TEXAS FORENSIC SCIENCE COMMISSION

Justice Through Science

FINAL INVESTIGATIVE REPORT CONCERNING COMPLAINT NO. 14.11, TAMARA PARSONS FOR GEORGE R. POWELL III (KNOX & ASSOCIATES; FORENSIC VIDEO)

April 12, 2016

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I. SUMMARY OF THE COMMISSION'S STATUTORY AUTHORITY

A. Legislative Background and Jurisdiction

The Texas Legislature created the Texas Forensic Science Commission ("Commission") during the 79th Legislative Session by passing House Bill 1068 (the "Act"). The Act amended the Texas Code of Criminal Procedure to add Article 38.01, which describes the composition and authority of the Commission. *See* Act of May 30, 2005, 79th Leg., R.S., ch. 1224, § 1, 2005.

During the 83rd and 84th Sessions, the Legislature further amended the Code of Criminal Procedure to clarify and expand the Commission's jurisdictional authority. *See* Acts 2013, 83rd Leg., ch. 782 (S.B.1238), §§ 1 to 4, eff. June 14, 2013; Acts 2015, 84th Leg., ch. 1276 (S.B.1287), §§ 1 to 7, eff. September 1, 2015, (except TEX. CODE CRIM. PROC. art. 38.01 § 4-a(b) which takes effect January 1, 2019).

The Commission has nine members appointed by the Governor of Texas. *Id.* at art. 38.01 § 3. Seven of the nine commissioners are scientists and two are attorneys (one prosecutor nominated by the Texas District and County Attorney's Association, and one criminal defense attorney nominated by the Texas Criminal Defense Lawyer's Association). *Id.* The Commission's Presiding Officer is Dr. Vincent J.M. Di Maio, as designated by the Governor. *Id.* at § 3(c).

1. Investigative Jurisdiction

Accredited Disciplines: Texas law requires the Commission to "investigate, in a timely manner, any allegation of professional negligence or professional misconduct that would substantially affect the integrity of the results of a forensic analysis conducted by an accredited laboratory, facility or entity." TEX. CODE CRIM. PROC. art. 38.01 § 4(a)(3).

The Act also requires the Commission to: (1) implement a reporting system through which accredited laboratories, facilities or entities may report professional negligence or professional misconduct; *and* (2) require all laboratories, facilities or entities that conduct forensic analyses to report professional negligence or misconduct to the Commission. *Id.* at § 4.

Disciplines Not Subject to Accreditation: The Commission is also authorized to investigate allegations of professional negligence and misconduct for forensic disciplines that are *not currently subject to accreditation*, such as the forensic video analysis at issue in this case. TEX. CODE CRIM. PROC. art. 38.01 § 4(b-1). However, for cases involving forensic disciplines not subject to accreditation, the Commission's reports are limited to the following three areas:

- Observations regarding the integrity and reliability of the forensic analysis conducted;
- Best practices identified by the Commission during the course of the investigation; and
- Other recommendations deemed relevant by the Commission. *Id.*

2. Accreditation Jurisdiction

The Commission is also charged with accrediting crime laboratories and other entities that conduct forensic analyses of physical evidence for use in criminal proceedings. TEX. CODE CRIM. PROC. art. 38.01 § 4-d(b). Unless forensic analysis and related testimony is accredited or falls under an exemption (see below), the evidence is *not admissible* in a criminal action. TEX. CODE CRIM. PROC. art. 38.35 § (d)(1).

Texas law exempts certain forensic disciplines from the accreditation requirement—either by statute, by administrative rule, or by determination of the Commission. TEX. CODE CRIM. PROC. art. 38.01 § 4-d(c). Digital evidence, which includes forensic video analysis, is exempt by statute. TEX. CODE CRIM. PROC. art. 38.35 § (a)(4)(C). Because of this exemption, forensic video analysis and related testimony may be admitted in criminal cases even if the analysis was not performed by an accredited laboratory or entity. The decision regarding admission of the evidence rests entirely with the judge as gatekeeper.

3. Licensing Jurisdiction

As a result of legislation passed during the 84th Legislative Session, the Commission is required to establish a forensic licensing program by January 2019. TEX. CODE CRIM. PROC. art. 38.01 § 4-a. While accreditation is granted to the *entities* that perform forensic analysis, licensure (sometimes referred to as certification) is granted to the *individual practitioners* once they fulfill certain education, training and competency requirements.

Currently, the licensing requirement applies to "forensic analysts" who perform their work on behalf of accredited laboratories only. *Id.* The Commission may establish voluntary licensing programs for disciplines falling outside the accreditation requirement, such as forensic video analysis. *Id.* at § 4-a(c). The Commission's licensing program is still under development as of the writing of this report. Updates will be published on the Commission's website and discussed at upcoming quarterly meetings.

II. INVESTIGATIVE PROCESS

A. Complaint Screening

When the Commission receives a complaint, the Complaint and Disclosure Screening Committee conducts an initial review of the document at a publicly noticed meeting. (*See* Policies and Procedures at 3.0). After discussing the complaint, the Committee votes to recommend to the full Commission whether the complaint merits further review. *Id.*

On February 7, 2014, Tamara Parsons, a friend of inmate George Powell, III ("Powell") filed a complaint with the Commission regarding the integrity and reliability of the forensic analysis used to determine the height of a suspect from video of an aggravated robbery of a 7-Eleven convenience store in Killeen, Texas. The Complaint Screening Committee discussed the complaint at a publicly noticed meeting in Fort Worth, Texas on July 31, 2014. The Commission discussed the complaint a second time the following day, on August 1, 2014, at its quarterly meeting, also in Fort Worth, Texas. After deliberation, the Commission voted unanimously to create an investigative panel to review the complaint pursuant to Section 3.0(b)(2) of the Policies and Procedures. Members voted to elect Dr. Jeffrey Barnard, Dr. Harvey Kessler, and Mr. Bobby Lerma as members of the panel, with Dr. Jeffrey Barnard serving as Chairman. Commissioner Richard Alpert was added as a fourth member of the panel on April 10, 2015.

Once a panel is created, the Commission's investigations include: (1) relevant document review; (2) interviews with stakeholders as necessary to assess the facts and issues raised; (3) collaboration with affected agencies (*e.g.,* accrediting bodies, District Attorney's Office, other law enforcement, etc.); (4) requests for follow-up information;

(5) hiring of subject matter experts where necessary; and (6) any other steps needed to meet the Commission's statutory obligations.

After consultation with various law enforcement agencies with experience in the area of digital and multimedia analysis, the Commission voted unanimously to retain forensic video expert Grant Fredericks ("Fredericks") to review: 1) the report and testimony originally presented at Powell's trial by Knox & Associates, Inc. ("Knox Report"), and 2) a subsequent report from Yonovitz and Joe, Inc., ("Yonovitz Report"), an expert hired after the trial by Tamara Parsons, a friend of Mr. Powell's. *See* **Exhibit A** for copies of the Knox Report and the Yonovitz Report along with the corresponding expert curriculum vitae.

B. Other Important Limitations on the Commission's Authority

In addition to the limitations described above regarding reports involving disciplines not subject to accreditation, the Commission's authority contains other important statutory limitations. ***For example, no finding contained herein constitutes a comment upon the guilt or innocence of any individual.*** TEX. CODE CRIM. PROC. art. 38.01 at § 4(g. The Commission's written reports ***are not admissible*** in a civil or criminal action. *Id.* at § 11.

The Commission also does not have the authority to issue fines or other administrative penalties against any individual, laboratory or entity. The information the Commission receives during the course of any investigation is dependent upon the willingness of stakeholders to submit relevant documents and respond to questions posed. The information gathered has ***not*** been subjected to the standards for admission of evidence in a courtroom. For example, no individual testified under oath, was limited by either the Texas or Federal Rules of Evidence (*e.g.,* against the admission of hearsay) or was subjected to formal cross-examination under the supervision of a judge.

Despite these limitations, the Commission's reports are important tools in improving the forensic science used in our criminal justice system. Texas judges take their gatekeeping role seriously and do their utmost to make sound decisions regarding admissibility of forensic evidence. However, most judges have neither the time nor the resources to analyze foundational research or assess current standards, especially considering the vast array of diverse forensic disciplines that come before them. Similarly, prosecutors rely heavily on the analysis of the experts they retain to assist them in seeking justice on behalf of victims. State and local resources are expended on experts, and the public should be able to have confidence in the reliability and validity of their work. For this reason, the observations and recommendations contained in this report are intended to provide guidance for all cases in which forensic video analyses using principles of photogrammetry are offered into evidence. Possible solutions and safeguards are offered in Section IX below.

III. SUMMARY OF CASE FACTS AND COMPLAINT

On November 20, 2009, a jury convicted Powell of aggravated robbery of a 7-Eleven convenience store and sentenced him to 28 years in prison. At trial, the State called the clerk and manager of the 7-Eleven store as witnesses. Both identified Powell as the man who robbed their store. The State then called two clerks from Mickey's, another area convenience store that was robbed the day before the 7-Eleven. The Mickey's clerks identified Powell as the man who robbed their store. They also testified they had watched the videotape of the 7-Eleven robbery and believed it depicted the same person who robbed Mickey's.

After the State rested its case, the defense called the clerk and manager of a third area convenience store, a Valero, that was robbed twelve days before the 7-Eleven. The manager testified she knew Powell personally because he had come into the Valero store several times. She also testified she believed Powell was not the man who robbed the Valero store, because Powell was taller and spoke differently from the robber. The clerk testified she saw the videotape of the 7-Eleven robbery and believed it showed the same man who robbed the Valero store, but she did not believe that man was Powell. The clerk echoed the manager's belief that Powell was taller than the robber. Powell maintains he did not commit any of the robberies.

At trial, the State presented Michael Knox as an expert in forensic video analysis. Mr. Knox's Report and testimony concluded that the suspect shown in the 7-Eleven surveillance video was at least 6'1" tall. *See* **Exhibit B** for a copy of the transcript excerpt. After Powell was convicted and sentenced, Ms. Parsons hired Dr. Al Yonovitz to conduct both a height determination of the suspect pictured in the Valero video and the 7-Eleven video as well as a voice recognition/comparison analysis, all of which are contained in the Yonovitz Report, dated January 14, 2014.[1] The Yonovitz Report concluded the suspect shown in the surveillance video used at Powell's trial was approximately 5'7½" with an approximate ½" margin of error.

On February 7, 2014, Ms. Parsons filed a complaint with the Commission questioning the integrity and reliability of the forensic video analysis and testimony used

[1] Voice recognition/comparison analysis was not addressed in this investigation and the Commission makes no finding as to the integrity and reliability of voice recognition/comparison analysis.

to determine the robber's height at trial. Along with the complaint form, Ms. Parsons provided the Commission with the two expert reports (Knox and Yonovitz), each with very different conclusions and very different methods for reaching their conclusions. Given the disparate conclusions and methodologies employed by the experts, the Commission determined the complaint merited further review. In addition, because the type of video analysis used in this case is commonly used in criminal courts, the Commission felt the case provided a good opportunity to offer guidance to the criminal justice community regarding the current state of the discipline. Because the discipline is not subject to accreditation, the Commission has no standard operating procedures to call upon as we would in other accredited forensic disciplines. This leaves the Commission and the legal community struggling to ascertain the status of standards development in the discipline.

Though the Commission has been assured by various experts in the field that well-trained forensic video analysts should reach the same conclusion (within a margin of error), the analyses performed in this case raise real questions about inter-examiner reliability. In other words, when given the same analytical problem (ascertaining the height of the robber in the video) will more than one qualified expert in the field reach the same result? Establishing inter-examiner reliability is absolutely critical to the criminal justice system and to the core questions gatekeepers face in deciding whether to allow a particular type of expert testimony into evidence.

IV. WHAT IS FORENSIC VIDEO ANALYSIS?

Forensic Video Analysis is recognized by the International Association for Identification (IAI) as a valid sub-specialty within the discipline of forensic imaging.

(*See* **Exhibit C**). It is broadly defined as the scientific examination, comparison, and/or evaluation of video in legal matters. **Exhibit C** at 2. A valid and reliable forensic examination requires advanced knowledge of video compression standards and proven skills in the use of advanced tools, techniques and applications. **Exhibit D** at 56.

Photogrammetry is the technical term used for obtaining reliable information about physical objects and the environment through the process of recording, measuring and interpreting photographic images and patterns of electromagnetic radiant energy and other phenomena. **Exhibit D** at 3. In forensic applications, photogrammetry is most commonly used to extract dimensional information from images, such as the height of a robber in surveillance images. *Id.*

There is more than one method accepted by the relevant scientific community for conducting a photogrammetric analysis and there are a number of valid tools available to analysts in applying photogrammetric principles. The discipline is relatively new in comparison with other forensic disciplines (e.g., latent print examination). As a result, there is an urgent need for more publicly accessible information regarding scientific research, developmental validation and standards in the discipline. Both the Scientific Working Group for Imaging Technology (SWGIT) and the Scientific Working Group for Digital Evidence (SWGDE) have published documents that are helpful in outlining general parameters for conducting a forensic video analysis, but they focus on process, workflow and requirements that should be contained in standard operating procedures, not on the fundamental reliability and validity of various photogrammetric methodologies. Nonetheless, SWGDE provides important guidance in documents entitled 2015-09-29 SWGDE Best Practices for the Forensic Use of Photogrammetry

(*See* **Exhibit E**) and 2016-02-08 SWGDE Training Guidelines for Video Analysis, Image Analysis & Photography. (*See* **Exhibit K**.)

Additionally, the National Institute of Standards and Technology (NIST) Organization of Scientific Area Committees (OSAC) was established at the federal level in June 2014 to address standards and guideline development in a more formalized way. The OSAC is part of an initiative by NIST and the Department of Justice to strengthen forensic science in the United States. OSAC is a collaborative body of more than 500 forensic science practitioners and other experts who represent local, state, and federal agencies, academia and industry. Indeed, many Texans participate in the OSAC process. NIST established the OSAC to support the development and promulgation of forensic science consensus documentary standards and guidelines, and to ensure that a sufficient scientific basis exists for each discipline.

The OSAC Video/Imaging Technology and Analysis Subcommittee will focus on standards and guidelines related to the application of methods and technologies to analyze information related to forensic imagery from a variety of systems. The Commission understands test methods in forensic video analysis will be among the issues addressed by the Subcommittee. These standards and guidelines are needed as soon as possible as illustrated by the facts of this case and ensuing Commission investigation.

V. GRANT FREDERICKS REVIEW OF MICHAEL KNOX REPORT

On October 7, 2014, Commissioners voted to retain forensic video expert Grant Fredericks to review Knox's report and advise the Commission on the integrity and reliability of the analysis. *See* **Exhibit F** for a copy of Fredericks' curriculum vitae. Fredericks began his investigation the following month. In August 2015, Fredericks traveled to Texas, performed his analysis at the convenience store where the robbery took place and took Powell's 3D-scanned height measurement. Fredericks created a WebEx demonstration explaining his concerns about the integrity and reliability of the forensic analysis at trial. A PowerPoint version of the demonstrative is attached as **Exhibit G**. Fredericks issued his final report and findings to the Commission on September 25, 2015. *See* **Exhibit D**.

In his original report, Knox concluded that the suspect in the 7-Eleven robbery video was at least 6'1" tall and his testimony at trial reflected this conclusion.

> Q: So the end result is—Go ahead and play that. Just pause. And is that your opinion? He's at least 6'1"?
> A: Yes.
> Q: The suspect there?
> A: Yes.
> Q: Now, why do you just say "at least 6'1"?
> A: Well there's some things that I can't account for. Mainly we've drawn him in the plane of the door, but in reality not only is he leaning to the side but he's also leaning somewhat in and out of the door. So that means that the foot is a little bit inside the door; the head is a little bit outside the door. That lean also tends to shorten the height, make him appear to be shorter than what he really is. But with the camera views that I have here, I don't have any way to know exactly how much—how far out the door his head is, how far in the door his foot is. So we're just basically assuming, okay, we're not going to count that. "Six-one" means that this is the minimum height. There is still some more height that has not been accounted for because of that lean.
> Q: So the minimal height of that suspect in that 7-Eleven is mathematically 6'1" and 1/8th inch?
> A: Yes.
> Q: Can't be 5'6", 5'7" or 5'8"?
> A: No.
> Q: He is definitely at least 6'1" and 1/8th?
> A: Yes.
> Q: Ok.

A. Technical Issues in Photogrammetric Analysis

Fredericks believes Knox failed to follow industry accepted standards and methodologies in the execution of his photogrammetric examination of the video evidence used to make his height determination. **Exhibit D** at 33. For example, rather than analyzing multiple images, Knox used only one. *Id.* In his measurements, he failed to accurately identify the top of the robber's head and he stretched the length of the robber significantly by selecting a point below the trailing foot of the robber. *Id.* In addition, the image he selected depicted the robber on an angle, rather than when he was standing erect. *Id.*

Mr. Knox acknowledged at trial that he could not determine if the robber's head was in or outside of the doorway plane, but for the purpose of his measurement he assumed the robber's head was at the same plane of the door measurement markers. *Id.* Despite this assumption, he produced a demonstrative video animation showing a known position for the robber's head. The animation shows that the head is further out of the doorway. *Id.*

In his testimony, Knox stated that the perspective of the robber, in relation to the measurement stickers on the door, changes when one recreates the robber's position from a lower angle. *Id.* In the animation, the robber's height grows significantly as the camera perspective lowers. *Id.* Since the camera is facing downward toward the door, objects that are farther away from the camera will appear higher in the image. *Id.* Knox's animation starts with an image showing an outline of the robber in the doorway. *Id.* at 34. The outline depicts the robber being much taller than the middle-height sticker. Knox then animates the camera perspective, lowering it to a position approximately 90 degrees to the robber's head. *Id.* In the animation, the robber's head rises in the image. If the robber were at the same plane of the door as the measurement stickers, the position of his head would not change in relation to the stickers when the camera perspective is lowered. *Id.* Essentially, the measurement stickers would not change with a lowered camera position. *Id.* Knox measured the top of the suspect's hat at a position that is higher than the middle sticker, even though his measured image shows that the suspect is at the same height of the sticker. *Id.*

Fredericks explained that during direct examination Knox testified that he created an outline of the suspect over the video images. *Id.* Knox's demonstrative showed the location of his outline. *Id.* Fredericks explained Knox's outline is actually outside the body of the robber. *Id.* Knox then used the outline geometry by importing the data into the PhotoModeler program. *Id.* Since the outline identified points outside the body, both higher and lower than the head and foot, Knox added additional height. Knox measured from above the top of the robber's head, on an angle through the back of the robber's body, to the rear of the robber's trailing foot. *Id.* The correct methodology, as Fredericks explains in his report, is to measure directly from the top of the head vertically to the ground below the head. *Id.* Fredericks believes this error added additional pixels (length) to Knox's estimation of height. *Id.*

B. Error Rate/Measurement Uncertainty

Knox did not acknowledge a potential rate of error in his measurement analysis. *Id.* Fredericks explains that at the position of the robber's head in the images, for example, each pixel represents approximately ½". *Id.* All measurements in this area must be stated with a potential rate of error of approximately +/- ½", because an edge cannot be identified with a single pixel. *Id.* The ability to accurately measure the location of the ground under the robber's feet has a higher potential rate of error and should be articulated as +/- 1". *Id.* at 35.

C. Documentation and Peer Review

Fredericks explains that Knox propagated errors throughout his workflow. *Id.* Due to the brevity of Knox's written report, lack of notes and due to the failure to apply accepted methodologies, it is not possible to repeat Knox's work. *Id.* Since his work is not repeatable, it is not possible to quantify error for each individual step in the analysis. *Id.*

Fredericks was also concerned that Knox failed to obtain a peer review for his inaugural forensic video analysis case. *Id.* A peer review by an appropriately trained and experienced analyst would have been helpful to the analyst, the prosecutor and the trier of fact at the time of trial.[2] *Id.*

D. Qualifications to Perform Analysis

Fredericks noted a number of red flags regarding Knox's qualifications to conduct the forensic video analysis: 1) Knox did not have a post-secondary degree; 2) he had no formal education in video analysis, television, engineering or photogrammetry; 3) when he performed his analysis, he had no training related to video analysis, image interpretation, video compression, reverse projection of compressed video images or any other functions listed in the industry training guidelines recommended for work in forensic video analysis; and 4) he admitted this was the first case for which he had conducted height analysis of any kind. **Exhibit D** at 21.

E. Summary of Fredericks Analysis

Mr. Fredericks used two primary methodologies for conducting his photogrammetric examination: 1) reverse projection/3D laser scanning, and 2)

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[2] After the Frederick's report was issued in 2015, Mr. Knox agreed to a peer review of his work by Dan Mills, a well-regarded expert in forensic video analysis using PhotoModeler software. For a description of the peer review and Mr. Mills' comments, please see **Section IV** of this report.

measurement scale analysis. *Id.* at 38. Reverse projection is the scientific process of obtaining accurate measurements from photographic and video images. *Id.* at 39. 3D laser scanning is a method of reverse projection that uses technology to capture a measureable, three-dimensional record of an environment. *Id.* The record is obtained using a 3D laser scanner that emits a laser and calculates the distance the laser travels from the scanner to objects in the environment. *Id.* Measurement scale analysis is a method for calculating measurable dimensions that can be used in a reverse projection analysis, for example the physical measurement dimensions of the suspect himself or the doorway at the convenience store. *Id.*

Fredericks concluded the height of the suspect in the video was between 5'5.8" and 5'9.4". *Id.* at 52. According to his report, there is a high confidence that the true value falls closer to the average of all measurements taken. The average value calculated for all height measurements in Fredericks report is 5'7.6". *Id.*

VI. MILLS PEER REVIEW OF KNOX'S REPORT

In response to the Commission's inquiry into the case, Knox completed a post-conviction explanation and analysis ("Knox Post-Conviction Report") of his findings used at trial. This Report contained more detailed measurement-control inputs that were not available to Knox at the time of the original analysis. *See* **Exhibit H**. His post-conviction findings measured the suspect in the video at approximately 5'10.4." *Id.*

Upon learning of the Commission's concerns regarding the integrity and reliability of the forensic analysis performed by Knox, Bell County District Attorney Henry Garza requested that Photomodeler expert Dan Mills ("Mills") conduct a peer review of Knox's work with a particular focus on his application of PhotoModeler software. A copy of Mills' curriculum vitae is attached as **Exhibit I.**

At first, Mills concluded that Knox's analysis was within the accepted range of conclusions and based on acceptable methodologies. *See* **Exhibit J**. In fact, Mills did not believe the difference between Fredericks' assessment (between 5'5.8" and 5'9.4" with an average of all height measurements at 5'7.6") and Knox's assessment (5'10.4") was significant. However, this conclusion was based on Mills' analysis of Knox's Post-Conviction Report, and not on the report and related testimony that was actually provided at trial.

When asked to comment on Knox's change in height determination from what he testified to at trial (at least 6'1") to what was provided in his Post-Conviction Report (5'10.4") Mills explained he would consider that a "noteworthy variance." Mills explained the digital file for the Knox Post-Conviction Report was a more scientifically relevant representation of the suspect's minimum height due to "increased knowledge of control measurement inputs now available for Knox's use in his analysis." Mills observed that the conclusions in the original Knox Report and testimony used at trial (at least 6'1") are not supportable in light of the revised conclusions in the Knox Post-Conviction Report (5'10.4").

VII. FREDERICKS REVIEW OF YONOVITZ REPORT

Dr. Yonovitz provided a post-conviction declaration and height analysis on behalf of Powell in 2014 at the request of Ms. Parsons, concluding the suspect in the video was approximately 5'7 ½". *See* **Exhibit L.** Fredericks reviewed Yonovitz' declaration and concluded it is void of any scientific methodology. **Exhibit D** at 36. Yonovitz' report merely states that the robber is at the same plane of the doorway as the stickers in the convenience store doorway, and if so, it appears that his height can be compared to the height of the sticker. *Id.* Though Yonovitz' approach applies some common sense, his analysis is the equivalent of "eye-balling" the video images. *Id.* He fails to provide any basis for his conclusion. *Id.* His approach offers no assistance to a trier of fact, it is not repeatable, and fails to meet the threshold for expert evidence. *Id.* Overall, as Fredericks explains, Yonovitz' analysis should lack any weight due to his failure to produce a scientifically sound report. *Id.* Though the report was not used in any legal proceeding, the Commission is concerned that Ms. Parsons was charged a considerable fee for a report with significant integrity and reliability concerns.

VIII. COMMISSION OBSERVATIONS REGARDING INTEGRITY AND RELIABILTY OF THE FORENSIC ANALSYIS

The Commission's observations in this report are limited to the integrity and reliability of the height determination. Forensic analysis is only one aspect of a criminal case. Often there are many other factors that result in the conviction of an individual. The Commission makes no comment regarding guilt or innocence in this case. At the same time, the forensic analysis of crime scene video is likely to carry tremendous weight with a trier of fact because it is one of the few types of evidence that literally shows the commission of the criminal act. The importance of reliable and valid forensic analysis in this context cannot be overstated.

After its investigation and review of: (1) the Knox Post-Conviction Report; (2) the Fredericks Report; and (3) the peer review and subsequent email clarification by Mills, the Commission concludes the original height determination issued in the Knox Report and related testimony is unsupportable. After additional post-conviction analysis, Knox himself adjusted his conclusion from testimony at trial that the robber was “at least 6’1” to the Post-Conviction Report conclusion of 5’10.4”. Even assuming arguendo that the actual height of the robber is at the higher end of the range provided by Fredericks (5’9.4”) and within one inch of Knox’s Post-Conviction Report assessment of 5’10.4”, this was not the conclusion offered to the trier of fact and thus raises concerns about the integrity and reliability of the forensic analysis.

IX. BEST PRACTICES AND OTHER RELEVANT RECOMMENDATIONS

The qualifications and analytical methods of the three forensic video analysts observed in this case—Knox, Yonovitz, and Fredericks—were vastly different, as were their conclusions. This fact alone gave the Commission pause and raised concerns as to the state of forensic video analysis and how the discipline is used to identify defendants in criminal cases. Given the observations made in the Fredericks Report and both Knox reports combined with the peer review by Mills, the subjectivity involved in the different approaches to making a height determination raises questions about inter-analyst reliability within the discipline. Both Fredericks and Mills assured the Commission that well-trained forensic video analysts should reach the same conclusion (within a reasonable margin of error). However, the discipline still has work to do on core issues such as developmental validation and publication of standards regarding test methodology. Because many forensic video analysts do not practice in a traditional crime laboratory setting, the Commission is not prepared to recommend accreditation for the discipline absent an impact analysis and discussions with the relevant stakeholder community. However, the lack of accreditation in the discipline leaves a gap in oversight for a rapidly growing and valuable forensic discipline.

Given these observations and the material reviewed by the Commission, the Commission makes the following recommendations:

RECOMMENDATION 1: The basis for analytical conclusions reached in forensic casework must be supported by clear and comprehensive scientific methods. Casework without that scientific support is not helpful to the trier of fact. Analysts who perform forensic video analysis to make identifications should make clear the method they are using to reach their conclusions and thoroughly document their work and final conclusions.

RECOMMENDATION 2: Analysts should address error rates and uncertainty in their reports. Guidance on these issues is contained in the SWGDE documents attached as exhibits and will be buttressed by upcoming OSAC standards and guidelines.

RECOMMENDATION 3: All analytical reports should be subject to peer review by another competent analyst before release to stakeholders in the criminal justice system.

RECOMMENDATION 4: In cases where post-conviction analysis is performed and further data is analyzed, the effect and conclusions of the subsequent analysis should be immediately communicated to stakeholders—the prosecutor, the court, and the defendant or his/her attorney.

RECOMMENDATION 5: Analysts should follow the guidelines set forth by SWGDE (and formerly SWGIT) as well as applicable standards and guidelines to be released by the OSAC in the future. These standards and guidelines represent a consensus in the relevant scientific community and constitute, at a minimum, a baseline level of expectation for practitioners in the discipline. Potentially applicable current SWGDE publications include but are not limited to: 2016-02-08 SWGDE Training Guidelines for Video Analysis, Image Analysis & Photography; 2015-02-05 SWGDE Establishing Confidence in Digital Forensic Results by Error Mitigation Analysis; and 2015-09-29 SWGDE Best Practices for the Forensic Use of Photogrammetry.

RECOMMENDATION 6: Analysts should take precautions to protect against confirmation bias by not considering task-irrelevant information or information regarding the height of the suspect before performing the video analysis.

RECOMMENDATION 7: In light of its prevalence in our criminal courtrooms and the concerns highlighted in this particular case, the Commission requests that its Licensing Advisory Committee determine whether adding the digital and multimedia evidence as a voluntary licensure category in the forensic licensing program is practicable and what requirements, educational or otherwise, should be required to obtain a license.

RECOMMENDATION 8: To the extent the Bell County District Attorney's office still has questions regarding the forensic video analysis and subsequent reporting, the DA may consider seeking further assistance from the FBI or another qualified law enforcement forensic service provider. For cases such as this, assistance of the FBI crime laboratory in Quantico, Virginia may be requested through the local FBI office.

RECOMMENDATION 9: Advanced training in the science of video analysis is available from a number of reputable, accredited educational sources. The Commission encourages the criminal justice community to seek assistance and recommendations from these sources when they encounter a forensic video analysis case and need to retain an expert witness. A non-exhaustive list of accredited educational sources is referenced in the Fredericks Report and provided below:

1. The Law Enforcement and Emergency Services Video Association (LEVA) has a well-developed Forensic Video Analyst Certification and Forensic Video Technician Certification program. The program is accredited by the University of Indianapolis' School for Adult Learning, which houses one of the most advanced forensic video training facilities in North America. LEVA requires approximately 288 hours of advanced course work, which includes testing, peer review, and boarding before certification is granted.

2. The International Association for Identification (IAI) provides a testing mechanism for Forensic Video Examiner Certification for its members.

3. The National Center for Media Forensics at the University of Colorado at Denver offers a Master's Degree program in Digital Media and provides course work in forensic video evidence.

4. Various private companies also offer advanced training in sub-disciplines of Digital Multimedia Evidence, including: Resolution Video, DME Forensics and Imaging Forensics.

EXHIBIT A

Forensic Reconstruction Report

State of Texas v. George Robert Powell

Prepared by:

Michael A. Knox
Chief Forensic Consultant

Prepared for:

Henry Garza
District Attorney
27th Judicial District of Texas
Bell County

August 7, 2009

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Certification of Truth and Accuracy

I, Michael A. Knox, as a qualified forensic consultant, do hereby certify this report and attest to its truth and accuracy to the best of my knowledge and ability. The conclusions made herein are my own, have been formed objectively, and have not been made under duress or promise of pecuniary benefit.

Michael A. Knox, Forensic Consultant

Materials Considered in This Analysis

As part of my analysis, I was supplied the following materials relevant to the crime scene reconstruction of this case:

1. The incident/investigation report prepared by the Killeen Police Department;
2. The surveillance video taken at the time of the robbery;
3. Additional video and photographs provided by Investigator Raymond Jacobs; and,
4. Additional measurements of the scene provided by Investigator Raymond Jacobs (at my request).

During the course of my analysis, I employed the use of the following computer software:

1. CadZone diagramming software;
2. PhotoModeler photogrammetry software; and,
3. Google SketchUp three-dimensional modeling software.

Analysis

In order to determine the height of the suspect shown in the surveillance video, a still photograph was obtained from the video showing the suspect at the moment that he passed through the doorway as he exited the business.

Figure 1. Photograph showing the suspect as he was passing through the plane of the doorway.

Measurements of the doors were used to prepare a scale diagram, which was mapped over the photograph using photogrammetry software.

Figure 2. The scale diagram of the doors was mapped over the photograph.

Because the suspect in the photograph is in the plane of the doorway, his outline was mapped using the photogrammetry software.

Figure 3. The suspect's outline was mapped on the plane of the doorway.

The complete model with the suspect's outline was exported, and a 3-dimensional model of the scene was created.

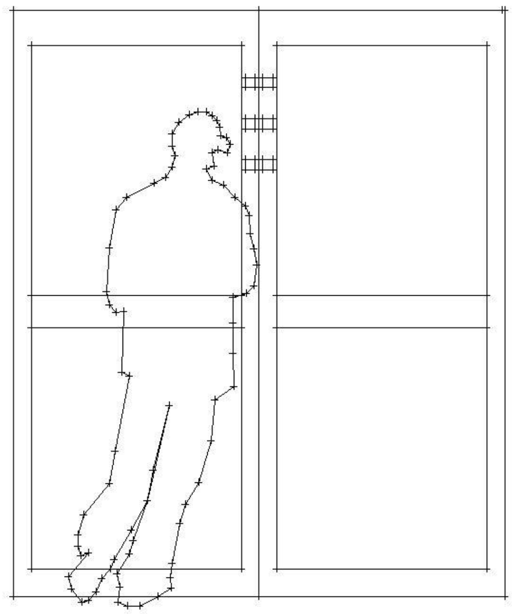

Figure 4. The mapped outline of the suspect was added to the scale diagram.

The model was then used both to obtain the suspect's height and to create a demonstrative video showing how the perspective of the camera affects the appearance of the suspect's height in the surveillance video.

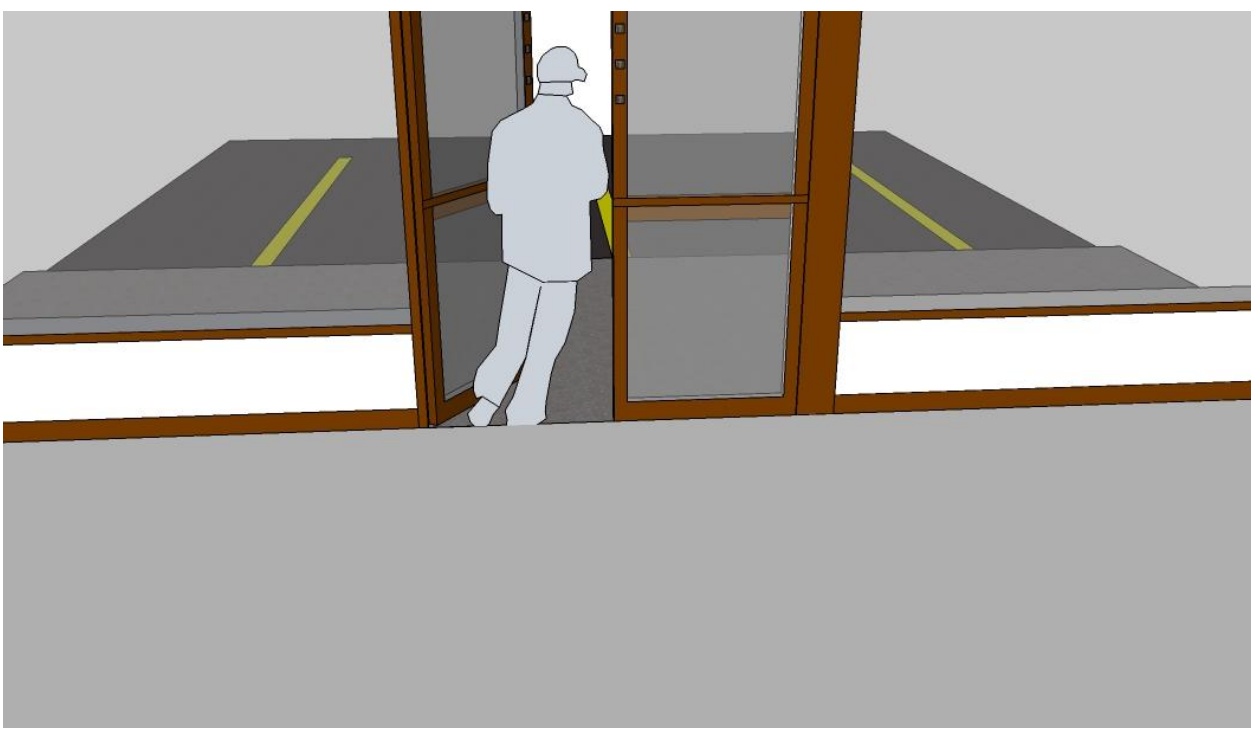

Figure 5. Three-dimensional model showing the approximate view of the camera.

Figure 6. View of three-dimensional model with camera perspective removed.

It is important to note that the suspect's body is leaning to the right in the photograph, which means that his height cannot be measured accurately by taking a vertical measurement. Instead, his height must be measured along the diagonal axis from the top of his head to the bottom of his right foot.

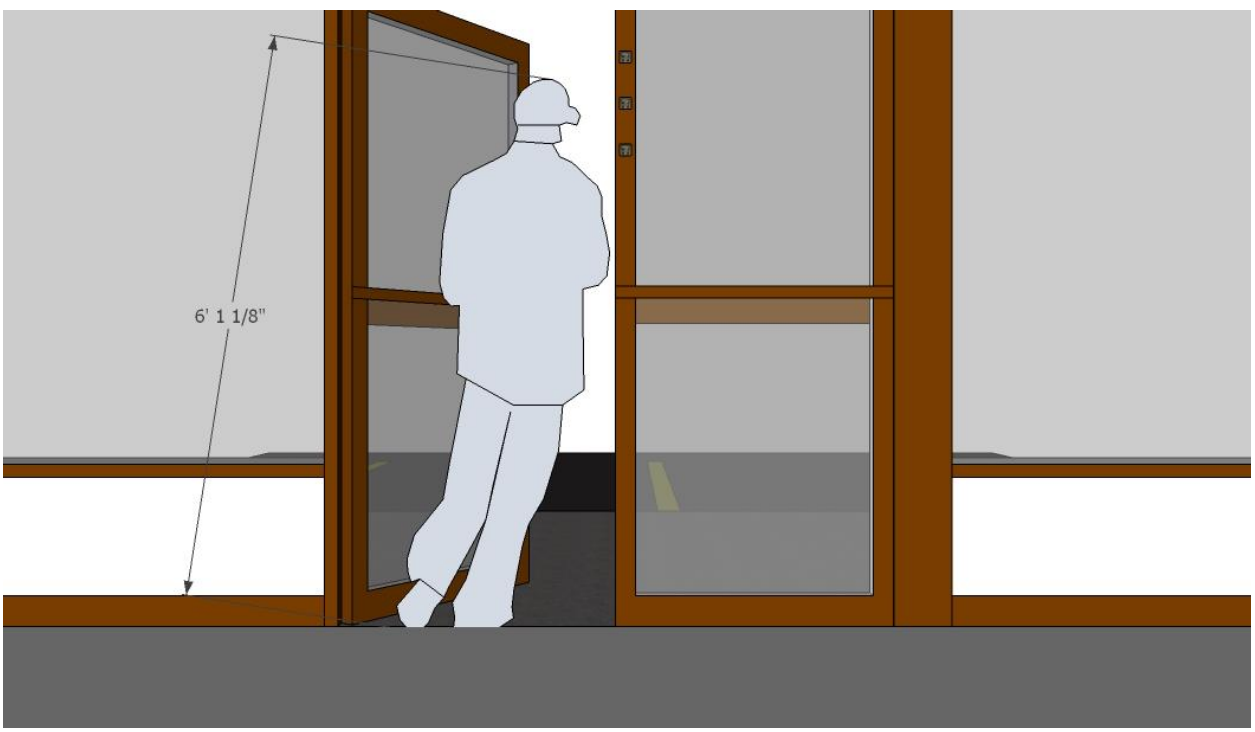

Figure 7. The suspect's height measured along the axis of his rightward lean.

This measurement is slightly over 6’1”, which is the minimum height of the suspect in the video. While it is not possible for the suspect to be any shorter than 6’1”, it is important to note that he is also leaning slightly forward as seen from the perspective of the camera behind the cashier’s area. This forward lean also serves to make the suspect appear shorter than he really is.

Opinion

Based upon my analysis in this case, it is my professional opinion that the suspect shown in the surveillance video is at least 6’1” tall.

Michael A. Knox
CURRICULUM VITAE

Contact Information:

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http://www.knoxandassociates.com/

Occupation: **Forensic Consultant**

Areas of Specialty:

- Traffic Accident Investigation, Analysis, & Reconstruction
- Crime Scene Reconstruction
- Shooting Incident Reconstruction
- Bloodstain Pattern Analysis

Summary of Qualifications:

- 15 Years Sworn Law Enforcement
- Florida Certified Criminal Justice Instructor (CJSTC) for General Subjects and Firearms
- Extensive Teaching and Presentation Experience
- Investigated/Reconstructed Hundreds of Traffic Crashes Including Approximately 100 Fatal/Life-Threatening Traffic Crashes
- Handled 350+ Forensic Death Scene Investigations
- Court-qualified Expert Witness in Bloodstain Pattern Analysis, Shooting Incident Reconstruction, & Crime Scene Reconstruction

Accreditation:

04/01 - Present **Traffic Accident Reconstructionist**
Accreditation Commission for Traffic Accident Reconstruction #1120

Professional Associations & Affiliations:

- National Association of Traffic Accident Investigators & Reconstructionists #536
- Society of Automotive Engineers
- International Crime Scene Investigators Association
- International Association of Bloodstain Pattern Analysts #3535

Education:

All Coursework Completed - Graduation Pending Completion of Foreign Language Requirement

Bachelor of Science in Mechanical Engineering
University of North Florida (Senior Standing)

Coursework Includes: statics, dynamics, mechanics of materials, thermodynamics, heat transfer, engineering statistics, engineering economics, robotics, finite element modeling, system dynamics, controls, computer-aided drawing, solid modeling, machine design, and computational methods.

Software Used: AutoCAD, MATLAB, Pro/Engineer, Mathcad, NX I-DEAS 6, LabView

Senior Design Project: Design of "Green Shuttle System" for the university's current parking shuttle bus demands; worked specifically in the area of current system research to include instrumentation and data collection on current buses within the system.

Completed 12/00 **Associate of Arts Degree (General College)**
Florida Community College at Jacksonville

Completed 12/00 **Associate of Science in Criminal Justice Technology**
Florida Community College at Jacksonville

Professional Experience:

04/08 – Present **KNOX & ASSOCIATES, LLC**
Jacksonville, Florida
President and Chief Forensic Consultant

01/04 – 10/09 **EAGLE CRIME SCENES, INC.**
Glen St. Mary, Florida
Associate Instructor for Crime Scene Training Programs

04/09 - Present **INSTITUTE OF POLICE TECHNOLOGY & MANAGEMENT**
Jacksonville, Florida
Adjunct Instructor for Crime Scene and Traffic Accident Courses

12/94 - Present **OFFICE OF THE SHERIFF**
Jacksonville, Florida

- Detective, Traffic Homicide Unit (02/07 – Present)
- Detective, Crime Scene Unit (05/00 – 02/07)
- DUI Enforcement Officer (04/97 – 04/99)
- Patrol Officer (12/94 – 04/97, 04/99 – 05/00)

Traffic Crash Reconstruction and Related Training:

10/09 **Collision Reconstruction Using PhotoModeler**
Eos Systems, Inc., 24 hours

04/08 **Advanced Roadside Impaired Driving Enforcement**
Institute of Police Technology and Management, 16 hours

09/07 **Traffic Engineering for Police**
Institute of Police Technology and Management, 16 hours

03/07 **Methodology and Techniques of Crash Data Retrieval**
Institute of Police Technology and Management, 24 hours

05/04 **Applied Physics for Traffic Accident Reconstruction**
Institute of Police Technology and Management, 40 hours

08/01 **Scene Mapping Using Speed Lasers**
Institute of Police Technology and Management, 40 hours

06/99 **Interviewing Techniques for the Traffic Accident Investigator**
Institute of Police Technology and Management, 24 hours

02/99 **Traffic Accident Reconstruction**
Institute of Police Technology and Management, 80 hours

08/98 **Motorcycle Accident Investigation**
Institute of Police Technology and Management, 40 hours

08/98 **Pedestrian and Bicycle Accident Investigation**
Institute of Police Technology and Management, 40 hours

08/98 **Investigation & Inspection of Commercial Vehicle Accidents**
Institute of Police Technology and Management, 40 hours

04/98 **Advanced Traffic Accident Investigation**
Institute of Police Technology and Management, 80 hours

General Law Enforcement Training:

05/94 **Basic Law Enforcement**
St. Augustine Criminal Justice Training Center, 762 hours

01/94 **Police Officer Indoctrination Training**
Northeast Florida Criminal Justice Training Center, 200 hours

11/94 **Street Survival Seminar**
Calibre Press, Inc., Myrtle Beach, NC, 24 hours

11/94 **Street Gangs: Identification and Investigation**
Institute of Police Technology and Management, 40 hours

03/95 **Concealment Areas Within a Vehicle**
Institute of Police Technology and Management, 16 hours

05/95 **Case Preparation and Courtroom Presentation**
Northeast Florida Criminal Justice Training Center, 40 hours

10/95 **Advanced Report Writing and Review**
Northeast Florida Criminal Justice Training Center, 40 hours

02/96 **Criminal Patrol Drug Enforcement**
Institute of Police Technology and Management, 40 hours

03/97 **Investigative Interview**
Northeast Florida Criminal Justice Training Center, 40 hours

Papers, Articles, and Publications:

Crime Scene Reconstruction: A 21st Century Approach. Current writing project. Authoring textbook on crime scene reconstruction. Expected completion sometime late 2009 or early 2010.

Crime Scene Processing. Co-authored electronic book on crime scene processing. Authored material on bloodstain pattern analysis, shooting incident reconstruction, and crime scene reconstruction, May 2008. (http://www.eaglecsi.com/)

Crime Scene Reconstruction of Shooting Incidents. Paper prepared as course material for shooting incident reconstruction course, March 2007.

Bloodstain Pattern Evidence at Crime Scenes. Paper prepared as course material for bloodstain pattern evidence course, June 2005.

A Primer on the Investigation and Reconstruction of Impaired Driving

09/02 **Crime Scene Reconstruction**
Institute of Police Technology and Management, 40 hours

11/01 **Hazardous Materials/Weapons of Mass Destruction Training**
Jacksonville Regional Fire-Rescue Training Center, 40 hours

07/01 **Light Energy Applications for Law Enforcement**
Institute of Police Technology and Management, 24 hours

11/00 **Crime Scene Processing Workshop**
Institute of Police Technology and Management, 40 hours

10/00 **Crime Scene Techniques for Buried Bodies and Surface Skeletons**
Institute of Police Technology and Management, 40 hours

01/96 **Basic Evidence Technician**
Northeast Florida Criminal Justice Training Center, 40 hours

Criminal Justice Instructor Training:

06/05 **Firearms Instructor**
Northeast Florida Criminal Justice Training Center, 44 hours

07/04 **Vehicle Operations Instructor**
Northeast Florida Criminal Justice Training Center, 40 hours

06/03 **Field Training Officer**
Northeast Florida Criminal Justice Training Center, 40 hours

04/02 **Instructor Techniques**
Northeast Florida Criminal Justice Training Center, 80 hours

02/01 **DUI Instructor Update**
Institute of Police Technology and Management, 16 hours

03/99 **Police Traffic Radar Instructor**
Institute of Police Technology and Management, 40 hours

05/97 **Mobile Videotaping Instructor Course**
Institute of Police Technology and Management, 40 hours

08/96 **DUI Instructor Course**
Institute of Police Technology and Management, 40 hours

11/94 **Verbal Judo: Train the Trainer**
Institute of Police Technology and Management, 40 hours

02/98 **Traffic Homicide Investigation**
Northeast Florida Criminal Justice Training Center, 40 hours

01/98 **AlcoSensor IV Portable Breath Testing Operator**
Office of the Sheriff, Jacksonville, Florida, 3 hours

06/97 **Traffic Enforcement's Role in Community Policing**
Institute of Police Technology and Management, 8 hours

04/97 **At-Scene Traffic Accident/Traffic Homicide Investigation**
Institute of Police Technology and Management, 80 hours

Numerous **Special Problems in Traffic Accident Reconstruction**
Institute of Police Technology and Management

08/96 **DUI Case Preparation and Courtroom Testimony**
Institute of Police Technology and Management, 40 hours

07/96 **8th Annual Symposium on Drug and Alcohol Enforcement**
Institute of Police Technology and Management, 20 hours

06/96 **In-Car Video Requirements for DUI Enforcement**
Institute of Police Technology and Management, 8 hours

05/96 **Radar Speed Measurement**
Northeast Florida Criminal Justice Training Center, 40 hours

05/96 **DUI Detection and Standardized Field Sobriety Testing**
Institute of Police Technology and Management, 24 hours

Crime Scene Investigation Training:

11/06 **Homicide Investigation**
Institute of Police Technology and Management, 40 hours

10/06 **Advanced Bloodstain Pattern Analysis**
Institute of Police Technology and Management, 40 hours

09/06 **Crime Scene Reconstruction of Shooting Incidents**
Institute of Police Technology and Management, 40 hours

02/05 **Digital Photography for Law Enforcement**
Institute of Police Technology and Management, 24 hours

04/03 **Bloodstain Pattern Analysis**
Institute of Police Technology and Management, 40 hours

Collisions. Paper prepared for Special Problems Y2K, Institute of Police Technology and Management, May 2000.

"Who Cares About Blood Alcohol Levels?" JSO Patrol News. January 2000.

"Eight Tips for Surviving Field Sobriety Exercises." Southern Lawman Magazine. Volume 2, number 2. Summer 1999.

Presentation and Instructional Experience:

08/03 – 02/07 **Crime Scene Unit Training Coordinator**
Responsible for in-house training of 27 investigators. Conducted training on such topics as computerized crime scene diagramming, fingerprint processing, death investigations, bloodstain pattern analysis, bullet trajectory reconstruction, crime scene reconstruction, tire & footwear impression evidence, general crime scene investigation procedures, blood & biological evidence handling, forensic mapping, and many other topics. Served as subject matter expert in matters relating to crime scene investigations.

COURSES TAUGHT (EAGLE CRIME SCENES, INC., & IPTM)

09/09 **Bloodstain Pattern Evidence at Crime Scenes**
St. Augustine Criminal Justice Academy, 40 hours
St. Johns River Community College, Orange Park, FL

06/09 **Scenario Based Crime Scene Processing Exercises**
Institute of Police Technology and Management, 21 hours
Connecticut State Police Academy, Meriden, CT

04/09 **Crime Scene Reconstruction of Shooting Incidents**
Institute of Police Technology and Management. Presented 4-hour block for American Criminal Justice Association National Conference

03/07 **Crime Scene Reconstruction of Shooting Incidents**
Northeast Florida Criminal Justice Training Center, 40 hours

10/05 **Bloodstain Pattern Evidence at Crime Scenes**
Northeast Florida Criminal Justice Training Center, 40 hours

06/05 **Bloodstain Pattern Evidence at Crime Scenes**
Northeast Florida Criminal Justice Training Center, 40 hours

02/05 **Crime Scene Photography**
Eagle Crime Scenes, Inc., Valdosta, Georgia, 40 hours

02/04 **Basic Crime Scene Processing Techniques**
Northeast Florida Criminal Justice Training Center, 40 hours

02/04 **Shooting Incident Reconstruction**
Jacksonville Sheriff's Office Crime Scene Unit, 40 hours

01/04 **Bloodstain Pattern Analysis**
Jacksonville Sheriff's Office Crime Scene Unit, 40 hours

09/03 **Basic Crime Scene Investigations Procedures**
Jacksonville Sheriff's Office Crime Scene Unit, 50 hours

04/03 **Bullet Trajectory Reconstruction**
Jacksonville Sheriff's Office Crime Scene Unit, 20 hours

07/02 **Crime Scene Procedures for Police Recruits**
Northeast Florida Criminal Justice Training Center, 2 hours

04/02 **Crime Scene Procedures for Police Recruits**
Northeast Florida Criminal Justice Training Center, 2 hours

05/00 **Investigation and Reconstruction of Impaired Driving Collisions**
Institute of Police Technology and Management, Jacksonville, Florida
Presented two breakout sessions at the Special Problems in Traffic Accident Reconstruction Seminar.

AGENCIES TAUGHT

- Jacksonville (FL) Sheriff's Office
- Jacksonville Beach (FL) Police Department
- Atlantic Beach (FL) Police Department
- St. Johns County (FL) Sheriff's Office
- St. Augustine (FL) Police Department
- Jacksonville (FL) Port Authority Police Department
- Mayport (FL) Naval Station Police Department
- Clay County (FL) Sheriff's Office
- Orange Park (FL) Police Department
- Florida Highway Patrol
- Columbia (TN) Police Department
- Grady County (GA) Sheriff's Office
- Bibb County (GA) Sheriff's Office
- Turner County (GA) Sheriff's Office
- Savannah-Chatham County (GA) Metro Police Department
- Aiken (SC) Police Department
- Connecticut State Police
- Connecticut EnCon Police
- Danbury (CT) Police Department
- Monroe (CT) Police Department

- New Britain (CT) Police Department
- New Haven (CT) Police Department
- Plainfield (CT) Police Department
- Wallingford (CT) Police Department
- West Haven (CT) Police Department

PUBLIC SERVICE APPEARANCES

02/07 to Present **Television News Appearances**
Made numerous television news appearances in reference to fatal or life-threatening traffic crash investigations; responsible for providing all initial on-scene information to members of the television and print media.

02/04 **Crime Scene Investigations Presentation**
Mandarin High School
Presented crime scene investigations information to approximately 60 high school forensic science students.

08/03 **Radio Talk Show Broadcast, Crime Scene Investigations**
WJGR 1320 AM, Jacksonville, Florida
Appeared as guest on hour-long Justice Coalition radio show

08/02 **Crime Scene Investigations Presentation**
Mandarin High School
Presented crime scene investigations information to approximately 60 high school forensic science students.

11/01 **Crime Scene Investigations Presentation**
Darnell Cookman Middle School
Presented crime scene investigations information to approximately 100 8th grade gifted science students.

11/98 **Impaired Driving Seminar**
United States Navy, Cecil Field, Jacksonville, Florida
Presented anti-drinking and driving material for members of the navy.

07/98 **Television News Broadcast, Impaired Driving Enforcement**
ABC Channel 25 News, Jacksonville, Florida
Appeared on news broadcast discussing impaired driving enforcement.

07/98 **Television News Broadcast, Underage Drinking and Driving**
ABC Channel 25 News, Jacksonville, Florida
Presented material on portable breath testing instruments.

Courtroom & Deposition Testimony Experience:

Circuit Court, 4th Judicial Circuit, *Jacksonville, Florida*
Testified in major crimes cases on matters of crime scene investigation; photography; latent fingerprint processing; firearms operation and testing. Testified on impaired driving/serious bodily injury; hearings on motions; provided technical testimony on field sobriety exercises; deposed for civil litigation; deposed in numerous criminal cases. Provided technical testimony, both in court and in deposition, regarding bullet trajectory reconstruction, bloodstain pattern analysis, luminol presumptive blood testing & processing, and crime scene processing procedures.

County Court, Duval County, *Jacksonville, Florida*
Testified in numerous impaired driving trials and hearings on motions; provided technical testimony about field sobriety exercises.

Department of Highway Safety and Motor Vehicles
Bureau of Driver Improvement, Jacksonville, Florida
Testified in numerous driver license suspension administrative hearings.

EXPERT WITNESS QUALIFICATIONS & TESTIMONY:

Connie Cornelius v. Wes Brown and Steve Smith, United States District Court, Northern District of Alabama, Jasper Division, Case No. 6:06-CV-2271-VEH. Provided expert analysis for defense in wrongful death case of police-involved shooting incident. Plaintiff's failed to depose prior to deadline. Testified at trial as expert witness in crime scene reconstruction. Jury trial resulted in verdict for the defense.*

State v. Jerry Alto Smith, Circuit Court, 4th Judicial Circuit of Florida, Duval County, Case No. 16-2008-CF-008429-AXXX-MA. Provided expert testimony at deposition regarding observations made from blood spatter evidence on the victim's arm and clothing in a shooting death, November 2008. Explained the meaning of the spatter evidence with regard to position of arm and head. Testified at trial on cross-examination as to these observations, but was not tendered as an expert witness, June 2009.**

Holly Garrett v. Bob Evans Concrete Construction, Inc., and Hiram Johnson, 4th Judicial Circuit of Florida, Duval County, Case No. 16-2008-CA-001399-XXXX-MA. Retained as expert witness by plaintiff's counsel (Coker, Shickel, Sorenson & Posgay) and performed analysis of traffic accident case involving personal injury to the plaintiff. Case settled shortly after report was submitted. No testimony required. March 2009.*

State v. Kary Key, Circuit Court, 4th Judicial Circuit of Florida, Duval County, Case No. 16-2008-CF-017878-AXXX-MA. Performed traffic crash reconstruction of single-motorcycle crash involving the DUI manslaughter of the passenger. Testified at deposition with regard to motorcycle speed and dynamics of the crash, 2009. Defendant pled guilty prior to trial.**

State v. Vicki Mullins, Circuit Court, 4th Judicial Circuit of Florida, Duval County, Case No. 16-2008-CF-013242-AXXX-MA. Performed extensive traffic accident reconstruction in case involving single-vehicle DUI manslaughter of passenger. Provided expert testimony at deposition as to the dynamics of the crash and vehicle speed analysis. Trial still pending.**

State v. Rasheem Dubose, Circuit Court, 4th Judicial Circuit of Florida, Duval County, Case No. 16-2006-CF-018285-AXXX-MA. Performed extensive trajectory reconstruction on scene in which multiple shooters fired at least 29 shots at a house. One shot killed an eight-year-old girl inside the house. Traced the shot that actually struck and killed the victim. Provided expert testimony at deposition, 2008. Trial still pending.**

State v. Joshua Charles, Circuit Court, 4th Judicial Circuit of Florida, Duval County, Case No. 16-2007-CF-006602-AXXX-MA. Performed bullet trajectory analysis and shooting incident reconstruction in case involving drive-by shooting of off-duty IRS agent. Provided expert testimony at deposition, September 2007. Testified at trial as to this analysis but was not tendered as an expert witness, June 2008.**

State v. Jay Blanchard, Circuit Court, 4th Judicial Circuit of Florida, Duval County, Case No. 16-2007-CF-001003-AXXX-MA. Performed crime scene reconstruction based on bloodstain pattern analysis in case involving the stabbing of the victim, who was seated in the driver's seat of a vehicle, by the defendant, who was seated in the front passenger seat. Analysis performed from photographs and documentation. Provided expert testimony at deposition, 2008. Defendant pled guilty prior to trial.**

Melanie Willis v. Gibson Truck & Equipment Co., Inc., et al, 4th Judicial Circuit of Florida, Duval County, Case No. 16-2007-CA-009854-XXXX-MA. Investigated life-threatening traffic crash that involved personal injury to the plaintiff. Provided expert-level testimony at videotaped deposition regarding the investigation and circumstances surrounding the crash, May 2008.**

State v. Robert Shelton, Circuit Court, 4th Judicial Circuit of Florida, Duval County, Case No. 16-2006-CF-009545-AXXX-MA, May 7, 2008. Testified as expert witness in the areas of Bloodstain Pattern Analysis, Shooting Incident Reconstruction, and Crime Scene Reconstruction in case of, before Judge Linda McCallum. The case involved the shooting death of a woman who was shot and killed by her husband who claimed self-defense. Testimony related to the approximate location of the victim when both gunshot wounds were inflicted, as well as the approximate

State v. John Mills, Circuit Court, 4th Judicial Circuit of Florida, Duval County, Case No. 16-2002-CF-011100-AXXX-MA, April 2003. Appointed as expert witness to conduct bullet trajectory analysis on behalf of insolvent defendant by Judge Henry Davis. Case involved defendant's claim that bullet holes documented at the time of the incident were actually from a previous incident and were fire toward the residence, not toward the street as the prosecution alleged. Determined through analysis that bullet holes were from shots fired toward the street and traced trajectories. Testified at trial as prosecution rebuttal witness, July 2003. **

State v. Carlton Lumpkins, Circuit Court, 4th Judicial Circuit of Florida, Duval County, Case No. 16-2002-CF-011749-AXXX-MA. Performed shooting reconstruction in case involving two shooters firing into a vehicle and killing a woman and two young boys. Provided expert testimony at deposition, 2003. Prosecution elected not to present the trajectory evidence at trial.**

State v. Christopher Thompson, Circuit Court, 4th Judicial Circuit of Florida, Duval County, Case No. 16-2002-CF-008178-AXXX-MA. Performed bloodstain pattern analysis and crime scene reconstruction in case involving the stabbing death of two people in their apartment. Determined through analysis that the defendant forced the male victim into the corner of the living room and stabbed him multiple times while in that area. Provided expert testimony at deposition, 2002. Defendants pled guilty before trial.**

** Denotes paid private-sector case.*
*** Denotes law enforcement case performed as detective with the Jacksonville Sheriff's Office.*

Awards and Recognition:

08/07, 10/08 **Heart of MADD Award** received collectively as a member of the Traffic Homicide Unit for outstanding victim support.

10/06 **Nomination for Officer of the Month** from Sgt. M. Monroe for reconstruction of police-involved shooting.

06/06 **Officer of the Month** Nominated by Sgt. T. C. Davis for crime scene reconstruction of brutal murder.

01/04 **Nomination for Officer of the Month** from Sgt. G. H. Davis for performance while in the Crime Scene Unit.

11/03 **Letter of Commendation** from Lt. M. S. Richardson for processing of homicide scene.

direction from which the shot was fired. Reconstruction was performed at the scene.**

State v. Ronnie Grimes, Circuit Court, 4th Judicial Circuit of Florida, Duval County, Case No. 16-2007-CF-017745-AXXX-MA. Performed traffic crash reconstruction with regard to DUI manslaughter case in which driver of pickup truck lost control and crossed the center line striking and killing a motorcyclist. Provided expert testimony at deposition as to the dynamics of the crash and establishing that, contrary to defense claims, the motorcyclist did not cross the center line. Defendant pled guilty before trial.**

State v. Kimberly Davis, Circuit Court, 4th Judicial Circuit of Florida, Duval County, Case No. 16-2007-CF-008315-AXXX-MA. Performed traffic crash reconstruction with regard to DUI manslaughter case in which driver of SUV ran red light and struck another vehicle broadside killing the driver. Provided expert testimony at deposition with regard to vehicle speeds and analysis of the condition of the traffic signal at the time of the collision. Defendant pled guilty before trial.**

State v. Steven Montgomery, Circuit Court, 4th Judicial Circuit of Florida, Duval County, Case No. 16-2005-CF-014980-AXXX-MA. Performed extensive crime scene reconstruction from bloodstain patterns and other evidence. Case involved beating death in which the defendant claimed self defense. Provided expert testimony at deposition for a period in excess of eight hours. Testified at trial regarding observations of bloodstain pattern evidence; however, through agreement with defense counsel, the prosecutor elected not to tender as expert witness to avoid protracted cross-examination, July 2007.**

State v. Jerrod Collins, Circuit Court, 4th Judicial Circuit of Florida, Duval County, Case No. 16-2005-CF-015344-AXXX-MA, May 17, 2007. Testified as expert witness in the areas of Crime Scene Reconstruction and Bloodstain Pattern Analysis before Judge Mallory Cooper. The case involved the shooting death of Jason Barber who was shot and killed while seated in a vehicle. Testimony related to the position of Jason Barber when he sustained several gunshot wounds, as well as the directions from which the three shots were fired. Reconstruction was performed from photographs and documentation.**

State v. Robert Snyder, Circuit Court, 4th Judicial Circuit of Florida, Duval County, Case No. 16-2003-CF-013754-AXXX-MA. Developed impression of human body using luminol at the scene of a homicide in which the defendant killed and dismembered his girlfriend. Provided expert-level testimony on luminol during a hearing on a motion to suppress the luminol evidence although not tendered as an expert. Testified at trial regarding the luminol evidence, April 2005.**

07/03 **Letter of Commendation** from Sgt. D. R. Justice for processing of homicide scene.

06/02 **Letter of Commendation** from Sgt. G. H. Davis for processing of homicide scene.

04/02 **Certificate of Commendation,** Office of the Sheriff, Jacksonville, Florida for performance during a homicide investigation.

02/02 **Letter of Commendation** from Sgt. J. A. Parker for processing of homicide scene.

09/00 **Letter of Commendation** from Sgt. G. H. Davis for participation in the handling of numerous crime scene processing calls.

10/97 **Letter of Commendation** from Lt. J. G. Coxen regarding participation in traffic control for a major fire incident.

08/96 **Letter of Commendation** from Lt. J. C. Boney regarding participation in a crowd control incident.

03/96 **Letter of Commendation** from Sgt. M. L. Remolde regarding performance in felony arrest.

01/96 **Letter of Commendation** from Lt. J. R. Ross regarding performance in a vehicle pursuit.

DECLARATION OF PROFESSOR AL YONOVITZ, Ph.D.

"I, Al Yonovitz, declare that: I am over the age of eighteen, of sound mind, have never been convicted of a felony or crime of moral turpitude, and am competent to make this Declaration. All facts recited in this Declaration are within my personal knowledge and are true and correct.

"Yonovitz & Joe, L.L.P., a registered partnership based in Dallas, Texas, is a team of forensic audio/video analysts, experts and consultants. We have been forensic audio/video experts for over sixty combined years. Our diverse legal, forensic, academic, research and clinical experience includes scientifically objective, verifiable and generally accepted analyses of audio and video evidence including, but not limited to, the forensic authenticity analyses of audio or video evidence, voice/speaker identification or elimination via aural-acoustic-spectrography, digital enhancement of audio or video recordings, transcription development and verification, etc. We have been retained in thousands of cases involving thousands of recordings throughout the U.S., Canada, Mexico, the United Kingdom, India, Sri Lanka, Australia, Singapore and the United Arab Emirates, and have testified in state and Federal courts in civil, criminal and administrative matters throughout the U.S., as well as overseas. Representative clients include Steptoe & Johnson (Washington, D.C.), Shearman & Sterling (NYC), Simpson Thacher & Bartlett (NYC), Mesereau & Yu (Los Angeles), Armstrong Teasdale (Kansas City), Ford & Harrison (Memphis), Rawle & Henderson (Philadelphia), McAfee & Taft (OKC), Bracewell & Patterson (Houston), Akin Gump (San Antonio), Jones Day (Dallas), Haynes & Boone (Houston), Thompson & Knight (Dallas), Vinson & Elkins (Dallas), Jenkens & Gilchrist (Dallas), Wal-Mart Stores, Inc., Georgia-Pacific, LLC, Costamare Shipping Inc., Motorola Corp., Vivint, Inc., BankOne, BlueCross Blue-Shield, Shell Oil Co., United Parcel Service, Inc., Shell Texaco & Saudi Refineries, Inc., Reliant Energy, 7-Eleven, Inc., Evercom Systems, Inc., Abu Dhabi (United Arab Emirates) Judicial Department, U.S. Attorney's Office (NM), Mississippi Attorney General's Office, Harris County (Houston) Attorney's Office, Harris County Sheriff's Office, City of Austin, City of San Angelo, City of Galveston, Plano (TX) and Akron (OH) Police Depts., Dallas, Maricopa (Phoenix), Tulsa (OK), Harris (Houston), Fulton (GA) and Summit (OH) County DA's Offices, Washington D.C., Houston, Little Rock, South Dakota, DuPage County (IL), Green County (PA), New Mexico, New Hampshire and New Jersey Public Defender's Offices, Kentucky Department of Public Advocacy, Louisiana Capital Assistance Center, Oklahoma Indigent Defense System, the Associated Press (AP), ABC, BBC, FOX-TV, etc. High profile cases include the *Branch Davidian* case; consultations include TMZ, *CSI:Miami* and *People* Magazine and recent speaking engagements include the 2002, 15th Annual Criminal Litigation Seminar, the 2003 annual convention of the American Speech & Hearing Association, the 2004 26th World Congress of the International Association of Logopedics and Phoniatrics, the 2005 annual conference of the Center for International Legal Studies, the 2005 3rd Annual Forensics Seminar, the 2006 4th Annual Forensics Seminar, the 2007 annual meeting of the North Carolina Bar Association, the 2007 5th Annual Forensics Seminar, the 2008 6th Annual Forensics Seminar, the 2009 Spring Meeting of the Forensic Expert Witness Association, the 2009 7th Annual Forensics Seminar, the 2010 8th Annual Forensics

Seminar, the 2010 2nd Pan American/Iberian Meeting on Acoustics (Cancún), the 2011 9th Annual Forensics Seminar, the 2011 annual meeting of the American Speech & Hearing Association, the April 2012 annual meeting of the Utah Association of Criminal Defense Lawyers, the 2012 Summer Meeting of the Forensic Expert Witness Association, the 2012 10th Annual Forensics Seminar, the 164th Annual Meeting of the Acoustical Society of America, the 2013 11th Annual Forensics Seminar, the 2013 annual meeting of the American Speech & Hearing Association and the 166th Annual Meeting of the Acoustical Society of America. Some forensic voice ID clients include Georgia-Pacific, LLC, Blue Cross Blue Shield Texas, Maricopa (Phoenix) County DA's Office, Fulton (Atlanta) County DA's Office, Summit (Akron, OH) County DA's Office, New Jersey Public Defender's Office, City of San Angelo, Public Prosecution Office of Abu Dhabi Judicial District (United Arab Emirates), the Associate Press, Dr. Phil, TMZ, People Magazine, ABC, BBC, FOX, etc.

"I am the senior partner of Yonovitz & Joe, L.L.P., a team of forensic audio/video analysts, experts and consultants. My 40 years of teaching and research include appointments at the Speech and Hearing Institute, Graduate School of Biomedical Sciences, and the School of Public Health at the University of Texas Health Science Center, Houston; Baylor College of Medicine; Department of Biomedical Engineering at the University of Houston; Conley Speech and Hearing Center, University of Maine; Menzies School of Health Research; consultant to the Veterans Administration Hospital (Houston), where I conducted speech research in psychiatric patients; Director of the Electronic Prosthesis Laboratory, Mansfield Training School; former member of the certification and standards committee of the International Association of Identification (IAI). I have authored over 100 publications or paper presentations, as well as over 30 grants. I am currently a Professor of the Speech and Hearing Sciences, Dean of Research Facilitation and former Chair of the Department of Communicative Sciences and Disorders at the University of Montana. Recent expert testimony in forensic voice ID cases include *State of Arizona vs. Bradley Tocker* (for the State; conviction), Bond Hearing in *State of Florida vs. Oscar Duran* (for the defense, bond granted), federal investigation of judicial department for the Public Prosecution Office of the Abu Dhabi Judicial Department of the United Arab Emirates (for the Government, sanctions granted), and consulting voice experts for the defense in *State of Florida vs. George Zimmerman*.

"Recent and relevant undergraduate and graduate courses that I have or am teaching include Auditory Systems and Disorders, Audiology, Seminar in Fluency Disorders, Biomedical Instrumentation, Industrial Audiometry and Hearing Conversation, Computer Applications in Speech Pathology and Audiology, Hearing and Speech Science, Research Methods in Speech Pathology and Audiology, Physiological and Psychological Acoustics, Special Topics: Middle Ear Mechanics, Special Topics: Audiometry with the Difficult to Test, Special Topics: Measurement of Voice, Hearing Impairment, Anatomy of the Speech and Hearing Mechanism, Aural Rehabilitation, Speech Science, Introduction to Audiology, and Audition. I am actively involved in academic, clinical and forensic research related to forensic voice identification. The result of some of my clinical/forensic research, *see, e.g.*, Yonovitz, A., Joe, H. *Speaker*

Identification: Effects of noise, bandwidth, and word count on accuracy, Journal of the Acoustical Society of America, Vol. 128, No. 4, Pt. 2 of 2, Oct. 2010, was presented at the 2nd Pan American/Iberian Meeting on Acoustics, Cancún, Mexico, Nov. 2010.

"We were retained on behalf of Mr. George R. Powell, III, an inmate at the Huntsville (TX) Correctional Institution, to 1) perform a forensic voice identification/ elimination analysis (described in detail below), and 2) determine the height of a particular suspect in a particular surveillance video (described in detail below). (This Declaration needs to be printed on a reliable color printer.)

"In the forensic voice identification or elimination procedures, we compared the known voice of Mr. Powell, acquired by my partner, with a particular "unknown" exemplar, provided by TX Attorney John Galligan. Specifically, Managing Partner Herbert Joe, M.A., J.D., LL.M., B.C.F.E. met with Mr. Powell at approx. 9:30A on November 20, 2013 at the Huntsville (TX) Correctional Institution. The known voice of Mr. Powell was recorded that that time. The "unknown" exemplar to compare with the actual voice of Mr. Powell was from the audio track of the QuickWave video entitled "STORE #1330 05-28-08 1121P-1123P.VID.60D" (size 15378 KB). This store that was robbed was reported as a Valero conveniences store. In that "Valero" video, the robber spoke the following:

> "Hey, how you doing?"
> "Give me the money"
> "Open the register."
> "Hurry up."
> "The money underneath."
> "Give me all your money."
> "That's it."
> "Where's the rest of it?"

These were parts of the same words, phrases and sentences spoken by Mr. Powell for his known voice sample.

"The voice samples above contain sufficient and intelligible speech materials to permit an Aural-Acoustical-Spectrographic Voice/Speaker Identification or Elimination to be carried out. Both the UNKNOWN and KNOWN exemplars were processed in a similar manner: The formant, pitch perturbation and pitch analyses were made with a Pentium IV-based computer. Appropriate anti-aliasing filters were utilized when needed. Avaaz Innovations Computerized Speech Research Environment (CSRE, signal and speech analysis software and Speech Analyzer 3.0.1) was utilized to present both time domain and frequency domain analyses, as necessary.

"The speaker identification or elimination procedure employed is one where an UNKNOWN voice is taken from an evidence recording and compared to exemplars of a KNOWN voice. In this manner, samples of a number of comparisons between the UNKNOWN and KNOWN combinations were placed in pairs or composites for direct and repeated comparisons. The Aural-Acoustic method of analysis follows the protocol and standards described in publications as well as a number of presentations to professional organizations, including the Acoustical Society of America (ASA) and the American Speech, Hearing and Language Association (ASHA). The principles of this protocol are to provide a basis for voice/speaker identification or elimination that is consistent with the known and well-established principles of the hearing, speech and language sciences.

"The Aural-Acoustic method has evolved from earlier standards developed by the International Association of Identification (IAI) (and later The American Board of Recorded Evidence (ABRE), whose standards are similar to those of the IAI). For example, section VII.B.5 of the 1996 "Voice Comparison Standards" of the Voice Identification and Acoustic Analysis Subcommittee (VIAAS) of the IAI and section 7.2.5 of the "Voice Comparison Standards" of the ABRE are entitled "Speech Characteristics". Speech and hearing scientists and phoneticians are particularly skilled in forensically assessing speech characteristics.[1] On the other hand and generally, examiners trained in spectrogram pattern matching receive little or no training in the assessment of speech characteristics.

"The Aural-Acoustical method does not rely on a spectrographic analysis as its principle bases. This aural-acoustical method uses a number of instrumental or digital signal processing procedures that delineate the microstructure of various vocal qualities or characteristics. It utilizes, with due caution, the use of these objective measures, not to overextend the conclusions that may be offered. Two publications discussing the Aural-Acoustic method at length are Hollien, *Acoustics of Crime*, Plenum, 1990, and Hollien and Hollien, *Forensic Voice Identification*, Academic Press, 2001.

"The undersigned is the lead investigator of a research team currently conducting and having conducted significant academic, clinical and forensic research on the various quantitative and qualitative requirements to conduct reliable forensic voice speaker identification or elimination via aural-acoustic-spectrographic analyses. For example, the initial results on the effects of noise, telephone bandwidth and word count on the accuracy of forensic voice identification or elimination were presented at the 2nd Pan American/Iberian Meeting on Acoustics in Cancún, Mexico, as well as a peer-reviewed publication in Yonovitz, A., Joe, H. *Speaker Identification: Effects of noise, telephone bandwidth, and word count on accuracy.* Journal of the Acoustical Society of America, Vol. 128, No. 4, Pt. 2 of 2, Oct. 2010.

"For a more detailed explanation of the appropriate methodology of forensic voice/ speaker identification or elimination, the undersigned is a co-author of a peer-reviewed article that was published in the Law Enforcement Executive Forum. This article, appended to this Declaration, entitled *Legal, Scientific and Forensic Controversies Over Spectrographic Voice Analysis for Identification or Elimination*, is

[1] See list of speech and hearing related publications, international presentations, abstracts, and undergraduate and graduate courses taught by the undersigned, whom has a doctorate (1973, University of Connecticut) in Physiological and Psychological Acoustics; the undersigned is also an associate professor of the speech and hearing sciences and is a clinical and forensic scientist.

appended to this Report. *See also, for example*, Yonovitz, A., Joe, H. *Speaker Identification: Effects of noise, telephone bandwidth, and word count on accuracy.* Journal of the Acoustical Society of America, Vol. 128, No. 4, Pt. 2 of 2, Oct. 2010.

"VOICE ID/ELIMINATION ANALYSES." The following speech features were analyzed and compiled to derive at the conclusion below:

- Articulation: Vowels/Consonants

As can be seen from the Table below, a number of observations were possible relative to the articulatory patterns observable in the KE compared with the UNE. Specifically the voices heard on both the KE and the UNE indicated dissimilarities in productions of patterned vowels and vowel prolongations. The same is also true for consonants and consonant clusters. Some confidence was placed in these categories. Values of +2 and +2.5 were determined for each variable, respectively.

- Voice Quality: Resonance/Vocal Fry/Nasality

Voice Quality encompasses the perception of the listener of the overall sound of the talker's voice. Just as different musical instruments produce different wave compositions, the human voice is similar. It is this overtone structure or timbre that can differentiate one voice from another. In this specific case the resonant pattern or voice quality was non identical between the KE and the UKE. The score of +2.0 has been assigned to this variable.

- Prosody: Rate/Melodic Pattern

The melodic patterns were dissimilar for the KE and UNE. A value of +2.0 was assigned for this variable. The speaking rate was assigned a value of +2.0

- Abnormalities: Misarticulation/Fluency

No misarticulations or fluency disorder was detected.

- Dialect:

The dialectical patterns were not significantly different, and assigned a value of +0.0.

Fundamental Frequency: Absolute/Variability

The perceived pitch is the psychophysical correlate of fundamental frequency. The fundamental frequency or the pitch of the voice was different for the KE of compared to the UNE. This was confirmed using acoustic analysis procedures. The fundamental frequency for UKE was consistently higher (AVG 190 Hz) compared to the KE (AVG 142 Hz). The frequency variability was also dissimilar for the KE and UKE.

Jitter:

Jitter is a frequency perturbation of the glottal source signal and was not assessed.

Shimmer:

Shimmer is amplitude perturbation of the glottal source signal and was not assessed.

Formant Descriptions: Steady State/Transitions

Steady state F1, F2 and F3 (when available) were assessed for a number of vowel utterances. Formant values were obtained for the KE and the UKE. These results confirmed the perceptual resonance differences that are audible from the exemplars. These differences were rated a value of +3.0.

Aural-Acoustical Spectrographic Analyses

	Most Similar Most Dissimilar -5 * *-4 * *-3 * *-2 * *-1 * * 0 * * 1 * * 2 * * 3 * * 4 * * 5
AURAL	
Articulation	
Vowels	-5 * * -4* *-3 * *-2 * *-1 * * 0 * * 1 * *▌ * * 3 * * 4* * 5
Consonants	-5 * * -4 * *-3 * *-2 * *-1 * * 0 * * 1 * * 2 *▌ * 3 * *4* * 5
Voice Quality	
Resonance	-5 * * -4 * *-3 * *-2 * *-1 * * 0 * * 1 * *▌ * * 3 * * 4* *5
Vocal Fry	-5 * *-4 * *-3 * *-2 * *-1 * * 0 * * 1 * * 2 * * 3 * * 4 * * 5
Nasality	-5 * *-4 * *-3 * *-2 * *-1 * * 0 * * 1 * * 2 * * 3 * * 4 * * 5
Prosody	
Rate	-5 * *-4 * *-3 * *-2 * * -1 * * 0 * * 1 * *▌ * * 3 * * 4 * * 5
Melodic Pattern	-5 * *-4 * *-3 * *-2 * * -1* * 0 * * 1 * *▌ * * 3 * * 4 * * 5
Abnormalities	
Misarticulations	-5 * *-4 * *-3 * *-2 * *-1 * * 0 * * 1 * * 2 * * 3 * * 4 * * 5
Fluency	-5 * *-4 * *-3 * *-2 * *-1 * * 0 * * 1 * * 2 * * 3 * * 4 * * 5
Dialect	-5 * *-4 * *-3 * *-2 * *-1 * *▌ * * 1 * * 2 * * 3 * * 4 * * 5

ACOUSTIC

Fundamental Frequency (f0)

Absolute	-5 * *-4 * *-3 * *-2 * *-1 * * 0 * * 1 * * 2 * * 3 * * 4 * * ▌
Variability	-5 * *-4 * *3 * -2 * *-1 * * 0 * * 1 * * 2 * * 3 * * ▌ * * 5
Jitter (cyclic (n/n+1) variation)	-5 * *-4 * *-3 * *-2 * *-1 * * 0 * * 1 * * 2 * * 3 * * 4 * * 5
Shimmer (cyclic (n/n+1) variation)	-5 * *-4 * *-3 * *-2 * *-1 * * 0 * * 1 * * 2 * * 3 * * 4 * * 5
Formant Descriptions	
Steady State	-5 * *-4 * *-3 * *-2 * *-1 * * 0 * * 1 * * 2 * * ▌ * * 4 * * 5
Transitions	-5 * *-4 * *-3 * *-2 * *-1 * * 0 * * 1 * * 2 * * ▌ * * 4 * * 5

"VOICE ID/ELIMINATION SUMMARY. The differences in the KNOWN and UNKNOWN exemplars are primarily in the resonance characteristics and the fundamental frequency (pitch). While some pitch change may be expected given the two tasks (KNOWN and UNKNOWN), the range of differences is very significant (<45-50 Hz). Articulation for vowels and consonants also show a marked difference for the KNOWN and UNKNOWN. The differences in the resonance of the voice when comparing the KNOWN and UNKNOWN are both available from aural and spectrographic comparison. As such, **<u>it is concluded with at least a reasonable degree of scientific certainty that there is a Probable Elimination when comparing the voice of the robber in the video described above with that of Mr. George R. Powell, III's voice.</u>**

"Height measurements. Below is a copy of "State's Exhibit 18", which is a screen grab of the "Valero" video. (Photo #1, below.)

Photo #1

We were also asked to make a determination about the height of the robber in a different video, in which the robber was reported to be robbing a "7-Eleven" convenience store #17529, Photo #2, below.

Photo #2

"The key in the reliable height measurement of the 7-Eleven robber above is that the robber is at the threshold or plane of the door and practically walking erect such that the robber's actual height is just at the top border of the middle set of height stickers.

Photo #3

The photo above (Photo #3) was taken on November 20, 2013 by Mr. Joe when he visited the same 7-Eleven store, *i.e.*, the 7-Eleven located at 1000 SWS Young Dr., Killeen, Texas. The height of the top of the 2nd or middle sticker (Photo #4, below) at the 7-Eleven store at issue relative to the floor is approximately 67¾", or 5'7¾". The 7-Eleven, Inc. Texas Zone Asset Protection Manager, whose area covers that store and was at the store with Mr. Joe, stated that there are no records about whether the set of height stickers on the 7-Eleven door on the day of the 2008 robbery (Photo #2) were the same and located in the exact same place as the set of height stickers in Photos #3 and #4.

"To determine if the sticker locations in Photos 3 and 4 are in the same location or not as on the day of the 2008 robbery (Photo #2), various measurements needed to be made and evaluated. Specifically, the distance from the lowest point on the door in Photo #2 to the metal bar used to open the door was measured, as well as the distance from that metal bar to the first sticker, and then the distance between each of the stickers. The same measurements were made relative to the door in Photo #3. Because there are differences in camera distances and angles between the two photos, the relative proportions of the above measurements are valuable.

"Each **blue number** below is an accurate measurement for Photo #3, *i.e.*, current locations of the height stickers. Each **red number** represents the relevant measurement from the photo taken during the 2008 robbery. Each **green number** is the ratio between the relevant two values. The relevant measurements[2] and ratios follow:

Handrail to floor:	**2.1** : **2.5** =	**1:1.19**
1st sticker to handrail:	**1** : **1.25** =	**1:1.25**
2nd sticker to 1st sticker:	**.35** : **.35** =	**1:1**
3rd sticker to 2nd sticker:	**.3** : **.25** =	**1:0.83**

The values above account for any differing camera angles. The distance in ratio from the lowest point of the door to the handrail compared to the distance from the handrail to the first sticker is virtually identical in both Photos 2 and 3, as are the proportionate distances of each sticker from each other. In other words, the values above substantiate that the current set of stickers (Photo #3) are in the same position as the height stickers on the night of the robbery (Photo #2). In other words, one can reliably conclude that

- the height of the top of the bottom sticker is approximately 61-15/16", or 5'1-15/16" from the floor in both photo nos. 2 and 3;

- the height of the top of the middle or 2nd set of stickers is approximately 67¾", or 5'7¾" from the floor in both photo nos. 2 and 3; and

[2] The measurement system is from Photoshop's internal system, and is accurate.

- the height of the top of the top or 3rd set of stickers is approximately 74", or 6'2" from the floor in both photo nos. 2 and 3.

- * Independent of the above measurements, but substantiating them just the same, there were relevant "Additional Officer Supplements." On page 23 of the Killeen Police Department "Incident / Investigation Report" ("OCA: 08-007971") prepared by KPD Officer Karl A. Ortiz (34864) at 16:02 hrs. on "4/21/2009," he states, in part:

> … As you face the [7-Eleven] door from inside the store, I had Detective Kaiser use a tape measure and measured from the floor to the top of three specific marking (labels) on the south front glass door. The measurements are as follows:
>
> 1st measurement – approx. 62 " from the floor to the top of the label
>
> 2nd measurement – approx. 68 " from the floor to the top of the label
>
> 3rd measurement – approx. 74 " from the floor to the top of the label

NOTE: The difference in height between our measurements and the KPD of the 1st sticker is **1/16"**.

The difference in height between our measurements and the KPD of the 2nd sticker is **1/4"**.

There is **no difference** in height between our measurements and the KPD for the 3rd sticker.

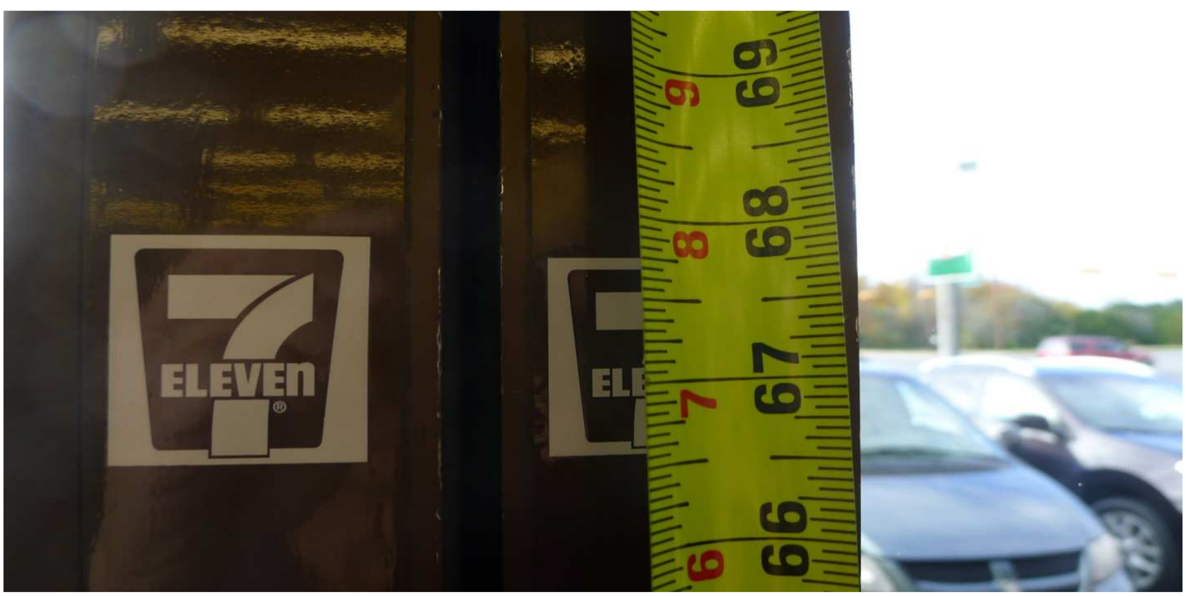

Photo #4

“HEIGHT MEASUREMENT CONCLUSION. The height of the 7-Eleven robber in Photo #2 may be just under 5’7¾“, as the robber’s shoes and the robber’s cap add a small amount of apparent height, *i.e*., **since the top of the 2nd height sticker is approximately 5’7¾”, then the robber in Photo #2 is approximately 5’7½” (with an approximate ½” margin of error).**

“The undersigned has reviewed the Aug. 07, 2009 Forensic Reconstruction Report prepared by Mr. Michael A. Knox of Knox & Associates. Page 2 of that report states that as part of his analysis, Mr. Knox used “[a]dditional measurements of the scene provided by Investigator Raymond Jacobs (at my request).” This statement is materially inconsistent with the content of his 1st of 2 Disclaimer paragraphs, quoted below:

> This report was prepared for the sole purpose of being used in criminal proceedings related to this case. *In preparing this report, the author has relied on materials supplied by the client [Bell County (TX) District Attorney]. Knox & Associates makes no guarantee as to the accuracy of any information or data that was not obtained directly by a member of our staff. Accuracy of this report and the conclusions contained herein likewise cannot be guaranteed insofar as the author has relied on such third-party and client-supplied information.* However, Knox & Associates does assert that this report contains the author’s best and most accurate ability to document, analyze, and reconstruct the suspect’s height based on the information provided. Knox & Associates reserves the right to amend or otherwise change the conclusions contained herein if new information becomes available that was not known to Knox & Associates at the time this report was prepared. (italics added)

“This Report by Mr. Knox appears fundamentally flawed on its face, and patently unreliable in its conclusion, for the following reasons:

1) Mr. Knox states that he has relied on materials supplied by the client [Bell County (TX) District Attorney]. We can only assume that he also relied on “[a]dditional measurements of the scene provided by Investigator Raymond Jacobs (*at my request*).” (italics added) If Mr. Knox requested certain on-site measurements, then we assume that such information was used in his analyses.

2) Since Mr. Knox requested certain on-site measurements from Investigator Jacobs, then his statement “Knox & Associates makes no guarantee as to the accuracy of any information or data that was not obtained directly by a member of our staff” effectively means: “Knox & Associates guarantees the accuracy of any information or data, since such data/measurements were obtained directly by a member of my staff.”

3) Mr. Knox requested certain on-site measurements from Investigator Jacobs. However, nowhere in his 6-page report details Investigator Jacobs’ “additional measurements.” One would think that the height of each of the three pairs of height

stickers, which happen to be a few inches from the robbers head at the time of the entrance to the store, would have been measurements requested by Mr. Knox of Investigator Jacobs, used in the height analyses of the robber by Mr. Know, and properly detailed in any formal written report.

4) Had a simple tape measure measurement of the top of each of the three height stickers been requested and made, then one would expect that most relevant data would be, quite simply –

- the top of the bottom height sticker measures approximately 61-15/16", or 5'1-15/16";
- the top of the middle or 2nd height sticker measures approximately 67¾", or 5'7¾";
- the top of the top height sticker measures approx. 74", or 6'2".

5) If (since) the simple but critically relevant information about the location of each of the height stickers were requested (by Mr. Knox of Investigator Jacobs), then it would be clearly obvious to any observer with acceptable vision that the suspect in Photo #2 is very close to the top of the middle height sticker, or very close to 5'8" – which is nowhere close to anyone "at least 6'1" tall" (Mr. Knox's conclusion on page 6 of his report), and way beyond any margin of error from 5'8". By his conclusion, anyone " at least 6'1" " would be at or above the top of the 3rd height sticker – again, referring to Photo #2 above, it is clear and obvious that the robber is right at the 5'8" sticker, and nowhere near the top of the top or 3rd height sticker, which is at 6'2", or a full 6" higher.

6) Mr. Knox's Report does not appear to utilize "[a]dditional measurements of the scene provided by Investigator Raymond Jacobs (*at my request*) (italics added)," notwithstanding his written statements to the contrary. Without the available and necessary on-site measurements, his data utilized is necessarily flawed or incomplete. Regardless of the reliability or not of his methodology, since he utilized wrong or incomplete data, his conclusion that the robber is "at least 6'1" tall" is necessarily unreliable, invalid and forensically untenable.

7) Mr. Knox's conclusion is that the robber is "at least 6'1" tall" (p.6, Knox Report). To not at least put a range on a measurement is untenable. For example, one would think, presumably including Mr. Know, that the robber in the photo could not possibly be seven feet (7') tall, although that hypothetical 7' robber would not be excluded in Mr. Knox's conclusion or opinion.

8) What may be most remarkable in the Knox Report is the lack of measurements or numbers to derive at a conclusion. The Knox Report does not imply, much less explain, how Mr. Know came up with the 6'1-1/8" value (p.5, Knox Report). As such, his conclusion of "*at least* 6'1" tall" (italics added, p.6, Knox Report) is scientifically flawed and forensically untenable.

9) Mr. Knox stated that he used CadZone software; however, he does not describe which one (or more) of the 10 CadZone products he used, much less how it was used. Such material omission prevents one from trying to replicate what Mr. Knox did in concluding that the robber was “at least 6’1” tall”.

10) Mr. Knox stated that he used PhotoModeler software; however, he does not describe how it was used. Such material omission prevents one from trying to replicate what Mr. Knox did in concluding that the robber was “at least 6’1” tall”.

11) Mr. Knox stated that he used Google SketchUp software; however, he does not describe why or how creating a 3-D model was used. Although p.4 of the Knox Report states that the “model was then used both to obtain the suspect’s height and to create a demonstrative video showing how the perspective of the camera affects the appearance of the suspect’s height in the surveillance video,” it is not clear at all what measurements were made or used and how the “at least 6’1”” value was derived at. Given that there was a point (Photo #2) in which the robber was right at the plane of the door, then any camera perspective on the stickers is identical to the perspective of the robber, such that whatever camera perspective does not affect the net calculations of the height of the robber. It is not clear why the SketchUp software was used, how any height determination could have been reliably determined thereof, and what part the “demonstrative video” was used in the opinion. Therefore, such material omissions prevent one from trying to replicate what Mr. Knox did in concluding that the robber was “at least 6’1” tall”.

12) Mr. Knox states on p.5 of his report: “It is important to note that the suspect’s body is leaning to the right in the photograph, which means that his height cannot be measured accurately by taking a vertical measurement. Instead, his height must be measured along the diagonal axis from the top of his head to the bottom of his right foot.” By his own admission, “[the robber’s] height cannot be measured accurately by taking a vertical measurement.” Given that the video captured the same robber as the robber was crossing the plane of the door *vertically*, see Photo #2, above, it is not clear why the photo Mr. Knox used in which the robber was “leaning to the right” was used or preferable to Photo #2 above in which there was no leaning. Using inferior data results in an unreliable conclusion, or underscoring the flaw in the conclusion that the robber was “at least 6’1” tall”.

13) It appears that the Know Report does not account for the added height of the robber wearing shoes. It also appears that the Know Report does not account for the added height of the robber wearing a cap. Such material omissions further erode any confidence in Mr. Knox’s conclusion that the robber was “at least 6’1” tall”.

14) The relevant height stickers at the 7-Eleven store at issue are in the ***same location*** at the time of our measurements (11/20/13) as they were at the time that the KPD made the same measurements (4/21/09). In the Knox Report,

detailed below, Mr. Knox states on page 2 of his report that as part of his analysis, he used “[a]dditional measurements of the scene provided by Investigator Raymond Jacobs (at my request).” However, nowhere in his report does he reveal these measurements, nor is there anywhere in his report that details how he came up with his conclusion that the suspect was “at least 6’1” tall” (p.6, Knox Report).

“In conclusion,

➢ with at least a reasonable degree of scientific certainty, there is a Probable Elimination when comparing the voice of the robber in the “Valero” video described above with that of Mr. George R. Powell, III’s voice;

➢ since the top of the 2nd height sticker in the 7-Eleven photo is approximately 5’7¾“, then the robber in Photo #2 is approximately 5’7½” (with an approximate ½” margin of error) – this conclusion is consistent with the independent measurements made by the Killeen Police Department; and

➢ it appears that the Knox Report is not based on any reliable facts, is not based on any apparently reliable methodology, not capable of being replicated or validated in any meaningful way, and in fact, the unsupported conclusion that the robber was “at least 6’1” tall” is not even physically possible, notwithstanding his attestation to his Report’s “truth and accuracy to the best of [his] knowledge and ability” and that his “conclusions … have been formed objectively.”

"I declare nothing further."

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APPENDIX:

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EXHIBIT B

then to measure straight up from the ground to the top of your head would not be accurate. You have to measure from the bottom of the feet to the top of the head which is what I have done there.

Q So the measurement has to be taken along what I would call, I guess, the "axis" of the body.

A Yes.

Q And that's exactly what you have done here.

A Yes.

Q So the end result is-- Go ahead and play that. Just pause.

And is that your opinion? He's at least 6'1"?

A Yes.

Q The suspect there?

A Yes.

Q Now, why do you just say "at least 6'1"'?

A Well, there's some things that I can't account for. Mainly, we've drawn him in the plane of the door, but in reality not only is he leaning to the side but he's also leaning somewhat in and out of the door. So that means that the foot is a little bit inside the door; the head is a little bit outside the door. That lean also tends to shorten the height, make him appear to be shorter than what he really is. But with the camera views that I have here, I don't have any way to know exactly how much-- how far out the door his head is, how far in the door his foot is.

EXHIBIT C

Section 7

Best Practices for Forensic Video Analysis

***Previously released as "Recommendations and Guidelines for the Use of Forensic Video Processing in the Criminal Justice System and "Definitions, Recommendations and Guidelines for the Use of Forensic Video Processing in the Criminal* Justice System"**

OBJECTIVE
The objective of this document is to provide guidance regarding appropriate practices for performing a variety of processing and analytical tasks involving video submitted for examination.

SWGIT POSITION ON FORENSIC VIDEO ANALYSIS
Forensic Video Analysis (FVA) is a forensic science. In 2002, the International Association for Identification (IAI) formally recognized Forensic Video as a valid sub-specialty within the scientific discipline of Forensic Imaging (IAI Resolution 2002-12).

INTRODUCTION
Forensic Video Analysis is the scientific examination, comparison, and/or evaluation of video in legal matters.

With an increased prevalence and awareness of Closed Circuit Television (CCTV) surveillance, there are additional investigative opportunities. For example, in 1970, when Sterling Hall at the University of Wisconsin was bombed, there were no CCTV recordings in the area. Twenty-five years later, in 1995, investigators reviewed hundreds of video recordings related to the Oklahoma City bombing. Just six years later, in 2001, thousands of video recordings were examined by federal, state, and local agencies in relation to the terrorist attacks of 9/11. In 2005, the Metropolitan Police Service in the United Kingdom (New Scotland Yard) seized over 55,000 videotapes, hard drives, compact disks, digital video recorders, and other media in support of the investigation of the July bombings in London.

FORENSIC VIDEO ANALYSIS – GENERAL TASKS
The process of FVA can involve several different tasks, regardless of the type of video analysis performed. These tasks fall into **three** categories: Technical Preparation, Examination, and Interpretation. The general principles and procedures used in these tasks are the same regardless of the format or media in which the images are recorded. This includes both analog and digital media.

Technical preparation is the performance of tasks in advance of examination, interpretation, or output. There are a multitude of technical decisions within the various tasks. Technical preparation will affect further stages of FVA. Tasks may include the following; instrument calibration, visual inspections, media characterization, write protection, organization of files, and playback optimization.

Examination is the application of image science expertise to extract information from video. Examples may include the following; demultiplexing, decoding digital video and/or images, duplication, capture, reconstruction, format conversion, timeline sequence reconstruction, and standards conversion. Image and video enhancement, frame averaging, video stabilization, and other video processing activities intended to improve the visual appearance of features in a video are also examination tasks.

Interpretation in Video Analysis is the application of specific subject matter expertise to draw conclusions about video recordings or the content of those recordings. An example of the former is video authentication. The latter may include determining that an article of clothing appears different in a video than it does under normal lighting conditions due to the properties of the recording process (e.g. an Infrared (IR) negative image effect on natural fibers). Content-based interpretations may also include comparison analysis of such things as clothing or vehicles. If such a content-based interpretation leads to an identification, then it falls within the discipline of Image Analysis. For further information on Image Analysis, refer to SWGIT document "*Best Practices for Forensic Image Analysis*".

Note: Technical Preparation, Examination, and Interpretation are tasks, not job descriptions or roles. An individual may perform part of one task or a combination of multiple tasks within the organizational structure of any given activity. Each of these tasks requires its own training and qualifications. Proper methods and practices are necessary in order to get the most out of video evidence.

BEST PRACTICES

The following are guidelines that describe the SWGIT recommended best practices for forensic video analysis.

Evidence Management

Agencies should have documented procedures for the handling, transportation, and storage of evidence. Agencies should have chain of custody procedures in place and should follow these procedures.

Quality Control and Quality Assurance

Quality control and quality assurance policies and procedures should be implemented and documented. Technical and administrative peer reviews are integral components of quality control.

Security

There should be procedures in place to maintain the security of the working data, all notes, and other such analysis related materials to provide the level of security and privacy needed by the organization. For example, archived case related materials should be stored in a manner that limits access. The degree of access will be agency specific.

Infrastructure

Agencies should have sufficient space, equipment and facilities to adequately support the required quality and volume of work.

Work Management
Forensic Video Analysis is a labor intensive process. An upper limit on caseload should be established for every category of tasks.

Documentation
Agencies should establish standards for information included in, and the format for, reporting results.

Training, Competency, and Proficiency
Forensic Video Analysts and/or examiners are encouraged to review SWGIT "*Guidelines and Recommendations for Training in Imaging Technologies in the Criminal Justice System*", "*SWGIT/SWGDE Guidelines and Recommendations for Training in Digital and Multimedia Evidence*" and "*SWGIT/SWGDE Proficiency Test Program Guidelines*".

Analysts should have certification in their knowledge domain and associated forensic discipline, when such certification is appropriate and available. Note however, that the existence of an external professional certification program does not imply that it is necessary, sufficient, or appropriate.

Analysts should demonstrate competency in their discipline prior to being assigned unsupervised case work responsibilities. Analysts should remain proficient through continuing education, training, and peer review of examinations. Agencies should document competency, proficiency and continuing education for each analyst.

The analyst should demonstrate:

- An understanding of the scope of work and how it will be applied in the forensic environment;
- subject matter knowledge and competence;
- working knowledge of image and/or video processing and evaluation techniques;
- working knowledge of applications and tools utilized in the specific agency;
- working knowledge of SWGIT guidelines for capturing, storing, and processing image/video, including issues relating to topics such as data integrity and compression artifacts;
- understanding of legal precedent for the use of specific image and/or video processing techniques;
- knowledge of appropriate case work documentation.

Standard Operation Procedures (SOPs)
There should be Standard Operating Procedures (SOPs) in place for the tasks being performed. These SOPs should be agency specific, reflect the work flow, and be general enough to permit flexibility for the required tasks.

FORENSIC VIDEO ANALYSIS – WORK FLOW

The following describes a generalized sequence of actions involved in the analysis of video evidence and recommendations for their performance. This is not a training manual, nor a step-by-step methodology. These recommendations represent specific considerations to be addressed by the examiner. The exact sequence will be dependent upon the evidence submitted and the required examinations.

Chain of Custody

Throughout the entire FVA process chain of custody must be maintained as per agency policy.

Submission Review

A submission form should be completed for every case the examiner receives, regardless of what type of examination or service the requestor is seeking. ***See Appendix A for an example***.

Ensure examiner safety is maintained by determining whether biohazards such as blood or body fluids are present or other special handling is required.

Ensure that no other prior examination is required such as latent print or trace evidence.

At all times precautions should be taken to ensure video evidence is protected from external factors that may cause damage to the media or to the recorded signal contained on the media. (e.g. magnetic fields, static electric charges, electrical hazards)

Physical Inspection

Document the physical condition of the evidence. Physical inspection may include the following determinations:

- Physical damage to media or housing
- Contaminants (dirt, grease)
- Media characteristics (manufacturer, size, format)
- Device settings (hard drive jumper settings, device switch positions)
- Write protect status
- Existing labels or identifiers

If the media is an obvious copy, such as marked on the label as a duplicate, contact the requestor to determine if the original is available.

Any deficiency should be documented and resolved if possible before beginning any forensic analysis (e.g. splicing a broken or damaged tape, restoration into a new cassette housing).

Evidence Marking

Evidence needs to be marked per agency policy. Markings could include labeling with initials, ID number, case number or any other identifying information.

The ideal method for marking CDs and DVDs is with a non-solvent based felt-tip permanent marker designed to mark optical media.

Notations should be made in the clear inner ring as no data information is recorded in that area. Any identifying information (such as serial numbers) should be documented. Inappropriate marking or labeling methods may affect playback and could potentially damage the evidence.

- Never use a ballpoint pen, pencil or other sharp writing instrument when marking CDs and DVDs
- Do not use markers that contain solvents
- Do not use adhesive labels

Write Protection

Video recording media must be treated in such a manner as to be write protected in order to prevent modification of the media content.

For tape based media, record tabs should be removed, or moved to the write-protect position.

When possible, playback and file access from optical media should be performed with units incapable of record operations (e.g. CD ROM and DVD ROM drives). This may not be possible for media that has not been finalized.

A write blocking method, whether hardware or software, should be utilized for any media whenever possible.

For other forms of media storage, the manufacturer's recommendations regarding write protection should be followed.

Virus Scan

Virus scanning should be performed on any submitted media containing file based digital video recordings. Virus scanning is necessary to both ensure the integrity of the evidential video data, and to protect against malfunction and/or corruption to video processing hardware and/or software systems. The specific methods and software applications used for virus scanning, and remedial actions if a virus is found, will be determined by individual agencies and will be documented within an agency's SOPs.

Equipment Selection and Playback Optimization

Playback optimization and equipment selection is the process of determining the most suitable equipment and settings for analyzing the output video signal. This includes time base correctors (TBC), playback devices (including field-based VCRs), monitors, capture cards, multiplexers, vectorscopes, waveform monitors, and write blockers.

NOTE: Examiners should be aware that audio may be present within video recordings.

In order to ensure the best possible playback and viewing conditions of tape based evidence as it passes through the video processing chain, each piece of equipment and connections between equipment should be optimized. This will allow for the best evidence to be preserved, examined and further analyzed.

Key components of the video chain may be assessed using test patterns. For example, test patterns assist in the detection of noise and allow for adjustments to be made. A regular maintenance and cleaning schedule will assist in equipment reliability.

For tape based media

Prior to inserting videotape evidence into a playback device, ensure the equipment is functioning properly by inserting a non-evidentiary test tape of known signal and image quality. When playback of the evidentiary tape is less than optimal or signal dropouts occur, and the analyst suspects player idiosyncrasies as a potential factor, multiple players and/or recorders should be utilized to preview the tape. In some cases, this may necessitate retrieving the original recorder and/or camcorder unit. For example, head misalignment on the original recorder may produce a tape in which video playback is degraded or not viewable when played back on any unit other than the original recording device. Tracking adjustment may be necessary to optimize playback of the original video.

Analog based media usually requires visual examination of the individual recorded fields.

NTSC, PAL, and SECAM standards require appropriate equipment for viewing, conversion, and playback purposes to accommodate varying frame rates, aspect ratios and lines per frame.

Care should be taken to avoid extended playing or pausing of tape based media to prevent damage or degradation of the original video.

For file based digital video recordings

The minimum specifications provided by the relevant manufacturers to ensure proper playback, display resolution, and overall quality should be utilized when playing back file based digital video recordings. This applies to the particular video workstation hardware (e.g. processor, hard drive, memory, graphics card) and software (e.g. operating system, proprietary video player).

Digital video files and software that are recorded on removable media (e.g. CD-R, flash memory card) should be copied to the video workstation for playback, if possible.

For Digital CCTV (DCCTV), if possible obtain the pertinent video information in the native file format with the appropriate player. The analyst should be aware that different methods of playback and extraction (including universal players) may yield different results. When reviewing digital video using the proprietary software, the player or on-screen display (OSD) may affect the representation of the video. An incorrect display aspect ratio will not accurately depict the dimensions of the actual recorded video. For example, objects that should have been recorded as circles may be depicted as ovals instead.

In some instances the original recording hardware, or equipment of the same make and model, may be necessary for playback.

In order to maintain image quality, the highest available signal path should be chosen for the devices in the FVA chain (e.g. s-video over composite).

Cable optimization can minimize electromagnetic interference, which can produce static or noise. Cable lengths should be as short as possible. Arrange any excess cable in an "S" or figure eight shape, avoiding loops and coils. Kinks or cables bent at sharp angles can damage cable connectors or the terminals of equipment.

Keep power cords away from audio and video cables if possible. Even shielded cables can be affected by power cords, which can cause electromagnetic interference and signal degradation. If cables must cross over power cords, these should cross at right angles.

Generation Determination

If during playback optimization there are indications that the submitted media is a copy, contact the submitter to obtain the original if it exists. Indications of an analog copy may include multiple head switching points viewed on an underscan monitor or an analog recording of a digital CCTV source. For digital media, a file playable in a universal player may be an indication that transcoding of the native file format has occurred.

Media Review

The submitted media for analysis should be reviewed. Information regarding recording method, time/date of incident, and problems in playback or viewing of the recording should be verified. Any observed discrepancies with the information documented in the submitted request should be noted.

A preliminary determination should be made with respect to the feasibility of the requested task (e.g. enhancement, comparison, duplication). If the analyst determines any additional tasks are necessary, these should be noted.

When identifying the area of interest for analysis, the following should be considered:

- There may be relevant information outside the area of interest requested by the submitter
- Details about the incident not directly related to the subject may be present. These include;
    - Images which could verify the time and/or place of the incident such as; clocks, signs, scoreboards
    - Potential witnesses or bystanders

Creation of a Work Copy and Verification

A working copy of the pertinent area of the recording should be created. This copy should be made to ensure the preservation of video data in the event of accidental corruption, erasure, or other unexpected damage or degradation to the original recording media. Examples of working copies are; copying of digital files from optical media to another medium (e.g. hard drive) and magnetic tape to digital files (uncompressed/lossless). The working copy should be digitally and/or visually verified as to content and quality.

For duplication purposes, a master copy should be created and all subsequent copies be made from this master. Where analog is concerned, this copy should be of the highest quality possible (VHS to VHS copying should be avoided whenever possible due to loss of quality).

Processing, Enhancement, and Examination

Video that has been processed should be documented. This documentation should include the order in which the processes were applied to ensure the integrity and the reproducibility of the results. Specific information and additional SWGIT recommendations related to video/image related enhancements may be found in the SWGIT document "*Best Practices for Documenting Image Enhancement*."

The following alphabetical list provides a brief discussion of various processing, enhancement, and examination techniques utilized in FVA, and specific recommendations for their use. Many of these techniques can be applied over an entire image (globally) or over a specific area (locally).

Brightness/Contrast

The specific settings for brightness and contrast filters should be set so that the level of detail for the area of interest is not adversely affected. Steps should be taken to ensure that clipping does not occur in the area of interest within the image. In a global brightness adjustment, areas of the image that are not pertinent may in fact be made less visible in order to optimize the pertinent area.

Color Correction

A known standard, such as MacBeth or SMPTE standardized charts, should be used when the most precise color correction is necessary. The chart should be captured under the same conditions, position and location as the original video and color balanced to a neutral tone. This color balance can be based on a visual display on a calibrated color monitor or by using the values displayed for this neutral toned object in the info palette of an image processing program.

Cropping/Resizing

Cropping/Resizing must not result in a misleading and/or inaccurate representation.

Deinterlacing

CCTV recordings may require deinterlacing to achieve the best image possible. This should be performed before any other process. Deinterlacing may be necessary in circumstances where display of the original interlaced signal results in obscured or degraded image detail. For example, a VHS CCTV recording may contain noise only in the odd field of the video signal, due to a damaged or dirty record head on the recording VCR. Another example is motion between individual fields, as shown in Figures 1 and 2. In these cases, normal playback of the interlaced video may obscure image details in the recording. Therefore, deinterlacing the video signal and creating a processed version from a single field may result in clearer video images.

Figure 1. Interlaced Image

Figure 2. Deinterlaced Image

Demonstrative Comparison

Demonstrative Comparison occurs when multiple images are placed side-by-side for the purpose of visual comparison. This consists solely of preparing the composite exhibit. If the analyst indicates points of similarity or dissimilarity this represents an opinion about the content of the images; subject matter expertise and the principles of Image Analysis thus apply.

Ensure that all the displayed images have the correct aspect ratio and that significant features are approximately the same size.

To the degree practical, displayed images should depict the same composition including such features as camera to subject geometry (perspective), lighting, color rendition, focus, etc.

Analysis of the content of video images for the purpose of rendering a conclusion regarding the depicted subject(s) is beyond the scope of this document. This may include photogrammetric analysis or photographic comparison. For further information refer to SWGIT document "*Best Practices for Forensic Image Analysis*".

Demultiplexing

Demultiplexing may be accomplished through hardware or software tools.

Hardware based

Hardware based demultiplexing may allow for the decoding of date, time, and other camera information.

Hardware based demultiplexing can result in cropping and/or softening of the images. Also, the verification of dropped and/or incorrectly sorted frames may not be possible.

If available, the same make and model of multiplexer/demultiplexer used in producing the original recording should also be used for hardware demultiplexing. Third party multi-format hardware demultiplexers may also be used; however, there may be a variation in the results.

Optimal hardware configuration includes a monitor before the demultiplexing as well as a review monitor. This allows for simultaneous input and output monitoring.

Playback speed should be adjusted to run at an appropriate time-lapse rate in order to minimize the potential of the multiplexer skipping or dropping frames.

Figure 3.
Figure 3 shows a three-camera multiplexed combined signal and Camera 1 demultiplexed.

Software based
Software based demultiplexing may allow the analyst to verify that frames were correctly sorted and none were dropped.

This method typically uses image content to separate multiplexed cameras. Time and date information is often not displayed.

Pay particular attention to Pan-Tilt-Zoom (PTZ) cameras, and cameras with drastic lighting and/or scene changes, as they may cause difficulty for software based demultiplexing programs.

Noise Reduction
The best method to reduce noise will depend on the type of noise present in a given image or video. Frame averaging and single frame noise reduction techniques may be effective for different types of image noise.

Frame averaging is most often useful when there are multiple frames and no movement of the camera or the subject of interest.

Any single frame noise reduction technique will always be a trade off between reducing the noise and blurring or eliminating detail.

Sometimes no noise reduction is the best choice when enhancing an image in order to maintain fine details and textures.

Sharpening/Deblurring

Sharpening techniques can be useful to enhance edge detail. Since the fine detail of an image lies in the high frequencies, video analysts may want to boost the high frequencies of an image in an attempt to better visualize these details.

Some noise also exists in high frequencies. Any attempt to boost the details contained in the high frequencies of an image will also boost the high frequency noise. This amplification of noise is the major limitation in any sharpening technique applied to images and video.

Over sharpening an image, besides boosting the noise, may also result in an unnatural look to the enhanced image. Some sharpening processes may change the average brightness and/or contrast of an image.

VCR circuitry can contain a sharpening element. Care should be taken that this effect is willfully activated or deactivated and the consequences of it are understood.

Image restoration techniques, such as deblurring, can be used to reduce the motion, lens, and Gaussian blur.

A deblurring technique is not the same as a sharpening technique. However, if no deblurring tool is available, a sharpening tool may be effective.

Speed Adjustment

Speed adjustment of forensic video is typically performed for the following reasons:

- To convert the playback speed of time lapsed video recordings to a real-time rate.
- To slow the playback speed of video to a less-than-real-time rate (“slow motion”).

This is often done to facilitate the viewing of images and action details occurring in the original recording.

Speed adjustments are made by varying the playback frame rate, and may be accomplished through hardware (e.g. time-lapse VCR) or video-processing software (e.g. motion effects).

Timeline Sequencing

Timeline sequencing can be an effective way to show subject movement through a scene or a series of events. Every pertinent image should be included in the timeline displayed or verified time/date information and/or frame numbers. Scene content may also be useful in verifying the proper sequence of recorded images. Examples of scene content may include movement of vehicles or people. Images used in timeline sequencing may come from multiple cameras at one location or multiple locations. Proper documentation when performing any of these methods is essential.

Video Stabilization

Video Stabilization is typically performed at the field level, and may be either an automatic or manual process. This is usually performed prior to attempting noise reduction using inter-frame adding or averaging operations.

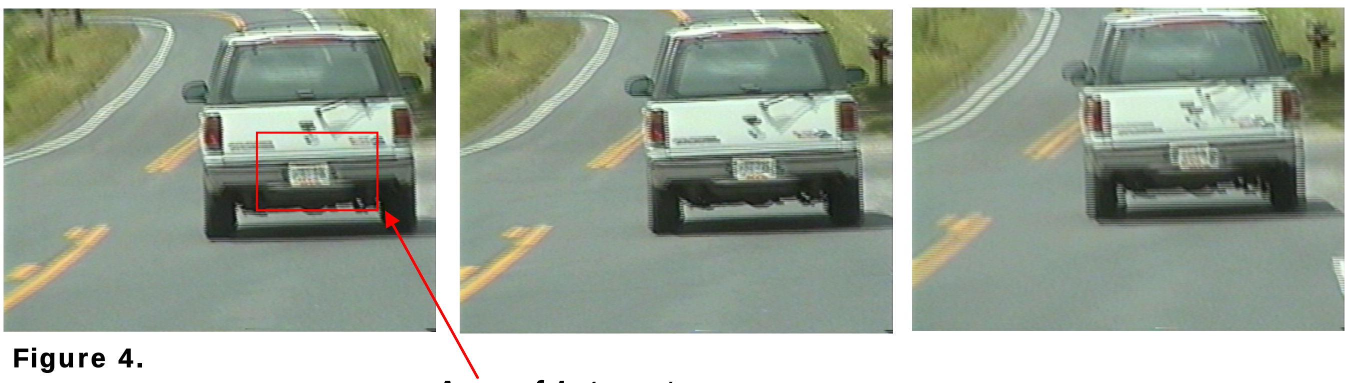

Figure 4.

Area of Interest

Figure 4 shows an original sequence of images captured with a handheld VHS-C camcorder. The vehicle is moving within the frames as the result of camera jitter and vehicle movement. To correct for this, an area of interest is defined within an image that subsequent video frames will be aligned with.

Figure 5.

Figure 5 shows the processed video sequence. The vehicle has been stabilized, by aligning the frames to the previously selected area of interest. Notice that the frames are being moved (horizontally and vertically) and rotated to align them.

Output

Results can be output to media, such as videotape, prints, write once optical media (e.g. DVD, CD), hard drive, etc., for return to the requestor. Media should be write protected, when possible. Rewritable optical media (e.g.DVD-RW, CD-RW) should not be used.

Any notations added to the final image results, such as agency logos, text, case information, or examiner markings, should not obscure the pertinent area.

The type of output images (video, stills, or a combination) is dependent upon what best illustrates the content, quality, and events to be depicted in the final product. When deciding what to output, consider the intended use and the quality of the images available as well as the needs of the requestor for playback and courtroom presentation.

If adjustments for pixel aspect ratio are required for printing, in most cases, they should be done after all image processing and enhancement is performed. Prior to output, ensure the pixel aspect ratio is correct for the chosen media. If the aspect ratio is not correct, the output results may not be proportionate (width to height) and will not be an accurate representation of the original image.

Durability, longevity and quality of prints produced should be considered. Whenever possible, the printer manufacturer's recommendation for ink, paper, storage, maintenance, and settings should be followed. The most important aspect of printing is that the printed still image files remain a true and accurate representation of the original event.

When outputting to digital media, be aware that several factors can reduce output quality. These include:

- High compression rates
- Long record times
- Poor quality equipment and media
- Incorrect settings

Verification

Any output should be verified to check that all content was transferred successfully and that the quality of the output accurately reflects the results of the examination and/or analysis.

The analyst should be aware that there may be compatibility issues between the output produced and the playback device. Ideally, output should be verified on multiple systems to ensure optimal playback compatibility.

After verification, the original media and all processed output should be properly labeled, sealed and packaged according to your agency's SOPs.

Appendix A – Video Submission Form

SUBMISSION OF VIDEO EVIDENCE

Date		Agency Case #		
Submitter Name				
Agency				
Offense		Phone #	Cell #	
VICTIM (or SUBJECT)		**RACE**	**SEX**	**DOB**
1				
2				
SUSPECT		**RACE**	**SEX**	**DOB**
1				
2				

Brief Details of Case (Attach Report if Necessary)

____
____
____
____

Examinations Requested

____
____
____
____

CCTV System Information

Digital Video Recorder Make, Model, Serial Number ________________________________

PC Based Stand Alone Networked (Circle One)

Playback software name and version____

Software provided with evidence YES or NO (Circle One)

System and/or Software Password ____

System Settings:
Image Quality (i.e. high, medium, low) ____
Frames per second (fps)/pictures per second(pps) ____________________________________
Image/Frame recorded size (e.g. 320 x 240) ____
Can it be determined if any cameras are alarm or motion triggered?____________________
Number of hard drives, storage capacity of each ______________________________________

System firmware version ____
Other available system settings (e.g. event log)____

Analog Video Recorder Make, Model, Serial Number_________________________________

VHS SVHS Other ___________________________ (Circle One)

What record mode was the system? (Circle One) 2 hour, 6 hour, 12 hour, 24 hour, 48 hour
72 hour, Other _________ Unknown

Multiplexer YES or NO Make and Model ____

Basic Information

Does the recorded date/time accurately represent the time of day? (circle) YES or NO

Date/Time displayed _____________________

Actual date/time ______________________

# of Camera/s __________ Active # of cameras

Camera make and model ____

Are any cameras infrared-sensitive and if so identify ______________________________

Is audio being recorded? ____

Is a copy of the most current maintenance/service log attached? (circle) YES or NO

Other Information: ____
____

Scene Contact Information

Scene Address ____

Hours of operation____

Scene point of contact _________________________Telephone: ____________________

CCTV system point of contact ___________________ Telephone: ____________________

Please provide a sketch of the scene indicating camera position and placement.

Submitted By ________________________ **Print Name**_______________________
Signature

EXHIBIT D

Texas Forensic Science Commission
Investigative Report

Forensic Video Analysis - Photogrammetry

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September 25, 2015

Introduction

In 2009 in Bell County, Texas, an expert witness provided a height determination based on an examination of video images of two robberies. His analysis ultimately contributed to the conviction of the accused. Post-conviction, this analysis was challenged by another expert witness. The height measurement determined by the second expert was different from what was presented in trial by more than six inches. While both experts claim to have employed accepted forensic techniques and methodologies, their conclusions are distinctly disparate.

This report is directed by the Texas Forensic Science Commission (FSC), and explores the question as to whether forensic video analysis, and specifically the sub-discipline of height comparison from video images, is a junk science or a bone fide discipline that can be appropriately admitted into Texas State Courts.

The forensic discipline in this case is not subject to accreditation under Texas law. Therefore, the Commission's investigative report in this case is limited to specific areas under the Texas Code of Criminal Procedure [1].

Video images provide among the most prolific sources of criminal evidence available to law enforcement today. Almost everywhere the public has access, by right or by invitation, likely comes within the view of one or more cameras that form a gauntlet of ubiquitous surveillance. Whether traveling in a taxi cab, a school bus, or a commuter train, whether attending a church, a concert, a community center, or a mall, the urban resident and the average criminal can be easily tracked from venue to venue. Despite concerns regarding loss of privacy, our surveillance society has created a boon for investigators who leverage public and private cameras in their efforts to collect evidence, identify criminals, exonerate the innocent, and convict the guilty.

In Texas, as in the rest of the United States, Canada, and countries throughout the world, police agencies and prosecutors are becoming more dependent on integrating visual evidence into their investigations and prosecutions. Many agencies are developing their own internal expertise, sending employees to advanced level courses in forensic video analysis in order to get the most from their video evidence, while ensuring accuracy, accountability, and justice for an accused person.

Forensic video analysis techniques, practices, and methodologies are used to conduct a wide variety of examinations, including, but not limited to, vehicle speed analysis, clothing comparison, vehicle identification, facial recognition, and height comparison. Guidelines for each of these Forensic Video Analysis and Digital Multimedia Evidence (DME) sub-disciplines exist within a number of publications, including Best Practice documents produced by the Federal Bureau of Investigation's Scientific Working Group on Imaging Technologies (SWGIT), and its Scientific Working Group on Digital Evidence (SWGDE) [2]. (As of 2015, SWGDE has taken over SWGIT's subcommittee responsibilities.) In addition, there is a rich record of criminal and civil case law that helps to establish standards of admissibility and that discusses expectations for training, foundational knowledge of the underlying technologies used, and relevant experience of the forensic video expert.

This report examines industry standards and practices, and discusses scientific methodologies that are generally accepted by the relevant scientific community engaged in the science of forensic video analysis and specifically in the area of height analysis. This report also examines the record of case law in the United States and other countries relating to the standards of admissibility and to testimony of height analysis evidence from video images presented in criminal courts. Rulings from the bench, supported by a significant record of peer-reviewed scientific publications, combine to establish the foundation for accepted standards, methodologies, and adequate training of the analyst, for the safe admission of this kind of scientific evidence in court. Finally, this report documents the failure of the trial expert in the 2009 Bell County case to employ accepted methodologies, which ultimately led to the introduction of incorrect height measurement evidence at trial.

Applicable Standards & Analytical Methodologies

> *Photogrammetry is the art, science, and technology of obtaining reliable information about physical objects and the environment through the processes of recording, measuring, and interpreting photographic images and patterns of electromagnetic radiant energy and other phenomena. In forensic applications, this is the mathematically based scientific principle used to extract dimensional information from images, such as the height of subjects depicted in surveillance images and accident scene reconstruction. [3]*

This definition is derived from The Manual of Photogrammetry, 4th Edition, 1980, American Society of Photogrammetry and Remote Sensing (ASPRS) [4]. It is updated in the International Association of Identification (IAI) and the Law Enforcement & Emergency Services Video Association (LEVA) joint publication *Forensic Imaging and Multi-media Glossary Covering Computer Evidence Recovery (CER), Forensic Audio (FA), Forensic Photography (FP), And Forensic Video (FV), Version 7.0, Last Updated July 15, 2006* [3].

The FBI's SWGDE defines forensic photogrammetry as, "The process of obtaining dimensional information regarding objects and people depicted in an image for legal applications." [2]

There are a number of photogrammetric techniques and methodologies commonly practiced by various industries, from engineering and manufacturing to mapping and warfare. Most methodologies use Long Range Photogrammetry utilizing forms of high density sensors, including high resolution stereoscopic imaging to multi-pass radar, lidar and sonar techniques. Forensic Video Analysts typically utilize Short Range Photogrammetry incorporating various geometric applications, combined with reverse projection techniques to examine low resolution images.

Reverse projection requires the analyst to reproduce the historic camera location, and then to overlay the historic image over a contemporary view of the original scene. By introducing objects or measurement standards into the contemporary environment, accurate measurements of the original images can be obtained. The FBI's Forensic Audio Image Analysis Unit (FAVIAU) and LEVA jointly provide annual training in the science of reverse projection for the sole purpose of obtaining accurate suspect heights from low resolution video images.

Other Short Range Photogrammetic methods for height analysis employ laser measurement tools and 3D scanning technology to create geometric models of a scene. Both methods also incorporate reverse projection processes whereby the historic images are overlaid onto the new scene geometry in order to compare and measure.

In all photogrammetric methods, errors are introduced into the analysis environment, primarily due to limitations of the source material, but also because of measurement errors created by the analyst and the sampling technology. In Short Range Photogrammetry, the primary source of the errors is the low-resolution historic image, usually one that was produced by a highly compressed digital video recording system (DVR). Most DVRs in use today encode images using a form of predictive MPEG compression (Moving Picture Experts Group). Predictive MPEG video encoding recreates images by tiling groups of pixels (picture elements) together in a montage of blocks. Each block of pixels represents an approximation of the sampled area of the original scene. The more densely populated that the sampled area is with pixel blocks, the more likely it is that the sampled area will have higher image resolution. An area of an image with low pixel density will have less resolution. Lower resolution images will generally account for an increase in potential error when an analyst attempts to define an accurate edge, such as the top of a suspect's head, or an edge of a measurement marker on a door frame. Commonly, inappropriate enhancement methods, such as interpolation methods that smooth images during enlargement making the image appear less blocky, actually alters the pixel relationship within an image and masks the ability to accurately define edges.

In low-resolution Short Range Photogrammetry, measurement locations are identified by noting a +/- N unit of measurement, based on a pixel-per-unit accuracy. For example, if an area being measured is twelve inches, and it is represented by twenty-four pixels, then the potential rate of error when measuring the top of the edge is +/- ½ ", because an edge cannot be determined with only one pixel (more error is created with higher compression). Likewise, the potential rate of error when measuring the bottom of the edge is also described as +/- ½ ".

When conducting height analysis of a suspect using low-resolution Short Range Photogrammetry, a number of factors must be considered that affect the accuracy of measurements [5].

- Training in imaging technology
- Training in applicable computer technology
- Proven skills with the underlying analysis technology
- Understanding of the underlying imaging technology used to create the source images (DVR compression)
- Understanding of lens distortion
- Calibration of the correct aspect ratio of the images (relationship between height to width of the images)
- The image targeted for examination should depict the suspect in an erect position. The analyst must be able to accurately determine the location of the top of the suspect's head, and the analyst must be able to accurately measure the ground directly below the suspect's head.
    - Added height produced by head covering, and by footwear
- The ability to determine the effects of gait of movement on changes to height appearance
- Ability to identify and recreate the original camera positions and angles to the target
- Image resolution
- Inappropriate camera angles
- Noise reduction techniques
- Frame grabbing technology and processes [6]
- Proper acquisition methods of the video and transcoding using methods that don't degrade the images

A large number of peer reviewed scholarly publications form a body of knowledge and validated testing results that contribute significantly to standards, techniques, and analytical methodologies for Short Range Photogrammetry analysis.

> *In the case of calculating the height of an unknown individual in an image, an object or a distance there are a number of techniques [324], [286], [272], [191], [287], [25], [73], [279] and [194] available to aid the forensic scientist. This height information could be used as an alternative means of providing useful information about the individual. However, any information taken from an image must be scrutinized for its reliability and then assessed in the context of the customer's requirements, whether it is for intelligence or corroborative evidence. The difference between measuring less complicated rigid objects and the complex non-rigid behaviour of the human body is well worth noticing. [6]*

Many of the publications acknowledge adverse issues relating to accuracy, and they focus specifically on methods to overcome compounding errors associated with determining a suspect's height from video images. Foremost in establishing a methodology is the requirement to identify the top of a suspect's head, and to measure vertically to the ground 'midway' between the feet [7].

> *The definition of body height is the vertical height from the floor to the top of the head when a person is in an upright position with feet together and knees extended. [5]*

> *The accuracy of the result from measuring the height of a person strongly depends on the person's position, which is well illustrated in the classical book 'Man in Motion' [237]. Shoes and masks further affect the measured value. [6]*

In most crime videos, the targeted suspect is in motion. The qualified video analyst conducting height analysis should appreciate the influences of height appearance when observing an individual on video who is standing motionless and erect, as opposed to the same individual who is walking casually, or who is in a full sprint. A number of academic research projects explore the questions of how gait affects the appearance of height. The overall findings support that when a person is in motion the vertical height is most accurately assessed at the point when the feet are in 'midstance' in the gait-cycle (when the advancing foot is swinging forward, passing the front of the body).

> *Midstance in walking is the position where vertical height corresponds best with actual height. [5]*

Some publications also note the dangers associated with attempting to determine suspect height from a single image. If the suspect is recorded to an image in a relaxed position, or in a full run, the measured results could be significantly different from the target's actual height. Likewise, lens distortion and compression effects on video could randomly alter the edge pattern necessary to accurately define the top of the head or the bottom of the feet. Where possible, research asserts that multiple measurements should be taken when the suspect is in different positions, and more effectively, measurements should be obtained from multiple camera angles when the suspect is captured in the same position by more than one camera at the same time. The different camera angles can be used to triangulate a suspect's height using 3D processes and tools.

Here, the technique that uses measurements from an image sequence and not only a few still images, is useful to analyze the dynamic behaviour, such as the height of a person in a crime scene. By using sequences, measurements from deformable and articulated objects can be more accurately determined. This has turned out to be very useful in operative casework. [6]

The standards and guidelines for height comparison methodologies and practices for forensic video analysts are set out in the FBI's Scientific Working Group on Digital Evidence (SWGDE) *Best Practices for the Forensic Use of Photogrammetry*. The document discusses the importance and practices relating to evidence preparation, and it highlights limitations in methodologies and the need to determine and to accurately state potential error rates in measurement calculations.

Practitioners of photogrammetry should have sufficient expertise in image science, which may include video engineering, to support conclusions and address potential sources of uncertainty in the measurement. [2]

Supporting its recommendation for proven expertise in image science, SWGDE also publishes related standards documents, including *Guidelines & Recommendations for Training in Digital & Multimedia Evidence*. Section 3.2.14.4 "Video Analysis", establishes the many areas of training and knowledge recommended for Analysts who work with video images. Among the recommendations is that the analyst obtain training in the following areas [8]:

- Scientific Foundation
  - Theory and history of television
  - Basic computer theory and application to video processing
  - Basic digital theory
  - Imaging science to include optics and cameras
  - Frequency fundamentals
- Technical Foundations
  - Image processing (traditional and digital); Compression artifacts
  - Video signal standards
  - Basic audio principles
  - Electronics
  - Principles of video recording (analog and digital); Video enhancement
  - Video editing
  - Signal analysis
  - Video media reconstruction
  - Video data recovery
  - Playback optimization /head alignment; Analog and digital CCTV concepts
  - Video formats, standards, and file identification
- Equipment
  - Recording and playback devices
  - Monitors and other output devices
- Tools for duplication, conversion, processing and analysis
  - Media types
  - Calibration and maintenance video signal measuring devices
- Software Applications
  - File identification
  - Processing and enhancement of video/images

- Metadata determination
- Diagnostic
- Calibration
- Recovery of corrupted video files
- Non-linear editing

- Video Analysis Procedures

There are a number of organizations that provide various levels of training in forensic video analysis. The Law Enforcement & Emergency Services Video Association (LEVA) is the only certifying body that also provides training to both the public and private sectors in areas of study including reverse projection photogrammetry, image analysis, DVR recovery, and photographic video comparison. LEVA courses focus on technical foundation and processing of digital video images in preparation for the analyst to testify in court. LEVA's Certification program requires over 288 hours of course work, testing, and a final boarding during which the certification candidate must defend an analytical case before a board of peers.

Court Acceptance of Height Analysis from Video Images

Case law on reverse projection and photogrammetry divides into areas that address one or more of the following issues:

1. Measurement of structures or property lines from aerial photographs. These cases are of little assistance to issues relating to human height evaluation.

2. Technical litigation between companies that manufacture software or utilize photogrammetry software. These cases are also of no assistance.

3. Convicted prisoners seeking a new trial or an acquittal on the basis of post-trial photogrammetry evidence which purports to show that the defendant could not possibly have been the perpetrator of the offense; precisely what is claimed the specific case examined in this review. However, coupled with most of these petitions is a claim of ineffective assistance of trial counsel for not leading photogrammetric evidence proving innocence. Almost all of these cases result in the petition being denied on the basis that the proposed evidence would not of itself mandate a reversal. Some of these cases are of value although typically photogrammetry is not discussed substantively. Where comments from the bench are helpful to this review, they are discussed below.

4. Cases where photogrammetry was used in criminal or civil litigation. These cases are of value in examining many issues relevant to this review, especially where comments are made about the science or about the expert providing the evidence.

For this report, some of the most relevant comments from the bench are included below in the section on the ***technical and foundational knowledge requirements*** for witnesses using photogrammetric techniques.

United States

State of Washington v. Dunya, 2015 WL 248708 (Wash.App. Div. 1) (Court of Appeals of Washington)

Dunya was charged with the murder of his wife. Part of the evidence against him was infrared surveillance video which showed a person near the victim's residence at the relevant time. The state called a forensic video analyst who testified regarding the effect of infrared light in assessing the true tonal value of image content. The analyst also conducted a reverse projection photogrammetry experiment for the purpose of determining the approximate height of the person shown in the video images. On appeal, the defendant argued that the trial judge erred in admitting the analyst's evidence. The Court of Appeals of Washington, after reviewing the analyst's evidence, commented at p. 12:

> *The court did not err in concluding Detective Schwallie qualified to testify as an expert witness. Detective Schwallie had specialized knowledge of infrared video, had analyzed the surveillance video using reverse projection photogrammetry, and was better able to compare the skin tone and height and build of the individuals in the video. Detective Schwallie's testimony was helpful to the jury and relevant to identifying the person in the video. Because the surveillance video was*

recorded in infrared mode, the color and tone of the images was distorted. As the court observed, the video images differed from "what would be seen with ... the naked eye or some other type of footage."

The evidence given by the analyst dealt with subject matter on which the trier of fact needed expert assistance in order to form a correct judgment. It would be improper to allow a jury to speculate on tonal value and suspect height when an expert witness could provide the necessary information. There was no detailed discussion of the reverse projection evidence beyond ruling that it was properly presented by a qualified expert with specific training in reverse projection photogrammetry and was therefore admissible.

Madden v. Cate, 2013 WL 5741781 (C.D.Cal.) (United States District Court)

In this petition, Madden sought habeas relief alleging that he was wrongly convicted. Part of his argument was that a post-conviction photogrammetry expert determined that his height was different from that of the actual robber. An expert, Stutchman, had in fact been retained by the defense at trial, but his evidence was not presented as the expert was of the view that there was no marked discrepancy in height between Madden and the robber. The second expert retained by Madden determined there was 2.999" difference in height between the robber and Madden.

The District Court was not satisfied that the second expert's calculations were sufficiently accurate. Specifically, the following defects were noted:

1. The expert assumed that the camera used in the photogrammetry was the same camera used to record the robbery, but did not establish that as a fact.

2. The expert did not adequately take into account the height of the hat worn by the robber or his shoes.

3. Image comparison was based on poor quality images.

This case is helpful in setting out the requirements that must be met in order for photogrammetry evidence to be sufficiently reliable to be considered by the court. Inferentially, it also comments on the need for a competent expert who takes into account all relevant data when proffering an opinion on height. It is important to note that the expert failed to consider the effect that the robber's hat or shoes may contribute to the calculated height, and also that there was no consideration by the expert for the ill-effect of the quality of the images.

State of Wisconsin v. Avery, 337 Wis.2d 560, 2011 WI App 148 (Court of Appeals of Wisconsin)

This was an appeal from a lower court refusal to grant a new trial following the discovery of new scientific evidence in a robbery case. Following convictions for two robberies, it was learned that new technology would allow a properly qualified expert to more accurately determine the height of the suspect in one of the two robberies. Evidence was given for the defendant (Grindstaff) and for the state (Vorder Bruegge), and both witnesses theorized that the suspect was shorter than the defendant. The lower court wrongly weighed the evidence of the experts, and, after preferring Vorder Bruegge's evidence, denied the application for a new trial. Since the lower court was not permitted to weigh the evidence in the application, the Court of Appeals ordered a new trial.

This case is not included for the procedural discussion, but rather because it shows that the court recognizes reverse projection photogrammetry as being a valid science and of considerable assistance to the court in determining the truth. As this is an appellate level decision, this case will be helpful for the broader discussion in this review.

State of Texas v. Stevenson, 304 S.W.3d 603; 2010 WL 323562 (Tex. App. – Fort Worth 2010) (Court of Appeals of Texas, Fort Worth)

In this murder case arising out of a convenience store robbery, the state's forensic video analysis expert overlaid 911 calls onto the store's surveillance video and developed a visual presentation to show what occurred during the robbery. As the presentation was shown, the expert narrated the events as they occurred. The defendant objected to the expert's evidence, relying on a Daubert analysis.

The Court noted that before admitting expert testimony under Texas Rules of Evidence 702, the trial court must be satisfied that three conditions are met:

1. The witness qualifies as an expert by reason of his knowledge, skill, experience, training or education.

2. The subject matter of the testimony is an appropriate one for expert testimony.

3. Admitting the expert testimony will actually assist the fact finder in deciding the case.

The court stated:

> *Furthermore, a trial court need not exclude expert testimony simply because the subject matter is within the comprehension of the average jury. See id. & n. 7. That is, if the witness has some special knowledge or additional insight into the field that would be helpful, then the expert can assist the trier of fact to understand the evidence or to determine a fact in issue. Id. at 527. An expert may add precision and depth to the ability of the trier of fact to reach conclusions about subjects that lie well within common experience. Id. Because the possible spectrum of education, skill, and training is so wide, a trial court has great discretion in determining whether a witness possesses sufficient qualifications to assist the jury as an expert on a specific topic in a particular case. Id. at 527–28. [at page 620]*

The court of criminal appeals has set out the following criteria to consider in assessing whether a trial court has abused its discretion in ruling on an expert's qualifications:

> *First, is the field of expertise complex? The degree of education, training, or experience that a witness should have before he can qualify as an expert is directly related to the complexity of the field about which he proposes to testify. If the expert evidence is close to the jury's common understanding, the witness's qualifications are less important than when the evidence is well outside the jury's own experience.... Second, how conclusive is the expert's opinion? The more conclusive the expert's opinion, the more important is his degree of expertise.... And third, how*

central is the area of expertise to the resolution of the lawsuit? The more dispositive it is of the disputed issues, the more important the expert's qualifications are. [at page 620]

Thus, when considering whether a trial judge should permit expert testimony, the court must consider the qualifications of the expert. The following factors are relevant:

1. The more complex the field of expertise, the more important the expert's qualifications become.

2. The more conclusive the expert's opinion, the more important the expert's qualifications become.

3. The more critical the expert's evidence is to solving the issue before the court, the more important the expert's qualifications become.

After noting that there had been an unsuccessful Daubert challenge at trial, the Court held that it was reasonable for the trial judge to conclude that the expert could assist the jury by clarifying what they were seeing in the video, particularly with regard to height comparisons.

However, Fredericks testified during the Daubert hearing that "part of the subdiscipline of forensic video analysis includes height comparison of individuals ... [by] going back to the scene, calibrating the camera, and taking a height standard, and placing it back where one of the individuals was standing," so that he could provide some information about height. He testified that he did not make estimates of the individuals' heights, i.e., how tall they were, but instead made observations about their comparative heights.

*Having reviewed the videotape evidence, with regard to this complaint, we conclude that the trial court did not abuse its discretion by allowing Fredericks to testify as an expert because it could have concluded, based on Fredericks's testimony at the Daubert hearing, that Fredericks was an expert in forensic video analysis, that the subject matter was appropriate for his testimony, and that admitting Fredericks's testimony would actually assist the jury in deciding the case. See Rodgers, 205 S.W.3d at 527. That is, the trial court could have reasonably concluded that even though the jurors could see for themselves the sequence of events at Terry's Food Mart on the videotape, Fredericks's testimony could help clarify what they were seeing on the poor-quality black-and-white video, particularly with regard the comparison of the individuals' heights. See, e.g., Lerma v. State, No. 14–98–00977–CV, 2000 WL 123768, at *5 (Tex.App.-Houston [14th Dist.] Feb. 3, 2000, pet. ref'd) (not designated for publication) (holding that it was not ineffective assistance of counsel to fail to object to qualifications of expert witness who testified concerning measurements made at the murder scene and his extrapolations of the height of one of the assailants from those measurements).*

This case is helpful in describing what use may be made of a properly qualified forensic video analyst at trial and specifically with respect to using reverse projection to determine height.

Hutchinson v. Hamlet, 243 Fed.Appx.238, 2007 WL 1982191 (C.A.9 (Cal.)) (United States Court of Appeals, Ninth Circuit)

Hutchinson was convicted of robbery in state court and unsuccessfully appealed his conviction in the state court arguing ineffective assistance of counsel. He then filed for a petition of habeas corpus in the federal court arguing that he was deprived of effective assistance of counsel at trial. Hutchinson argued that his trial counsel failed to investigate and present expert evidence about the height of the robber. During the federal habeas proceeding, Hutchinson presented expert evidence (Stutchman) who, using photogrammetry, examined CCTV images of the robbery and concluded that Hutchinson could not possibly be the robber because of the height differential. The United States District Court granted the application and granted relief. The United States Court of Appeals upheld this ruling.

This case does not offer much commentary on photogrammetry itself, but is helpful in arguing that the failure to present such evidence at trial could amount to ineffective assistance of counsel requiring relief at the appellate or federal level. Inferentially, it also endorses the value of photogrammetry in ascertaining the truth.

United States v. Williams, 235 Fed.Appx. 925, 2007 WL 1643197 (C.A.3 (Pa.)) (United States Court of Appeals, Third Circuit)

Williams was convicted following trial on two counts of bank robbery. Part of the evidence used by the prosecution was reverse projection photogrammetry and on appeal, Williams argued that the District Court erred in admitting such expert evidence on the basis that it did not meet the standards set out by Daubert.

The primary issue at trial was the height of the robber in each of the robberies. FBI Examiner Smith used reverse projection photogrammetry, and concluded that the robber in each case was approximately 5’11”, with a margin of error of 1”. Defense experts had opined that the robber was between 5’2” and 5’7”. Williams’ height is 6’. Following a Daubert hearing, the trial court was satisfied that Smith’s evidence was admissible, having met the requirements of FRE 702. The issue on appeal is whether reverse projection photogrammetry is scientifically reliable.

Williams argued that:

> *The District Court erred in admitting Smith's testimony because the government failed to proffer evidence demonstrating the reliability of Smith's reverse projection photogrammetry technique as it was used in this case, including evidence that the technique has been published or subjected to peer review, evidence as to the technique's error rate, evidence as to the standards controlling the technique's operation, or evidence that the technique, as used in this case, is accepted by anyone outside of the FBI. [at page 928]*

The Court of Appeals rejected this claim noting that not all Daubert factors apply equally (or at all) in each case nor are such factors a complete list of reliability measurements.

The Court of Appeals concluded:

> *Under the liberal Daubert standard, the plaintiffs do not have to prove to the judge by a preponderance of the evidence that their expert's testimony is correct, they must only show that it is reliable. The requirement of reliability is lower than the standard of correctness. A judge can find an expert opinion reliable if it is based on “good grounds” or methods and procedures of*

science rather than on subjective belief or unsupported speculation. Daubert, 509 U.S. at 590, 113 S.Ct. 2786. The judge does not have to determine that these methods are necessarily the best grounds to ascertain certain facts, but only that the evidence presented will help the trier of fact.

Additionally, the reliability factor is not a strict requirement that should be used to exclude all questionably reliable evidence. "The reliability of evidence goes 'more to the weight than to the admissibility of the evidence.' " Velasquez, 64 F.3d at 849 (citing United States v. Jakobetz, 955 F.2d 786, 800 (2d Cir.1992)). In order to be admissible, evidence need only be sufficiently reliable to help the trier of fact. In re Paoli R.R., 35 F.3d at 744.

Here, the government proffered a detailed explanation of the technique of reverse projection photogrammetry. Smith testified about the methodology used in the technique and detailed how the methods were applied in this case. He also testified that he has published articles about the technique and that it is employed by the FBI and by a few other law enforcement agencies.

We conclude that the District Court did not abuse its discretion in determining, based on this evidence, that the reverse projection photogrammetry technique is sufficiently reliable to satisfy the admission requirements of Rule 702. Because Smith's evidence spoke to the paramount concern in the case (the height of the robber) and because the District Court found Smith's technique to be sufficiently reliable, the District Court did not abuse its discretion in admitting Smith's testimony.

Once the foundation for admissibility required by Daubert has been established, concerns about the validity of an expert's conclusions should not result in the exclusion of the expert's testimony. Rather, such concerns should be presented to the jury through cross examination, presentation of contrary evidence and careful instruction on the burden of proof. Rock v. Arkansas, 483 U.S. 44, 61, 107 S.Ct. 2704, 97 L.Ed.2d 37 (1987). [at page 928-929]

This case is helpful because it confirms that reverse projection photogrammetry, when presented by a competent, articulate and knowledgeable witness, is sufficient and scientifically reliable to be admitted at trial. Further, because it is an appellate level decision, it will have some precedential value.

Chappel v. Garcia, 2006 WL 1748424 (E.D.Cal.) (United States District Court)

Chappel was convicted of a variety of offences, and part of the evidence against him was reverse projection photogrammetry used by the prosecution. In this habeas proceeding, Chappel argued that his trial counsel did not adequately challenge the expert's evidence. The Court described the expert evidence in positive terms pointing out that the expert (Vorder Bruegge) did the following:

1. selected an image that showed the best upright position recorded to use for measurement

2. determined that the bank's camera had not been moved since the event

3. placed a height chart exactly where the suspect stood

4. measured to the top of the suspect's hood

5. acknowledged a range of variance due to image resolution (could not be more accurate than plus/minus ¼ inch), could not determine distance from top of head to top of hood, did not know thickness of suspect's shoe soles, and knee was slightly bent

These factors resulted in a height estimate of 5'3" to 5'7".

Though not specifically called upon to assess the validity of the expert evidence, it is implicit in the court's finding that it found the expert evidence to be conservative, and that it took into account appropriate areas of variance.

Vincente v. City of Rome, Georgia, 2005 WL6032876 (N.D.Ga.) (United States District Court)

This case involved a fatal shooting of a suspect by the police, and ensuing litigation by the estate of the deceased against the city. An application was brought by the estate to exclude five experts whom the city proposed to call in the civil litigation. One was an expert who proposed to give evidence as to the location of the officer in relation to the deceased when he fired his gun, relying in part on photogrammetry. The estate argued that he was not properly qualified, that photogrammetry was not a reliable science, and that the expert did not do his analysis properly. The first two arguments failed, but the third gained traction.

The court stated:

> *The Court, however, observes that problems exist with respect to the manner in which Mr. Stokes performed his analysis. As an initial matter, Mr. Stokes' analysis of the Lopez vehicle did not involve conditions sufficiently similar to that of the incident to allow his testimony to be reliable. For example, the exemplar is missing tires and is parked on dirt pavement, and also is lower to the ground. As Mr. Stokes acknowledged in his deposition, those factors could affect the height of the gun, which in turn could change the estimate of Sergeant Smith's location. Even though Mr. Stokes contends that any change in the height of the gun would change the location of Sergeant Smith by a foot or less, such a small distance could make a significant difference in the outcome of the case.*
>
> *Additionally, Mr. Stokes appears to estimate the distance from the end of the gun to Hector Lopez's vehicle. Mr. Stokes, however, cannot determine that information from the videotape, because Officer Pace is standing in front of Sergeant Smith and the gun during this part of the videotape.*
>
> *Further, the location of the driver's seat and the incline of the seat affect the trajectory analysis. Mr. Stokes had no measurements from the GBI to make that determination, but instead estimated the location of the seat and the incline of the seat from a photograph. The photographs, however, do not show the driver's seat in relation to the other front seat or to the rear seat, which could cause some problems with perspective.*

Given the above circumstances, the Court finds that Mr. Stokes simply is "guessing" as to the location and position of the car seat, the bullet trajectory, measurements of distances, and the position of Sergeant Smith. The Court therefore will exclude Mr. Stokes' testimony as to those issues, as well as Mr. Stokes' testimony pertaining to his exemplar shot. [at pages 10-11]

This decision is of value because it emphasizes the importance of both the competence of the expert and the requirement to base any opinion on valid and verifiable data.

State of California v. Mouser, 2004 WL 114687 (Cal.App. 5 Dist.) (California Court of Appeal, Fifth District)

In this homicide case, photogrammetry was used to measure markings on the deceased's body as observed on photographs. A reconstruction was undertaken using an exemplar model of the same general size as the deceased. The court was urged to reject expert evidence of a scene reconstruction that was conducted for the purpose of conducting measurements of the marking on the body. The court commented on the degree of exactitude required for a valid reconstruction to be admissible as follows:

The trial court possesses broad discretion in determining whether to admit "experimental" evidence. (People v. Bradford (1997) 15 Cal.4th 1229, 1326.) The party seeking to admit such evidence bears the burden of establishing that the evidence rests on an adequate foundation. The party must prove (1) that the experiment is relevant; (2) that the experiment was conducted under at least substantially similar, although not necessarily absolutely identical, conditions as those of the actual occurrence; (3) the individual testifying about the experiment is qualified; (4) evidence of the experiment will not consume undue time, confuse the issues or mislead the jury. (People v. Turner (1994) 8 Cal.4th 137, 198.)
…

Defendant's argument is premised on the misperception that a reconstruction experiment must be identical to the original conditions in all respects. This is not the state of the law. While the experiment must be substantially similar, precise duplication is not required. (People v. Turner, supra, 8 Cal.4th at p. 198; Beresford v. Pacific Gas & Elec. Co. (1955) 45 Cal.2d 738, 748; People v. Roehler (1985) 167 Cal.App.3d 353, 385-386.) Determination whether conditions of an experiment were sufficiently similar to the original conditions to make the experiment an aid to the jury is a matter that rests in the judge's sound discretion. (Beresford v. Pacific Gas & Elec. Co., supra, 45 Cal.2d at p. 748.) [at pages 22-23]

Given that a reverse projection requires a reconstruction of the scene, this case sets out the test that must be followed. The reconstruction must be substantially similar, but precise duplication is not required. This can be useful in rebutting the contrary argument that a reverse projection will not be an exact replication. This case also comments on the importance of the expert's qualifications.

There are two additional reported cases wherein photogrammetry evidence was led and admitted without debate:

- ***United States v. Bobbitt and Jones***, 203 F.3d 822, 2000 WL 102925 (C.A.4(Va.)) (United States Court of Appeals Fourth Circuit);

- ***United States v. Johnson***, 114 F.3d 808 (United States Court of Appeals, Eight Circuit)

UNITED KINGDOM

R. v. Barnes and Burton, [2012] EWCA Crim 1605 (Court of Appeal, Criminal Division)

In this robbery case, the prosecution called an expert who gave evidence as to a reverse projection he conducted for the purpose of determining the approximate height of the suspects. The process followed by the expert was described as follows:

> *Mr Coxon was able to prepare a photographic overlay for each of the acted recordings, which could be, and was, superimposed upon the crime scene recording. By this means a direct comparison could be made between the actor known to be 5'7" tall and the gunman, and between the actor known to be 6' and the gunman, while each of them was in the same position in the post office as was the gunman. For some reason this technique was described by Mr Coxon as "reverse projection". But it seems to us that far from being new science, it employed photographic techniques well-known to criminal courts; for example, facial mapping is routinely demonstrated by preparing images, one of which can be overlaid on the other. The technique requires that the two images are properly aligned, comparable, clear and undistorted.*

As to the margin of error for such a process:

> *Because absolute replication of choreography was not possible, Mr Coxon accepted that there was a margin for error. The appearance of the images created by the actors may, for example, be affected by footwear and a particular stance adopted by the actor when in the same position within the post office as was the gunman. However, the absolute accuracy of the choreography was not required for the purpose of the height comparison. What was required was that the actor stood in the same spot, as had the gunman, to enable a proper comparison to be made. The ultimate question for the jury was simply whether or not the gunman appeared to be 6' tall, as had been asserted by Mr Barnes, or whether he may have been in the region of 5'7". Indeed, Mr Coxon accepted that there was a margin for error and said that the gunman could have been, in his view, any height between 5'5" and 5'8".*

This decision endorses the use of reverse projection in circumstances very similar to the methods used in North America. It does not demand precision, and accepts that a margin of error is proper. Lastly, it states that it is a question of weight for the jury to determine how to assess and incorporate the expert evidence.

Technical and Foundational Knowledge Requirements

Reverse projection photogrammetry requires specialized knowledge of the tools, processes and applications associated with the technical examinations. An analyst must be able to understand and then articulate what influences the technology may have had on the outcome of the exhibit.

The following cases discuss the level of knowledge required for reverse projection photogrammetry and other computer based analysis:

State of Connecticut v. Swinton, 268 Conn. 781; 2004 Conn. LEXIS 190 (Supreme Court of Connecticut)

The Supreme Court of Connecticut issued a significant ruling on the issue of authentication and the use of computer generated evidence. In Swinton, part of the evidence against the defendant was a forensic comparison between bite marks found on the murder victim's breast, and dental impressions taken from the defendant. The state tendered photographs of a bite mark that were enhanced using LUCIS software and Adobe Photoshop images of the defendant's dental impressions superimposed (overlaid) on the LUCIS enhanced photographs. A forensic odontologist concluded that the defendant inflicted the bite marks on the victim's breast. The defendant argued that the state did not present adequate foundation testimony on the adequacy of LUCIS and Photoshop for the forensic matching process that was utilized. He argued that the state experts had only an elementary familiarity with those programs, and that as a result his constitutional right to confrontation was violated.

The photographic enhancements were introduced through a state forensic expert who, while not an expert in LUCIS software, provided a reasonably comprehensive explanation and demonstration of how the software worked and what affect it had on the photographs in question. The forensic odontologist, who merely observed the Photoshop overlays being created, and had no skill or experience with the program, was able to provide very limited evidence about Photoshop and its workings.

In analyzing the issue of what is necessary to lay a proper foundation for the admission of computer generated evidence, the Court said:

> *We agree that "reliability must be the watchword" in determining the admissibility of computer generated evidence; Nooner v. State, supra, 322 Ark. 104; and we conclude that these six factors adequately refine our requirement enunciated in American Oil Co. that, in order to lay a proper foundation for computer generated evidence, there must be "testimony by a person with some degree of computer expertise, who has sufficient knowledge to be examined and cross-examined about the functioning of the computer." American Oil Co. v. Valenti, supra, 179 Conn. 359. In addition to the reliability of the evidence itself, what must be established is the reliability of the procedures involved, as defense counsel must have the opportunity to cross-examine the witness as to the methods used. We note that "reliability problems may arise through or in: (1) the underlying information itself; (2) entering the information into the computer; (3) the computer hardware; (4) the computer software (the programs or instructions that tell the computer what to do); (5) the execution of the instructions, which transforms the information in some way - for example, by calculating numbers, sorting names, or storing information and retrieving it later; (6) the output (the information as produced by the computer in a useful form, such as a printout of tax return information, a transcript of a recorded conversation, or an animated graphics simulation); (7) the security system that is used to control access to the computer; and (8) user errors, which may arise at any stage." R. Garcia, "'Garbage In, Gospel Out': Criminal Discovery,*

Computer Reliability, and the Constitution," 38 UCLA L. Rev. 1043, 1073 (1991); see also K. Butera, "Seeing is Believing: A Practitioner's Guide to the Admissibility of Demonstrative Computer Evidence," 46 Clev. St. L. Rev. 511, 525 (1998) (proper authentication requires that reliability of computer process and accuracy of results be subject to scrutiny).

We believe that these factors effectively address a witness' familiarity with the type of evidence and with the method used to create it, and appropriately require that the witness be acquainted with the technology involved in the computer program that was used to generate the evidence. These factors also ensure that the hardware and software used to generate the evidence were adequate for that purpose and that the technology was reliable. As in our decision in Porter, we stress that these factors represent an approach to the admissibility of computer generated evidence, and not a mechanical, clearly defined test with a finite list of factors to consider. See State v. Porter, supra, 241 Conn. 79. "Trial courts must have considerable latitude in determining the admissibility of evidence in this area as in others." American Oil Co. v. Valenti, supra, 179 Conn. 360. Although a trial court should weigh and balance these factors and decide whether they ultimately support the admissibility of the evidence, we offer these factors to serve as guideposts, and do not suggest that these factors necessarily are to be held in equipoise…[at pages 812-814]

And at pages 829-830:

A witness must be able to testify, adequately and truthfully, as to exactly what the jury is looking at, and the defendant has a right to cross-examine the witness concerning the evidence. Without a witness who satisfactorily can explain or analyze the data and the program, the effectiveness of cross-examination can be seriously undermined, particularly in light of the extent to which the evidence in the present case had been "created."

The Court concluded that the bite mark photographic evidence that was generated by LUCIS software was admissible because the forensic expert that presented the evidence had a sufficient level of knowledge regarding LUCIS to provide foundation evidence. However, the Photoshop evidence was ruled inadmissible because the forensic odontologist did not possess the requisite foundation knowledge.

This decision has direct application to any digital image evidence that undergoes forensic processing, where those images will be presented in court. The witness who presents such evidence must have sufficient training in the use of the underlying technology, and the witness must have sufficient knowledge of the technical processes and computer equipment used in order to lay the appropriate foundation for the evidence. It is not necessary for the witness to be an expert in the computer programs involved but the witness must have a competent understanding of the technical work that was undertaken and the tools that were used for that purpose. This would also apply to reverse projection and photogrammetry as the witness would be required to understand the technical limitations of the underlying images as well as have sufficient knowledge of the computer processes used to analyze them.

While Swinton is not binding in other jurisdictions, the principles set out by the Connecticut Supreme Court are compelling, and attorneys who present digital image evidence, especially via expert witnesses, find this approach helpful.

Swinton was cited with approval by the United States District Court in **Lorraine v. Markel American Insurance Company**, 241 F.R.D. 534.

It was also applied by the Superior Court of Connecticut in **State of Connecticut v. Anderson**, 2012 WL 5204622 (Conn.Super.), a case dealing with the use of computer animation as part of collision reconstruction evidence.

The Ponca Tribe of Indians of Oklahoma v. Continental Carbon Company, et al., 2008 WL 7211981 (W.D.Okla.) (United States District Court)

In this civil case, the issue was the ability of the expert witness to interpret aerial photogrammetry images. The Court said that the expert must have sufficient skill and experience, and must use the proper equipment in order to accurately interpret images.

State of Connecticut v. Melendez, 291 Conn. 693, 970 A.2d 64 (Supreme Court of Connecticut)

The Swinton case was revisited by the Connecticut Supreme Court in the context of video evidence in State of Connecticut v. Melendez. At issue was whether digital video of drug buys was admissible at trial. Some of the state tendered video had been enhanced or slowed to 10% real time or both. The state did not call sufficient evidence to comply with the requirements of Swinton, and even though the trial court admitted the video evidence, the Supreme Court ruled that it should not have done so, and excluded the evidence. Other video consisting of DVD copies of the original 8 millimeter video that were not subjected to any modifications were also admitted at trial. As to their admissibility, the Supreme Court stated:

> *We reach a different conclusion, however, with respect to the portions of the DVD containing the footage that Brunetti did not modify, that is, the two video clips that are exact copies of the footage originally captured on the eight millimeter videotape while the transactions were occurring. In Swinton we acknowledged the difficulty in establishing a precise definition of what constitutes "computer generated" evidence. We did, however, draw a distinction between technologies that may be characterized as merely presenting evidence and those that are more accurately described as creating evidence. With that fundamental distinction in mind, we conclude that the portions of the DVD containing the exact duplicates of the original, unenhanced footage played in real time, simply do not constitute computer generated evidence for purposes of Swinton. Thus, to the extent that Brunetti merely transferred a copy of the contents of the original eight millimeter videotape to the DVD, that process, which Rubinstein witnessed, does not implicate the foundational standard that we adopted in Swinton. Although it is true, of course, that generating such a copy required the use of technology, that technology, which is widely used and readily available, involves nothing more than the reproduction of video footage from one medium to another. Indeed, the defendant has provided no reason why the admissibility of copies that are produced by that process-copies that have not been enhanced, altered or changed in any way-should be subject to the more rigorous requirements of Swinton. We conclude, therefore, that compliance with Swinton was not a prerequisite for admission of the unmodified video clips contained on the DVD.*

Therefore, Swinton is clearly applicable to digital image evidence, but the detailed requirements set out by the Court do not apply to the process of copying video without modification. However, the court did differentiate that the creation of evidence was different than merely presenting evidence. Clearly, Swinton would apply to cases where the evidence is 'generated' by a computer. In those cases, the expert would be required to establish technical knowledge of the process.

The Queen v. Shadrock et. al., [2012] NZHC 1449 (High Court of New Zealand)

In this case, the prosecution called a forensic imagery expert whose proposed evidence was challenged by the defense. The defense called a forensic video analyst. At issue was whether the prosecution expert would be permitted to express an opinion as to the position of the victim relative to a motor vehicle. The court ruled that because the prosecution expert did not have sufficient knowledge of the underlying technology that created the digital images, and the impact of compression algorithms, he could not use those images to express an opinion on positioning. Though not binding in the United States, this common sense approach is applicable in any jurisdiction. Foundational knowledge of the underlying recording technology is critically important to the analyst's ability to interpret and to process the source video images.

An Examination of the Case at Issue

On November 20, 2009, George R. Powell, III was convicted of aggravated robbery of a 7-Eleven store in Killeen, Texas, and was sentenced to 28 years in prison. At trial, the trier of fact was told of additional robberies linked to the same suspect: direct evidence regarding consistent suspect height was given regarding another robbery at a nearby Valero Gas Station. At the time of the investigations, numerous witnesses described the suspect as being between 5'7 and 5'9. Mr. Powell is 6' 3" tall. He first became a suspect as the result of a Crime Stoppers tip. In his complaint to the FSC, Mr. Powell alleges the State's expert provided false height analysis evidence from video images at both stores, ultimately leading to Powell's conviction.

The State's expert (Knox and Associates) conducted a height evaluation of the robber using a single digital video image from the 7-Eleven, and a single digital video image from the Valero Gas Station. The expert, Michael Knox, testified that he employed photogrammetry analysis using PhotoModeler software. Mr. Knox opined that the robber at the 7-Eleven is taller than 6' 1", and that the Valero robber could be the same height, but is at least 5' 11½". Mr. Knox provided no margin of error for either examination.

After the trial, a friend of Mr. Powell retained her own forensic experts, Dr. Al Yonovitz and Mr. Herbert Joe, to examine the video surveillance used to convict Mr. Powell. Their findings contradict the evidence used to convict Mr. Powell at trial. Their report concludes the robber is approximately 5' 7½" tall, with an approximate ½" margin of error.

This examination explores the work conducted by both sets of experts based on the foundation for such analysis as established by the reported legal cases, the analytical methodologies from experiential academic work, and by the published industry guidelines relating to training, knowledge, experience and the application of standards, all of which are outlined in detail above.

Knox's Training & Technical Knowledge

At the time of his testimony for the prosecution, Mr. Knox was a detective in the Traffic Homicide Unit of the Jacksonville Sheriff's Office in Florida. Mr. Knox was hired through his private company to conduct the analysis in this case. He did not have a post-secondary degree, he had no formal education in video analysis, television engineering, or in photogrammetry. Mr. Knox had no training relating to video analysis, image interpretation, video compression, reverse projection of compressed video images, or any other functions listed in the industry training guidelines recommended for work in this field of science.

Mr. Knox testified that this was the first case for which he had conducted height analysis of any kind.

In foundation questioning during direct examination and in cross examination, Mr. Knox misidentified the source video format as a videotape. A videotape produces an analog video signal with considerably different technical attributes from the actual digital video recordings from two robbery locations. The examination and measurements of individuals captured to an analog video recording require a different approach to photogrammetry than images from a digital recording. The actual source of the recording at the 7-Eleven was a digital video recorder, producing MPEG compressed digital images. The digital video recording at the Valero produced Wavelet compressed images. In his written report, Mr. Knox describes the images as 'surveillance video'. However at trial, he describes that he was working with images from a videotape.

McWilliams:

Specifically, you were requested to do an analysis of a crime scene videotape; is that correct?

Knox:

Yes.

[Tr. at 10-92:14-10-92:16]

McWilliams:

And you were provided with a videotape from a 7-Eleven store, were you not?

Knox:

Yes.

McWilliams:

And did you request some specific measurements of things you saw at a particular point in that videotape?

Knox:

Yes.

[Tr. at 10-98:23-10-99:3]

Barina:

…. you indicated to Mr. McWilliams that you had the offense reports and you had the videotape.

Knox:

Yes.

[Tr. at 10-100:5-10-100:8]

Mr. Knox's written report describes that his analysis in this case was completed on August 7, 2009 [Tr. at 11-41:20]. His report detailed that the primary photogrammetry tool that he used to produce his height analysis was a program called PhotoModeler. PhotoModeler is a well-known photogrammetric tool, most commonly used in the accident reconstruction industry, but is also frequently used by appropriately trained experts to conduct height estimation of suspects from video images.

According to his CV, at the time he completed his work on this case, Mr. Knox lists no training on the PhotoModeler software. His CV does list one 24-hour 'Accident Reconstruction' course on the tool's operation. He attended the course in Chicago in October of 2009, two months after he completed his report using the software. Approximately one month later, on November 17, 2009, Mr. Knox provided direct evidence in voir dire, in which he detailed his use of PhotoModeler to obtain his height measurements of the robbery suspect. Although he testified that he had recently attended a training course in the software, he did not explain that he took the course after he had submitted his PhotoModeler analysis of the robber's height.

McWilliams:

Have you had specialized training regarding the use of the software?

Knox:

Yes, I have.

McWilliams:

And what kind of software is it?

Knox:

It's Photo Moduler which is actually a software program that was released in 1993. It's in its sixth version now. And then I just recently attended a training course that's through the manufacturer that's using Photo Moduler, that's specific to accident reconstruction, but we also dealt with some crime scene reconstruction-type stuff in there as well.

[Tr. at 10-95:20-10:96:4]

Knox:

This is probably the only case where I have used it to measure the height of-- Given this type of circumstance where I'm given a-- what I would call an "unknown camera." In this case it would be a video of a suspect and determine the height from that.

[Tr. at 10-102:3-10-102:7]

Knox's Approach

Mr. Knox testified that when he was hired, he began his analysis by requesting that the police investigator take measurements and photographs of the doorway where the suspect was seen exiting the store. Mr. Knox did not attend the scene himself to take any measurements or photographs until after he had submitted his final report, and not until the trial had already started.

However, under direct examination on November 19, 2009, Mr. Knox described in detail the photogrammetric methodology he employed during one of the evenings of the trial to measure the robber depicted in the Valero Gas Station, which he later compared to the 7-Eleven robbery. The new methodology he described is clearly not the original methodology he used to opine on height in his written report. The new methodology required sophistication, at least as it relates to the process of calibrating the scene photographs needed for his analysis.

Knox:

What I've done is gone through a procedure where I have taken photographs of a grid that contains stops that are equally spaced out. And there are several in there that actually have a special code around them where the computer could recognize this dot is different from this one. And once I take a series of 12 photographs from different angles of that particular grid, I feed it to the software. The software knows the calculations, and it then knows all the parameters about my camera which means the focal length of the lens and the lens distortion, the things that it needs to be able to do with that camera.

McWilliams:

And, Mr. Knox, did you actually, I guess, make a recording of what you actually did in regard to the photos you took, State's 18, and then the end result as it goes through the software you spoke of the other day?

Knox:

Yes

McWilliams:

And would that be helpful to you to explain what you did to the jury?

Knox:

Yes

[Tr. at 12-28:23-12-29:16]

Knox:

This is actually a shot from the Photo Moduler Software, and what you're seeing is three photographs that I took. Each one is taken from a different angle. And what I do is--- You will actually see there is a lot of little gray X marks in different places. And what you do is you take the photographs from different angles, and you basically mark in one photograph a particular point -- say, a corner of the door -- and then you—

McWilliams:

So the little X marks are here?

Knox:

Yes.

McWilliams:

That we see? Okay, go ahead.

Knox:

And then what you do is you take and mark that same point on the other photographs so that the computer knows that this spot on this photograph is the same as this spot on the second photograph, which is the same as this spot on the third photograph. And by doing that the camera then knows where all these photographs are oriented, and it's actually able to determine where the camera was for each one of those three photographs.

And then I also have along the left side, just to the left of the fire extinguisher, I've taped up a 6' tape measure. It's a special one that I have with large numbers that I can see when I zoom in on the photograph. And I have measured-- marked the "0" mark at the bottom of it, and I have marked the "6'" mark of it. And I go in and I tell the software that this is six feet, and so now it knows how big everything is. It scaled it and it knows where everything is in relation to every other thing that's been marked.

McWilliams:

Once you have the measurements of the door, what's the next thing you do? I guess I should say the measurements of the door and kind of the orientation of the camera, I guess.

Knox:

Yes. It's the measurements of orientation is actually creating a three-dimensional model of where these points are in the 3D space.

The next step, actually, is to bring in that photograph. And you can see that there is also the gray X marks in different areas because what I've done is taken from the three photographs that I took with my camera and then started marking points that appear in those photographs that also appeared in this photograph, and then the software is able to determine what it needs to know about this camera.

So, for example, like these points right here, this point right here. And what they have to be-- enough of them and spread about the photograph that the software will actually solve and it will determine what this camera is.

And then once I've done that, I just define this plane. I tell it that, basically, this plane is all one flat surface, and then I draw on that service which what I have done is drawn the outline of the suspect coming through the door. And then I'm able to measure it. And what I've done to measure it is --again, like I explained yesterday -- you have to measure in line with the lean of the body, from the bottom of the feet to the top *of the head. So I have measured a line from the bottom of the foot to the top of the head.*

And, then, I can actually-- in the software, as you can see in this one, the line is now read. It's been selected. And I come up here, and it will give me the measurement. How long is that line? And, of course, the measurement it reads is 5.9726 which is a decimal which actually works out to 5'11-1/2". And what that represents is, again, the same as with the other store -- the minimum height (sic). He has to be at least that tall because that is the line from the bottom of his feet to the top of his head as projected on the plane of the door. So it can't be anything shorter than that. It could be taller because there is some leaning and stuff we can't account for -- the spread of the feet, leaning coming through the door -- but it can't be anything less than that so it has to be at least 5'11-1/2".

And, then, what I also did is-- just a check measurement that this is accurate, that I measured correctly, is I marked from the bottom corner of the door to where the 6' mark is on the door. And the software gives me a measure of 5.9233 feet which is 5'11". And, of course, I've measured from the bottom of the door, not from the floor. And there is probably close to an inch gap beneath the door so I'm coming up to right about 6' with that measurement which tells me that this has been done accurately.

[Tr. at 12-30:1-12-33:2]

The description of his methodology at trial required that the camera producing the foundation photographs be calibrated prior to conducting suspect measurements. However, the police investigators did not produce the series of twelve gridded photographs that Knox stated at trial was needed by PhotoModeler to solve for the camera calibration. During cross examination, Mr. Knox acknowledged that he applied his methodology for the first time the night before trial.

Barina:
And the measurements were not done by you specifically on-site, were they?
Knox:
No, they weren't. Not at the time that I did the-- my report and my initial analysis.
Barina:
Have you done that since then?
Knox:
Yes, I have.
Barina:
When did you do that?
Knox:
Last night.

[Tr. at 10-100:9-10-100:16]

Mr. Knox's primary analysis was conducted on the digital video recorded at the 7-Eleven. The video was recorded using an MPEG data compression process in which only one of every sixteen images was a fully refreshed (spatially encoded) reference frame. The other fifteen frames in each Group of Pictures (GOP) were produced using prediction in a temporal encoding process. Spatially encoded images are more reliable for measurement, since each pixel in the image is independent of previous images and are not subject to predictive influences from previous or future movement in surrounding images. Predictive images often approximate pixel values and edge location based on change between images. Predictive image values are dependent on movement between neighboring images. The image used by Mr. Knox in his height estimation was the 2nd image, the 1st predicted image in that GOP (Figure 1). Predictive images can be used in photogrammetry, but the analyst must account for the potential increase in error.

Figure 1
Door Camera 00:06:31.215

A magnified view of the selected image (Figure 2) shows that the original pixels that represent the top of the hat are located in a macroblock above the most likely location of the top of the suspect's actual head. The resolution of the macroblock makes it difficult to define the actual edge pattern of the suspect's head. However, the top white pixels of his hat are not the location of the suspect's head.

Magnification using Nearest Neighbor interpolation highlights the limitation of the image resolution and helps to establish a potential rate of error.

Figure 2

Understanding the MPEG encoding process and knowing the limitation of compressed video is critical to performing this level of analysis.

Despite the technical limitations of the video image, Knox testified during cross examination that he did not have to know anything about the recording system, and despite his lack of technical knowledge, he testified that the quality of the images were sufficient for his analysis.

Barina:

Do you know what their ability to take a good picture is then?

Knox:

No.

Barina:

Okay. So you know nothing about them.

Knox:

No.

[Tr. at 11-45:10-11-45:14]

Knox:

I didn't need information about the video camera.

Barina:

Part of what you need is also a sharp photo, correct?

Knox:

No, it can--

Barina:

No--

Knox:

-- poor quality photos—

[Tr. at 11-48:18-11-48:23]

Knox:

It can be, you know, fairly poor quality in the photographs, and the photos taken from the video were of sufficient quality to do this type of analysis.

[Tr. at 11-49:4-11:49-6]

As outlined in the *Applicable Standards & Analytical Methodologies* section of this report, published research and industry guidelines establish that accurate measurements are more reliably attained when multiple measurements of a suspect are taken, especially when the suspect is depicted in a synchronized position on multiple camera views. Although there were four overlapping cameras that showed the robber standing motionless in the same position and for some time prior to approaching the clerk, Mr. Knox chose to use a single image recorded when the robber was exiting the store.

Mr. Knox testified incorrectly that his methodology was limited to two dimensional photogrammetry, because he claimed that there were no images of the suspect depicted in the same location, at the same time, that would allow him to triangulate the suspect's location for 3D examination or for validation measurements.

Knox:

If I had two separate angles, I could have done 3-D, but it would have had to both been shot at exactly the same instant, and I just couldn't guarantee that in this case.

McWilliams:

And when you talk about "two angles", it's got to be--Or does it have to be two angles of that photograph?

Knox:

It has to be exactly that. He would have to be in exactly the same position in both images. So even if you had two video cameras, you would have to be sure they both were taking an image at exactly the same instance, and in most cases you just can't assure that.

McWilliams:

Because as the jury knows -- they have seen photographs and they have seen videos -- there is more than one camera angle, but they show different parts of the store and you can't put those together, right?

Knox:

That's correct.

McWilliams:

It would have to be the suspect in that position in another camera angle—

Knox:

Exactly.

[Tr. at 11-35:9-11-36:1]

Despite his testimony, many dozens of images were recorded between 00:05:09 and 00:05:18 (and elsewhere) showing the robber standing motionless, in the same location (Figure 3), prior to approaching the counter. By using the combined images in the sequence, Mr. Knox could have conducted a 3D examination, partially because of the ability to accurately triangulate.

Figure 3

The single image (Figure 1) that Mr. Knox did use for his examination showed the robber at an angle as he moved through the doorway. The position of the robber's head was not precisely located at the plane of the doorway, yet for the purpose of his analysis Mr. Knox made the assumption that it was.

In direct evidence on November 18, 2009, Mr. Knox was asked why he chose the specific image that he used for his analysis. He explained that because he only had one camera view, he required an image that depicted the suspect at the same plane of the doorway.

Knox:

What I needed was a photograph that showed the suspect in basically the same plane as the door. And the reason being is that I-- you know, in this particular case we have one camera view so we can't do three-dimensional photogrammetry.

[Tr. at 11-35:4-11-35:7]

McWilliams:

Okay. And I believe you said the importance is, is he's within the plane of that door.

Knox:

Yes.

[Tr. at 11-36:4-11:36:6]

Knox:

Yes. Because what I've done basically is told the computer that he's on the same plane as the door, and then I can just trace on that. And what that does is it tells the computer one dimension. It tells where he is in the door, and then by tracing around it, I'm telling where his outline is on that plane.

[Tr. at 11-36:23-11:37:3]

Although Mr. Knox described that it was important that the suspect was in the plane of the doorway, he later testified that the suspect is not actually in the plane of the doorway. The methodology that he claims was important to his process falls apart in his explanation that not only is the suspect's head not in the plane of the doorway, but he states *" … I don't have any way to know exactly how much – how far out the door his head is … "*

Knox:

Mainly, we've drawn him in the plane of the door, but in reality not only is he leaning to the side but he's also leaning somewhat in and out of the door. So that means that the foot is a little bit inside the door; the head is a little bit outside the door. That lean also tends to shorten the height, make him appear to be shorter than what he really is. But with the camera views that I have here, I don't have any way to know exactly how much-- how far out the door his head is, how far in the door his foot is. So we're just basically assuming, okay, we're not going to count that. "Six-one" means that is the minimum height. There is still some more height that has not been accounted for because of that lean.

[Tr. at 11-39:18-11-40:4]

Although Mr. Knox provides an explanation of his methodology, he diverts from it in practice.

Mr. Knox also diverts from accepted photogrammetric methodologies that clearly establish that to obtain the most accurate height of a human, one must measure from the top of the head, not to the top of the headwear, and that the measurement must be taken vertically to the ground below the head. Mr. Knox's approach is to measure from the top of the hat along the 'apex' of the body to the rear of the trailing foot (Figure 4).

Figure 4

It is important to note that a magnified view of Mr. Knox's source image (Figure 5) shows that the level of interpolation he used smooths the block structure of the original pixels. The result is an image that may look more pleasing to the eye, but is less accurate because it interpolates (changes) edge patterns, such as the location of the top of the hat, increasing potential error.

In addition, the red line (Figure 5), produced by Mr. Knox, demonstrates that he measured to the ground behind the trailing foot of the robber, rather than directly to the ground below the suspect's head, adding significant height to his measurement.

Figure 5

Knox:

You have to measure from the bottom of the feet to the top of the head which is what I have done there.

McWilliams:

So the measurement has to be taken along what I would call, I guess, the "axis" of the body.

Knox:

Yes.

[Tr. at 11-39:2-11-39:7]

Measurement Errors

Mr. Knox failed to follow industry accepted standards and methodologies in the execution of his photogrammetric examination. Rather than testing multiple images, he used only one. In his measurements, he failed to accurately identify the top of the robber's head and he stretched the length of the robber significantly by selecting a point below the trailing foot of the robber. In addition, the image he selected depicted the robber on an angle, rather than when he was erect.

The following observations identify a partial list of technical and methodological errors, each of which contributed to incremental increases to Mr. Knox's ultimate height estimation of the robber.

Although Mr. Knox acknowledged at trial that he could not determine if the robber's head was in or outside of the doorway plane, but for the purpose of his measurement he assumed that the robber's head was at the same plane of the door measurement markers. Despite this assumption, he produced a demonstrative video animation showing a known position for the robber's head. The animation shows that the head is further out of the doorway. In his testimony, he stated that the perspective of the robber, in relation to the measurement stickers on the door, changes when the one recreates the robber's position from a lower angle. In the animation, the robber's height grows significantly as the camera perspective lowers. Since the camera is facing downward toward the door, objects that are further away from the camera will appear higher in the image. Mr. Knox's animation starts with an

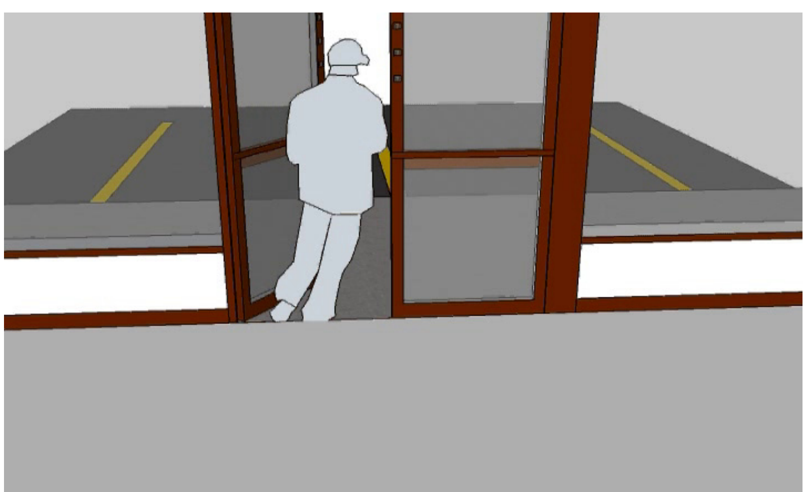


Figure 6

image showing an outline of the robber in the doorway (Figure 6). Note that the outline depicts the robber being much taller than the middle height sticker.

Mr. Knox then animates the camera perspective, lowering it to a position approximately 90 degrees to the robber's head. In the animation, the robber's head rises in the image (Figure 7). If the robber is at the same plane of the door as the measurement stickers, the position of his head would not change in relation to the stickers when the camera perspective is lowered. Essentially, the measurement stickers and the suspect's head are tied to the same perspective plane and their relationship to one another would not change with a lowered camera position. Mr. Knox measured the top of the suspect's hat at a position that is higher than the middle sticker, even though his measured image (Figure 8) shows that the suspect is at the same height of the sticker.

Figure 7

Figure 8

During direct evidence, Mr. Knox testified that he created an outline of the suspect over the video images. His demonstrative shows the location of his outline. The outline is actually outside of the body of the robber (Figure 5). Mr. Knox then used the outline geometry by importing the data into the PhotoModeler program. Since the outline identified points outside of the body, both higher and lower than the head and foot, he added additional height.

Knox measured from above the top of the robber's head, on an angle through the back of the robber's body, to the rear of the robber's trailing foot. The correct methodology is to measure directly from the top of the head vertically to the ground below the head [5] [6] [7]. This error added additional pixels (length) to his estimation of height.

Mr. Knox also failed to acknowledge a potential rate of error in his measurement analysis. At the position of the robber's head in the images, for example, each pixel represents approximately ½". All measurements in this area must be stated with a potential rate of error of approximately +/- ½" because an edge cannot be identified with a single pixel.

The ability to accurately measure the location of the ground under the robber's feet has a higher potential rate of error and should be articulated as +/- 1".

Mr. Knox propagated errors throughout his workflow. Due to the brevity of his written report, lack of notes, and due to the failure to apply accepted methodology, it is not possible to repeat his work. Since his work is not repeatable, even by him (during this review in 2015, Mr. Knox was unable to locate his historic notes), it is not possible to quantify the error of each individual step.

The combined errors of Knox's work added approximately 5.5" to his height analysis (see *Methodology for Short Range Photogrammetry* section below).

Additionally, Mr. Knox failed to obtain a peer review for his inaugural forensic video analysis case. A peer review by an appropriately trained and experienced analysts would have assisted Mr. Knox [2].

Yonovitz's Approach

Al Yonovitz is the senior partner of Yonovitz and Joe, LLP, and lists on his CV that he is the former Chair of the Department of Communicative Sciences, Dean of Research Facilitation at the University of Montana, and Professor of Speech and Hearing Sciences, a Clinical Audiologist and Forensic Scientist. His publications are vast and with an apparent focus primarily on audio sciences. Dr. Yonovitz does not appear to have any advanced training or publications in the area of digital imaging sciences or specifically in photogrammetry or reverse projection.

In January of 2014, Dr. Yonovitz submitted a post-conviction Declaration on behalf of Mr. Powell. The Declaration focused on three areas of examination: 1) a voice comparison between the recorded robber's voice and the voice of Mr. Powell, 2) an analysis of the height of the robber, and 3) a critique of the work performed by Mr. Knox.

This report does not comment on the voice comparison analysis conducted by Dr. Yonovitz, as it is outside of the scope of the requested review, and it is beyond the expertise of the writer.

In his analysis of the robber's height, Dr. Yonovitz writes that his partner (Mr. Joe) attended the scene and obtained data of the measurement stickers on the door. He concluded that the stickers were at slightly different heights from what was reported by Mr. Knox. Dr. Yonovitz noted that the bottom sticker was measured at 1/16" lower than the measurement used by Mr. Knox, and the middle sticker was ¼" lower than the measurement used by Mr. Knox. The top sticker was measured at the same height as the height used by Mr. Knox.

Dr. Yonovitz conducted a number of test measurements between various features of the doors and the ground, and then studies the relationship between the measurement markers on the doors and various photographs and images. His ultimate conclusion is that, although his measurements of the sticker heights are slightly lower than Knox's measurements, the markers had not changed since the time of the robbery. (In practice, because of the low resolution of the recorded images, the difference in measurement is less than the potential rate of error when examining the video images, and therefore the difference would have little to no impact on a final height measurement of the robber.)

Following his conclusion of the measurement of the height stickers on the door, Dr. Yonovitz offers no further analysis, calculations, or description of a photogrammetric method. He provides no comment or observation of the underlying digital compression. He simply states an opinion about the robber's height, providing no foundation for his opinion:

> *HEIGHT MEASUREMENT CONCLUSION. The height of the 7-Eleven robber in Photo #2 may be just under 5'7¾", as the robber's shoes and the robber's cap add a small amount of apparent height, i.e., since the top of the 2nd height sticker is approximately 5'7¾", then the robber in Photo #2 is approximately 5'7½" (with an approximate ½" margin of error). [9]*

Dr. Yonovitz' Declaration is void of any scientific methodology. He offers no clues as to his approach or standards used to formulate his conclusion. His report merely states that the robber is at the same plane of the doorway as the stickers, and if so, it appears (although not directly stated by Yonovitz) that his height can be compared to the height of the sticker. Although Dr. Yonovitz' approach applies some common sense, his analysis is akin to simply 'eye-balling' the video images. He fails to provide any basis for his conclusion. His approach offers no assistance to a trier of fact, it is not repeatable, and it fails to meet the threshold for expert evidence [2].

Dr. Yonovitz follows his opinion section with a review of Mr. Knox's report. His analysis contains some valid criticisms, but it lacks weight due to his failure to produce a scientific analysis report.

2015 Forensic Review & Height Analysis

In the spring of 2015, approximately five years into Mr. Powell's twenty-eight year sentence, the Texas Forensic Science Commission engaged the writer to review previous forensic video analysis examinations relating to this case, and to conduct an independent examination of the video images. The purpose of the case-review was to evaluate the height analysis and trial testimony provided by the prosecution's expert, and the post-conviction rebuttal analysis of a second expert, in order to determine why the experts' opinions of height differed so dramatically from one another.

The robbery occurred on June 9, 2008. At the time of this examination, almost seven years had passed, and the original cameras were replaced with newer cameras that were located in different positions throughout the store. In addition, many displays, and other physical features within the store had been moved.

Although it is not required that forensic video comparative analysis be conducted under the exact conditions as the questioned events [10], the changes to the scene can introduce increased potential error in measurement that must be considered when conducting reverse projection photogrammetry. Additional error can be introduced when attempting to replicate historic camera positions for the purpose of reverse projection, especially when the camera positions are unknown.

During an initial evaluation of the historic video images, and a later examination of the contemporary physical attributes of the 7-Eleven store, it was determined that enough similarities exist between the two environments to accurately evaluate the height of the robber [2].

Two methodologies, reverse projection/3D laser scanning, and measurement scale analysis were selected for the photogrammetric examination [6].

Methodology for Short Range Photogrammetry

Reverse Projection

Reverse Projection is defined as the scientific process of obtaining accurate measurements from photographic or video images. The methodology involves calibrating historic video images and overlaying the perspectives onto contemporary views or geometry. In this case, the “historic video images” refers to the digital video images that were recorded by the 7-Eleven DVR during the robbery that occurred on June 9, 2008. The “contemporary views/geometry” refers to 3D laser scanning measurements that were produced inside the 7-Eleven store on April 28, 2015. This is explained in detail in the “3D Laser Scanning” section below.

Once the historic images are calibrated and overlaid on top of the contemporary geometry, accurate measurements and positions of individuals/objects within the images can be obtained. When measuring the height of individuals, the following criteria (not an exhaustive list) is considered:

- the suspect’s head is visible and its 3D location can be known,
- the location of the suspect’s feet can be known,
- the suspect is standing relatively erect,
- if in motion, the suspect is in ‘mid-stance’ in the gait cycle (or consideration is given to changes in height based on the position of the feet in the gait cycle),
- the suspect is measured from the top of the head, directly to the ground under the head,
- the resolution of the image can be defined,
- a potential rate of error can be calculated,
- height added by headwear is considered,
- height added by footwear is considered,
- where possible, measurements from multiple positions should be obtained in order to increase the confidence range of the averaged results.

3D Laser Scanning

The purpose of 3D laser scanning is to capture a measurable, three dimensional record of an environment. The record is obtained using a 3D laser scanner, which is a technology that emits a laser and calculates the distance the laser travels from the scanner to objects in the environment. Typically, millions of measurements are captured during a single laser scan. The measurement data can then be digitally visualized in 3D, and new measurements can be obtained between any two scanned points in the geometry. The geometry can then be used as the foundation for Reverse Projection measurements. In addition, the visual model can provide 3D perspectives of the environment in order to examine and measure the location and objects from any angle.

In this case, a Faro Focus 120 was used to capture roughly 88,000,000 samples from eight scans within the 7-Eleven. Each sample includes data representing the distance (i.e. X, Y, Z position) and reflective intensity of the point where the laser bounced off of an object. When the combined scan samples are digitally visualized, they produce a dense cloud of data points (referred to as a point cloud). The point cloud allows for the measurement between any two sampled areas within the scene with a high rate of accuracy. In addition, the point cloud allows for the visualization of any perspective within the scene, including the perspective of the historic camera angles from within the 7-Eleven store. The historic camera angles are reproduced in the digital 3D visualization to create contemporary images that can be used as foundations for calibrating the historic images in the reverse projection process (see the Reverse Projection section above).

Margin of Error

There are three primary variables that contribute to the estimation of possible error in 3D laser scanning reverse projection measurements. The variables are: the accuracy of the laser scanner, the resolution of the historic images, and the accuracy in calibrating the historic image to the contemporary 3D laser scanned geometry. Measurements obtained through 3D laser scanning reverse projection reference the total error based on these three variables. The total possible error is calculated as the sum of all three variables [2]. In other words, when measuring an object through 3D laser scanning reverse projection, the final calculation will contain a range of possible measurements that include plus or minus the sum of the error produced by each of the three variables.

The error introduced by the accuracy of the scanner is calculated by comparing reference measurements with a second technology in the physical environment. In this case, eight measurements were obtained with a Leica Disto handheld point-to-point laser measurement device. The measurements included the width of the doorway, the height of the stickers, the height of the doorway, and the height/length of the cashier's counter. The measurements calculated by the Leica Disto are then compared to the same measurements calculated by the 3D Laser Scanner. The difference in the calculations between the two measurement technologies is primarily attributed to human factors, and assists in defining error that can be introduced through the measurement process itself. In this case, the error introduced by the accuracy of the scanner is calculated to be +/- 0.05 inches.

The error introduced by the resolution of the historic images is calculated by measuring the pixels per inch in the target area, and by identifying the ability to define an edge in the target area. A pixel (picture element) is the smallest, indivisible element of a digital image. Pixels are generally in a square shape and contain one solid color value. Measurements taken within a digital image are measured in terms of pixel. As such, defining the beginning and end of a desired measurement cannot be more accurate than the length of a pixel on each end. For example, when calculating the length of an object, the minimum error introduced by the resolution of the image will be plus or minus one pixel on each end of the measurement (2 pixels total). Additional errors related to image resolution can be introduced by factors such as: the quality of the lens (e.g. if there are smears/smudges on the lens), the quality of the image compression (e.g. the quantization level in the discrete cosign transform process of MPEG/JPEG encoding), motion blur, etc.

In this case, the length of pixels in the target area on the Door Camera is 0.5 inches. The ability to define the location of the head is limited to a range of +/- 1 pixel. The ability to define the location of the center of the feet is limited to a range of +/- 2 pixels, due to the subjectivity of defining the closest edge to the center position. The total potential error introduced, due to factors related to resolution, is +/- 3 pixels (3 pixels = 1.5 inches). The length of pixels in the target area provided by the Aisle Camera is 1.21 inches and the potential error introduced due to factors related to resolution is +/- 2 pixels (2 pixels = 2.43 inches).

The error introduced by the accuracy of calibrating the historic images to the contemporary 3D laser scanned geometry is calculated by overlaying the calibrated historic images on top of the 3D laser scanned geometry and measuring the location of several objects in the environment around the target area within the historic images. The overlay is then taken away, and the same objects are identified in the 3D laser scanned geometry. The difference between the measured locations in the historic images is compared to the accurate locations in the 3D laser scanned geometry. The difference between the two measurements identifies the error introduced by the accuracy of calibrating the historic images. In this case, the potential error introduced by the calibration accuracy on the Door Camera is calculated to be +/- 1.125 inches on each end of the measurement (2.25 inches total). The potential error introduced by the calibration accuracy on the Aisle Camera is calculated to be +/- 0.6 inches on each end of the measurement (1.2 inches total).

The sum of the three primary variables that affect margin of error is 3.8 inches for the Door Camera (0.05 inches attributed to the possible error in the accuracy of the scanner, 1.5 inches attributed to the historic image resolution, and 2.25 inches attributed to the calibration accuracy) and 3.68 inches for the Aisle Camera (0.05 inches attributed to the possible error in the accuracy of the scanner, 2.43 inches attributed to the historic image resolution, and 1.2 inches attributed to the calibration accuracy).

Initial Analysis

Prior to pursuing 3D laser scanning reverse projection as a viable means of measuring the height of the suspect in this case, careful consideration was given to the following:

- The resolution of the video images
- The number of available angles for measurement
- Whether triangulation of the suspect's head and/or feet is possible by using images from multiple camera angles
- The lens distortion in the images
- How erect the suspect stands/walks throughout the recorded images
- Whether the location of the suspect's head can be identified in three dimensions (X, Y, Z)
- Whether the location of the suspect's foot can be identified in three dimensions (X, Y, Z)
- That the original cameras were no longer present in the 7-Eleven store
- That the position of objects may have changed since the time of the recordings.

In order to answer whether or not 3D laser scanning reverse projection was an appropriate technique for measuring the suspect's height in this matter, each of the items above was addressed in an initial analysis. The analysis focuses on the moment when the suspect's head passes through the plane of the doorway. Images from both the Door Camera and the Aisle Camera are examined, and the suspect's height is approximated using known measurements from the physical scene.

Three relative, measurable dimensions are required for any photogrammetric process. Video images are two dimensional, but in order to provide meaningful measurements from the two dimensional images, a third dimension must either be known or measurable from additional information. In other words, given a two dimensional image without any additional measurable information, photogrammetry is not possible. Therefore, when the suspect's head is positioned in the plane of the doorway, the location provides the third dimension to the video images. Because the measurement scale along a plane is closely perpendicular to the camera, then any objects along the same plane can be measured using the same measurement scale.

The suspect's head passes through the plane of the door at 00:04:28.062 on the Door Camera. The suspect's gait cycle is close to mid-stance.

The Aisle Camera validates the suspect's position.

25 miliseconds later, at 00:04:28.087 on the Aisle Camera, the suspect is also visible passing through the plane of the door.

The Door Camera shows the location of the three measurement stickers that assist with establishing a measurement scale.

During the site visit on April 28, 2015, the height from the top of each sticker to the threshold was measured using the Leica Disto hand-held laser measurement device. The measurements are consistent with measurements of the stickers that were obtained by investigators shortly after the original video recordings. The Leica Disto measurements are listed below.

- Top of bottom sticker = 5' 2.16"
- Top of middle sticker = 5' 8.16"
- Top of top sticker = 6' 2.04"

Using the above known measurements from the doorway, any object within the same plane of the doorway can also be measured using the same measurement scale. Therefore, since the suspect is in the plane of the doorway, his height can be measured using this measurement scale.

In order to measure the suspect's height using the measurement scale, the image from the Door Camera at 00:04:28.062 was analyzed in Adobe Photoshop CC. Photoshop is an industry standard image processing tool that is used across many forensic disciplines including forensic video/image analysis, finger print measurement examinations, tool-mark analysis, accident investigation, etc.

Photoshop can be used to measure the length of objects in an image when a measurement scale along the same plane is known. There are three variables that can potentially affect the accuracy of the resulting measurements. The variables are: any potential error introduced when measuring the standard in the physical environment, any potential error introduced when setting the measurement scale within Photoshop, and any potential error introduced due to the resolution of the image. The total margin of error is calculated as the sum of the potential error from the three variables [2].

The potential margin of error introduced when measuring the standard in the physical environment is defined by the accuracy of the Leica Disto hand-held laser that was used to measure the height of the stickers. The margin of error for the first variable is calculated to be +/- 0.05 inches (See Margin of Error section).

The potential margin of error introduced when setting the measurement scale within Photoshop is defined as the ability to accurately determine the location of the top of the sticker and the floor underneath the sticker in the video image. The potential error is calculated to be +/- 2 pixels (1 pixel on each end of the measurement). Each pixel is calculated to be 0.5 inches in the target area, so the margin of error for this second variable is +/- 1 inch (2 pixels = 1 inch).

The potential margin of error introduced due to the resolution of the image is dependent on the ability to define the location of the top of the suspect's head and the floor below the suspect's feet. The potential error for this third variable is calculated to be +/- 3 pixels (3 pixels = 1.5 inches). The total error for measurements obtained through the Photoshop custom measurement scale is +/- 2.55 inches

The margin of error for measurements using the above process is narrower than the margin of error for measurements acquired through 3D laser scanning reverse projection. Unlike reverse projection, no calibrated overlay is necessary when using a calibrated scale, reducing the total potential error. See the Margin of Error section.

For the purpose of this initial analysis, a measurement scale was established in Photoshop CC, relative to the height of the top sticker on the doorway to the ground. The top sticker was physically measured at 6’ 2.04’ above the ground. This measurement was used to set a custom measurement scale within Photoshop so that any measurements along the same plane were calculated using the same scale. The custom measurement scale was then used to measure the height of the suspect.

The custom measurement scale set in Photoshop along the plane of the door from the top sticker to the floor is 6’ 2.04”.

The robber’s height is then measured using the same measurement scale. Using this method, the height of the robber is calculated to be 5’ 6.6” from the top of his head to the threshold.

The robber is standing on the mat below the threshold, which adds 0.2” to the calculated height of the robber.

At this position, the robber is measured at 5’ 6.8”.

When considering the margin of error of +/- 2.55”, the possible range of heights for the suspect is between 5’ 4.25” and 5’ 9.35”.

During this initial analysis, it was identified that:

- The resolution of the video images is sufficient for reverse projection analysis.
- There are multiple camera angles available for measurement, and triangulation of the suspect's head is possible through 3D laser scanning reverse projection.
- The lens distortion in the images is minor and can be calibrated.
- The suspect walks relatively erect, and stands erect at multiple locations in the video images
- The location of the suspect's head/feet can be identified in three dimensions using photogrammetry/reverse projection.
- There is sufficient information to reproduce the perspective of the camera, and although some objects have changed position since the time of the recording, there is enough information in the environment to properly calibrate the historic video images.

According to best practices for photogrammetry (especially when related to the measurement of suspect height), it is valuable to obtain measurements from multiple perspectives when possible [2]. By obtaining multiple measurements, an average can be calculated which results in a more reliable estimation of true height. The larger the number of samples, the greater the confidence that the average value is close to the true value.

In addition, the larger the number of samples, the more narrow the margin of error for the averaged value. Given that the historic camera positions were not known, it was determined that 3D laser scanning reverse projection was the most appropriate methodology to use to obtain additional measurements of the height of the suspect.

3D Laser Scanning Methodology

For the purpose of 3D laser scanning reverse projection, four positions were identified from the Door Camera where the suspect is either standing relatively erect, is passing the plane of the door, or is in motion mid-stance in the gait-cycle. These four positions will be referred throughout this section as RP1, RP2, RP3, and RP4.

Door Camera – RP1 at 00:04:27.795

Door Camera - RP2 at 00:04:28.062

Door Camera – RP3 at 00:04:29.262

Door Camera – RP4 at 00:05:02.326

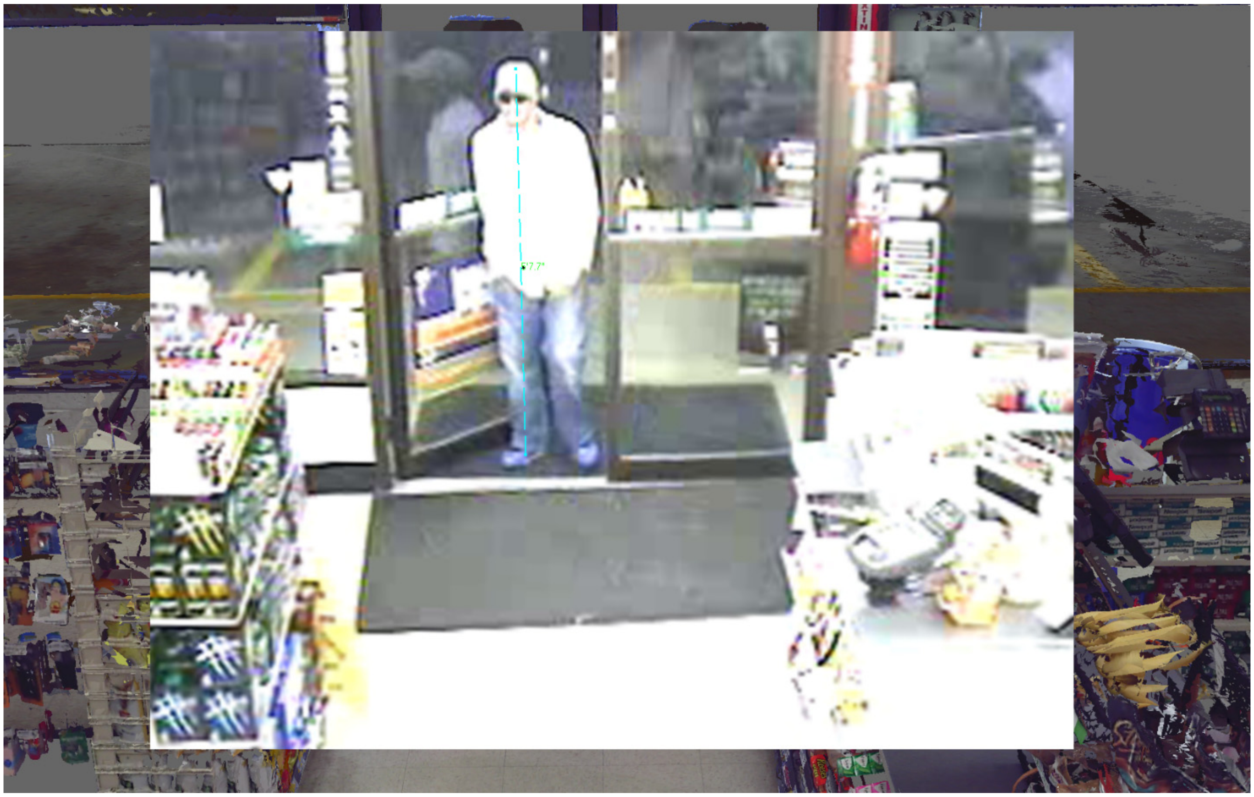
To increase the reliability and confidence of the height measurements for the four reverse projection positions, reverse projection positions from the same point in time on the Aisle Camera were also identified. (Note: the average difference in time between the Door Camera and the Aisle Camera for RP2, RP3, and RP4 is 30 miliseconds. Note that the difference in time between the two cameras for RP1 is 92 miliseconds. Because of the large disparity in time, no measurements were obtained from RP1 on the Aisle Camera.)

Aisle Camera – RP2 at 00:04:28.087

Aisle Camera – RP3 at 00:04:29.287

Aisle Camera – RP4 at 00:05:02.285

After calibrating the historic images above and overlaying the results on top of the 3D laser scanned geometry, measurements were obtained of the height of the suspect from each position. Note that in cases where the suspect's feet are not directly visible, the top of the head was triangulated between the perspective of the Door Camera and the perspective of the Aisle Camera, and the position of the feet was measured directly below the head to the floor.



Door Camera - RP 1 = 5’ 7.7”

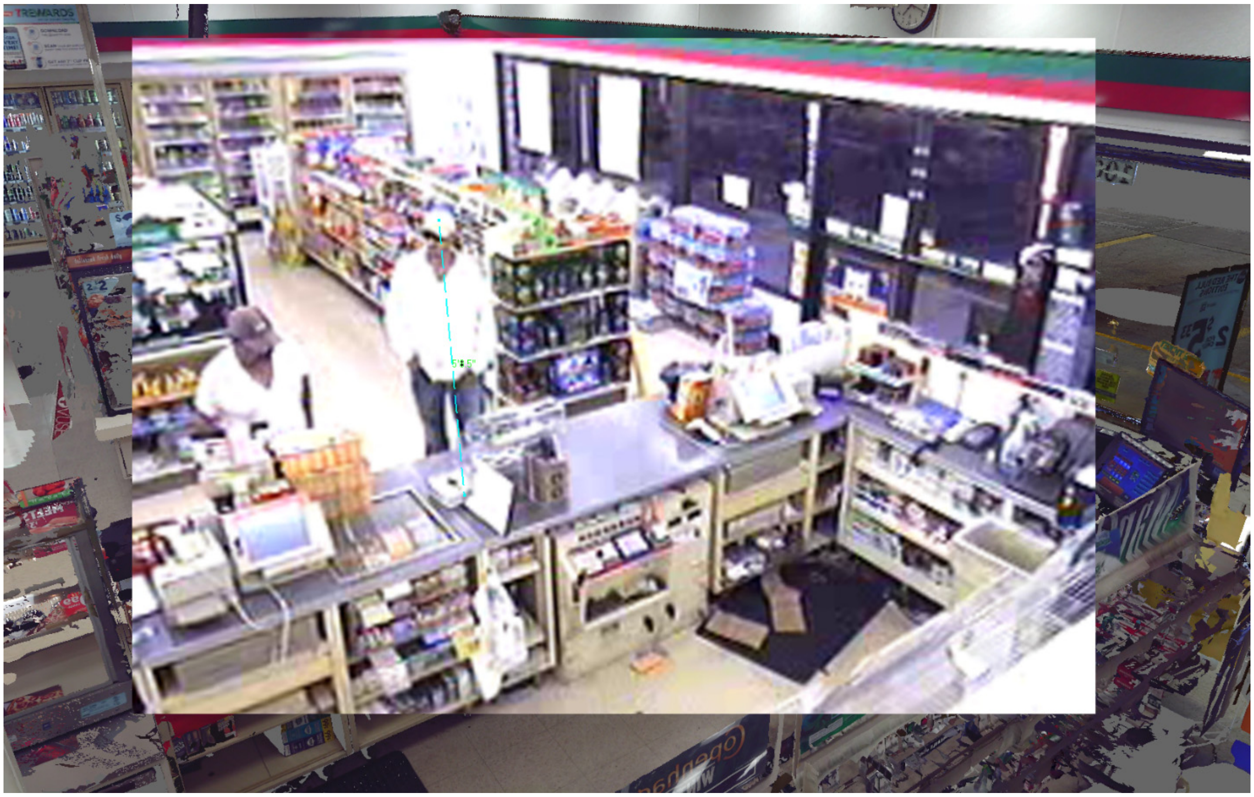
Door Camera - RP 2 = 5’ 6.6”

Aisle Camera - RP 2 = 5' 6.7"

Door Camera - RP 3 = 5'8.3"

Aisle Camera - RP 3 = 5’9.5”

Door Camera - RP 4 = 5’6.7”



Aisle Camera - RP 4 = 5’8.5”

Each of the seven RP measurements are combined with the measurement from the initial review in the graph below (Chart 1). The margin of error for each measurement is depicted with a range bar that shows all of the possible values for that measurement.

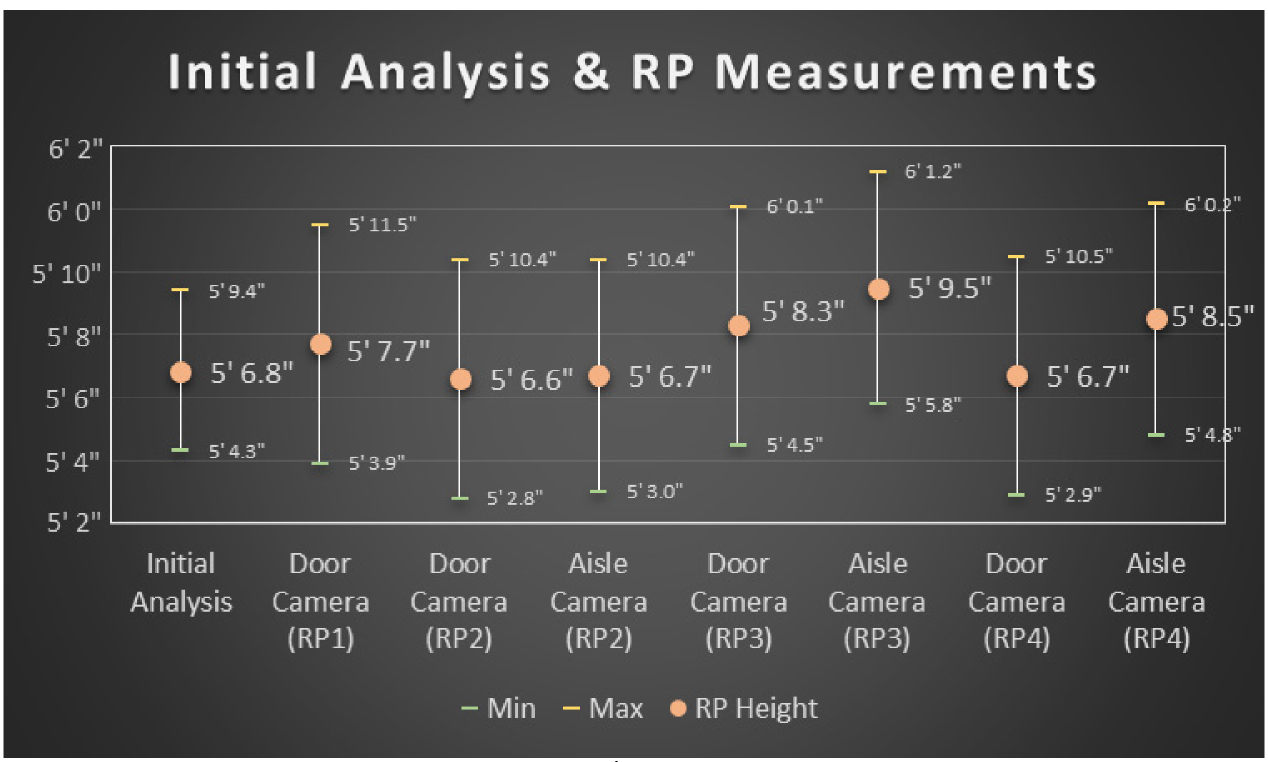


Chart 1

In the following graph (Chart 2), the blue region depicts the confidence region. The confidence region is between 5’ 5.8” and 5’ 9.4” and depicts the constrained area represented by the lowest margin of error of the highest measurement, and the highest margin of error of the lowest measurement. In other words, the confidence region represents the most likely range of the suspect’s height.

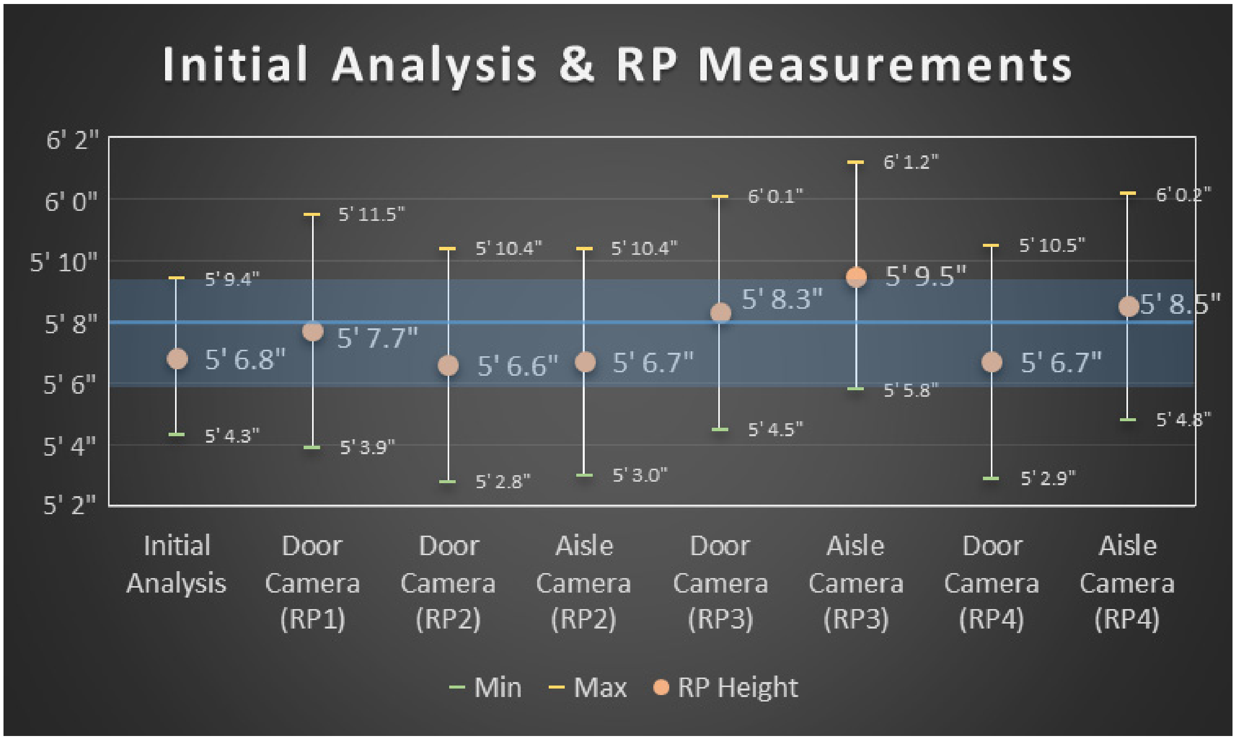


Chart 2

Although the confidence range for the height of the suspect is between 5’ 5.8” and 5’ 9.4”, there is a high confidence that the true value falls closer to the average of all eight measurements. The average value for all height measurements is 5’ 7.6”.

Chart 3 shows the average measurement for the height of the suspect, and it depicts the confidence range for all measurements that were collected for this analysis.

This analysis establishes that the suspect’s height is 5’ 7.6”, within a confidence range from 5’ 5.8’ to 5’ 9.4” to a reasonable or greater degree of scientific certainty.

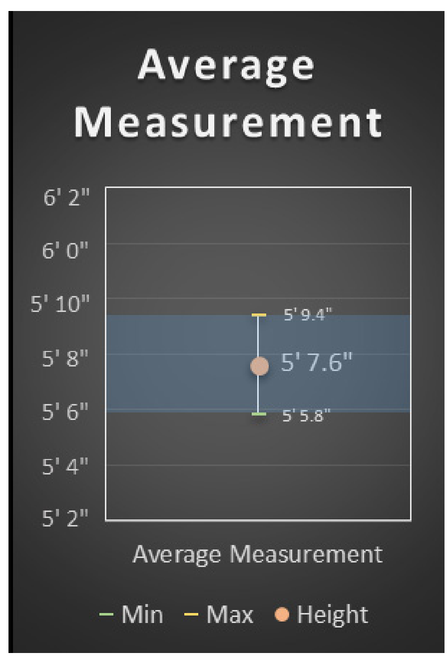


Chart 3

Demonstratives - Robber vs. Powell

In addition to the above measurements and observations regarding the height of the robber, the images of the robber were also compared to the actual height of Mr. Powell. Mr. Powell made himself available for measurement through 3D laser scanning.

The following demonstratives are akin to using a stand-in who shares the similar physical build and height of a known suspect as a scaled model for comparison purposes. However, in this case, the actual accused person is used as the reverse projection standard for comparison.

To generate the measurements necessary for the following analysis, the writer met Mr. Powell at the Texas State Penitentiary at Huntsville on April 28, 2015. Mr. Powell agreed to a number of measurement processes which included the use of a Leica Disto hand-held laser measurement device and a Faro Focus 120 3D laser scanner.

Four measurements of Mr. Powell's height were obtained with the Leica Disto as he stood in an erect and still position. Two measurements were taken from the front of Mr. Powell from his head to the floor, and two measurements were taken from the back from his head to the floor. Mr. Powell wore his shoes throughout the measurement process. The two measurements from the front were calculated to be 6' 2.88" each. The first measurement from the back was calculated to be 6' 3.24", and the second was calculated to be 6' 3". The subtle differences in the four measurements are explained by human error in the measurement process and by changes in Mr. Powell's posture. The average of the four measurements is calculated to be 6' 3". This average measurement is used throughout this section as the known value for Mr. Powell's height.

Five scans of Mr. Powell's body were obtained with a Faro Focus as he lay on the ground in a straight and prone position. Each scan contained 11,000,000 measurement samples for a total of 55,000,000 samples. The combined samples were used to create an accurate visual representation of Mr. Powell's body. The geometry of his body is combined with the 7-Eleven geometry in the following section so that he can be compared with the robber of the 7-Eleven store through 3D laser scanning reverse projection analysis (see the 3D Laser Scanning section). The height of Powell's 3D geometry was validated and measured to be 6' 3" within the 7-Eleven model. The Powell model is generated solely from the 3D laser scanned data and is unscaled.

See the images below for a comparison and overlay between Mr. Powell's figure and the robber's figure as the robber is positioned in the plane of the door in RP2. The red lines indicate the heights of the top two door stickers. The tallest sticker is measured to be 6' 2.04", the middle sticker is measured to be 5' 8.16".

Note that the model of Mr. Powell stands approximately 1" above the top calibrated height sticker, adding validation to the process, and proving a demonstrative supporting the earlier measurements that Mr. Powell is 6' 3" tall (when wearing regular tennis style shoes).

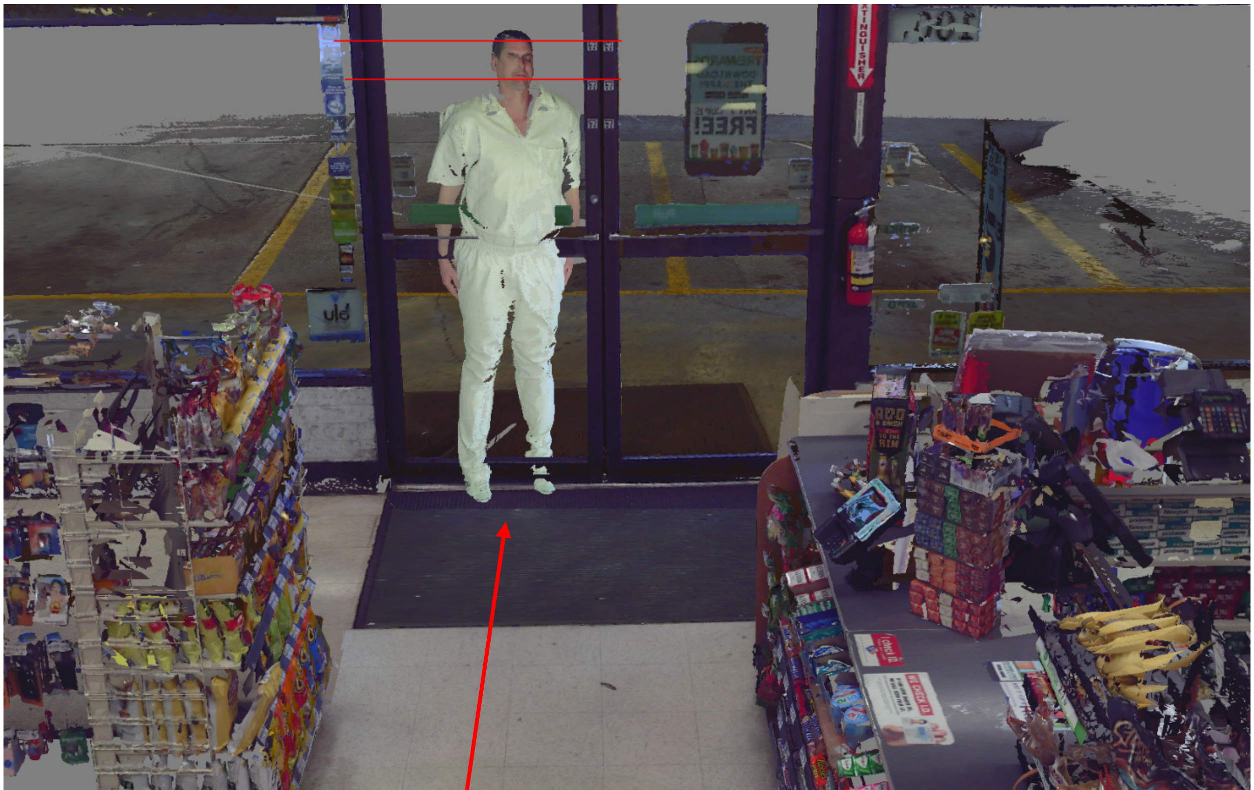


Figure 9

In Figure 9, Powell's figure is in the plane of the doorway. He is measured to be 6' 3" tall and his head extends slightly above the top sticker, which is measured to be 6' 2.04"

Figure 10

In Figure 10, the robber is in the plane of the doorway in the calibrated video image. He is measured to be 5' 7.6" with a confidence range 5' 5.8" to 5' 9.4". The top of his head is slightly below the middle sticker which is measured to be 5' 8.16"

Figure 11, below, is a combination of both of the previous images (Figures 9 & 10). Figure 11 depicts Mr. Powell superimposed in the same position as the robber as he passes through the door.

Mr. Powell's geometry is significantly larger than the height of the robber. Mr. Powell's shoulders are distinctly broader than those of the robber, and he is measured to be 7.4 inches taller than the robber.

Recommendations

Forensic Video Analysis is defined as the scientific examination, comparison, and/or evaluation of video in legal matters [3].

The scientific examination requires advanced knowledge of video compression standards and proven skills in the use of advanced tools, techniques and applications. Training in areas of video interpretation, image processing, engineering, photogrammetry, comparison, and in many other sub-disciplines of Digital Multimedia Evidence is essential to ensuring the safe introduction of video evidence in court [8].

This report recommends that the Forensic Science Commission encourages the Texas State Legislature to consider the value of Certification in the field of Forensic Video Analysis for individuals presenting opinion evidence relating to the identification of an accused person in a criminal trial.

Advanced training in the science of video analysis is available from a number of accredited educational sources. The Law Enforcement and Emergency Services Video Association (LEVA) has a well-developed Forensic Video Analyst Certification and Forensic Video Technician Certification program [11]. The program is accredited by the University of Indianapolis' School for Adult Learning, which houses one of the most advanced forensic video training facilities in North America. LEVA requires approximately 288 hours of advanced course work, which includes testing, peer review, and boarding before certification is granted.

The International Association for Identification (IAI) provides a testing mechanism for Forensic Video Examiner Certification for its members [12].

The National Center for Media Forensics at the University of Colorado at Denver offers a Master's Degree program in Digital Media and provides course work in digital video evidence [13].

A number of for-profit private companies also offer advanced training in various sub-disciplines of Digital Multi-media Evidence, including:

- Resolution Video [14]
- DME Forensics [15]
- Imaging Forensics [16]

The old adages that 'an image is worth a thousand words', and that 'video is the silent witness that can speak for itself' are archaic concepts from an analog videotape era, a time when video evidence was mostly standardized in a single videotape format, but was rarely introduced as evidence. By contrast, today's digital video systems are not subject to any recording standards. DVR's produce video evidence in a wide array of often proprietary image qualities, sometimes changing the size, colors, and the shape of objects, even altering the timing of events and the order in which playback occurs. For the experienced forensic video analyst, every case starts as a research project. The analyst must be able to accurately interpret not just the compression methods used to produce the evidence, but must ensure that the video is fit for the purpose for which it is being used in court. The complicated structure of digital video algorithms, and their prolific use by our surveillance society, compels the increased involvement of video experts in criminal and civil trials.

Forensic Video Analysis today is supported by a rich history of judicial rulings and by a wide variety of academic and industry publications.

The case studied in this review highlights the potential dangers when scientific evidence is prepared and presented in court without proper foundation, and without following accepted industry standards and methodologies.

About the Writer

Grant Fredericks is a Certified Forensic Video Analyst and a contract instructor at the FBI National Academy in Quantico, VA. He is the owner of Forensic Video Solutions and is an instructor for the Law Enforcement & Emergency Services Video Association. As a consultant for Major Crime and Joint Forces Operations involving video evidence, Grant has provided technical assistance for high-profile investigations in the UK, Canada, the United States, and in many other jurisdictions around the world. Grant was the Technical Manager for a large scale criminal investigation in 2011 involving over 5,000 hours of video evidence, directing the work of fifty forensic video analysts from the US, Canada and the UK. His work won the International Association of Chiefs of Police (IACP) top award for Technical Advances in a Criminal Investigation. Grant is a consultant to the US Department of Justice, the IACP, and the National Institute of Justice, and is a co-author of the standards document *Digital Video Systems Minimum Performance Specifications for Digital In-Car Video Recording Systems* for US law enforcement agencies. Grant is a former police officer and coordinator of the Vancouver Police Forensic Video Unit in Canada.

Writer's Note

Jonathan Hak, QC, contributed to the valued legal research included in this report. Jonathan is a prosecutor for Alberta Justice, Canada and specializes in the area of video related prosecutions. Jonathan lectures throughout the US, Canada, and the UK to law enforcement and legal professionals in the admissibility of video evidence.

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EXHIBIT E

SWGDE Best Practices for the Forensic Use of Photogrammetry

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SWGDE Best Practices for the Forensic Use of Photogrammetry

Table of Contents

1. Purpose

The purpose of this document is to provide personnel with recommendations regarding appropriate practices when performing photogrammetric examinations as a part of forensic analysis.

2. Scope

This document provides basic information on the evidentiary value, methodology, and limitations when conducting photogrammetric examinations as a part of forensic analysis. The intended audience is examiners in a laboratory setting.

This document is not intended to be used as a step-by-step guide for conducting a proper forensic examination or reaching a conclusion. This document should not be construed as legal advice.

3. Limitations

Many forensic disciplines (e.g., image analysis, video analysis, crime scene reconstruction, bloodstain pattern analysis) utilize photogrammetric analysis. This document will only describe the analytical techniques and limitations associated with photogrammetry as applied to video and image analysis. For the purposes of this document, the word “imagery” may mean images, photographs, or still imagery derived from video.

4. Evidence Preparation

General guidelines concerning the preparation of evidence for photogrammetric analysis are provided as follows:

4.1. Complete an initial assessment of the imagery.

4.1.1. Determine if the submitted imagery is the original, or a bit-for-bit duplicate. If the submitted imagery is not a bit-for-bit duplicate, determine if one is available.

4.1.2. Determine if the submitted material is suitable for analysis. Suitability for analysis is determined by the requested examination. For example, in a subject height analysis, the practitioner may determine that the subject must be visible from head to toe, and the body length is at least 25% of the image. Further, the practitioner may examine the image for the presence of stationary objects in the foreground and background of known dimensions, and may make an assessment as to whether the angle of capture is conducive to examination.

4.1.3. Determine if all of the submitted material, or some subset of the material, is to be subjected to analysis.

4.2. Produce working copies of the imagery to be subjected to analysis. This may require digitization from negatives, prints, or conversion from other media.

4.3. Enhance images. Refer to *SWGIT Section 11 – Best Practices for Documenting Image Enhancement*.

5. Method

Multiple techniques exist for completing photogrammetric analysis, including reverse projection, analytical photogrammetry, and dimensional scanning. Practitioners of photogrammetry should have sufficient expertise in image science, which may include video engineering, to support conclusions and address potential sources of uncertainty in the measurement.

5.1. Determine if the criteria necessary for reaching a conclusion are present in the processed image.

5.2. Identify a methodology for reaching a conclusion. This may include reverse projection, analytical photogrammetry, or some other method.

5.2.1. Reverse projection photogrammetry involves the positioning of a camera and recording in the perspective and aspect ratio duplicating the original imagery. A calibrated measuring device may then be used to complete the requested analysis.

5.2.2. Analytical photogrammetry involves applying knowledge of the geometrical properties of the imaging process, and known measurements associated with the imagery, to obtain unknown measurements. Perspective based analysis and direct scaling are two approaches.

5.3. Enact chosen methodology and record results. If the chosen methodology is not discussed above, the methodology should be sufficiently documented and have a scientific basis.

6. Conclusions

Based on the observations and measurements, a conclusion should be reached. This may or may not involve a numerical result.

6.1. Report conclusions, as appropriate, for the requested analysis. The basis for, and uncertainty of, any conclusions should be documented and reported.

6.2. The results of the examination should undergo independent review by a comparably trained individual. If disputes during review arise, a means for resolution of issues should be in place.

7. Evidentiary Value and Limitations of Methodology

Photogrammetric analysis is a long-standing science that can aid in the exclusion and inclusion of items and people in forensic analysis. It can also answer specific questions regarding speed, location, and distances. Reference materials and case studies provide information as to the history, theory, and application of photogrammetric analysis.

In photogrammetric examinations, multiple sources of uncertainty and potential error can be examined. Uncertainty can result from the mechanics of the imaging process, as well as from contextual biases. An analysis of such uncertainty should be performed and documented. See **Appendix A** for further information.

It should be noted, the measured result might require interpretation by the examiner based on the identified sources of uncertainty (and potential error). For example, the individual frame of a subject selected for height analysis will affect results, as height will vary over time. The examiner can use the measured height, as well as calculated uncertainty, to determine whether a suspect can be excluded or included.

8. References

[1] Scientific Working Group on Imaging Technology, "Section 11: Best Practices for Documenting Image Enhancement". [Online]. https://www.swgit.org/documents/Current%20Documents

Appendix A: Reporting Conclusions through Quantitative Means

Photogrammetric evaluation is amenable to estimation of error, either through the propagation of error involved in the calculations, or in comparison with known measurements that may be present in an image. Both common kinds of error (imprecision and bias) should be estimated if possible, and if not possible, the limitations of the method should be mentioned in the final report.

Example: As in the workflow example, the practitioner is requested to complete a photogrammetric examination of a bank robber depicted in a DCCTV surveillance video. The police have two different suspects, and would like to determine if either can be eliminated based on height.

The practitioner elects to use the recommended workflow for photogrammetry, incorporating reverse projection as the analytical methodology. Photogrammetric measurement estimates the height of the individual to be 6’1”. This measurement is based on the vertical distance from the floor to the top of the individual’s headwear, in a single selected image.

However, multiple areas of uncertainty can be calculated, and multiple limitations in this measurement should be noted in the analytical report.

1. In photogrammetric examinations, the estimated uncertainty relies on the overall resolution of the imagery. When the number of pixels representing a given area (or a line of video) in an image increases, the practitioner will be able to narrow the uncertainty based on resolution. This uncertainty may need to be calculated at two points when completing two examinations, as in an analysis of the velocity of a subject.
2. In photogrammetric examinations, the estimated uncertainty relies on the ability of the practitioner to locate the position in which the subject was located at the time the original image was captured. This uncertainty can be calculated by determining the uncertainty in the measured distance within a given radius of position, based on geometric principles.
3. In subject height analysis, the measurement is captured at only a single moment of time. Given that multiple factors can change a subject’s stature, including choice of footwear, choice of headwear, positioning in gait, and the natural circadian rhythms of the human body, the measured height can be no more than an estimation.
4. In the case of a velocity analysis, the calculated value for velocity relies upon a known, regular frame rate. The uncertainty in the calculated value must be examined based on these assumptions, based on principles of video engineering.
5. Ideally, a practitioner of photogrammetry should strive to be unbiased in examination. To avoid potential bias, the practitioner should avoid contextual information that would tend to bias results prior to release of report, such as the measured height of a suspect.

Appendix B: Work Flow Examples

Scenario: A local police agency asks the crime lab to determine the height of the individual depicted robbing a bank in a surveillance video, captured by a DCCTV system. The agency has two suspects of different heights, and would like the crime lab to determine if either can be excluded on this basis.

Following the workflow delineated above, the practitioner proceeds as follows:

1. The practitioner determines that the imagery is the original video, not a transcoded copy.
2. The practitioner reviews the material and determines if images exist conducive to an accurate photogrammetric examination
3. The practitioner determines if more than one examination is appropriate to complete the request.
4. The practitioner transfers the contents of the video file to a working file.
5. The practitioner processes the video files.
    a. Still images are output from the video files, and images conducive to an accurate photogrammetric analysis are selected.
    b. Standard image processing techniques, such as brightness and contrast adjustments, are applied to the working images.
6. The practitioner imports the images into a photogrammetric application and conducts analysis. This analysis results in a calculated value for the robber's height, as well as a determination of the accuracy and precision of this result.
7. The practitioner writes the report. Per the crime lab's standard operating procedures, the report includes a review of the materials received, the request, the methods used, the results obtained, the basis for the conclusion, the conclusion, and an estimate of the accuracy and precision.
8. The report is administratively and technically reviewed prior to release.

Scenario: A local police agency asks the crime lab to determine the velocity of a vehicle, as it is driven toward impact. The vehicle is captured for approximately four seconds, just prior to collision. The agency would like to know the vehicle's velocity as a possible aggravating factor in the investigation of the collision.

The practitioner proceeds as follows:

1. The practitioner determines that the imagery is the original video, not a transcoded copy.
2. The practitioner reviews the material and determines if images exist conducive to an accurate photogrammetric examination.

3. The practitioner determines if more than one examination is appropriate to complete the request.
4. The practitioner transfers the contents of the video file to a working file.
5. The practitioner processes the video files.
    a. Still images are output from the video files, and images conducive to an accurate photogrammetric analysis are selected, taking into account the known time elapsed between the images.
    b. Standard image processing techniques, such as brightness and contrast adjustments, are applied to the working images.
6. The practitioner imports the images into a photogrammetric application and conducts analysis. This analysis results in a calculated value for the vehicle's velocity, as well as a determination of the accuracy and precision of this result.
7. The practitioner writes the report. Per the crime lab's standard operating procedures, the report includes a review of the materials received, the request, the methods used, the results obtained, the basis for the conclusion, the conclusion, and an estimate of the accuracy and precision.
8. The report is administratively and technically reviewed prior to release.

Appendix C: Sample Questions Asked in Forensic Photogrammetry

- How tall is the individual?
- How fast was the vehicle/person/object traveling?
- What time of day was the photograph taken?
- Where is the scene depicted in the image?
- What are the dimensions of this object?
    - (e.g., how long is this firearm?)
- Where was the camera at the time this photograph was taken?
- Can you determine the location of this object within the scene?
    - How far apart were the two objects/people?

SWGDE Best Practices for the Forensic Use of Photogrammetry

History

Revision	Issue Date	Section	History
1.0	06/04/2015	All	Original working draft created. Voted for release as a Draft for Public Comment.
1.0	06/20/2015	All	Formatting and tech edit for release as a Draft for Public Comment.
1.0	09/17/2015	None	SWGDE voted to release as an Approved Document.
1.0	09/29/2015	All	"Section 3 – Definitions" was removed and the terms were moved to the latest iteration of the SWGDE Glossary as part of final publication process. Formatting and technical edit performed for release as an Approved Document.

EXHIBIT F

CURRICULUM VITAE - GRANT FREDERICKS
Forensic Video Analyst

105 West Rolland Avenue, Spokane, WA 99218
(509) 467-3559
www.forensicvideosolutions.com
grant@forensicvideosolutions.com

SUMMARY OF QUALIFICATIONS

- Former police officer with twenty-nine years of experience processing video evidence in the United States, Canada, the United Kingdom, Mexico and in other countries throughout the world; conducted thousands of video related investigations.
- Provides expert testimony throughout the United States and Canada at all court levels; has testified in New York, Illinois, Florida, Pennsylvania, Michigan, Missouri, Massachusetts, Maine, Iowa, Texas, Arizona, California, Connecticut, Nevada, Oregon, Washington, Idaho, Colorado, British Columbia, Alberta, Manitoba, the Yukon Territories, the Cayman Islands, London, England, and in Auckland, New Zealand.
- Consultant for forensic video applications to the US Department of Justice, Office of the US Attorney General, International Association of Chiefs of Police and to various industry leaders in the area of forensic video technology.
- Twenty years of experience as a leading provider of forensic video training to government and to private video analysts from throughout the world.
- Contract Instructor of Forensic Video Analysis at the FBI National Academy in Quantico, VA.

AREAS OF EXPERTISE

- Forensic Video Analysis, including:
    - *Image interpretation*
    - *Digital Video Examination, Recovery & Processing*
    - *Photographic Video Comparison*
    - *Image Enhancement*
    - *Motion Analysis*
    - *Speed Estimation*
    - *Height Comparison*
    - *Reverse Projection*
    - *Object Measurement*
    - *Color Correction*
    - *Forensic Video Synchronization*

RELATED WORK EXPERIENCE

1991.01 to present **Forensic Video Analyst:** Forensic Video Solutions Analyst/Consultant/Expert Witness

2002 to present **Instructor**: FBI National Academy, Quantico, VA.

1998 to present **Instructor**: Law Enforcement & Emergency Services Video Association (LEVA).

LEVA Principal Instructor – 1998 – 12/31/12

- ***Forensic Video Analysis & The Law*** – Level I (40 hour course taught two times per year)
- ***Digital Multimedia Evidence Processing*** – Level II (40 hour course taught approximately two times per year)
- ***Advanced Forensic Video Analysis*** – Level III (40 hour course taught once a year)

2004 to present **Adjunct Instructor**: University of Indianapolis, IN, Forensic Video Analysis

- ***Photographic Video Comparison*** (40 hour course, taught at least once per year)

2000.03 to 2006.12 **Manager:** Avid Technology, Public Safety Video Solutions Forensic Video Development, Sales, Marketing & Training

1998.01 to 2006.08 **Adjunct Instructor*:*** British Columbia Institute of Technology, Canada - Forensic Sciences Program

- ***CCTV Surveillance Technologies*** (40 hrs)
- ***Photographic Video Comparison*** (40 hrs)

1988.12 – 2000.04 **Police Officer:** Vancouver Police Department, Patrol, K-9, Coordinator/Analyst: Forensic Video Unit, 98/01/15 to 00/04/03

1984.10 - 2000 **Producer**, **Director**: West Coast Communications (FVS) Film and Video Productions, Crime Recreations & Video Clarification/Enhancement, including:

- 1994, '95 & '96 **Producer, Director, Writer**: Annual BC Road Test Series; aired on BCTV '92 & '93, and on CBC

- 1988 **Producer, Creator:** "MANHUNT LIVE" Internationally syndicated 2hr. live program investigating The Green River Murders, hosted by CBS's DALLAS star Patrick Duffy.

- 1987.11 - 1988.12 **Writer, Producer, Director**: Seattle King-County Crime Stoppers Re-enactments. Weekly Productions.

- 1984.10 – 1988.01 **Writer, Producer, Director:** Greater Vancouver Crime Stoppers, Re-enactments. Weekly Productions.

- 1984 to present **Free-lance Writer:** Published: Maclean's, Vancouver Magazine, Government Video Magazine, Law Enforcement Technology Magazine, Forensic Imaging

1983.01 - 1988.01 **News Reporter/Producer:** VU 13 TV, Vancouver, B.C. On-Air Field Reporting, Nightly News Break Anchor.

EDUCATION

1978 - 1982 B.A., Broadcast Communications; Gonzaga University, Spokane, WA 99258. Graduated 1982.

PROFESSIONAL MEMBERSHIPS

- 10/04/94 to Present – Law Enforcement & Emergency Services Video Association (LEVA)

- 04/01/02 to Present – International Association for Identification (IAI)

ADVISORY COMMITTEE/BOARD

- Global Strategic Solutions Working Group – 10/15/13 - current
  - Federal Advisory Committee to the U.S. Attorney General

- National Institute of Justice (NIJ)
  - Sensors and Surveillance Technical Working Group – 01/01/11 - current

- Law Enforcement & Emergency Services Video Association (LEVA)
  - Forensic Video Analysis Certification Committee – 10/04/01 – 12/31/12

- Law Enforcement & Emergency Services Video Association (LEVA)
  - Forensic Video Analysis Curriculum Development Committee – 7/15/97 - current

- International Association of Chiefs of Police (IACP)
  - Police In-car Camera Advisory Board – current
  - Digital Video System for Public Safety Advisory Panel - current

- Security Industry Association (SIA)
  - SIA Standards Committee, Digital Video Subcommittee – 2001 - 2006

GOVERNMENT HEARINGS & BRIEFINGS

- 03/14/02 – Held separate briefing on "CCTV in America for Homeland Security" on Capital Hill in Washington, DC
    - Judiciary Subcommittee on Technology, Terrorism & Government – Senator Feinstein
    - Judiciary Subcommittee on Immigration – Chief Counsel to Senator Ted Kennedy
    - Judiciary Subcommittee on Technology/Intellectual Properties – Senator Cantwell

- 12/12/02 - Testified in Washington, DC during the Public Oversight Hearing for the Committee on the Judiciary, Council of the District of Columbia, Bill 14-946, "Limited Authorization of Video Surveillance and Privacy Protection Act of 2002"

- 5/25/09 Braidwood Commission - "Expert in Forensic Video Analysis", In-custody Death, Vancouver, BC Commissioner Thomas Braidwood

BROADCAST NEWS APPEARANCES

Various local and national broadcasts in Canada US & UK, including:

- 11/20/94 HBO – Shock Video 2: The Show Business of Crime and Punishment
- 10/24/01 ABC News 20/20, FBI Academy – Training the Terrorist Hunters/Anthrax
- 10/28/01 MSNBC, NY – Forensic Video Applications In the News
- 12/18/01 CNN Headline News, Atlanta, GA – examination of Osama bin Laden video
- 10/11/02 Good Morning America, ABC News – Washington DC Sniper
- 10/14/02 ABC World News Tonight with Peter Jennings
- 10/22/02 CNN Headline News, Atlanta, GA – Washington, DC Sniper
- 10/24/02 FoxNews, "On the Record with Greta Van Susteren"
- 10/24/02 Fox5, Washington DC, - examination of Osama bin Laden video
- 04/09/03 FoxNews, with John Gibson - examination of Saddam Hussein video
- 2006 – 2007 CourtTV – Video Justice Series (five programs)
- 2006 National Geographic – Monsters of the Deep – Forensic Video Consultant
- 2009 BBC Television – BBC NewsNight – Nico Bento Wrongful Conviction

AWARDS

1990 International Association of Business Broadcasters Award
Best Television Program

1988 Crime Stoppers International **Best Television Re-enactment**

1987 SAM Award **Best Public Service Television Commercial**

1987 Crime Stoppers International **Best Television Re-enactment**

1987 R.T.N.D.A. Award **Best Investigative Story Of The Year**

1986 **B.C. Broadcaster's Public Service Award**

1986 R.T.N.D.A. Award **Excellence In TV News Broadcasting**

1985 Radio and Television News Directors' Association (R.T.N.D.A.)
Award **Excellence In TV News Broadcasting**

CERTIFICATES OF RECOGNITON

* **Chief Constable's Commendation, 2013.** For Technical Management of large scale video investigation. Vancouver Police Department

* **Vollmer Award for Excellence in Forensic Sciences** – Presented to LEVA by the International Association of Chiefs of Police - 2011

* **Chief Constable's Commendation, 1996.**

* **Superintendent's Commendation, 1995.**

* **Superintendent's Commendation, 1994.**

* **Inspector's Commendation, 1993.**

* **Outstanding Contribution** to Seattle King County Crime Stoppers, l989.

* **Outstanding Contribution** to Traffic Safety in the Community, l988. Insurance Corporation of British Columbia.

* **Outstanding Contribution** to Greater Vancouver Crime Stoppers, l987.

* **Deputy Commissioner's Commendation** for Search and Rescue Operation, l987. R.C.M.P.

* **Chief Constable's Commendation** for Professional Conduct as a T.V. News Reporter, 1984. Vancouver Police Department.

GUEST LECTURER & INSTRUCTOR

Primary Instructor of more than 400 Forensic Video Workshops, Lectures & Seminars in the United States, Canada, Brazil, Singapore, England & the Bahamas.

ADDITIONAL SPECIALIZED TRAINING

- Crime Stoppers International, Calgary, Alberta - 1986
- Law Enforcement & Emergency Services Video Association, Kansas City, MO – 1994
- International Association for Identification, Miami, FL – 2001
- Avid Media Composer Editing, Washington, DC - 2001 (24 hrs)
- Ocean Systems dTective Training, Burtonsville, MD - 2001 (16 hrs)
- Law Enforcement & Emergency Services Video Association, Vancouver, Canada – 2001
- International Association for Identification, Ottawa, Canada – 2003
- Law Enforcement & Emergency Services Video Association, St. Charles, IL – 2003
- Forensic Applications of Photoshop - 2004 University of Oklahoma (16 hrs)
- Reverse Projection Photogrammetry - 2004 Spokane, WA LEVA (32 hrs)
- Law Enforcement & Emergency Services Video Association, Washington, DC – 2004
- Law Enforcement & Emergency Services Video Association, Coeur d'Alene, ID – 2005
- Digital Video Evidence Recovery - 2006 Spokane, WA LEVA (32 hrs)
- Expert Witness Testimony, San Francisco, CA – 2006 (24 hrs)
- Advanced Forensic Video Analysis Issues – February 2010 Spokane, WA LEVA (32 hrs)
- Forensic Image Processing & Analysis Workshop – May 2010 (32 hrs), North Carolina State University, College of Textiles, Raleigh, NC
- 3D Imaging Technology – Feb 2012 (24 hrs), 3rd Tech, Colville, WA

APPENDIX – A

EXPERT TESTIMONY (Last 10 Years)

5/6/14 R v. Aasif Patel & Wariskhan Pathan
"Expert in Forensic Video Analysis"
Murder
Ontario Superior Court, Toronto, ON

4/8/14 People v. Kassim Alhimidi
Case No: SCE325289
"Expert in Forensic Video Analysis"
Murder
San Diego Superior Court, CA Judge William McGrath

2/25/14 Mitchell COHEN v Transportation Insurance Company
1:10-CV-0743 (GTS/RFT)
"Expert in Forensic Video Analysis"
Civil
United State District Court, Northern District of New York, Judge Glenn T. Suddaby

2/03/14 Flores-Haro, Adalberto et al v. WC et al,
"Expert in Forensic Video Analysis"
Ciivil – Case No. 3:12-cv-01616-HA
Multnomah County – Grand Jury, Portland, Oregon

12/20/13 People v Villalta
"Expert in Forensic Video Analysis"
Possession of Child Pornography – Indictment #2928-2012
Queens County Court, NY – Judge Charles S. Lopresto

11/25/13 State of Oregon v. Silvano Velasquez
"Expert in Forensic Video Analysis"
Homicide – Case No. 1310-35017
Multnomah County – Grand Jury, Portland, Oregon

11/13/13 State of Washington v. Morris Talaga 11-1-12176-0 KNT
"Expert in Forensic Video Analysis"
Aggravated Assault
King County, WA Judge James Cayce

10/31/13 People v. Shane Grattan
"Expert in Forensic Video Analysis"
Murder
San Diego, CA Judge Amalia L. Meza

10/22/13 State of Texas v. Tyrone Pierre Thomas
Cause # 1195093
“Expert in Forensic Video Analysis”
Murder 1
Tarrant County Criminal District, TX Court #4 Judge Mike Thomas

10/09/13 R v Mignot, et al
"Expert in Forensic Video Analysis"
Robbery
Grand Court of the Cayman Islands, Justice Alistair Malcolm

1/7/13 Manal Al Mehdhar v. Greyhound Lines, Inc. et al
Index Number: 12010-4702
“Expert in Forensic Video Analysis”
Civil
New York State Erie County Supreme Court, Judge was Joseph R. Glownia

12/3/12 State of Texas v. Randy Siebel
Cause # 1195090
“Expert in Forensic Video Analysis”
Murder 1
Tarrant County Criminal District Court #4 Judge Mike Thomas

10/15/12 Anthony Pirone v Bay Area Rapid Transit
“Expert in Forensic Video Analysis”
Employee Relations
Arbitration – Oakland, CA

8/22/12 Arsenault v. City of Seattle
“Expert in Forensic Video Analysis”
Use of Force
United States District Court for the Western Division of Washington, US Federal Judge James L. Robarts

6/20/12 R v. Christopher Shadrock
“Expert in Forensic Video Analysis”
Murder
High Court of New Zealand, Auckland Registry, Honorable Justice Brewer

5/30/12 Amilton Nicolas Bento vs. The Chief Constable of the Bedfordshire Police, Case No: HQ10D01015
“Expert in Forensic Video Analysis”
Slander
High Court of Justice, Queen’s Bench Division, London, England Mr. Justice David Michael Bean

1/5/12 State of Texas v. Kwane A. Rockwell, DA Case # 1195088
“Expert in Forensic Video Analysis”
Murder 1
Criminal District Court, Texas, Judge Elizabeth Berry

12/5/11 R v Devon Anglin indictment
"Expert in Forensic Video Analysis"
Murder
Grand Court of the Cayman Islands, Chief Justice Anthony Smellie

11/30/11 State v. Alfred Joseph Sanchez, Cause # 09-1-591-9
"Expert in Forensic Video Analysis – Rebuttal Evidence"
Attempted Murder
Thurston County Superior Court, WA Judge Christine Pomeroy

11/09/11 State v. Alfred Joseph Sanchez
"Expert in Forensic Video Analysis"
Attempted Murder
Thurston County Superior Court, WA Judge Christine Pomeroy

10/25/11 Paskalidis v. Caprice Hospitality, et al
"Expert in Forensic Video Analysis"
Personal Injury - Civil
Vancouver Supreme Court Justice William F. Ehrcke

10/19/11 People v. Chu Vue & Lang Vue, Court No. 09F02572-b
"Expert in Forensic Video Analysis"
First Degree Murder
Sacramento Superior, CA Hon. Steve White

08/19/11 R v Devon Anglin indictment 70/10
"Expert in Forensic Video Analysis"
Murder
Grand Court of the Cayman Islands, Mr. Justice Cooke

05/31/11 TX v. State v. Trevante Smith, Cause numbers 10CR3584 and 10CR3585
"Expert in Forensic Video Analysis"
Robbery
Galveston County, TX, 405th District Court, Judge Wayne Mallia

04/20/11 WA v. Lipsey, 09-1-02790-7 SEA
"Expert in Forensic Video Analysis"
Murder 2
King County Superior Court, WA, Hon. Bruce E. Heller

03/30/11 State v. Aaron J. Larose, 0911-CR03956-01
"Expert in Forensic Video Analysis"
Homicide
St. Charles County, MO 11th Judicial Circuit, Division 2, Judge Nancy Schneider

03/23/11 WA v. Darcus Dewayne Allen, 10-1-00938-0
"Expert in Forensic Video Analysis"
Murder x 4
Pierce County, WA, Judge Frederick Fleming

11/2/10 WA v. Alfred Joseph Sanchez, Cause # 09-1-591-9
"Expert in Forensic Video Analysis"
Attempt Murder
Thurston County, WA Superior Court Judge Christine Pomeroy

9/30/10 WA v. Curtis Ware, 09-C-05947-7
"Expert in Forensic Video Analysis"
Murder
Seattle, WA King County Superior Court Judge Regina Cahan

9/21/10 State of Iowa v. Justin Andrew Pollard, Criminal No. FECR 232424
“Expert in Forensic Video Analysis”
First Degree Murder
Iowa District Court for Polk County, Iowa Judge Joel Novak

8/24/10 People v. Chu Vue & Lang Vue, No. 09F02572
"Expert in Forensic Video Analysis"
First Degree Murder
Sacramento Superior Court, CA Hon. Steve White

2/26/10 People v. Marquise Grady SCD216913/ACJ642
"Expert in Forensic Video Analysis"
Murder
San Diego, CA Judge Jeffrey Fraser

2/16/10 WA v. Rey Davis-Bell Cause No. 08-1-01294-4
"Expert in Forensic Video Analysis"
Murder
Seattle, WA King County Superior Court Judge Laura Inveen

2/09/10 WA v Jaycee Fuller
“Expert in Forensic Video Analysis”
First Degree Murder
Pierce County, WA Superior Court Judge Katherine Stolz

12/16/09 State of Maine v. Jason Twardus, Docket No. CR-09-077
“Expert in Forensic Video Analysis”
First Degree Homicide
York County Superior Court, ME Justice Arthur Brennan

11/9/09 State of FL v. Allen McGriff, Docket No. 2006CF18335AXXX
“Expert in Forensic Video Analysis”
Attempt Murder X 2
Jacksonville, FL Fourth Judicial Circuit Judge Charles Arnold

8/31/09 People v. Dennis Potts SCD 211145
"Expert in Forensic Video Analysis"
First Degree Murder X 2
San Diego, CA Judge Bernard Revak

5/22/09 USA v Wayne Simoes
"Expert in Forensic Video Analysis"
Color of Right
White Plains, NY US District Court Hon. Judge Kenneth Karas

3/04/09 Otioti, et. al. v. State of Arizona, et. Al, #CV07-0443-PHX-SRB
"Expert in Forensic Video Analysis"
Wrongful Death
Phoenix, AZ US District Court, District of Arizona Judge Susan Bolton

2/09/09 People v. John Galtieril, Indictment 42/2007
"Expert in Forensic Video Analysis"
2nd Degree Murder
Staten Island, NY Part 5 of Richmond Co. Supreme Court Hon. Justice Stephen Rooney

1/14/09 Morningstar v City of Detroit, et al
"Expert in Forensic Video Analysis"
Malicious Prosecution
Detroit, MI US District Judge Patrick Duggan

11/06/08 USA v. James Eric Matthews, CASE NO. 3:08-cr-239-J-32MCR
"Expert in Forensic Video Analysis"
Motion to Suppress
Jacksonville, FL Judge Monte C. Richardson

10/09/08 People v. Mark Brown SCD164173/AAY783
"Expert in Forensic Video Analysis"
Homicide
San Diego, CA Judge David Gill

9/11/08 Regina v. Rajinder Benji
"Expert in Forensic Video Analysis"
Homicide
Vancouver Supreme Court, BC Madame Justice Stromberg-Stein

5/29/08 State of Illinois v. R. Kelly
"Expert in Forensic Video Analysis"
Producing Child Pornography
Cook County Court, IL Judge Vincent Gaughan

5/5/08 State of Idaho v. Hector Brito Almaraz
"Expert in Forensic Video Analysis"
First Degree Murder
Third Judicial District Court, ID Judge Gregory M. Culet

4/18/08 State of Texas v. Darrell Bell
"Expert in Forensic Video Analysis"
Murder 1
Criminal District Court, Texas Judge Wayne Salvant

2/22/08 State of Missouri v. Nathan Speaks, 0611-CR07324
“Expert in Forensic Video Analysis”
Murder
St. Charles County, MO Judge Nancy Schneider

1/24/08 Supreme Court of the State of NY v. Richard Lawlor
“Expert in Forensic Video Analysis”
Attempted Murder, Kidnapping, Robbery
County of New York: Part 39 Hon. Judge Lewis Bart Stone

1/09/08 State of Florida v Allen McGriff
“Expert in Forensic Video Analysis”
Attempted Murder
Forth Judicial Circuit, Duval County, FL County Court Judge Charles W. Arnold

8/9/07 State v. Joshua Jones
“Expert in Forensic Video Analysis”
Possession of Cocaine with Intent to Deliver
King County Superior Court, WA

7/26/07 State v. Joshua Jones
“Expert in Forensic Video Analysis” – Motion to Suppress
Possession of Cocaine with Intent to Deliver
King County Superior Court, WA

7/25/07 State of Iowa v. Justin Andrew Pollard
“Expert in Forensic Video Analysis”
First Degree Murder
Iowa District Court for Polk County, Iowa Judge Eliza Ovrom

4/18/07 State of Texas v. Darrell Bell
“Expert in Forensic Video Analysis”
Murder 1
Criminal District Court, Texas Judge Wayne Salvant

4/16/07 State of Washington v. Anthony Trujillo
“Expert in Forensic Video Analysis”
Suppression Hearing
King County Superior Court, WA Judge Richard McDerrmott

3/20/07 State of Washington v. Tihn Lam
“Expert in Forensic Video Analysis”
Murder 1
King County Superior Court, WA Judge Jeffrey Ramsdell

2/7/07 State of Texas v. Birmingham, Jared Dwayne
“Expert in Forensic Video Analysis”
Murder 1
396th Judicial District Court, Texas Judge George Gallagher

11/14/06 State of Texas v. Calhoun, Shiela
“Expert in Forensic Video Analysis”
Arson
213th Judicial District Court, Texas Judge Robert Gill

09/28/06 State of Florida v. Jeremy Lane,
“Expert in Forensic Video Analysis”
Murder 2
Forth Judicial Circuit, Duval County, FL County Court Judge Jack M.Schemer

07/19/06 People v. Christopher Porco,
“Expert in Forensic Video Analysis”
Murder 2
Orange County District Court, New York County Court Judge Jeffrey G. Berry

05/25/06 State v. Richard Case, Cause No. 03-1-00440-1 KNT
“Expert in Forensic Video Analysis”
Murder 1
King County District Court, Washington Judge George Mattson

07/28/05 State of Texas v. ADAMS, Roy
“Expert in Forensic Video Analysis”
2nd Degree Murder
396th Judicial District Court, Texas Judge George Gallagher

05/18/05 Regina v. PRINCE
“Expert in Forensic Video Analysis”
Homicide
Manitoba Supreme Court, Justice J. Suche

05/16/05 State of Washington v. Robert Lemieux
Expert evidence presented in Forensic Video & Audio Analysis
Homicide
Pierce County Superior Court of Washington, Tacoma, Washington
Judge Donald Culpepper

04/18/05 Inquest into the Death of Clark Edward Whitehouse
Expert evidence presented in Forensic Video & Audio Analysis
Coroner's Inquest
Chief Coroner for the Yukon, Whitehorse,
Coroner Sharon Hanley

12/7/04 R. v RCMP
“Expert in Forensic Video Analysis”
Dangerous Driving Causing Death
Yukon Territory Court, Whitehorse, CA, Deputy Judge Barnet

10/20/04 State of Texas v. SMITH, Richard
“Expert in Forensic Video Analysis”
Capital Murder
297th Judicial District Court, Texas Judge Everett Young

09/22/04 State of Texas v. GONZALES, Filepe
“Expert in Forensic Video Analysis”
Capital Murder
297th Judicial District Court, Texas Judge Everett Young

06/15/04 R. v PRINCE
“Expert in Forensic Video Analysis”
Homicide
Court of Queens Bench, Winnipeg, MB Mr. Justice Hansen

03/09/04 State of Texas v. GONZALES, Jose
“Expert in Forensic Video Analysis”
Capital Murder
297th Judicial District Court, Texas Judge Everett Young

1/20/04 R. v Bhatti
“Expert in Forensic Video Analysis”
Homicide
B.C. Supreme Court, Vancouver, B.C.

11/24/03 Commonwealth of Pennsylvania v. WILSON
“Expert in Forensic Video Analysis”
Capital Murder – Suppression Hearing
***Lebanon County Court of Common Pleas,* Pennsylvania** Judge John C. Tylwalk

6/10/03 Commonwealth of Massachusetts v. Lichter & Quinn
“Expert in Forensic Video Analysis”
Assault
Norfolk County Court, Canton, Massachusetts

6/5/03 State of Oregon v. Thomas Calkins
“Expert in Forensic Video Analysis”
Arson – Case No. 0210-36298
Multnomah County Court, Portland, Oregon Judge Linda Bergman

11/21/02 Regina v. PRINCE
“Expert in Forensic Video Analysis”
Homicide – Preliminary Hearing
Winnipeg Provincial Court, Manitoba Judge Bruce Miller

11/01/02 State v. MUNIZ
“Expert in Forensic Video Analysis”
First Degree Murder
Jefferson County District Court, Colorado Judge James Zimmerman

10/30/02 State of Washington v. Ramirez-Garcia & Nickalus Gonzales
Expert evidence presented in Forensic Video Analysis
Attempt Murder X 4
Pierce County Superior Court of Washington, Tacoma, Washington
Judge Frederick Fleming

10/24/02 Pamela Grunow as PR of the Estate Barry Grunow, deceased v. Valor Corporation of Florida
Expert evidence presented in Forensic Video Analysis
Palm Beach County, Florida, Fifteenth Judicial Circuit**,** Judge Jorge LaBarga

07/31/02 State v. MUNIZ
"Expert in Forensic Video Analysis"
First Degree Murder
Jefferson County District Court, Colorado Judge James Zimmerman

05/30/02 State of Washington v. John Phet, Jimmee Chea
Expert evidence presented in Forensic Video Analysis
Homicide X 5
Pierce County Superior Court of Washington, Tacoma, Washington
Judge Karen Strombom

05/13/02 Trans North Turbo Air Ltd. v North 60 Petro Ltd., et al
"Expert in Forensic Video Analysis, Including Photographic Comparisons"
Civil case involving commercial loss
Supreme Court of The Yukon Territory, White Horse Registry #00-A0174
Mr. Justice R. Veale

Depositions

01/29/02 LEVY v. Chubb Corporation, et al
Case No. 00 C 5698
Chicago, IL

02/01/06 Florida v Claudia MURO
via Telephone
Spokane, WA

09/11/06 Florida v Jeremy LANE
via Telephone
Spokane, WA

7/25/07 Iowa v Justin Andrew Pollard
Polk County District Court
Des Moines, Iowa

1/10/08 State of Florida v Joe Losada
Miami-Dade County
Miami, FL

3/04/08 Otioti v. Arizona
Via Teleconference
Spokane, WA

8/24/09 Dena Johnson v. Circle K Stores, Inc.
Via Teleconference
Spokane, WA

7/22/10 Iowa v. Justin Pollard
Spokane, WA

12/20/11 Blanca Elizabeth Cornejo v. Veolia es Solid Waste Southeast, Inc., FL.
Case No. 2010-CA-014656-0
Portland, OR

2/14/12 Mary Piskura, et al., vs. City of Oxford, OH et al,
CASE No. 1:10-cv-00248
Spokane, WA

3/2/12 United States vs. Karl F. Thompson, Jr.
No. CR-09-0088-FVS
Spokane, WA

10/3/12 Anita Russell v. Denny Wright
Civil Action No. 3:11-cv-00075-GEC
Spokane, WA

3/19/13 JACKELIN GUTIERREZ v. ROYAL CARIBBEAN CRUISES, LTD.,
CASE NO.: 09-65741 CA 09
Spokane, WA

4/26/13 Blanca Elizabeth Cornejo v. Veolia es Solid Waste Southeast, Inc., FL.
Case No. 2010-CA-014656-0
Dallas, TX

6/26/13 SONIA VISHNO, ADMINISTRATRIX OF THE ESTATE OF JOEL GONZALEZ v. LARRY FORAN; NEW PENN MOTOR EXPRESS, INC.; and ALL STAR APPLIANCE, INC.,
DOCKET NO. UWY-CV-08-5008713 S
Jacksonville, FL

4/15/14 Michael Pepperman v The District of Columbia
Case No. 09-cv-02294
Spokane, WA

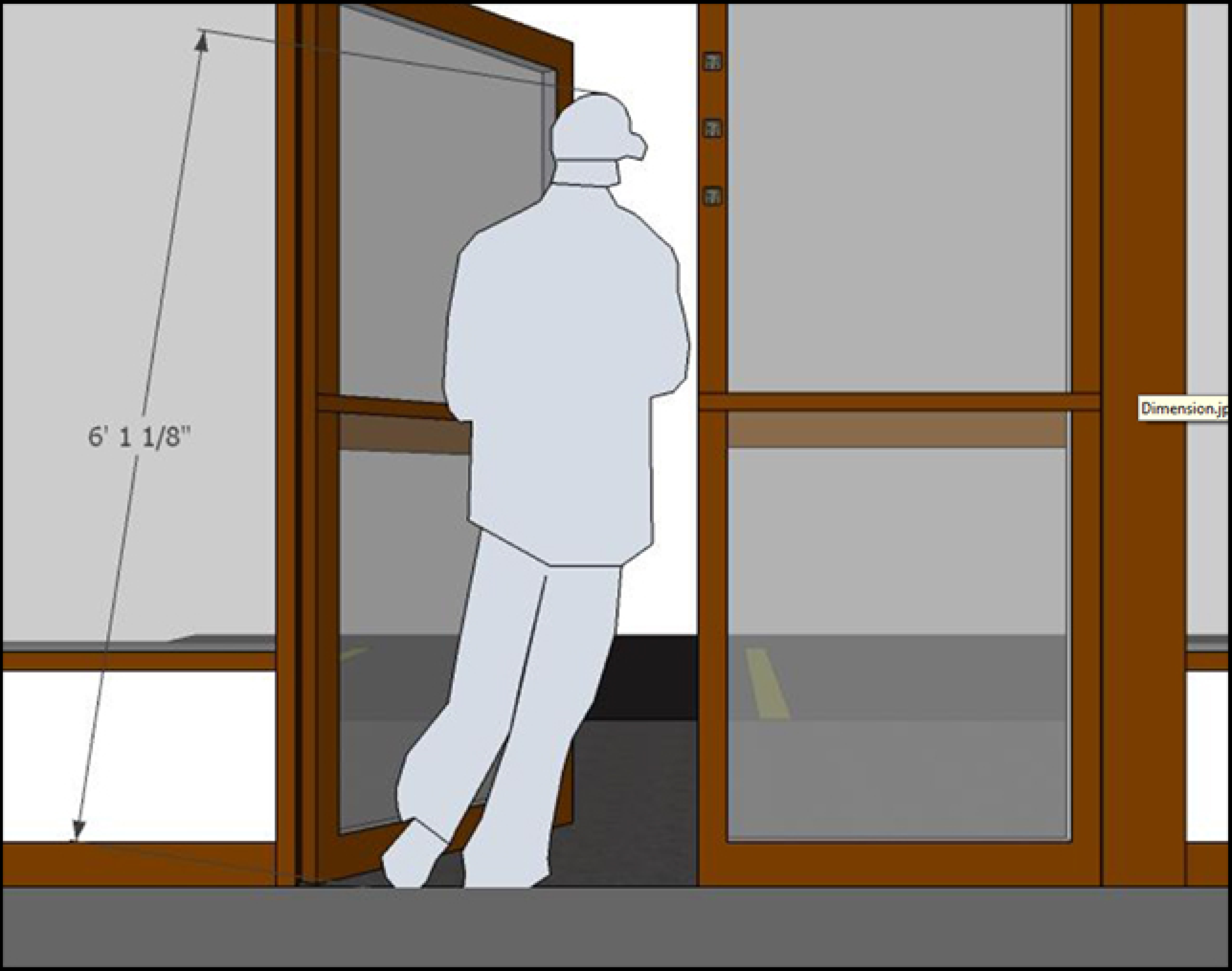
EXHIBIT G

Original image magnified 200%

Measurement standard relative to top of head

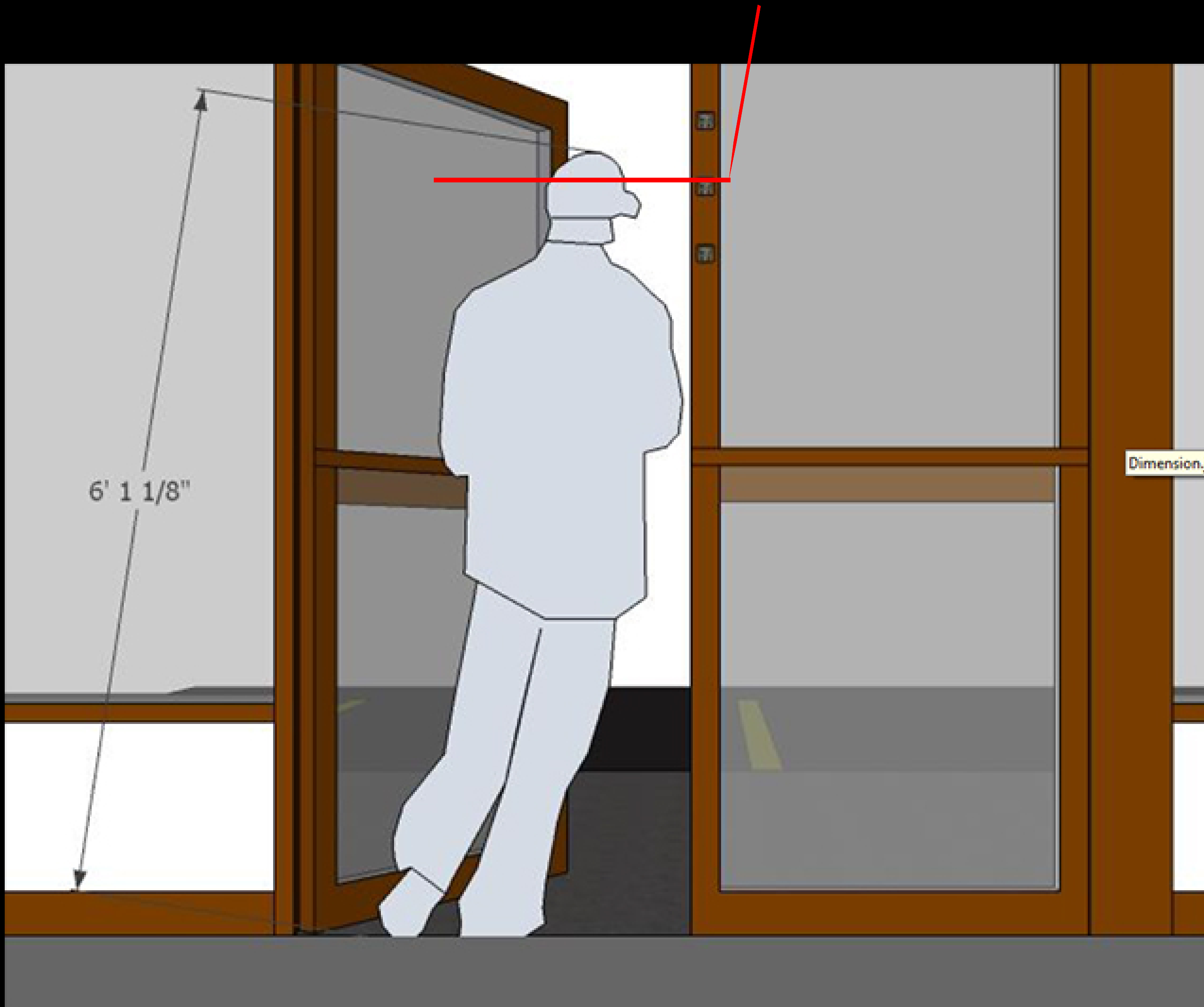
Knox states suspect is in plane of doorway

Knox's traced reproduction



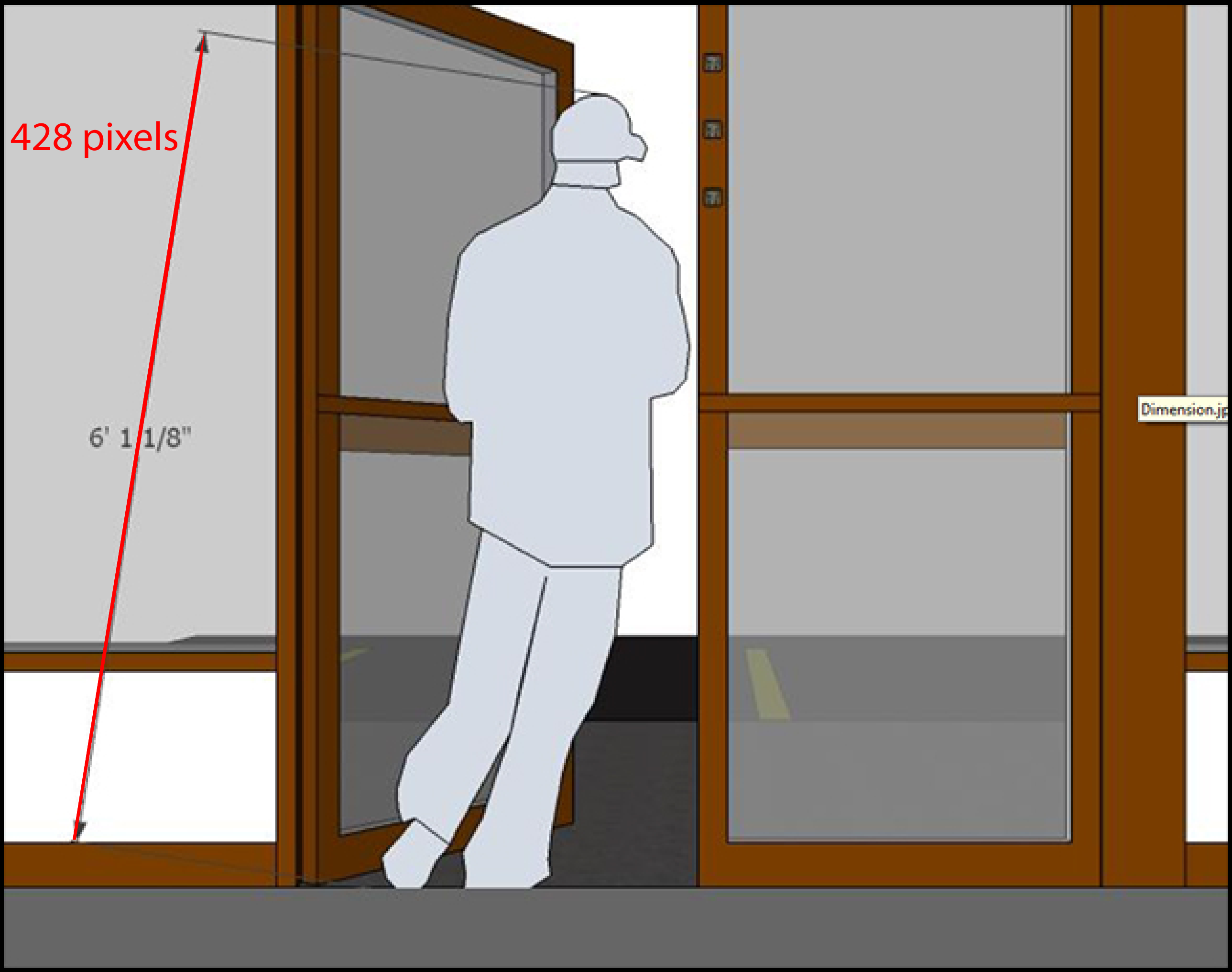
Knox states suspect is in plane of doorway

Measurement standard relative to top of head



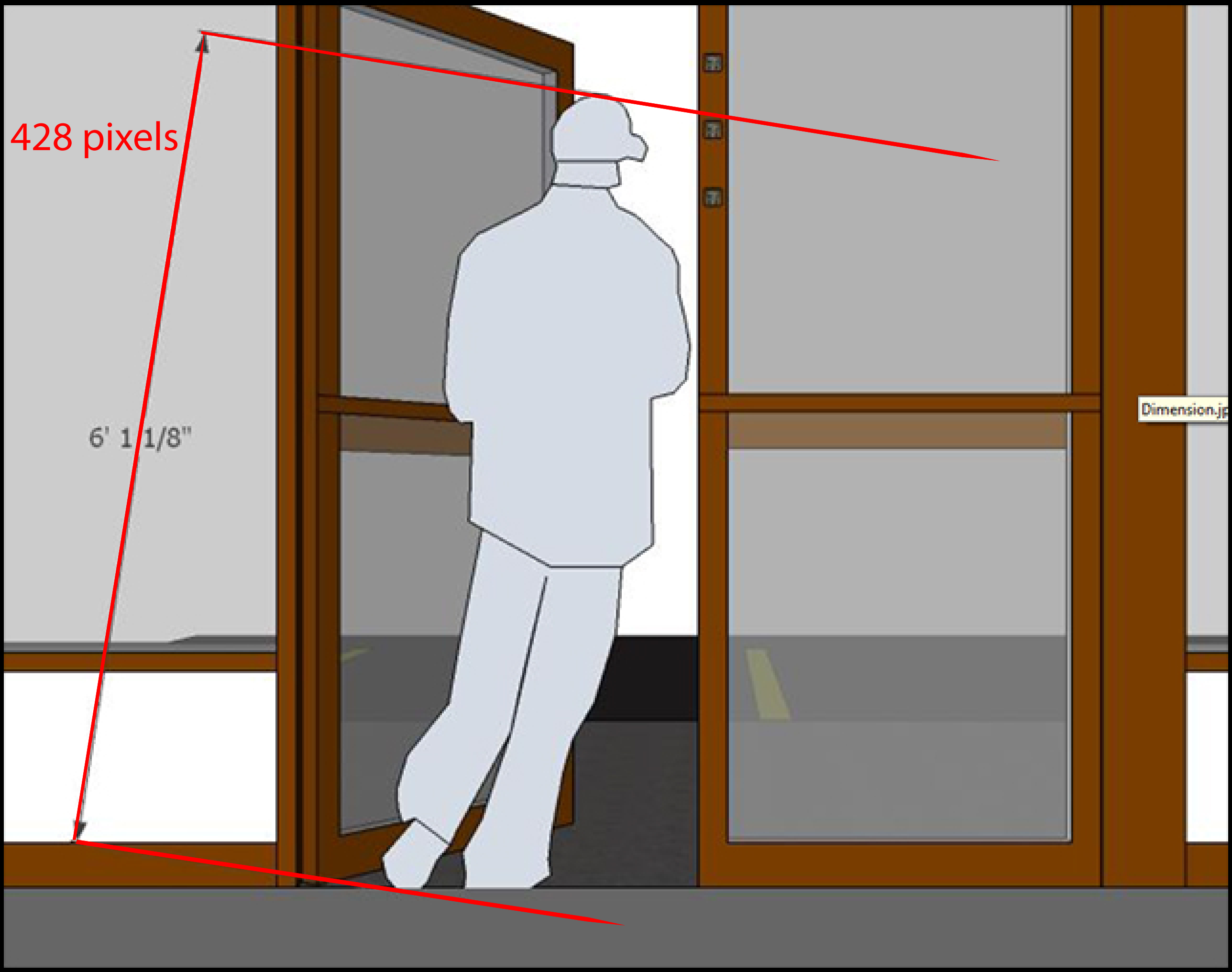
Knox states suspect is in plane of doorway

Knox's traced reproduction



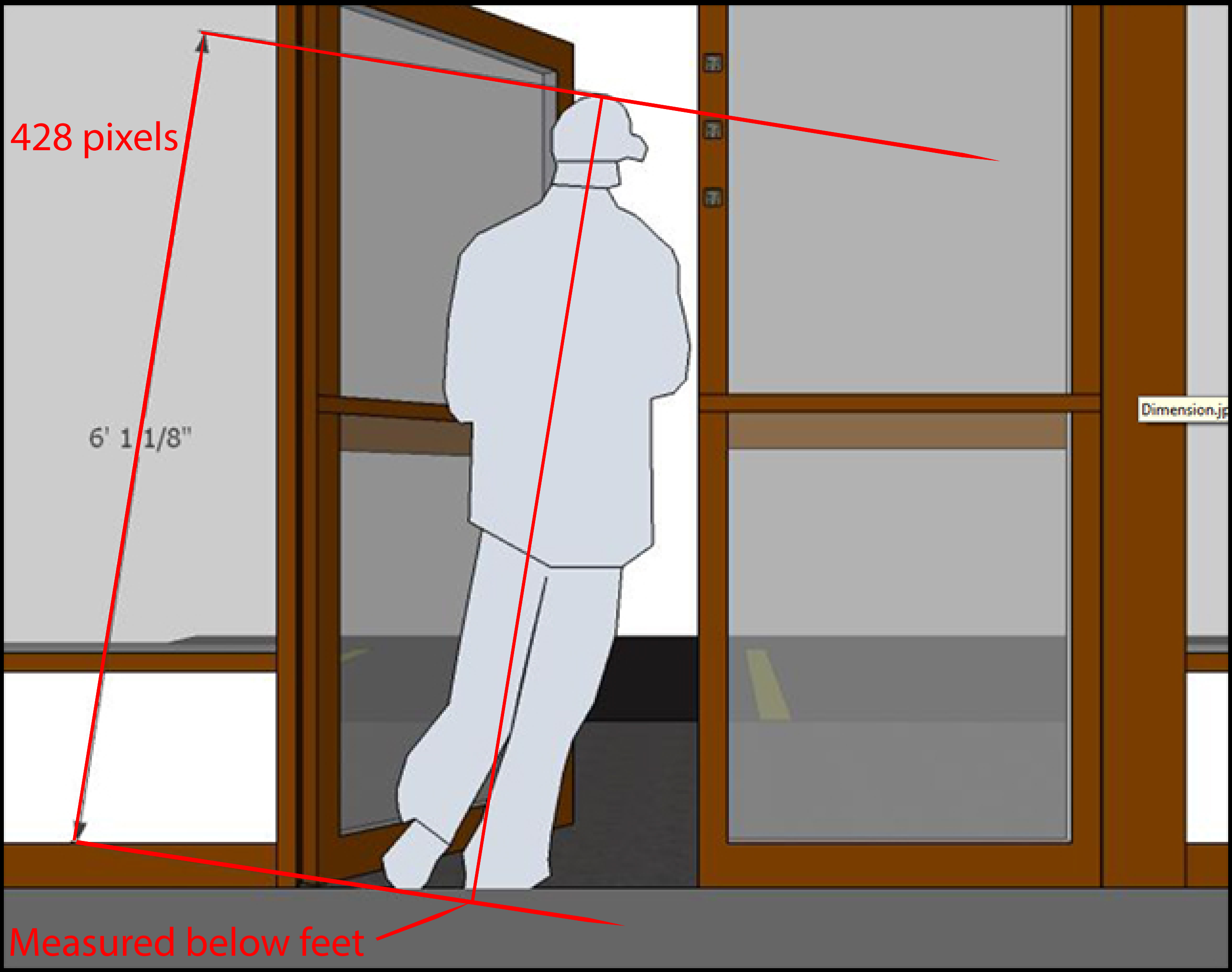
Knox states suspect is in plane of doorway

Knox's traced reproduction



Knox states suspect is in plane of doorway

Knox's traced reproduction



Knox states suspect is in plane of doorway

Approximate point of measurement for feet

Knox states suspect is in plane of doorway

Door Standard at same level

Knox states suspect is in plane of doorway

Suspect head at different height

Knox states suspect is in plane of doorway

EXHIBIT H

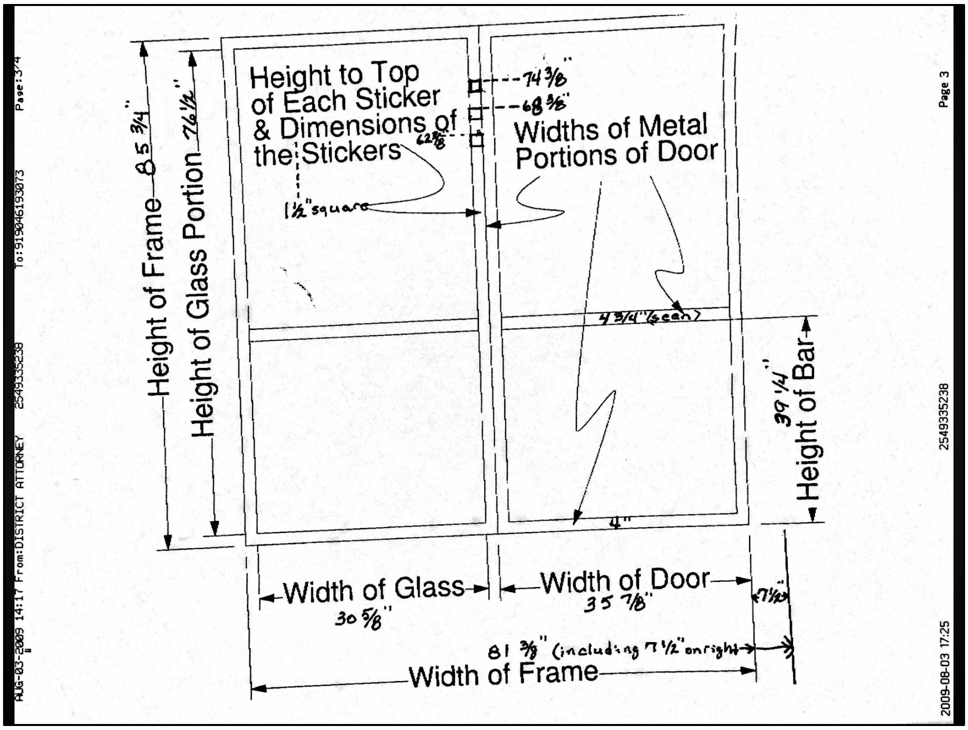
Knox & Associates
Forensic Consulting
We Bring Truth to Light

Forensic Analysis & Reconstruction

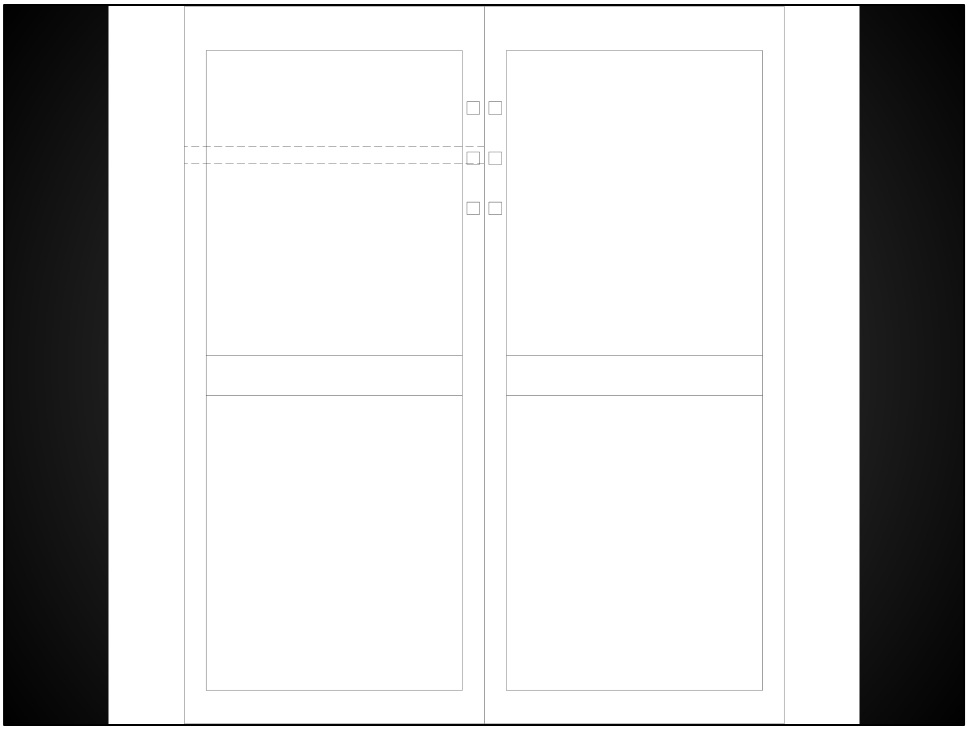
State of Texas v. George Powell

Michael A. Knox
Board Certified Crime Scene Reconstructionist
Accredited Traffic Accident Reconstructionist
Knox & Associates, LLC
P.O. Box 8081
Jacksonville, FL 32239
(904) 619-3063
mike@knoxforensics.com

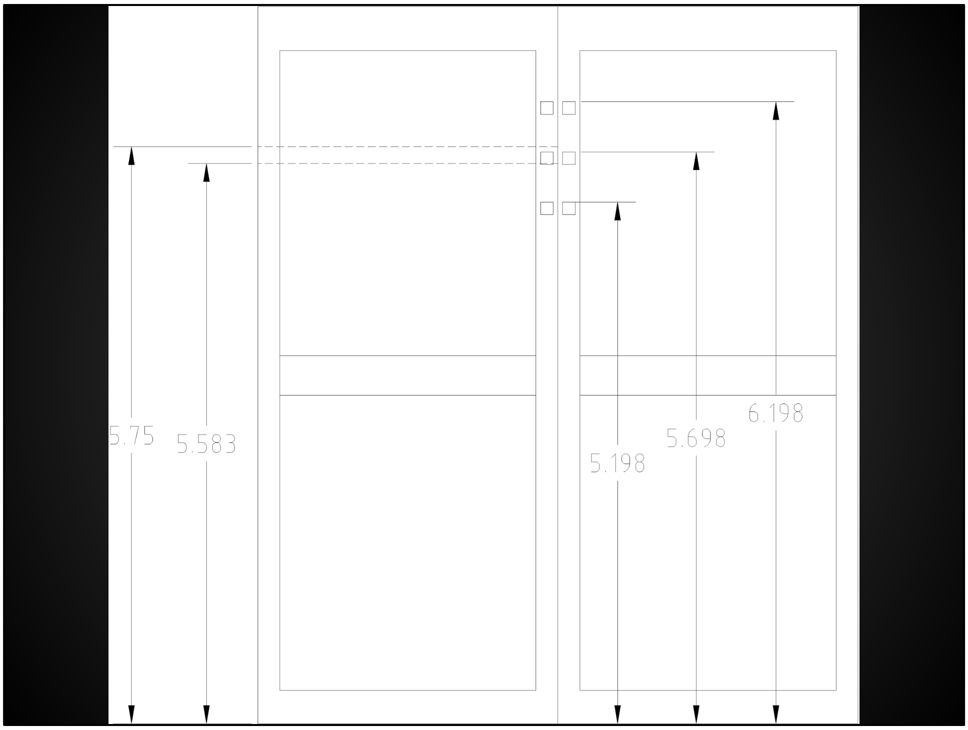
Measurements



These measurements were obtained at the location by investigators with the Bell County District Attorney's Office and were provided to Knox & Associates, LLC. (Diagram not to scale).



The measurements were used to build a DXF file in CAD software to be imported as control points for a PhotoModeler project.



The heights to the top of each sticker are shown for confirmation of the measurements. In addition, lines have been added to show the heights of 5’7” and 5’ 9” as per the height range determined by Grant Fredericks.

Control Points Project

Offender Entering

The control points were marked on an image from the surveillance video showing the offender entering the store. He is within the plane of the doorway.

The project was solved, and the CAD diagram was projected onto the video image.

The outline of the offender's body was marked on a two-dimensional surface placed on the plane of the doorway. Hence, the outline as mapped in PhotoModeler represents the planar projection of the offender's body.

The video image was rectified by PhotoModeler to remove the perspective introduced by the fact that the plane of the camera sensor and the plane of the doorway were not parallel.

The CAD diagram was superimposed on the rectified image. It is readily apparent that the top of the offender's head extends above the 5'9" line and thus exceeds the upper bound of the height range provided by Grant Fredericks. It is important to note that the offender is not standing fully upright, has his feet apart, and has his knees bent to at least some extent, though the amount of knee bending is concealed by his clothing.

A measurement taken using PhotoModeler shows a minimum height of 5.87 feet (5' 10.4").

Control Points Project

Offender Leaving

The image used at trial showing the offender leaving the store was also imported into the new project. Control points were marked for an inverse camera solution.

The CAD file was superimposed on the image.

The outline of the offender's body was marked on the plane of the doorway.

The outline was added to the model and was superimposed on the rectified image. Note that, even with the significant lean angle of the offender’s body, his head reaches the upper bound height of 5’9” as presented by Grant Fredericks.

A measurement was obtained. Note that the bottom point is aligned with the lower line from the CAD file defining the geometry of the doorway. The measurement showed a minimum height of 5.82 feet (5’9.8”).

Calibrated Camera Project

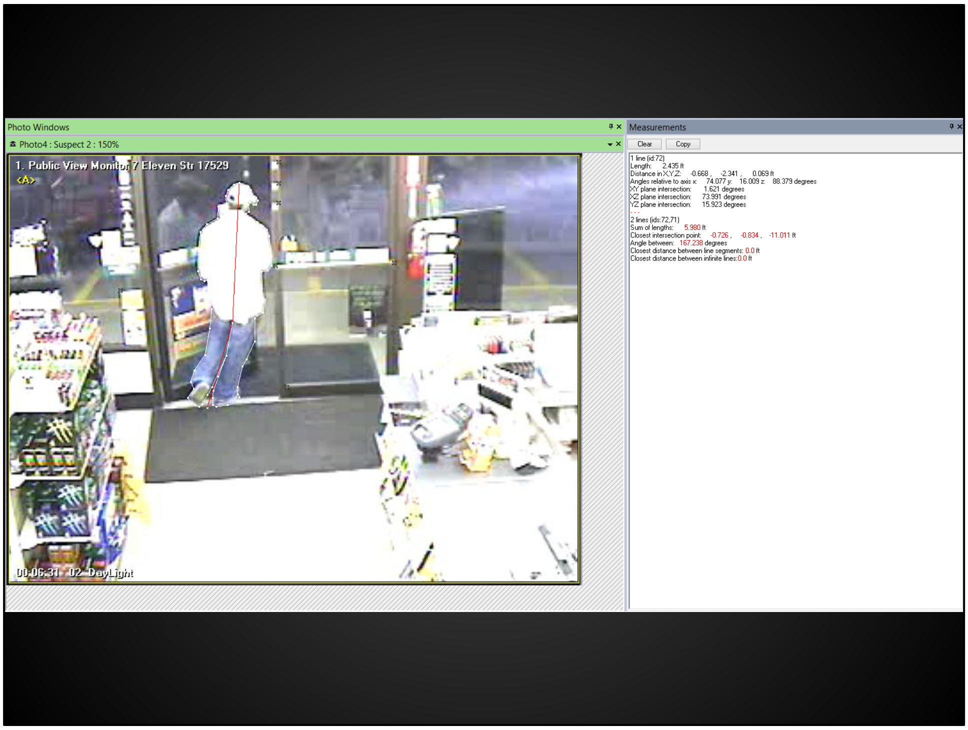
Offender Leaving

This section shows the original calibrated camera project that was carried out prior to trial and was part of trial testimony. Three photographs taken at the scene using a camera and lens combination that had undergone calibration for use with PhotoModeler were imported into the software to be used for modeling. Note the marked points, which were marked across photographs and were used for an inverse camera solution for surveillance video images.

The previous surveillance image was imported and points were referenced for an inverse camera solution.

The outline of the offender's body was traced on a surface on the plane of the doorway.

Consistent with the control points project, the offender’s height when measured linearly is at least 5.88 feet (5’10.6”).



When measured along a curved path following the approximate midline of the offender’s body, the height was measured at a minimum of 5.98 feet (5’11.8”).

Calibrated Camera Project

Offender Entering

As part of this review, the image of the offender entering the store was also imported into the calibrated camera project. Points were marked for an inverse camera solution.

The outline of the offender’s body was traced on the plane of the doorway.

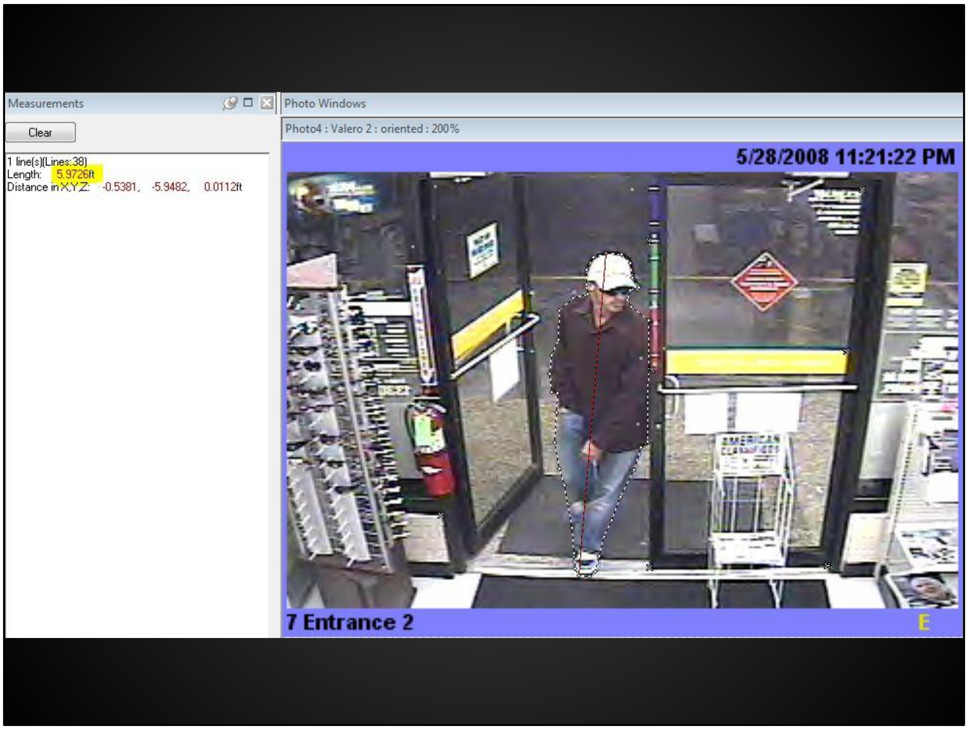
The offender’s height was measured linearly at a minimum of 5.89 feet (5’10.7”).

The body outlines were superimposed on the photos taken at the store.


BUY
GIFT CARDS
HERE!
PUSH
PUSH
GRAB OUR
KILLER DEAL
$1.49
REFILLABLE
COFFEE MUG
Home Phone Service
$19.95 a YEAR!
Includes Your Own Phone Number
and FREE Voicemail
EXTINGUISHER
AMERICAN
CLASSIFIEDS
Chex
MIX
WHY?


BUY GIFT CARDS HERE!
PUSH
GRAB OUR KILLER DEAL
$1.49
REFILLABLE COFFEE MUG
PUSH
Home Phone Service
$19.95 a YEAR!
Includes Your Own Phone Number and FREE Voicemail
FIRE EXTINGUISHER
50% OFF
WHY?

Additional Robbery



During trial, I was asked to carry out the same examination at a Valero store in another apparently-related robbery case. Similarly, the store was photographed using the same calibrated camera and lens combination and an image showing the offender approximately in the plane of the door was marked for an inverse camera solution. The outline of the offender was marked on a surface on the plane of the doorway, and the height was measured at a minimum of 5.97 feet (5’11.6”).

The heights measured are consistent with what was presented at trial.

EXHIBIT I

C.V. of Dan Mills

Unit 211 – 146 Thirtieth St, Toronto, ON M8W 3C4
P: 416-618-7683 E: dmills@dcmtechservices.com

Education

Masters of Civil Engineering (partially complete), **Transportation**
Ryerson Polytechnic University, 2001 - 4 courses completed

Post-graduate Certificate: Digital Geographic Information Systems
Ryerson Polytechnic University, 1999-2001

Bachelors of Technology, Survey Engineering
Ryerson Polytechnic University, 1992-1996

Undergraduate thesis; designed a Cost Benefit Analysis and procedure for implementing a Geographic Information System in local government. This procedure was then applied in a case study of a Southern Ontario town.

Experience

Bubl Technology Inc – www.bublcam.com
2011 to Nov 2015

Co-founder, Bubl Technology Inc. Positions held: VP Hardware, CEO and CTO. Integral in the design, manufacture and patenting of a spherical, 4 lens video camera and developing the associated advanced stitching algorithms to present the video and still images as a properly blended sphere.

DCM Technical Services Inc. - www.dcmtechservices.com
1996 to present

Owner and Consultant, DCM Technical Services Inc. Areas of consulting include photogrammetry, 2D and 3D mapping using conventional survey methods and forensic collision reconstruction. Have used these skills to:

- Design the world’s only pool safety cover measurement system from un-calibrated camera images
- Design an automated human jaw movement imaging and measurement system used in the reconstruction of dental implants
- Train over 700 military, police and private consultants on the application of photogrammetric measurements in their forensic tasks

Humber College
2006 - 2012

Partial load professor in the School of Applied Technology, Civil Engineering Technology. Areas of instruction included Survey II and Survey III and Envinronemental Assessment courses to Civil Engineering Technology diploma students.

Ryerson Polytechnic University
2000 – 2003

Lead Collision Investigator, Vehicle Safety Research Centre (VSRC). The VSRC is a research project for Transport Canada whose overall objective is to determine the effectiveness of the Canadian Motor Vehicle Safety Standards and to evaluate vehicle crash worthiness. Responsibilities include all aspects of collision reconstruction, providing technical expertise and training to other VSRC investigators and police officers, providing expert testimony if necessary for court on completed investigations, and maintain/create contacts with police agencies, vehicle manufacturers and all levels of government. Photogrammetric training was provided to various members of Transport Canada, both for use in scene measurement and crush determination. This role and the Geomatics Technician/Researcher role have had me involved with more than 200 collision investigations and reconstructions.

1996 to 2000

Geomatics Technician/Researcher, Department of Civil Engineering. Responsibilities included maintenance of geomatics lab equipment and research in geomatics related topics. Research topics included application of GIS in various scenarios, aerial photogrammetry, global positioning systems and applying close range photogrammetry to collision reconstruction and forensic measurement. Continued research in the field of collision reconstruction with the Vehicle Safety Research Centre. Collision investigations involving air bag, side impact beam and child restraint safety. Training of new VSRC employees on completion of collision investigations for Transport Canada. Radiation Safety Officer for all of Ryerson. Responsibilities of this position include liaison with the Canadian Nuclear Safety Commission and Ryerson departments containing radioactive equipment, licence applications and developing safety procedures

Expert Testimony
(Forensic Measurements/Photogrammtry)

- Ontario Court of Justice
- Ontario Superior Court
- Financial Services Commission of Ontario
- 14^{th} Judicial Court, Lake Charles, LA
- 12^{th} Judicial Court, Will County, Jolliet, IL
- Appellate Pre-trial hearing, Indinapolis, IN
- 13^{th} Judicial Ciruit, Hillsborough County, FL

Patents

Systems and methods for generating spherical images
Patent number: 8902322
Granted: Dec 2, 2014

Spherical imaging system
Patent number: D700232
Granted: Feb 25, 2014

Publications

Chapman, M., Holker, G, Mills, D., Ramay S., **Bubl Cam : A Commercial-grade Spherical Camera**; Commission I – Working Group 3, International Society of Photogrammetry and Remote Sensing Congress, Melbourne, Australia; 2012

Castaneda, R., Jones, W., Shattuck, M., Mills, D. et al., **Trailer Side Underride Crash Testing: Relating Collision Damage to Impact Speed;** SAE Technical Paper 2012-01-0614, 2012

Le V, Rothman L, Mills D, Howard A; **A Pilot Study on Child Pedestrian and Cyclist Versus Motor Vehicle Collisions;** Canadian Multidisciplinary Road Safety Conference XX, Niagara Falls, ON; 2010

Howard A, Moses McKeag A, Rothman L, Mills D, Blazeski S; **Cervical Spine Injuries in Forward Facing Child Restraints**; Journal of Trauma; June 2004

Mills D, Carty G; **Comparative Analysis of Low Speed Live Occupant Crash Test Results to Current Literature;** Canadian Multidisciplinary Road Safety Conference XIV, Ottawa ON; 2004

Howard A, Rothman L, Moses McKeag A, Pazmino-Canizares J, German A, Monk B, Comeau JL, Hale I, Mills D, Blazeski S; **Children in Side Impact Motor Vehicle Crashes: Seating Position and Injury Mechanism**; Canadian Multidisciplinary Road Safety Conference XIII, Banff AB; 2003

Chapman M, Mills D; **Vehicle Crush Measurements Using High Resolution Terrestrial LIDAR**; Canadian Multidisciplinary Road Safety Conference XIII, Banff AB; 2003

White Papers

Mills D, Carty G; **Semi-Automated Crush Determination Using Coded and Non-Coded Targets with Close-Range Photogrammetry**, published as part of ARC Network Monthly Newsletter, March 2005

Skills and Training

- ARC/CSI Crash Conference, Las Vegas, NV (2015)
- ARC/CSI Crash Conference, Las Vegas, NV (2014)
- ARC/CSI Crash Conference, Las Vegas, NV (2013)
- ARC/CSI Crash Conference, Las Vegas, NV (2012)
- SAE World Congress, Detroit, MI (2012)
- ARC/CSI Crash Conference, Las Vegas, NV (2011)
- SAE World Congress, Detroit, MI (2011)
- ARC/CSI Crash Conference, Las Vegas NV (2010)
- ARC/CSI Crash Conference, Las Vegas NV (2009)
- SPAR/IAFSM Conference, Denver CO (2009)
- ARC/CSI Crash Conference, Las Vegas NV (2008)
- ARC/CSI Crash Conference, Las Vegas NV (2007)
- ARC/CSI Crash Conference, Las Vegas NV (2006)
- ARC/CSI Crash Conference, Las Vegas NV (2005)
- Low Speed Collision Reconstruction Course, OPP (2004)
- Pedestrian Collision Reconstruction Course, RCMP (2002)
- Rollover Collision and Momentum Applications, Collision Safety Institute (2002)
- Biomechanics of Injury Workshop, Canadian Multidisciplinary Road Safety Conference XII (2001)
- WinCRASH software training, Trantech (2001)
- Vetronix Crash Date Retrieval System, Collision Safety Institute (2001)
- Collision Reconstruction Training, Transport Canada (1999)
- Infant and Child Restraint Training, Transport Canada (1999)
- Fundamentals of Applied Physics for Traffic Accident Investigators, Institute of Police Technology and Management (1999)
- Joint Occupational Health and Safety Committee Certification, Industrial Accident Prevention Association (1999)
- Handling of Radioactive Chemicals, International Radiochemical Centre (1998)

Activities

- Crash Testing to date:
  - 69 low speed, live occupant, vehicle to vehicle collisions
  - 16 low speed, live occupant, bumper car rear-end tests

- 90 high speed, live occupant and robotic, vehicle to vehicle collisions
- 5 high speed, crash tunnel, vehicle to vehicle collisions
- 6 motorcycle to car collisions
- 3 static crash test
- 8 static air bag deployments
- 6 radio controlled vehicle rollover
- 2 child restraint dynamic compliance tests

- SAE Photogrammetry in Accident Reconstruction Expert Panel, Invited panellist, SAE World Congress (2011)
- Photogrammetry in Collision Investigation Seminar, invited speaker, SATAI Spring Meeting (2011)
- Using Digital Photogrammetry with Surveillance Video; invited presentation at the Digital Summit International Conference (2010).
- Using Photogrammetry in Collision Investigation; invited presentation at Crashteams Annual Meeting, Las Vegas NV (2010) and Puerto Vallarta Mexico (2009)
- Continued training of the 3-day Photogrammetry/PhotoModeler Pro for police agencies and collision reconstruction consultants.
- Forensic Documentation using Photogrammetry and Stereo-Pair Image Point Clouds; invited presentation at the SPAR/IAFSM Conference (2009)
- Collision Scene Data Collection; invited presentation at the NAFA Fleet Management Association, Canadian Fleet Conference (2007)
- Photogrammetry/PhotoModeler techniques; invited presentation at the Canadian Association of Technical Accident Investigators Conference, Calgary AB (2005)
- Train-The-Trainer PhotoModeler Pro for Collision Reconstruction course to the Washington State Police in Jan 2004.
- On-going Child Safety Restraint workshops for the Toronto and Toronto Catholic District Children's Aid Society
- Taught a 1-day workshop on close-range photogrammetry applications and techniques in the field of Forensics for the 15th Annual Toronto Police Services, Forensic Identification Seminar (2001)
- Taught numerous 1-day seminars on the application of close-range photogrammetry in collision reconstruction to police officers and consultants.

- Presented talks on geomatics innovations to Women in Engineering Camp held at Ryerson each summer
- Webmaster and councillor, Ontario Association of Remote Sensing (O.A.R.S.)

Affiliations

- Member and moderator of the PhotoModeler Training Discussion Group
- Member of the International Network of Collision Reconstruction (INCR) group
- Member of the Collision Data Recorder (CDR Tools) group

EXHIBIT J

DCM TECHNICAL SERVICES INC
PROVIDING MEASUREMENT & MAPPING SOLUTIONS

Peer Review

RE : Mr. Knox and Mr. Fredericks Analysis
State of Texas v. Mr Powell

DCM Technical Services Inc. file number : 160-05

Analysis completed for:

Lynn Robitaille Garcia
Texas Forensic Science Commission
1700 North Congress, Suite 445
Austin, Texas 78701

Analysis completed by:

Dan Mills
DCM Technical Services Inc.

January 29th, 2016

146 Thirtieth St, Unit 211, Toronto, ON M8W 3C4
Phone: 416-618-7683 Email: dmills@dcmtechservices.com

DCM Technical Services Inc. was asked to complete a peer review of the available reports and analysis relating to a criminal case of State of Texas v. George Powell. Specifically, DCM was tasked at to review the measurement methods used by two experts and comment on their validity of the scientific method. The two measurement methods identified were single image inverse photogrammetry and point cloud scanning. Both methods have been previously proven to be valid measurement procedures and would be considered valid by experts within the field of forensic measurements. A deeper investigation into the suitability of their application in this analysis, as well as adherence to best practices by the experts was undertaken.

Single Image Inverse Photogrammetry

In the case of State of Texas v. George Powell, Mr. Michael Knox completed two analyses of the surveillance video using still images, taken from the video and using photogrammetry. The first analysis the Mr. Knox completed was utilizing single image inverse photogrammetry, completed using commercially available PhotoModeler software, and 3D control points (points of known 3D coordinates) around the convenience store door way. He used these 3D control points to calculate and inverse camera for use in his analysis. He then created a plane across the door way that the suspect crossed through when entering and exiting the convenience store. He then traced the perimeter of the suspect as he passed through this plane to determine a minimum height for the suspect. This 2D analysis represents the minimum height that the suspect could be since he is leaning to the side and out of the doorway plane to an unknown amount that would result in a reduction in the measured height.

The second analysis completed by Mr. Knox utilized the same methods as in his first analysis, with the exception that the 3D control points were determined using photogrammetry and a known calibrated camera. This project had more points used as control to determine the inverse setting of the unknown surveillance camera. The procedure of creating a plane across the doorway and analysing the 2D representation of the suspect as he passed through the doorway remained the same as in Mr. Knox's first analysis. The results shown in PhotoModeler are included in Figure 1.

Figure 1 – Mr. Knox's analysis of the suspect entering the convenience store.

Both methods of analysis completed by Mr. Knox within PhotoModeler were utilizing valid photogrammetric procedures that are part of the PhotoModeler training class. Both would be expected to yield accurate results with the 2D, minimum height limitation that is included in Mr. Knox's report. Solving an inverse camera using control points is accurate assuming that the points being used for control were accurate. The second project, using control determined from a calibrated camera would be considered accurate control and would be solution that should be relied on as the most accurate photogrammetric solution in Mr. Knox's analysis. Solving measurements using photogrammetry in this manner is scientifically valid and Mr. Knox's application of the method also was applied properly.

Point Cloud Scanning

Mr. Grant Fredericks completed a measurement analysis of the convenience store as well as a male, dressed in a white top and pants, Mr. Powell. The technology used to complete the measurements is unknown and the raw data was not provided to DCM for analysis. The results shown in a video file named TX_Powell_Demo.avi appear consistent with the point cloud measurements being completed by a tripod based laser scanner. This technology, when properly calibrated and set up, would be considered a valid and accurate measurement method. Mr. Fredericks appears to have inserted the point cloud scan of the male into the point cloud scan of the convenience store. Assuming both models to be scaled at a 1:1 (life sized) and the male to be placed with his feet bottoms along the ground plane then this would provide a model that could position the male at various points in the store and allow for rotation of the model to show it from various angles. Mr. Fredericks appears to have rotated his model and adjusted his field of view such that is closely matched the position and angle of the surveillance cameras within the convenience store. These perspectives were included in TX_Powell_Demo.avi and the surveillance images showing the suspect entering and exiting the convenience store were overlaid with different levels of opacity to show their relation to the laser scan models. With the surveillance camera position, rotation and field of view approximated in the point clouds scan results it would be possible to compare any frame of the video taken with that camera to other scaled point cloud objects inserted in to the convenience store point cloud. One example (taken 00:55s) in Mr. Fredericks AVI is included as Figure 2.

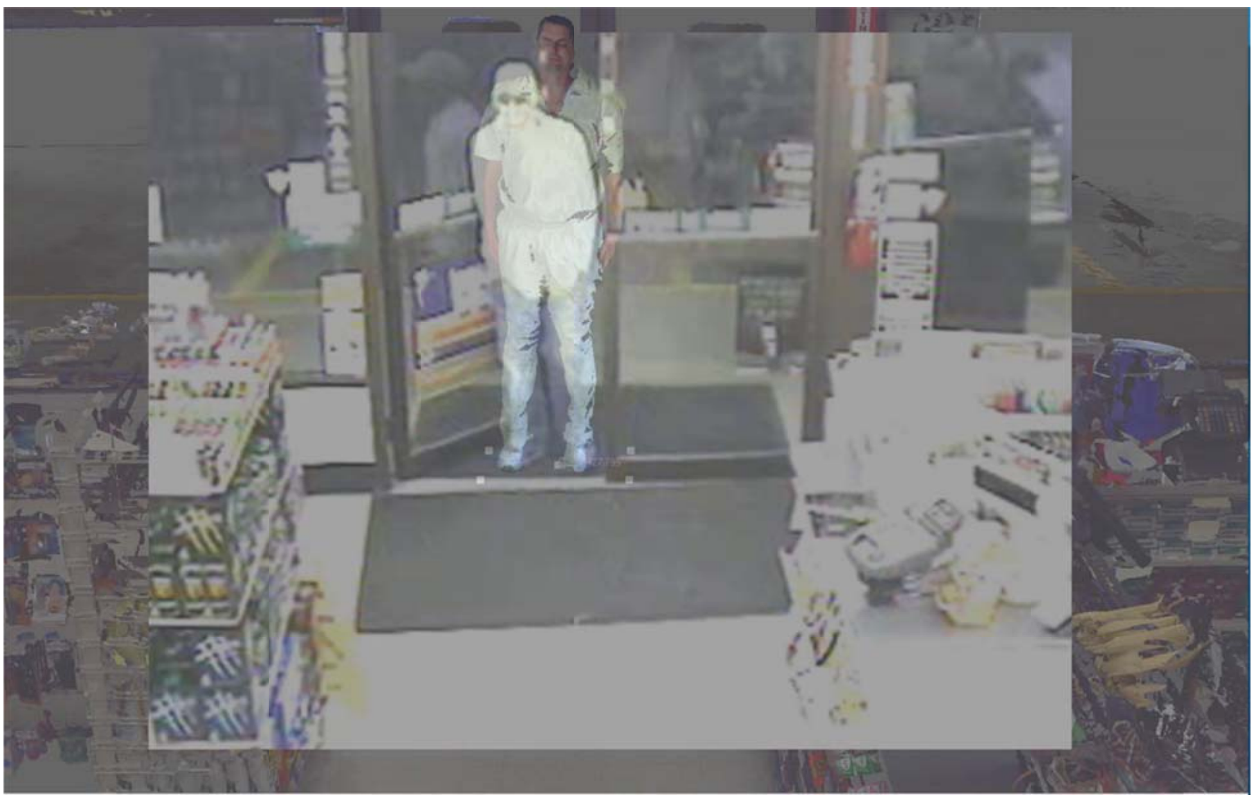


Figure 2 – Overlay of surveillance video image into 3D point cloud

This perspective matched surveillance image provides a comparative representation of the suspect relative to Mr. Powell. It needs to be noted that the 3D model of the Mr. Powell shows him standing very erect and the 2D surveillance image provides a single plane representation of the suspect and any lean out of plane or the 3D nature of a human body is not accounted for in this type of single plane representation. While both people seen in Figure 2 have their feet placed in almost the exact relative positions, their shoulders and heads are tilted to different positions in a left/right manner. The forward tilt of the suspect cannot be accounted for in this single image analysis. As such, any comparisons would result in the 2D suspect height being some amount taller than shown in this comparison. The exact height of the suspect cannot be quantified as much as the minimum height as he passes through this plane. This was stated in Mr. Knox's report and the same remains true in this form of comparative analysis completed by Mr. Fredericks. This would also remain true for each of the comparisons shown in the TX_Powell_Demo.avi video. The position and perspective of both the suspect and Mr. Powell is presented in a scientifically valid manner in Mr. Fredericks' comparisons.

In Mr. Fredericks' analysis of the 2D suspect within the TX-Powell_Demo.avi video, a green line is used to represent the height of suspect at the top of the suspect's head in different surveillance camera angles. Given that the surveillance images are positioned well within the 3D model, this can be considered a scientifically valid way of determining the minimum height of the suspect. The method is valid but the point chosen to measure on the top of the suspect's is subjective and I would suggest that it would be higher than the point selected. The point chosen is shown by a red dot near the top of the suspect's head in the TX_Powell_Demo.avi video at 01:35s (Figure 3). Assuming that the point was moved to the top of the suspect's head and in a similar position to the points selected by Mr. Knox, the height results obtained in this 3D model of the suspect would appear to result similar results to the measurements provided by Mr. Knox.

Figure 3 – Height of suspect determined by Mr. Fredericks.

Suggested Next Steps

Both experts' measurement methods have been set up using proper procedures and the height measurement represents a minimum in Mr. Knox's report. Given the difference between the 2D, minimum height results in the single image inverse photogrammetry solution, and the 3D point cloud solution for the convenience store/Mr. Powell analysis, the height comparison results are subject to expert opinion. While all analysis of this manner contains expert opinion in the conclusions, the two different measurement methods will leave a large amount of subjectivity in the interpretation. In the absence of proper 3D measurements to quantify the lean to the right (person right, not camera right) and lean forward of the suspect, I would suggest a further comparison be completed by one or both of the experts to likely reduce the subjectivity of the comparison. Mr. Fredericks' 3D model of Mr. Powell can be rotated to better represent the position of the suspect in the surveillance video and provide a better height representation of Mr. Powell when compared to the surveillance video. This will tell a few important things. Firstly it will help determine how far ahead and to the right does the 3D model need to be rotated to make the top of the Mr. Powell 3D model to match the suspect. Is the amount that the model needs to be rotated close to the amount that someone would lean in the process walking forward? Secondly, it would put the Mr. Powell 3D model closer to the similar plane as the 2D surveillance suspect image and shoulder width etc. would be a closer representation to person(s) represented in this analysis. There will still be some mismatch between models, but using this method would help to bring both forms of measurement analysis into a single comparison. The amount of knee bend etc. seen in the surveillance images would not be quantified by a simple rotation of the 3D model but the subjective differences between the two models would be reduced. I would suggest that the 3D model be rotated to the right and forward around a pivot point of the left heel. This will result in the 3D model's right heel dipping below the ground plane slightly but the overall result should bring the 3D model into a similar plane as the suspect in the 2D surveillance image. If it is found that the forward rotation of the 3D model is angled quite far forward, some analysis of the body lean of a few males of similar height while walking could be completed and then the model rotated into similar planes to get a better representation of the 3D model "walking" though the door rather than standing erect.

One further thing that needs to be included in both expert's analysis and an accuracy statement about the measurements provided using their respective measurement technologies and methods.

I trust this suitably outlines the results of my peer review of the data provided to me for this matter. Please contact me if there is further information or clarification required.

Dan Mills

DCM TECHNICAL SERVICES INC
PROVIDING MEASUREMENT & MAPPING SOLUTIONS

February 11, 2016

Attention: Lynn Robitaille Garcia
Texas Forensic Science Commission
1700 North Congress, Suite 445
Austin, Texas 78701

Re: Peer review of photogrammetric analysis in State of Teas v. Mr. Powell

Dear Ms. Garcia,

Please accept this letter as my response to the clarification questions that you posed to me for consideration. I had submitted a peer review to the Texas Forensic Science Commission, on January 29th, 2016, of some photogrammetric and video analysis completed Mr. Knox and Mr. Fredericks.

You are correct in your understanding that the review that I completed on Mr. Knox's analysis was most heavily based around the digital PhotoModeler file and its resulting measurements. It was my understanding that these results were the most up to date measurements in Mr. Knox's analysis and were completed using more detailed measurement control inputs than his original analysis.

You have asked for clarification on these measurements and how they would relate to the measurements testified to by Mr. Knox. In Mr. Knox's testimony he indicated that the minimum height of the suspect seen in the 7-Eleven video was 6' 1-1/8". This testimony appears to relate to Mr. Knox's August 7, 2009 written report which was his initial photogrammetric analysis which did not utilize the more detailed control measurements included in the digital PhotoModeler file that I analyzed. The digital file that I analyzed had a minimum height of 5'10.4" for the same suspect. The difference between these two minimum height measurements can be explained in part due to the improved control measurement information used in the more up to date analysis.

You have posed clarification questions to me on behalf of the Commission. I will answer each of them in the order provided to me.

Question - Are you able to offer any observations regarding the photogrammetric files you reviewed in light of the case report and testimony?

Dan Mills Answer – The digital file that I analyzed was a more scientifically relevant representation of the suspect minimum height as he passed through the doorway of the 7-Eleven. This is due to the increased knowledge of control measurement inputs to use in the analysis. Mr. Knox's trial testimony of a minimum suspect height of 6'1-1/8" was consistent with his August 7th, 2009 written report. The testimony did not reference the 5'-10.4" measurement.

Question - Are the conclusions in the case report and testimony supported by the data?

Dan Mills Answer – No, the digital PhotoModeler file with the 5'10.4" minimum height was a subsequent analysis with updated information that was not reflected in the written report and also does not appear to be reflected in the testimony.

Question - What are the standards in the discipline relative to changes in height assessment?

Dan Mills Answer – The discipline of photogrammetric measurement and image analysis is a measurement science and does not take into account what is being measured. Distances between coordinated points are determined but the actual object being measured does not typically change the scientific method used. The height of the suspect was determined using the upper and lower point of the suspect deemed to be passing through a vertical plane created by the doorway. The same method could be used on any object passing through the plane. The practitioner does have some subjectivity on what part of the object (in this case the top of the suspect's head and bottom of his shoe) is crossing the vertical plane. This can be characterized by a variance in one or two pixels of where a practitioner selects a measurement point.

Question - Would a change such as this (6'1" to 5'10.4") merit the issuance of an amended report?

Dan Mills Answer - I do not know of a specific variance that is considered the boundary requiring an amendment to a report. In this instance, Mr. Knox's original testimony indicated that the suspect had a minimum height of 6'1-1/8" and the subsequent PhotoModeler analysis determined the minimum height to be 5'10.4". This represents a percentage difference of 3.8% in the suspect's minimum height. I would consider that to be a noteworthy variance. I would not consider that the variance is what would require an amended report. Any time further data is analyzed a report, even in the form of a short letter, would normally be provided. If an initial analysis is completed and reported on then further data is analyzed, the effect and conclusions of the subsequent analysis should also be reported. If the conclusion is that the subsequent analysis does not change the original conclusion then it still is typical to report this for documentation of the scientific process and updated conclusions. I am unsure if that was completed by Mr. Knox after the updated PhotoModeler analysis was completed. If it was not then I suggest that a letter or report outlining the updated conclusions is required so that the courts and Commission can decide on the effect of the change in minimum height measurement in the legal decision.

Question - In most other forensic disciplines, changes in analytical conclusions require the issuance of an amended report. Is this something the Commission should recommend for the discipline as a whole?

Dan Mills Answer – Similar to my response above, I do not think it is something that the Commission needs to recommend for the discipline as a whole. The discipline follows “normal” scientific procedures, which would include detailed reporting of the process and resulting conclusions. Any time further analysis is completed, details of the analysis and the resulting conclusions also should typically be reported in the form of a formal report or detailed letter. This procedure should be, and in my experience already is typically, followed regardless of a change in the overall conclusion.

I trust this adds further clarification to my review of photogrammetric and image analysis procedures used, and subsequent reporting, in this matter. Please contact me if any further information is required.

Kindest regards,

Dan Mills

EXHIBIT K

SWGDE Training Guidelines for Video Analysis, Image Analysis and Photography

Intellectual Property:
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SWGDE Training Guidelines for Video Analysis, Image Analysis and Photography

Table of Contents

1. Purpose

The purpose of this document is to provide guidelines and recommendations to assist organizations in designing a training program for forensic video analysts, image analysts, and photographers to ensure competency in the completion of forensic tasks and analyses.

2. Scope

This document will recommend topics and guidelines for training within the disciplines of video analysis, image analysis, and photography.

3. Terminology

The following definitions apply to this document. For additional definitions, please refer to the *SWGDE Glossary*.

- *Video Analysis:* the scientific examination, comparison, or evaluation of video in legal matters.
- *Image Analysis:* the application of image science and domain expertise to examine and interpret the content of an image, the image itself, or both in legal matters.
- *Photography:* the mix of art and science for the capture of images on a light sensitive surface.
- *Education:* the baseline degree(s), previous training, or prior experience of an analyst.
- *Competency:* an evaluation of the knowledge and ability of an analyst prior to independent completion of analysis.
- *Training:* the process of obtaining competency.
- *Proficiency:* an evaluation of the quality of performance of an analyst or an organization.
- *Continuing Education:* the process of maintaining proficiency, through additional training in evolving technology

4. Limitations

SWGDE recognizes that some organizations may include topics of training other than what is recommended in this document. Regardless of the exact training topics selected, the program should demonstrate and document the training selected is adequate to ensure competency for the specific tasks being undertaken by the trainee.

Training topics introduced in this document may not fit the needs of individual organizations, when job specific duties are limited to a subset of those listed. Each organization should determine the minimum training guidelines for examinations performed.

This document is intended to recommend topics for training. It will not endorse a specific vendor.

Training can quickly become obsolete, and continuing education is needed to maintain proficiency.

5. Introduction

Personnel that collect, preserve, process, analyze, and/or examine video, image, and photographic evidence (or supervise these functions) must be aware of the capabilities and limitations of specific technologies. Those engaged in the video, image, and photographic evidence process should be aware of the procedures commonly followed within the forensic community, and should strive to meet or exceed these recommendations. Maintaining awareness of new developments is part of every practitioner's job.

In support of these goals, the following recommendations are offered:

- Define and employ a quality assurance program for the implementation of a training program for the valid and reliable use of appropriate procedures.
- Training should include only the use of validated technologies and methods. Training should include awareness of and/or methods used for validating technologies.
- Commit to continuous learning in video, image, and photographic technologies and stay abreast of new findings, equipment, techniques, legal developments, and technological advances.
- Implement a program for continual assessment of employees' skills
- Pursue professional development and certification.

6. Categories of Training

Categories of training relevant to those who collect, preserve, process, analyze, and/or examine video, image, and photographic evidence (or supervise these functions) are identified and defined as follows:

6.1. *Awareness:* Training designed to provide personnel with a general knowledge of the major elements of video, image, and photographic evidence including the capabilities and limitations of methods, hardware, and software.

6.2. *Skills and Techniques:* Training designed to provide personnel with the ability to competently use specific tools and procedures.

6.3. *Knowledge and Application of Processes:* Training designed to provide personnel with an understanding of video, image, and photographic evidence procedures, the application of that understanding in various situations, and the knowledge of other forensic discipline requirements and their intended uses.

6.4. *Witness Testimony and Legal Aspects:* Training designed to provide personnel with the ability to present clear and unbiased video, image, and photographic evidence based testimony in court. Legal implications for the integrity of collected and/or submitted evidence should be considered. (e.g. search and seizure authorization)

6.5. *Forensic Results Preparation:* Training designed to provide personnel with the ability to prepare accurate, clear, and concise documentation of results and/or opinions, and visual aids.

7. Job Categories

Organizations may choose to use different names, but responsibilities within this field are commonly defined below. Differentiation between job categories is based on the degree to which personnel are involved in the collection and examination process. However, since job categories frequently overlap, training programs should be specific to the tasks performed by the individual, and may contain topics related to several job categories.

7.1. *First Responder* Includes personnel who are the first to secure, preserve, and/or collect video, image, and photographic evidence at a crime scene. These personnel often have general crime scene evidence collection responsibilities.

7.2. *Field Photographer/Videographer* includes personnel who document and preserve conditions and evidence through photography or videography outside the laboratory.

7.3. *Technician* includes personnel whose primary responsibility is to collect and/or prepare video, image, and photographic evidence for examination and analysis.

7.4. *Laboratory Photographer* includes personnel whose primary responsibility is to document and preserve evidence through photography within the laboratory.

7.5. *Examiner/Analyst* includes personnel for whom examination, analysis, and/or recovery of video, image, and photographic evidence is a major component of their routine duties.

8. Training Sources

Training is obtained through different sources at various points in an individual's career. Such sources can include the following:

8.1. *Baseline education:* The possession and type of degree, and or prior experience of personnel. Baseline education may be dictated by the forensic discipline or the requirements of the agency. An assessment of an individual's knowledge, skills, and/or abilities, may affect the individual's specific training program.

8.2. *Internal Training:* A documented training program provides personnel with the relevant knowledge necessary to perform job related tasks. It may include written exercises, practical exercises, competency and proficiency testing, and supervised casework. Because experience is a critical training tool, personnel who train under a competent practitioner can gain valuable experience, as well as knowledge and improved skills.

8.3. *External Training:* Training from entities and personnel outside an organization can result in exposure to new innovations and techniques, and assist with ensuring organizations are continuing to use best practices. External training can be obtained from conferences, trade shows, professional organizational memberships, professional publications, current literature, and specialized courses or workshops.

9. Training Evaluation and Documentation

Evaluation of a training program is necessary to ensure that the goals of the training are being met and to verify that personnel have the technical skills and abilities to perform the duties required of them.
A training program has:

- A written training program for each job description/category.
- A lesson plan for each topic.
- Feedback from trainees and reviews by management.
- Documentation of the training received, training notes, problems, questions, successes, and evaluations. There should be sufficient detail so that the employee, trainers, supervisors, and/or assessors clearly understand the training program. Such documentation should be maintained and reviewed as required.
- A means of testing an individual's competency with given tasks, in order to establish the end of the official period of training.
- A formal means to recognize the successful completion of training and the authorization for unsupervised work.
- A means of testing an individual's ongoing proficiency with specific tasks, as well as a schedule for the completion of testing.

Certification is one method to evaluate personnel. Certifications can be comprehensive, tool-based, or topic specific, and can be an additional tool in verifying technical skills and abilities. Comprehensive certifications generally require training be completed, as well as a specified amount of experience in the discipline, and the successful completion of an examination. Certifications can be beneficial and should be considered.

10. Training Topics According to Job Category

10.1. Field Photographer

10.1.1. Technical Foundations

10.1.1.1. Selection, framing and composition of appropriate images

10.1.1.2. Procedures for recording quality images in various situations

10.1.1.3. Image handling and integrity

10.1.2. Equipment

10.1.2.1. Camera suitable for job function

10.1.2.2. Lighting Sources

10.1.2.3. Ancillary equipment and accessories (tripods, removable media, scales, etc.)

10.1.2.4. Software/applications

10.1.3. Techniques

10.1.3.1. Various lighting techniques

10.1.3.2. Comparative photography

10.1.3.3. General crime scene documentation

10.1.3.4. Subject (person) photography

10.1.3.5. Specialized photography (e.g. trajectory, blood stain patterns, and techniques related to other forensic disciplines)

10.1.3.6. Evidence handling and packaging

10.1.4. Legal Foundations

10.1.4.1. Specific legal requirements and admissibility issues

10.1.4.2. Courtroom testimony

10.2. Laboratory Photographer

10.2.1. Technical Foundations

10.2.1.1. Those topics included in 10.1.1

10.2.1.2. Photomicrography

10.2.1.3. Copy-stand photography

10.2.1.4. Scanner image capture

10.2.2. Equipment

10.2.2.1. Those topics included in 10.1.2

10.2.2.2. Copy stands

10.2.2.3. Microscopes

10.2.2.4. Scanners

10.2.3. Techniques

10.2.3.1. Those topics included in 10.1.3

10.2.3.2. Photomicrography

10.2.3.3. Other imaging technologies

10.2.4. Legal Foundations

10.2.4.1. Those topics included in 10.1.4

10.3. First Responder

10.3.1. Technical Foundations

10.3.1.1. Principles of digital video recording

10.3.1.2. Digital video security system concepts

10.3.1.3. Video formats, standards and file identification

10.3.2. Equipment

10.3.2.1. Recording and playback devices

10.3.2.2. Monitors and other output devices

10.3.2.3. Media types

10.3.3. Techniques

10.3.3.1. Video data recovery

10.3.3.2. Video verification and integrity

10.3.3.3. Evidence handling and Packaging

10.3.4. Legal Foundations

10.3.4.1. Those topics included in 10.1.4

10.4. Video Technician

10.4.1. Technical Foundations

10.4.1.1. Those topics included in 10.3.1

10.4.1.2. Principles of analog video recording

10.4.1.3. Compression artifacts

10.4.1.4. Analog video security system concepts

10.4.1.5. Basic audio principles

10.4.2. Equipment

10.4.2.1. Those topics included in 10.3.2

10.4.2.2. Hardware for duplication, conversion and optimization

10.4.2.3. Software for duplication, conversion and processing

10.4.2.4. Video signal measuring devices

10.4.3. Techniques

10.4.3.1. Those topics included in 10.3.3

10.4.3.2. Playback optimization

10.4.3.3. Video processing techniques

10.4.3.4. Image processing techniques

10.4.4. Legal Foundations

10.4.4.1. Those topics included in 10.1.4

10.5. Video Analyst

10.5.1. Technical Foundations

10.5.1.1. Those topics included in 10.4.1

10.5.1.2. Broadcast theory and history

10.5.1.3. Basic digital theory

10.5.1.4. Imaging science

10.5.1.5. Frequency fundamentals

10.5.1.6. Video signal standards

10.5.1.7. Video editing

10.5.1.8. Human factors relating to forming conclusions in analysis (e.g. bias)

10.5.2. Equipment

10.5.2.1. Those topics included in 10.4.2

10.5.2.2. Hardware for calibration and maintenance

10.5.3. Techniques

10.5.3.1. Those topics included in 10.4.3

10.5.3.2. Video editing

10.5.3.3. Advanced video enhancement techniques

10.5.3.4. Advanced image enhancement techniques

10.5.3.5. Signal analysis

10.5.3.6. Video media reconstruction

10.5.3.7. Content authenticity

10.5.3.8. Source authenticity

10.5.4. Legal Foundations

10.5.4.1. Those topics included in 10.1.4

10.5.4.2. Moot court exercises, including admissibility issues (e.g. Daubert, Frye, hearings, etc.)

10.5.4.3. Testimony Monitoring

10.6. Image Technician

10.6.1. Technical Foundations

10.6.1.1. Principles of video recording

10.6.1.2. Principles of traditional and digital photography

10.6.1.3. Principles of digital media, file identification, and recovery

10.6.1.4. Image types and formats

10.6.1.5. Compression artifacts

10.6.2. Equipment

10.6.2.1. Recording and playback devices

10.6.2.2. Monitors and other output devices

10.6.2.3. Media types

10.6.2.4. Hardware for duplication, conversion and optimization

10.6.2.5. Software for duplication, conversion and processing

10.6.3. Techniques

10.6.3.1. Video processing techniques

10.6.3.2. Image processing techniques

10.6.3.3. Evidence handling and packaging

10.6.4. Legal Foundations

10.6.4.1. Those topics included in 10.1.4

10.7. Image Analyst

10.7.1. Technical and Scientific Foundations

10.7.1.1. Those topics included in 10.6.1

10.7.1.2. Image science and technology

10.7.1.3. Image comparison theory

10.7.1.4. Optics

10.7.1.5. Photogrammetry theory

10.7.1.6. Data integrity and imaging artifacts

10.7.1.7. Specific domain knowledge for content analysis and comparison

10.7.1.8. Statistics

10.7.1.9. Human factors relating to forming conclusions in analysis (e.g. bias)

10.7.2. Equipment

10.7.2.1. Those topics included in 10.6.2

10.7.2.2. Capture, input and output devices

10.7.2.3. Digital storage devices and media

10.7.2.4. Software, including

10.7.2.4.1. File identification

10.7.2.4.2. Diagnostics

10.7.2.4.3. Calibration

10.7.2.4.4. Restoration of corrupted files

10.7.2.4.5. Analysis

10.7.2.4.6. Metadata determination

10.7.3. Techniques

10.7.3.1. Those topics included in 10.6.3

10.7.3.2. Photogrammetry

10.7.3.3. Comparison

10.7.3.4. Content authentication

10.7.3.5. Source authentication

10.7.3.6. Advanced video enhancement techniques

10.7.3.7. Advanced image enhancement techniques

10.7.4. Legal Foundations

10.7.4.1. Those topics included in 10.5.4

SWGDE Training Guidelines for Video Analysis, Image Analysis and Photography

History

Revision	Issue Date	Section	History
1.0	06/04/2015	All	Original working draft created. Voted for release as a Draft for Public Comment.
1.0	06/20/2015	All	Formatting and technical edit performed for release as a Draft for Public Comment.
1.1	09/17/2015	All	Re-worked all sections based on public comments. Voted by SWGDE for re-release as a Draft for Public Comment.
1.1	09/29/2015	All	Formatting and technical edit performed for release as a Draft for Public Comment.
1.1	01/14/2016	N/A	Voted by SWGDE for release as an Approved Document.
1.1	02/08/2016	All	Formatting and technical edit performed for release as an Approved Document.

EXHIBIT L

DECLARATION OF PROFESSOR AL YONOVITZ, Ph.D.

"I, Al Yonovitz, declare that: I am over the age of eighteen, of sound mind, have never been convicted of a felony or crime of moral turpitude, and am competent to make this Declaration. All facts recited in this Declaration are within my personal knowledge and are true and correct.

"Yonovitz & Joe, L.L.P., a registered partnership based in Dallas, Texas, is a team of forensic audio/video analysts, experts and consultants. We have been forensic audio/video experts for over sixty combined years. Our diverse legal, forensic, academic, research and clinical experience includes scientifically objective, verifiable and generally accepted analyses of audio and video evidence including, but not limited to, the forensic authenticity analyses of audio or video evidence, voice/speaker identification or elimination via aural-acoustic-spectrography, digital enhancement of audio or video recordings, transcription development and verification, etc. We have been retained in thousands of cases involving thousands of recordings throughout the U.S., Canada, Mexico, the United Kingdom, India, Sri Lanka, Australia, Singapore and the United Arab Emirates, and have testified in state and Federal courts in civil, criminal and administrative matters throughout the U.S., as well as overseas. Representative clients include Steptoe & Johnson (Washington, D.C.), Shearman & Sterling (NYC), Simpson Thacher & Bartlett (NYC), Mesereau & Yu (Los Angeles), Armstrong Teasdale (Kansas City), Ford & Harrison (Memphis), Rawle & Henderson (Philadelphia), McAfee & Taft (OKC), Bracewell & Patterson (Houston), Akin Gump (San Antonio), Jones Day (Dallas), Haynes & Boone (Houston), Thompson & Knight (Dallas), Vinson & Elkins (Dallas), Jenkens & Gilchrist (Dallas), Wal-Mart Stores, Inc., Georgia-Pacific, LLC, Costamare Shipping Inc., Motorola Corp., Vivint, Inc., BankOne, BlueCross Blue-Shield, Shell Oil Co., United Parcel Service, Inc., Shell Texaco & Saudi Refineries, Inc., Reliant Energy, 7-Eleven, Inc., Evercom Systems, Inc., Abu Dhabi (United Arab Emirates) Judicial Department, U.S. Attorney's Office (NM), Mississippi Attorney General's Office, Harris County (Houston) Attorney's Office, Harris County Sheriff's Office, City of Austin, City of San Angelo, City of Galveston, Plano (TX) and Akron (OH) Police Depts., Dallas, Maricopa (Phoenix), Tulsa (OK), Harris (Houston), Fulton (GA) and Summit (OH) County DA's Offices, Washington D.C., Houston, Little Rock, South Dakota, DuPage County (IL), Green County (PA), New Mexico, New Hampshire and New Jersey Public Defender's Offices, Kentucky Department of Public Advocacy, Louisiana Capital Assistance Center, Oklahoma Indigent Defense System, the Associated Press (AP), ABC, BBC, FOX-TV, etc. High profile cases include the *Branch Davidian* case; consultations include TMZ, *CSI:Miami* and *People* Magazine and recent speaking engagements include the 2002, 15th Annual Criminal Litigation Seminar, the 2003 annual convention of the American Speech & Hearing Association, the 2004 26th World Congress of the International Association of Logopedics and Phoniatrics, the 2005 annual conference of the Center for International Legal Studies, the 2005 3rd Annual Forensics Seminar, the 2006 4th Annual Forensics Seminar, the 2007 annual meeting of the North Carolina Bar Association, the 2007 5th Annual Forensics Seminar, the 2008 6th Annual Forensics Seminar, the 2009 Spring Meeting of the Forensic Expert Witness Association, the 2009 7th Annual Forensics Seminar, the 2010 8th Annual Forensics

Seminar, the 2010 2nd Pan American/Iberian Meeting on Acoustics (Cancún), the 2011 9th Annual Forensics Seminar, the 2011 annual meeting of the American Speech & Hearing Association, the April 2012 annual meeting of the Utah Association of Criminal Defense Lawyers, the 2012 Summer Meeting of the Forensic Expert Witness Association, the 2012 10th Annual Forensics Seminar, the 164th Annual Meeting of the Acoustical Society of America, the 2013 11th Annual Forensics Seminar, the 2013 annual meeting of the American Speech & Hearing Association and the 166th Annual Meeting of the Acoustical Society of America. Some forensic voice ID clients include Georgia-Pacific, LLC, Blue Cross Blue Shield Texas, Maricopa (Phoenix) County DA's Office, Fulton (Atlanta) County DA's Office, Summit (Akron, OH) County DA's Office, New Jersey Public Defender's Office, City of San Angelo, Public Prosecution Office of Abu Dhabi Judicial District (United Arab Emirates), the Associate Press, Dr. Phil, TMZ, People Magazine, ABC, BBC, FOX, etc.

"I am the senior partner of Yonovitz & Joe, L.L.P., a team of forensic audio/video analysts, experts and consultants. My 40 years of teaching and research include appointments at the Speech and Hearing Institute, Graduate School of Biomedical Sciences, and the School of Public Health at the University of Texas Health Science Center, Houston; Baylor College of Medicine; Department of Biomedical Engineering at the University of Houston; Conley Speech and Hearing Center, University of Maine; Menzies School of Health Research; consultant to the Veterans Administration Hospital (Houston), where I conducted speech research in psychiatric patients; Director of the Electronic Prosthesis Laboratory, Mansfield Training School; former member of the certification and standards committee of the International Association of Identification (IAI). I have authored over 100 publications or paper presentations, as well as over 30 grants. I am currently a Professor of the Speech and Hearing Sciences, Dean of Research Facilitation and former Chair of the Department of Communicative Sciences and Disorders at the University of Montana. Recent expert testimony in forensic voice ID cases include *State of Arizona vs. Bradley Tocker* (for the State; conviction), Bond Hearing in *State of Florida vs. Oscar Duran* (for the defense, bond granted), federal investigation of judicial department for the Public Prosecution Office of the Abu Dhabi Judicial Department of the United Arab Emirates (for the Government, sanctions granted), and consulting voice experts for the defense in *State of Florida vs. George Zimmerman*.

"Recent and relevant undergraduate and graduate courses that I have or am teaching include Auditory Systems and Disorders, Audiology, Seminar in Fluency Disorders, Biomedical Instrumentation, Industrial Audiometry and Hearing Conversation, Computer Applications in Speech Pathology and Audiology, Hearing and Speech Science, Research Methods in Speech Pathology and Audiology, Physiological and Psychological Acoustics, Special Topics: Middle Ear Mechanics, Special Topics: Audiometry with the Difficult to Test, Special Topics: Measurement of Voice, Hearing Impairment, Anatomy of the Speech and Hearing Mechanism, Aural Rehabilitation, Speech Science, Introduction to Audiology, and Audition. I am actively involved in academic, clinical and forensic research related to forensic voice identification. The result of some of my clinical/forensic research, *see, e.g.*, Yonovitz, A., Joe, H. *Speaker*

Identification: Effects of noise, bandwidth, and word count on accuracy, Journal of the Acoustical Society of America, Vol. 128, No. 4, Pt. 2 of 2, Oct. 2010, was presented at the 2nd Pan American/Iberian Meeting on Acoustics, Cancún, Mexico, Nov. 2010.

"We were retained on behalf of Mr. George R. Powell, III, an inmate at the Huntsville (TX) Correctional Institution, to 1) perform a forensic voice identification/ elimination analysis (described in detail below), and 2) determine the height of a particular suspect in a particular surveillance video (described in detail below). (This Declaration needs to be printed on a reliable color printer.)

"In the forensic voice identification or elimination procedures, we compared the known voice of Mr. Powell, acquired by my partner, with a particular "unknown" exemplar, provided by TX Attorney John Galligan. Specifically, Managing Partner Herbert Joe, M.A., J.D., LL.M., B.C.F.E. met with Mr. Powell at approx. 9:30A on November 20, 2013 at the Huntsville (TX) Correctional Institution. The known voice of Mr. Powell was recorded that that time. The "unknown" exemplar to compare with the actual voice of Mr. Powell was from the audio track of the QuickWave video entitled "STORE #1330 05-28-08 1121P-1123P.VID.60D" (size 15378 KB). This store that was robbed was reported as a Valero conveniences store. In that "Valero" video, the robber spoke the following:

> "Hey, how you doing?"
> "Give me the money"
> "Open the register."
> "Hurry up."
> "The money underneath."
> "Give me all your money."
> "That's it."
> "Where's the rest of it?"

These were parts of the same words, phrases and sentences spoken by Mr. Powell for his known voice sample.

"The voice samples above contain sufficient and intelligible speech materials to permit an Aural-Acoustical-Spectrographic Voice/Speaker Identification or Elimination to be carried out. Both the UNKNOWN and KNOWN exemplars were processed in a similar manner: The formant, pitch perturbation and pitch analyses were made with a Pentium IV-based computer. Appropriate anti-aliasing filters were utilized when needed. Avaaz Innovations Computerized Speech Research Environment (CSRE, signal and speech analysis software and Speech Analyzer 3.0.1) was utilized to present both time domain and frequency domain analyses, as necessary.

"The speaker identification or elimination procedure employed is one where an UNKNOWN voice is taken from an evidence recording and compared to exemplars of a KNOWN voice. In this manner, samples of a number of comparisons between the UNKNOWN and KNOWN combinations were placed in pairs or composites for direct and repeated comparisons. The Aural-Acoustic method of analysis follows the protocol and standards described in publications as well as a number of presentations to professional organizations, including the Acoustical Society of America (ASA) and the American Speech, Hearing and Language Association (ASHA). The principles of this protocol are to provide a basis for voice/speaker identification or elimination that is consistent with the known and well-established principles of the hearing, speech and language sciences.

"The Aural-Acoustic method has evolved from earlier standards developed by the International Association of Identification (IAI) (and later The American Board of Recorded Evidence (ABRE), whose standards are similar to those of the IAI). For example, section VII.B.5 of the 1996 "Voice Comparison Standards" of the Voice Identification and Acoustic Analysis Subcommittee (VIAAS) of the IAI and section 7.2.5 of the "Voice Comparison Standards" of the ABRE are entitled "Speech Characteristics". Speech and hearing scientists and phoneticians are particularly skilled in forensically assessing speech characteristics.[1] On the other hand and generally, examiners trained in spectrogram pattern matching receive little or no training in the assessment of speech characteristics.

"The Aural-Acoustical method does not rely on a spectrographic analysis as its principle bases. This aural-acoustical method uses a number of instrumental or digital signal processing procedures that delineate the microstructure of various vocal qualities or characteristics. It utilizes, with due caution, the use of these objective measures, not to overextend the conclusions that may be offered. Two publications discussing the Aural-Acoustic method at length are Hollien, *Acoustics of Crime*, Plenum, 1990, and Hollien and Hollien, *Forensic Voice Identification*, Academic Press, 2001.

"The undersigned is the lead investigator of a research team currently conducting and having conducted significant academic, clinical and forensic research on the various quantitative and qualitative requirements to conduct reliable forensic voice speaker identification or elimination via aural-acoustic-spectrographic analyses. For example, the initial results on the effects of noise, telephone bandwidth and word count on the accuracy of forensic voice identification or elimination were presented at the 2nd Pan American/Iberian Meeting on Acoustics in Cancún, Mexico, as well as a peer-reviewed publication in Yonovitz, A., Joe, H. *Speaker Identification: Effects of noise, telephone bandwidth, and word count on accuracy.* Journal of the Acoustical Society of America, Vol. 128, No. 4, Pt. 2 of 2, Oct. 2010.

"For a more detailed explanation of the appropriate methodology of forensic voice/ speaker identification or elimination, the undersigned is a co-author of a peer-reviewed article that was published in the Law Enforcement Executive Forum. This article, appended to this Declaration, entitled *Legal, Scientific and Forensic Controversies Over Spectrographic Voice Analysis for Identification or Elimination*, is

[1] See list of speech and hearing related publications, international presentations, abstracts, and undergraduate and graduate courses taught by the undersigned, whom has a doctorate (1973, University of Connecticut) in Physiological and Psychological Acoustics; the undersigned is also an associate professor of the speech and hearing sciences and is a clinical and forensic scientist.

appended to this Report. *See also, for example*, Yonovitz, A., Joe, H. *Speaker Identification: Effects of noise, telephone bandwidth, and word count on accuracy.* Journal of the Acoustical Society of America, Vol. 128, No. 4, Pt. 2 of 2, Oct. 2010.

"VOICE ID/ELIMINATION ANALYSES." The following speech features were analyzed and compiled to derive at the conclusion below:

- Articulation: Vowels/Consonants

As can be seen from the Table below, a number of observations were possible relative to the articulatory patterns observable in the KE compared with the UNE. Specifically the voices heard on both the KE and the UNE indicated dissimilarities in productions of patterned vowels and vowel prolongations. The same is also true for consonants and consonant clusters. Some confidence was placed in these categories. Values of +2 and +2.5 were determined for each variable, respectively.

- Voice Quality: Resonance/Vocal Fry/Nasality

Voice Quality encompasses the perception of the listener of the overall sound of the talker's voice. Just as different musical instruments produce different wave compositions, the human voice is similar. It is this overtone structure or timbre that can differentiate one voice from another. In this specific case the resonant pattern or voice quality was non identical between the KE and the UKE. The score of +2.0 has been assigned to this variable.

- Prosody: Rate/Melodic Pattern

The melodic patterns were dissimilar for the KE and UNE. A value of +2.0 was assigned for this variable. The speaking rate was assigned a value of +2.0

- Abnormalities: Misarticulation/Fluency

No misarticulations or fluency disorder was detected.

- Dialect:

The dialectical patterns were not significantly different, and assigned a value of +0.0.

Fundamental Frequency: Absolute/Variability

The perceived pitch is the psychophysical correlate of fundamental frequency. The fundamental frequency or the pitch of the voice was different for the KE of compared to the UNE. This was confirmed using acoustic analysis procedures. The fundamental frequency for UKE was consistently higher (AVG 190 Hz) compared to the KE (AVG 142 Hz). The frequency variability was also dissimilar for the KE and UKE.

Jitter:

Jitter is a frequency perturbation of the glottal source signal and was not assessed.

Shimmer:

Shimmer is amplitude perturbation of the glottal source signal and was not assessed.

Formant Descriptions: Steady State/Transitions

Steady state F1, F2 and F3 (when available) were assessed for a number of vowel utterances. Formant values were obtained for the KE and the UKE. These results confirmed the perceptual resonance differences that are audible from the exemplars. These differences were rated a value of +3.0.

Aural-Acoustical Spectrographic Analyses

	Most Similar Most Dissimilar -5 * *-4 * *-3 * *-2 * *-1 * * 0 * * 1 * * 2 * * 3 * * 4 * * 5
AURAL	
Articulation	
Vowels	-5 * * -4* *-3 * *-2 * *-1 * * 0 * * 1 * *[redacted] * * 3 * * 4* * 5
Consonants	-5 * * -4 * *-3 * *-2 * *-1 * * 0 * * 1 * * 2 *[redacted] * 3 * *4* * 5
Voice Quality	
Resonance	-5 * * -4 * * -3 * *-2 * *-1 * * 0 * * 1 * *[redacted] * * 3 * * 4* *5
Vocal Fry	-5 * *-4 * *-3 * *-2 * *-1 * * 0 * * 1 * * 2 * * 3 * * 4 * * 5
Nasality	-5 * *-4 * *-3 * *-2 * *-1 * * 0 * * 1 * * 2 * * 3 * * 4 * * 5
Prosody	
Rate	-5 * *-4 * *-3 * *-2 * * -1 * * 0 * * 1 * *[redacted] * * 3 * * 4 * * 5
Melodic Pattern	-5 * *-4 * *-3 * *-2 * * -1* * 0 * * 1 * *[redacted] * * 3 * * 4 * * 5
Abnormalities	
Misarticulations	-5 * *-4 * *-3 * *-2 * *-1 * * 0 * * 1 * * 2 * * 3 * * 4 * * 5
Fluency	-5 * *-4 * *-3 * *-2 * *-1 * * 0 * * 1 * * 2 * * 3 * * 4 * * 5
Dialect	-5 * *-4 * *-3 * *-2 * *-1 * *[redacted] * * 1 * * 2 * * 3 * * 4 * * 5

ACOUSTIC

Fundamental Frequency (f0)

Absolute	-5 * *-4 * *-3 * *-2 * *-1 * * 0 * * 1 * * 2 * * 3 * * 4 * * ▌
Variability	-5 * *-4 * *3 * -2 * *-1 * * 0 * * 1 * * 2 * * 3 * * ▌ * * 5
Jitter (cyclic (n/n+1) variation)	-5 * *-4 * *-3 * *-2 * *-1 * * 0 * * 1 * * 2 * * 3 * * 4 * * 5
Shimmer (cyclic (n/n+1) variation)	-5 * *-4 * *-3 * *-2 * *-1 * * 0 * * 1 * * 2 * * 3 * * 4 * * 5

Formant Descriptions

Steady State	-5 * *-4 * *-3 * *-2 * *-1 * * 0 * * 1 * * 2 * * ▌ * * 4 * * 5
Transitions	-5 * *-4 * *-3 * *-2 * *-1 * * 0 * * 1 * * 2 * * ▌ * * 4 * * 5

"VOICE ID/ELIMINATION SUMMARY. The differences in the KNOWN and UNKNOWN exemplars are primarily in the resonance characteristics and the fundamental frequency (pitch). While some pitch change may be expected given the two tasks (KNOWN and UNKNOWN), the range of differences is very significant (<45-50 Hz). Articulation for vowels and consonants also show a marked difference for the KNOWN and UNKNOWN. The differences in the resonance of the voice when comparing the KNOWN and UNKNOWN are both available from aural and spectrographic comparison. As such, **<u>it is concluded with at least a reasonable degree of scientific certainty that there is a Probable Elimination when comparing the voice of the robber in the video described above with that of Mr. George R. Powell, III's voice.</u>**

"Height measurements. Below is a copy of "State's Exhibit 18", which is a screen grab of the "Valero" video. (Photo #1, below.)

Photo #1

We were also asked to make a determination about the height of the robber in a different video, in which the robber was reported to be robbing a “7-Eleven” convenience store #17529, Photo #2, below.

Photo #2

“The key in the reliable height measurement of the 7-Eleven robber above is that the robber is at the threshold or plane of the door and practically walking erect such that the robber’s actual height is just at the top border of the middle set of height stickers.

Photo #3

The photo above (Photo #3) was taken on November 20, 2013 by Mr. Joe when he visited the same 7-Eleven store, *i.e*., the 7-Eleven located at 1000 SWS Young Dr., Killeen, Texas. The height of the top of the 2nd or middle sticker (Photo #4, below) at the 7-Eleven store at issue relative to the floor is approximately 67¾", or 5'7¾". The 7-Eleven, Inc. Texas Zone Asset Protection Manager, whose area covers that store and was at the store with Mr. Joe, stated that there are no records about whether the set of height stickers on the 7-Eleven door on the day of the 2008 robbery (Photo #2) were the same and located in the exact same place as the set of height stickers in Photos #3 and #4.

"To determine if the sticker locations in Photos 3 and 4 are in the same location or not as on the day of the 2008 robbery (Photo #2), various measurements needed to be made and evaluated. Specifically, the distance from the lowest point on the door in Photo #2 to the metal bar used to open the door was measured, as well as the distance from that metal bar to the first sticker, and then the distance between each of the stickers. The same measurements were made relative to the door in Photo #3. Because there are differences in camera distances and angles between the two photos, the relative proportions of the above measurements are valuable.

"Each **blue number** below is an accurate measurement for Photo #3, *i.e*., current locations of the height stickers. Each **red number** represents the relevant measurement from the photo taken during the 2008 robbery. Each **green number** is the ratio between the relevant two values. The relevant measurements[2] and ratios follow:

Handrail to floor:	**2.1** : **2.5** =	**1:1.19**
1st sticker to handrail:	**1** : **1.25** =	**1:1.25**
2nd sticker to 1st sticker:	**.35** : **.35** =	**1:1**
3rd sticker to 2nd sticker:	**.3** : **.25** =	**1:0.83**

The values above account for any differing camera angles. The distance in ratio from the lowest point of the door to the handrail compared to the distance from the handrail to the first sticker is virtually identical in both Photos 2 and 3, as are the proportionate distances of each sticker from each other. In other words, the values above substantiate that the current set of stickers (Photo #3) are in the same position as the height stickers on the night of the robbery (Photo #2). In other words, one can reliably conclude that

- the height of the top of the bottom sticker is approximately 61-15/16", or 5'1-15/16" from the floor in both photo nos. 2 and 3;
- the height of the top of the middle or 2nd set of stickers is approximately 67¾", or 5'7¾" from the floor in both photo nos. 2 and 3; and

[2] The measurement system is from Photoshop's internal system, and is accurate.

- the height of the top of the top or 3rd set of stickers is approximately 74", or 6'2" from the floor in both photo nos. 2 and 3.

- * Independent of the above measurements, but substantiating them just the same, there were relevant "Additional Officer Supplements." On page 23 of the Killeen Police Department "Incident / Investigation Report" ("OCA: 08-007971") prepared by KPD Officer Karl A. Ortiz (34864) at 16:02 hrs. on "4/21/2009," he states, in part:

> … As you face the [7-Eleven] door from inside the store, I had Detective Kaiser use a tape measure and measured from the floor to the top of three specific marking (labels) on the south front glass door. The measurements are as follows:
>
> 1st measurement – approx. 62 " from the floor to the top of the label
>
> 2nd measurement – approx. 68 " from the floor to the top of the label
>
> 3rd measurement – approx. 74 " from the floor to the top of the label

NOTE: The difference in height between our measurements and the KPD of the 1st sticker is **1/16"**.

The difference in height between our measurements and the KPD of the 2nd sticker is **1/4"**.

There is **no difference** in height between our measurements and the KPD for the 3rd sticker.

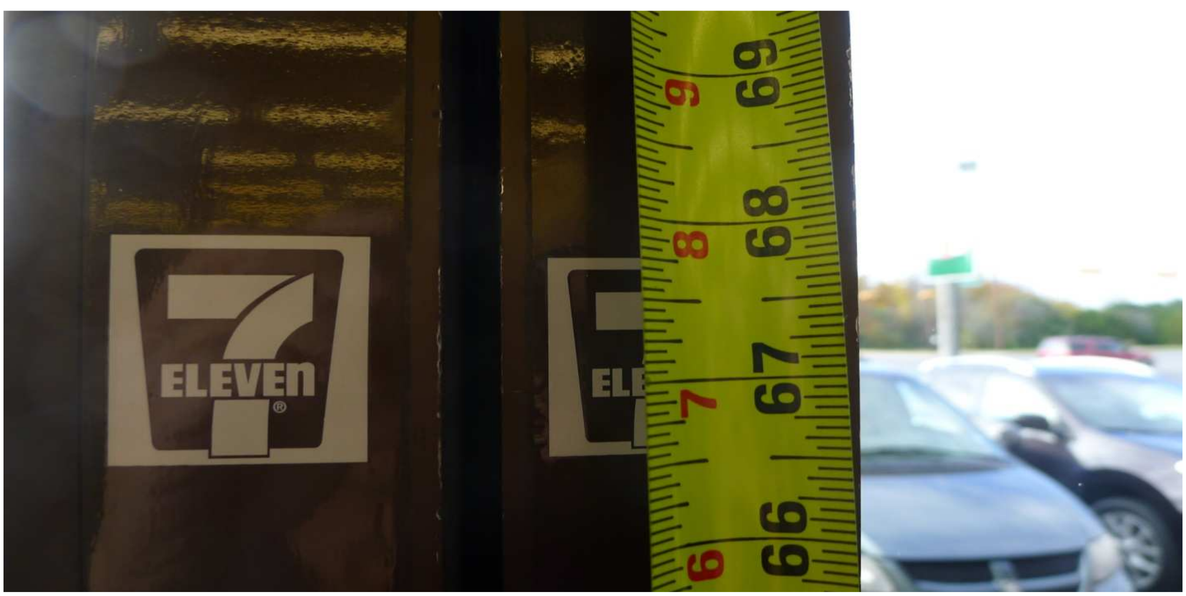

Photo #4

“HEIGHT MEASUREMENT CONCLUSION. The height of the 7-Eleven robber in Photo #2 may be just under 5’7¾“, as the robber’s shoes and the robber’s cap add a small amount of apparent height, *i.e*., **since the top of the 2nd height sticker is approximately 5’7¾”, then the robber in Photo #2 is approximately 5’7½” (with an approximate ½” margin of error).**

“The undersigned has reviewed the Aug. 07, 2009 Forensic Reconstruction Report prepared by Mr. Michael A. Knox of Knox & Associates. Page 2 of that report states that as part of his analysis, Mr. Knox used “[a]dditional measurements of the scene provided by Investigator Raymond Jacobs (at my request).” This statement is materially inconsistent with the content of his 1st of 2 Disclaimer paragraphs, quoted below:

> This report was prepared for the sole purpose of being used in criminal proceedings related to this case. *In preparing this report, the author has relied on materials supplied by the client [Bell County (TX) District Attorney]. Knox & Associates makes no guarantee as to the accuracy of any information or data that was not obtained directly by a member of our staff. Accuracy of this report and the conclusions contained herein likewise cannot be guaranteed insofar as the author has relied on such third-party and client-supplied information.* However, Knox & Associates does assert that this report contains the author’s best and most accurate ability to document, analyze, and reconstruct the suspect’s height based on the information provided. Knox & Associates reserves the right to amend or otherwise change the conclusions contained herein if new information becomes available that was not known to Knox & Associates at the time this report was prepared. (italics added)

“This Report by Mr. Knox appears fundamentally flawed on its face, and patently unreliable in its conclusion, for the following reasons:

1) Mr. Knox states that he has relied on materials supplied by the client [Bell County (TX) District Attorney]. We can only assume that he also relied on “[a]dditional measurements of the scene provided by Investigator Raymond Jacobs (*at my request*).” (italics added) If Mr. Knox requested certain on-site measurements, then we assume that such information was used in his analyses.

2) Since Mr. Knox requested certain on-site measurements from Investigator Jacobs, then his statement “Knox & Associates makes no guarantee as to the accuracy of any information or data that was not obtained directly by a member of our staff” effectively means: “Knox & Associates guarantees the accuracy of any information or data, since such data/measurements were obtained directly by a member of my staff.”

3) Mr. Knox requested certain on-site measurements from Investigator Jacobs. However, nowhere in his 6-page report details Investigator Jacobs’ “additional measurements.” One would think that the height of each of the three pairs of height

stickers, which happen to be a few inches from the robbers head at the time of the entrance to the store, would have been measurements requested by Mr. Knox of Investigator Jacobs, used in the height analyses of the robber by Mr. Know, and properly detailed in any formal written report.

4) Had a simple tape measure measurement of the top of each of the three height stickers been requested and made, then one would expect that most relevant data would be, quite simply –

- the top of the bottom height sticker measures approximately 61-15/16", or 5'1-15/16";
- the top of the middle or 2nd height sticker measures approximately 67¾", or 5'7¾";
- the top of the top height sticker measures approx. 74", or 6'2".

5) If (since) the simple but critically relevant information about the location of each of the height stickers were requested (by Mr. Knox of Investigator Jacobs), then it would be clearly obvious to any observer with acceptable vision that the suspect in Photo #2 is very close to the top of the middle height sticker, or very close to 5'8" – which is nowhere close to anyone "at least 6'1" tall" (Mr. Knox's conclusion on page 6 of his report), and way beyond any margin of error from 5'8". By his conclusion, anyone " at least 6'1" " would be at or above the top of the 3rd height sticker – again, referring to Photo #2 above, it is clear and obvious that the robber is right at the 5'8" sticker, and nowhere near the top of the top or 3rd height sticker, which is at 6'2", or a full 6" higher.

6) Mr. Knox's Report does not appear to utilize "[a]dditional measurements of the scene provided by Investigator Raymond Jacobs (*at my request*) (italics added)," notwithstanding his written statements to the contrary. Without the available and necessary on-site measurements, his data utilized is necessarily flawed or incomplete. Regardless of the reliability or not of his methodology, since he utilized wrong or incomplete data, his conclusion that the robber is "at least 6'1" tall" is necessarily unreliable, invalid and forensically untenable.

7) Mr. Knox's conclusion is that the robber is "at least 6'1" tall" (p.6, Knox Report). To not at least put a range on a measurement is untenable. For example, one would think, presumably including Mr. Know, that the robber in the photo could not possibly be seven feet (7') tall, although that hypothetical 7' robber would not be excluded in Mr. Knox's conclusion or opinion.

8) What may be most remarkable in the Knox Report is the lack of measurements or numbers to derive at a conclusion. The Knox Report does not imply, much less explain, how Mr. Know came up with the 6'1-1/8" value (p.5, Knox Report). As such, his conclusion of "*at least* 6'1" tall" (italics added, p.6, Knox Report) is scientifically flawed and forensically untenable.

9) Mr. Knox stated that he used CadZone software; however, he does not describe which one (or more) of the 10 CadZone products he used, much less how it was used. Such material omission prevents one from trying to replicate what Mr. Knox did in concluding that the robber was “at least 6’1” tall”.

10) Mr. Knox stated that he used PhotoModeler software; however, he does not describe how it was used. Such material omission prevents one from trying to replicate what Mr. Knox did in concluding that the robber was “at least 6’1” tall”.

11) Mr. Knox stated that he used Google SketchUp software; however, he does not describe why or how creating a 3-D model was used. Although p.4 of the Knox Report states that the “model was then used both to obtain the suspect’s height and to create a demonstrative video showing how the perspective of the camera affects the appearance of the suspect’s height in the surveillance video,” it is not clear at all what measurements were made or used and how the “at least 6’1”” value was derived at. Given that there was a point (Photo #2) in which the robber was right at the plane of the door, then any camera perspective on the stickers is identical to the perspective of the robber, such that whatever camera perspective does not affect the net calculations of the height of the robber. It is not clear why the SketchUp software was used, how any height determination could have been reliably determined thereof, and what part the “demonstrative video” was used in the opinion. Therefore, such material omissions prevent one from trying to replicate what Mr. Knox did in concluding that the robber was “at least 6’1” tall”.

12) Mr. Knox states on p.5 of his report: “It is important to note that the suspect’s body is leaning to the right in the photograph, which means that his height cannot be measured accurately by taking a vertical measurement. Instead, his height must be measured along the diagonal axis from the top of his head to the bottom of his right foot.” By his own admission, “[the robber’s] height cannot be measured accurately by taking a vertical measurement.” Given that the video captured the same robber as the robber was crossing the plane of the door *vertically*, see Photo #2, above, it is not clear why the photo Mr. Knox used in which the robber was “leaning to the right” was used or preferable to Photo #2 above in which there was no leaning. Using inferior data results in an unreliable conclusion, or underscoring the flaw in the conclusion that the robber was “at least 6’1” tall”.

13) It appears that the Know Report does not account for the added height of the robber wearing shoes. It also appears that the Know Report does not account for the added height of the robber wearing a cap. Such material omissions further erode any confidence in Mr. Knox’s conclusion that the robber was “at least 6’1” tall”.

14) The relevant height stickers at the 7-Eleven store at issue are in the ***same location*** at the time of our measurements (11/20/13) as they were at the time that the KPD made the same measurements (4/21/09). In the Knox Report,

detailed below, Mr. Knox states on page 2 of his report that as part of his analysis, he used "[a]dditional measurements of the scene provided by Investigator Raymond Jacobs (at my request)." However, nowhere in his report does he reveal these measurements, nor is there anywhere in his report that details how he came up with his conclusion that the suspect was "at least 6'1" tall" (p.6, Knox Report).

"In conclusion,

➢ with at least a reasonable degree of scientific certainty, there is a Probable Elimination when comparing the voice of the robber in the "Valero" video described above with that of Mr. George R. Powell, III's voice;

➢ since the top of the 2nd height sticker in the 7-Eleven photo is approximately 5'7¾", then the robber in Photo #2 is approximately 5'7½" (with an approximate ½" margin of error) – this conclusion is consistent with the independent measurements made by the Killeen Police Department; and

➢ it appears that the Knox Report is not based on any reliable facts, is not based on any apparently reliable methodology, not capable of being replicated or validated in any meaningful way, and in fact, the unsupported conclusion that the robber was "at least 6'1" tall" is not even physically possible, notwithstanding his attestation to his Report's "truth and accuracy to the best of [his] knowledge and ability" and that his "conclusions … have been formed objectively."

"I declare nothing further."

a. Yonovitz

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APPENDIX:

Joe, H., Yonovitz, A. *Legal, Scientific and Forensic Controversies Over Spectrographic Voice Analysis for Identification or Elimination*. Law Enforcement Executive Forum, Sept. 2007, Vol. 7, No. 6, pp. 51-58. (Attached)

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14. Yonovitz, A., Mitchell, C.W. and Lozar, J., Audiological testing via telephone. The design of a digitally controlled audiometer. Presented at Acoustical Society of America, June 1977.

15. Yonovitz, A., Thompson, C.L. and Lozar, J., Binaural interaction in consonant perception. Presented at Acoustical Society of America, June 1977.

16. Bickford, J., Yonovitz, A., Lozar, J. and Mitchell, C.W., Electroacoustic distortions: Multidimensional analysis of quality judgments of hearing aid transduced speech and music. Presented at American Speech and Hearing Association Annual Meeting, November 1977.

17. Perez, F., Sargent, B., Yonovitz, A. and Lozar, J., Communicative disorders in Children: The multivariate structure of differential diagnosis as measured by language and learning profiles. Presented at the First Annual Mexican Academy of Neurology, Puebla, Mexico, November 1977.

18. Yonovitz, A., Lozar, J., Thompson, C.L., Ferrell, D. and Ross, M., "Fox-Box Illusion". Simultaneous presentation of conflicting auditory and visual CV's. Presented at Acoustical Society of America, December 1977.

19. Yonovitz, A., Bickford, J. and Lozar, J., Multidimensional analysis of electroacoustic distortions in low-fidelity circuitry. Presented at Acoustical Society of America, December 1977.

20. Yonovitz, A., Lozar, J., and Thompson, C.L., Binaural Interaction: Consonant intelligibility and distinctive feature perception. Presented at American Speech and Hearing Association Annual Meeting, November 1977.

21. Yonovitz, A., Bickford, J., Lozar, J., and Ferrell, D., Electroacoustical distortions: Multidimensional analysis of hearing aid transduced speech and music. Presented at IEEE International Conference on Acoustics, Speech and Signal Processing. (78CH1285-6ASSP), April 1978.

22. Yonovitz, A., Ferrell, D. and Harris, B., Paired comparison judgments in low fidelity circuitry. Presented at Acoustical Society of America, May 1978.

23. Sargent, B., Yonovitz, A., Lozar, J. and Perez, F., Multivariate structure of diagnostic classifications of language-learning profiles. Presented at American Speech and Hearing Association Annual Meeting, November 1978.

24. Stump, D.A., Cooke, N., Yonovitz, A., Perez, F.O. and Meyer, J.S., Selective regional cerebral blood flow responses to auditory stimuli: White noise versus human voice. Presented at 90th International Conference on Cerebralvascular Disease, Salzburg, Austria, September 1978.

25. Wilson, J., Yonovitz, A., Campbell, I., Spydell, J. and Thompson, C.L., The effect of interaural electroacoustic hearing aid properties on sound localization abilities in normal and hearing impaired listeners. Presented at Acoustical Society of America, November 1978.

26. Yonovitz, A., Mitchell, C.W. and Lewis, H., Microcomputer applications in hearing conservation. Presented at Acoustical Society of America, November 1978.

27. Yonovitz, A., Thompson, C.L. and Harper, D., Frequency compression effects on consonant intelligibility in the normal ear. Presented at Acoustical Society of America, June 1979.
28. Yonovitz, A., Genuth, A. and Brown, G., Concurrent Averaging of Auditory Evoked Potentials to Masking Level Difference Stimuli. Presented at American Speech and Hearing Association Annual Meeting, November 1980.
29. Lawler, P., Falck, F. and Yonovitz, A., The effects of stuttering on fundamental frequency. Presented at American Speech and Hearing Association Annual Meeting, November 1980.
30. Hughes, L., Yonovitz, A. and Fann, E., Voice analysis in Tardive Dyskinesia. Presented at American College of Psychoneuropharmacology, November 1982.
31. Evans, B., Yonovitz, A. and Fox, D., Triethyltin-induced hearing loss: A study using pure tone auditory Brainstem responses. Presented at Society of Toxicology, April 1983.
32. Evans, B., Yonovitz, A. and Fox, D., Ototoxic effects of triethyltin: Electrophysiological Correlates. Presented at Society of Toxicology, April 1984.
33. Yonovitz, A. and Ostrum, S. The use of a reflectionless tube in jitter measurement. Presented at American Speech and Hearing Association Annual Meeting, November 1984.
34. Evans, B., Yonovitz, A, and Mitchell, C. Image Analysis with the Apple II: Otologic histology. Presented at conference "Microcomputers in Speech, Hearing and Language", February 1984.
35. Ostrum, S. and Yonovitz, A. Vocal Jitter Analysis: High rate digital sampling with the Z-80 microprocessor. Presented at conference "Microcomputers in Speech, Hearing and Language", February 1984.
36. McKinney, B., Yonovitz, A., Evans, B. and Smolensky, M. Circadian modulation of Aminoglycoside ototoxicity. Paper presented at Satellite symposium "Circadian effects in the Central Nervous System" of the International Conference of Pharmacology, August 1984.
37. Yonovitz, A., Mitchell, C.W., Ostrum, S. and Evans, B. Sinusoisdal signal generation: Analog and digital design techniques. Presented at the 17th International Congress on Audiology, August 1984.
38. Anderson, C.W., Yonovitz, A. and Anderson, W.L. Frequency and amplitude perturbations of the human voice determined with a reflectionless tube. Presented at Acoustical Society of America, November 1985.
39. Evans, B.E., Marc, R.E., and Yonovitz, A. Slow evoked motile responses in guinea pig outer hair cells. Presented at Acoustical Society of America, November 1986.
40. Evans, B.E., and Yonovitz, A. Magnitude and Phase Response in outer hair cell motility as a function of direct current bias. Presented at Association for Research in Otolaryngology, February 1987.
41. Yonovitz, A. and Yonovitz, L. Cycle to cycle spectral perturbations in voices of female speakers. Presented at the Acoustical Society of America, November 1987.
42. Evans, B.E. and Yonovitz, A. Ultrastructural Correlates of Hair cell Motility. Presented at the Acoustical Society of America, November 1987.

43. Yonovitz, A. and Yonovitz, L. Shimmer, jitter and spectral perturbations in the female voice. Presented at the American Speech and Hearing Association Annual Meeting, November 1988.
44. Yonovitz, A. and Yonovitz, L. Spectral perturbation analysis of male and female speakers. Presented at Acoustical Society of America, November 1988.
45. Yonovitz, A. and Yonovitz, L. Cycle to cycle spectral perturbations in the voices of male and female speakers. Presented at the American Speech and Hearing Association Annual Meeting, November 1988.
46. Yonovitz, A. The expert witness and tape-recorded evidence. Miniseminar presented at the American Speech and Hearing Association Annual Meeting, November, 1988.
47. Yonovitz, A. and Yonovitz, L. Ultra-high rate digital sampling of voice. Presented at the American Speech and Hearing Association Annual Meeting, November 1989.
48. Yonovitz, A. and Ostuni, J. Ultra-high rate digital sampling: Jitter, shimmer and spectral perturbation of Speech. Presented at the Acoustical Society of America, May 1990.
49. Yonovitz, A. Tape recorded evidence: The use of speech-language and audiological techniques in criminal trials. Presented at the Maine Speech-Language-Hearing Association, March 1990.
50. Yonovitz, A., Roy, M., Shane, S., Smith, A., Stone, E. and Thibodeau,C. Jitter, Shimmer, and spectral perturbation in female speakers. Presented at American Speech-Language-Hearing Association Annual Meeting, November 1990.
51. Yonovitz, A. The humanist and the scientist. Presented at Acoustical Society of America, May 1991.
52. Roy, M., Langill, C. and Yonovitz, A. Circadian rhythm dependent gentamicin induced hearing loss in rodents. Presented at Acoustical Society of America, May 1991.
53. Improved signal to noise ratios: A thirty-two channel computer enabled microphone system used with classroom auditory trainers. Presented at Academy of Rehabilitative Audiology, June 1991.
54. Lamoreux, C. and Yonovitz, A. Evoked potential responses to homophasic and antiphasic stimuli. Presented at American Speech-Language-Hearing Association Annual Meeting, November 1991.
55. Yonovitz, A. A computer controlled thirty-two channel microphone auditory trainer. Presented at American Speech-Language-Hearing Association Annual Meeting, November 1991.
56. Yonovitz, A. and Smith, A. Intraspeaker/interspeaker variation in selected voice parameters and speaker identification. Presented at the Acoustical Society of America, November 1991.
57. Lamoreux, C. and Yonovitz, A. Binaural interaction: Auditory evoked responses to homophasic and antiphasic click stimuli. Presented at the Acoustical Society of America, November 1991.
58. Yonovitz, A and Smith, Sharon. Intersubject and Intrasubject variation in voice parameters. Presented at the American Speech-Language-Hearing Association Annual Meeting, November 1992.
59. Yonovitz, L. and Yonovitz, A. Current Issues in Amplification and Discourse Assessment in Classrooms for Children with Hearing Impairment. Invited colloquium at

the Menzies School of Health Research, Darwin, Northern Territories, Australia, July 1992.

60. Yonovitz, A. and Yonovitz L. B. The Forensic Analysis of Tape Recorded Evidence. Presented at the American Speech-Language-Hearing Association Annual Convention, November 1993.

61. Yonovitz, A. and Ostuni, J. Spectral Harmonic Perturbation of the Glottal Sound Source Signal. Presented at the American Speech-Language-Hearing Association Annual Meeting, November 1993.

62. Yonovitz, A. Research Methodologies in Studying the Glottal Sound Source Signal. Presented at the Christchurch College of Education, February 8, 1994, Christchurch, New Zealand.

63. Lynch, Julie, Yonovitz, Leslie, and Yonovitz, A. Noise Modulation and Differential Diagnosis of CAPD and ADHD. Presented at the American Speech-Language-Hearing Association Annual Meeting, November 1994.

64. Holland, Nancy, Yonovitz, A. and Yonovitz, Leslie. Event-related brain potentials preceding speech. Presented at the American Speech-Language-Hearing Association Annual Meeting, November 1994.

65. Mascari, Mary, Yonovitz, A., Yonovitz, Leslie and Dean, James. Speech discrimination with bone conduction transducers. Presented at the American Speech-Language-Hearing Association Annual Meeting, November 1994.

66. Yonovitz, A., Yonovitz, Leslie, Boswell, Judith and Nienhuys, Terry. Application of bone conduction FM amplification in Australian Aboriginal schools. Presented at the American Speech-Language-Hearing Association Annual Meeting, November 1994.

67. Holland, Nancy and Yonovitz, A. Event-related vertex potentials preceding vowel onset. Presented at Acoustical Society of America, December 1994.

68. A. Yonovitz, Leslie Yonovitz and Terry Nienhuys. Digitization of video-otoscopic images in a remote Aboriginal community. Presented at the American Speech-Language-Hearing Association Annual Meeting, November 1995.

67. A. Yonovitz, Leslie Yonovitz, Geoff Plant, Judith Boswell and Terry Nienhuys. Application of an adaptive speech testing procedure with Aboriginal Children. Presented at the American Speech-Language-Hearing Association Annual Meeting, November 1995.

68. Yonovitz, A, Yonovitz, L, Boswell, J. and Nienhuys, Terry. Central auditory processing deficits in Aboriginal children with early-onset OME. Presented at the International Congress of Audiology, Bari, Italy, 1996.

69. Yonovitz, A. Morris, Peter, Leach, Amanda, Yonovitz, Leslie, Angela Melder and Mathews, John. Prevalence and Natural History of Otitis Media in Australian Aboriginal Infants Living in Remote Communities. Presented at the annual meeting of the South African Society for Ear, Nose and Throat, 1996.

70. The masking level difference in Aboriginal and non-Aboriginal children. Evidence for Central Auditory Processing Disorders. Presented at the annual meeting of the South African Society for Ear, Nose and Throat, 1996.

71. Yonovitz, A. Joe, Herbert, and Yonovitz, Leslie. Acoustic and Linguistic Analysis of Tape Recorded Evidence. Presented at the American Speech-Language-Hearing Association Annual Meeting, November 1996.

72. Yonovitz, A. Morris, Peter, Scott, Jeanette, McDonald, Craig, Daby, Joe and Aithal, Venkatesh. The Video Otoscope with Aboriginal Ear Disease: Diagnosis, Research and Health Education. Presented at the Annual Meeting for Australian Health Promotion, 1997.
73. Morris, PS, Yonovitz, A. Leach, Amanda, Yonovitz, Leslie, Angela Melder and Mathews, John. Acute otitis media in Aboriginal infants living in remote communities. Presented at the XVI International Meeting of Ear, Nose and Throat, Sydney, 1997.
74. Yonovitz, A. Designing and selecting culturally and linguistically appropriate hearing measures. Symposium: Hearing Problems for Aboriginal Australians. Presented at 13th ASA National Conference, 1998.
75. Aithal, V, Yonovitz, A, Aithal, S, Foreman, A, and Vercoe, G. Hearing benefit following myringoplasty in rural and remote Australian Aboriginal patients. Presented at 13th ASA National Conference, 1998.
76. Yonovitz, A, Aithal, V. and Yonovitz, L. Presentation of revised NAL AB words with speech spectrum and white noise at various signal to noise ratios. Presented at 13th ASA National Conference, 1998.
77. Yonovitz, L and Yonovitz, A. Auditory processing deficits in Australian Aboriginal children. Presented at 7th International Congress of Pediatric Otorhinolaryngology. Helsinki, 1998.
78. Yonovitz, A. Use of concurrent evoked potentials to determine conductive hearing loss in Aboriginal children. Presented at American Speech-Language Hearing Association, 1998.
79. Yonovitz, A. Joe, Herbert, and Yonovitz, Leslie. Acoustic and Linguistic Discourse Analysis of Tape-Recorded Evidence. Presented at the American Speech-Language-Hearing Association Annual Meeting, 1998.
80. Scott, P and Yonovitz A. Measurement of Classroom Acoustics in Rural/Remote Aboriginal Schools. Presented at the American Speech-Language-Hearing Association Annual Meeting, 2000.
81. Yonovitz, A, Yonovitz, L. Aithal, V and Aithal S. Best-Practice Audiological Service Delivery in Remote Northern Territory Aboriginal Communities. Presented at the American Speech-Language-Hearing Association Annual Meeting, 2000.
82. Acoustic & Linguistic Analysis of Tape-Recorded Evidence. Presented at the American Speech-Language-Hearing Association Annual Meeting, 2000.
83. Scott P and Yonovitz A. ACCLASTICA: A GUI Based Classroom Acoustics Analysis System. Presented at the Audiological Society of Australia Conference. 2000.