases, photographs of the overall pattern, groups of stains, or the individual stains themselves are required to be photographed in order to accurately match a digital ellipse over the elliptical shape created by each individual bloodstain, from which a calculation for the impact angle and gamma angle of the stain is performed. The basic process can be broken down into documentation activities which are performed at the scene and the analysis portion which is performed on a computer.

The documentation steps performed at a scene to conduct an AO analysis are organized as follows:

1. A qualified bloodstain pattern analyst inspects the overall bloodstain pattern and decides on which regions or specific bloodstains to include in the analysis.
2. The analyst places reference markers on the wall, either beside or around individual bloodstains or multiple stains grouped together.
3. The analyst then takes measurements for either the individual bloodstain positions or the reference markers, or the analyst captures laser scans of the overall impact pattern with markers in place.
4. Finally, the analyst takes photographs of the bloodstains, including the reference markers, which later aid in positioning the photographs in most software packages.

The analysis steps performed on a computer are organized as follows:

1. The analyst imports the photographs, laser scanner data, and/or hand measurements into the software.
2. The analyst scales and orients the photographs to their measured positions either by matching the reference markers in the photographs to the markers in the laser scanner data or by entering measurements for the hand measured positions. This effectively assigns 3D coordinates to the 2D pixel locations in the photographs.
3. The analyst matches ellipses with the selected bloodstains which thereby creates the bloodstain trajectories.
4. The software calculates the AO and the resulting representation of the AO is visualized on the computer screen in two or three dimensions.

The above process is common among the aforementioned software packages and requires a qualified bloodstain pattern analyst to choose the appropriate bloodstains for an effective AO analysis [10,11]. There are currently no software packages which automatically determine the appropriateness or suitability of stains for an AO analysis, although, with the advent of machine learning algorithms, it is possible, in theory, to analyze the stain shape and isolate the analysis to a set of bloodstains that meet a specific criteria. However, for the current practice, selected bloodstains should be from an identified impact pattern and the selected bloodstains should (ideally) form a wide, radiating pattern with elongated bloodstains [12].

Many software packages offer automated bloodstain marking tools. These tools, although convenient, are not always accurate in the identification and marking of the edge of the bloodstain ellipse. The most common error observed in these automated tools is the resulting ellipse ends up shorter than the actual elliptical bloodstain, thereby affecting the impact angle. Errors in automated ellipse marking occur when there is insufficient contrast between the bloodstain and the background surface, thereby causing the marked ellipse to result in an incorrect shape. In addition, partially overlapping bloodstains may also cause an incorrectly marked ellipse. Thus, many analysts resort to manually marking the ellipses or using the semi-automated tools as a starting point but then make manual adjustments to the resulting ellipse. Ultimately, the analyst has the final say in which stains to include in the analysis and how they are marked with digital ellipses.

Laser Scanner Equipment

The 3D laser scanner used in this study was the Leica RTC360 scanner, a product of Leica Geosystems [13]. The scanner has a measuring rate of up to 2 million points per second and HDR capabilities for the capture of photographs. The laser scanner also has a 3D point accuracy of 1.9 mm at a range at 10 m. One of the most important aspects of laser scanning bloodstain patterns is the ability to collect dense, accurate point clouds with minimal point spacing between points. The “scanning resolution” setting on the scanner directly affects the point density, as does the scanner to target distance. The RTC360 has three pre-programmed user -selectable resolution settings of 3 mm, 6 mm and 12 mm at a range of 10 m. Thus, the 3 mm setting is the densest setting with the tightest point spacing but the actual point density on a surface is a direct result of the scanner to target distance. For example, if the scanner operator sets the scanner at a resolution of 3 mm at 10 m, the resultant point spacing on a wall that was 2 m from the scanner would be 0.6 mm (see Figure 1). Having a point spacing of less than 1 mm on a surface is normally sufficient for ensuring a good placement of the photographic images into the point cloud when performing an area of origin analysis. This is sufficient because typical errors in an AO analysis are usually on the order of a few centimeters or more. Thus, minimizing the point spacing allows for more precise image placement [14].

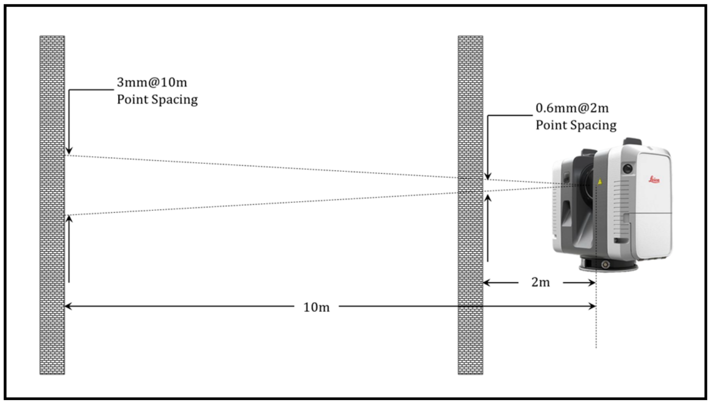

Figure 1*—Visual depiction of the difference between point spacing on a surface at a distance of 2 m vs 10 m from the laser scanner with the same resolution setting of 3 mm at 10 m.*

The laser scanner allows for rapid documentation of complex crime scenes when compared to taking manual measurements. The resultant laser scanner data also allows for alignment and scaling of bloodstain photographs to the point cloud. The scan time on the RTC360 is approximately 26 seconds for the lowest resolution setting, 56 seconds for the medium setting and 1 minute and 46 seconds for the highest resolution setting. Image capture is an additional 60 seconds regardless of resolution setting, for a total scan time of 1 minute 26 seconds, 1 minute 56 seconds and 2 minutes 46 seconds, respectively.

Map360 Process

The directional analysis of bloodstains in Map360 has several steps for importing and aligning point cloud data. It has simple ellipse marking tools with the ability to output a final report with all results. There are many steps in the process of AO analysis depending on the type and configuration of the bloodstain pattern being analyzed. The process shown below is a basic outline of the workflow in Map360 for a single impact pattern. Note that multiple impacts may be created in Map360 and multiple walls maybe used. However, for the purposes of this study, only a single impact per project was performed. The process below begins after the creation a new project (New Scene):

1. Import a point cloud data by selecting the “Import PC as LGS” button (see Figure 2). This allows the user to import scan data in different formats such as e57, LAS, and PTX, which may not be native to the Leica scanner.

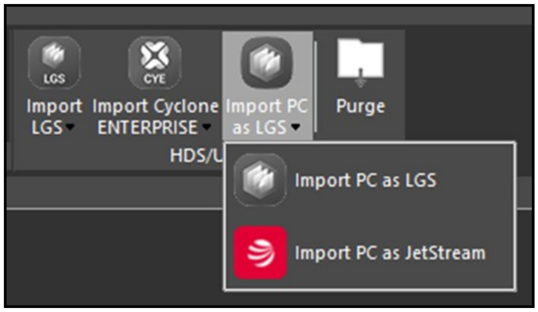

Figure 2*—Screenshot of the “Import PC as LGS” function which allows point clouds in other formats to be used inside the Map360 software; PC=Point Cloud, LGS=Leica Geosystems Scan.*

2. Use the “BPA Open” icon to begin the AO analysis using the BPA tools menu which is found under the analysis tab (see Figure 3).

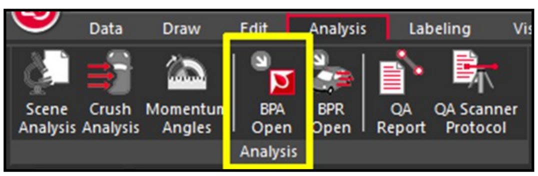

Figure 3*—Screenshot of the “BPA Open icon under the Analysis tab.*

3. Choose the “BPA Coordinate System” icon to define the coordinate system for how the results will be reported (note that the coordinate system is for the user to decide whether they wish to work in a Y axis up or Z axis up coordinate system).

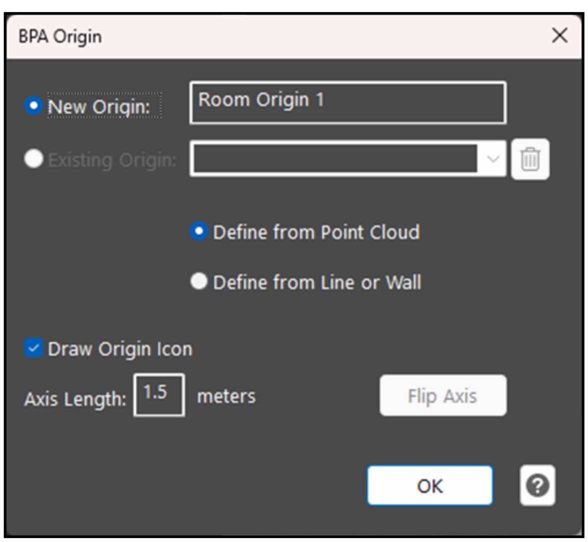

Figure 4*—Screenshot of the BPA Origin menu which allows the user to define surfaces from the point cloud which will be used to establish the coordinate system and to subsequently use as planes for image placement.*

4. Choose the “BPA Origin” icon. This will define the origin of the room. The process involves selecting the “front wall,” “left wall” and “ground.” The software creates an origin point at the intersection of the three walls, in addition to defining each wall as a surface that can be used to place images. Note that other options are possible to assist the analyst in defining a custom origin point at a specific location such as using a single surface or by picking a specific point (see Figure 4).

5. Choose the “Surface” icon which allows the user to create new surfaces where images can be placed. In the case in which the same walls for the origin location are used, no new surfaces are required to be created and “Existing Surface” can be chosen (see Figure 5). This window also allows for the colors of the bloodstain trajectory lines to be chosen along with the length of the bloodstain trajectories. With the “Align view to surface” selected, the 3D viewport changes to align to the selected surface such that it is orthogonal in the viewport. By default, Map360 works with an orthogonal camera in the 3D view. It is recommended to keep the camera in orthogonal mode when working with the BPA tools. Using orthogonal mode avoids point picking errors when dealing with multiple surfaces or with complex scans and ensures the analyst is working on a single surface at one time.

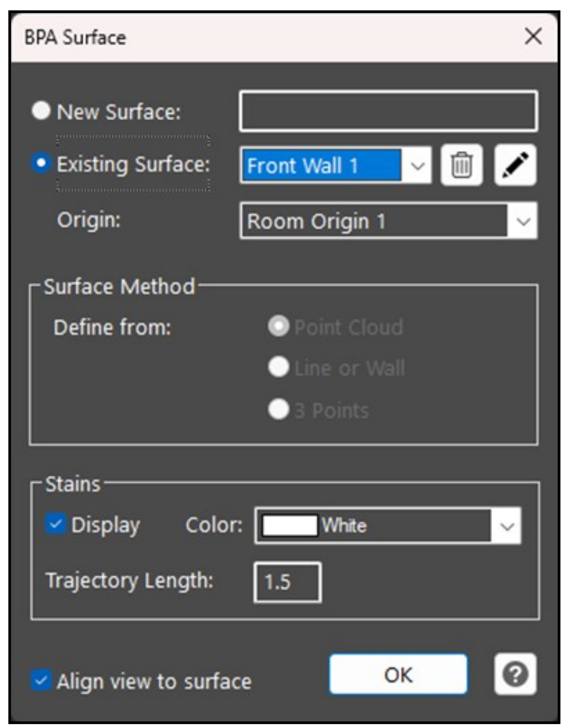

Figure 5*—Screenshot of the “BPA Surface menu” which functions to isolate a specific surface from which the user will work to place images.*

6. Import a photograph and scale it to the point cloud data by selecting the "Photo" icon. After the photo is imported, click on reference points in the image. This allows the image to properly align to the common reference points in the point cloud data. At least three reference points on the photograph should be selected, although more may be helpful in some instances where the alignment does not work or is difficult to place correctly. Once completed, press the "Enter" key and this completes the selection. Next, choose the same corresponding points in the point cloud. The user interface shows a connecting line between the points selected in the reference image and the points selected in the point cloud. Once all points are selected, the photograph is aligned and scaled to the point cloud (see Figure 6).

7. Use the transparency dialog to ensure the image is aligned correctly by looking at the bloodstains and other features on the photograph and ensure they are properly aligned with the point cloud. If any major offsets are noted, meaning the point cloud and photos are not visibly aligned by more than a few millimeters, the "Align" tool can be used to run through the alignment process again for a better fit. In addition, manual adjustment tools exist in the software that can be used to make fine adjustments to the position of the photograph. Note that misalignments can come from other reasons such as not having a photograph which was taken at 90 degrees to the surface of when there are lens distortions present which have not been corrected for.

8. Once the image is aligned, click the "Stain" icon to initiate the ellipse marking process. Ellipse marking is completed with three clicks: 1) click on the leading edge of the bloodstain, 2) click on the trailing edge of the bloodstain, 3) use the mouse to adjust the width of the bloodstain with the final click. In case the ellipse requires adjusting, simply click on the ellipse and adjust the size and shape with the length, width and rotation controllers. Once the stain is finalized, the impact angle (alpha angle) and directional angle (gamma angle) are automatically calculated, as well as the resultant trajectory. Additional ellipses can be added by pressing the "Stain" button or spacebar, which repeats the last command (see Figure 7).

9. The aforementioned process of image alignment and ellipse marking must be repeated for all images. Once complete, select the "Convergence" icon to select all the trajectories/stains to be used in the convergence calculation. Note that stains may be excluded by deselecting them or by removing them through the BPA Convergence window which has additional settings for how the convergence location is drawn, including its size, shape, and color (see Figure 8).

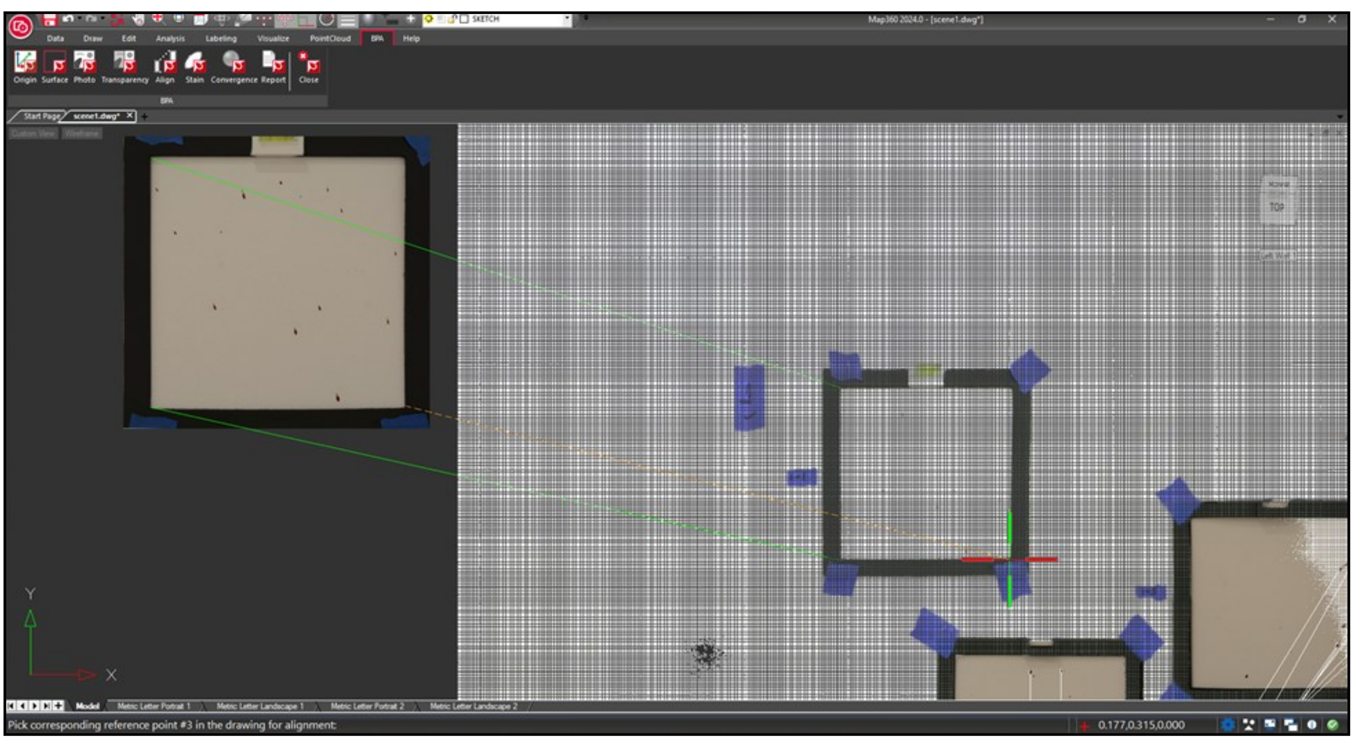

***Figure 6**—Screenshot of the image alignment tool in Map360 depicting virtual reference lines connecting the photograph to the corresponding reference point chosen on the point cloud.*

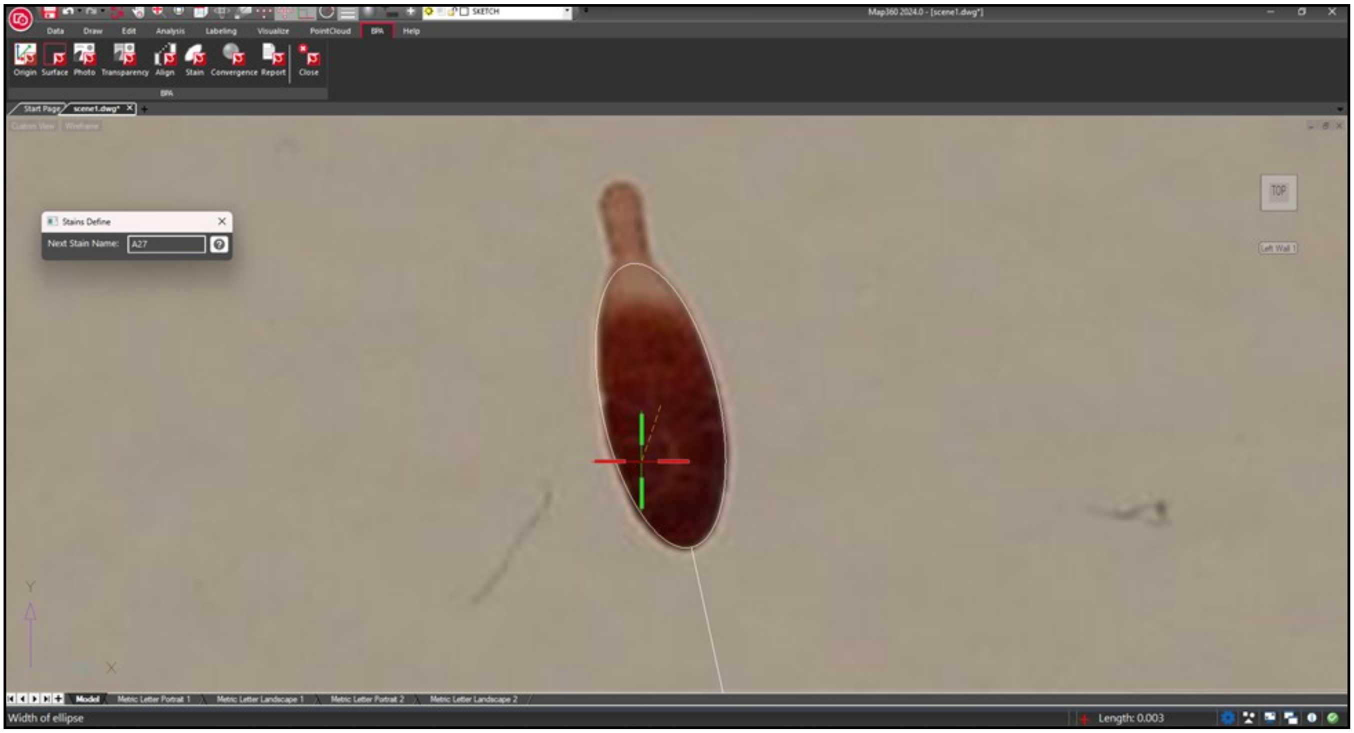

Figure 7*—Screenshot of the process of bloodstain marking with ellipses in Map360 which requires three clicks to define the leading edge, trailing edge, and the ellipse width.*

10. The final step is to produce a report of all the results in the analysis. This is done through the "Report" icon. Choose the group of stains, the room origin, and the units for the report. Also choose whether to include details about the individual stains selected and respective photographs of each bloodstain (see Figure 9). After the report is saved as a PDF file, exit out of the BPA tool and visualize the calculated AO (see Figure 10).

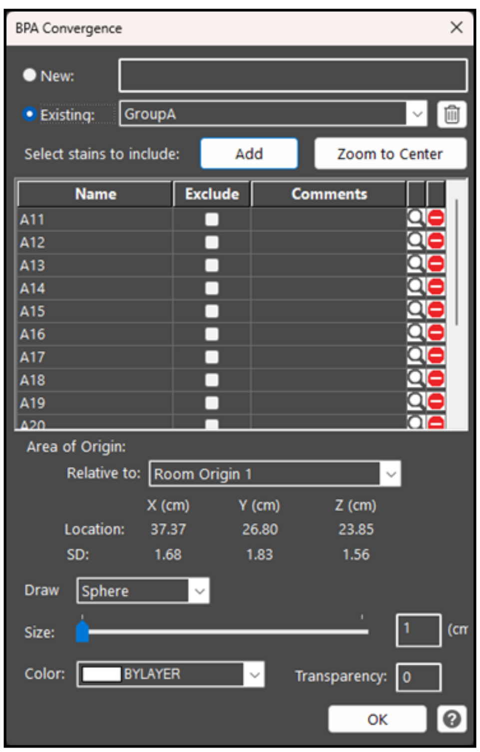

Figure 8*—Screenshot of the BPA Convergence window in Map360 which allows the user to add or remove any of the marked stains into the calculation for area of convergence. There are also additional settings to define the size, shape, and color of the area of origin marker.*

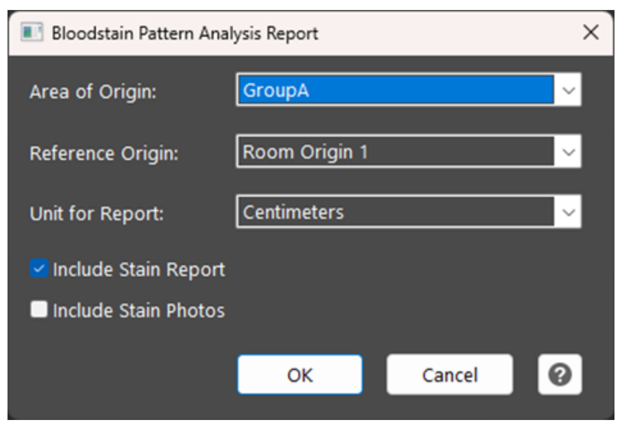

Figure 9*—Screenshot of the BPA Report tool; reporting in Map360 may include a full report for each of the selected stains and their corresponding images.*

TESTING METHODOLOGY

The goal of this preliminary study of the Map360 BPA tool was to analyze the AO of a series of random bloodstain impacts on single and multiple surfaces and compare the results with the known impact origin, which varied in 3D position from each target surface. A series of five impacts were created using an impact rig and ethically sourced sheep's blood. The known impact location was

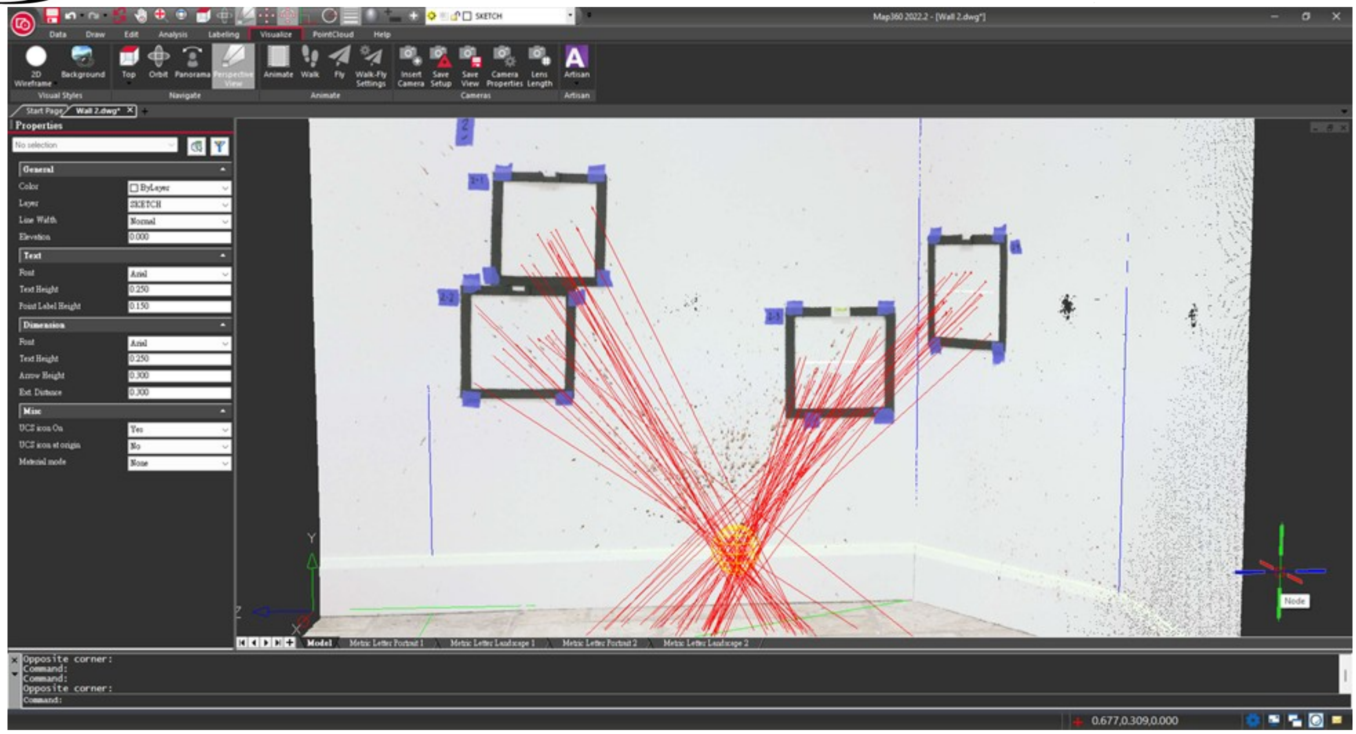

Figure 10—*Screen capture from Map360 showing the results of one of the impact patterns on two walls. Note the yellow sphere represents the area of convergence.*

photographed, measured with a steel tape measure, and laser scanned before and after each impact to capture the known impact origin for comparison to the analyzed results. A threshold of 20 cm was chosen for the acceptance level as this distance is sufficient to determine if the source of the impact was close to the ground, from a person who was kneeling, or a person who was struck while standing.

Impact Setup

The target surfaces were painted walls with a matte finish paint coated in white. Three of the impacts were created on a single surface, while two of the impacts were created in the corner of two perpendicular walls which were at approximately 90 degrees to one another (see Figure 11).

A custom-made impact rig consisting of a PVC pipe with an impacting cylinder made of a wooden dowel was used to create the impacts. A small pin was placed in the PVC pipe at set locations above which the wooden dowel rested. To initiate the impact mechanism, the pin was pulled by a short string and the wooden dowel was then free to fall down the pipe and into a small volume of blood of approximately 3 milliliters placed with a syringe at the known impact location.

Scans were taken prior to creating the impact to document the exact 3D location of the known impact location from the origin (corner of the room), indicated by a black and white checkerboard target shown on the base of the rig. Two scans

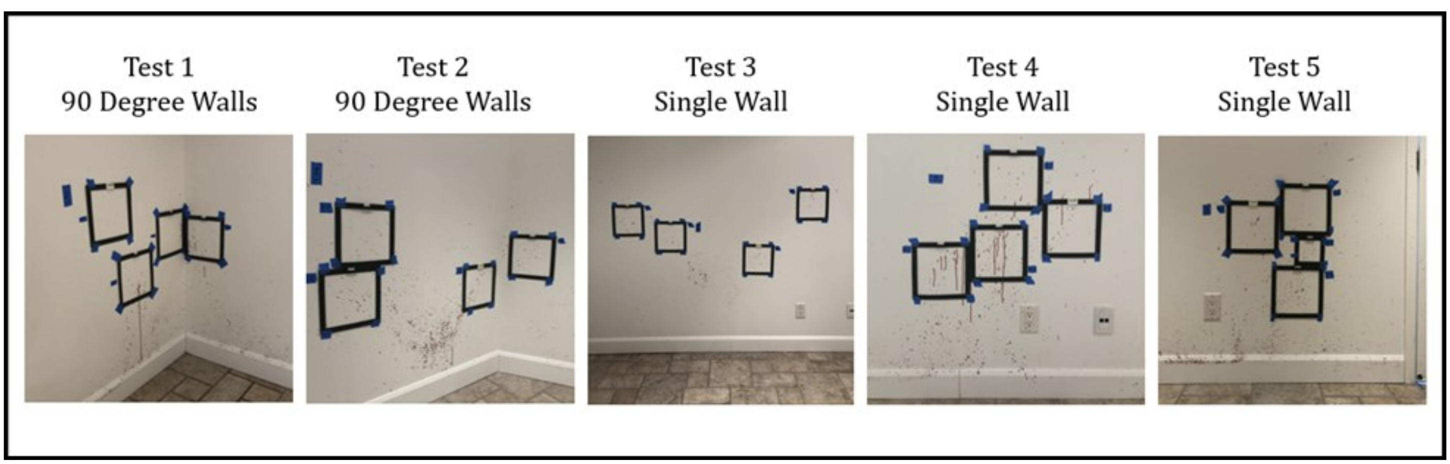

Figure 11—*Photographs of each of the five test scenarios.*

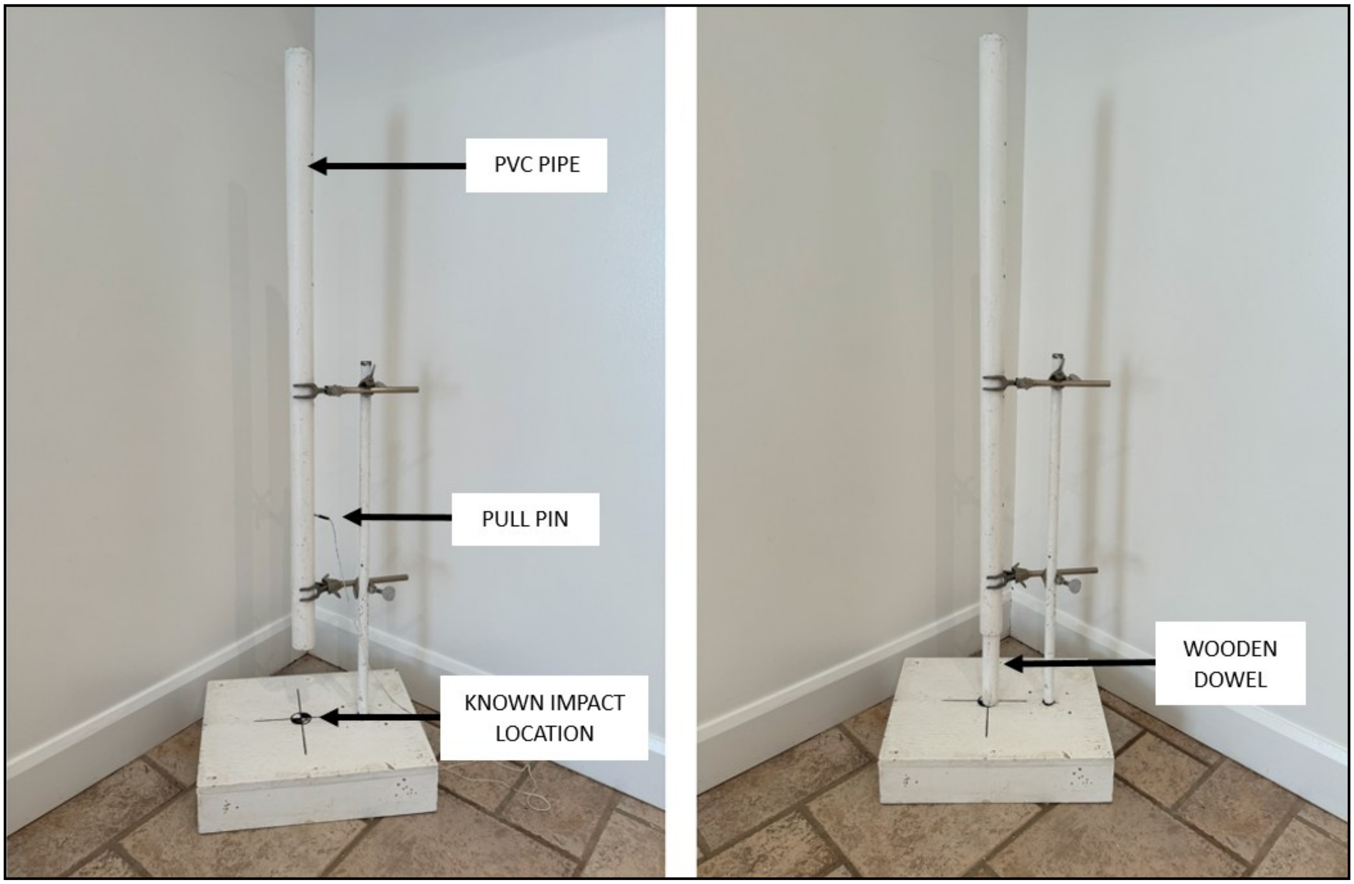

Figure 12—*Impact rig showing the pull pin in the PVC pipe (left image) and the wooden dowel at rest on the impact surface (right image).*

were required for each impact pattern: one scan before and one after the impact. Scans were captured at a 3 mm at 10 m with color, resulting in a scan time of less than approximately 3 minutes per scan.

The origin of the room was chosen as the corner of the three intersecting walls as shown in Figure 12. The main wall was chosen as the X direction, the wall on the right was chosen as the Y direction and the Z axis was oriented vertically, up and down. In cases where only a single wall was used, the direction chosen across the wall was the X direction. Measurements of the impact rig to the room origin point are shown in Table 1.

Photographs and Reference Markers

An important requirement in the Map360 BPA tool is the requirement to take photographs which are perpendicular to the impact surface, as well as being properly exposed, in clear, sharp focus and properly filling the frame with the selected bloodstain area. In addition, the process of marking and aligning the photographs to the point cloud requires three or more common reference points between the two sources (photographs and laser scan data) be selected. When dealing with plain, painted walls, this is often very difficult to do without the addition of high-contrast

Impact Rig | Known Impact Location Coordinates from Room Origin (mm)			
Test #	X (Front Wall)	Y (Adjacent Wall)	Z (Elevation from Floor)
1	295	375	95
2	183	707	91
3	501	791	94
4	310	299	99
5	257	81	94

Table 1—*Coordinates for the recorded impact locations for each test as measured from the room origin (i.e., corner of the room).*

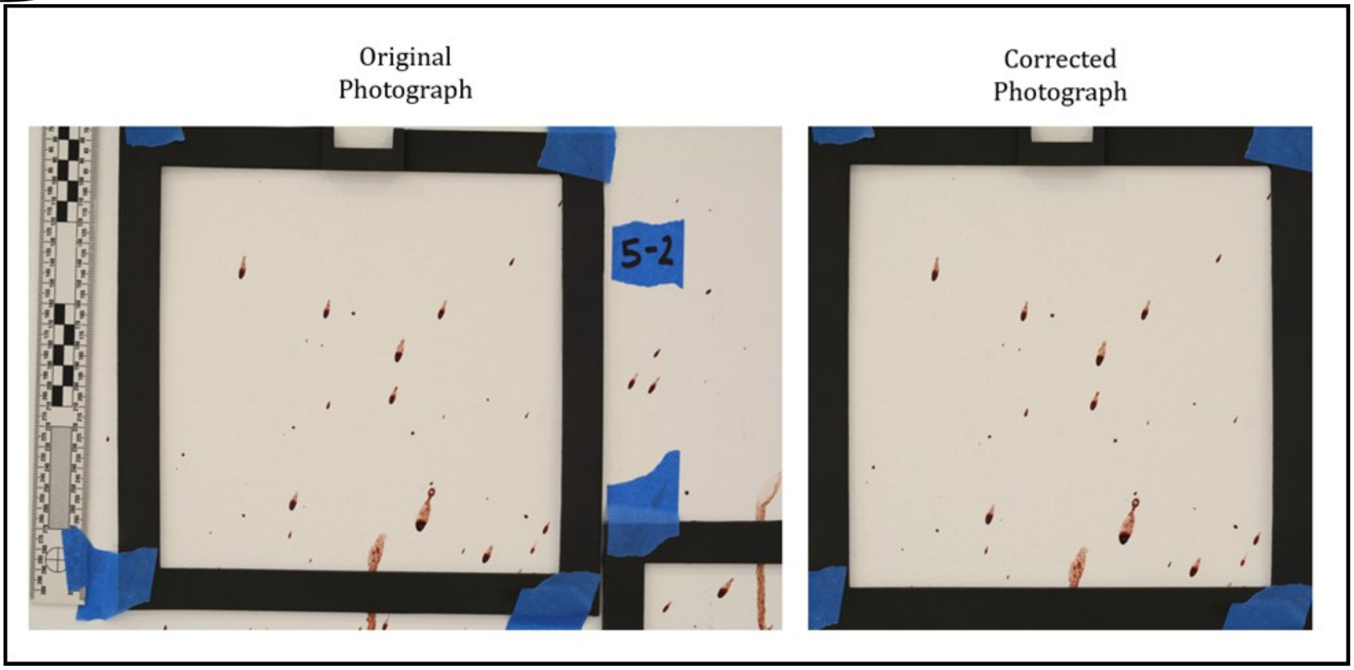

Figure 13—The use of perfectly square 3D printed scales allows for images to be corrected for lens distortion, perspective distortion and to be cropped to the area of interest.

reference markers. Thus, in this study, a series of 3D printed square scales made of PLA plastic with inner dimensions of 10 cm square and 20 cm square were affixed to the wall surrounding the selected bloodstain areas. This was done to first assist in identifying the areas of the impact patterns selected to analyze, as well as to assist with ensuring the photograph was perpendicular to the impact surface, and if not, it could be corrected. The inside corners of the scales were used as reference points that could be selected in the Map360 BPA tool and subsequently matched to the point cloud. When captured properly, the square scales also helped correct for any lens or perspective distortion which is not always apparent in the photographs. Although not the subject of this study, importing the images into a software program such as Photoshop or GIMP allows for lens correction, perspective adjustment and cropping of the image to provide a photograph which provides the most accurate depiction of the bloodstains on a flat surface, minimizing the possibility of the analysis being affected by the distortions inherent in digital photographs, as seen in Figure 13. It is advised to use a digital camera with a lens that has minimal lens distortion . These are typically prime lenses, especially those designed for specific purposes like portrait or macro photography. Fixed focal length lenses, such as 35mm, 50mm, or 85mm, generally have less distortion compared to zoom lenses. Wide angle lenses should be avoided where possible.

RESULTS

Each analysis was performed in Map360 using the procedure detailed in the previous section and the reported results were reported in Table 2. Each pattern was analyzed once by an experienced analyst familiar with more than one digital AO software program. However, their experience level with the Map360 program was relatively new.

The error for each axis (Table 3), standard deviation (Table 4) and the real and absolute errors (Figures 14 and 15) are calculated by comparing the Map360 results (Table 2) to the known impact locations (Table 1).

Map360 Values (mm)			
Test #	x (Front Wall)	Y (Adjacent Wall)	Z (Elevation from Floor)
1	273	357	219
2	174	696	150
3	491	780	244
4	276	301	204
5	255	70	121

Table 2—Values obtained for the calculated area of origin coordinates in Map360.

Error (Difference between known and estimated values in mm)				
Test #	x (Front Wall)	Y (Adjacent Wall)	Z (Elevation from Floor)	Total Error
1	22	19	-124	127
2	9	11	-59	61
3	10	11	-150	150
4	34	-2	-105	110
5	2	11	-27	29
AVERAGE	16	10	-93	96

Table 3*—Actual error calculated between the known and estimated positions for the area of origin.*

Standard Deviation (mm)			
Test #	x (Front Wall)	Y (Adjacent Wall)	Z (Elevation from Floor)
1	14	20	11
2	15	15	15
3	25	22	26
4	19	17	15
5	14	14	16

Table 4*—Standard deviations for each axis for all five tests as reported by Map360.*

What can be noted from the results is that the average total error is less than 100mm for all five scenarios tested. The average errors for the X, Y, and Z axes were 16 mm, 10 mm, and -93mm respectively. The distribution of errors between the X, Y and Z axes shows that the Z axis had the greatest errors which is expected due to the assumption of straight-line trajectories without the effect of gravity. In each case, the Z axis was overestimated. Test #3 had the greatest errors with the Z axis at 150 mm. The contribution of errors in the X and Y directions for this test were relatively small at 10 mm and 11 mm, respectively.

Additionally, looking at the absolute errors is a more conservative approach since it only looks at the magnitude of errors and not the signed distance. Thus, it ignores whether the values were over or underestimated. However, since most errors were almost always overestimated or underestimated, (except for the Y axis value for Test #4), the results remain unchanged or are not impacted significantly.

The standard deviation as reported by the AO tool in Map360 is a measure of how well the bloodstain trajectory lines intersect along each axis. The closer and more tightly spaced the intersections, the smaller the standard deviation. The average standard deviation for the X, Y and Z axes were found to be 1.766 cm, 1.738 cm, and 1.674 cm, respectively. These values show a relatively small threshold across all five tested impact patterns.

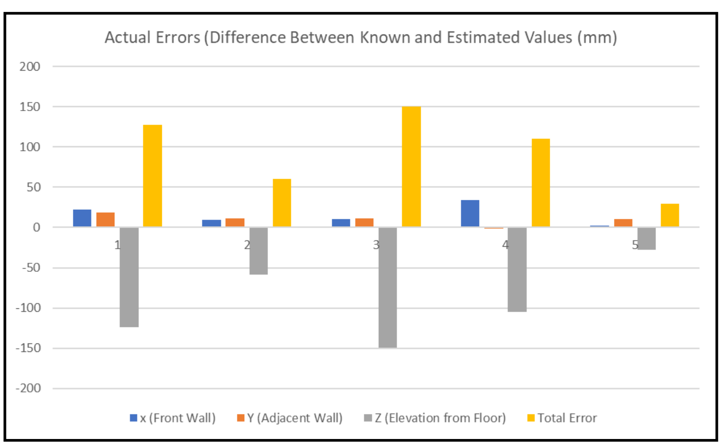

Figure 14*—Graph showing errors for all tests broken down by axis. Errors shown are between the known impact location and the calculated values from Map360.*

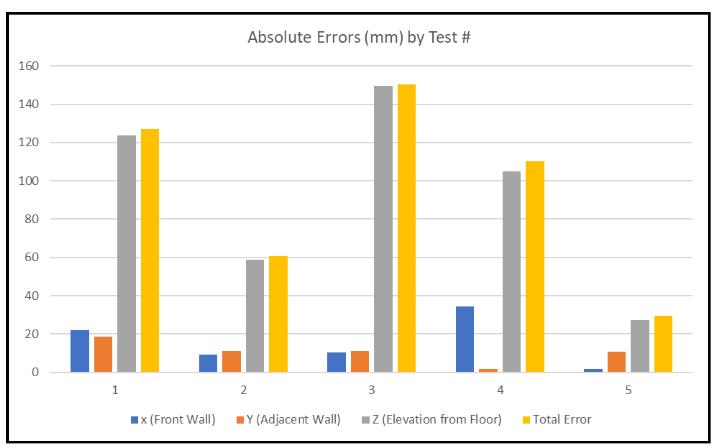

Figure 15*—Absolute errors for all tests broken down by axis and total error. Note that the greatest errors are in the Z axis which contributes greatly to the total error.*

DISCUSSION

This study analyzed five impact patterns with known origins, to do a preliminary investigation into the BPA tool in the Map360 software, specifically focusing on the accuracy of its area of origin (AO) analysis.

The results of this study indicate that Map360 demonstrated an average total error of 96 mm across different impact scenarios. Both the individual X and Y values were relatively low when compared to the Z values in all tests; the absolute errors for the X and Y values all fell under 4 cm while the Z axis values varied between 6 cm to 15 cm. This behavior is quite common in software which uses directional analysis for AO determination. This is so because the assumption of straight-line trajectories ignores the influence of curved flight paths due to gravity.

The highest error observed in this study was in impact #3 at 15 cm on the Z-axis, which is significant depending on the forensic context. This impact was the furthest impact in the series from both the front the wall (50.1 cm) and the adjacent wall (79.1 cm). It is well known that as the impact location moves farther from a target wall/surface, the errors increase as a result of the blood droplets moving farther along their curved flight paths; this directly impacts the Z axis errors [15]. However, this performance falls within the range of previous studies in the field suggesting a similar level of accuracy and performance to other software programs [16,17]. From a practical forensic perspective, and in many cases, the height of the blow is one of the most forensically significant pieces of information and although a 15 cm error is significant, it is still valuable and useful in many cases [18].

As with any study, there are often limitations and sources of errors coming from each of the different parts of the setup and process. A single analyst performed all the analysis in this study, and it would be useful to have a large-scale comparison of inter-observer errors when providing the same data sets to a large number of analysts. This would account for multiple aspects of the process such as how the analyst aligns the images with the laser scanner data, the number and selection of which bloodstains to include in the analysis, and how the bloodstain ellipses are marked.

The sample size in this study was small and there are many other scenarios which could be run by both varying the distance of the impact rig to the main wall but also creating more complex surface arrangements for the overall bloodstain pattern. Having many repeated trials would have also been useful to look at repeatability and would provide for greater confidence in the summative statistics.

Additionally, the analyst in this study was not blinded to the known origin locations and as such, could have introduced bias in the results. Blind studies are important since they reflect real world scenarios at crime scenes when investigators have little or unknown locations of the mechanisms which produced the spatter patterns.

CONCLUSION

This preliminary study shows that the Map360 area of origin tool works well under various scenarios of single and double walls, with impact patterns created up to 50 cm from the front wall. All results fell below a 20 cm acceptance range with the greatest errors always being in the vertical direction. This is similar to past studies for BPA software programs using directional analysis. The workflow and analysis in the Map360 software has benefits including a reduction in documentation time at the scene, ability to analyze many bloodstains, and it provides the ability to handle complex scenarios that would otherwise be very difficult or impossible to do with traditional methods.

Future testing is recommended to fully appreciate the software's capabilities and to better understand the limitations of this software. This would include involving blind participants in future studies to eliminate potential biases and to further enhance how well Map360 performs between different analysts and under different scenarios.

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