

Identification of Blood Prints on Fabric Using Amido Black and Digital Enhancement

Patrick Warrick

*King County Sheriff's Office
Seattle, WA*

Abstract: Blood prints were developed on cotton fabric using amido black and digital enhancement and were ultimately identified to a suspect in a homicide case. The court trial centered on the digitally enhanced latent fingerprint and palm print used for comparison with the defendant. After the defendant was convicted for murder in the first degree, his appeal was based on the contention the trial court erred in admitting the digitally enhanced latent images after conducting a Frye hearing. The Washington State Court of Appeals reviewed the case and affirmed the conviction.

Introduction

On Sunday morning, May 14, 1995, Dawn Fehring, a 27-year-old student, was found dead on the bedroom floor of her Kirkland, Washington apartment. Her nude body was near the foot of her bed with a T-shirt and the top bed sheet wrapped loosely around her head. Blood stains were visible on the carpet near her pelvic area and bloody hand transfer marks were seen on the fitted bed sheet that was still on the mattress. An autopsy revealed that Fehring died from mechanical asphyxia to include both smothering and strangulation sometime the previous Friday evening. The sources of the blood at the scene were two tears to the victim's hymen and some bleeding from the victim's mouth. Kirkland Police Detectives collected the fitted bed sheet for examination.

During the investigation, Eric Hayden, a neighbor of Fehring's, became a suspect. Police interviewed Hayden during a routine canvass of the area and he seemed nervous while talking to the detectives. He was unable to provide an alibi for the night of the murder and told police that he was out drinking with friends, but could not identify the friends. His girlfriend said that Hayden had told her that he was too drunk to remember where he had been on Friday night.

Unable to find any other physical evidence to connect Hayden to the scene, Kirkland Police Department requested King County Sheriff's Office to examine the fitted bed sheet for any possible latent evidence. King County latent examiners received the sheet eighteen days after the estimated time of death for examination. The sheet was a light pink cotton material with several faint blood transfer marks concentrated mostly at the head and the foot of the bed.

Discussion was held on possible development techniques and the decision was made to utilize amido black to try and enhance any blood prints on the fabric. Amido black is a chemical dye solution that binds to protein molecules in blood and yields a dark blue color [1].

Methods and materials

Blood enhancement

A section of material that showed the best amount of blood transfer (figure 1) was selected and cut from the sheet for processing. It should be noted that the fabric did not have any visible ridge detail and exhibited only vague appearances of hand marks. Since it had been eighteen days since the crime, the blood on the fabric was not "fixed" prior to processing. The three solutions used for development were put into glass trays for dipping. Because of the possibility of a large volume of rinse solution being used, the decision was made to utilize straight methanol for the rinse. Comparisons between using the acetic acid/methanol rinse versus straight methanol rinse have shown no differences in latent development or long term stability of the ridge detail on the item.

Working solution:

2 g	amido black (naphthol blue black)
100 mL	glacial acetic acid (99.7% purity)
900 mL	methanol (methyl alcohol)

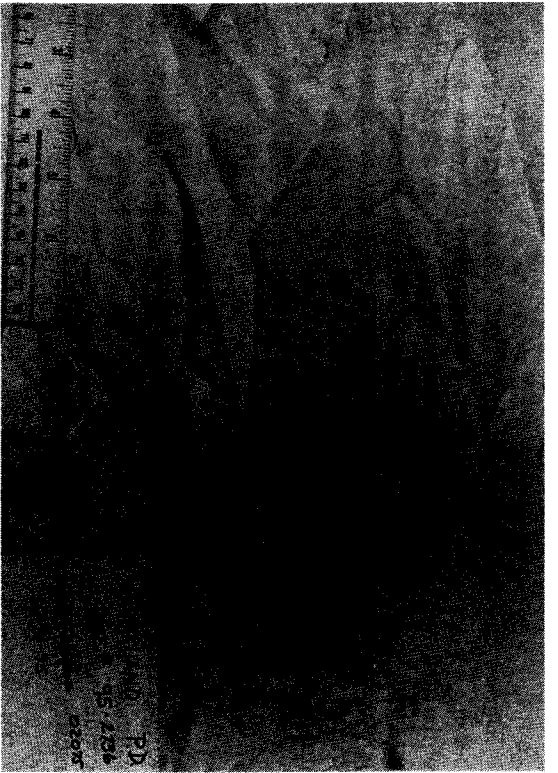


Figure 1

Section of sheet prior to amido black processing

Rinse solution: methanol

Final rinse solution: distilled water

The item was immersed in the working solution and agitated for approximately 15 seconds. Because of the absorbcency of the cotton fabric, the entire item immediately took on a very dark blue/black color. After being agitated, the item was held over the tray to allow the excess solution to drain off, then it was immersed in the rinse solution and agitated. After several seconds the excess dye began rinsing away. There was so much working solution absorbed by the fabric, it became necessary to replace the rinse solution with fresh methanol to remove the remainder of the excess dye. The resulting ridge detail visible on the fabric was quite amazing (figures 2, 3, 4).

After the rinse solution, the item was placed in a final rinse solution to remove the methanol from the material and then allowed to air dry. Based on the development of latents on the first piece of fabric, four other sections were cut from the sheet for processing. Eventually, the entire sheet was processed prior to trial.

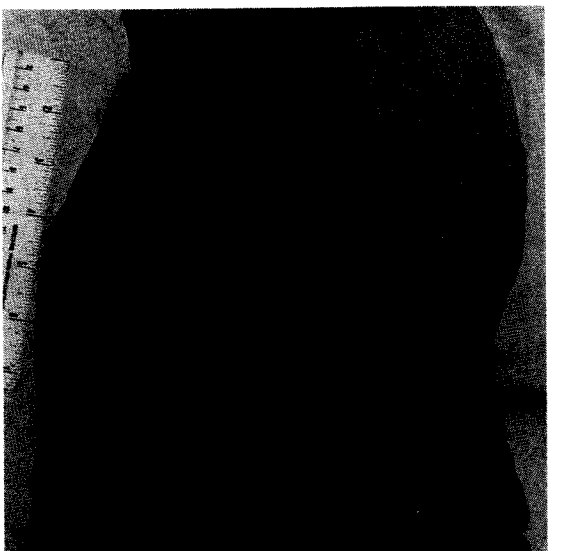


Figure 2

Same section of sheet as figure 1 after amido black processing

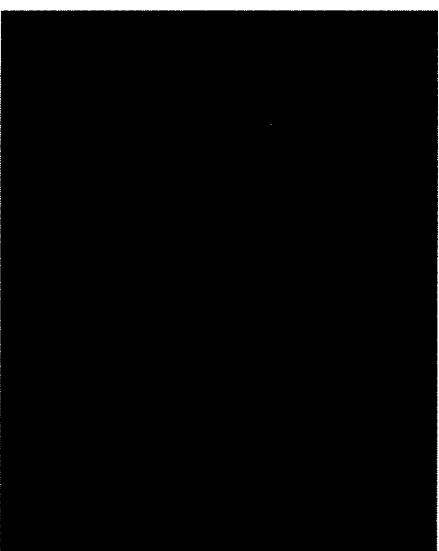


Figure 3

Adjacent areas of the sheet along the cut; top section has not been processed while the bottom section has been treated with amido black (note there is no visible detail prior to processing)

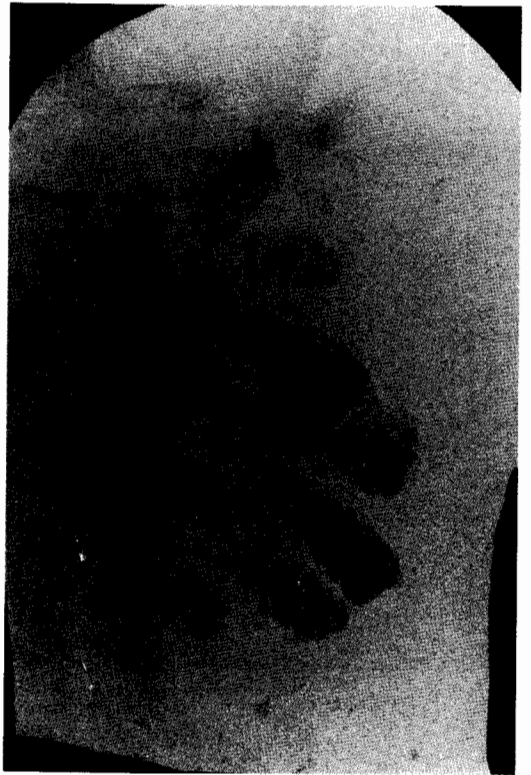


Figure 4
Section of fabric showing overall ridge detail after amido black processing

Ridge formation was clearly visible on the fabric, but under magnification, the detail needed to discern clear characteristics was hidden by the weave of the fabric. King County latent examiners contacted the Forensic Services Section of the Tacoma Police Department in an effort to deal with the weave background of the fabric. Two sections of the sheet that showed the most promise were taken to the Tacoma Police Department for possible digital enhancement.

Digital Enhancement

Several images of ridge detail were captured using a Kodak DCS 420 color digital camera (figure 5). High angle tungsten illumination was used to help eliminate shadows in the weave pattern. The images were then acquired into a digital image tracking computer program called MOREHITS™. The system encrypts sensitive case data that is saved into the program. The image itself is not encrypted or altered in any way.

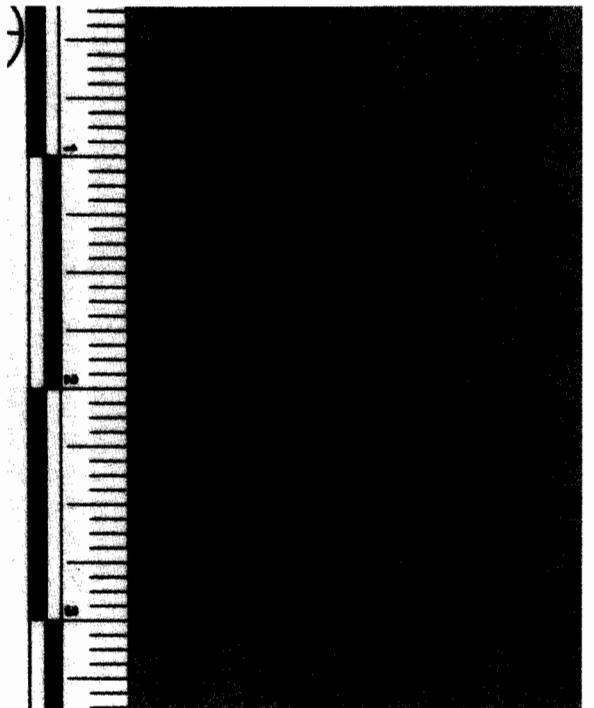


Figure 5
Digital image of amido black developed latent palmprint on cotton fabric prior to enhancement

The program contains an algorithm that is used to scan the image and detect any alteration of the image since it was captured. The algorithm is capable of detecting a change to even one pixel. All subsequent enhancements are performed on copies of the original image. Specific enhancement tools and processes can be tracked by the computer program and also are encrypted for data integrity. In the end, the user has an original image with encrypted data and one or more enhanced versions of that original with any accompanying encrypted enhancement data. While it is impossible to absolutely prove the true representation of an image and the need for this type of image and data tracking is debatable, it is just one more tool showing case documentation that can be used in court.

The main enhancement software for the computer program is Adobe® Photoshop™. Photoshop™ was to be used to deal with the low contrast image, but it lacked any tools to adequately handle the issue of the weave pattern interference. To address this problem, Micrografix® Picture Publisher™ was used. It contains an algorithm

called a pattern removal filter that seems to be a variation of the gaussian blur, where repeating patterns are softened, making them much less noticeable. This differs from the Fast Fourier Transform (FFT) filter in that the Picture Publisher™ doesn't actually remove the repeating patterns from the image [2]. The pattern removal filter was applied to the images, which resulted in the repeated weave pattern being significantly muted.

To deal with the low contrast image specifically, several tools from Adobe® Photoshop™ were utilized. The algorithms found under the Image>Adjust submenu in Photoshop™ such as Levels, Curves, Color Balance, Brightness/Contrast, and Variations all basically do the same thing. They map the pixel ranges within the digital image and enable the user to adjust those ranges [3]. In this instance, the Curves function was the main contrast adjustment tool used to measure and adjust the tonal ranges of the ridge detail while leaving the background tones unaffected. The finished images had good contrast between the ridge detail and the muted background weave of the fabric.

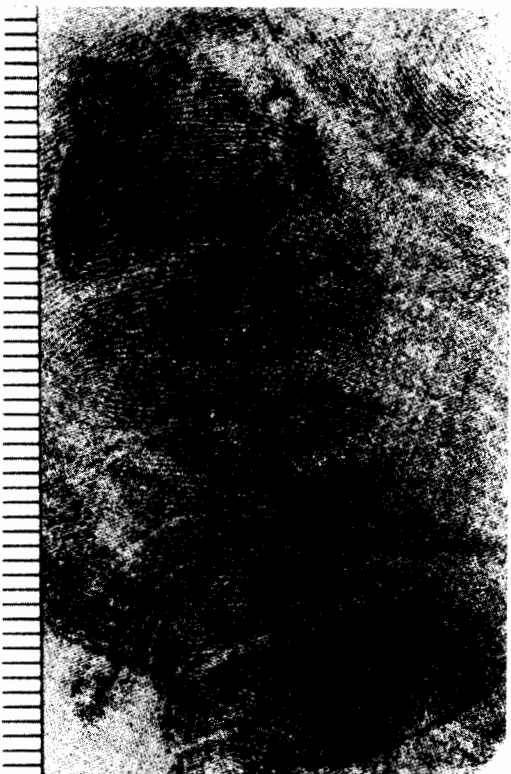


Figure 6

Digital image after the weave pattern has been softened and the contrast improved

King County latent examiners contacted the Kirkland Police detectives and advised them that several identifiable latents had been developed on the sheet. For comparison purposes, Kirkland Police provided the names of five male individuals, including Eric Hayden, who lived in the apartment complex and had prior violent criminal histories. Hayden had been booked in January, 1995, and had fingerprints and palm prints on file with King County Sheriff's Office. Comparison of the enhanced images of the latent prints from the sheet with the known prints of Hayden resulted in two positive matches*. A latent palm print from the foot of the bed matched Hayden's right hand and a latent fingerprint from the head of the bed matched the right middle finger of Hayden.

Court proceedings

Trial court

On June 5, 1995, the State charged Eric Hayden with one count of felony first degree murder. Specifically, it alleged that Hayden raped Fehring, and in the course of committing that crime, caused her death. Prior to trial, Hayden requested a hearing to determine the admissibility of the print evidence identified by the use of enhanced digital imaging. He argued that the digital enhancement was a novel scientific technique and therefore did not meet the Frye standard [4]. Under the Frye test, scientific evidence is admissible if it is generally accepted in the relevant scientific community, but not allowed if there is significant dissension among qualified experts as to its validity. If the evidence in question does not involve novel techniques or methods, it precludes the need for a Frye hearing.

Testimony by two forensic experts involved with this case outlined the steps taken to process and digitally enhance the latent prints on the bedsheet. Arguments were given that digital technology evolved over 25 years ago by the NASA Jet Propulsion Laboratory to isolate and enhance data from deep space. The State contended that the technology of digital enhancement was not new and it was more the high cost and lack of knowledge that kept the law enforcement community from using this technology earlier. Hayden did not present any witnesses

* - In December, 1995, a third latent was identified to Hayden after subsequent digital enhancement. However, due to trial date deadlines, this information was not presented in court.

against the State and presented no opposing literature. The trial court found that the amido black chemical process was generally accepted by forensic scientists and that the enhanced digital imaging process was not a novel scientific process to which the Frye test applies. Nevertheless, the court found that digital enhancement of images passed the Frye standard.

During trial, two King County latent examiners testified that they had identified both a bloody palm print and fingerprint developed on the victim's bedsheet as having been made by the defendant. When asked under cross-examination if the comparisons were based on the prints actually found on the sheet or the digitally enhanced versions, both examiners stated that the weave pattern made identifications to the actual sheet extremely difficult if not impossible.

An imaging system similar to the one used by the Tacoma Police Department was set up in the courtroom to show jurors what steps were taken to enhance the fabric prints. The imaging expert from Tacoma went through the entire enhancement process step-by-step, including capturing the image from the actual piece of evidence. Jurors were shown how the images and data were protected from tampering and that all enhancements were done on a copy of the original to protect the integrity of the evidence. The jurors saw the enhancement tools used and their effects on the image. The important part of the demonstration was that it allowed the jurors to see first hand the results of the enhancement and established both the repeatability of the process and demonstrated visually that the enhanced version had not been altered so as to identify an innocent person [2].

The defense contended that the identifications were flawed due to the fact Hayden could not be identified to the actual sheet. Their argument was that the prints were worthless until an outside "imaging expert" from Tacoma with some new computer software made the prints identifiable. They tried to convince the jury that the computer had somehow altered the enhanced images and the wrong man was identified. The jury, which included three Microsoft employees, deliberated for three hours before finding Eric Hayden guilty of first degree murder.

Appeal court

Hayden's appeal was based on the argument that digital imaging has not obtained general acceptance in the relevant scientific community because the use for this specific type of forensic application is new and the computer programs used to enhance the images were not designed for forensic science. He maintained that the trial court erred in admitting the enhanced images as evidence because they did not satisfy the Frye standard. The State countered that digital enhancement is not novel and is generally accepted, even in the latent print examiner's scientific community. With that criteria met, the State contended that the Frye standard had been satisfied.

The appellate court reviewed the trial record and found that the State's arguments had merit. However, they also realized that no Washington court, or any other court in a published opinion, had determined the admissibility of digitally enhanced prints with regards to the Frye standard. With that in mind, the appellate court conducted another Frye test to examine the question of whether the digital imaging process was too novel and if it is generally accepted in the relevant scientific community [5].

During trial, the State had argued that the unique application of an accepted technology did not constitute a novel process and cited *State v. Nolie* [6] for support. In *Nolie*, images of a child abuse victim's sex organs that were obtained using a colposcope were challenged. A colposcope is a microscope developed and normally used to diagnose cancer, and in the opinion of the court, basically a magnifying glass with a long name. The appellate court concluded that the use of that scientific technology was not novel, even though the application of that technology in child abuse cases was relatively new; therefore, it was not subject to the Frye test. Certainly digital imaging in general is not a new process and even the average person understands and accepts computer enhancement of photographs and video. More at issue in this case was the question of acceptance of digital technology in the forensic science community.

A case that has been adjudicated but not appealed to a higher court is considered unpublished and cannot be cited to support evidence in another case, however, unpublished cases can be used to show accepted technology or practice by a profession. In *Commonwealth of Virginia v. Knight* [7], a 22-year-old victim was found stabbed to death in March, 1990. A faint bloody fingerprint was seen on a pillowcase

found next to the victim. The fabric was processed with DFO and some ridge detail was developed. Because of the interference of the fabric pattern, the latent print could not be identified. Investigators sent a photograph of the DFO print to a private company for possible digital enhancement. The process included the removal of the fabric pattern from the background, which resulted in an identification to the suspect. During the suppression hearing, the analyst from the private company provided details of the enhancement process. After the demonstration and supporting expert testimony, the court admitted the enhanced print concluding that the process did not alter the characteristic arrangement of the latent print.

The only published case that deals with a digitally enhanced amido black print is *Litaker v. Texas* [8]. In that trial, a retired Army latent print examiner testified that he had matched a digitally enhanced latent print that had been developed with amido black to a known print. However, the admissibility of the identification was not challenged and the process was not discussed in detail by the court. The significance of *Litaker v. Texas* is that it showed the combination of amido black and digital enhancement was presented in at least one court as early as 1990.

To document the acceptance of digital technology in the Hayden case, the appellate court researched its use in the forensic community. It is clear that digital technology was being utilized by law enforcement for some time, albeit on a limited scale. According to literature by Alan McRoberts [9], digital image enhancement had been a tool for latent processing at the Los Angeles County Sheriff's Office since at least 1987. The appellate court concluded that there was not a significant dispute among qualified forensic personnel on the validity of digitally enhanced images performed by qualified experts using appropriate software. Hayden's argument that the trial court erred by admitting the enhanced images was rejected and his conviction was affirmed [5].

Conclusion

The successful prosecution of Eric Hayden was the result of the cooperation of three law enforcement agencies and the prosecutor's office. Agencies and personnel should not be limited to the confines of their jurisdictions when sharing information and technology. This is especially true as digital technology becomes more common in law enforcement. The court demonstration of the enhancement methods

used was invaluable to the jury and this type of testimony should always be an option for the forensic professional during trial. It allowed qualified experts to repeat for the court and jurors the enhancement process and they could see for themselves that the identifying characteristics were not altered. This case is significant because it is the first time digitally enhanced latent prints have withstood direct challenge under appeal, and has been subsequently published.

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For further information, please contact:

Patrick Warrick
Latent Print Examiner
King County Sheriff's Office
516 Third Avenue
Seattle, WA 98104
(206) 296-7446, Voice
(206) 205-7898, Fax
patrick.warrick@metrokc.gov

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