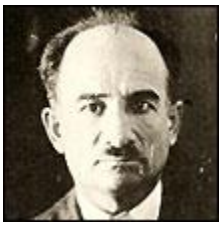
BALLISTICS: THE SCIENCE OF GUNS

By Katherine Ramsland

The Pressure Is On

On the afternoon of Friday, April 15, 1920, in South Braintree, Massachusetts, two men approached a couple of security guards delivering the payroll money for the Slater and Morrill Shoe Factory, and without warning, they opened fire. One of the men shot both guards, and the other pumped several more bullets into them. They then took the payroll boxes containing nearly $16,000 and sped off in a black Buick with three other men. Eyewitnesses described them as "Italian-looking" and one had a handlebar mustache.



Mike Boda, police mugshot

Investigators recovered six ejected shell casings from the sidewalk around the dead men and traced them back to three manufacturers: Remington, Winchester and Peters. They also found the getaway car, abandoned, and they soon linked it with an earlier robbery. Police surmised that the mastermind was an Italian thug named Mike Boda, but when they located his hideout, he had already fled to Italy.

Nicola Sacco's Colt &
Bartolomeo Vanzetti's H&R

However, two of his associates were arrested, some sources say at Boda's hideout, some say on a streetcar. They were ordinary Italian laborers who fit the general descriptions: Nicola Sacco, 29, and Bartolomeo Vanzetti, 32,. While they denied owning guns, they had illegal pistols on their person and Sacco's was the same caliber—a .32 Colt automatic—as the murder weapon. Sacco also sported a handlebar mustache and had two dozen bullets on him made by the three manufacturers matched to the shells. Both men were also members of a radical anarchist group that supported violence to resolve injustice. They were promptly arrested.

Nicola Sacco

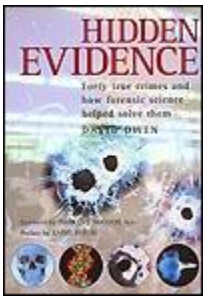
Sacco was tried for robbery in the earlier case and found guilty. He was later tried with his partner, Vanzetti, for the murder of Alessandro Berardelli, one of the shoe company security guards.

The trial began on May 31, 1921, and public opinion was clearly against them. Regardless of their guilt or innocence in the murders, they were perceived as dangerous men. Yet there were many foreigners, feeling the burn of xenophobia, who sided with them and the Sacco-Vanzetti Defense Committee called the whole ordeal a witch-hunt, with these men serving as scapegoats for America's fear of the political beliefs of other countries.

Bartolomeo Vanzetti

Four bullets had been removed from the murdered payroll guards. Experts were brought in to testify as to whether Sacco's .32 pistol was indeed the murder weapon, and on the prosecution side, opinions were mixed. The experts for the defense were more confident in their opinion, although no one had based what they offered on scientific techniques. All were self-taught.

Nevertheless, the verdict that both men were guilty was likely based on one significant fact that had little to do with what the experts had said: the bullet that had killed Berardelli was so outdated that the only bullets similar to it that anyone could locate to make comparisons were those in Sacco's pockets. The jury had even used a magnifying glass to examine the bullets for themselves, and had finally bought the prosecution's case. The defendants were sentenced to death and a date was set.



Book cover: *Hidden Evidence*

Around the world, these two men were portrayed as innocent victims to American fears and to a capitalist system. Right away another expert entered the fray and declared the others frauds. According to David Owen in *Hidden Evidence*, that expert's opinion was sufficient to get the verdict overturned and a hearing for a new trial.

To bolster its side, the defense had hired Albert H. Hamilton to definitively state that the gun in the possession of the two men was not the murder weapon. This same expert had testified six years earlier in another case—that of Charles Stielow, a German immigrant convicted in the double homicide of his employer, Charles Phelps, and Phelps' housekeeper, Margaret Wolcott. Both had been shot to death with a .22 caliber revolver. According to the account on the History Channel's *Forensic Firsts*, Stielow was quickly arrested and found to own such a weapon. He'd even tried to hide it. Since he wanted to go home to his wife, he confessed, believing he would be released. He would not sign a statement, however, and once in jail, he recanted the confession.

Hamilton, whom Evans says passed himself off falsely as a doctor, was a hired gun. He would say whatever he was paid to say, and among his many professed specialties was firearms. He claimed to be able to match an abnormal scratch in the barrel of Stielow's weapon to marks on the bullets. He even took photographs to further impress the jury, although he had to admit one could not see the scratches on them. However, he had never test-fired the gun. When asked to point out the scratch on the gun barrel, he said it could not be done because the bullet's momentum had expanded the bullet in such a way as to fill in the scratch, rendering it invisible. As nonsensical as it sounds in retrospect, the jury believed it and Stielow was convicted and sentenced to die. Only at the last minute was he spared when two drifters were caught who confessed. Hamilton's glib pseudo-science had nearly sent an innocent man to his death. It had also cost the county so much money that it declined to prosecute the real killers.

Added to that, an examination of Stielow's gun found that it had such a rust buildup that it could not have been fired in several years.

In 1917, the bullets were brought to a lab in New York. Officer Charles Waite first fired test bullets identical to those found in the bodies from Stielow's gun into water. Then optics expert Max Poser examined the bullets under a high-powered microscope and could not see any of the alleged scratches that Hamilton had "observed." He then found that the murder bullets had been fired from a weapon with an abnormal land-and-groove pattern—a manufacturer's defect—-whereas Stielow's gun was normal, so it could not have been the murder weapon. Stielow could have been excluded very early in the case.

Although humiliated, Hamilton inexplicably continued to make his mark in the legal system. Hired by Sacco and Vanzetti's lawyers, he wasted no time in making authoritative pronouncements based on no real expertise.

So the prosecution's expert, Charles Van Amburgh, re-examined the evidence in 1923, when bullet comparison technology had improved somewhat. He enlarged the photos of the fatal wounds and the photos of the bullets fired from Sacco's revolver. He insisted they were identical, and he prepared for a retrial of the two men.

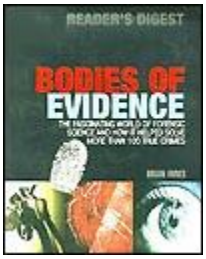
With his usual cunning, Hamilton tried to pull off a sleight-of-hand that would prove his point. He brought in Sacco's .32 and two new Colt revolvers. There in court, he disassembled them all and then tried to exchange one of the new barrels with the one from Sacco's gun. Judge Thayer saw what he was doing and demanded he return the original barrel for Sacco's gun. Thayer then denied the motion for another trial. Hamilton had blown it, both for the defense and for himself.

Yet a committee was appointed to review the case and they contacted Calvin Goddard in 1927, who had worked with Charles Waite at the Bureau of Forensic Ballistics in New York. He used Philip Gravelle's newly invented comparison microscope and helixometer, a hollow lighted magnifier probe used to inspect gun barrels, to make a rigorous examination. In the presence of one of the defense experts, he fired a bullet from Sacco's gun into a wad of cotton and then put the ejected casing on the comparison microscope next to casings found at the scene. Then he looked at them carefully. The first two casings were no match, but the third one was. Even the defense expert agreed that these two bullets had been fired from the same gun. The second original defense expert also concurred, and that clinched the case. That same year, the two men went to the electric chair. Vanzetti still claimed he was innocent, while Sacco said, "Long live anarchy!"

Subsequent investigations with better technology in 1961 and 1983 both supported Goddard's findings. Even so, in 1977, the governor of Massachusetts issued a proclamation for their innocence, and the case still remains controversial.

The Bullets of Valentine's Day

When smoothbore pistols and muskets were replaced in the late 18th century by rifled weapons, spent bullets acquired a distinct signature. The process of making grooves in rifles for more accurate projectiles meant that they would leave a mark on the softer metal of the bullet as it spun through the barrel. Because of the wearing of the machines that made them, any bullet fired from a specific weapon will bear the same distinct markings. When bullets were then encased in cartridges, even more marks were made, helping investigators make a match between a bullet and a gun.



Book cover: *Bodies of Evidence*

Firearms evidence identification matching bullets to guns was born in 1835 in England when the unique ridge on a bullet taken from a victim was linked with a bullet mold in the suspect's home, exposing a burglary as a fake. Confronted, the suspect confessed. While that's not a very precise method of matching, it was a start.

The first time an expert proved in court that a specific gun was used for a murder was in America in 1902. Oliver Wendell Holmes, says Brian Innes in *Bodies of Evidence*, had read a book about firearm identification, so he called a gunsmith to test-fire the alleged murder weapon into a wad of cotton wool. He then used a magnifying lens to match marks on the bullet from the victim to the test-fired bullet, and these he showed to the jury.

St. Valentine's Day Massacre (CHS)

It was a firearms case, the St. Valentine's Day Massacre on a snow-blown February 14, 1929, that led to the opening of the first independent scientific crime detection laboratory in America. Seven men were waiting that morning around 10:30 a.m. in a red brick warehouse for the S-M-C Cartage Company on Chicago's North Side, at 2122 North Clark Street. Three men wearing police uniforms and two dressed as civilians arrived in a police car and went inside. Witnesses in the neighborhood heard multiple gunshots made by machine guns. Then the police left, and a dog inside left alive the building began to bark and howl. Neighbors checked and found a bloody scene: the seven unarmed men lay on the floor, all shot in the back multiple times. The wall against which they had been lined up for the assassination was a gory mess.

The victims, according to the History Channels' *Forensic Firsts*, were known associates of mobster George "Bugs" Moran. He pointed the finger at Al Capone, while Capone, down in Florida, pointed it back at him. However, many people thought the police had killed a gang in cold blood, so it was left to firearms comparisons to unearth the true story.

Thomson submachine gun

The shooters had left behind 70 cartridge casings and the weapons were identified as .45-caliber Thomson submachine guns.

The person who would make all the difference in this case was a cardiologist named Calvin Goddard—the same person who had confirmed the ballistics evidence in the Sacco and Vanzetti case two years earlier. With Charles Waite, who had test-fired the Stielow gun for proof that the immigrant had not committed the double homicide for which he'd been convicted, he began to acquire data from all known gun manufacturers to develop a comprehensive database. Together they catalogued the results of the test fires from each type of gun. At the time, there were 12 known handgun manufacturers, and they started what would become one of the most comprehensive collections of crime-solving information about guns. Waite died in 1925, but Goddard took over the work, and he was responsible, with his scientific procedures, for bringing the science of ballistics into its own.

With the invention of the comparison microscope by Goddard's partner, two objects could be laid side-by-side for high-powered comparative examination using a series of reflective mirrors and lenses. Bullets could be laid out in such a way as to show whether there was a match in the markings that a gun would leave on them after they were fired from that gun. That made for a controlled examination, which was needed as a defensive weapon against the increase in crime during the 1920s.

Thus, when the seven bullet-ridden bodies were found in the Chicago warehouse on St. Valentine's Day in 1929, it was just a matter of finding the murder weapon. Goddard came in from New York as an independent investigator and fired each of the eight machine guns owned by the Chicago police. He then compared the results to evidence collected at the

scene. No casings matched, which cleared the police. That meant that someone had impersonated police officers to commit the murders.

Ten months later, the police raided the home of a hit man for Al Capone. They found two machine guns, which they gave to Goddard. He test-fired them and proved they were the weapons used in the massacre. That sent at least one of the killers to prison.

George "Bugs" Moran (AP)

The infamous incident turned out to have been part of a gang war between Capone and Moran. Evidently the men had been lured there—and Moran was supposed to have been among them—by a call from Detroit indicating that a truck full of hijacked whiskey was coming in. Moran himself was late, and he just missed being victim number eight. In fact, he had spotted the police car outside the warehouse and left.

Goddard's work inspired two businessmen who had been on the coroner's jury to set him up at Northwestern University in Chicago in the first independent crime lab in the country. Ballistics, fingerprinting, blood analysis and trace evidence were brought under one roof and the lab became a prototype. Science and the police were united, and according to Nickell and Fischer, Goddard then advised the FBI in 1932 when they set up a similar criminological laboratory. Their first piece of equipment was a comparison microscope.

Firearms Interpretation

To develop the science of firearms comparison, the most important tool was the microscope. The earliest crude microscopes were invented in the 1600s, allowing a magnification of ten to twenty times, but images were still blurred. The invention of the compound microscope that relied on multiple lenses fused together improved the situation, as optics magnification and clarity increased exponentially.

From years of data collection and experiments, firearms identification specialists can:

1. Compare bullets and match them to a specific firearm
2. Accurately estimate the distance of a shooting
3. Detect gunpowder residue around wounds and on shooters
4. Restore obliterated serial numbers

The following is based on information from numerous crime scene investigation and evidence manuals, a tour of two crime lab firearms sections, as well as books like *Bodies of Evidence, Hidden Evidence*, and *Practical Homicide Investigation*.

Guns and ammo

Briefly, firearms these days are of two basic types: hand-held and shoulder. Of hand-held pistols, there are single-shot or multiple-shot, like revolvers and self-loading pistols. Shoulder firearms have long barrels and include rifles, machine repeaters, and smoothbore shotguns. There are many variations on these basic types.

In mass-produced guns, different makes and models have standardizing characteristics. Since the 18th century, guns have been made with internal helical grooves cut into the barrels that are similar to the threads of a screw. They form "lands," or metal ridges between the grooves. The lands grip the bullet and give it accuracy, range and spin.

The interior part of a gun barrel is the bore, and the caliber of a bullet is determined by the bore's diameter, expressed in hundredths of an inch or in millimeters. As already noted above, when a bullet travels through a gun barrel, the bullet's metal gets worn in a unique pattern by the harder metal of the barrel. Any bullet fired from a specific gun will show the same marks, unless there's been some intentional alteration between firings.

"Rifled" weapons (rifles and many handguns) fire single bullets, and the weapon may also eject shell casings. If no casings are found at the scene, it may indicate that the shooter used a revolver, which retains spent cartridges until manually reloaded. Smoothbore shotguns fire multiple pellets.

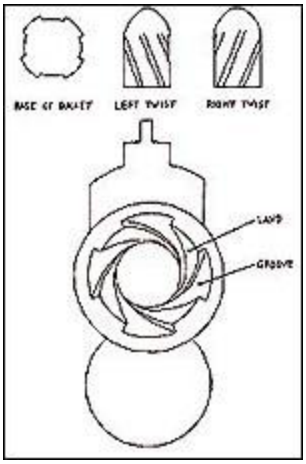
Bullets found at the scene (or in a victim) offer plenty of information, and investigators are looking for two specific parts:

- The bullet (lead or lead alloy, and may be jacketed in another metal)
- The compartment containing the propellant (black or smokeless powder)
- The cartridge casing that wraps around all of this and is stamped with manufacturer's mark and caliber
- The soft metal cap at the cartridge head containing the primer

When triggered, the gun's firing pin hits the cartridge in a place that has a shock sensitive primer, or explosive. That charge sets the gunpowder into a rapid burn, which builds pressure until the cartridge can't contain it. This forces the bullet outward and the cartridge backward against the weapon's breech. The impact stamps a distinct impression onto the cartridge head. (There's a little give in each gun, so the stamp isn't necessarily always in exactly the same place.) In addition, the mechanisms that extract and eject the shell leave their own characteristic marks. Whatever scratches the cartridge picks up are unique to that gun.

Matching an ejected casing to a gun may mean shooting the suspect gun (if recovered) in the lab's firing range. Then a comparison can be done between the casing from the scene and the one shot by the scientist, as they did in the Sacco and Vanzetti case. People sometimes mix different brands of ammunition, so it's necessary to use the brand under investigation. Since the test bullet must be recovered, the gun is fired either into a tank of water for very soft metals or into thick cotton batting for others. Then it's compared for microscopic scratches.

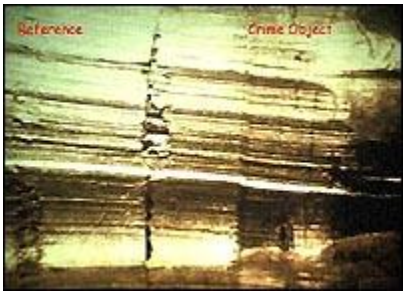
On a comparison microscope, the views are linked optically. It takes skill and experience to make a definitive match, but it's possible to say that a certain bullet came from a certain gun, and only that gun.



If the gun is not recovered, there's yet another approach.

It's possible to tell something about the make of a gun from the type of cartridge case or bullet found. The direction of twist refers to the way the rifling gives a right or left-handed spin to the bullet when fired. Smith & Wesson guns have five lands that twist to the right, for example, and a Colt .32-caliber revolver has six that twist to the left. To get this determination, the analysts point the casing away and examine how the lines of striation angle from base to nose, and they add up the number of marks around it. To say that two bullets are from the same gun, the land impressions must match both in number and on the angle of twist.

These days, crime labs can use a computer analysis to make such comparisons. Computers are networked to statewide and national databases (even international), similar to the system for fingerprints. One is called Drugfire, sponsored by the FBI. The Bureau of Alcohol, Tobacco and Firearms has a program called Bulletproof for bullet images and Brasscatcher for cartridge cases. IBIS, by Forensic Technology, also offers automated comparisons of evidence images.



Striations match, comparison microscope

For example, when there's a shooting in one locality and the casing is recovered, it's put into the Drugfire database. (If the gun is recovered, it may be test fired and that spent casing used.) To get a comparison on the way a mark is left by the firing pin of that gun, the ejected case is placed in a device with a video camera that links to a computer. An image of the marks is run through the database to get the closest matches. If matching the firing pin's mark, an image of the base is positioned on the screen and the computer then lines up the other images for comparison, 24 at a time. They can be moved around to get better side-by-side views. Examiners eliminate all but the most likely candidates, which go to a microscope for a more precise comparison.

Distance determinations

The firing range also has another use. To measure the distance from muzzle to target, the gun is shot from varying distances at a thick cardboard target. The shooter then examines the size of the hole and the diameter of gunpowder residue, because when guns are fired, fragments of unburned powder fly out of the barrel. They don't travel far, only a few feet, but if the gun is close enough for the residue to hit something, it leaves distinct circular patterns, with size depending on distance from target. Thus, a person shot at close range will get what's called stippling, a gunpowder burn. Replicating the size of the burn from different distances yields the actual distance measurement.

Gunshot residue

Gunshot residue detection

The gunshot residue can also be swabbed from the skin or clothing of the suspected shooter (as long as it didn't involve a gun where the primer chemicals eliminate metals). For example, if a man kills himself with a handheld gun, he will undoubtedly have residue on his hand. It can be subjected to analysis for its composite content under the scanning electron microscope. (Some labs use a different method.) One problem is that just standing near a gun when fired can result in gunshot residue. Yet the experts can still examine relative amounts and make educated guesses.

Restoration

An interesting aspect of firearm examination is the ability to trace a serial number to a registered owner—-even if it appears to be gone. Although some criminals file it off to prevent a trace, it may still be recoverable.

This stamping process actually goes deeper than the surface numbers indicate, so when criminals can no longer see the number, they believe they've obliterated it. The examiner grinds the metal down past the deepest scrapes to get a strip of polished metal. He or she then applies a solution of copper salts and hydrochloric acid, and that makes the strained area just beneath the stamped number dissolve at a faster rate than the metal around it. That temporarily brings up the number (or a partial), making it available for a photograph before it disappears.

Even beyond firearms analysis and projectile measurements, another aspect of the behavior of bullets gets us into yet another arena: that of the forensic pathologist. Many will attest to the tricky trajectories they have seen when tracing a bullet's path from entrance to exit wound (if there is one). Among the most puzzling cases is that of the bullet trajectories in the body of the late President John F. Kennedy.

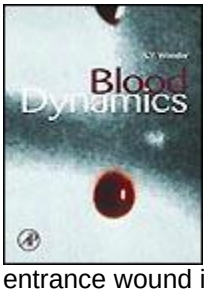
By Katherine Ramsland

The Magic Bullet

It's not impossible for a bullet to behave erratically, and that awareness influences trajectory studies, as well as bloodstain pattern analysis. In one Oklahoma case, as reported by Innes, a bank robber put a .357 Magnum to the back of the head of a female witness and fired. The bullet entered her skull, made a sharp turn, went around inside her head and exited out the forehead. The girl was knocked unconscious but she recovered and testified against him. In another case, a .22 caliber bullet entered a vein at the wrist, a seemingly innocuous wound, but it traveled inexplicably up the arm and right into the heart, killing the person.

When faced with bullet wound cases, forensic pathologists must make determinations about where the bullet entered a body and if and where it exited. (For inorganic substances, trajectory studies involve lasers and calculus, as well as computerized simulations that include ricochet effects.) Often, it's difficult in human tissue to know which wound is entrance and which is exit, but there are some telltale signs.

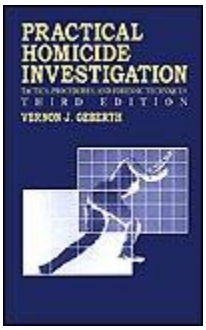
According to FirearmsID.com, bullet entrance holes "typically have very even margins." If the gun muzzle made no contact with the clothing, the hole through most materials will be smaller than the bullet. There may also be gunshot residue present if the gun was shot at close enough range, and sometimes one can tell from the blood spatter pattern near the body.



Book cover: A. Y. *Wonder's Blood Dynamics*

A.Y. Wonder, in *Blood Dynamics*, says that "Impact spatter patterns resulting from gunshot are combinations of contact between an exposed blood source, the bullet, and gas components." The entrance wound involves a missile, or bullet, and the exit may be the missile or fragments of it. The bullet may open up a wound or strike blood that's already there from a previous wound, such as when someone is shot more than once. If the target person is in motion, especially rapid motion, the gas and missile may strike different areas and make identification of an entrance wound more complicated. The condition of the wound has to be analyzed fully before any conclusions can be drawn.

High velocity bullets are often equated in formulaic evaluations with a "mist" pattern, which means the blood droplets are finer and create a lighter pattern. However, Wonder points out, mist is often not about the bullet's speed, and mist also results from other wound-causing incidents, so one should not identify gunshot solely in terms of spatter size or quality. The properties of the gun must also be considered, as well as the angle of the shooting and whether or not the victim was in motion of any kind—running, struggling, falling, riding in a car.



Book cover: *Practical Homicide Investigation*

Vernon J. Geberth, in *Practical Homicide Investigation*, says that entrance wounds are generally smaller than exit wounds and have an "abrasion collar" where the skin was forced inward, and a gray or black ring around the edge. However, if the bullet hits an obstruction before entering, it may enter in fragments. Exit wounds are often ragged in appearance, and can have shreds of tissue extruding outward (but not always). To some extent, identification will depend on the condition of the body, but there may be some evidence of more blood escaping through the exit wound. If the gun is held against the skin, creating a contact wound, that makes for easier identification of where the bullet entered.

Of course, not all bullets actually exit. They may not have sufficient velocity or a bone may deflect them, possibly causing them to travel under the skin and all around the body in unpredictable ways.

Michael Baden
(CORBIS)

Former New York City medical examiner, Michael Baden, agreed to serve on Congressional Select Committee on Assassinations in 1977, and he recruited eight other medical examiners to assist. Their assignment was to go over the records from the autopsy for the November 22, 1963, assassination of John F. Kennedy and evaluate the findings. One goal was to put to rest the many diverse theories that there were more shooters than just the one the police quickly arrested, Lee Harvey Oswald.

Lee Harvey Oswald,
mugshot

President Kennedy was shot in Dallas, Texas, while riding with his wife in the backseat of an open-top car before a large crowd of admirers. One bullet also wounded Governor John Connally, who was in the front seat. The dying Kennedy was rushed to Dallas's Parkland Hospital, but then the FBI illegally transported him to Bethesda Naval Hospital in Washington. Unfortunately, as Baden discovered, even a case as significant as this one can be mishandled by untrained people. None of the doctors who worked on the body were trained in forensic pathology, so they did not know how to trace bullet trajectory paths in human tissue. In addition, the Warren Commission, which was set up in 1964 to dispel rumors of conspiracies, failed to interview pathologists with experience in gunshot wounds.

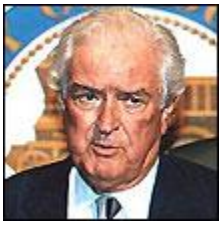
John F. Kennedy and the motorcade (AP)

As Baden's team looked further into the incident to see what could be determined, Baden noted what he described as a "forensic disaster." He contends that if the autopsy procedure had been done correctly, the many conspiracy theories would never have gotten off the ground.

Yet as it turned out, Commander James J. Humes, the pathologist who performed the autopsy, had been instructed not to perform a complete autopsy, but only to find the bullet, which was believed to still be lodged in the body. Try as he might, he couldn't find it. In his subsequent reports, his medical descriptions were nonexistent, and he basically referred interested parties to the photos, which were also badly done by an inexperienced photographer. Humes didn't even turn Kennedy over to look at the wound in the back of his neck, or call the receiving hospital in Dallas until too late to discover that a tracheostomy had been performed there, which he'd have found (if he'd looked) going right through the exit wound in the throat. He erroneously assumed the bullet had fallen out the same hole it had entered. He also failed to shave the head wound to see it clearly, and it was photographed through the hair. In addition, Humes miscalculated the wound's location by an error of four inches. With all of these mistakes, it would be impossible to make accurate determinations about bullet trajectories.

After only two hours (a very short time for an autopsy, especially on someone of such stature), he prepared the body for embalming. Then, because his notes were stained with blood, he burned them. After he found out about the procedure done in Dallas, he rewrote his notes based on what he recalled and what he could figure out. He ended up including material he himself never saw and failing to track the bullets properly. Thus, his report was filled with errors, which put Baden's team at a serious disadvantage.

They looked at the blurry crime scene and autopsy photographs, Kennedy's clothing, autopsy reports, and X-rays. It soon became clear that the people in charge had not realized the difference between an exit and entrance wound, and therefore they could not pinpoint the bullet's origin. They also couldn't tell how many shots had been fired.



Governor John Connally (AP)

Then Baden realized that Kennedy's brain was missing, along with slides of tissues, so they had to rely on the clothing. The team managed to piece together the fact that two bullets had entered Kennedy. There was a small hole in the back of Kennedy's shirt and jacket, and small exit holes going through his shirt collar and tie. That was the bullet that had pierced his throat and gone into Governor Connally. It had fallen out of Connally's leg while he was on a stretcher. Years later, the governor showed Baden his entrance wound and it was found that the bullet had been moving sideways, which helped to calculate its actual trajectory. The other bullet had gone through the back of Kennedy's head and out over his right eye, ending up hitting a post on the car's windshield and falling to the floor. Both had come from behind.

After that, they wrote a two-volume report. "One of the recommendations we made," says Baden, "was that there should be some national attention paid to improving death investigation in this country. Part of the problem with that case was that the investigation was poorly done. The people who did the autopsy were not qualified to do it, and a poor autopsy can be misleading. Having a hospital pathologist who trained in natural diseases do an autopsy on President Kennedy is like having a general surgeon doing brain surgery. There are different kinds of expertise, and those doctors made lots of mistakes, such as creating false descriptions for why they couldn't find the bullet. They said it and they were wrong, and it lives with us even today."

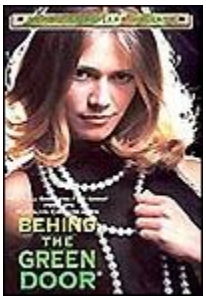
Today, bullet trajectories are often mapped, calculated and run through a computerized simulation to aid in reconstruction. This has been a controversial tool, but it's also been helpful in difficult cases. Whether it was positive or negative in the following case depends on one's perspective.

A Difference Between Life and Death

Jim Mitchell (AP)

A book, movie and television miniseries have all been devoted to the killing of one brother, Artie Mitchell, by another, Jim Mitchell, both of them moguls in the pornography industry. It was the work of a ballistics expert that made a difference in the trial's outcome and ensured that the case would be endlessly controversial.

Artie and Jim had created a major industry out of the burgeoning pornography market in California, beginning in the early 1970s. Censorship standards had loosened and bans were lifted. For almost two decades, they thrived off high-profit X-rated movies, achieving their claim to fame from the movie, *Behind the Green Door*, starring Marilyn Chambers. Then they opened strip clubs in San Francisco and engaged in a reckless lifestyle of drugs and sex.



Video cover: Behind the Green Door

Jim, the elder brother by two years, had decided to clean up, but Artie was deeply addicted to the fast life, and his resistance to rehab was, according to Jim in later testimony, to threaten Jim and his family. Since Jim and Artie had grown up taking care of things with guns, Jim brought two guns with him on the night he had chosen to force his brother to get into drug rehab.

It was February 27, 1991. Jim went to see Artie and they got into a bad argument. Even as Artie's girlfriend was screaming to a 911 operator, gunshots could be heard. Officers came and found Jim walking around in a daze and carrying a .22 rifle and a .38 Smith and Wesson Special. Inside Artie's house, they found Artie in the bedroom. He had been shot through the eye, abdomen and right arm by a .22, and he was dead. Eight spent cartridges were picked up in the room.

While Jim was charged with premeditated murder, he claimed it had been the result of an argument and a struggle while trying to get his brother to get help. He had never intended to kill him. However, there were those who said that Jim had a motive: he wanted to sell the business and Artie was not about to let that happen. A lot of money was at stake.

The 911 recording was brought into evidence, and Dr. Harry Hollien, an expert in acoustics, said that he had isolated the shots. He used a room in his own home that was about the same size and came up with recordings of his test shots. From

his experiments, he concluded how many seconds there were between each of five shots recorded on the tape. Between the third and fourth shot, there had been a significant gap of about half a minute. The prosecution viewed that as evidence of a clear and deliberate act, not something done in the heat of the moment or by mistake.

Then expert Lucien Haag showed a video of his devising of a computer simulation of the incident. Artie was shown as being shot twice on his way into the hallway and then shot in the head in the hallway. Haag included all eight shots as he believed they would have occurred, although there were only five recorded on the 911 call. The way he did this was to trace the paths of the bullets by calculating in room angles and impact points from the point at which Jim Mitchell was standing when he fired. Haag represented these trajectories with dramatic red lasers.

When the defense, who had stridently opposed having this tape admitted into evidence, asked Haag if there were other possibilities besides the ones he had mapped, he was forced to admit that there were quite a few other possibilities. It was not an exact science, but an interpretation based on speculation.

That was a blow to the prosecution, and it made a difference in how the jury voted. On February 18, 1992, they found Mitchell guilty only of manslaughter. He was sentenced to six years but served only three.

From the time a bullet was first matched to a weapon until now, the technology of projectile behavior in motion and firearms evaluations has only gotten better, but it still depends to some extent on interpretation. Bullets do not always behave as expected.