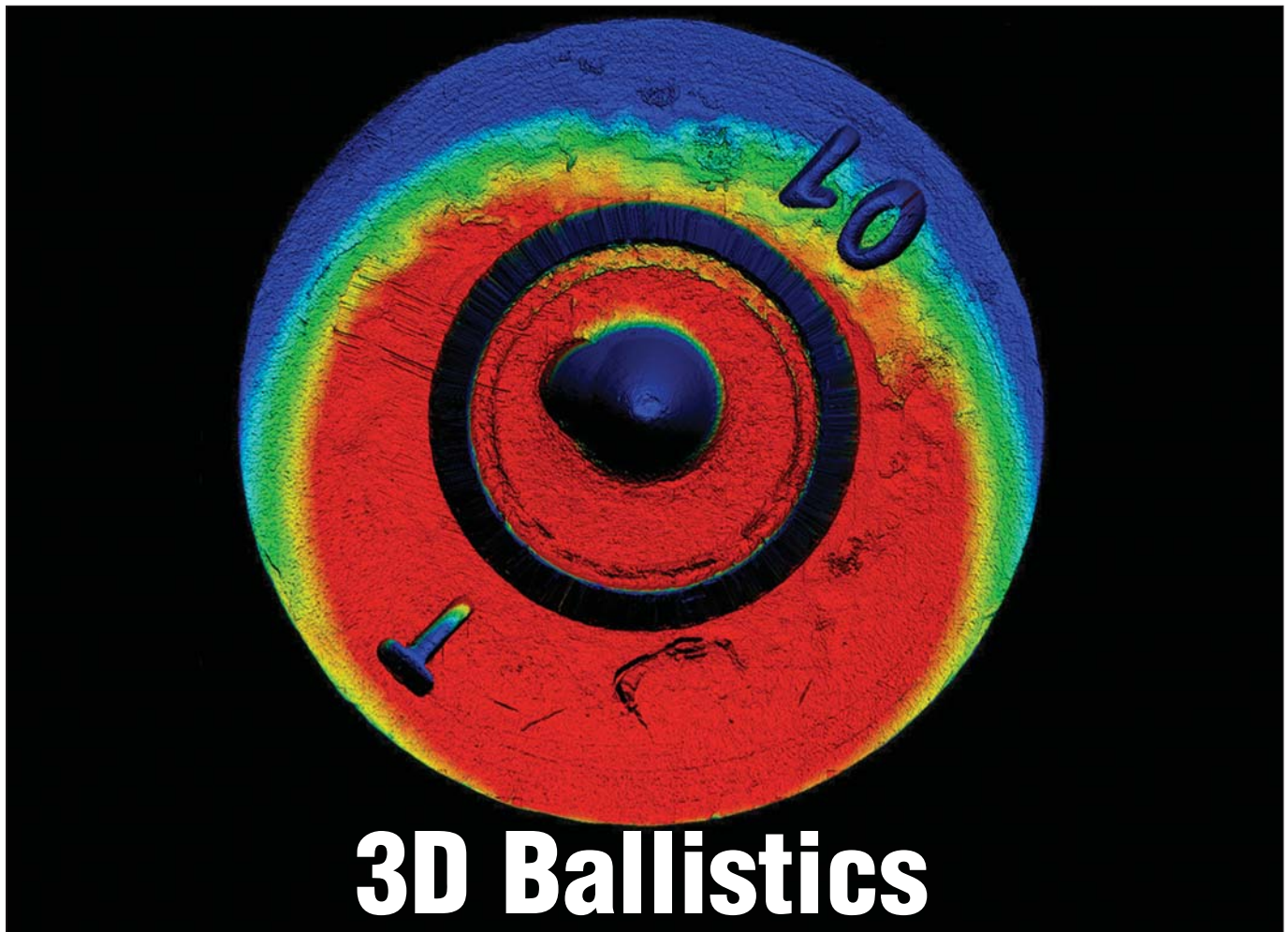


# EVIDENCE TECHNOLOGY MAGAZINE

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### TOPICS IN THIS ISSUE

- Trends in Latent Print Testimony
- Water-related Death Investigation
  - Ethics and Forensic Science
- iPhone Apps at the Crime Scene

The Matchpoint+ comparison-and-analysis station from Forensic Technology Inc. uses a side-by-side viewer that can accurately compare either two bullets (on the left in the photo below) or two cartridge cases (on the right) using both 2D and 3D information.



# Recent Advances in Forensic Ballistics

Written by Dale Garrison

**B**ALLISTICS ANALYSIS is realizing a technological shift that offers new advances for law-enforcement professionals. Some of the new technology may seem like science fiction: three-dimensional imaging technology for cartridge cases and bullets, with an interface so sleek and sophisticated that it looks like it might have been lifted straight from the often-exaggerated world of television crime shows.

But utilizing 3D imagery for the forensic comparison of bullets and cartridge cases provides specific advantages that reach well beyond an attractive image on a computer's monitor. Two-dimensional images are essentially photographs, often black and white, with a distinct limit of detail. Even if the photos are taken with the help of a comparison microscope, they are flat images that only represent a fraction of a multi-dimension reality. Two-dimensional images are subject to the limits of visible light and what the human eye can see. The latest three-dimensional renderings are more like an incredibly

**Using 3D imagery for the forensic comparison of bullets and cartridge cases provides specific advantages over a simple image on a computer monitor.**

accurate GPS mapping of an object's surface, and the mathematical model can be viewed from many perspectives.

Equally important, some experts say that the mathematical information derived from a 3D image can be shared locally, nationally, or even internationally as easily or more easily than what is currently done with traditional 2D images. With modern computer technology, technicians can operate processes that are largely automated—quickly culling down thousands of candidates to a half-dozen viable suspects. That smaller sampling can then be viewed by a skilled examiner, saving hours—or even days—of work.

## Good Things, Small Package

Among the most recent advances in forensic ballistics are those by Pyramidal Technologies Ltd. and its ALIAS system. Company President Mike Barrett highlighted several aspects of the compact, portable technology, but most important is the 3D rendering output that provides a substantially different result than photographic or scanned images.

“There are just a lot of limitations with the old technology,” Barrett said.

ALIAS (an acronym for *Advanced Ballistics Analysis System*) consists of just a few relatively small components, including an enhanced Apple Mac Pro computer, and an interferometer that surveys a cartridge case or bullet to create mathematically based renderings. In simple terms, laser beams are used to measure a surface down to variances as small as two microns (about 1/50 of a human hair). Using those measurements, ALIAS creates a mathematical model (or “digital clone”) and stores this visualization in its open database. The operator can then call up a 3D rendering of

# 3 D BALLISTICS

the object on an HD monitor. Using one of ALIAS' algorithms, the operator can then request to execute a correlation of the questioned cartridge case or bullet, and ALIAS generates a set of possible matches.

The word "match" does not do justice to the technology's capabilities. For example, the mathematically generated renderings are light independent; the examiner can create different "light" effects (the angle, direction, and intensity of light, for example) to highlight various details in the cartridge case or bullet. The examiner can also rotate and manipulate the image, examining it from any perspective—or even combinations of perspectives.

Barrett compared the shift from 2D to 3D comparison with the introduction of high-powered magnification. "If you think of Sherlock Holmes with a magnifying glass, what if one day someone gave him a microscope? All of a sudden, he would be seeing remarkable details that he didn't even know were there before."

Three-dimensional systems take that advance and multiply it dramatically, with no loss of detail. The ALIAS system was recently used to enlarge a cartridge primer 3,000 times while maintaining focus.

## Splitting Light

Interferometer technology, the foundation of the ALIAS technology, is not new. Named from its use of "split" (or *interfered*) light beams, the ALIAS interferometer uses technology proven in a number of highly technical industries—such as astronomy and quantum mechanics—and rebuilt for specific forensic standards. Barrett said the result is inherently better than even the best microscope that ultimately relies on light and the human eye.

"When you think of it, our eyes operate at a very limited spectrum," he said. "That's why the military uses infrared, for example. These 3D images are light-independent; they are based on highly detailed measurements. Then, an image is rendered from that."

A major key to the confirmation is the process of correlation, based



*A central component of the ALIAS system from Pyramidal Technologies Ltd. is the interferometer. The device captures light-independent images of both bullets and cartridge cases based on highly detailed measurements.*

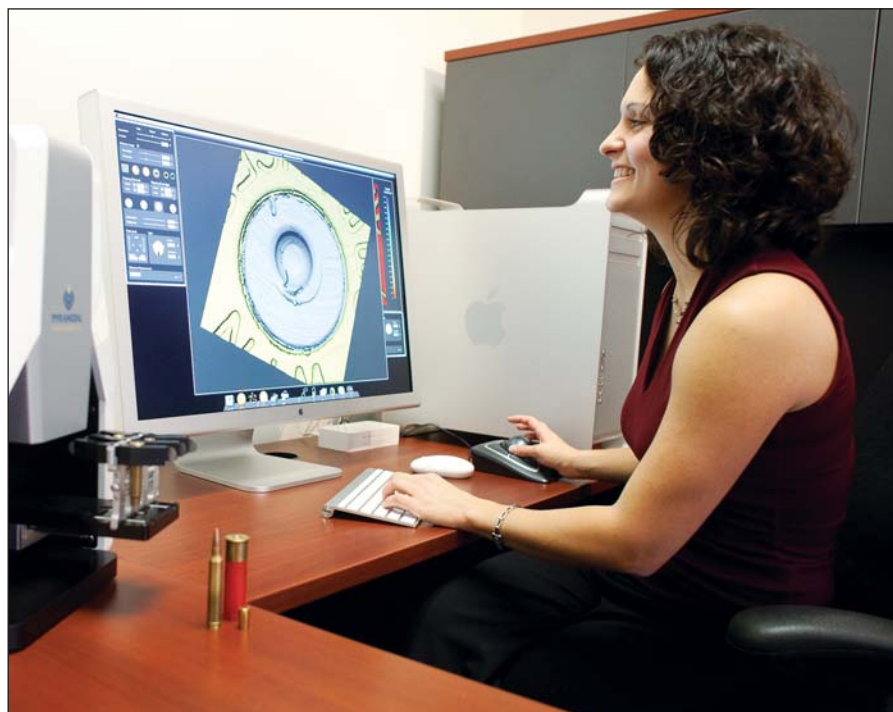
upon specialized mathematical instructions for performing calculations: in another word, *algorithms*. To date, ALIAS has utilized two of the 15 algorithms that Pyramidal Technologies

developed, and they are perfecting more algorithms that will focus on specialized examinations, such as classes of fire-arms that have traditionally proven very difficult for examiners. The company will also allow the integration of other developers' algorithms.

"If an algorithm is better than ours—say it analyzes AK-47 rounds better than ours—we will provide the hooks so they can import it into the system," he said. "We don't have all the brains in this field. If we can use it for society's benefit, why not?"

ALIAS is designed to produce results in three short steps. First, the interferometer captures a detailed survey of a cartridge case or bullet, using billions of measuring points. Those measurements are then processed to create the 3D image. Finally, the user can analyze the image and make comparisons utilizing the ALIAS confirmation tools to reach a conclusion.

The advanced technology does not come at the expense of processing time. The interferometer can scan up to six cartridges in a sequence, and



*Pyramidal Technologies' ALIAS fits into a relatively small footprint on the examiner's workstation. Components include the interferometer (left) and a high-powered Apple Mac Pro.*

# 3 D BALLISTICS

all images contain identical sets of information. A ballistics analyst can compare images within one case, as well as images from other cases. Users can compare images side-by-side or superimposed over each other. They can adjust color on the matching areas or visualize non-matching areas. The 3D objects representing crime-scene evidence that are captured in ALIAS can also be exported to other visualization programs or department systems because ALIAS was developed on an open-system architecture.

Pyramidal Technologies (a Barbados-based company) embarked on a two-year development process that integrated software development and hardware technology from experts in Canada and Switzerland. In 2009, Pyramidal Technologies launched the ALIAS system in Germany. Sales are pending in both North and South America. "It really is a global effort," said Barrett.

The ALIAS technology is a relative newcomer to the forensic field, but its primary developer, Barrett, is not. More than 20 years ago, Barrett was working with Forensic Technology Inc. developing the Integrated Ballistics Identification System (IBIS). Today, that system—with more than 500 installations worldwide—is used as the platform for the National Integrated Ballistic Information Network (NIBIN) in the United States.

As sometimes happens in science, Barrett had retired when a chance

**Sophisticated 3D ballistics systems can help narrow the options an examiner must study. For example: Some of the highly automated equipment can be used to select reduced lists of candidates before an examiner becomes involved.**

conversation with a college professor led him to explore the application of the interferometer to ballistics analysis. He doesn't expect the development process to stop.

"We see this product as never being finished," he said. "It is going to continue to evolve. Future potential is somewhat mind-boggling."

Although the current ALIAS system is relatively compact—its three main parts could be transported in a van—a handheld device is under development. "You'll be able to scan in the field, then get the answer back in the field," he said. "We're not far from where officers in the field will have investigative leads from this." The portable equipment will focus on

the examination of cartridge cases, since bullets are usually not immediately recoverable in field situations.

Equipment of this type does not operate in a vacuum. Built to Application Program Interface (API) standards and collaborating with continued international standards development, the ALIAS process also takes into account court admissibility, such as meeting Daubert standards. Equally important, ALIAS was designed from the beginning to be user friendly and to operate with no license fees and a simple choice of service plans.

Though remarkably automated, Barret stressed that the ALIAS system does require a human in the loop. "Ultimately, there's always a human in the process," he said. "Someone could be going to the gas chamber. So we have made sure the final call is made by a human."

## Combining Strengths

While acknowledging the strength of 3D-imaging technology, spokesmen for Forensic Technology Inc., the manufacturer of IBIS, say that other factors are relevant as well.

"One of the strengths with IBIS is the amount of information that can be compared across different states' ballistic databases," Product Manager Michel Paradis said. "If you can't compare something between New York and Colorado, what's the point?"

Andre Demers, Marketing Manager with Forensic Technology, agreed.



The interactive visualization interface provided by Pyramidal Technologies' ALIAS can render images of bullets or cartridge cases in natural color, grey-scale, or topographically sensitive color, and allows users to easily switch between these views. The image on the left shows two cartridge cases with their primer areas. On the right, the images of two cartridge cases are merged to aid in comparison and prove a match. An examiner can split two cartridge images vertically and slide them together to determine if the halves match.

# 3 D BALLISTICS

“Imaging is really only half the story. You need a very good quality image. But, if you only have an image, what do you do with it?”

Forensic Technology is taking forensic-ballistics technology in other directions, such as creating new systems that combine two- and three-dimensional technology into a hybrid product that the company considers more advanced than its forebears. Available in BulletTrax-3D and BrassTrax-3D systems, this technology offers what Forensic Technology calls “the best of both worlds.”

“Two-dimensional imaging is good,” Senior Vice President Pete Gagliardi said. “Three-dimensional is better. But 2D merged with 3D is best.”

Paradis said other components of advanced ballistic-imaging technology are equally important. “Choosing the right sensor is key,” he added. “One size does not fit all.” For example, cartridge cases and bullets need different levels of resolution, he said. Submicron measurements are needed for bullets—but for cartridge cases, magnification that high would create too much noise.

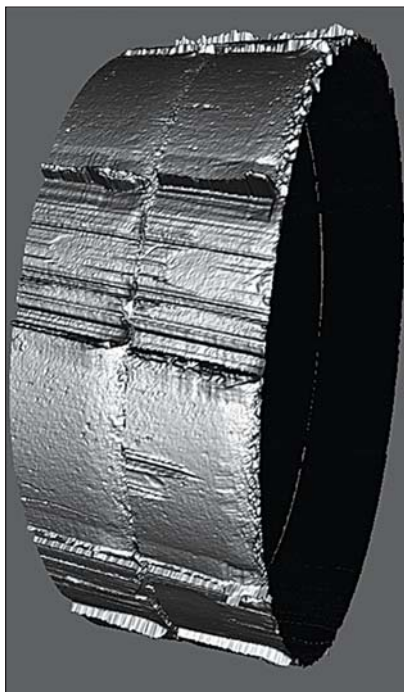
Paradis also believes that the combination of two- and three-dimensional imagery is important for other reasons. “Three-dimensional imaging is actually a rendering,” he noted. “A sensor can misread a speck of blood or dust as a dent or other feature on the surface. When every dent is important, that can be critical. By combining 2D and 3D, you can see that it’s not part of the cartridge.”

Paradis also agreed the human element must be included in the equation. “The expert has to go back to the microscope, because you have to take that to court and say, ‘I have seen these marks in the microscope.’ But using 3D technology to get there can save days.”

Demers also noted that 3D helps with narrowing the options an examiner must study. “A lot of these tools help with what is essentially triage. If you can give them five to six likely candidates, that can really save them time,” he said.



*The BulletTrax-3D from Forensic Technology Inc. is a bullet-imaging station that uses three-dimensional sensory technology to allow operators to capture 2D digital images, and then create 3D topographic models of the bullet's surface area.*

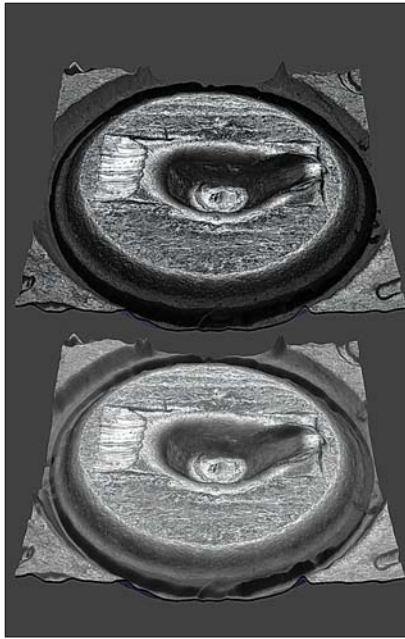


*Using the 2D and 3D data acquired from Forensic Technology's BulletTrax-3D, the virtual comparison microscope (VCM) can recreate a 3D rendering of multiple bullet exhibits. The VCM provides access to a bullet's surface details and makes it easy to compare multiple bullets at the same time. And being computer-powered, the VCM's almost endless capabilities can greatly assist the firearm examiner.*

# 3D BALLISTICS

In many cases, the highly automated equipment can be used to select reduced lists of candidates before an examiner becomes involved. Technicians with less training than an examiner can perform several data-entry steps so the examiner only needs to work on the most likely candidates. High levels of multi-tasking—the ability to operate multiple systems simultaneously—are also helpful and speed the process. Demers noted a department in South Africa where three systems operate essentially non-stop to process hundreds, or even thousands, of cases in short periods of time.

Forensic Technology has also developed a prototype virtual comparison microscope (VCM). This particularly advanced technology utilizes images from the company's BulletTrax-3D system and is especially useful with deformed bullets, various types of rifling, and bullet fragments. Examining these products in a traditional microscope is extremely time



*Because Forensic Technology's BrassTrax-3D acquires both 2D and 3D information from a cartridge case, investigators have access to never-before-seen views of the primer. Examiners can easily view as much or as little 3D information as they want.*

consuming because of the need to constantly readjust focus, lighting, and perspective to achieve different views. With the VCM, bullets can be moved in any direction while maintaining a consistent appearance. In a fraction of the time, using standard techniques, examiners can more easily find significant markings and make their assessments.

As with other recent advances, the technical achievement is based not just on equipment development, but also on the increased ability to correlate information. For example, one algorithm is being developed to account for barrel distortions after thousands of firings. Paradis noted that this is useful, because "a criminal isn't going to put the weapon in his glove box between crimes."

The evolution of calculations—the algorithms—also increases examiner accuracy in areas once considered troublesome, or even impossible. Work is under way to develop techniques for matching smoothbore firearms, an advantage not only for historic weapons, but also useful when dealing with gang violence, even in India. Likewise, the highly computerized imagery is offering some of analysts' first capabilities to realistically try matching polygonal-barrel ballistics.

"This technology is shining a light into areas that were once considered untouchable," Demers said.

Much of Forensic Technology's work is also with the more mundane efforts to integrate the advances into existing infrastructure. "It is important to acquire the information, but it is also important to help them do what they do a lot faster," Demers added. "It is all imaging, but it is much more than a pretty picture on a screen. There is so much behind it, like providing the right tools for the right people."

## Real World Use

Santa Ana, California Firearm Examiner Rocky Edwards is among the few law-enforcement professionals in the United States who use several of these systems, including a virtual comparison microscope that was



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applied to a pending case. He is also currently developing a program to apply some of this technology to track gang violence. Through all of his field experience, he is painfully aware of the realities of law-enforcement budgets.

“Cost and availability are a big factor,” he said, noting that he flew to Montreal, Quebec in order to use some of Forensic Technology’s most advanced equipment, including the VCM. “A lot of this is just not available or affordable for normal departments right now.”

Yet, Edwards emphasizes that technology like the virtual comparison microscope should be made readily accessible. “I was able to see things clearer than I could even on a microscope,” he said, noting one case where marks on casings were so faint they could have been missed if viewed only with a standard microscope.

Edwards also said 3D and related technology is especially helpful for departments with large caseloads. “When they work on several cases, examiners’ eyes may tend to play tricks because they have looked at it too long. The 3D images are like an additional check and balance. But that does not take away from traditional methods. If I don’t see it on the microscope, I won’t call it. I need to see it on both.”

Edwards is outspoken regarding the need to increase use of this equipment, though he acknowledges that

might be a tough sell in today’s economy. “The world is bypassing the U.S. in many advanced technologies,” he said. “It is sad that an examiner in this country has to go to Montreal when Malaysia or Third World countries have it. We should be leading the charge in forensics, but we are sitting in the back seat—or, at least, it feels that way.”

Ultimately, the advantages may make demand for the equipment overwhelming. “The advantage of 3D is that you can change the shape of what you are looking at with the stroke of a mouse,” Edwards concluded. “Lighting is not an issue. The advantage of 3D technology over a (conventional) comparison microscope is you take all of your images and see all of those at one time. The future of forensics is definitely 3D.”

#### For More Information

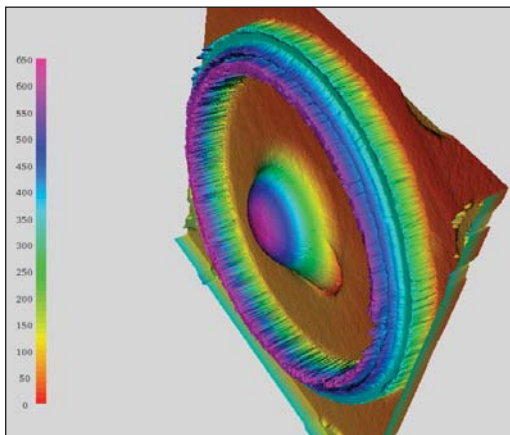
To learn more about Pyramidal Technologies’ ALIAS system, go to:  
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To learn more about BulletTrax-3D, BrassTrax-3D, and IBIS from Forensic Technology Inc., go to:  
[www.forensictechnology.com](http://www.forensictechnology.com)


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In Pyramidal Technologies’ ALIAS system, 3D objects can be manipulated in any way the user desires, including the ability to use images rendered with the ALIAS system in other comparison or imaging programs. Here, a digital model of a cartridge case has been exported from ALIAS and then imported into another graphics program for examination.




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