IN THE CIRCUIT COURT OF COOK COUNTY

CRIMINAL DIVISION

THE STATE OF ILLINOIS	)	
	)	20 CR 0899601
v.	)	
	)	JUDGE VINCENT GAUGHAN
MICHAEL WILLIAMS	)	PRESIDING

MOTION TO EXCLUDE SHOTSPOTTER EVIDENCE PURSUANT TO *FRYE* AND RULE 403

ShotSpotter is a for-profit business[1] which has prioritized aggressive marketing over legitimate science when promoting its microphone-based noise detection system (deployed to try to distinguish and locate gunshot noises in urban neighborhoods) to police departments. The most important casualty of this corner-cutting approach to forensic method development is the absence of required validation testing. Despite validation testing representing the only scientifically recognized and defensible method for a corporation like ShotSpotter to establish the reliability of a forensic method, ShotSpotter has ignored this requirement, instead relying on empty and misleading claims of accuracy contained in marketing materials. While the absence of validation testing is the most important casualty of ShotSpotter's substandard approach to forensic science, it is not the only one. Also missing in the ShotSpotter method are adequately trained forensic experts, meaningful guidance in the form of forensic protocols, and black-box studies proving the reliability of the ShotSpotter method. The result of this substandard approach to science has been predictable: police departments experiencing incredibly high incidents of false alerts (generated by innocence noises such as nail guns, car backfires, truck

[1] ShotSpotter went public in June, 2017, seeking to raise $30 million through the sale of stock shares to investors. https://www.marketwatch.com/story/shotspotter-ipo-five-things-to-know-about-the-gunshot-detection-company-2017-05-26. ShotSpotter receives approximately 18% of its annual revenue through its contract with the City of Chicago alone, which requires the Chicago Police Department to pay ShotSpotter $33,000,000 over 3 years. https://ir.shotspotter.com/all-sec-filings/content/0001564590-21-016134/0001564590-21-016134.pdf. While ShotSpotter's revenue model relies heavily on securing subscription contracts with law enforcement agencies such as the Chicago Police Department, ShotSpotter has historically struggled to achieved profitability with this revenue model. https://ir.shotspotter.com/quarterly-reports/content/0001564590-20-052562/0001564590-20-052562.pdf.

downshifting, helicopter noises, college campus noises, and many other urban sounds), police officers racing to crime scenes that don't exist, and spectacular failures where ShotSpotter got everything wrong.[2]

While it is a bad idea for police agencies to rely on ShotSpotter as an investigative aid absent validation testing, the lack of these tests is outright fatal to the State's hopes of admitting results from the system at trial- the scientific community has been loud and clear that general acceptance only comes after adequate validation testing of a forensic method. Unreliable ShotSpotter evidence should not be used in the criminal justice system until the proponent can establish the reliability and performance parameters of the system through adequate validation testing. A Frye inquiry is especially critical in this case, where a still-anonymous ShotSpotter employee[3] secretly switched the determination of the ShotSpotter algorithm from firecracker to gunshot and where a second ShotSpotter employee rejected the ShotSpotter algorithm's location determination in favor of a different location one mile away that just happened to line up with the preferred police location of events. When combined with the facts that ShotSpotter forensic examiners are uniquely unqualified[4] to conduct forensic analyses and ShotSpotter's

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[2] Attachment A- Testimony of Paul Greene in the Silvon Simmons case, Rochester, New York, October 17, 2017, p. 36-39. (In Rochester, New York, on April 1, 2016, the ShotSpotter system deployed in that city failed to issue an alert for gunshots when it misclassified the sounds as helicopter-generated. Two days later, the local police department contacted ShotSpotter to inquire why there had been no alert. At that time, a ShotSpotter employee reclassified the sound events "per the [police department's] instruction" from helicopter-generated to gunshots and reported that there had been 4 separate shots. Thereafter, a second ShotSpotter employee reviewed the same sound data and again changed the results, this time altering the number of gunshots detected from 4 to 5.); See also, Attachment A- Testimony of Paul Greene in the Silvon Simmons case, Rochester, New York, October 17, 2017, p. 90, 113. (In Rochester, New York, the deployed ShotSpotter system failed to detect 25 of 29 gunshots and mislocated the shots by 1 ½ miles.); See also, San Antonio Express-News, "San Antonio police cut pricey gunshot detection system," August 16, 2017 (In 2017, a ShotSpotter system deployed in San Antonio, Texas, failed to register alerts for all 5 homicide shootings that occurred in one day in a ShotSpotter coverage area. The San Antonio Chief of Police recommended that ShotSpotter use be discontinued.).

[3] Despite the fact that a defense subpoena in this case (Attachment B) ordered the production of names of ShotSpotter employees "who reviewed the noise event in this matter," ShotSpotter continues to hide the identity of the employee who overrode the ShotSpotter algorithm determination in this case that the noise event was caused by a firecracker, not by gunfire.

[4] Attachment C- Testimony of Paul Greene, Trial of Michael Reed, San Francisco, California, July 6, 2017, p. 154-155 (stating that the ShotSpotter employees who initially review noise events and decide whether to reject the determinations of the ShotSpotter algorithm are "Service Operations Center Operators" who must only have a high school diploma and 1 year of customer service experience.): See also, Attachment D- ShotSpotter Job Description for Service Operation Specialist (stating that eligible candidates must possess a "minimum of one year of professional experience, preferably in a call center" and stating that an Associates Degree or Law Enforcement training is "strongly preferred.").

secret algorithm has never been independently tested and validated, the many significant problems with this system should prevent the admissibility of ShotSpotter evidence in criminal cases in Chicago and everywhere else until such time as ShotSpotter gets serious about science and displays a basic respect for Brady v. Maryland[5] and the notion of a fair trial.

A. ShotSpotter purports to identify and locate gunshot events in complex urban environments through a combination of recording sensors, a secret computer algorithm, and human customer service representatives.

The ShotSpotter noise detection system is a three-part system marketed to police agencies as having the capability to quickly alert police dispatchers to gunfire events. The noise detection system starts with a network of microphones planted on various structures in targeted areas[6] with the purpose of detecting impulsive noises that may have originated from the muzzle blast associated with gunfire.[7] The microphones transfer the noise and other data to the second part of the system- a proprietary and secret computer program that is supposed to determine if the noise resulted from a gunshot, determine the time of the noise event, and determine the approximate location of the noise event.[8] Finally, because the secret computer program regularly "misinterprets" the noise data[9], the third part of the ShotSpotter system is a human operator who reviews the computer-generated results, attempts to determine if they are

[5] 373 U.S. 83 (1963)(where the U.S. Supreme Court held that "the suppression by the prosecution of evidence favorable to an accused upon request violates due process.").

[6] Attachment E- Testimony of Paul Greene, Trial of Michael Reed, San Francisco, California, July 5, 2017, p. 4-12.

[7] The sudden exit from a gun barrel of burning propellant under high pressure and temperature produces an acoustic muzzle blast that results in soundwaves diverging spherically, though not symmetrically, away from the barrel in all directions. While different technology used by the military to detect sniper locations involves the detection of the separate phenomenon of supersonic shock waves that can be detected a mile or more from the source, civilian gunshot detection systems are designed to detect noise events from handguns and other weapons that do not fire bullets at a speed that exceeds the speed of sound. Therefore, these civilian systems are designed to detect only muzzle blast soundwaves at shorter distances and not supersonic shock waves at longer distances. Aguilar, "Gunshot Detection Systems in Civilian Law Enforcement," Journal of the Audio Engineering Society, Vol. 63, p. 280 (2015).

[8] To attempt to discern the location of a noise event such as a gunshot, systems like ShotSpotter rely on a technique called multilateration. This involves measuring the difference in arrival times of soundwaves to microphone sensors, with the time difference resulting from the varying distances from the noise source to multiple microphone sensors. The Time Difference of Arrival (TDOA) is then used to plot hyperbolas (smooth curves lying in a single plane), with the intersection of the hyperbolas representing the possible or approximate location of the noise source in theory. Maher, Hoerr, "Audio Forensic Gunshot Analysis and Multilateration," Audio Engineering Society Convention Paper (2018).

[9] Attachment C- Testimony of Paul Greene, Trial of Michael Reed, San Francisco, California, July 6, 2017, p. 104, ShotSpotter employee Paul Greene testified that he has to alter ShotSpotter algorithm results frequently: "anywhere from half to two-thirds of the incidents that I review require some form of correction."

accurate, and forwards gunshot alerts to police departments. Unfortunately, these human operators are not legitimate forensic experts[10], but rather are customer service representatives with little more than high school diplomas.[11] Equally troubling is the fact that these customer service representatives spend no more than 30-40 seconds conducting their "forensic evaluation" of the noise event data before deciding whether to overrule the ShotSpotter algorithm and quickly forward alerts to police departments.[12] Such a system, deployed in the Woodlawn neighborhood in Chicago, is at issue in this case.

B. General acceptance of a forensic method in the scientific community requires that the method have undergone adequate validation testing to determine the reliability of the method as developed and as deployed.

The scientific community has spoken loudly, clearly, and repeatedly: to be generally accepted in the scientific community, a forensic method must undergo testing to assess reliability (the frequency with which the method generates results consistent with ground truth). There is no substitute for adequate validation of a forensic method because "empirical testing of validity and reliability is the *only way* to demonstrate how well a forensic analysis system actually

[10] Attachment C- Testimony of Paul Greene, Trial of Michael Reed, San Francisco, California, July 6, 2017, p. 20, 154-155- Human operators at ShotSpotter have the task of reviewing forensic impulsive noise data and overruling the ShotSpotter algorithm's determination of the cause of the impulsive noise. These human operators generally do not have training as forensic scientists- they typically have no more education than high school diplomas, come from work backgrounds as customer service representatives and schoolteachers, and receive minimal training consisting of 2 to 6 weeks of "mentoring."

[11] In forensic disciplines where legitimate forensic examiners are employed to review scientific data and draw conclusions from the data, there are national guidelines for training and qualification of such examiners that are set by consensus in the forensic community. For example, forensic laboratories seeking to hire and train new employees in forensic fingerprint examination can look to national standards set by SWGFAST, a committee of fingerprint experts convened by the FBI to publish national standards for the practice of forensic fingerprint comparison. In a document entitled "Standards for Minimum Qualifications and Training to Competency for Friction Ridge Examiner Trainees," standards are set for the training of new forensic fingerprint examiners- new trainees must have a college bachelor's degree with science-related coursework, they must undergo a year-long apprenticeship covering specified concepts in the discipline, and they must successfully complete practical exercises and tests. Additionally, new fingerprint examiners must undergo annual proficiency testing (usually provided by a national testing provider named Collaborative Testing Services) to establish their baseline competency to conduct forensic analyses. Finally, fingerprint examiners can further establish their expertise by obtaining certification- a multi-step process involving written competency tests and fingerprint comparison problems. Such scientific working groups exist for most recognized forensic disciplines- DNA, fingerprint, ballistics, drug chemists, document examiners, arson investigators, shoeprint examiners, and others. See, www.nij.ojp

[12] Attachment F- Testimony of Paul Greene, Blackshell Grand Jury Proceeding, Rochester, New York, September 18, 2015, p. 241.

works."[13] Such is the position not only of the broader scientific community but even the more narrow forensic science community. In fact, the requirement of validation of forensic methods is so fundamental that crime labs cannot attain accreditation until they have conducted proper validation assessments of forensic methods which they seek to deploy.

The broader scientific community has left no room for doubt, repeatedly calling for the comprehensive validation of all forensic methods. One of the most influential committee of scientists ever assembled in the U.S. is the President's Council of Advisors on Science and Technology.[14] According to their ground-breaking 2016 report on the status of forensic science in the U.S, all forensic methods must undergo validation testing to establish that opinions resulting from the methods are based on "reliable principles and methods that have been reliably applied to the facts of the case."[15] The PCAST explains that nothing in science can substitute for adequate scientific validation:

> "Neither experience, nor judgment, nor good professional practices (such as certification programs and accreditation programs, standardized protocols, proficiency testing, and codes of ethics) can substitute for actual evidence of foundational validity and reliability. . .For forensic feature-comparison methods,

[13] Thompson, Morrison, "Assessing the Admissibility of a New Generation of Forensic Voice Comparison Testimony," Columbia Science and Technology Law Review, Vol. 18, p. 326, 363, 2017. (emphasis added).

[14] The PCAST "is the leading scientific and technology advisory body to the executive branch" and their forensic science report was based on a years-long review of 2100 scientific papers as well as "hundreds of pages of input invited from the forensic-science community." Lander, "Fixing Rule 702: The PCAST Report and Steps to Ensure the Reliability of Forensic Feature-Comparison Methods in the Criminal Courts," Fordham Law Review, Vol. 86, p. 1661, 2018. In 2016, the PCAST consisted of leading scientists from across the country, including: a geneticist from MIT, an engineer and Vice President of the National Academy of Engineering, a mathematician and former CEO of The Aerospace Corporation, a doctor who was the first female president of the American College of Physicians, a chemist who directs the Institute for Nanotechnology at Northwestern University, the director of The Laboratory for Geochemical Oceanography at Harvard University, a doctor of biochemistry and professor emeritus at the University of California Berkeley, and a physicist who is a Senior Vice President at a leading aerospace and technology corporation (to name a few). For several decades, the PCAST has reported to U.S. presidents on a wide range of scientific issues, including but not limited to nanotechnology, internet broadband development, cloning, and the uses of science and technology to combat terrorism. In short, the PCAST represents one of the most important and authoritative collections of scientists in the country. See, President's Council of Advisors on Science and Technology, "Forensic Science in Criminal Courts: Ensuring Scientific Validity of Feature-Comparison Methods," 2016.

[15] President's Council of Advisors on Science and Technology, "Forensic Science in Criminal Courts: Ensuring Scientific Validity of Feature-Comparison Methods," 2016.

establishing foundational validity based on empirical evidence is thus a sine qua non. Nothing can substitute for it."[16]

Prior to the PCAST, the National Academy of Science[17] issued a similar call for all forensic methods to undergo sufficient validation, stating that "the validity of forensic methods" must be established through studies that are "peer reviewed and published in respected scientific journals."[18]

In addition to the consensus of the broader scientific community represented by these national commissions, the consensus of the more narrow community of forensic scientists likewise establishes that validation of forensic methods is fundamental and required. Committees of leading forensic scientists, such as the National Commission on Forensic Science[19] (NCFS) and the Human Factors Subcommittee of the Organization of Scientific Area Committees for Forensic Science[20] (OSAC), have unequivocally expressed the requirement that forensic methods must be validated prior to use in casework. While the NCFS has said that "all forensic

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[16] President's Council of Advisors on Science and Technology, "Forensic Science in Criminal Courts: Ensuring Scientific Validity of Feature-Comparison Methods," 2016, p. 6.

[17] The NAS is an organization of scientists, scholars and researchers which was chartered by an act of Congress to advise the federal government on scientific and technical matters. In 2005, the U.S. Congress authorized the NAS to study the state of forensic science in the criminal justice system and to issue recommendations for best-practices. The Committee was co-chaired by a Judge from the Washington D.C. Court of Appeals and a Professor of Statistics from Brown University. Other members of the Committee included chemists, engineers, and other scientists. For 3 years, the NAS heard testimony from dozens of forensic experts, including many practicing forensic examiners, and issued a report which detailed how to best reform forensic science practices in the United States.

[18] National Research Council, "Strengthening Forensic Science in the United States: The Path Forward," National Academy Press, 2009.

[19] The NCFS was a collaboration between the U.S. Department of Justice and the National Institute of Standards and Technology. The stated mission of the NCFS was to provide recommendations concerning "*national methods and strategies for [] strengthening the validity and reliability of forensic science. . .*" The NCFS Board included representatives from law enforcement forensic agencies from around the country, including but not limited to: the founder of the Armed Forces DNA Identification Lab, a chemist formerly with the U.S. Customs Lab, a member of the FBI DNA Advisory Board, the Director of the Palm Beach Sheriff's Office Crime Lab, a forensic chemist with ATF, the Director of the Virginia State Crime Lab, and a forensic chemist with the FBI. The NCFS was co-chaired by the Deputy U.S. Attorney General. https://www.justice.gov/ncfs.

[20] The Organization of Scientific Area Committees for Forensic Science is a federally-funded network of forensic science subcommittees, organized by NIST, and working to "identify existing technically-sound forensic science standards, draft new documents and facilitate their development through the formal standards development process." The Human Factors subcommittee, which produced the validation recommendations described here, contains representatives from numerous recognized forensic disciplines, including but not limited to DNA, fingerprints, toxicology, ballistics, document examination, arson, pathology, footwear, and facial recognition. The Human Factors subcommittee represents an important and influential voice in the practice of forensic science in the U.S. See, www.nist.gov/topics/organization-scientific-area-committees-forensic-science/human-factors-task-group.

test methods should be shown to be fundamentally valid,"[21] OSAC has explained the high stakes involved in the forensic validation process:

> "Why should forensic scientists conduct empirical studies to assess the accuracy of their methods? Validation is necessary in all scientific disciplines. It is particularly important in forensic science because of the consequences that may follow from a single forensic science analysis or comparison."[22]

In addition to these forensic science commissions, individual forensic disciplines form national advisory committees, sometimes called Scientific Working Groups[23] (SWGs), and the fundamental requirement of validation is unmistakably reflected in SWG standards. For example, SWGDAM (the Scientific Working Group for DNA) explains in a document entitled, "Validation Guidelines for DNA Analysis Methods," that both developmental and internal validation are required before a crime lab can deploy forensic DNA methods and further requires that developmental validation be published in peer-reviewed scientific journals.[24] For forensic toxicology, the SWGDRUG standard entitled, "Quality Assurance/Validation of Analytical Methods," describes at length the validation testing a drug lab must undergo to establish the reliability of their methods.[25] Even in the forensic fingerprint discipline (which did not develop under the same level of scientific rigor as DNA science or toxicology science), SWG standards require forensic fingerprint laboratories to adhere to written validation plans when implementing new methods, and even when modifying the use of older methods.[26] These SWG

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[21] National Commission on Forensic Science, "Validation of Forensic Science Methodology," 2016, justice.gov/archives/page/file/831546/download.

[22] OSAC Human Factors Committee, "Human Factors in Validation and Performance Testing in Forensic Science," March, 2020, p. 26.

[23] Scientific Working Groups exist for most forensic disciplines, including DNA, fingerprints, ballistics, shoeprints, document examiners, digital evidence, blood pattern interpretation, arson, handwriting, toxicology and others. SWGs are bodies of forensic scientists, organized on a national level by the FBI Crime Lab, with the purpose of establishing "minimum standards for a forensic discipline." Such standards are published and freely available to forensic practitioners around the country. https://www.ascld.org/wp-content/uploads/2014/08/CFSO-Scientific-Working-Group-Paper-December-2013.pdf.

[24] Scientific Working Group on DNA Analysis Methods, "Validation Guidelines for DNA Analysis Methods," 2016. https://1ecb9588-ea6f-4feb-971a
73265dbf079c.filesusr.com/ugd/4344b0_813b241e8944497e99b9c45b163b76bd.pdf

[25] Scientific Working Group for the Analysis of Seized Drugs, "Quality Assurance/Validation of Analytical Methods," 2006. http://www.swgdrug.org/Documents/Supplemental%20Document%20SD-2.pdf.

[26] Scientific Working Group on Friction Ridge Analysis, Study and Technology, "Standard for the Validation and Performance Review of Friction Ridge Impression Development and Examination Techniques," 2012.

examples and others[27] demonstrate that the forensic science community agrees with the broader scientific community- proper validation is a bright-line requirement of generally accepted science.[28]

As one final indicator of the central role that validation plays in forensic science, forensic science labs cannot attain accreditation until they have fully validated their forensic methods. The large majority of forensic labs in the U.S. are accredited.[29] And in order to attain accreditation, crime labs must validate their methods and demonstrate through testing data that methods can be reliably employed for forensic casework.[30] In the accreditation process, validation is scientifically sufficient when, in part, it "identifies limitations of the method, reported results, opinions, and interpretations."[31] When seeking to sufficiently validate forensic methods and attain accreditation, crime labs such as the Illinois State Police Crime Lab have

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[27] The forensic science community is in the midst of a slow and staggered transition from SWG standards to new forensic standards organized and published by the Organization of Scientific Area Committees for Forensic Science (OSAC). Through NIST, OSAC houses a Registry of new forensic science standards adopted by committees of subject-matter experts in each discipline. While the work of the OSACs continues at a slow pace, the new standards adopted to date reflect the same requirement of validation as the older SWG standards. For instance, the "Standard for Validation Studies of DNA Mixtures" mandates that "data from validation studies performed by the [DNA] laboratory shall be the basis for interpretation parameters and protocols," and explains that internal validation must be conducted on representative samples that include the number of contributors and the ratios of contribution that are likely to be encountered in casework. https://asb.aafs.org/wp-content/uploads/2018/09/020_Std_e1.pdf. Likewise, the new OSAC standard for forensic toxicology mandates that "[m]ethods shall be validated to verify a method's performance parameters are fit for use for a particular analysis," and requires assessment of a range of parameters including precision, limits of detection, and carryover. http://www.asbstandardsboard.org/wp-content/uploads/2019/11/036_Std_e1.pdf. Additionally, the new OSAC standard (in comment adjudication phase) for the validation of bloodstain pattern analysis methods requires that crime labs "shall validate all procedures for bloodstain pattern analysis prior to casework." http://www.asbstandardsboard.org/wp-content/uploads/2019/05/072_Std_e1.pdf.

[28] See, Thompson et al., "Forensic Science Assessments: A Quality and Gap Analysis-Latent Fingerprint Examination," American Association for the Advancement of Science (2017) (reviewing the scientific validity of forensic fingerprint comparisons and stating that forensic methods must be assessed for "foundational validity" where "empirical studies have shown that the method is 'repeatable, reproducible, and accurate,' and must also be assessed for "validity as applied" where testing shows that "the method has been applied in a manner that is reliable and appropriate in the case at hand.")

[29] While 88% of crime labs in the U.S. were accredited as of 2016, that percentage has likely increased in the years since 2016. https://www.bjs.gov/content/pub/pdf/pffclqap14.pdf

[30] See, ISO Standard 17025. Section 5.4.2. (A crime lab in the U.S. must comply with ISO 17025 in order to attain accreditation, including the obligation to "confirm that it can adequately operate standard methods before introducing the tests or calibrations); See also, AOAC, "How to Meet ISO 17025 Requirements for Method Validation," 2008 (stating that accreditation requires labs to assess the accuracy and precision of a forensic technique by providing "objective evidence" of the performance of the technique on "actual lab data").

[31] ANAB ISO/IEC 17025:2017-Forensic Science Testing and Calibration Laboratory Accreditation Requirements. https://anab.qualtraxcloud.com/ShowDocument.aspx?ID=12371.

dedicated departments and scientists who focus on the validation of new forensic methods prior to deployment.[32] Even with all of these resources devoted to scientific validation, the ISP conducts months (sometimes years) of testing and generates thousands of pages of empirical data when seeking to validate a new forensic method. There is no shortcut to this process- it is the only generally accepted way for forensic scientists to responsibly deploy forensic methods.

Should there be any doubt whether noise detection systems such as ShotSpotter are subject to the validation requirements expected of every other forensic method, the limited literature in the discipline should erase that doubt. As scientists who have attempted to validate a noise detection system similar to ShotSpotter have explained, validation of noise detection systems is critical because "it is impossible to determine from operational data the percentage of non-gunshot acoustic events that result in a false alarm"[33] and a system's true performance "can only be determined through a live fire test in the operational area."[34] Therefore, police departments such as the Chicago Police Department who wish to deploy noise detection systems must "conduct careful testing in each of its coverage areas" to assess the "accuracy of the system for detecting or localizing actual gunshots."[35]

[32] The Illinois State Police Crime Lab "operates a Research and Development laboratory where new technologies are evaluated and validated before being implemented in the laboratories and used in actual forensic cases." See, www.isp.state.il.us/aboutisp/deptorg_dfs.cfm.

[33] Litch, Orrison, "Draft Technical Report for SECURES Demonstration in Hampton and Newport News, Virginia," U.S. Department of Justice, 2011 ("Data from the operational test period- dispatching system records and filed officer reports- can be used to answer a variety of questions about the usefulness of automated gunshot detection for law enforcement. Such data cannot, however, be used for assessing the accuracy of the system for detecting or localizing actual gunshots. Making such an assessment requires knowledge of when and where gunshots actually occurred. . .Since there is no other way of measuring undetected shots, a key measurement of system accuracy- the percentage of actual gunshots detected by the system- is not possible with operational data, but can only be determined through a live fire test in the operational area.")

[34] Litch, Orrison, "Draft Technical Report for SECURES Demonstration in Hampton and Newport News, Virginia," U.S. Department of Justice, 2011.

[35] Id. at 20, 27.

C. To be scientifically rigorous and generally accepted, validation testing must be properly designed, must assess both metrics of selectivity and specificity, and must be repeated when methods are changed or modified during deployment.

The path to successful validation testing is not a mystery- forensic scientists have known how to design proper validation studies for years. To be scientifically acceptable, validation testing must: 1) be conducted separately by both the manufacturer and the end-user, 2) assess the method against the range of variables likely to be encountered in deployment, 3) provide reliability assessments for selectivity and specificity, and 4) be repeated when methods change during deployment. Equally important, the results of all validation testing should be documented[36] and transparent, with all validation information freely available to interested parties, preferably in peer-reviewed scientific journals.[37] Once this fundamental process has been followed, the criminal justice system can have some idea of the reliability of a forensic method.

Both the manufacturer of the forensic method and the police agency-user have important roles to play in the validation process, which requires testing by both parties. First, the manufacturer must conduct "developmental validation" which involves "the acquisition of test data and determination of conditions and limitations of a new methodology; this generally occurs while the conditions and parameters are being worked out prior to the establishment of a defined assay, procedure, or product."[38] Because the conditions and variables involved in the actual

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[36] See, Morrison et al, "Vacuous Standards- Subversion of the OSAC Standards-developing Process," Forensic Science International: Synergy, (2020), doi: hppts://doi.org/10.1016/j.fsisyn.2020.06.005. (stating that "the acceptance criteria for the validation study shall be pre-defined and should not be known by the practitioner implementing the method.").

[37] Organization of Scientific Area Committees, "Human Factors in Validation and Performance Testing of Forensic Science, March 8, 2020. ("A data collection plan should provide for systematic, comprehensive and transparent documentation of what takes place in the study, including preparation of test specimens, recruitment of participants, how test specimens were presented to the participants, participants' judgments, and any processing or analysis of the resulting data. . .Once researchers publish their findings, however, they should freely share their study materials and data with academics, fellow researchers, and all other interested parties to the extent possible under IRB restrictions and privacy laws."); See also, National Research Council, "Strengthening Forensic Science in the United States: A Path Forward," National Academy Press (2009)(stating that "[a] critical step in such validation is their publication in peer-reviewed journals, so that experts in the field can review, question, and check the repeatability of the results.").

[38] Organization of Scientific Area Committees, "Human Factors in Validation and Performance Testing of Forensic Science," March 8, 2020, p. 6.

deployment of a forensic method into real-world usage will necessarily differ from those assessed during development, the forensic method must separately undergo "internal validation" by the police agency-user.[39] Internal validation assesses whether the circumstances of deployment of a forensic method and the environment in which it is used results in reliable outcomes as predicted by the developmental validation.[40] This two-step process- developmental validation followed by internal validation- represents the only generally accepted path to successful forensic method deployment.

Both developmental and internal validation studies need to be properly designed and one of the most important aspects of scientifically adequate design is "representativeness."[41] Neither developmental nor internal validation can provide a meaningful assessment of the reliability of a forensic method unless the testing is performed under circumstances that "represent" the range of variables that will be encountered when the method is deployed and in action:

> "A key issue in validation is whether the test specimens adequately represent the range and difficulty of the items encountered in ordinary casework. If the study is designed to test the accuracy of a method for casework in general, then the samples should represent the full range and distribution of types and difficulty normally seen in casework."[42]

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[39] U.S. v. Gissantaner, 417 F.Supp.3d 857 (W. Dist. Mich. 2019) (stating that "the adoption of a new software program by a forensic laboratory requires a separate validation study, called an 'internal validation' with a goal to "demonstrate that a particular methodology or approach or tool generates results that are consistent with what the proponents of the tool or methodology suggest will be obtained.").

[40] Organization of Scientific Area Committees, "Human Factors in Validation and Performance Testing of Forensic Science, March 8, 2020, p. 6.

[41] See, Morrison, et al., "Consensus on Validation of Forensic Voice Comparison," Science & Justice (2021)(stating that validation samples in forensic voice comparison "should be sufficiently representative of the relevant population for the case, and sufficiently reflective of the conditions of the questioned-speaker and known-speaker recordings in the case, that the results of validating the system using those data will be informative as to the expected performance of the system when it is applied in the case.").

[42] See, Organization of Scientific Area Committees, "Human Factors in Validation and Performance Testing of Forensic Science, March 8, 2020, p. 11; See also, Morrison et al, "Vacuous Standards- Subversion of the OSAC Standards-developing Process," Forensic Science International: Synergy, (2020), doi: hppts://doi.org/10.1016/j.fsisyn.2020.06.005. (stating that method validation must occur "using data that reflect anticipated casework conditions."); See also, SWGDAM, "The Guidance Document for the FBI Quality Assurance Standards for DNA Testing and DNA Databasing Laboratories, 2020 (stating that "mock samples should be reflective of the type and quality expected to be encountered in casework- e.g., various substrates, various stain concentrations" and requiring validation testing of complex mixture samples, samples of varying contributor ratios, and samples with varying template amounts.); See also, OSAC, "Standard for Validation Studies of DNA Mixtures, and Development and Verification of a Laboratory's Mixture Interpretation Protocol," 1st Ed., 2018 (stating that internal validation must include test samples that are "representative of those typically encountered" in casework,

For this reason, forensic labs seeking to implement forensic DNA testing techniques do not simply test the system with easy, single-source blood stains. Rather, they must test DNA systems on the broad range of variables that impact the reliability of casework analyses, including:

- Sample size and limits of detection
- Number of contributors to a mixture
- Ratio of contributions in a mixture
- Degradation effects
- Inhibition effect
- Artifact/Stutter occurrence
- Others[43]

For the variable of sample size alone, the Illinois State Police DNA laboratory conducts extensive validation testing on numerous DNA samples containing smaller and smaller qualities of DNA: 1000pg, 500 pg, 250 pg, 125 pg, 62 pg, 31 pg, and 15pg. Only once this validation data is analyzed can the lab assess how this single variable- sample size- effects the reliability of casework analysis. This same process is then repeated for each of the variables listed above[44], requiring a substantial commitment to good science.

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with a focus on the parameters of the number of contributors to a mixture, the ratio of contribution to a mixture, the amount of allele sharing in mixed samples, and others.).

[43] See, Frank, W., "AmpFISTR Identifiler Plus Validation Study," Illinois State Police Research and Development Laboratory.

[44] Testing must be repeated on a large enough sample size to ensure that results are not random but rather a true indicator of performance. See, Organization of Scientific Area Committees, "Human Factors in Validation and Performance Testing of Forensic Science, March 8, 2020. ("The accuracy of a method or procedure cannot be tested adequately with small numbers of test specimens, or with small numbers of examiners. Results obtained with small samples often vary greatly due to random factors. A larger sample of examiners will tend to better represent the underlying population of examiners. . .Statisticians and other experts familiar with statistical power and sample size requirements for experimental research can assist in determining the appropriate number of test specimens and examiners for validation and reliability studies."); See also, Morrison et al, "Vacuous Standards- Subversion of the OSAC Standards-developing Process," Forensic Science International: Synergy, (2020), doi:hppts://doi.org/10.1016/j.fsisyn.2020.06.005 (stating that a "validation study shall use a sufficient number of test trials to support the anticipated or ultimately claimed level of performance of the method" and further explaining that while it may be reasonable to estimate a false positive rate of 10% based on 100 false positive tests in 1000 test trials "it would not be reasonable to make the same claim based on 1 false positive from a total of 10 truly negative test trials."); See, Morrison, et al., "Consensus on Validation of Forensic Voice Comparison," Science & Justice (2021)(stating that the number of samples used to validate a forensic voice comparison method must be large enough because small validation data sets "give results that are not representative of the case conditions.").

In addition to the design consideration of representativeness, a generally accepted validation study must be designed to assess two critical metrics of forensic reliability- selectivity and specificity. The use of a categorical forensic method[45] may result in two important types of errors- false negative errors and false positive errors. False negative errors- also known as selectivity- occur when a method erroneously results in a "no match" opinion for samples that match as a matter of ground truth.[46] False positive errors- also known as specificity- occur when a method erroneously results in a "match" opinion for samples that don't share a common source as a matter of ground truth.[47] With the metrics of selectivity and specificity both representing important sources of potential forensic unreliability[48], scientifically adequate validation testing must assess both:

> "The accuracy of a method generally should not be reduced to a single percentage. It is misleading to say something like 'the study showed that examiners were 98% accurate' because accuracy is likely to vary for same-source and different-source comparisons, and because the overall rate of accuracy of a method will depend on how many same-source and different-source comparisons examiners make, the sensitivity and specificity of the method, and various other factors."[49]

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[45] Many types of forensic methods have traditionally employed a categorical approach, meaning the method results in match/no match conclusions (while also sometimes including an inconclusive conclusion option). For example, forensic fingerprint conclusions have traditionally been categorical, with examiners claiming either that a crime scene print matched or did not match a suspect (while also sometimes reaching an inconclusive opinion). ShotSpotter takes a categorical approach to gunshot audio detection, reporting either that a noise event was generated by gunfire or was not generated by gunfire.

[46] Organization of Scientific Area Committees, "Human Factors in Validation and Performance Testing of Forensic Science, March 8, 2020. ("Sensitivity refers to the probability that examiners will deem two items to be from the same source when they are from the same source. . .Sensitivity is sometimes also called the 'hit rate' or the 'true positive rate.'").

[47] Organization of Scientific Area Committees, "Human Factors in Validation and Performance Testing of Forensic Science, March 8, 2020. ("Specificity refers to the probability that examiners will deem two items to be from a different source when they are actually from different sources. . .Specificity is sometimes called the 'true negative rate' or the 'correct rejection rate.'")

[48] The proposed OSAC standard (in comment adjudication phase) in Bloodstain Pattern Analysis entitled, "Standard for the Validation of Procedures in Bloodstain Pattern Analysis," states that adequate validation of methods in this forensic discipline require the study and documentation of sensitivity, specificity, reliability, and accuracy. http://www.asbstandardsboard.org/wp-content/uploads/2019/05/072_Std_e1.pdf.

[49] Organization of Scientific Area Committees, "Human Factors in Validation and Performance Testing of Forensic Science, March 8, 2020.

For this reason, forensic scientists who sought to assess the reliability of the forensic fingerprint method in 2011 conducted a large-scale study of examiner performance and reported both the false negative rate (reported as 7.5%) and the false positive rate (reported as 0.1%).[50]

One additional important aspect of validation design is planning for re-validation. Scientists know that comprehensive testing that might adequately validate a forensic method today may not be adequate down the road when conditions change:

> "The validation process is not a one-time event for a method. It must be considered dynamic in order to assess periodically the impact of new knowledge and findings to assess material modifications made to existing methods and procedures. Indeed, monitoring and reassessment are tools to ensure that even previously validated processes remain valid if the parameters under which the process is carried out are altered."[51]

For this reason, forensic DNA labs must conduct repeat validation testing for many reasons, including when they implement a new capillary model, adopt new software, or when they introduce "modifications to any algorithm."[52] Likewise, forensic toxicologists who perform GCMS analysis on drug samples must re-validate their analytical processes when they alter their methods in even small ways.[53] Both of these examples and others[54] stand for the proposition that validation must be an ongoing process for any forensic method to remain generally accepted in the scientific community.

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[50] Ulery et al., "Accuracy and Reliability of Latent Fingerprint Decisions, PNAS, Vol. 108, p. 7733 (2011).

[51] Budoule et al., "Criteria for Validation of Methods in Microbial Forensics," Applied and Environmental Microbiology, Vol. 74, p. 5599 (2008).

[52] SWGDAM, "The Guidance Document for the FBI Quality Assurance Standards for DNA Testing and DNA Databasing Laboratories, 2020.

[53] See, American Board of Forensic Toxicology, "Forensic Toxicology Laboratory Accreditation Checklist," 2013.(stating that toxicology labs must re-validate their methods when they use a new reagent in the testing process, and further stating that "it is necessary for the laboratory to validate any modification to a commercially available immunoassay.").

[54] See, Organization of Scientific Area Committees, "Standard for the Developmental and Internal Validation of Forensic Serological Methods," 2018 ("Any change to a validated [serology] method shall be evaluated to determine if analytical results are affected. If a modification affects analytical results, the procedure shall require additional validation prior to implementation."); See also, Organization of Scientific Area Committees, "Best Practice Recommendation for Forensic DNA Software, 2018 (when modifications and updates are made to software used as critical components of a forensic DNA method, new validation testing must be performed.).

Given this generally accepted roadmap for scientifically defensible validation, the necessary components for even the most minimally acceptable ShotSpotter validation are clear. First, separate ShotSpotter validation testing would need to be conducted by ShotSpotter Inc. (developmental validation) and the Chicago Police Department (internal validation). Second, this validation would have to assess the important variables that are known to affect the reliability of noise detection systems, including:

- Distance from gunshot to microphone.[55]
- Angle of gunshot to microphone.[56]
- Line-of-sight or non-line of sight status between gunshot and microphone.[57]
- Level of environmental noise.[58]

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[55] Ryan Lilien, "Development of Computational Methods for the Audio Analysis of Gunshots," U.S. Department of Justice, 2019. ("If the blast is close to the recording device, the volume of the blast may overwhelm the recorder resulting in saturation and spectral information loss."); See also, Beck, Nakasone and Marr, "Variations is Recorded Acoustic Gunshot Waveforms Generated by Small Firearms." Journal of the Acoustical Society of America, 2011 (Figures 1 and 6 show variations in gunshot waveforms due to distance from gunshot to microphone).

[56] Ryan Lilien, "Development of Computational Methods for the Audio Analysis of Gunshots," U.S. Department of Justice, 2019. ("Secondary factors affect the recorded sound. . .the muzzle blast is highly directional, dependent on the azimuth angle formed between the muzzle direction and recording device.); See also, Beck, Nakasone and Marr, "Variations is Recorded Acoustic Gunshot Waveforms Generated by Small Firearms." Journal of the Acoustical Society of America, 2011 (Figure 8 shows variations in gunshot waveforms due to azimuth angle between gunshot and microphone); See also, Beck, Nakasone, and Marr, "An Introduction to Forensic Gunshot Acoustics," 162nd Meeting of the Acoustical Society of America, November 3, 2011 ("the difference in level and waveform details between on-axis and off-axis recordings of the same firearm are often significantly greater than the difference between two firearm types at the same azimuth."); See also, Maher, "Advancing Audio Forensics in Gunshot Acoustics," U.S. Department of Justice, 2018 (reporting the results of live fire testing where gunshots located directly behind a microphone are not detected even when the fired gun and microphone were in close proximity to each other).

[57] Aguilar, "Gunshot Detection Systems in Civilian Law Enforcement," Journal of the Audio Engineering Society, 2015 ("Once a possible gunshot has been detected, the next step is to discriminate if the signal corresponds to an actual gunshot or if it constitutes a different type of high-amplitude impulse sound. This could be quite a problematic task and very susceptible to environmental issues such as background noise, acoustic multipath, and NLOS condition. The performance of gunshot discrimination algorithms directly impacts system false positive detection rates. . . environmental issues affecting muzzle blast propagation in the outdoors imposes severe shortcomings on the accuracy of shooter location estimates. Most significant are the high sensitivity of gunshot detection algorithms to NLOS conditions, acoustic multipaths, background noise, and wind. ").

[58] Freire, Apolinario, "Gunshot detection in noisy environments," 7th International Telecommunications Symposium, 2010 (Table III shows that noisier environments create more false positive errors for gunshot detection systems); See also, Renda, Zhang, "Comparative Analysis of Firearm Detection Recorded by Gunshot Detection Technology and Calls for Service in Louisville, Kentucky," International Journal of Geo-Information, 2019 ("Heavily noisy environments, such as real-world urban settings, have been shown to affect GDT effectiveness where up to 9% of

- The make and model of the gun, along with the type of ammunition discharged.[59]
- Density and variation of urban structures and landscape.[60]
- Time of day (daytime v. nighttime).[61]
- Weather conditions such as temperature, rain, thunder, and wind.[62]

Looking at only the variable of the angle of the gunshot to the microphone sensor (often called azimuth), this one variable can have dramatic effect on the ability of a system like ShotSpotter to capture reliable soundwave data. In the image below depicting soundwaves from the test-firing of a handgun surrounded by sensors, the sensor that was located in front of a gunshot captured

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actual gunfire is not detected and approximately 25% of non-gunfire events with a similar acoustic signature,. i.e., balloon popping and hand clapping, were falsely identified as gunfire.).

[59] Ryan Lilien, "Development of Computational Methods for the Audio Analysis of Gunshots," U.S. Department of Justice, 2019. ("The recording is also influenced by the firearm make/model, caliber, and ammunition type. Each device has a frequency response that describes how efficiently the device captures sound at different frequencies.") See also, Maher, Shaw, "Directional Aspects of Forensic Gunshot Recordings," AES 39th International Conference, Hillerod, Denmark, 2010 ("The on-axis waveforms for the ten firearms are shown in Figure 12 with the same amplitude scale for each waveform. . .For visual examination, the gunshot waveform features show noticeably different and distinct waveshapes.").

[60] Maher, Routh, "Wideband audio recordings of gunshots: waveforms and repeatability," Audio Engineering Society Convention Paper (Los Angeles, CA), 2016 ("The muzzle blast acoustical characteristics depend upon the type and size of the firearm, the characteristics of the ammunition, the direction with respect to the barrel axis, the presence of acoustical reflections from nearby surfaces, and diffraction from nearby obstacles."); See also, Aguilar, "Gunshot Detection Systems in Civilian Law Enforcement," Journal of the Audio Engineering Society, 2015 ("The presence of surrounding buildings that compose the urban landscape also affects the muzzle blast propagation phenomena as it introduces multipath distortion, acoustic diffraction, and non-line-of-sight (NLOS) conditions between shooter and sensor locations.") See also, Embleton, "Tutorial on sound propagation outdoors," Journal of the Acoustical Society of America, 1996 ("asphalt and grass-covered grounds have different effects on those parts of a sound field that propagate near the ground surface. It is necessary to be able to categorize these and other commonly occurring ground surfaces such as concrete, snow, or earth in order to be able to predict their effects.").

[61] Renda, Zhang, "Comparative Analysis of Firearm Discharge Recorded By Gunshot Detection Technology and Calls for Service in Louisville, Kentucky," International Journal of Geo-Information, Vol. 8, p. 275 (2019)(reporting that "the accuracy and sensitivity of GDT to detect actual gunfire has been shown to vary spatially and temporally, with better performance at nighttime and with increased density of sensors.").

[62] Ryan Lilien, "Development of Computational Methods for the Audio Analysis of Gunshots," U.S. Department of Justice, 2019. ("Finally, the audio is susceptible to environmental conditions (temperature, humidity, wind) and scene geometry (absorption, reflection, focusing)"); See also, Nikolaos, "Recording and Calculating Gunshot Sound-Change of the Volume in Reference to the Distance," American Institute of Physics Conference Proceedings, 2010 ("There are several different factors which influence the volume of the gunshot intensity, [such] as the following: the length of the gun barrel (the shorter the barrel, the louder the sound), the powder of the ammunition that is used for the fire, the speed/direction of the wind."); See also, Embleton, "Tutorial on sound propagation outdoors," Journal of the Acoustical Society of America, 1996 ("Wind and temperature gradients in the atmosphere cause refraction with can either increase or decrease sound pressure levels significantly.").

a waveform (top waveform at .03 degrees) which is very characteristic of impulsive shooting events while the sensor located behind the very same gunshot captured a waveform (bottom waveform at 180 degrees) that is not recognizable as a gunshot in any way[63]:

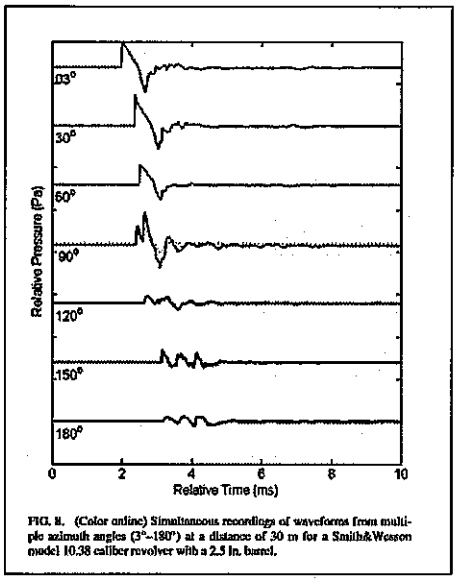

FIG. 8. (Color online) Simultaneous recordings of waveforms from multiple azimuth angles (3°–180°) at a distance of 30 m for a Smith&Wesson model 10.38 caliber revolver with a 2.5 in. barrel.

Successful ShotSpotter validation testing of just this one variable- azimuth- would require live-fire testing to document the effects of azimuth on the performance of ShotSpotter systems in urban environments. Once this testing was completed, proponents of ShotSpotter would then have to conduct similar testing on the other variables listed above. Third, ShotSpotter validation would need to assess both the selectivity and the specificity of deployed systems.[64] ShotSpotter (both the secret algorithm and the human examiner) may dismiss a noise as non-gunfire when it actually originated from the firing of a gun (a false negative error) or may report a noise as gunfire when it did not originate from a gun (a false positive error). While validation testing must be designed to assess both of these types of errors, an assessment of ShotSpotter's false positive

[63] Beck et al., "Variations in Recorded Acoustic Gunshot Waveforms Generated by Small Firearms," Journal of the Acoustic Society of America, Vol. 129, p. 1748 (2011)(showing the differing waveforms captured by sensors at various azimuths from the gunshot when all sensors are located only 30 meters from the shot location).

[64] Because ShotSpotter claims not only to be able to identify a noise event as originating from a gunshot but also to be able to accurately locate the noise event, successful validation of ShotSpotter would have to assess a third form of error- uncertainty in location decisions. In fact, the scientific theories that form the basis of location decisions are distinct from those that form the basis of identification decisions. Therefore, validation of system identification performance would not provide any insight into system location performance.

rate is especially critical given the multitude of innocent environmental noises that are known to trigger ShotSpotter false alerts, including:

- firecrackers[65]
- car backfires[66]
- loud mufflers[67]
- jack hammers[68]
- nail guns[69]
- manual hammer strikes[70]
- truck downshifting[71]
- helicopter noises[72]
- college campus noises[73]
- many other urban sounds.[74]

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[65] Broward County Sun-Sentinel, "Broward Sheriff Dropping Gunshot Detection System," November 22, 2011 (Broward County Sheriff quit using ShotSpotter because the system was "picking up noises such as firecrackers or a backfiring car and registering those sounds as gunfire. The sensors were also triggered by helicopters and the roar of downshifting trucks from nearby Interstate 95.").

[66] See, Broward County Sun-Sentinel, "Broward Sheriff Dropping Gunshot Detection System," November 22, 2011.

[67] Attachment C- Testimony of Paul Green, Trial of Michael Reed, San Francisco, California, July 6, 2017, p. 113.

[68] See, Grant, "ShotSpotter Sends SDPD Officers to False Alarms More Often Than Advised," Voice of San Diego, September 22, 2020; See also, Attachment B and C- Testimony of Paul Greene, Trial of Michael Reed, San Francisco, California, July 5-6, 2017, p. 20, 113.

[69] See, Grant, "ShotSpotter Sends SDPD Officers to False Alarms More Often Than Advised," Voice of San Diego, September 22, 2020; See also, Kara Grant, "ShotSpotter Sensors Send SDPD Officers to False Alarms More Often then Advertised," Voice of San Diego, September 22, 2020.

[70] See, Grant, "ShotSpotter Sends SDPD Officers to False Alarms More Often Than Advertised," Voice of San Diego, September 22, 2020; See also, Kara Grant, "ShotSpotter Sensors Send SDPD Officers to False Alarms More Often then Advertised," Voice of San Diego, September 22, 2020.

[71] Attachment C- Testimony of Paul Green, Trial of Michael Reed, San Francisco, California, July 6, 2017, p. 113.

[72] Attachment A- Testimony of Paul Greene in the Silvon Simmons case, Rochester, New York, October 17, 2017, p. 36-39.

[73] Times Union, "Troy Will Turn Off ShotSpotter," 2012.

[74] "Detailed Forensic Report Certification" of Simone Ellison, March 4, 2017, Customer Reference # 301714144 ("SST, Inc., does not guarantee 100% detection because real world, urban environments may contain intervening buildings, topography, foliage, periods of increased traffic or construction noise, and other urban acoustic noises that may either prevent the sound of a gunshot form being detected by the sensor(s), or may change or modify the audio characteristics of the sound of a gunshot so that it no longer matches the sensor(s) detection parameters.").

Fourth, after this comprehensive testing is completed and documented, ShotSpotter and the Chicago Police Department would have to repeat this validation process when important changes to the system occurred, such as software updates, source code alterations, changes in sensor models, and other such changes. This comprehensive testing (both the original validation testing and any necessary retesting) would then form the basis both for ShotSpotter operating protocols (defining when ShotSpotter can reliably identify and locate a shooting event) and for assessments of general acceptance and reliability in the criminal justice system when prosecutors seek to introduce ShotSpotter evidence in criminal trials.

D. ShotSpotter and the Chicago Police Department have both ignored their scientific obligation to conduct validation testing, with ShotSpotter instead resorting to empty marketing claims that mislead the public about system reliability.

Neither ShotSpotter nor the Chicago Police Department have conducted the validation testing necessary to provide a scientifically defensible assessment of the reliability of the system deployed in Chicago and at issue in this case. ShotSpotter has admitted that no internal validation whatsoever has been done for the system deployed in Chicago.[75] This means that not only have ShotSpotter and CPD ignored generally accepted scientific standards for forensic method development, the prosecution in this case cannot present this court with a single witness who can testify to the level of unreliability of the ShotSpotter system at issue in this case. This failure alone should be dispositive of the question of ShotSpotter's admissibility. But ShotSpotter's failure extends to developmental validation as well because ShotSpotter has never conducted any developmental validation to assess the false positive rate (and other important attributes of the ShotSpotter method) of its system prior to marketing them to unwitting police departments such as the Chicago Police Department. There should not be a jurisdiction anywhere in the U.S. where this record of scientific failure results in admissible evidence in criminal cases.

There is every indication that unwitting police departments are suffering the consequences of unreliable ShotSpotter noise detection systems deployed without validation testing. Most importantly, operational data points to a troubling false alert problem with

[75] Attachment G- Letter from ShotSpotter Vice-President Mike Will dated April 8, 2021, where he states that "no live fire DQV testing was performed in any district as part of [the service with the Chicago Police Department."

deployed ShotSpotter systems. In 2016, Forbes Magazine obtained a massive database of ShotSpotter response data (totaling over 25,000 individual alerts from seven U.S. cities) and determined that the huge majority of ShotSpotter alerts sent police racing to scenes where they encountered zero evidence of an actual gun crime- no victim, no witnesses, no bullet holes, no fired casings, no blood, nor any other indicator of a real gunfire event.[76] A similar study in Chicago found that 90% of ShotSpotter alerts are likewise unfounded.[77] For this very reason- an overwhelming number of false alerts- police agencies around the country have abandoned their ShotSpotter systems despite millions of dollars of taxpayer money invested in deployed systems:

- Broward County (Florida) Sheriff Department: In 2011, the Broward County Sheriff's abandoned their $500,000 investment in ShotSpotter after discovering that the system "was wasting too much manpower sending deputies to false alarms" generated by firecrackers, car backfires, and other innocent sources.[78]
- Troy (New York) Police Department: In 2012, the Troy Police Department ditched ShotSpotter after determining that the microphone system "wasn't reliable," the system generated false alerts from innocent noises on a college campus, and 911 calls did a better job at identifying true gunshot events.[79]
- Fall River (Massachusetts) Police Department: In 2018, the Chief of Police for Fall River, Massachusetts, stopped paying ShotSpotter $120,000/year after determining that "ShotSpotter had reported too many false alarms of gunfire while missing actual shot-fired incidents in Fall River." The ShotSpotter system worked "less than 50 percent of the time."[80] The disappointed Chief of Police reported that "the city was told that the system was capable of doing things it just couldn't do."
- Charlotte (North Carolina) Police Department: In 2016, the Charlotte Police Department discontinued its use of ShotSpotter after determining that the "gunshot detection system didn't help them make arrests or identify crime victims." In fact, Charlotte police who responded to the alerts were "unable to find evidence of a gun being fired" for all 41 ShotSpotter alerts sent to the police.[81]

[76] Drange, "ShotSpotter Alerts Police to Lots of Gunfire But Produces Few Tangible Results," Forbes Magazine, November 17, 2016 (for instance, the Milwaukee ShotSpotter system reported 10,000 alerts for gunfire between 2013 and 2015 but 7000 of those alerts (70%) were "unfounded," meaning officers encountered no evidence of actual gunfire 70% of the time).

[77] Wasney, "The Shots Heard Around the City: Are Chicago's New Shot Detection and Predictive Policing Technologies Worth It?," South Side Weekly, December 19, 2017.

[78] Broward County Sun-Sentinel, "Broward Sheriff Dropping Gunshot Detection System," 2011.

[79] Times Union, "Troy Will Turn Off ShotSpotter," 2012.

[80] The Herald News, "After Too Many Shots Missed, Fall River, Mass, Ends Deal with ShotSpotter," 2018.

[81] The Charlotte Observer, "Charlotte Ends Contract With ShotSpotter Gunshot Detection System," 2016.

- San Antonio (Texas) Police Department: In 2017, the San Antonio Police Department ditched ShotSpotter after discovering that the microphone system did not work because "police could not find evidence of a shooting at the scene about 80 percent of the time" and after identifying five shooting victims in ShotSpotter zones which the system failed to detect.[82]

Even police agencies that have chosen to maintain ShotSpotter systems despite evidence of a massive false alert problem report in survey data that false alerts "are the single most common complaint of ShotSpotter users and they pose an operational problem."[83]

Should this Court need additional evidence of ShotSpotter's substandard approach to forensic method development and the many flaws with their noise detection system, the attached expert report[84] of John Hansen[85] contains a detailed critique of ShotSpotter. After an extensive review of the present state of ShotSpotter technology, Professor Hansen informs this Court of the following:

- "Unfortunately, gunshot acoustic detection and classification has a little to non-existing research community with no formal standards for validity testing, unlike speaker recognition."
- "There is a severe lack of independent evaluation of [gunshot detection systems] in terms of detection performance and even less for location performance."
- "Urban spaces including buildings/structures, or situational acoustic spaces, evolve over time/years, so true performance values cannot be known without regular tests."
- "Without effective setup calibration, and regular testing, the viability of ShotSpotter Detection and Location performance cannot be accurately known."
- "The fact that ShotSpotter employs their analysts with limited/no actual formal forensic training, and no academic background in the field, and are instructed to perform 'post-processing' to manually modify automatic system output to produce what is perhaps their opinion on data, it is very troubling if this is to be used in any legal context."
- "The current ShotSpotter technology and human-in-the-loop determination of output events, the limited company performance studies [with] a lack of transparency, and the lack of sufficiently rigorous independent evaluations of the deployed systems in actual

[82] The San Antonio Express-News, "San Antonio Police Cut Pricey Gunshot Detection System, 2017.
[83] Shelby et al., "ShotSpotter Gunshot Location System Efficacy Study," CSG Analysis (2011).
[84] Attachment H- Expert Report of John Hansen.
[85] John Hansen is a Professor in the Department of Electrical and Computer Engineering at the University of Texas at Dallas, the Associate Dean for Research of the Erik Jonsson School of Engineering and Computer Science, an IEEE Fellow, founder of The Center for Robust Speech Systems at UT Dallas, recipient of The Acoustical Society of America's "25 Year Award," author of over 100 peer-reviewed journal articles, and the recipient of millions of dollars of scientific research grants from the U.S. Air Force, DARPA, Samsung, the National Science Foundation, and many other grant sources. His curriculum vitae is attached at Attachment I.

urban locations, all call into question how this technology could be introduced as reliable evidence."

- "The main recommendations here are that [gunshot detection system] technology is still not a mature domain in the field of forensics. There are little if any formal standards for independent testing, calibration, and performance benchmarking."

These conclusions and others by Professor Hansen highlight the many flaws with the ShotSpotter method and the tremendous amount of uncertainty about the reliability of deployed systems.

Faced with this reality- no meaningful validation testing data, mounting operational data showing a massive false alert problem, and a questionable business model that places forensic analysis in the hands of customer service representatives- one could expect that ShotSpotter would be very cautious about any performance claims it makes about its deployed systems. But to the contrary, ShotSpotter has continuously issued false claims about system reliability and the impact that ShotSpotter systems have on urban crime rates. For instance, in marketing materials on ShotSpotter's website, they make this misleading claim[86]:

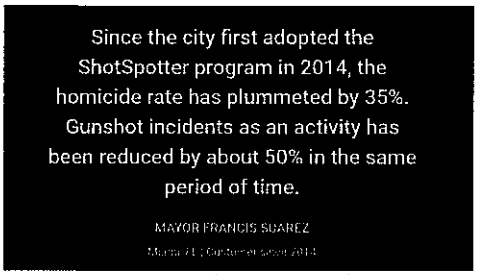
> **5. How accurate is ShotSpotter's gunshot detection solution?**
>
> **The ShotSpotter system is highly accurate at detecting outdoor gunshots. In 2019 the system had a 97% aggregate accuracy rate across all of our customers including a very small false positive rate of less than 0.5% of all reported gunfire incidents.**

Besides the simple scientific truth that ShotSpotter system accuracy cannot be determined in the absence of comprehensive validation data, these ShotSpotter accuracy claims are nonsense for additional reasons. For one, because ShotSpotter claims to be able to both identify gunshot events and accurately locate them, ShotSpotter does not have an "aggregate accuracy rate" but rather at least three accuracy rates that matter- a false negative rate, a false positive rate, and the rate at which the system mis-locates gunfire events. There exists no scientifically defensible way to aggregate these different forms of error into one "accuracy" rate. Separately, ShotSpotter's claim of a "very small false positive rate of less than 0.5%" is nothing less than scientific fraud due to the fact that ShotSpotter has never conducted a valid study of its false positive problem. Given this record of scientific failure, it should come as no surprise that a

[86] ShotSpotter Respond FAQ, December 2020. https://www.shotspotter.com/wp-content/uploads/2020/12/ShotSpotter-Respond-FAQ-Dec-2020.pdf.

ShotSpotter employee has testified under oath that ShotSpotter accuracy claims were "put together by our sales and marketing department, not our engineers."[87]

When not generating misleading accuracy claims, ShotSpotter's sales and marketing department has referenced overall long-term crime trends that have nothing to do with ShotSpotter as alleged proof that ShotSpotter is reliable and effective. For example, below is a screen shot of a marketing claim from the ShotSpotter website:



In similar marketing materials, under a heading entitled, "Do you have any supporting data to show that your technology helps reduce gunfire in coverage areas," ShotSpotter claims that cities that have deployed their noise detection systems "have experienced up to an 80% reduction in gunfire and as much as a 40% reduction in related violent crimes and homicides."

These marketing claims in no way represent real indicators of ShotSpotter performance. First, these marketing claims are based on crime trend data that does not isolate ShotSpotter impact in any way. Because all crime trends (including shooting events) in the U.S. have been on a downward path for the past three decades for complex reasons that have nothing to do with ShotSpotter[88], it is nothing more than a marketing ploy for ShotSpotter to attempt to take credit for these trends. Second, the two truly scientific assessments of the impact of gunshot detection systems on crime do not support these marketing claims in any way.[89] The authors of one such

[87] Attachment J- Testimony of Paul Greene, Trial of Michael Reed, San Francisco, California, July 10, 2017, p. 311.
[88] https://www.pewresearch.org/fact-tank/2019/10/17/facts-about-crime-in-the-u-s/
[89] To separate out the effects of overall crime reduction from the impact of ShotSpotter deployment, scientists must compare ShotSpotter coverage areas with control group areas (similar neighborhoods which do not have deployed ShotSpotter systems). Only one published study has undertaken this rigorous analysis, by comparing neighborhoods in St. Louis that were covered by ShotSpotter systems to neighborhoods that weren't. See, Mares, Blackburn, "Acoustical Gunshot Detection Systems: A Quasi-Experimental Evaluation in St. Louis, MO," Journal of Experimental Criminology, 2020.

study found that, after comparison with control neighborhoods, ShotSpotter deployment resulted in "no reductions in serious violent crime."[90] In fact, the authors found that traditional citizen 911 calls were seven times more efficient than ShotSpotter alerts in leading to actionable evidence of a crime scene.[91] The authors concluded that there is little evidence to support ShotSpotter claims that their noise detection systems are "productive in uncovering crimes or criminals."[92] In the second study, researchers compared control areas in Philadelphia with areas surrounded by gunshot detection sensors and found that the gunshot detection sensors only resulted in an explosion of false-alert investigations by officers, not more efficient police investigations[93]:

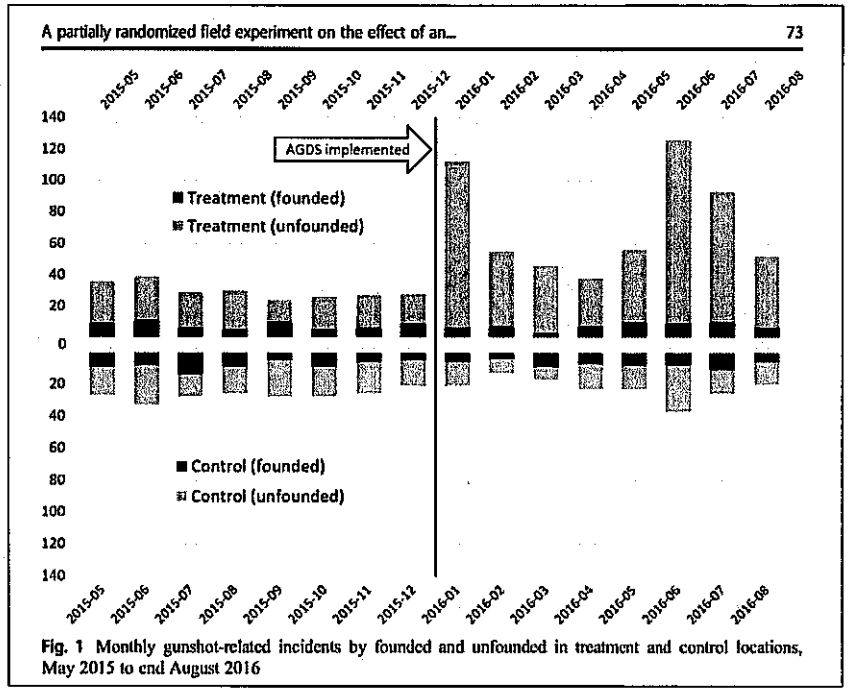


Fig. 1 Monthly gunshot-related incidents by founded and unfounded in treatment and control locations, May 2015 to end August 2016

These researchers concluded that "[p]olice workload increased [in areas with gunshot sensors] but without an associated increase in founded incidents."[94] Given these studies and the lack of

[90] Mares, Blackburn, "Acoustical Gunshot Detection Systems: A Quasi-Experimental Evaluation in St. Louis, MO," Journal of Experimental Criminology, 2020, p. 1.
[91] Id. at 8-9.
[92] Id. at 14.
[93] Ratcliffe et al., "A Partially Randomized Field Experiment on the Effect of an Acoustic Gunshot Detection System on Police Incident Reports," Journal of Experimental Criminology, Vol 15, p. 67 (2018).
[94] Id.

any scientific basis for ShotSpotter's performance claims, the defense has confidence that this Court will not be fooled into accepting these marketing tricks as legitimate substitutions for rigorous scientific method development through validation.

E. General acceptance in the scientific community of an algorithm-based forensic tool requires an additional and important type of validation- software validation- and there is no evidence that ShotSpotter has complied with this scientific obligation.

While the validation process described above- determining false positive and negative rates through testing of a sufficient quantity and quality of validation samples- suffices to validate forensic techniques that are not reliant on computer algorithms for the manipulation of data, algorithm-based forensic methods require an entirely separate layer of validation: software validation.[95] Separate software validation is an industry requirement because software can fail in very unexpected ways and can operate with covert biases.[96] In the criminal justice system,

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[95] Forensic Science Regulator, "Software Validation for DNA Mixture Interpretation," 2020 (stating that "ensuring that software is fit for purpose cannot be achieved simply by testing the software once it has been written. Software must be developed within a quality framework to ensure that the end result has been developed to the required standard, ideally through an iterative process of development, testing, and error correction.").

[96] See, Andrea Roth, "*Machine Testimony*," 126 Yale L. Journal 1972, 1994-95 (2017) ("Therac-25, a computer-controlled radiation therapy machine...'massively overdosed' six people in the 1980s based on a software design error"); See also, Shepardson, "Federal Regulators are Reviewing 23 Tesla Crashes After a Spate of Wrecks Possibly Involving Autopilot," Reuters, March 18, 20201 (reporting that the NHTSA is investigating numerous crashes of Telsa cars while operating during computer-assisted driving with "Autopilot."); See also, Halfon, "Uber's Self-Driving Car Killed Someone- Why Isn't Uber Being Charged," Slate, October 20, 2020 (reporting that a self-driving Uber car killed a pedestrian when the algorithm controlling the car operation mistook a woman for an inanimate object and overrode sensors that detected her presence six seconds before she was struck and killed); See also, James Gleik, "*Little Bug, Big Bang*," N.Y. TIMES MAGAZINE (Dec. 1, 1996) (discussing coding error that led to the crash of the $7 billion Ariane 5 rocket); See also, Stephanie J. Lacambra *et al.*, "*Opening the Black Box: Defendants' Rights to Confront Forensic Software*," 42 CHAMPION 28 (2018) (discussing coding problems of a probabilistic genotyping program, the Forensic Statistical Tool, that unfairly favored the prosecution); See, also, *In re Source Code*, 816 N.W.2d 525, 528 & 543 (Minn. 2012) (reporting that defense attorney access to source code revealed errors impacting reliability of Intoxilyzer breath test); See also, New Jersey v. Chun, 943 A.2d 114, 119 (N.J. 2008) (discussing series defects in source code for the Alcotest breath-testing device and ordering changes); See also, Simonite, "Meet the Secret Algorithm That's Keeping Students Out of College," Wired Magazine, July 10, 2020 (reporting that some students lost college scholarships and others reported incorrect scoring when The International Baccalaureate program used a computer algorithm to grade student performance); See also, Griffith, "10 Embarrassing Algorithm Fails, PC Magazine, September 23, 2017 (reporting that Tesla issued upgrades to their autonomous driving car computer code after a Telsa owner crashed into a tractor-trailer while in autonomous mode); See also, Angwin et al., "Facebook Enabled Advertisers to Reach 'Jew Haters,'" ProPublica, September 14, 2017 (reporting how a flaw in Facebook algorithms allowed advertisers to locate potential customers and direct sales pitches through search terms such as 'Jew hater' and 'How to burn Jews.'"); See also, Bushwick, "How NIST Tested Facial Recognition Algorithms for Racial Bias," Scientific American, December 27, 2019 (reporting that scientists at the National Institute for Standards and Technology tested 189 facial recognition algorithms and found that many of the algorithms were biased against people of color- producing significantly more accurate results when tested on Caucasian faces than on Black faces);

faulty computer code has already been a major problem: an error with a DNA interpretation algorithm resulted in incorrect interpretations in at least 60 cases[97], two different DNA interpretation algorithms generated opposite results in a murder case in New York when interpreting the same evidence[98], and a law enforcement computer algorithm designed to predict gun violence that was advertised as 75% accurate was so riddled with error as to be unusable.[99] In fact, as one scientist who has developed his own forensic algorithm for DNA interpretation explains, it is "absolutely inconceivable" that any complex forensic algorithm would be free of coding errors.[100] So while assessing false positive and negative rates through developmental and internal validation provides some insight into software performance, such testing is by its nature limited and cannot substitute for the safeguards which accompany scientifically-rigorous software development.[101]

Those who would seek to develop forensic algorithms need not hunt around in the dark for validation guidance because "decades of experience with software failures have [in fact] led to established practices for what is known as verification and validation of software."[102]

See also, Albanesius, "Google Explains Racist Maps Results," PC Magazine, May 21, 2015 (the Google map algorithm failed in an unintended way during the Obama administration when a search of the term "n*****king" returned results which directed users to the White House.); See also, Pringle, "When Algorithms Go Bad: Online Failures Show Humans are Still Needed," CBC News, October 1, 2017 (reporting that when Amazon users innocently selected a certain item for purchase, the Amazon algorithm unexpectedly offered users the chance to purchase the additional items that could be combined to make a home-made explosive device.); See also, Manancourt, "UK to End Controversial Visa screening Algorithm," Politico, August 4, 2020 (reporting that England discontinued the algorithm used to screen visa applications when it was discovered to discriminate based on nationality.).

[97] Murray, "Queesland Authorities Confirm 'Miscode' Affects DNA Evidence in Criminal Cases," The Courier Mail, March 20, 2015.

[98] https://www.cybgen.com/information/newsroom/2016/sep/Hillary-acquitted-of-Potsdam-murder-by-New-York-judge.shtml.

[99] Burgess, "Police Built an AI to Predict Violent Crime. It was Seriously Flawed," Wired, August 6, 2020.

[100] Ward, "Legal Question: How do you cross-examine a computer?," Pittsburgh Post Gazette, August 28, 2016.

[101] By way of example, the developers of STRMix, the computer algorithm designed to interpret forensic DNA evidence, have published dozens of studies in peer-reviewed journals (a process completely ignored by ShotSpotter developers) detailing false positive/negative assessments, as well as detailing the performance of their system across numerous other types variables that could affect performance: multiple contributor numbers, low template DNA, allelic dropout, artifact identification, DNA peak height variability, the effects of close relatives on DNA interpretation, and others. https://www.strmix.com/strmix/published-data/. Despite this substantial body of peer-reviewed developmental validation data, the admissibility of STRMix results in criminal trials required the additional process of software validation. See, U.S. v. Lewis, 442 F.Supp.3d 1122 (MN. D. C. 2020)(holding STRMix admissible because its software validation scheme complied with several recognized software validation standards, including written standards by SWGDAM, the Forensic Science Regulator, and the International Society for Forensic Genetics.).

[102] Adams *et al.*, *"Appropriate Standards for Verification and validation of Probabilistic Genotyping Systems,"* 63 J. For. Sci. at 339.

Promulgated by, among other organizations, the Institute of Electrical and Electronics Engineers ("IEEE"),[103] these standards call for rigorous attention to, and investment in, the process of evaluating computer code to determine "through the provision of objective evidence, that the requirements for a specific intended use or application have been fulfilled," with a focus on "review of both the software product itself [the code or binary equivalent] and...the software development processes undertaken during the development of that product."[104] Through this process, code developers can "find defects and [] determine if required functions and attributes are built into the software system."[105]

Several IEEE standards describe the type of documentation and procedures that software engineers would demand of any noise detection algorithm used as evidence in criminal cases.[106] Most importantly, for algorithms deployed in arenas where the consequences of malfunction may result in "loss of human life...or extensive financial or social loss" (a definition that must apply to the potential for wrongful convictions), IEEE standards mandate a verification and validation process that is independent from developers of the forensic algorithm- with code validation conducted by an organization that is not affiliated with the developers and that has a

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[103] This Court should treat standards from the IEEE as authoritative and as representative of the views of the software engineering community. *See e.g., Electro-Mechanical Corp. v. Power Distribution Prods.*, 894 F. Supp. 2d 798, 807 (W.D. Va. 2012) (referring to an IEEE dictionary standard as "a well-regarded reference"). Multiple private and governmental organizations recognized and adopted such standards, including the Food and Drug Administration, the Department of Defense, the Nuclear Regulatory Commission, and the International Organization for Standardization ("ISO"), *See* Transcript of Proceedings, United States v. Gissantaner, No. 1:17-cr-130, at 135-37 (May 24, 2018). Even in the forensic context, the International Society of Forensic Genetics has adapted certain IEEE standards for use in validating probabilistic genotyping programs. *See* Coble, "*DNA Commission of the International Society for Forensic Genetics: Recommendations on the validation of software programs performing biostatistical calculations for forensic genetics applications*," 25 For. Sci. Int'l Genetics at 192. And the United Kingdom's Forensic Science Regulator (a division of that nation's Home Office set up to "ensur[e] that the provision of forensic science services across the criminal justice system is subject to an appropriate regime of scientific quality standards," *see* https://www.gov.uk/government/organisations/forensic-science-regulator), has gone even further by urging almost wholesale compliance with IEEE standards. *See* Forensic Science Regulator, "*Guidance: DNA Mixture Interpretation Software*," at 11, 26-28.

[104] Adams, "What Does Software Engineering Have to do With DNA," 42 Champion 58 (2018).

[105] Choi, "Software Verification and Validation Plan," Carnegie Mellon University, 2003.

[106] *See* IEEE, "*Std. 2012-2016 Standard for System, Software, and Hardware Verification and Validation*," (2016); IEEE, "*Std. 730-2014 Standard for Software Quality Assurance Processes*," (2014); IEEE, "*Std. 829-2008 Standard for Software and System Test Documentation*," (2008); IEEE, "*Std. 12207-2017 International Standard - Systems and software engineering -- Software life cycle processes*," (2017); IEEE, "*Std. 24765-2017 International Standard - Systems and software engineering--Vocabulary*," (2017).

budget that is likewise independent of the developers.[107] In addition to independent assessment, algorithmic validation requires a written verification and validation plan that "shall describe the project life cycle and milestones and shall summarize the schedule of V&V tasks and task results as feedback to the development, organizational project-enabling, and supporting processes."[108] This written plan must also "summarize the V&V resources, including staffing, facilities, tools, finances, and special procedural requirements" and "describe a method of reporting and resolving anomalies."[109] These requirements of generally accepted software development, plus the many others embodied in the IEEE standards, place a significant responsibility on code developers to act responsibly when developing new computer algorithms for use in the criminal justice system.

While discovery thus far in this matter has not involved production by ShotSpotter of its computer code, there are many red flags that already point to problems with ShotSpotter's source code. In addition to the massive false alert problem described above (which, of course, results from failures of ShotSpotter code), ShotSpotter has admitted to other code problems in mandatory filings with the Securities and Exchange Commission. While exhibiting a level of candor in these SEC filings that ShotSpotter has never displayed in the criminal justice system, ShotSpotter admits in their SEC disclosures that "[b]ecause our software is complex, undetected errors, failures or bugs may occur."[110] Regarding their software, ShotSpotter additionally admits that:

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[107] Adams *et al.*, "*Appropriate Standards for Verification and validation of Probabilistic Genotyping Systems*," 63 J. For. Sci. at 339 (noting that IEEE describes "three distinct dimensions of independence," technical, managerial, and financial, and defines them respectively as, "utilizing personnel who are not involved in the development of the software...V&V responsibilities are administered by an organization that is separate from the organizations that develop and manage the software system...V&V budget be vested in an organization independent of the development organization"); See also, President's Council of Advisors on Science and Technology, "Forensic Science in Criminal Courts: Ensuring Scientific Validity of Feature-Comparison Methods," 2016 (stating that validation assessments of algorithms used in DNA probabilistic genotyping "should consist of studies by multiple groups, not associated with the software developers.")

[108] Institute of Electrical and Electronics Engineers, "IEEE Standard for System, Software, and Hardware Verification and Validation," 2016, p. 183.

[109] Institute of Electrical and Electronics Engineers, "IEEE Standard for System, Software, and Hardware Verification and Validation," 2016, p. 184-185.

[110] https://ir.shotspotter.com/quarterly-reports/content/0001564590-20-052562/0001564590-20-052562.pdf.

> "Our software is often installed and used with different operating systems, system management software, and equipment and networking configurations, which may cause errors or failures of our software or other aspects of the computing environment into which it is deployed. In addition, deployment of our software into computing environments may expose undetected errors, compatibility issues, failures or bugs in our software."[111]

And rather than the risk of computer-related errors being hypothetical, ShotSpotter admits to the SEC that it has experienced a range of "performance issues" including "software errors"[112] and further admits that the deployment of ShotSpotter systems in the field "may expose undetected errors, compatibility issues, failures or bugs in our software."[113] Finally, ShotSpotter admits that they sometimes lack the capacity to "identify the cause or causes of these performance problems within an acceptable period of time."[114] In light of these corporate admissions and the known problems with false ShotSpotter alerts, this Court should not admit ShotSpotter alert evidence until such time as the Cook County State's Attorney Office can establish general acceptance of the steps taken to verify and validate ShotSpotter's questionable computer code.[115]

F. ShotSpotter's method also involves human examiners and there is nothing generally accepted about the way that ShotSpotter combines untrained personnel and absurd "protocols" when giving these employees the forensic task of overruling the determinations of their secret algorithm.

The final component of the ShotSpotter method is supposed to involve human expertise, but this part of ShotSpotter's method is hopelessly flawed and not generally accepted in any scientific community. In this part of ShotSpotter's method, human examiners are given the task of reviewing the determinations of the ShotSpotter algorithm (both the determination of whether a noise event originate from gunfire and the location determination for the noise event), rejecting these determinations, and substituting their own subjective judgments. This human method played a dramatic role in Mr. Williams arrest and prosecution when a ShotSpotter

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[111] Id.

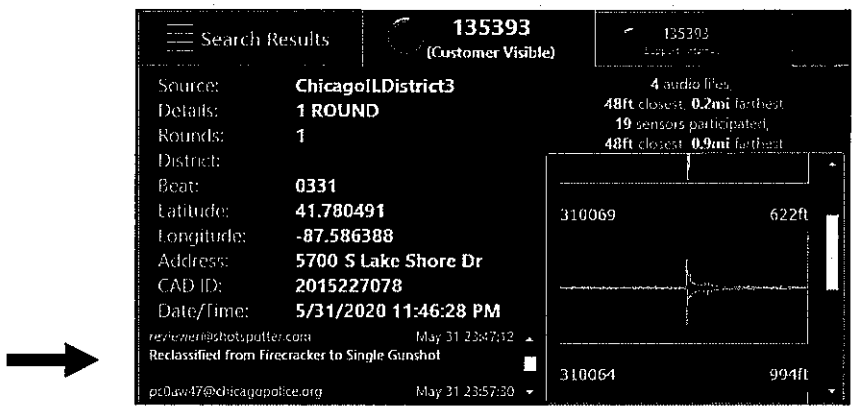
[112] Id.

[113] https://ir.shotspotter.com/all-sec-filings/content/0001564590-21-016134/0001564590-21-016134.pdf.

[114] Id.

[115] See, Illinois v. McKown, 924 N.E.2d 941 (2010)(stating that for a scientific method that is new or novel, the burden is on the proponent to demonstrate that the method is generally accepted in the relevant scientific community).

employee[116] apparently rejected the algorithm determination that the noise event in this case was the result of fireworks and substituted his/her own opinion that the noise event originated from gunfire:



(stating that the noise event was "Reclassified from Firecracker to Single Gunshot")

Months later, a second ShotSpotter employee identified as Walter Collier rejected the second critical determination of the ShotSpotter algorithm- that the noise event occurred near 5700 South Lake Shore Drive. Instead, Collier substituted his own opinion that the event occurred over one mile away near 6300 South Stoney Island:

> **At 23:46:28 (11:46:28 PM) hours on May 31, 2020 ShotSpotter® detected a Single Gunshot incident in Chicago, IL. ShotSpotter® recorded the incident as Incident ID #778-135393 and located it at 5700 S LAKE SHORE DR. After post-process analysis, the incident is found to have occurred at or near 63RD STREET & STONY ISLAND.**

Through this human-involved method, the ShotSpotter output in this case was dramatically transformed from data that did not support criminal charges of any kind to data that now forms the centerpiece of the prosecution's murder case against Mr. Williams.

Subjective human forensic decisions, such as the ones in this case that transformed innocent random noise data into evidence of first-degree murder, "require particularly careful scrutiny because their heavy reliance on human judgment means they are especially vulnerable to human error, inconsistency across examiners, and cognitive bias."[117] In the scientific

[116] Despite the fact that a defense subpoena in this case (Attachment B) ordered the production of the names of ShotSpotter employees "who reviewed the noise event in this matter," ShotSpotter continues to hide the identity of this employee.

[117] President's Council of Advisors on Science and Technology, "Forensic Science in Criminal Courts: Ensuring Scientific Validity of Feature-Comparison Methods," p. 5, 2016.

community, such scrutiny would involve analysis of several important indicators of scientific reliability. First, the scrutinized method would have to be described in written protocols.[118] Second, the protocols would have to provide some legitimate scientific basis for examiner decisions while protecting against the influences of cognitive biases that are known to infect the forensic process and cause error.[119] Third, the protocols would have to be placed in the hands of competent forensic experts who have not only received formal forensic training, but have also demonstrated that such training has resulted in competency.[120] Fourth, the method would need to have been the subject of "black box" studies to provide the criminal justice system with some empirical evidence of reliability.[121] Yet ShotSpotter's method fails every one of these prerequisites.

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[118] See, National Research Council, "Strengthening Forensic Science in the United States: A Path Forward," National Academy Press (2009)(stating that written laboratory protocols "provide the foundation against which performance, reliability, and validity can be assessed" and further stating that written protocols "reduce variability resulting from idiosyncratic tendencies of the individual examiner."); See also, American Bar Association, "Standards for Criminal Justice 3d," (2007) (stating that forensic laboratories should "be governed by written policies and procedures, including protocols for testing and interpreting test results, and permit deviations from protocols only by a technical leader or other appropriate supervisor): See also, Organization of Scientific Area Committees, "Standard for Forensic DNA Interpretation and Comparison Methods," (2019)(stating that forensic labs must operate pursuant to written protocols which are "developed from and supported by internal validation studies.").

[119] See, Cooper, Meterko, "Cognitive Bias Research in Forensic Science: A Systematic Review," Forensic Science International, Vol. 297, p. 35 (2019)(after a comprehensive review of cognitive bias literature in forensic science, the authors concluded that the available research supports the idea of susceptibility of forensic science practitioners to various types of cognitive bias."); See also, National Commission on Forensic Science, "Ensuring that Forensic Analysis is Based Upon Task-Relevant Information," National Institute of Justice (stating that "forensic science experts are vulnerable to cognitive and contextual bias" and further stating that "forensic scientists should rely solely on task-relevant information when performing forensic analyses."); See also, American Bar Association, "Standards for Criminal Justice 3d," (2007)(stating that forensic labs should "follow procedures designed to minimize bias when interpreting test results.")

[120] "A Guideline to Forensic Fundamentals: Identifying the Underpinning Science of Human Based Forensic Science Disciplines," Australia New Zealand Policing Advisory Agency & National Institute of Forensic Science (2019)(stating that for forensic methods like ShotSpotter's that rely on human examiners to make critical decisions, "it is important to identify the level of expertise required to perform the analysis," a process that is best accomplished "using appropriately designed competency instruments which cover the full spectrum of tasks the practitioner is required to perform in casework.").

[121] President's Council of Advisors on Science and Technology, "Forensic Science in Criminal Courts: Ensuring Scientific Validity of Feature-Comparison Methods," p. 5, 2016 (stating that "[f]or subjective feature-comparison methods, because the individual steps are not objectively specified, the method must be evaluated as if it were a 'black box' in the examiner's head," further stating that "[e]valuations of validity and reliability must therefore be based on 'black-box studies,' in which many examiners render decisions about many independent tests and the error rates are determined," and determining that the forensic fingerprint discipline had conducted enough black-box studies to be considered foundationally valid while other disciplines had not, including bitemarks, firearms, and footwear comparison.).

The document which ShotSpotter offers as its operating protocol[122] is unscientific and reckless in countless ways[123], including [redacted]

- [redacted]
- [redacted]
- [redacted]
- [redacted]

[122] Attachment K- Redacted per the Protective Order of Judge Gaughan dated April 14, 2021 (ShotSpotter disclosed this document in response to a subpoena requiring the production of "all operating procedures of any kind that ShotSpotter employees follow when reviewing noise event data in order to determine whether the noise event originated from gunshots and to determine the location and timing of suspected gunshots," which can be found at Attachment L).

[redacted] and the Chicago Police Department. The contract (at Attachment M) provides for a monetary penalty to ShotSpotter if they fail to detect "90% of unsuppressed outdoor gunfire incidents" but does not provide for a similar penalty for false alarms no matter how many ShotSpotter issues. This provides a direct monetary incentive for ShotSpotter employees to issue false alarms in hopes of hitting the 90% quota.

- [redacted]
- [redacted]
- [redacted]

[redacted], and represents a method of audio gunshot analysis that will never be generally accepted in the scientific community.[126]

These substandard and dangerous "protocols" are not salvaged in the ShotSpotter method by highly trained scientists who apply their wealth of scientific knowledge of acoustic engineering to render reliable opinions. For any person who wishes to attain the title of forensic expert, the forensic science community has established some baseline requirements to supply the criminal justice system with some assurances of competency. For starters, a prospective forensic expert must have an educational background in science.[127] With that base, they must receive formal and documented training on the underlying science and the particular forensic

[redacted]

[126] See, Maher, "Principles of Forensic Audio Analysis," Springer Publishing, 2018 (where the author of the leading textbook in forensic gunshot detection describes the scientifically accepted methods for conducting forensic gunshot audio analysis which in no way align with the method described in ShotSpotter's protocol document).

[127] See Scientific Working Group on Friction Ridge Analysis, Study and Technology, "Standards for Minimum Qualifications and Training to Competency for Friction Ridge Examiner Trainees," (2012)(stating that anyone seeking to become a fingerprint expert must possess a bachelor's degree with science-related coursework.); See also, Scientific Working Group for the Analysis of Seized Drugs, "Recommendations," (2016)(stating that forensic examiners must possess a bachelor's degree in "natural/physical science."); See also, Scientific Working Group for Firearms and Toolmarks, "Requirements/Recommendations for the Forensic Firearm and Toolmark Laboratory," (stating that firearm trainees must possess "a minimum of a Bachelor's degree in natural/physical science based on a field of study from an accredited academic institution.").

methods involved.[128] And after receiving documented training, they must establish that the training sunk in by participating in competency testing and ongoing proficiency testing.[129]

ShotSpotter employees fail each of these indicators of legitimate forensic competence. Perhaps the most important human in the ShotSpotter method is the employee who examines the forensic data in real-time (and decides whether to issue gunfire alerts that send police officers racing through urban settings) and the people hired by ShotSpotter to fill this expert role have neither college degrees nor any formal education that indicates scientific aptitude.[130] With such an inauspicious start, a formal training program for would-be ShotSpotter experts takes on added importance, yet ShotSpotter does not provide a training program that would be generally accepted in any legitimate forensic lab in the country. Rather, in response to a defense subpoena ordering the production of "all materials used by ShotSpotter during the training of Walter Collier," ShotSpotter could not produce a single training document- not a textbook, a powerpoint

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[128] See, Organization of Scientific Area Committees, "Standard for Forensic DNA Analysis Training Programs," (2019)(stating that forensic laboratories "shall have a written training program" for forensic DNA trainees.); See also, Scientific Working Group for the Analysis of Seized Drugs, "Recommendations," (2016)(stating that "there shall be a documented training program" for drug identification labs.); Scientific Working Group for Forensic Document Examination, "Standard for Minimum Training Requirements for Forensic Document Examination," (2015)(stating that a written "training record for each trainee will be maintained" and that this document must reflect the performance of trainees on written tests and practical exercises.); See also, Scientific Working Group for Firearms and Toolmarks, "Requirements/Recommendations for the Forensic Firearm and Toolmark Laboratory," (stating that firearm trainees must undergo formal training assignments and practical exercises over the course of 18-30 months, followed by competency testing.).

[129] See, National Commission on Forensic Science, "Views of the Commission: Certification of Forensic Science Providers," (2016)(stating that "all forensic science practitioners should [b]ecome certified in all categories of testing in which examinations are performed."): See also, National Commission on Forensic Science, "Proficiency Testing In Forensic Science," (2016)(stating that participation in regular proficiency testing of forensic examiners is a "current requirement of [forensic] accreditation bodies and further stating that "proficiency testing is required of all [Forensic Science Service Providers]."); See, Expert Working Group on Human Factors in Latent Print Analysis, "Latent Print Examinations and Human Factors: Improving the Practice through a Systems Approach," National Institute of Justice, p. 187 (2012)(stating that forensic laboratories "should develop and implement a comprehensive testing program that includes competency testing, certification testing, and proficiency testing."): See, Organization of Scientific Area Committees, "Standard for Forensic DNA Analysis Training Programs," (2019)(stating that forensic DNA trainees must "successfully complete [] competency tests" prior to performing any casework analyses.).

[130] Attachment C- Testimony of Paul Greene, Trial of Michael Reed, San Francisco, California, July 6, 2017, p. 154-155 (stating that the ShotSpotter employees who initially review noise events and decide whether to reject the determinations of the ShotSpotter algorithm are "Service Operations Center Operators" who must only have a high school diploma and 1 year of customer service experience.): See also, Attachment N- ShotSpotter Job Description for Service Operation Specialist (stating that eligible candidates must possess a "minimum of one year of professional experience, preferably in a call center" and stating that an Associate Degree or Law Enforcement training is "strongly preferred.").

presentation, a written exercise, or any other training document. Instead, ShotSpotter offered the following:

> "Our experts are trained using a variety of 'on the job' training sessions, and transfer knowledge from our scientists and other experienced employees. As such no official or formal training materials exist for our forensic experts specifically." (emphasis added).

And ShotSpotter has likewise not produced a single document in response to a defense subpoena ordering the disclosure of the "proficiency testing record (including actual proficiency tests with answers) of any ShotSpotter employee who reviewed the noise event in this matter." Together, these substandard attributes of the ShotSpotter method mean that ShotSpotter employees who are tasked with implementing the method can provide no true indication of expertise.

This lack of scientific expertise with the ShotSpotter employees who make important forensic determinations is exacerbated by the lack of even a single black-box study in the field of forensic audio gunshot analysis. Such black-box studies have been conducted in other forensic fields, including fingerprints[131], DNA[132], firearms[133], bite marks[134], footwear[135], while other forensic disciplines will shortly join this list.[136] These studies have provided the criminal justice system with important data establishing empirical-based rates of error, rates of repeatability and reproducibility of examiner decisions, and other important metrics of reliability. Some black-box studies have shown that forensic disciplines which once espoused the impossibility of error[137] in

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[131] Ulery et al., "Accuracy and Reliability of Forensic Latent Fingerprint Decisions," Proceedings of the National Academy of Sciences, Vol. 108, No. 19 (2011).

[132] Butler et al., "NIST Interlaboratory Studies Involving DNA Mixture: Variation Observed and Lessons Learned," Forensic Science International: Genetics, Vol 37, p. 81-94 (2018).

[133] Baldwin et al., "A Study of False-Positive and False-Negative Error Rates In Cartridge Case Comparisons," Ames Laboratory, USDOE, Technical Report #IS-5207 (2014).

[134] Freeman, Pretty, "Construct Validity of Bitemark Assessments Using the ABFO Decision Tree," https://online.wsj.com/public/resources/documents/ConstructValidBMdecisiontreePRETTYFREEMAN.pdf.

[135] Hammer et al., "Study of the Variability in Footwear Impression Comparison Conclusions," Journal of Forensic Identification, Vol. 63, p. 205-218 (2013).

[136] Forensic tire comparison experts are conducting their own black-box studies. https://nij.ojp.gov/funding/awards/2020-dq-bx-0026. Forensic bloodstain pattern experts are likewise in the process of conducting a black-box study. https://nij.ojp.gov/funding/awards/2018-du-bx-0214.

[137] State v. Rose, No. K06-0545 (Md.Cir.Ct. Oct. 19, 2007)(Stephen Meagher, a top FBI fingerprint examiner, testified to FBI policy that matches were 100% certain, and that the error rates for fingerprint comparisons were zero).

forensic determinations are in truth subject to considerable error.[138] Other black-box studies have called into question the outright validity of forensic methods long used by prosecutors in search of conviction.[139] And yet, no one in the field of forensic gunshot audio analysis- not at ShotSpotter or anywhere else- has sought to assess the reliability of forensic decisions by examiners who listen to audio files and claim to be able to reliably distinguish the sounds of gunshots from similar impulsive sounds. When combined with the lack of rigorous method protocols and the substandard education and training of ShotSpotter's employees, the lack of a black-box study should surely doom any chance that ShotSpotter evidence is admissible now or in the foreseeable future.

G. Because Illinois courts have never assessed the general acceptance of ShotSpotter's noise detection systems, this Court must do so now.

One important question raised in this litigation- whether the ShotSpotter noise detection system is generally accepted in the scientific community - should be resolved by an evidentiary hearing. As the Supreme Court noted in Illinois v. McKown, a trial court may only determine general acceptance through one of two means: 1) based on the results of an evidentiary hearing, or 2) by taking judicial notice of unequivocal and undisputed prior judicial decisions or technical writings on the subject.[140] First, this Court cannot take judicial notice of prior judicial decisions- this issue is one of first impression in Illinois. Second, prior judicial decisions in other jurisdictions are not "unequivocal and undisputed"- rather, courts have excluded ShotSpotter evidence in criminal cases.[141] Third, the "technical writings" regarding ShotSpotter provide no basis for

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[138] Koehler, Liu, "Fingerprint Error Rate on Close Non-Matches," Journal of Forensic Science, September 1, 2020 (finding that when 125 fingerprint examiners were tested with two close non-match comparisons, the resulting false-positive error rates were 16% and 28% for the two close non-match pairs tested.).

[139] See, Whittaker, "Some Laboratory Studies on the Accuracy of Bitemark Comparison," International Dental Journal, Vol. 25, p. 166-171 (1975)(establishing very high error rates- from 28% to 65%- when bitemark experts were tested on controlled samples where ground truth was known).

[140] Illinois v. McKown, 924 N.E.2d 941 (2010).

[141] Attachment O- Admissibility ruling of Judge Kennedy in California v. Gillard, June 2, 2014 (After conducting a Kelly-Frye hearing, Judge Gillard held that "the expert testing that a gun was fired at a particular location at a given time, based on the ShotSpotter technology, is not presently admissible in court, because it has not, at this point, reached general acceptance in the relevant scientific community." Judge Kennedy also noted a lack of evidence to establish that ShotSpotter alerts are reliable indicators of actual gunfire.); See also, California v. Hardy, 2021 WL 716643 (holding that is was reversible error for the trial court to fail to conduct a Kelly/Frye admissibility hearing to determine whether ShotSpotter is generally accepted in the scientific community); See also, U.S. v. Rickmon, 952 F.3d 876 (7th Cir. 2020)(stating that a ShotSpotter alert is no more reliable than an uncorroborated "anonymous

avoiding an admissibility hearing because ShotSpotter has chosen not to publish any. By way of comparison, the developers of the algorithm-based DNA method called STRmix have published over 50 peer-reviewed technical articles covering numerous aspects of validation and reliability and describing in detail the operation of its forensic tool[142], all of which are publicly available in leading forensic journals such as Forensic Science International and the Journal of Forensic Science and many of which have formed the basis of comprehensive Frye/Daubert inquiries into STRmix admissibility.[143] Additionally, end user police-agencies have repeated much of this STRmix validation during the internal validation process and have likewise made these technical writings available to the criminal justice system during admissibility litigation.[144] In stark contrast, neither ShotSpotter nor the Chicago Police Department have published a single peer-reviewed technical writing regarding the noise detection system at issue in this case. Given this absence of legitimate indicia of general acceptance, this Court should conduct a comprehensive Frye hearing in this matter of first impression. If a Frye hearing is not warranted in this matter- where ShotSpotter has ignored their scientific obligation to conduct validation testing, left forensic decisions in the hands of untrained customer service agents with 40-second analysis windows, and then spread corporate lies about system performance- then Frye represents a fictitious standard in Illinois that operates as nothing more than a welcome mat for any prosecution-proposed forensic evidence regardless of scientific efficacy.

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tipster" and holding that a ShotSpotter alert does not even amount to probable cause to detain someone- "indeed, we question whether a single ShotSpotter alert would amount to reasonable suspicion.").

[142] Judge Thaddeus Wilson, "Order on Admissibility of Probabilistic Genotyping Evidence Pursuant to Evidence Rule 702, State v. Kevin Edwards, 16cr0871503, July 19, 2019, p. 7.

[143] U.S. v. Gissantaner, 417 F.Supp.3d 857 (W. Dist. Mich. 2019)(In the context of a recent admissibility hearing in Federal District Court involving STRmix, the judge specifically considered "whether [STRmix] has been subjected to peer review and publication" and discussed the impact of the dozens of peer-reviewed STRmix articles on Daubert admissibility).

[144] Id. (where the court reviewed in detail the extent of internal validation conducted by the Michigan State Police laboratory at issue in the case and found that the internal validation was not extensive enough to establish that the lab could reliably deploy STRmix under the conditions of low-template DNA in a complex mixture).

H. Separately from *Frye*, this Court should exclude the prosecution's ShotSpotter evidence because it will mislead the trier of fact.

This Court should exclude ShotSpotter testimony in this case pursuant to Illinois Rule of Evidence 403. Rule 403 requires exclusion of evidence "if its probative value is substantially outweighed by the danger of unfair prejudice, confusion of the issues, or misleading the jury." Courts use Rule 403 when assessing the admissibility of forensic testimony,[145] and exclude forensic testimony when the testimony would confuse or mislead the trier of fact.[146] Even when forensic evidence satisfies Frye, "the trial court might rule such evidence inadmissible on grounds of undue prejudice."[147] And when evaluating forensic evidence pursuant to Rule 403, the U.S. Supreme Court notes that "[e]xpert evidence can be both powerful and quite misleading because of the difficulty in evaluating it" and advises trial court judges to "exercise more control over experts than over lay witnesses."[148]

When this Court applies this heightened scrutiny to the prosecution's ShotSpotter evidence in this case, the danger of confusing and misleading the jury is clear. The unfair prejudice in this case comes from the fact that the prosecution, through the testimony of police officers and/or ShotSpotter personnel, will seek to inform the jury that ShotSpotter data in this case establishes that: 1) there was a noise event on May 31, 2020, that originated from gunfire, 2) that this noise event happened at exactly 11:46pm, and 3) that ShotSpotter can reliably locate

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[145] See, U.S. v. Van Wyk, 83 F. Supp. 2d 515 (D.N.J. 2000)(holding that "in assessing a proffer of expert testimony [ ], the court must also consider other applicable rules such as F.R.E. 403. . ."); See also, Bowers, "Forensic Testimony: Science, Law and Expert Evidence," Academic Press, 2014 (stating that courts can use Rule 403 to exclude expert testimony that is unfairly prejudicial).

[146] See, U.S. v. Santillan, 1999 WL 1201765 (N.D. Cal. 1999)(holding that handwriting comparison testimony was more prejudicial than probative); See also, William v. Reynolds, 904 F.Supp. 1529 (E.D. Oka. 1995) (holding that the probative value of hair comparison evidence was substantially outweighed by its prejudicial effect); See also, Mnookin, "The Courts, The NAS, and the Future of Forensic Science," Brooklyn Law Review, Vol. 75, p. 51-55 (2010).

[147] Illinois v. Luna, 989 N.E.2d 655 (1st Dist. 2013); See also, McKown, 236 Ill. 2d at 305; People v. Floyd, 2014 IL App (2d) 120507, ¶22-24 (2d Dist. 2014); United States v. Frazier, 387 F.3d 1244, 1263 (11th Cir. 2004); Murray, 2014 D.C. Super. LEXIS at 33-35, 56-58; United States v. Van Wyk, 83 F. Supp. 2d 515 (D.N.J. 2000); United States v. Santillan, 1999 WL 1201765 (N.D. Ca 1999); United States v. Reynolds, 904 F.Supp. 1529, 1558 (E.D. Oka. 1995); Bowers, "Forensic Testimony: Science, Law and Expert Evidence," Academic Press (2014); Mnookin, "The Courts, NAS, & the Future of Forensic Sciences," Brooklyn L. R., Vol. 75, p. 51-55 (2010).

[148] Daubert, 509 U.S. at 595 (internal quotations & citations omitted); See also, United States v. Monteiro, 407 F.Supp.2d 351, 358 (D. Mass. 2006) ("The court's vigilant exercise of this gatekeeper role is critical because of the latitude given to expert witnesses to express their opinions on matters about which they have no firsthand knowledge, and because an expert's testimony may be given greater weight by the jury due to the expert's background and approach.")

this noise event to the intersection of 63rd Street and South Stony Island. This presentation would mislead jurors because it would not inform them that a ShotSpotter alert means no such thing. The prosecution would fail to inform the jury that a ShotSpotter alert really means that the noise detected by the ShotSpotter may have originated from a firecracker[149], a car backfire[150], loud mufflers[151], equipment[152], truck downshifting[153], helicopter noises[154], college campus noises[155], or many other urban sounds[156] that can generate false positive alerts and would not inform the jury that the large majority of ShotSpotter alerts are false alarms. The prosecution presentation of ShotSpotter testimony would further mislead the jury by failing to acknowledge that ShotSpotter has no idea how massive their false positive alert problem is because they have failed to conduct the scientifically necessary studies to quantify this problem. Finally, the prosecution would fail to inform the jury that because ShotSpotter has failed to conduct the necessary validation, their location estimates are not scientifically defensible and are known to be wrong.

While the prosecution is likely to respond to this Rule 403 argument with the refrain that such problems with ShotSpotter evidence "go to weight and not admissibility," such a hands-off approach could only be justified if cross-examination or the conflicting opinion of a defense expert possessed the potential to rectify misconceptions about ShotSpotter alerts contained in direct testimony offered by the prosecution. However, the research bears out precisely the opposite conclusion. Study after study shows that jurors have a difficult time accurately assessing

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[149] Broward County Sun-Sentinel, "Broward Sheriff Dropping Gunshot Detection System," November 22, 2011 (Broward County Sheriff quit using ShotSpotter because the system was "picking up noises such as firecrackers or a backfiring car and registering those sounds as gunfire. The sensors were also triggered by helicopters and the roar of downshifting trucks from nearby Interstate 95.").

[150] Id.

[151] See Attachment C- Testimony of Paul Green, Trial of Michael Reed, San Francisco, California, July 6, 2017, p. 113.

[152] See Attachment C, E- Testimony of Paul Greene, Trial of Michael Reed, San Francisco, California, July 5-6, 2017, p. 20, 113.

[153] See Attachment C- Testimony of Paul Green, Trial of Michael Reed, San Francisco, California, July 6, 2017, p. 113.

[154] See Attachment A- Testimony of Paul Greene in the Silvon Simmons case, Rochester, New York, October 17, 2017, p. 36-39.

[155] Times Union, "Troy Will Turn Off ShotSpotter," 2012.

[156] "Detailed Forensic Report Certification" of Simone Ellison, March 4, 2017, Customer Reference # 301714144 ("SST, Inc., does not guarantee 100% detection because real world, urban environments may contain intervening buildings, topography, foliage, periods of increased traffic or construction noise, and other urban acoustic noises that may either prevent the sound of a gunshot form being detected by the sensor(s), or may change or modify the audio characteristics of the sound of a gunshot so that it no longer matches the sensor(s) detection parameters.").

the real value of forensic evidence.[157] These same studies also show that with forensic evidence in particular, cross-examination is ineffective in rectifying erroneous assessments of forensic evidence by jurors.[158] Finally, even when the defense presents its own expert, juror misconceptions about the forensic evidence can persist.[159] It is for these reasons that researchers who investigate the effects of expert testimony on jurors conclude that their "results should give pause to anyone who believes that the traditional tools of the adversarial process will always undo the adverse effects of weak expert testimony."[160] The Illinois Supreme Court has offered

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[157] See, Thompson, "Lay Understanding of Forensic Statistics." Law & Human Behavior, Vol. 31, p. 332-49 (2015) (reviewing studies on juror comprehension of statistics and concluding that factfinders are susceptible to statistical fallacies, both prosecution and defense varieties); See also, Koehler, "If the Shoe Fits They Might Acquit," Northwestern University Public Law Research Paper, January 12, 2011 (concluding that jurors "are slow to revise incorrect probabilistic hypotheses" "fall prey to logical fallacies" and "failed to appreciate the role that error plays in interpreting the value of a reported match"); See also, Sanders, "Reliability Standards—Too High, Too Low, or Just Right?," Seton Hall L. Rev., Vol. 33, p. 881-1282, at 901, 919 (2003) (describing jurors as struggling with statistical information and unable to detect expert witness biases); See also, Dawn McQuiston-Surrett & Michael J. Saks, *Communicating Opinion Evidence in the Forensic Identification Sciences: Accuracy & Impact*, 59 Hastings L.J. 1159, 1170 (2008) ("most jurors have an exaggerated view of the nature and capabilities of forensic identification"); See also, People v. New, 2014 IL 116306, at ¶26 (Ill. 2014) (noting the "natural inclination of the jury to equate science with truth and, therefore, accord undue significance to any evidence labeled scientific"); See also, People v. Zayas, 131 Ill. 2d 284, 292 (1989) (in ruling hypnotically-assisted-recall testimony inadmissible court emphasized the likelihood and danger of prior juror exposure to misleading information about hypnosis).

[158] See, Sanders, "Reliability Standards—Too High, Too Low, or Just Right?," Seton Hall L. Rev., Vol. 33, p. 881-1282, at 934-936 (2003)(Concluding that multiple studies bear out the sobering reality that even robust cross examination of experts affects neither ultimate verdicts nor even juror confidence in said verdicts); See also, Koehler, "If the Shoe Fits They Might Acquit," Northwestern University Public Law Research Paper, January 12, 2011 ("Contrary to predictions, none of the source and guilt dependent measures in the main experiment were affected by the introduction of cross examination. There was no effect for cross examination on source confidence, source probability, guilt confidence, guilty probability, or verdict. Likewise there was no effect for cross examination across the two individualization conditions on any of the dependent measures."); See also, Saks, "The Testimony of Forensic Identification Science: What Expert Witnesses Say and What factfinders Hear," Law & Human Behavior (Authors conducted a study and reviewed others, ultimately finding "little or no ability of cross-examination to undo the effects of an expert's testimony on direct examination, even if the direct testimony is fraught with weaknesses and the cross is well designed to expose those weaknesses." Interestingly, the authors conclude that cross examination can effect juror evaluation of expert evidence if it is presented honestly as a subjective guess, but that "...the unshakeableness of the traditional forms: match and similar-in-all-microscopic-characteristics produce something of a ceiling effect, which resist moderation by the presentation of other information."); See also, Shari Seidman Diamond, et al., "Juror Reactions to Attorneys At Trial," 87 J. Crim. L. & Criminology 17, 41 (1996) (The author conducted an experiment, using 1925 jury-eligible residents of Cook County, which varied the strength of an attorney's cross examination of an expert witness and found that, "Although juror perceptions of the attorney appear susceptible to influence by the attorney's efforts during cross-examination, the strong cross-examination had no effect on the verdict.").

[159] Sanders, "Reliability Standards—Too High, Too Low, or Just Right?," Seton Hall L. Rev., Vol. 33, p. 881-1282, at 934 (2003).

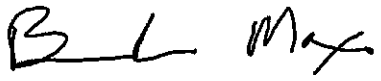
[160] McQuiston-Surrett & Saks, "Communicating Opinion Evidence in the Forensic Identification Sciences," Hastings Law Journal, Vol. 59, at p. 1188; See also, Sanders, "Reliability Standards—Too High, Too Low, or Just Right?," Seton Hall L. Rev., Vol. 33, p. 881-1282, at 936 (2003) ("experimental findings should give pause to ... others who believe

similar cautions with regard to expert testimony, stating that "evidence labeled 'scientific' carries greater weight in the eyes of the jury, which may accord it undue significance because 'science' is equated with truth."[161] These crucial factors- jurors misperceptions of the value of forensic evidence and the ineffectiveness of cross examination- make clear that an approach of just leaving it to the jury to sort out is untenable. Rather, this Court should embrace its role as gatekeeper pursuant to Rule 403 and exclude the prosecution's misleading ShotSpotter evidence.

Wherefore, Mr. Williams requests the following:

- That this Court conduct a comprehensive evidentiary hearing pursuant to Frye,
- That this Court exclude any mention of a ShotSpotter alert during the trial in this matter because the ShotSpotter system is not generally accepted in the scientific community, and
- That this Court exclude any mention of a ShotSpotter alert during the trial in this matter pursuant to Illinois Rule of Evidence 403.

Respectfully Submitted,



Lisa Boughton

Brendan Max

Assistant Cook County Public Defenders

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that the traditional tools of the adversarial process are a full substitute to restrictions on the admissibility of unreliable expert testimony."); See also, Murray v. Motorola, 2014 D.C. Super. LEXIS 16 (2014)(wherein the court decided not to leave it up to the jury to assess the methods of an expert epidemiologist, reasoning that "the court cannot be confident that effective advocacy can eliminate the risk that a jury would be misled by [the expert's] testimony and reach a result on an improper basis.").

[161] State v. McKown, 875 N.E.2d 1029 (2007).