

Reconstruction of a Fatal Shooting using Audio for Timeline

The following case study contains many of the same elements PSI has been employing in creating compelling forensic animations since the late 1990s. In this day and age, it seems that just about every event is captured by video either via surveillance cameras or cell phones. Once a video's frame rate is established it is not difficult to create a timeline of events. However, in this case we don't have the ability to create or piece together a timeline from video as we have an audio file from a 911 call that lasted throughout the events presented at trial. Armed only with this audio and witness statements, PSI was tasked to create an animation of the event.

The Scenario

In early June, 2014, a man calls 911 to report that his younger sister, whom is a schizophrenic, has been refusing her medication, yelling at their parents and is acting out. He requests assistance from paramedics to help her calm down and resume her medication. The caller remains on the phone with 911 for the duration of the incident, (approximately 13 minutes).

Prior to the arrival of any emergency responders, the caller tells the 911 operator that his sister had picked up a knife and was outside the house and is even more agitated.

A sheriff's deputy was made aware of this development via radio dispatch, arrives and parks his patrol car around the far corner, as his partner was still in route.

As the deputy approaches the scene, the agitated young woman, armed with a knife begins running toward him, wielding the knife and screaming. After yelling for the woman to stop, which is heard on the deputy's radio transmission, the deputy retreats toward his patrol car as the woman continues to pursue him. As the deputy runs past his patrol car, he turns and again commands the woman to stop. She continues her pursuit, closing the distance between her and the deputy with the knife raised overhead.

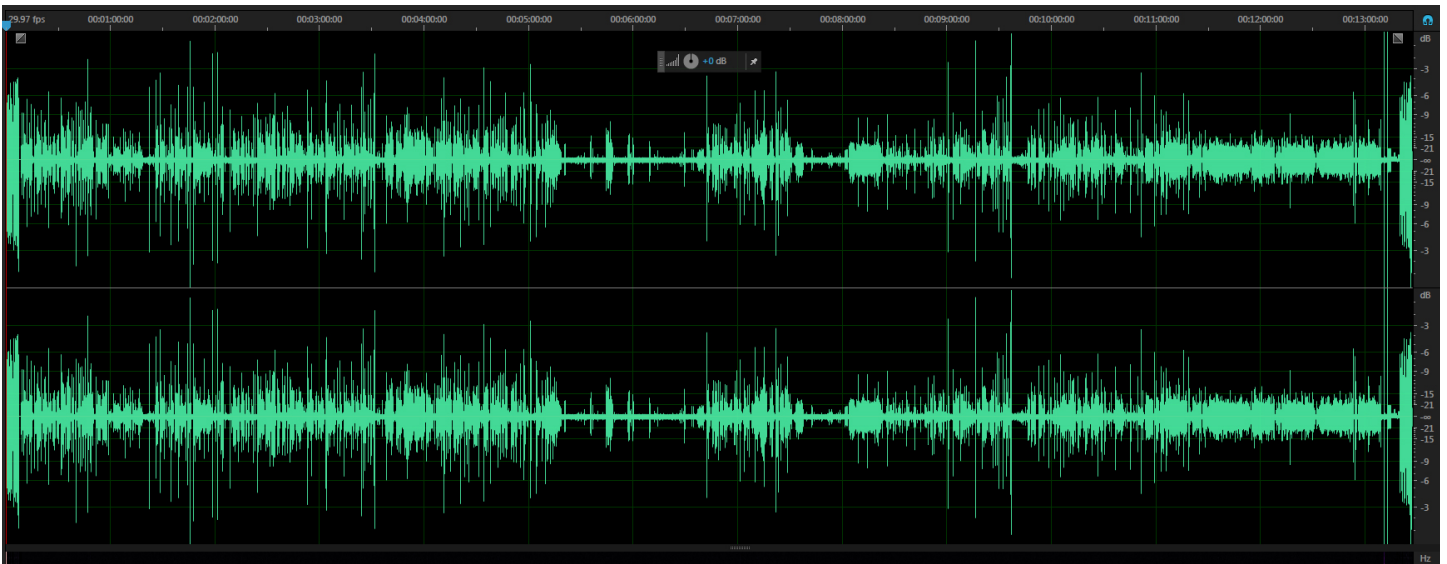
The deputy fires a single shot, fatally wounding the woman.



The Challenge

Reconstruct the event with sufficient fidelity to the forensic evidence to ensure the resulting 3D animation is admitted at trial. Adding to this challenge, the initial scene drawing is incorrect in critical areas and details that witnesses used as landmarks in their testimony.

A final challenge to the case; the assailant who pursued the deputy was 5 feet tall, weighed 200 pounds and suffered from a birth defect that effectively gave her a “club foot”. The prevailing theory for the defense was that this defect precluded the young girl from moving in a normal fashion and this would prove to be a contentious issue as the analysis unfolds. In addition, the assailant’s family testified that the deputy “lunged” at the assailant prompting her to pursue him and that the assailant walked slowly/limped towards the deputy, contradicting the deputy’s testimony that she was running after him at a speed that precluded him from getting safely away.



The Solution

Develop a timeline for the event based on the synchronization and analysis of the recordings of the 911 call and the radio traffic between the deputy and dispatch. Use 3D laser scanning of the scene and laser assisted photogrammetry to create an accurate 3D working model, (replacing the inaccurate drawing created by the police department and used in every deposition).

Use the synchronized audio recordings, witness testimony and analysis of the physical evidence in order to illustrate the key people’s actions, locations and movements.

The Physical Evidence

In order to complete the analysis of the event, PSI reviewed specific documents and evidence, the most critical of those being:

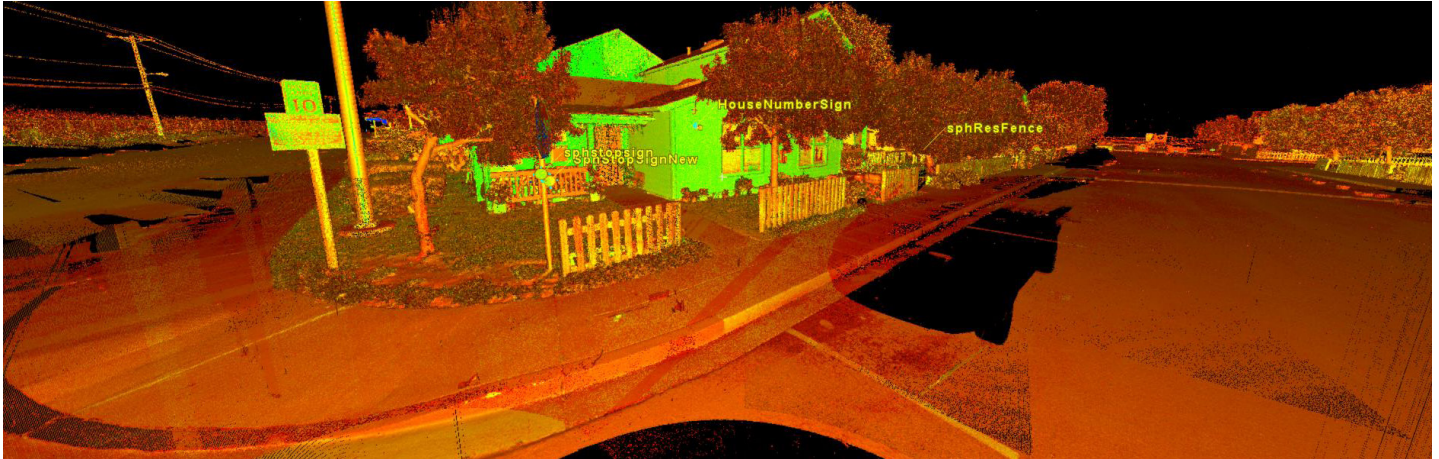
- The Incident History Report
- Deposition Testimony from Witnesses – family members that were present, the shooting witness as well as the shooting deputy and his partner.
- Video Taped interview of the Shooting Deputy
- Audio Recording of the 911 Call
- Audio Recording of Sheriff's Radio Traffic
- Photographs of the Scene
- Photographs and Measurements of the Shooting Deputy
- The Autopsy Report
- Crime Lab Diagram, Sketches and Measurements
- District Attorney Investigative Report



Samples of Physical Evidence

3D Laser Scanning

PSI pioneered the use of 3D laser scanning in the late 1990's. 3D laser scanning is a method of crime and accident scene documentation that uses a focused beam of laser light to measure the location of objects in the scene. The system sends out the laser beam up to 976,000 pulses/second, with each pulse measuring a portion of the scene. The millions of measurements that are returned create an accurate, thorough 3D model of the scene, preserving the scene in detail for later use in computer-aided analysis and visualization.



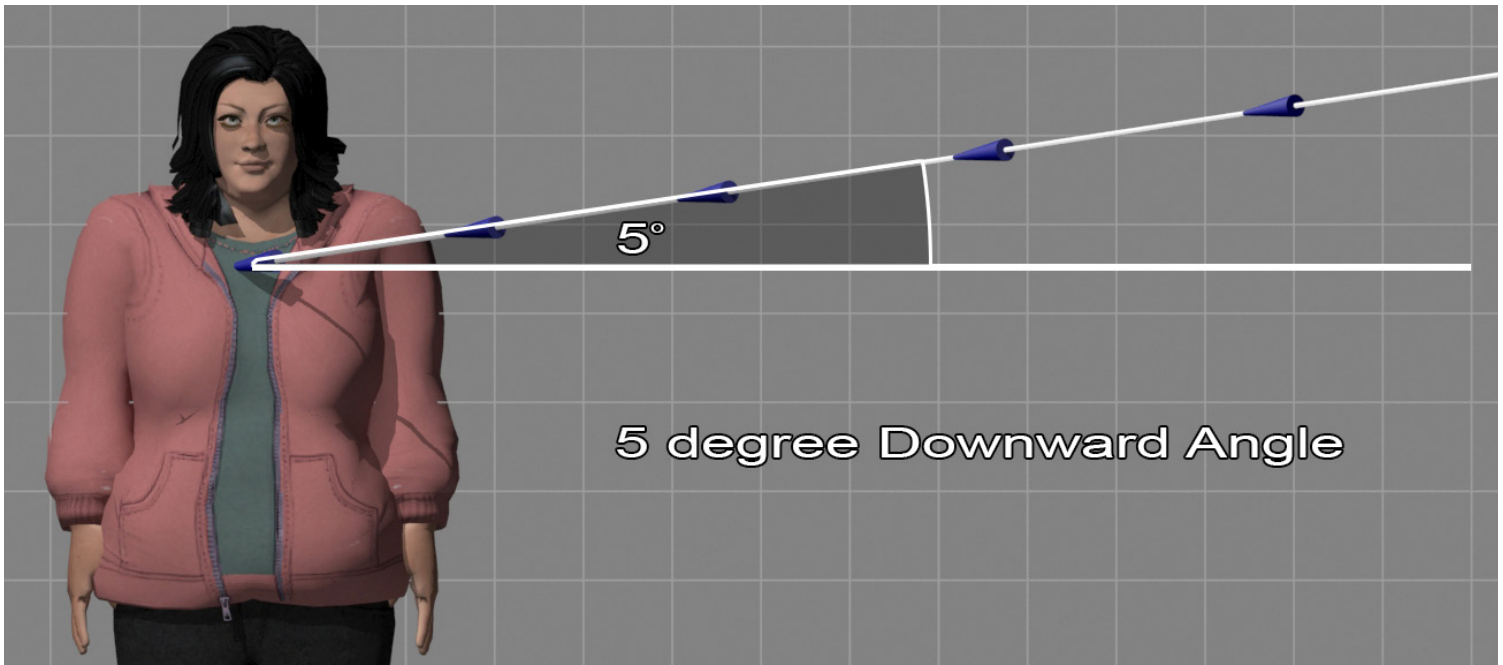
Laserscan Data of Scene

The scene was measured from five locations, generating approximately 41,000,000 measurements. The resultant 3D model was used in the trajectory analysis, the 3D animation and to locate physical evidence as documented by the Sheriff's Department.

3D Ballistic Trajectory Model

PSI was provided with the official autopsy report. Of note are the following that are detailed in the report:

1. There is a single gunshot wound.
 - A. Entry is listed as 4.5 inches below the sternal notch.
 - B. The Medical Examiner measured the distance from the assailant's feet to her sternal notch as 53 inches.
 - C. Therefore, the entry wound is located 48.5 inches above the assailant's feet.
2. The path of the bullet trajectory is listed as front to back, right to left and downward.
 - A. The downward trajectory is listed as approximately 5-degrees.
 - B. The horizontal trajectory is listed as approximately 35-degrees right to left.



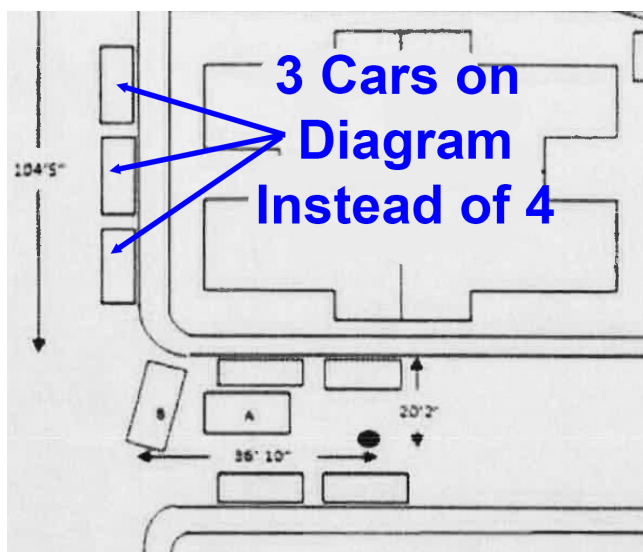
PSI uses the measurements and descriptions of the wounds in the autopsy report to create a 3D model of the assailant, 62 inches in height, weighing 200 pounds and then creates the entry location for the single gunshot wound detailed in the report. PSI creates a bullet path on this 3D model to match the 5-degree vertical/35-degree horizontal path as listed in the autopsy report and extends this bullet path in order to align it with the location and measured height of the deputy's weapon.

The 3D Working Model - Physical Environment and Physical Evidence

In order to determine the location and body posture of the assailant when she receives the gunshot wound, it is necessary to properly locate the 3D model within the overall crime scene. PSI uses the 3D laser scanning data to generate an accurate and detailed 3D model of the scene and then combines the 3D working model with the measurements of the physical evidence found at the scene, including the position of the expended casing and the assailant's position of rest.

Laser Assisted 3D Photogrammetry

The District Attorney's Office generates a diagram of the scene and physical evidence, but the drawing itself is not to scale and contains critical inaccuracies, although there are specific measurements provided for some of the physical evidence.



Sheriff's Department Diagram

The drawing incorrectly shows only three vehicles parked along the south curb of the street where the incident occurred. This is in error as there were in fact four vehicles in this space. This error adds confusion during the depositions when used as basis for labeling certain locations with witnesses, each of whom uses the inaccurately drawn vehicles as reference points for their own recollections of the event. The location of these vehicles relative to the other scene elements, as well as the location of the deputy's patrol car, is supplemented by photogrammetry techniques using the incident scene photographs. This process uses the 3D laser scan measurements in conjunction with the scene photos to accurately position the objects at the scene as they were at the time of the incident and generates images illustrating the accuracy of the match.

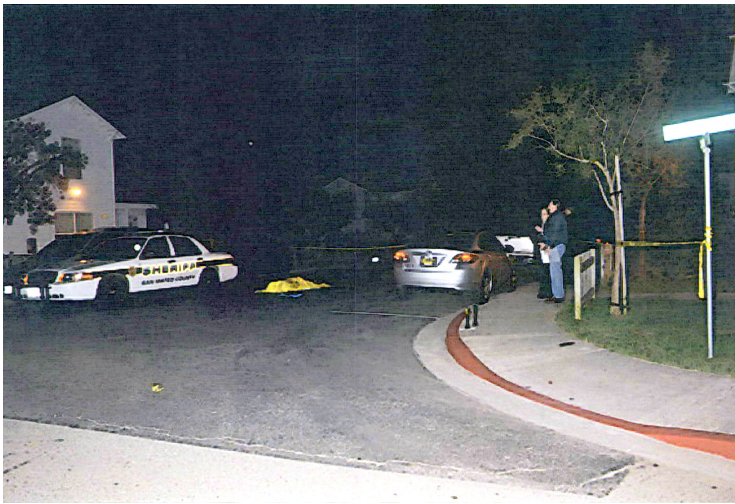


Photo of Scene



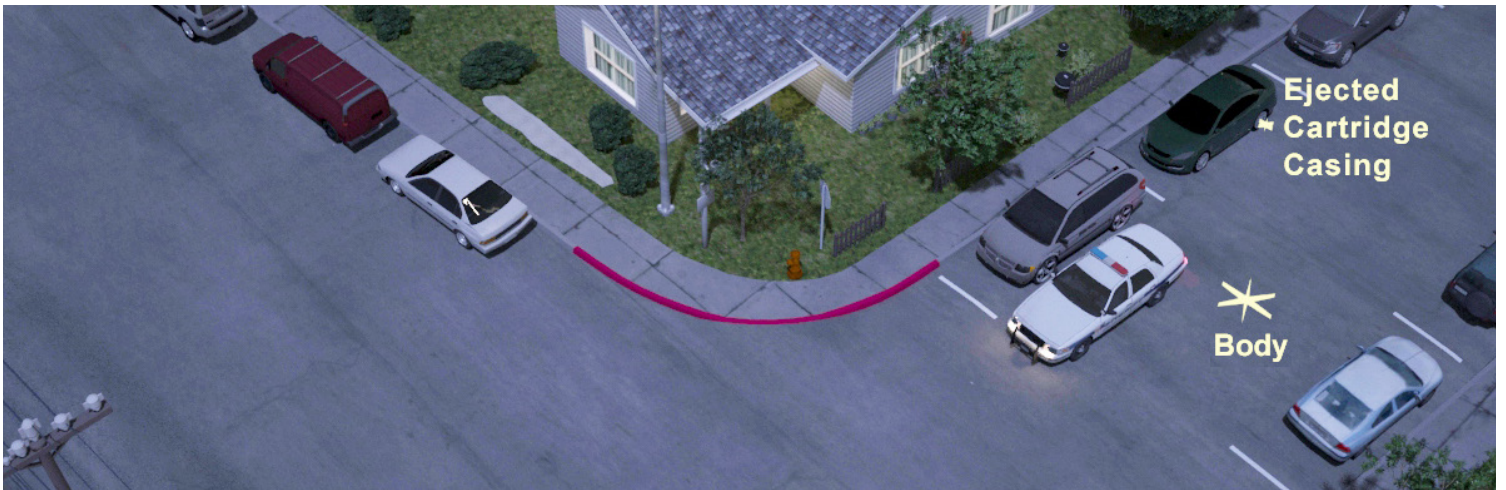
3D Model of Scene from Photogrammetry



Photo of Scene



3D Model of Scene from Photogrammetry

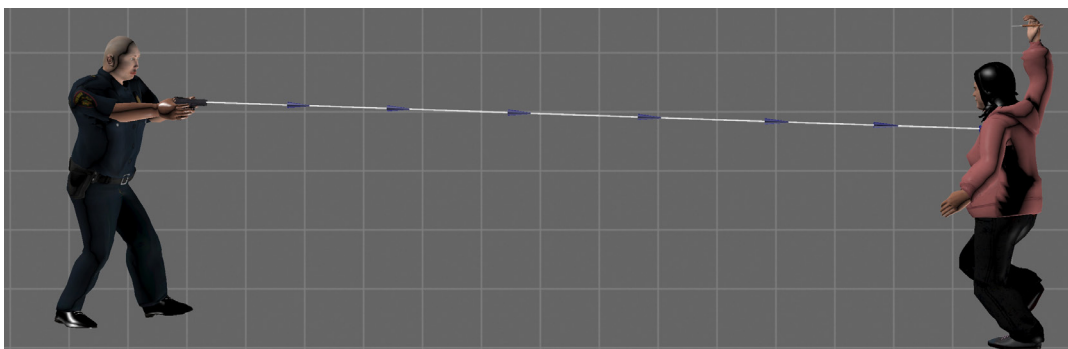


This compiled 3D working model contains all the physical evidence needed to recreate the scene as it was immediately after the shooting.

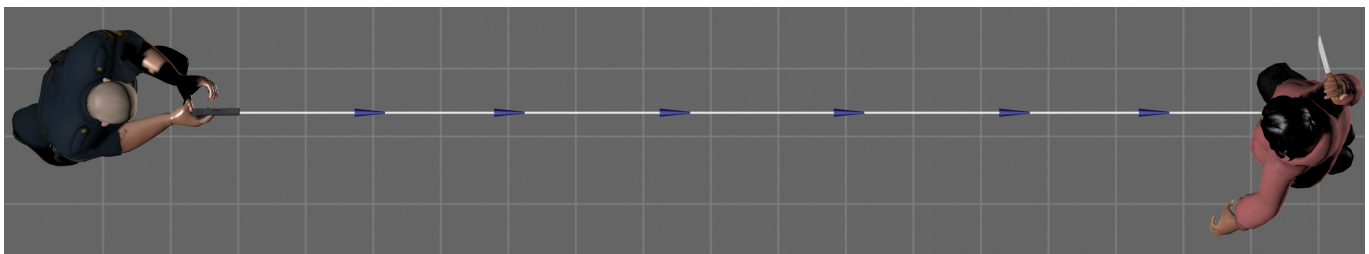
Articulating the 3D Model to Derive Body Postures

With each of the individual 3D models completed, the final step is to derive the assailant's posture at the time she receives the gunshot wound. This was achieved by combining the 3D model of the assailant and the gunshot wound path with the physical evidence at the scene. PSI imports the 3D model of the assailant and the gunshot wound path into the 3D working model of the scene and positions the assailant model according to the available testimony and physical evidence.

The shooting deputy and the only witness to the actual shooting each testified that the deputy fired at the assailant when they were near the rear of the deputy's patrol car. The deputy stated that the assailant was approximately 10 feet away when he fired, and that she came to rest approximately 7 feet from his feet. The witness to the shooting testified that the assailant was about 10 to 15 feet away from the deputy as she chased him with the knife. The measurements at the scene positions the assailant's body 36 feet 10 inches from the south curb of the street and 22 feet 2 inches from the east curb of the cross street. In addition to these data points, PSI considers the distance traveled by the assailant between receiving the gunshot wound and coming to rest on the ground. To do this, PSI calculates the assailant's footspeed from the available evidence, as approximately 13 feet per second. This is derived by dividing the total distance of the assailants' pursuit path of 160 feet by the elapsed time from the start of her pursuit to the time gunshots are heard on the 911 call of 12.5 seconds – $160/12.5 = \sim 13$. The assailant's height of 62 inches places her center of mass approximately 31 inches above the ground. Based on her forward speed of 13 feet per second and the rate of her falling center of mass after being shot of 32.2 feet per second, per second due to gravity, PSI calculated that the assailant would travel approximately 6 feet further forward as she is falling to the ground.



Derived Body Postures During Shooting - Side View



Derived Body Postures During Shooting - Top View

Creating the Timeline from 911 Call Audio

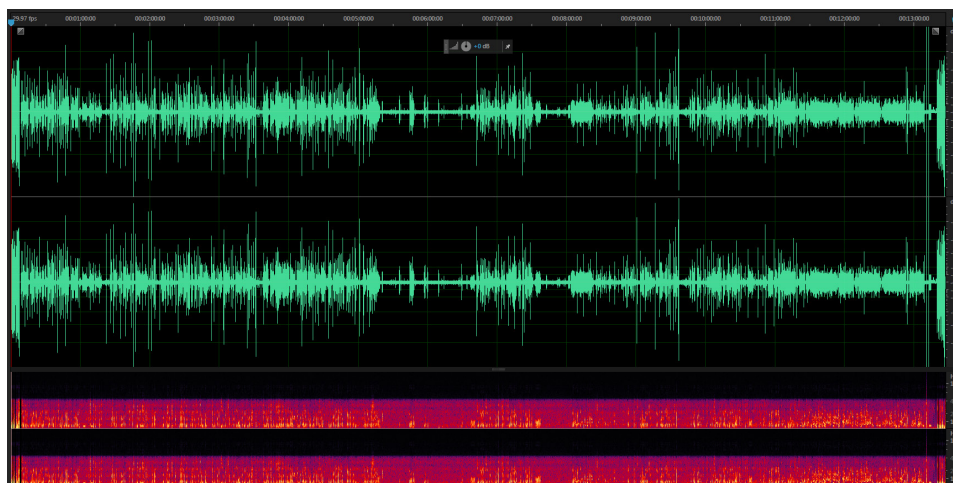
The 3D model derived from laser scan data and photogrammetry analysis of the available photos provides an accurate virtual crime scene in which the animations of the involved parties' movements can be illustrated. In order to create a 3D animation of the event, it is necessary to derive timing for the foot pursuit, statements and locations of each event and party illustrated.

As a starting point, the audio from the 911 call and radio transmissions provide a time reference for the events that occurred leading up to and including the shooting. It is important to note that the timecode in the radio transmission is not necessarily synchronized with the 911 call times or the Incident History Report. For instance, the incident history report lists that the deputy arrived on scene at 21:32:38 – 3 seconds *after* the sound of the gunshot is heard on the 911 call at 21:32:35.

The 911 call audio file that PSI received and reviewed was initially combined with the radio traffic audio. In listening to this file, it was apparent that they were not synchronized as the deputy's transmission of "76, fired, shots fired" preceded the sound of the gunfire recorded on the 911 call by a matter of minutes, which is clearly impossible. PSI then asked to receive the two recordings in separate digital files to facilitate synchronizing the 911 call and radio transmission.

In attempting to synchronize the two audio files, PSI used the starting timecode heard at the beginning of each file and recorded the offset from this starting point for each audio statement in the recordings.

These individual statements for each recording and their offsets from the initial timecode were brought into an Excel spreadsheet for review. However, after this process was complete PSI was once again not able to synchronize the audio files as the "76, fired, shots fired" transmission still preceded the sound of the gunshot by a matter of minutes. Further analysis showed that the problem lay with the radio transmission file, which is not a continuous recording, as opposed to the 911 call which is. The raw radio transmission file, without silences removed was requested and received.



This file came much closer to synchronizing with the 911 call, yet the deputy's transmission of "76, she's running after me" heard on the radio file had a timecode that was 4.2 seconds after the sound of the gunshot on the 911 call – which does not make sense and is counter to the deputy's testimony that he made this transmission via his microphone as the assailant was chasing him near the intersection. After a thorough analysis of the audio files, the error lies either in an offset between the 911 call automated timecode and the automated timecode of the radio transmissions, or the radio transmission recording has been truncated by some amount of time. In the end, it was not possible to perfectly align the two audio files and PSI relied on the 911 call file for the basis for all but one event timing.

911 Timecode	Time From "Watch Out" in seconds	Speaker	Event
21:32:22	0.00	Assailant's Brother	"w- w-w-w watch out, watch out, watch out"
21:32:24	2.00	Deputy	"Hey Hey Hey"
21:32:25	2.67	Assailant's Brother	"Assailant's Name, Assailant's Name"
21:32:28	5.67	911 Operator	"What's happening sir?"
21:32:28	6.21	Assailant's Brother	"She's following the policeman"
21:32:29	6.74	Deputy	"Stop! Stop!"
21:32:30	8.34	Assailant's Brother	"She's, she's following the cop with the...."
21:32:32	10.51	Assailant's Mother in Background	Exclamation from Mother
21:32:33	11.11	Deputy	"Stop!"
21:32:33	11.34	911 Operator	"She's following the cop with the knife?"
21:32:35	12.55	Deputy's Gun	Sound of gunshot
21:32:41	18.69	911 Operator	"Hello, sir?"
21:32:44	21.69	911 Operator	"Sir what's happening? Tell me what you see"
21:32:46	24.36	Assailant's Brother	"She just got shot"

Using the 911 call and associated timecodes as the basis for the temporal component of the 3D animation, the real-time data begins with the assailant's brother, who was the 911 caller exclaiming "w-w-w-w- watch out, watch out, watch out.", recorded at 21:32:22. He testified that he exclaimed "w-w-w-watch out" in reaction to seeing his sister begin to pursue the deputy with the knife starting near her front porch. The real-time data ends with the sound of a single gunshot, recorded at 21:32:35, for a total time of 12.55 seconds.



Still Frames from Animation

Conclusions

From our analysis of the data PSI concluded the following:

1. The total time between the assailant's brother's exclamation "w-w-w-w- watch out, watch out, watch out" and the time the deputy fired a single round at a charging assailant was 12.5 seconds.
2. Despite her gait impediment, the assailant covered approximately 160 feet from the area of her front porch to her location when she was shot in 12.5 seconds. This results in an average foot speed of approximately 13 feet per second.
3. The deputy fired his firearm a single time when the assailant was approximately 1 second away from reaching him with the knife, given her footspeed of 13 feet per second during her pursuit of the deputy.
4. The deputy's testimony regarding the locations and timing of the events is generally supported by the physical evidence and the timing on the 911 call. The deputy's testimony of his location when he turned and ran conventionally from the assailant is likely incorrect, as it would require an unreasonably high foot speed while running to match the known timeline of the 911 call.
5. The assailant's brother's testimony regarding timing, speeds and locations is not supported by the 911 call or probable human performance values in regards to the foot speed of the assailant. Specifically, given the narrative offered by the assailant's brother, the assailant could not have been slowly walking towards the deputy and then walked while limping and dragging her foot to the point where she was shot. To do so would require a walking/limping speed that equals the running speed of collegiate track & field athletes. Additionally, given his narrative, it is unlikely that the deputy was sprinting towards the assailant as she was taking two steps backwards, or that the deputy "lunged" at the assailant, given the 15 to 20-foot distance between their two locations at the time the assailant's brother claims this occurred.
6. The radio traffic audio has a timing error in either the base timecode as compared to the 911 systems timecode or has been truncated resulting in 4 plus seconds of error in elapsed time compared to the continuous recording of the 911 call.
7. The 3D animations PSI created based upon the available evidence and testimony accurately reflect the timing and locations of the events depicted and maintain fidelity to the foundational information PSI was provided.

Proving the Opposition's Claims False

The deputy, the witnesses and all the physical evidence place both the deputy and the assailant down the street and around the corner, approximately 160 feet from the starting location. This evidence proved conclusively, once derived from the audio recordings, that the assailant did in fact pursue the deputy for the length he claimed and also proved that the assailant was capable of maintain a running speed of ~13 ft/second, despite the family's and plaintiff attorney's claims to the contrary. PSI used the deputy's testimony in regards to specific locations and events, synchronized with his exclamations and the 911 caller's recorded narrative, to create the animation. PSI also attempted to use the assailant's brother's testimony in regards to specific locations and events. This proved impossible to reconcile with the physical evidence.

Expert's Note

This case would have fallen along the "he said - she said" line so often seen in officer involved shootings had it not been for the availability of the continuous 911 recording and PSI's ability to synchronize the transcript with the testimony of the witnesses and deputy. The audio recording itself, along with PSI's 3D working model, proved conclusively that the deputy's version of events was supported by the physical evidence, including key details provided by the deputy's radio transmission as the event unfolded in real time. I considered these recorded statements as above suspicion as they were recorded contemporaneous with the dynamic and life threatening events facing the deputy. Further, it proved that the family's version that had the assailant slowly walking/limping towards the deputy and therefore not a threat, was physically impossible.

Although video recording of an event is often considered the "holy grail" for reconstruction of a complex incident, the audio alone can often be enough to determine what happened, and equally importantly, what did not happen. One can argue whether we truly have privacy any longer in our lives with the array of recordings taken and shared, one area of our lives is very well served by them – the unwavering pursuit of justice.