

## **Digital-image enhancement took a print from "no value" to "identifiable"**

**... but defense-attorney accusations that the technology was "junk science" propelled that print into the hot spotlight of controversy.**

**AS EVIDENCE TECHNOLOGY** moves further into the digital age, many law-enforcement agencies are facing the decision of just how much they should depend on the capabilities that digital technology offers them. Among the questions they face are: "How reliable is the technology?" And "How will digital evidence be received in court?"

These pressing questions may be why a seemingly routine murder trial in Broward County, Florida attracted such a large amount of attention from the media-and from the forensic community, as well--even months after the conclusion of the trial.

In the early stages of the *State of Florida v Victor Reyes*, the image of a palm print that had been digitally enhanced was challenged by the defense and subjected to scientific standards during a Frye Hearing. The hearing drew close attention to the technology that enables digital-image enhancement, but the hearing also provided a sounding board for those who challenged that technology's validity-labeling it "junk science."

At the end of the Frye Hearing, the prosecution had presented witnesses who ably demonstrated the scientific validity of digital-image enhancement. But when the trial ended in an acquittal, the term *junk science* continued to appear in reports from the local media, which perplexed experts involved in the case. And, even today, some in the forensic community continue to ask those questions about digital-imaging technology: "How reliable is it?" And "How will it be received in court?"

### **State of Florida v Victor Reyes**

This case began in September of 1996 when the body of Henry Guzman -a drug addict and drug dealer-was found lying on the side of a road in Pompano Beach, Florida. The victim had been killed execution-style with a gunshot to the head. His body had been concealed inside a blanket and his head was inside a plastic bag. The bundle was wrapped with duct tape.

The Broward County Sheriff's Office crime-scene unit received the duct tape as potential evidence after the postmortem examination was performed. The tape was processed using laser-grade dye stains and a Coherent ion-argon laser. Six latent prints were photographed and the photos were sent to the latent-fingerprint section for examination and comparison. Two latent fingerprint examiners came to the conclusion that all six prints were of "no value" due to blurring and smudging.

Meanwhile, investigators suspected that Victor Reyes might have had something to do with the homicide. Guzman had ties to Reyes' brother. There were other indications that Victor Reyes-who was a convicted drug dealer himself-might be the perpetrator. Those indications included the bloodstains found in Reyes' apartment that had DNA matching that of the victim. There was also a witness who claimed to have heard the shooting take place over the telephone. In addition, the victim's girlfriend reported that she had received a phone call from the victim shortly before the shooting, when he said he was on his way to visit Reyes.

The authorities decided they had a good case against Reyes, even without the "no value" fingerprint evidence. The Broward County Sheriff's Office issued an arrest warrant for Reyes. But Reyes was out of state at that time, visiting his brother in North Carolina. He remained out of state until 1999. When he returned to Florida that year, he was arrested.

Investigators began to build their case against Reyes. In an effort to accumulate more evidence against him, the detectives decided to revisit the duct-tape latent prints that had earlier been labeled "no value." In June of 2001, they selected three of the original black-and-white film negatives and sent them for further processing to Forensic Analyst David Knoerlein in the Broward County Sheriff's Office crime-scene unit's digital-imaging lab. Knoerlein enhanced the images of the prints using PC Pros More Hits software, which incorporates Adobe Photoshop software. This technology had not been used earlier because it was only beginning to emerge in the crime scene field five years earlier when the victim had been killed.

As a result of this digital enhancement, Knoerlein returned a palm print that was identifiable to the known prints of the suspect, Victor Reyes.

Prior to the beginning of the trial, the defense requested a Frye Hearing to determine if the technology used in processing the prints met the standards for admissibility of scientific evidence. The defense called one witness as an expert in Adobe Photoshop to discredit the use of the digital image enhancement technology. The prosecution presented the testimony of three expert witnesses: Erik Berg, developer of the PC Pros More Hits program; David Witzke, a sales executive for PC Pros More Hits and an expert in forensic digital imaging; and Knoerlein, a forensic analyst with more than 18 years experience as a forensic photographer and six years of experience in forensic digital imaging.

At the end of the Frye Hearing, the judge stated that the prosecution's expert witnesses had demonstrated that the process of digital enhancement does not change the basic image; and that the process of digital-image enhancement of fingerprints is used and accepted throughout the forensic community. On October 21, 2002, the judge ruled that both the evidence and the testimony of the expert witnesses were admissible and that the trial could proceed.

The prosecution, however, suffered a serious setback when the key witness -the one who allegedly had heard the shooting over the telephone-refused to testify on the day he was scheduled to do so. The rest of the evidence was admittedly circumstantial in nature.

The trial took up the better part of a month-but the jury took only three and a half hours to reach its decision:  
Not Guilty.

### **A reasonable doubt ... but not about digital imaging**

Following the acquittal of Reyes, this headline about the trial appeared in *The Miami Herald*: "Fingerprint wins man freedom." That headline was just one example of media coverage that forensic experts involved in the case called inaccurate and misleading.

Headlines and reports implied that the defense's argument labeling all digital-imaging technology as "junk science" had been successful. But a post-trial discussion with the jurors, conducted by Prosecuting Attorney Debra Zimmer, indicated that the jurors fully accepted the digitally enhanced fingerprint evidence that was presented by the prosecution.

There were two primary factors that caused the jurors to rule "not guilty." First, jurors were concerned that Reyes' prints could have been put on the roll of duct tape *before* it was used to wrap the body. Or, even if the suspect had helped to wrap the body in the blanket and plastic bag, he might not have been the person who actually committed the murder. Their second major concern was the failure of the key witness to testify during the trial.

The technology of digital-image enhancement allowed a print to go from "no value" to "identifiable" with a few clicks of the mouse. But in the end, no technology could resolve in the jurors' minds the question of when -and under what circumstances the print was put onto the duct tape.

### **The technology: darkroom to digital**

When Knoerlein was presented with three original black-and-white film negatives taken five years earlier, he proceeded to process them according to the standard operating procedures in place at the Broward County Sheriff's Office. The process began by scanning the original negatives with a Polaroid SprintScan 35 Plus, thereby creating digital versions of the images on the negatives. Those images were then loaded into the PC Pros More Hits forensic image-tracking system application, which provides digital-image management, control, storage, retrieval, and security and data encryption. Using Adobe Photoshop, which is integrated with the More Hits program, Knoerlein applied several different enhancement techniques to the images, including 'Levels' adjustments, pattern removal, and the use of the 'Dodge' and 'Bum' tools. This enhancement yielded a match of one of the prints-a palm print-to the suspect, Reyes.

Critics say that the application of digital-enhancement techniques (such as the dodge and bum) to evidence takes the possibilities of computer technology too far-and might even verge on outright forgery. But even though Knoerlein performed that process through a series of mouse clicks and keystrokes, the basis of the process emerged directly from the traditional photographer's darkroom.

"The science of digital-image enhancement is a phenomenal tool," said Knoerlein. "The argument would be that this is the same type of technique that has been done in the photo lab for years. My own roots are in the photo lab. I have done dodge and bum quite a bit in the dark room, so I can tell you that the Photoshop version of dodge and bum is an exact copy of that application-but with much more precision. I don't see a problem with it."

And digital-image enhancement is not a new or novel application in the field of evidence technology, either. Knoerlein points to his own position with the Broward County Sheriff's Office as an example: He works full time doing exclusively digital-image enhancement. Across the country, the technology is being used by numerous federal agencies, including the FBI, the DEA, and the Secret Service, as well as more than 150 municipal and state law-enforcement agencies in the United States.

But critics of the use of this technology, such as the defense in the Reyes case, question the integrity of the powerful tools found in digital-image enhancement software. They ask jurors to consider ways that everyday people use Adobe Photoshop: To cut and paste a personal image onto a backdrop of Hawaii, for example-or to put the head of a baby on the body of an alligator for a startling tabloid cover photo. Would it not be possible, the critics ask, to forge a print on an image where it did not exist before?

"During the Frye Hearing of the Reyes trial, the defense attorney asked me, 'Isn't it possible that you could create a print?... recalled Knoerlein. "My answer: 'Yes, it is possible. But I couldn't do it.' I told her that with all my years of experience, I know I could not forge a print. Because it involves much more than drawing lines to represent the ridges of finger prints. There is much more detail than that in a fingerprint, "

In addition, Knoerlein said, law enforcement agencies can initiate procedures that ensure digital forgery of a print could never happen. "Here at the Broward County Sheriff's Office Crime Laboratory, I do not have access to the defendant's prints," said Knoerlein. "I don't even know who the defendant is. Plus, there is the fact that I am not a latent fingerprint examiner-I am a forensic analyst, a specialist who deals only with digital enhancement full time, every day."

Another issue with digital-image enhancement is repeatability. Critics will argue that if digital-image enhancement is truly scientific, then the process should be 100% percent repeatable. David Witzke, vice president of sales and marketing for PC Pros, disagrees. He argues that it is impossible for anyone to guarantee 100% repeatability in almost any of the accepted scientific procedures.

"Two individuals performing the same DNA test with the same samples can only guarantee a 99% rate of accuracy," said Witzke. "So why are those in the field of digital-image enhancement challenged with a requirement that is mathematically unattainable? In addition, there is no conclusion of any court or other legal precedent established that requires this level of repeatability. "

Witzke argues that there are two factors involved in the concept of repeatability. First, he said, it is always necessary to maintain records of the steps taken during the enhancement process both for verification purposes as well as to allow others to repeat the process. Second, he said it should be possible to give the same original image to two individuals and find that when both independently enhance the image, they arrive at the same result.

"It is true that the contrast for the two images of the print might be slightly different," said Witzke. "Perhaps one person used 'Levels' in Adobe Photoshop to adjust the contrast within the image while another used 'Curves.' Or maybe one used 'Brightness/Contrast' while another used 'Hue/Saturation' to achieve the desired results.

"The bottom line is simply this: Photography is a subjective process. What may be clear to one person may not be clear to another. The results can and should vary from person to person. But as long as there is no wrongdoing and people are not misusing the tools available to them, then the resulting images will still be clearly identifiable as the same image. In other words," said Witzke, "the end result will be exactly the same fingerprint, ridge for ridge."

### **The future of digital-image enhancement**

Given the media attention that the Reyes trial received, Knoerlein said he would not be surprised to see similar challenges rise up against digital-image enhancement in the future. "Anyone involved in this type of work should expect the possibility of challenges," he said. "And with the information about the Reyes case that got out into the media, some defense attorneys could say, 'Oh, I heard this case was lost in Broward County because of digital imaging! That may raise some questions in the future."

There are some steps being taken, however, to ensure that any future challenges to the technology of digital image enhancement will meet a wall of solid scientific facts and firmly established procedures.

"We're ready for them," Knoerlein said. "Those in the forensic community who are doing digital imaging have some organizations and groups they look to for guidance."

One of the main guiding bodies for this field is the Scientific Working Group on Imaging Technologies (SWGIT). The mission of SWGIT is "...to facilitate the integration of imaging technologies and systems within the criminal-justice system by providing definitions and recommendations for the capture, storage, processing, analysis, transmission, and output of images. "

In addition, Knoerlein pointed to a local organization, Digital Imaging for Florida Law Enforcement (DIFFLE), which works with the users of these technologies to develop guidelines and standards on a statewide basis.

Adopting a set of standard operating procedures for digital imaging is vital for protecting the integrity of digital evidence. Knoerlein used a policy at the Broward County Sheriff's Office as an example. In his position, Knoerlein deals only with digital-image enhancement-and he never sees the known prints of the suspects, nor is he expected to perform comparisons. This differs from the situation in many law-enforcement agencies, where no one person is entirely dedicated to digital-image enhancement.

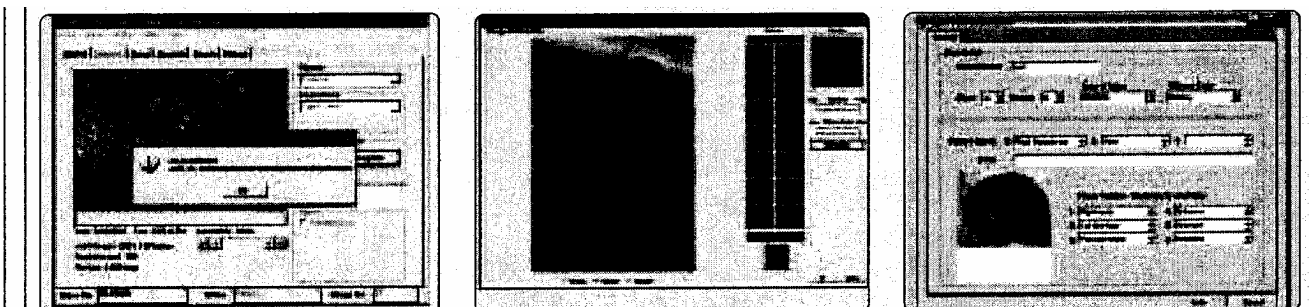
**Transform filters are plug-ins to Adobe Photoshop. They allow the technician to identify and remove repetitive patterns that interfere with the recovery of forensic evidence (above, center). And with More Hits ARS Connect (above, right), you send an image directly to an ARS system without making a hard copy.** It would be much more difficult to testify as an expert witness if digital image enhancement is not something that you do full time, on a regular basis - especially if it is with a new technology where the courts are going to tend to go after every little piece of it," said Knoerlein. As guiding bodies continue to aid the progression of digital-imaging technologies, Knoerlein said he hopes to see two changes in the field:

The first change would address any challenges from defense attorneys against the tools used and to eliminate accusations of forgery. "In the future, I would like to see an application that will document every little motion-all these factors involved with tools like 'dodge and burn,'" said Knoerlein. "Currently, the process is documented, but not necessarily each step."

The second change Knoerlein would like to see is the establishment of dedicated positions for digital-image enhancement. "The two disciplines of latent-print examiner and image enhancement technician need to be separated," he said. "That's because there can always be a challenge from an defense attorney. They might ask, 'If you're a latent examiner, don't you have access to the inked prints? Isn't it possible that you could have added a ridge to make it a match?'"

Currently, said Knoerlein, most law-enforcement agencies do not have dedicated positions like this. But he thinks that perhaps the results of the Reyes case and cases like it will help move digital-image enhancement further into the realm of acceptance by law enforcement.

"I think right now, a lot of law enforcement agencies are waiting for cases like the Reyes case to wind



**When an image is loaded into the PC Pros More Hits program, the software can automatically identify where the original image came from, maintain the relationship between an original image and an enhanced image, and provide authentication of images (above, left). The More Hits Pattern Removal and Chromatic Fast Fourier**

their way through the courts," said Knoerlein.

"They're waiting for the courts to be more confident in the technology of digital-image enhancement and to be more accepting of it.

"Once that happens," Knoerlein said, "I think you

will probably see a number of law-enforcement agencies all around the country begin to create dedicated positions like mine."

*-By Kristi Mayo*

## The Technology Behind the More Hits@ Software

At the center of the Reyes trial's Frye Hearing was the technology used to digitally enhance an image of a print found on a piece of duct tape. The technology that helped make that enhancement possible was the PC Pros More Hits forensic-image tracking system.

This software program was designed to allow digital image technicians to capture an image of a latent print from any source—a digital camera, flatbed scanner, film scanner, or existing image file. The integrity of that image is then protected by the More Hits system with security features and data encryption. The software also allows information to be stored regarding the history of the image, including any enhancements. Here are some of the features found in the PC Pros More Hits software:

**Automatic calibration:** The program's Image Calibration Utility—automatically calibrates the images during acquisition by measuring the scale in the image and inputting the correct distance between two points on that scale.

**Pattern removal:** The More Hits Pattern Removal Filter— is a plug-in for Adobe Photoshop. This tool removes repetitive patterns that obscure forensic evidence such as a latent print.

**Export to ANS:** With the More Hits AFIS Connect feature, you can export an authenticated, enhanced image directly to an AFIS workstation without producing a hard copy, thereby protecting the image from loss of detail.

The More Hits program incorporates Adobe Photoshop, allowing digital-image technicians to enhance a photo with tools such as "Dodge" and "Burn," or through adjustments to "Levels" or "Curves." Meanwhile, these changes are tracked through the More Hits program.

The program also allows important information to be stored along with the image, such as source, fingerprint processing information, image description, AFIS data, case information, user data, and user notes. (For more information, visit their website: [www.pcprosusa.com](http://www.pcprosusa.com).)