January 11–14, 2022

2022 Firearm and Toolmarks Policy and Practice Forum

FIREARM & TOOLMARKS POLICY & PRACTICE FORUM

NIJ | National Institute of Justice

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Forensic Technology CENTER OF EXCELLENCE

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NIJ is the federal government's lead agency for forensic science research and development as well as the administration of programs that facilitate training, improve laboratory efficiency, and reduce backlogs. The mission of NIJ's Office of Investigative and Forensic Sciences is to improve the quality and practice of forensic science through innovative solutions that support research and development, testing and evaluation, technology, information exchange, and the development of training resources for the criminal justice community.

Through the research, development, testing, and evaluation process, we provide direct support to crime laboratories and law enforcement agencies to increase their capacity to process high-volume cases and provide needed training in new technologies. With highly qualified personnel and strong ties to the community, NIJ's Office of Investigative and Forensic Sciences plays a leadership role in directing efforts to address the needs of our nation's forensic science community.
RTI International and its academic- and community-based consortium of partnerships work to meet all tasks and objectives for the Forensic Technology Center of Excellence (FTCoE), put forward under the National Institute of Justice (NIJ) Cooperative Agreement No. 2016-MU-BX-K110.

Forensic Technology CENTER OF EXCELLENCE

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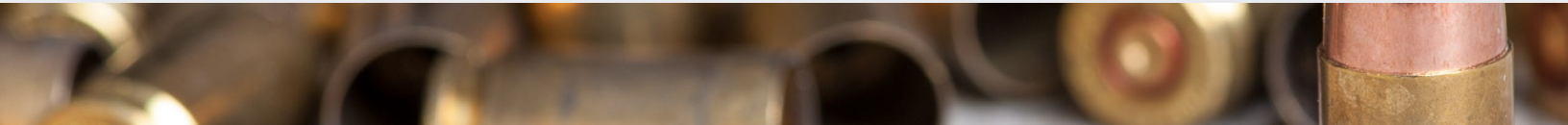
The FTCoE is led by RTI International, a global research institute dedicated to improving the human condition by turning knowledge into practice. With a staff of more than 5,000 providing research and technical services to governments and businesses in more than 75 countries, RTI brings a global perspective. The FTCoE builds on RTI's expertise in forensic science, innovation, technology application, economics, DNA analytics, statistics, program evaluation, public health, and information science.

RTI INTERNATIONAL

This forum is funded through a cooperative agreement from the National Institute of Justice (2016-MU-BX-K110), Office of Justice Programs, U.S. Department of Justice. Neither the U.S. Department of Justice nor any of its components operate, control, are responsible for, or necessarily endorse, this forum. The opinions, findings, and conclusions or recommendations expressed in this forum are those of the presenter(s) and do not necessarily reflect those of the Department of Justice. Any products and manufacturers discussed are presented for informational purposes only and do not constitute product approval or endorsement by the U.S. Department of Justice.



INTRODUCTION

Welcome Letter

Greetings,

The National Institute of Justice (NIJ) and its Forensic Technology Center of Excellence (FTCoE) at RTI International want to welcome you to the 2022 Firearm and Toolmarks Policy and Practice Forum. We are excited to offer the first event of the year and our first forum of this type!

NIJ supports research to advance efficiency, quality, reliability, and capacity in the criminal justice and forensic science communities. This research focuses on developing technologies, providing proof for evidence-based practices, and evaluating findings for case investigations and legal proceedings. Individuals from the forensic, research, and legal communities volunteered their time and expertise to serve as subcommittee members, and these subcommittees helped develop a program that we feel is timely, necessary, and engaging.

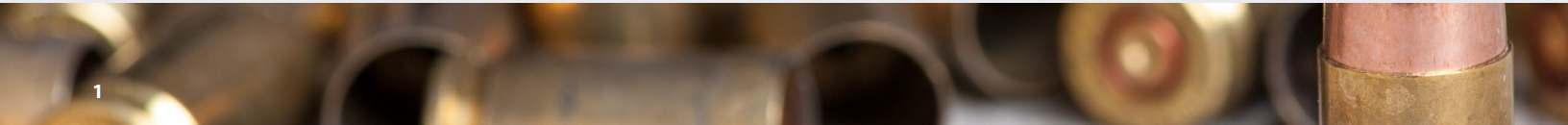
This 4-day program highlights four main areas: Research, Emerging Technologies, Intelligence, and Legal Aspects. Each day features a Keynote address, with an opportunity for live questions and answers after the presentation. More than 20 subject matter experts will present during the event. At the conclusion of each day's presentations, the panel moderator will lead an interactive panel discussion with presenters. The forum will also include updates from NIJ on its Research and Development Portfolio, a presentation on NIJ's Forensic Intelligence Initiative, and an overview of the FTCoE. On the final day, we have dedicated time for an interactive panel discussion with all four panel moderators to focus on future/next steps. Many presentations will be archived and available on the FTCoE's website for on-demand viewing at no cost.

If you have not done so already, please register for and attend this year's virtual event. Registration and event details can be found at https://forensiccoe.org/2022-firearm-toolmarks-forum. Whether you are attending an NIJ-sponsored event for the first time or are already familiar with the educational and research opportunities NIJ has to offer, we are pleased to have you—our partners within the criminal justice and forensic science communities—join us for this event.

During these challenging times, we are confident that you will learn valuable information to help guide your firearm/toolmark analysis, research, and legal cases. Grounded in the present but with an eye toward the future of the field, the 2022 Firearm and Toolmarks Policy and Practice Forum will lead to opportunities for enhanced learning, continued discussions, further research, and a more informed understanding of the associated legal aspects. Welcome to the forum—we hope you enjoy the program!

Jeri D. Ropero-Miller, PhD, F-ABFT
Director, Forensic Technology Center of Excellence
Center for Forensic Sciences
RTI International

Lucas Zarwell, MFS, D-ABFT-FT
Director, Office of Investigative and Forensic Sciences
National Institute of Justice



Directors

Jeri D. Ropero-Miller

Dr. Jeri D. Ropero-Miller, F-ABFT, is the Senior Director in the Applied Justice Research Division and directs its Center for Forensic Sciences at RTI International. Prior to her tenure with RTI, she served as the Deputy Chief Toxicologist at North Carolina's Office of the Chief Medical Examiner. Her expertise and board certification in forensic toxicology as well as her expertise with broader policy and criminal justice research areas have led her to publish about several topics. Dr. Ropero-Miller previously served as Secretary of the American Board of Forensic Toxicology and as a Forensic Science Foundation Trustee. In 2021, she was appointed to the Forensic Sciences Standards Board of the National Institute of Standards and Technology Organization of Scientific Area Committees for Forensic Science; she has also served on its Toxicology Subcommittee and as the Executive Secretary of its Chemistry Scientific Area Committee. She served as the 2020–2021 President for the American Academy of Forensic Sciences and will join the Board of Directors for the Society of Forensic Toxicologists in 2022. She is a member of The International Association of Forensic Toxicologists, The American Society of Crime Laboratory Directors, the International Association of Chiefs of Police, and The International Association of Coroners and Medical Examiners.

During her 25-year tenure of conducting research, educating, and enabling innovation, she has supported more than 20 federally funded programs. Her ongoing projects include the National Institute of Justice's (NIJ's) Forensic Technology Center of Excellence, NIJ Criminal Justice Testing and Evaluation Consortium, the Drug Enforcement Administration–funded National Forensic Laboratory Information System, and the Bureau of Justice Statistics–funded 2018 Census of Medical Examiners/Coroners' Offices and 2019 Census of Publicly Funded Forensic Crime Laboratories. She received her doctorate in clinical chemistry and forensic toxicology from the University of Florida College of Medicine. Her work has been extensively published, and she is recognized nationally and internationally.

Lucas Zarwell

Lucas Zarwell started at the National Institute of Justice (NIJ) in March 2020. He currently leads a team of dedicated forensic scientists who work to facilitate research and implement new technologies nationwide. Prior to this position, Mr. Zarwell served as Chief Toxicologist, Deputy Chief Toxicologist, and Toxicologist for the District of Columbia Chief Medical Examiner (2002–2020). Past employments include DC Pre-Trial Services Forensic Drug Testing Laboratory, the Armed Forces Institute of Pathology Forensic Toxicology Laboratory, and Poison Lab Incorporated (San Diego, CA). Mr. Zarwell maintains his certification from the American Board of Forensic Toxicology. He currently co-chairs the Office of Justice Programs/Department of Health and Human Services Federal Interagency Medicolegal Death Investigation Working Group, which is hosted by NIJ. Mr. Zarwell obtained an MFS with an emphasis in forensic toxicology from George Washington University in 1999 and has an undergraduate degree from the University of San Diego in both biology and marine science.

Acknowledgments

Emerging Technologies Subcommittee
Wes Grose
Heather Seubert, Chair
Andy Smith
Jody Wolf
Lucas Zarwell
Xiaoyu Alan Zheng

Intelligence Subcommittee
Hugo Barrera
Tammy Brown
William Demuth II
Basia E. Lopez
Jonathan McGrath
Mallory O'Brien
Stephanie Stoiloff, Chair

Legal Aspects Subcommittee
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Sabrina S. Cillessen
Gregory Dutton
Ryan Lilien
Max Morris
Robert M. Thompson, Chair
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FIREARM & TOOLMARKS
POLICY & PRACTICE FORUM

AGENDA

Use the interactive tabs along the right side of the page to navigate easily between sections.

Tuesday, January 11: 1:00 p.m.–4:40 p.m. Eastern Time (ET)

RESEARCH	
1:00–1:50	**Welcome** Lucas Zarwell, National Institute of Justice
	Opening Remarks John Grassel, RTI International
	Keynote—A Review of the Scientific Foundations of Firearm Examination and Related Research Theodore Vorburger, National Institute of Standards and Technology
1:50–2:05	**Q&A** John Grassel
2:05–2:35	**Support for Firearms and Toolmarks R&D at the National Institute of Justice** Gregory Dutton, National Institute of Justice
2:35–2:45	**BREAK**

RESEARCH	
2:45–4:05	**Research Panel** Moderated by Robert M. Thompson, National Institute of Standards and Technology **3D Microscopes and Their Application to Firearm and Toolmark Examination** Thomas Brian Renegar, National Institute of Standards and Technology **Virtual Comparison and Software Technology** Todd J. Weller, Weller Forensics LLC **Computer-Aided Firearm and Toolmark Analysis** Johannes Soons, National Institute of Standards and Technology
4:05–4:35	**Q&A Panel Discussion** Robert M. Thompson
4:35–4:40	**Adjourn** John Grassel

Wednesday, January 12: 1:00 p.m.–4:45 p.m. ET

EMERGING TECHNOLOGIES	
1:00–1:50	**Opening Remarks** John Grassel, RTI International
	Keynote—Emerging 3D Technologies in Firearm and Toolmark Examination Ryan Lilien, Cadre Forensics
1:50–2:05	**Q&A** John Grassel
2:05–2:25	**2022 Forensic Technology Center of Excellence (FTCoE) Update** Jeri D. Ropero-Miller, RTI International
2:25–2:35	**BREAK**
2:35–4:10	**Emerging Technologies Panel** Moderated by Heather Seubert, FBI Laboratory **Ballistics IQ from a Law Enforcement Perspective** Lacey Oden, Escambia County Sheriff's Office **Ballistics IQ for the Crime Laboratory** Deion P. Christophe, Plano Police Department **Evofinder®: From Validation to Implementation** Michael Beddow, Phoenix Police Department Crime Laboratory **Reference Population Database of Firearm Toolmarks (RPDFT)** Xiaoyu Alan Zheng, National Institute of Standards and Technology **Cadre Verification and Use in Casework** Sabrina S. Cillessen, Virginia Department of Forensic Science

EMERGING TECHNOLOGIES	
4:10–4:40	**Q&A Panel Discussion** Heather Seubert
4:40–4:45	**Adjourn** John Grassel

Thursday, January 13: 1:00 p.m.–4:40 p.m. ET

INTELLIGENCE	
1:00–1:50	**Opening Remarks** John Grassel, RTI International
	Keynote—The Crime Gun Intelligence Revolution Thomas Chittum, Bureau of Alcohol, Tobacco, Firearms and Explosives
1:50–2:05	**Q&A** John Grassel
2:05–2:35	**National Institute of Justice's Forensic Intelligence (FOR-INT) Initiative: Using Forensics for Crime Disruption and Prevention** Jonathan McGrath and Basia E. Lopez, National Institute of Justice
2:35–2:45	BREAK
2:45–4:05	**Intelligence Panel** Moderated by Stephanie Stoiloff, Miami-Dade Police Department Forensic Services Bureau **Forensic Intelligence: Incorporating Forensic Data Sets in Criminal Investigations** Yaneisy Delgado, Miami-Dade Police Department Forensic Services Bureau **Milwaukee Police Department—NIBIN Overview** Branko Stojsavljević and Ryan Orlovsky, Milwaukee Police Department **Technical Intelligence: An Operational Tool** Tara Garvey, Philadelphia Police Department Intelligence Bureau Mike Garvey, Philadelphia Police Department Office of Forensic Science **Evidence Screening in Support of NIBIN** Jessica Ellefritz, Phoenix Police Department

INTELLIGENCE	
4:05–4:35	**Q&A Panel Discussion** Stephanie Stoiloff
4:35–4:40	**Adjourn** John Grassel

Friday, January 14: 1:00 p.m.–4:40 p.m. ET

LEGAL ASPECTS	
1:00–1:50	**Opening Remarks** John Grassel, RTI International
	Keynote—The Accuracy, Repeatability, and Reproducibility of Firearms/Toolmarks Comparisons Erich Smith, FBI Laboratory
1:50–2:05	**Q&A** John Grassel
2:05–2:15	**BREAK**
2:15–3:05	**Legal Aspects Panel** Moderated by Raymond Valerio, Queens District Attorney's Office **Five Years Later: An Overview of Firearms and Toolmarks Admissibility Decisions After the PCAST Report** Amie Ely, National Association of Attorneys General **Firearms & Toolmark Evidence Admissibility & Current Challenges** Raymond Valerio
3:05–3:35	**Q&A Panel Discussion** Raymond Valerio
3:35–3:45	**BREAK**

LEGAL ASPECTS	
3:45–4:30	**Chairs Panel—Future/Next Steps** Moderated by John Grassel **Research Panel:** Robert M. Thompson, National Institute of Standards and Technology **Emerging Technologies Panel:** Heather Seubert, FBI Laboratory **Intelligence Panel:** Stephanie Stoiloff, Miami-Dade Police Department Forensic Services Bureau **Legal Aspects Panel:** Raymond Valerio
4:30–4:35	**Closing Remarks** Lucas Zarwell, National Institute of Justice
4:35–4:40	**Adjourn** John Grassel


FIREARM & TOOLMARKS
POLICY & PRACTICE FORUM

ABSTRACTS

An asterisk denotes the presenter(s) for presentations that have multiple authors.

DAY 1—RESEARCH

A Review of the Scientific Foundations of Firearm Examination and Related Research

Theodore Vorburger,* John M. Butler, Steve Lund, Robert M. Thompson, Heather Waltke, Shannan Williams, and James Yen, National Institute of Standards and Technology; Wayne Arendse, Firearm and Toolmark Consultant; Gregory S. Klees, Bureau of Alcohol, Tobacco, Firearms and Explosives

Forensic science plays a vital role in the criminal justice system by providing scientifically based information through the analysis of physical evidence. Several scientific advisory bodies have expressed the need for scientific foundation reviews of forensic science disciplines, and the National Institute of Standards and Technology has been tasked as an appropriate agency for conducting them. A scientific foundation review is a study that seeks to document and evaluate the foundations of a scientific discipline, that is, the trusted and established knowledge that underpins the discipline's methods. These reviews seek to answer the question, "What empirical data exist to support the methods that forensic science practitioners use to analyze evidence?" The purpose of a scientific foundation review is to document and consolidate information supporting the methods used in forensic analysis and identify knowledge gaps where they exist. This review of scientific foundations for firearm examination is the fourth in the series. The project team is evaluating a wide body of published literature and other materials devoted to firearm examination. A bibliography database has been developed containing 791 references (as of November 2021). Among other topics, the final report will include historical perspectives of the field, current methods in use, key takeaways and considerations for the field, and studies of advanced methods of 3D acquisition and objective algorithmic analyses, but the primary emphasis is placed on the scientific foundations of comparison microscopy, which has been the most widely used method by far. To this end, all known literature and materials that contain studies of error rates for identification and exclusion of matching bullets and cartridge cases based on microscopy comparisons have been included, with a focus on 20 reports of interlaboratory studies, method validations, and proficiency tests. We classify these works into five categories—depending on the scenario of the experimental designs, for example—on whether each question posed in a study is independent and uncorrelated from the others or whether each identification or other decision changes the *a priori* probability of other decisions. In addition, six other factors are considered as possible influence factors on the values of measured error rates:

- The region of interest—bullet land engraved area, breech face impression, and so on
- The size of the study—number of questions multiplied by number of participants
- Whether known pairs are included as examples and standards
- Whether the study includes consecutively manufactured firearms

- Whether questions are declared to participants or covertly included in case work
- Test difficulty

The project team will also briefly review research into advanced methods for firearm examination, including acquisition of 3D surface images by optical topographic microscopes and automated analyses of surface images by algorithmic methods.

Support for Firearms and Toolmarks R&D at the National Institute of Justice

Gregory Dutton, National Institute of Justice

As a federal funding agency with a criminal justice mission, the National Institute of Justice (NIJ) supports research and development (R&D) across the forensic sciences. An important element is an active R&D portfolio in forensic firearms and toolmarks. At present, forensic firearms examination is at the cusp of a transition from traditional 2D optical comparison microscopy to 3D surface comparison. This holds promise for the wider application of objective, quantitative methods of comparison as well as for the digital exchange of evidence. NIJ's programs have played a role in bringing together researchers, technology developers, federal laboratories, and forensic practitioners to facilitate this transition. This presentation will include an overview of NIJ's recent and current R&D portfolio in forensic firearms and toolmarks. Examples of notable projects and lines of research include quantitative measures of similarity, instrument development, database development, and standards development.

3D Microscopes and Their Application to Firearm and Toolmark Examination

Thomas Brian Renegar, National Institute of Standards and Technology

For many years, forensic examiners have relied on 2D optical microscopy to inspect and identify forensic firearm evidence. Newer 3D technology is becoming available to the forensic laboratory and has many advantages over traditional 2D microscopy. This presentation will provide an overview of 3D microscopy as it applies to the forensic laboratory and discuss some of the advantages and disadvantages compared to 2D microscopy. In particular, issues related to the consistency of illumination with 2D microscopy and their importance for making identifications will be highlighted. Several types of 3D microscopes will be reviewed—including confocal, focus variation, interferometric, and photometric stereo. A brief description of each method and its respective technologies will be described. In addition, some aspects of the calibration and quality control of measurements using these techniques will be discussed. Calibration of measuring equipment is an important part of ensuring accurate measurements and is a necessary step in demonstrating metrological traceability. Conducting routine or periodic checks is also necessary to ensure consistent performance and is an important part of quality control that helps to satisfy the requirements of an accredited laboratory. Some of the types of calibrations and checks necessary for 3D microscopes in the forensic laboratory will be discussed.

Virtual Comparison and Software Technology

Todd J. Weller, Weller Forensics LLC

Mr. Weller's presentation will provide an overview of the concept of Virtual Comparison Microscopy (VCM) and how this technology has the potential to enhance the quality and accuracy of firearm and toolmark examinations. For the past 100 years, firearm and toolmark comparisons have been performed using physical samples viewed through comparison microscopes. Emerging technology now allows the use of hardware that is capable of accurately measuring and digitizing microscopic surfaces. Then, computer software can be used by forensic examiners to compare the digitized microscopic marks present on (un)fired ammunition components. The computer monitor is thus converted into a comparison microscope. This technology opens up new possibilities such as the digital archiving of evidence, near-instant and remote access to samples, and examiners directly annotating the surfaces used for their decisions. Finally, it is believed that this technology will allow for the use of statistically based algorithms to supplement examiners' conclusions. Mr. Weller will cover these concepts with examples taken from his experience and the published literature and will provide attendees with an introduction to VCM technology.

Computer-Aided Firearm and Toolmark Analysis

Johannes Soons, National Institute of Standards and Technology

This presentation provides an overview of emerging computational techniques to assist the examiner in performing toolmark comparisons. The presenter will describe image processing methods that improve the suitability of the sample images for analysis. The methods include image segmentation to extract the region of interest, filtering and averaging to attenuate noise and highlight toolmark features of interest, image registration to achieve overlap of common features, and visualization techniques. Next is an overview of similarity metrics or scores that quantify the degree of toolmark similarity between samples. These scores are used for database search and automated comparison. The presenter will discuss the classification of comparison results into conclusions, such as identification or exclusion, versus a representation of comparison results on a more continuous scale. The various techniques will be illustrated with examples of bullet and cartridge case comparisons. The presentation will conclude with a discussion on the strengths and limitations of computer-aided methods and their implementation into casework workflow.

DAY 2—EMERGING TECHNOLOGIES

Keynote—Emerging 3D Technologies in Firearm and Toolmark Examination

Ryan Lilien, Cadre Forensics

The most significant emerging technologies within the discipline of firearm and toolmark examination involve the use of high-resolution 3D surface topography measurements. The use of these measurements is termed "3D Virtual Microscopy," which is a powerful tool for microscopic examination. These methods present examiners with highly detailed visualizations of toolmark surfaces. Virtual Comparison Microscopy (VCM) provides a number of advantages over traditional Light Comparison Microscopy (LCM) in the areas of access, speed, documentation, and quality. For example, after evidence and test fires are scanned at a 3D microscope, the topography data may be viewed down the hall or off-site on a second computer where examiners can annotate the surfaces, link items with common source, capture screenshots, record text notes, and export structured case notes for inclusion in laboratory information management systems. Several recent studies—such as our VCM Error Rate Study and our VCM Topography Resolution Study, each involving over 100 participants—provide strong support for the quality of VCM examination. These studies establish 3D VCM as a viable alternative to traditional LCM within the discipline of firearm examination. 3D surface measurements can also be analyzed with comparison algorithms. Algorithms are used to (1) search databases to identify links between cases; (2) establish quantitative match statistics such as false match rate; and (3) facilitate the examination process through functionality such as micron-scale alignment, evidence triage, and surface annotations. Methods are currently being developed to address each of these aims. The developed methods are being complemented by specific visualizations capable of providing interpretability to the numeric score and instilling confidence in their conclusions. Over the next few years, VCM will continue its migration from the research laboratory to the crime laboratory. Overall, the incorporation of advanced surface measurement technologies should increase the accuracy and quality of the forensic work product. This presentation will review the uses of VCM within a laboratory—covering such topics as validation, visualization, source conclusions, documentation, remote access, triage, database search, and verification.

2022 Forensic Technology Center of Excellence (FTCoE) Update

Jeri D. Ropero-Miller, RTI International

The National Institute of Justice (NIJ) Forensic Technology Center of Excellence (FTCoE), led by RTI International, is supported through a Cooperative Agreement from NIJ. The NIJ FTCoE supports the implementation of new forensic technology and best practices by end users and is dedicated to elevating the status of forensic science by advancing technology, sharing knowledge, and addressing challenges. The NIJ FTCoE bridges the gap between the scientific and justice communities. This presentation will address the new initiatives, upcoming events, and future deliverables supported by the NIJ FTCoE and NIJ.

Ballistics IQ from a Law Enforcement Perspective

Lacey Oden, Escambia County Sheriff's Office

The Escambia County Sheriff's Office (ECSO) Crime Scene Unit's (CSU's) ability to find and capture physical evidence related to ballistics evidence in the least destructive manner while providing the highest quality results is hampered by CSU's current resources. The potential to obtain physical evidence using advanced and high-quality equipment has been recognized as the solution to CSU's current dilemma. The ECSO CSU has been actively researching equipment that would assist in the detection of physical evidence. Additionally, CSU has been looking for ways to streamline the processing of evidence using advanced technology to improve overall timeliness and provide valuable information for investigative purposes. The Evidence IQ software, known as Evidence IQ Ballistic Imaging System, has been identified as one possible solution to this dilemma.

ECSO has implemented Ballistic IQ into its workflow as of May 2021. As of November 2021, ECSO has scanned 1,860 cartridge casings, identified 144 unique firearms, and established 18 links. Ballistic IQ offers various benefits—such as fast turnaround times, around-the-clock customer service, potential links to other crime scenes that can result in arrests for violent crimes, and immediate intelligence that can be used in investigations. Ballistics IQ can identify the number of unique firearms used in the incident and sometimes even the make/model of the firearm. Speeding up evidence workflow, ECSO's proprietary software identifies the best cartridge case(s) for entry into the National Integrated Ballistic Information Network (NIBIN), which allows resources to be allocated for other essential duties while providing NIBIN-accurate triage and quality information for correlations within NIBIN. Ballistic IQ is an evolving system; it has become an essential item within the realm of crime scene processing for law enforcement agencies.

In this presentation, Ms. Oden will discuss a law enforcement perspective of the applicability of the system, benefits and limitations, concerns, and progression of Evidence IQ Ballistic IQ Imaging Software System.

Ballistics IQ for the Crime Laboratory

Deion P. Christophe, Plano Police Department

The Plano Police Department (Plano PD) Firearms Unit provides forensic firearm analysis services to law enforcement agencies throughout Collin, Dallas, Tarrant, Denton, Ellis, Rockwall, and Johnson counties. The unit serves as a regional Bureau of Alcohol, Tobacco, Firearms and Explosives National Integrated Ballistic Information Network (NIBIN) entry point and provides critical analysis and support in the investigation and prosecution of criminal activity throughout the North Texas region. Although firearm examiners employ comparison microscopes to assess the quality and quantity of marks present on fired ammunition components, the utilization of ballistic imaging technology assists with timely intelligence and a reduction in firearms-related violence. Recent evaluations of the Plano PD Firearms Unit indicated that growth was not feasible, and maintaining current levels of support would be challenging unless additional instrumentation was obtained.

In April 2021, Plano PD acquired Evidence IQ's Ballistics IQ system to determine the accuracy and specificity of Ballistics IQ for triage of both evidence and exemplars for entry into the NIBIN database. This presentation addresses this agency's approach to prevention, protection, mitigation, and criminal activity response throughout the North Texas region. Specifically, this presentation provides a brief summary of internal validation results and is a laboratory's perspective of the suitability of Ballistics IQ for triage and collateral advantages.

Evofinder®: From Validation to Implementation

Michael Beddow, Phoenix Police Department Crime Laboratory

For more than a decade, researchers—including forensic, academic, and government—have been investigating the application of existing surface metrology and 3D surface topographical microscopy methods within forensic firearms examination as it pertains to bullet and cartridge case comparison. Over the past 2 years, the Firearms Section of the Phoenix Police Department Crime Laboratory has validated and implemented a Virtual Comparison Microscopy (VCM) system; the instrument selected was the Evofinder®. The Evofinder system uses focus variation topographical microscopy, multi-sided illumination technology, and frame-fragment technology to create a 3D rendering of the surface topography with exceptional reproducibility and resolution. The primary benefits of VCM, using the Evofinder system, are that it is less sensitive to lighting conditions and has an infinite depth of field when compared to traditional light comparison microscopy (LCM). Use of the Evofinder system may allow the examiner to more completely evaluate a sample and the toolmarks it possesses. Our Evofinder validation and implementation design focused entirely on VCM. Use of the Evofinder for databasing, statistical analysis, or conclusion support was not investigated or evaluated. The validation and implementation processes revealed the utmost importance of extensive practice with conducting VCM comparison as part of the training and validation programs. The volume of information presented to the examiners in a single frame of view is so immense that adequate time must be provided to adjust to this view. Implementation of the Evofinder system has demonstrated that VCM has a place within a forensic laboratory alongside LCM; however, VCM is not a replacement for LCM. VCM is an excellent tool to be used in conjunction with LCM. During the first approximate 6 months of our implementation into casework, our examiners found instances where evidence samples are better suited for VCM and likewise for LCM.

Reference Population Database of Firearm Toolmarks (RPDFT)

Xiaoyu Alan Zheng, National Institute of Standards and Technology

The last decade has seen exciting progress in the development of measurement instruments, algorithms, data, and methods to facilitate objective analysis of toolmark comparisons. The primary goal is to provide firearms and toolmark examiners with the ability to support their testimonies with objective similarity values and statistically sound quantitative expressions for the weight of the evidence. The National Institute of Standards and Technology (NIST), the Federal Bureau of Investigation (FBI), and the Netherlands Forensics Institute (NFI) have been collaborating to develop the Reference Population Database of Firearm Toolmarks (RPDFT). RPDFT consists of a reference database of firearm toolmarks (impressed and striated), data-processing modules, quantitative similarity

metrics, statistical weight of evidence calculation protocols, and a user interface. In the past 3 years, a reference database infrastructure has been developed to index test fires generated by the FBI according to their class characteristics. The reference database consists of ground truth known matching and known non-matching comparisons and is designed to be filtered according to matching or relevant class characteristics of the evidence being analyzed. NIST and NFI's objective toolmark analysis algorithms and statistical protocols have also been integrated into the database, which allows for quantitative one-to-one comparisons of firearm toolmarks that are then used in conjunction with the relevant reference populations to calculate its statistical weight of evidence. This presentation will describe the reference database design, analysis modules, proposed workflow/implementation, statistical analysis, milestones, and future plans of RPDFT.

Cadre Verification and Use in Casework

Sabrina S. Cillessen, Virginia Department of Forensic Science

Sabrina S. Cillessen, the Physical Evidence Program Manager with the Virginia Department of Forensic Science, will provide a summary of the three verification studies completed utilizing the TopMatch-3D High-Capacity Scanner and the Virtual Comparison Microscopy software. The equipment verification established accurate, reproducible, and repeatable measurements as well as determined sources of variability. Scans of the sinusoidal standard were collected at various times, by different users, and with different gels to identify the sources of variability. The gels contributed to the variability of the measurements, but the gels did not affect the image quality. The Virtual Comparison Microscopy (VCM) verifications determined the limitations of rendering comparison conclusions from 3D images. Cartridge cases from previously examined tests were used for one of the VCM verifications. The image quality was identified as a limitation in the verification. The use of software tools allowed examiners to document the basis for the conclusion as well as image quality evaluations. The second VCM verification was conducted on cartridge cases for similar firearms to determine limitations associated with grouping items, but not conducting conclusive comparison examination, with the 3D images. The Virginia Department of Forensic Science's Eastern Laboratory Firearms Section implemented the use of 3D images in a National Integrated Ballistic Information Network triage workflow.

DAY 3—INTELLIGENCE

Keynote—The Crime Gun Intelligence Revolution

Thomas Chittum, Bureau of Alcohol, Tobacco, Firearms and Explosives

The tools and concept of Crime Gun Intelligence (CGI) are revolutionizing the way law enforcement fights gun crime. Firearm and toolmarks examiners play a crucial role in this revolution. This presentation will cover the history and evolution of CGI—including missed opportunities; the reasons behind the increasing prominence of ballistic imaging; the importance of laboratory services to prevent violent crime (not just to prosecute offenders); and the emerging role that data, analytics, and intelligence personnel play in effective crime detection and prevention.

This presentation will also (1) include an overview of the two broad threats of gun crime that America faces and an in-depth discussion of the Department of Justice's enforcement strategy for combatting them; (2) examine the indispensable role of state and local authorities and how partnerships and intelligence are central to the effort; and (3) examine some of the technological, scientific, cultural, legal, and human challenges we must overcome to achieve CGI's full potential. The presenter will offer some promising innovations and techniques and look at what the future holds. This presentation will touch on important ways that everyone can contribute to the collective effort to make America safer.

National Institute of Justice's Forensic Intelligence (FOR-INT) Initiative: Using Forensics for Crime Disruption and Prevention

Jonathan McGrath* and Basia E. Lopez,* National Institute of Justice

The National Institute of Justice (NIJ) is developing a "Forensics Intelligence" (FOR-INT) framework to assist state, local, and tribal law enforcement as well as forensic laboratories with integrating forensic crime laboratory data into the criminal intelligence and analysis process to advance the disruption and prevention of crime through actionable intelligence. Forensic intelligence is defined as the collection, organization, interpretation, and sharing of forensic case data in support of criminal investigations and intelligence procedures. Current practices utilize forensic data to solve and prosecute individual crimes. However, there are rich datasets amassed within state and local forensic laboratories. The NIJ FOR-INT approach uses these datasets to link and track crime patterns specific to local jurisdictions and ultimately reduce crime in those areas. This presentation will focus on program updates, including progress on related research; findings from visits to international and domestic agencies that implement forensic-led policing strategies; and updates about the development of the NIJ FOR-INT framework.

Forensic Intelligence: Incorporating Forensic Data Sets in Criminal Investigations

Yaneisy Delgado, Miami-Dade Police Department Forensic Services Bureau

The Miami-Dade Police Department Forensic Services Bureau (FSB) has a robust National Integrated Ballistic Information Network (NIBIN) program located within its Forensic Identification Section. Historically, the Forensic Identification Section distributed NIBIN link information associated with gun crimes but did not have an effective way to merge these investigative leads with traditional investigative databases. In 2019, the FSB hired its first Intelligence Analyst to fully integrate all types of forensic data into criminal investigations, creating a foundation for downstream intelligence efforts. This methodology is a departure from a traditional Crime Gun Intelligence Center, as the intelligence analyst is embedded within the forensic operation. Utilizing social media, open-source information, and various law enforcement databases, an intelligence analyst receives the NIBIN link information and creates Crime Gun Event reports. These reports translate the forensic information provided by the crime laboratory via the generation of spiderweb charts displaying the inter- and intra- connections of associated criminal incidents. These efforts yield concise investigative leads to aid a criminal investigation that are independent of both the forensic analyses and the law enforcement investigation.

Milwaukee Police Department—NIBIN Overview

Branko Stojsavljević* and Ryan Orlovsky,* Milwaukee Police Department

Members of the Milwaukee Police Department will provide a brief overview of the structure of the department and how the National Integrated Ballistic Information Network program is leveraged to support the City of Milwaukee by reducing crime and disorder through intelligence-led and problem-oriented policing.

Technical Intelligence: An Operational Tool

Tara Garvey,* Philadelphia Police Department Intelligence Bureau, and Mike Garvey,* Philadelphia Police Department Office of Forensic Science

The Philadelphia Police Department (PPD) Technical Intelligence Program (TIP) is a joint program between the Office of Forensic Science (OFS) and the Intelligence Bureau/Delaware Valley Intelligence Center that supports investigative and patrol operations within the PPD. The program includes information sharing of technical data generated by the OFS; generation of analytic products or situational awareness products using the OFS data; a coordinated review process of all technical intelligence analytic products by OFS personnel; and the sharing of any information/products on emerging trends received by the Delaware Valley Intelligence Center from their federal, state, or local partners with OFS personnel. The PPD/TIP includes the complete intelligence cycle, incorporating forensic results with other information and intelligence sources—such as gang information, human intelligence, and other law enforcement data—into the final products. Building off of the PPD's success with Crime Gun Intelligence, the PPD/TIP continues the critical collaborations with partner agencies—such as the Bureau of

Alcohol, Tobacco, Firearms and Explosives' Crime Gun Intelligence Center, the Federal Bureau of Investigation, the PA Attorney General's Gun Violence Taskforce, and other city departments—to build requirements, enhance products, and generate strategic and tactical products. This comprehensive approach to intelligence allows the PPD to provide actionable intelligence to assist investigations, deploy resources more efficiently, and enhance public safety.

Evidence Screening in Support of NIBIN

Jessica Ellefritz, Phoenix Police Department

Any effective Crime Gun Intelligence Program relies on the expeditious processing of firearms-related evidence to achieve the goal of intelligence lead and firearms investigations. The possible intelligence gained through National Integrated Ballistic Information Network (NIBIN) leads loses value the longer it takes to identify the associations and pass that information on to investigators. In NIBIN processing, timeliness is crucial. As law enforcement agencies across the country begin to establish their own Crime Gun Intelligence Center (CGIC) sites outside of the lab environment, many are faced with a recurring concern: how to implement a timely NIBIN process that coincides with the needs for DNA, latent prints, and further firearms processing by forensic scientists and meets prosecutorial needs for later trials. Phoenix Police Department was awarded the Bureau of Justice Assistance CGIC grant in 2016. This presentation will discuss their pre-grant structure, the challenges they faced in making a department-wide cultural change in evidence handling, and the partnerships required to implement new evidence screening and processing strategies in support of CGIC goals. It will also display the pre-grant versus post-grant impact that making these collaborative changes had on the effectiveness of their CGIC program.

DAY 4—LEGAL ASPECTS

Keynote—The Accuracy, Repeatability, and Reproducibility of Firearms/Toolmarks Comparisons

Erich Smith*, Keith L. Monson, and Jennifer L. Stephenson, FBI Laboratory; L. Scott Chumbley, Stanley J. Bajic, Max D. Morris, Daniel S. Zamzow, Ames Laboratory

After attending this presentation, attendees will better understand the design process and results achieved in a large-scale decision analysis ("black box") study involving a large group of firearms examiners. This presentation will impact the forensic science community by providing empirical measurements of the accuracy, repeatability, and reproducibility of analyses performed by firearms examiners for cartridge case and bullet sample sets.

The study hypothesis was that trained/qualified firearms examiners can accurately determine source conclusions (repeatability) when applying the Association of Firearms and Tool Mark Examiners Theory of Identification and reproduce the same result(s) when later encountering the same comparison. This study complements those conducted previously, adding important features. A previous study conducted on the accuracy of firearms examiners was generally viewed favorably by the President's Council of Advisors on Science and Technology (PCAST), but PCAST advised that additional, similarly designed black box investigations were required to establish foundational validity.

The present study implemented a fully randomized, open set, and double-blind design involving challenging comparisons of fired bullets and cartridge cases. To maintain double-blind conditions, the experimental study was conducted under contract by scientific staff at another organization, which sent randomized specimens to participating examiners and performed statistical analysis. Following a call for participants, volunteer active examiners were provided with 15 comparison sets of three cartridge cases (two known and one unknown) fired from a collection of Beretta® and Jimenez® firearms and 15 comparisons sets of three bullets (two known and one unknown) fired from Beretta and Ruger® firearms. To minimize the reproduction of marks, the ammunition selected for testing were Wolf Polyformance® 9 mm Luger (9x19mm), with acrylic polymer-coated, steel cartridge cases and lead core, copper-plated, steel-jacketed bullets. The firearms and ammunition selected for this study were purposely chosen because of their propensity to produce challenging and ambiguous test samples, creating difficult comparisons for examiners. The firearms, bullets, and cartridge cases used for the study were collected by researchers in the first laboratory and delivered to scientists in the contract laboratory, who then conducted the study and engaged in the generation and distribution of test packets and collection and analysis of the data. A total of 173 qualified examiners took part in the study. The participating examiners were asked to follow the provided instructions rather than adhere to their laboratory policies, and they were instructed not to discuss their results with anyone else in their laboratory. To further maintain the double-blind, black box nature of the study, the team associated with communicating with the examiners was not aware of the contents of each comparison set, and the experimental or analysis group was never aware of the examiners' identities.

Of the 20,130 comparisons carried out, 8,640 were tested for accuracy, 5,700 were tested for repeatability, and 5,790 were tested for reproducibility. Definitive false-positive error rate estimates that take examiner heterogeneity into account are 0.66% for bullets and 0.93% for cartridge cases. False-negative error rate

estimates are 2.87% (bullets) and 1.87% (cartridge cases). The numbers found in the current study are generally consistent with the results reported in prior studies and therefore constitute the foundational validation the PCAST report said was lacking.

Five Years Later: An Overview of Firearms and Toolmarks Admissibility Decisions After the PCAST Report

Amie Ely, National Association of Attorneys General

In September 2016, the President's Council of Advisors on Science and Technology (PCAST) issued a report to President Barack Obama titled "Forensic Science in the Criminal Courts: Ensuring Scientific Validity of Feature-Comparison Methods." In this report, PCAST assessed a number of forensic science disciplines for "foundational validity." PCAST concluded that certain disciplines met its standard; however, PCAST opined that "current evidence" supporting firearms and toolmarks "falls short of the scientific criteria for foundational validity." The National Association of Attorneys General has endeavored to track "PCAST decisions"—that is, post-September 2016 court decisions that address the admissibility of forensic science evidence. Most of these decisions were issued through written opinions and almost all of them cite the previously mentioned PCAST report—typically because the party seeking to exclude or limit forensic science evidence cited the report. This presentation will provide a snapshot of nearly 100 PCAST decisions that address the admissibility of forensic science evidence, with additional analysis of more than 50 firearms and toolmark decisions. The presentation will also include a short overview of potential amendments to Federal Rule of Evidence 702 and Federal Rule of Criminal Procedure 16, as well as an introduction to the National Institute of Justice National Center on Forensics.

Firearm & Toolmark Evidence Admissibility & Current Challenges

Raymond Valerio, Queens District Attorney's Office

This presentation will discuss current challenges to firearm and toolmark evidence. Specifically, the presenter will discuss two main criticisms: how to treat inconclusive decisions in validation studies and how to define the relevant scientific community. Critics argue that inconclusive decisions in validation studies should be counted as error, even though studies show that not all casings mark well enough to identify or eliminate. This insistence that all decisions must be "correct" or "error" is overly simplistic. Identification, elimination, and inconclusive are all legitimate outcomes both in casework as well as in validation studies.

As it relates to defining the relevant scientific community, many courts have recognized that "relevance" is key. In this talk, we will consider where to draw the line for "relevance." These two issues have been argued against the use of firearm and toolmark evidence in various state and federal courts through Frye/Daubert litigation. Despite these challenges, firearm and toolmark evidence is still a reliable forensic science discipline.


FIREARM & TOOLMARKS
POLICY & PRACTICE FORUM

PRESENTER BIOS

Michael Beddow

Michael Beddow received his BS in chemistry from Northern Arizona University and his MS in forensic science from the University of California at Davis. He was first introduced to the field of forensic firearms examination during his undergraduate education. At the time, he assisted prominent members of the forensic firearms community with various research projects, including analysis of bullet lead isotopic pattern distribution and variation between smoothbore and rifled barrels. Mr. Beddow's graduate thesis, "Micro-Marked Firing Pins: Their Character Durability and Micro-Mark Legibility on Fired Cartridge Cases," gained national attention because it related to proposed legislation in multiple states. His thesis was presented at the American Academy of Forensic Sciences and Association of Firearm and Tool Mark Examiners (AFTE) annual conferences in 2007 and was successfully published in the AFTE journal in 2008. Mr. Beddow's professional career began as a laboratory National Integrated Ballistic Information Network technician employed by the Sacramento County District Attorney's Crime Laboratory. In 2008, he accepted a job as a forensic firearms examiner with the Phoenix Police Department Crime Laboratory. In his 14 years with the Phoenix Police Crime Laboratory, he has advanced from a Forensic Scientist I to a Lead Forensic Scientist IV. He has assisted with multiple validations and implementations of new processes and technologies, including Quantofix® Nitrite Sheets for use in the Modified Griess test and the Evofinder® system for Virtual Comparison Microscopy. His validation of the Quantofix Nitrite Sheets was published in the *AFTE Journal* in 2018. Mr. Beddow is an active member in the AFTE community and currently sits on one subcommittee. He is also a member of the 3D Toolmark Technologies Technical Working Group, which is working to develop standards for the validation and implementation of 3D technologies into firearm and toolmark laboratories. Upon his promotion to a Forensic Scientist IV in 2013, Mr. Beddow became the primary trainer of new firearms examiners for his laboratory. Since then, he has successfully trained four firearms examiners, with two more currently in training.

Thomas Chittum (Keynote Speaker)

Thomas Chittum currently serves as the Acting Deputy Director and Chief Operating Officer, the second highest official of the Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF). He is a lawyer, a career federal agent, a member of the Senior Executive Service, and an adjunct law professor. He has spent more than 2 decades enforcing federal firearms laws. He regularly speaks on matters related to criminal justice, law enforcement, and firearms law to cabinet-level and other high-ranking government executives, industry trade groups, law enforcement officials, and the national media. Mr. Chittum's law enforcement career began in his home state of West Virginia in 1997 as a special agent with the Internal Revenue Service's Criminal Investigation Division. He came to ATF in the late 1990s and has been assigned to offices in Miami, FL; Louisville, KY; Las Vegas, NV; Seattle, WA; Detroit, MI; and multiple assignments in Washington, DC. He worked

extensively in undercover assignments from 2002 to 2008. From 2005 to 2012, he regularly testified as an expert witness in federal court on firearms matters. Mr. Chittum has a BA in criminal justice from Marshall University in Huntington, WV; an MS in criminal justice from Eastern Kentucky University in Richmond, KY; and a JD from the University of Nevada—Las Vegas. He is a licensed attorney in Virginia, West Virginia, and Kentucky. He lives with his wife and three children in Virginia.

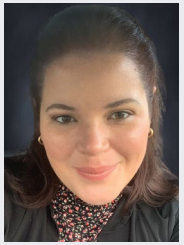
Deion P. Christophe

Deion P. Christophe specializes in identifying, collecting, preserving, examining, and interpreting the physical evidence associated with specific criminal acts. Mr. Christophe has conducted countless examinations on firearms and ammunition components, and has testified as an expert witness in both state and federal courts of law. He has previously assisted in research efforts with Delfino Studios (*Saving Grace*) and has coauthored the workbook *Forensic Analysis of Impressions Evidence*. Mr. Christophe is dedicated to the advancement of firearm and toolmark analysis and tailors his research interests to aid in the understanding of technologies that can advance investigations.

Sabrina S. Cillessen

Sabrina S. Cillessen started her career with the Arizona Department of Public Safety in 1998. She conducted latent prints examinations, responded to methamphetamine clandestine labs, and analyzed controlled substances. In 2006, Ms. Cillessen became the Supervisor of the Latent Print section in addition to supervising DNA serology examiners and lab technicians. In 2011, she joined the Virginia Department of Forensic Science as the Physical Evidence Program Manager. Her initial responsibilities included the quality and technical aspects of the Bloodstain Pattern, Questioned Documents, Latent Prints, Shoe/Tire Impression, Firearms & Toolmarks, and Digital Multimedia Evidence sections. Due to the reduction in forensics services within the department, her current responsibilities focus on the Latent Prints, Shoe/Tire Impressions, Firearms & Toolmarks, and Digital Multimedia Evidence sections. Ms. Cillessen works closely with the technical resource teams to ensure technical procedures are appropriate and meet accreditation criteria. During her time in Virginia, she implemented the Mideo Systems Inc. Latent Works for complete latent print case file documentation, as well as random case selection for blind verification. She is currently working with the Firearms & Toolmarks Section to implement 3D technology for the comparison of cartridge cases. Ms. Cillessen graduated from Metropolitan State College of Denver with a BS in chemistry with an emphasis in criminalistics and an MS in pharmacy with a forensic science focus from the University of Florida. She served as an adjunct faculty member at Phoenix College teaching the course Criminalistics: Biological Evidence. She is a member of the International Association for Identification and the American Society of Crime Laboratory Directors.

Yaneisy Delgado

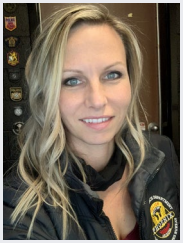


Yaneisy Delgado is an intelligence analyst currently assigned to the Miami-Dade Police Department (MDPD) Forensic Services Bureau. She has been employed by the MDPD for almost 6 years, including 1 year as a real-time crime center specialist and 2 years in her current role as an intelligence analyst. She is responsible for generating Crime Gun Event Reports that translate the information generated from forensic analyses to actionable intelligence. Her work assists in disrupting the cycle of violence by identifying key subjects connected to gun crime events linked through the National Integrated Ballistic Information Network. Ms. Delgado serves on multiple multi-jurisdictional task forces composed of investigators, high-ranking law enforcement personnel, federal and state prosecutors, and other criminal justice stakeholders. Her expertise in combining traditional and forensic datasets has been a transformative force in the way gun crimes are investigated in Miami-Dade County.

Gregory Dutton

Dr. Gregory Dutton is a program manager at the National Institute of Justice (NIJ) within the U.S. Department of Justice. He manages portfolios in Forensic Science Research & Development as well as NIJ's Graduate Research Fellowship Program. Trained as an experimental physical chemist, he now works to bring advances from across the physical and life sciences into the forensic sciences. His portfolio includes imaging and pattern comparison in the impression and pattern evidence disciplines (e.g., latent fingerprints, firearms, footwear); advanced spectroscopy and machine learning for trace evidence (e.g., paint, fibers, gunshot residue); and trace microbiome analysis for forensic applications. Prior to joining NIJ, Dr. Dutton was a postdoc at the National Institute of Standards and Technology. He has a PhD in chemistry from the University of Minnesota and a BA from Williams College.

Jessica Ellefritz



Jessica Ellefritz is a criminal intelligence analyst and supervisor with the Phoenix Police Department Violent Crimes Bureau, Crime Gun Intelligence Unit. She has worked for Phoenix Police for 17 years and has been working with the Crime Gun Intelligence Unit since 2010. Ms. Ellefritz became a certified National Integrated Ballistic Information Network trainer in Arizona in 2014 and has trained over 45 new users from across the country in acquisition protocols for the Integrated Ballistics Identification System. As a founding member of the Phoenix Crime Gun Intelligence Unit, she has assisted law enforcement agencies across the country that are recipients of the Bureau of Justice Assistance Crime Gun Intelligence Center grant to establish the groundwork for implementing their programs. Ms. Ellefritz has provided Crime Gun Intelligence training to sworn law enforcement at the Arizona Homicide Investigators Association Annual Conference,

presented advancements in police investigative techniques at the International Association of Chiefs of Police Conference, and taught at the Office of the Attorney General Advanced Forensic Science Academy. She graduated from Arizona State University in 2002 with a BS in justice studies.

Amie Ely

Amie Ely is the Director of the Center for Ethics and Public Integrity at the National Association of Attorneys General (NAAG). Her Center provides training and research focused on anticorruption and ethics to attorney general offices and other government attorneys. Ms. Ely is also a co-editor of *The Anticorruption Manual: A Guide for State Prosecutors*, a 660-page book released in August 2021. In addition to her anticorruption and ethics work, she has conducted national forensic science trainings for prosecutors and has been invited to speak nationally and internationally about forensic science.

In early 2021, she began leading NAAG's efforts to establish and manage the National Institute of Justice's National Center on Forensics (NCF), in partnership with George Mason University, the American Society for Clinical Pathology, and the Montana Forensic Science Division. Through the NCF, she focuses on providing forensic science–related trainings and resources to prosecutors and judges.

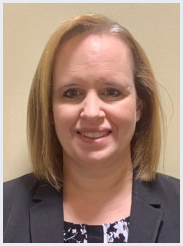
Ms. Ely majored in psychology, biology, and neuroscience at Oberlin College. Her law degree is from Cornell Law School, where she was an articles editor on law review and elected commencement speaker. After law school, she clerked for the Honorable Stephen C. Robinson in the Southern District of New York as well as for the Honorable Richard C. Wesley on the Second Circuit Court of Appeals. Following her clerkships, she joined the U.S. Attorney's Office for the Southern District of New York. During nearly 7 years as an assistant U.S. attorney, she prosecuted hundreds of defendants, was lead or co-lead counsel in more than 10 trials, and represented the U.S. government in over a dozen appeals to the Second Circuit.

Mike Garvey

As a deputy managing director for the City of Philadelphia, Mike Garvey serves as the Director of the Office of Forensic Science for the Philadelphia Police Department (PPD). He is responsible for an ISO 17025 accredited full-service forensic laboratory, providing oversight to all PPD forensic operations, maintaining national quality standards, and advancing the city's forensic capabilities. Director Garvey participates in numerous national forensic organizations. He is the Chairperson of the Major Cities Chiefs Association's Forensic Science Committee and Forensic Laboratory Needs Technology Working Group Technology Needs Subcommittee, and he is a member of the Bureau of Alcohol, Tobacco, Firearms and Explosives National Crime Gun Intelligence Governing Board, International Association of Chiefs of Police's Forensic Science Committee, Criminal Justice Information Services Division Advisory Board, the Federal Bureau of Investigation Task Force on Rapid DNA, and the American Society of Crime Laboratory Directors. Prior to joining the PPD, Director

Garvey served the U.S. Government for approximately 15 years as a scientific expert and executive in both the Federal Bureau of Investigation and Central Intelligence Agency. In these positions, he worked on traditional criminal casework, counter-terrorism cases, and other intelligence operations around the globe. In 2011, he returned home to Philadelphia to lead the city's forensic operations. In addition to his public service, Director Garvey has also served as an adjunct professor in Biology and Forensic Science at the University of the Sciences in Philadelphia, Temple University in the Fox School of Business and Beasley School of Law, and as an advisor for the Drexel University graduate program in Forensic Science. He has also taken an interest in youth programs as a scout leader in his son's Boy Scouts of America troop and is developing a Science Explorers program at the PPD/Office of Forensic Science.

Tara Garvey



Tara Garvey is currently a deputy director within the Philadelphia Police Department Intelligence Bureau supporting the Chief Inspector in the development of policies, procedures, and operations. She previously served as the Deputy Director of the Delaware Valley Intelligence Center (DVIC) in Philadelphia, PA. She was responsible for managing the daily operations of the DVIC, which included the development of all analytical products; collaborations with local, state, and federal agencies; partnerships with the community; and other related activities. She has been with the Philadelphia Police Department since January 2013. Dr. Garvey is a graduate of Rutgers University and The George Washington University, where she received a PhD in Genetics through a joint program with the National Institutes of Health (NIH). Upon receiving her doctorate, she completed an NIH Post-Doctoral Fellowship at the National Institute of Allergy and Infectious Diseases. From there, she joined the United States Patent and Trademark Office in Alexandria, VA, as a biotechnology patent examiner. In this role, she examined patent applications in technical areas that ranged from gene therapy to biodetection assays. After a few years, she decided to pursue a career that would allow her to better serve her country. Dr. Garvey joined the Central Intelligence Agency, embarking on an exciting profession that allowed her to apply her knowledge of science and technology to matters of national security. She originally worked in the Directorate of Science and Technology as a technical intelligence officer, supporting various operations, intelligence analyses, and research and development projects. In an assignment with In-Q-Tel, she enhanced the capabilities of the U.S. government through the development of venture capital programs. Based on her extensive technical knowledge and ability to develop practical solutions, she had the opportunity to further expand her operational expertise by working as a special skills officer in the Counterproliferation Center of the National Clandestine Service.

Ryan Lilien (Keynote Speaker)

Dr. Ryan Lilien focuses his research expertise on the use of advanced scientific computing and statistical models to solve interdisciplinary research problems. He earned his MD from Dartmouth Medical School and his PhD from Dartmouth's Department of Computer Science. Dr. Lilien was a faculty member at the University of Toronto, cross-appointed between the Department of Computer Science and the Faculty of Medicine. Now at Cadre Forensics, he leads development of the TopMatch-3D High-Capacity system. For the past 8 years, he has presented at national and regional Association of Firearm and Tool Mark Examiners meetings about his group's steady progress on developing and validating the system. Dr. Lilien has provided instruction at the National Firearms Examiner Academy and regional training seminars, and within individual laboratories. He is currently a member of the Subcommittee on Firearms & Toolmarks within the National Institute of Standards and Technology's Organization of Scientific Area Committees for Forensic Science.

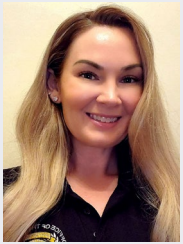
Basia E. Lopez

Basia E. Lopez is a social science research analyst in the Office of Research, Evaluation, and Technology at the National Institute of Justice (NIJ), where she leads Firearm Violence and Victims of Crime programs of research. She also works on projects related to terrorism and school safety. Ms. Lopez co-initiated and now leads a scientific, collaborative effort to develop NIJ's Forensic Intelligence Framework to assist local and state law enforcement agencies in integrating forensic crime laboratory data into the criminal intelligence and analysis process to advance approaches to crime prevention and reduction. She is a recipient of the NIJ Special Act Award in recognition of her leadership in developing the collaborative research project on mass shootings with the Federal Bureau of Investigation's Behavioral Analysis Unit. She coauthored articles on the topics related to her areas of expertise. Prior to her career with NIJ, Ms. Lopez worked as a crime and criminal intelligence analyst in Jonesboro City Police Department, AR, where she developed and led all the processes related to crime, intelligence, and investigative analysis. Concurrently, she worked in academia teaching courses in both Criminology and Political Science departments at Arkansas State University. Her research interests include public policy and program evaluation and crime prevention and disruption through the lens of socio-ecological perspective and utilization of geographic information system social science applied research/spatiotemporal analysis and statistics. She has a BA in criminology and an MA in public administration from Arkansas State University—Jonesboro. She also obtained a post-baccalaureate certificate in Crime and Intelligence Analysis from the California State University—Sacramento. Currently, she is working on her dissertation at Walden University for a PhD in public policy and administration with a concentration in policy analysis.

Jonathan McGrath

Dr. Jonathan McGrath joined the National Institute of Justice (NIJ) in 2015 and serves as a senior policy analyst with the NIJ Office of Investigative and Forensic Sciences in Washington, DC. He co-manages the Forensic Technology Center of Excellence program and co-initiated the scientific, collaborative effort to develop NIJ's Forensic Intelligence Framework to assist local and state law enforcement agencies in integrating forensic crime laboratory data into the criminal intelligence and analysis process to advance approaches to crime prevention and reduction. He led the Department of Justice's needs assessment of forensic laboratories and medical examiner and coroner offices and served as program manager for the National Commission on Forensic Science. Prior to joining NIJ, he served as forensic scientist and program manager at the U.S. Customs and Border Protection's Laboratories and Scientific Services in Houston, TX (2007–2011), and Washington, DC (2011–2015), where he supported Customs and Border Patrol's trade, forensic, and Weapons of Mass Destruction operations programs.

Lacey Oden



Lacey Oden has been employed at the Escambia County Sheriff's Office (ECSO) for almost 15 years. In 2006, at the age of 18, she started her career at ECSO. Her first position was a detention assistant at the Central Booking Center. A year later, she was ready to expand her career into the field of forensics. Ms. Oden was promoted to evidence technician, where, after a few months, she made a lateral move into the Crime Scene Unit as a crime scene technician. Over 12 years, she has served as a forensic field training officer. She was the first certified ECSO member to obtain the International Association of Identification (IAI) Crime Scene Analyst Certification and is currently one of 321 IAI senior certified crime scene analysts in the United States. Ms. Oden graduated with honors with a 4.0 grade point average from Oklahoma State University with an MS in forensic science. Since 2015, she has coordinated and instructed block training for ECSO Law Enforcement Sworn personnel on crime scene processing, fingerprint examination, and death investigations. She is a certified Basic Life Support Instructor for the American Heart Association, making her responsible for certification and recertification of sworn and non-sworn personnel. As of July 2021, Ms. Oden has investigated over 6,000 crime scenes. She has been listed as a witness for court testimony in 2,034 cases and has received Letters of Appreciation for expert testimony from Assistant State Attorney Bridgett Jensen (2015), Alvin Myers (2016), and Sheriff David Morgan (2015) and a Unit Citation and Certificate of Special Congressional Recognition for forensic work on Billings homicide investigation (2010). She has been invited to various universities and colleges as a guest speaker on various disciplines in forensic science. Ms. Oden received the Survivor Support Star Award from The Escambia/Santa Rosa Sexual Assault Response Team for instructing sexual assault nurse examiner nurses on forensic photography and chain of custody (2019), Awarded Law Enforcement Employee of the Quarter (2018), and Law Enforcement Employee of the Year (2019). She participates in quarterly meetings for the Mass Casualty Response Team and in community relation events such as Citizen Law Enforcement Academy, ECSO Crime Lab Tours, school functions, neighborhood watch meetings, and Boy Scouts of America presentations. In addition, she is a certified Florida Department of Law Enforcement Instructor and a part-time vocational instructor

for Escambia County School District, where she instructs cadets at the Law Enforcement Academy on scene security and preservation, crime scene processing, fingerprint examination, and courtroom testimony. In September 2020, Ms. Oden was promoted to the first crime scene supervisor for ECSO, one of few civilian supervisory roles at ECSO.

Ryan Orlovsky

Ryan Orlovsky is the Crime and Intelligence Manager of the Milwaukee Police Department's Fusion Division. In that role, Mr. Orlovsky directly manages 13 tactical crime analysts that support the department by providing actionable intelligence, data, and case support to the Patrol Bureau and Criminal Investigation Bureau. Mr. Orlovsky has been employed with the Milwaukee Police Department since 2015 and served as a crime analyst prior to being promoted in 2020. As a crime analyst, he supports several areas of the department including patrol, the robbery division, violent crimes, and the real-time event center. Before pursuing a career in law enforcement, he worked in the private sector as a loss prevention manager in a corporate setting.

Thomas Brian Renegar

Thomas Brian Renegar is a physical scientist in the Physical Measurement Laboratory at the National Institute of Standards and Technology. He has performed scanned probe and optical 3D measurements and calibrations in the field of surface metrology for over 25 years. Mr. Renegar is also heavily involved in research of measurement methods for forensic ballistic identifications of firearms and toolmarks. He currently serves as Chair of the American Society of Mechanical Engineers B46 Committee on the Classification and Designation of Surface Qualities. He is a technical advisor to the Association of Firearm and Tool Mark Examiners, and is also a member of the Technical Working Group on 3D Toolmark Technologies, which provides guidance and recommendations for the firearms and toolmark community in the adoption of 3D imaging technology.

Heather Seubert (Moderator, Emerging Technologies Panel)

Heather Seubert serves as the Section Chief of the Scientific Analysis Section (SAS) for the Federal Bureau of Investigation (FBI) Laboratory Division. The SAS consists of two senior-level scientists and six units covering five caseworking units and research. The mission of the SAS is to provide the FBI, law enforcement, and the intelligence community with timely and accurate scientific and technical support in the forensic disciplines and sub-disciplines of chemistry, cryptanalysis, firearms and toolmarks, questioned documents, and trace. Prior to serving in this role, Ms. Seubert was the Unit Chief of the Firearms/Toolmarks Unit at the FBI Laboratory from 2010 to 2020. During her time there, she oversaw deployments of unit personnel to such mass shootings as the Aurora Movie Theatre, the Naval Yard, the Pulse Nightclub, the Route 91 Harvest music festival, and the Tree of Life Synagogue. While serving as the Unit Chief of the Firearms/Toolmarks Unit, she supported the implementation of 3D Virtual Comparison Microscopy for ammunition components, leading the nation as the first laboratory to implement this technology for casework examinations. As a result of this accomplishment, she and some of her unit members were the recipient of the FBI Director's Award for Outstanding Scientific Achievement in 2019. She joined the FBI in October 1998 and started her career in the FBI Laboratory as a biologist in the Mitochondrial DNA Unit. In 2000, she was promoted to a forensic examiner in the Nuclear DNA Analysis Unit. During her time in the DNA Unit, she performed serological analysis, conducted DNA examinations, performed bloodstain pattern analysis, provided testimony as an expert in courts across the country, and was one of the primary instructors for the DNA Auditor training to over 3,000 local, state, and federal DNA scientists on the FBI's Quality Assurance Standards. In 2009, Ms. Seubert moved to the Federal DNA Database Unit as an examiner and was a part of the team that worked to eliminate the backlog of convicted offender samples to be profiled and uploaded into the National DNA Index. She was a recipient of the FBI Director's Award for Outstanding Scientific Achievement in 2011. During her time in the DNA Analysis Units, Ms. Seubert was a member of the Scientific Working Group on Bloodstain Pattern Analysis and Vice-Chair of the Scientific Working Group on DNA Analysis Methods. Prior to joining the FBI, Ms. Seubert was employed with the Michigan Department of State Police (1993–1998), Forensic Science Services, East Lansing, MI, where she performed serological examinations, crime scene reconstruction, and blood stain pattern analysis and testified in court. Ms. Seubert is a native of Michigan and holds a BS in Forensic Science from Michigan State University in East Lansing, MI, and an MS in Pharmacy from the University of Florida in Gainesville, FL.

Erich Smith (Keynote Speaker)

Erich Smith is an expert witness in the field of firearms/toolmarks, gunshot residue, and serial number restoration. He examines evidence, prepares case notes, and issues findings regarding evidence submitted for firearms/toolmarks examination. He provides training and assistance to federal, state, and local law enforcement agencies with shooting reconstructions. Mr. Smith participates in and is a member of The Association of Firearm and Tool Mark Examiners. He assisted in the Firearms/Toolmarks Unit's Techniques in Firearms Identification and Shooting Incident Reconstruction schools and was an American Society of Crime Laboratory Directors/Laboratory Accreditation Board International Assessor, and Scientific Working Group for Firearms and Toolmarks representative. He was also an associate professor

of firearms and toolmarks at Virginia Commonwealth University and a member of the Organization of Scientific Area Committees for Forensic Science—Physics/Pattern Interpretation Scientific Area Committee and the Technical Working Group 3D Toolmark Technologies.

Johannes Soons

Dr. Johannes "Hans" Soons is a mechanical engineer in the Surface and Interface Metrology Group of the Physical Measurement Laboratory at the National Institute of Standards and Technology (NIST). He leads the Forensic Firearm and Toolmark Analysis Project at NIST. Dr. Soons received his PhD at the precision engineering laboratory of the Eindhoven University of Technology in the Netherlands. Since 1994, he has worked at NIST as a researcher, group leader, and project leader. His work involves surface texture metrology, precision machining, measurement of precision optics, and forensics. His current research focuses on improving methods for objective firearm and toolmark analysis and addresses measurement methods, standards, databases, similarity metrics, algorithms, and weight of evidence.

Stephanie Stoiloff (Moderator, Intelligence Panel)

Stephanie Stoiloff has served as Commander of the Miami-Dade Police Department Forensic Services Bureau for more than 16 years. The Forensic Services Bureau operates a full-service, accredited crime laboratory. The laboratory provides forensic services for the Miami-Dade Police Department, all municipal agencies in Miami-Dade County, and state and federal agencies upon request. Ms. Stoiloff currently serves on many working groups and advisory boards, including the Forensic Laboratory Needs Technology Working Group established by the National Institute of Justice, the Federal Bureau of Investigation's Rapid DNA Crime Scene Technology Advancement Task Group, the Practitioner and Technical Advisory Board for the Center for Statistics and Applications in Forensic Evidence, and the External Board of Advisors for the Florida International University International Forensic Research Institute. Ms. Stoiloff is also a member of the Major Cities Chiefs Forensic Science Committee and the International Association of Chiefs of Police's Police Investigative Operations Committee. Ms. Stoiloff also served on the American Society of Crime Laboratory Directors Board of Directors and served as a member of the Technical Working Group for the Preservation of Biological Evidence and the Sexual Assault Forensic Examination Response Working Group. During 2018–2019, Ms. Stoiloff was also a member of a task team under the Criminal Intelligence Coordinating Council to develop Promising Practices in Forensic Lab Intelligence. Ms. Stoiloff has provided presentations at national and international meetings on topics including forensic intelligence, accreditation, managing forensic operations, biological evidence preservation, and Rapid DNA analysis.

Branko Stojsavljević

Lieutenant Branko Stojsavljević is the Commanding Officer of the Milwaukee Police Department's Fusion Division and Director of Southeastern Wisconsin Threat Analysis Center—1 of 80 United States Department of Homeland Security–recognized Fusion Centers. Throughout his 27 years of law enforcement experience, Lieutenant Stojsavljević worked in both patrol detective bureaus. His assignments as a Lieutenant have included overseeing the Homicide Division and other detective units. He currently oversees the Joint Terrorism Task Force Officers and Detectives, the Real Time Events Center, Tactical Analysis Unit, National Integrated Ballistic Information Network Unit, High Technology Unit, Election Fraud Unit, and the Dignitary Protection Unit. Lieutenant Stojsavljević is a member of the Coast Guard Selected Reserve component serving as a special agent attached to the Coast Guard Investigative Service. In that capacity, he has completed the Leadership and Management School and Direct Entry Petty Officer Training.

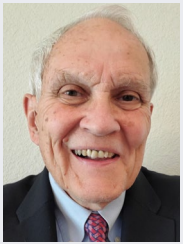
Robert M. Thompson (Moderator, Research Panel)

Robert M. Thompson has been a senior forensic science research manager with the Special Programs Office–Forensic Sciences at the National Institute of Standards and Technology (NIST) for 14 years. He has over 40 years of experience as a forensic scientist and criminalist. He is certified in criminalistics by the American Board of Criminalistics and is a past chairman and current member of the Association of Firearm and Tool Mark Examiners (AFTE) Certification Program Committee. He is a Distinguished Member of AFTE and a Fellow of the American Academy of Forensic Sciences. Mr. Thompson was awarded an MFS degree from The George Washington University in Washington, DC, and a BS in forensic science with a minor in chemistry from the California State University in Sacramento, California. Prior to joining NIST, Mr. Thompson was a senior firearms and toolmark examiner for the Bureau of Alcohol, Tobacco, Firearms and Explosives Forensic Science Laboratories, and a forensic scientist and criminalist in crime laboratories with the Washoe County Sheriff's Department (Reno, NV); the Oregon State Police; and the GeneLex Corporation (Seattle, WA). His court-accepted expert testimony includes firearm/toolmark identification, proximity testing, serology and DNA analysis, drug analysis, hair and fiber examination, blood spatter reconstruction, shoe print comparison, and crime scene/shooting reconstruction. Mr. Thompson has testified as an expert witness in numerous federal and state courts and has active professional affiliations with several regional, national, and international forensic science societies and standards development organizations. He is published in the *Journal of Forensic Sciences; Forensic Science International; Journal for the Association of Firearm and Tool Mark Examiners; Proceedings of SPIE—The International Society for Optical Engineering; NIST Journal of Research; Surface Topography: Metrology and Properties; Measurement Science and Technology; Measurement Science Review; Inside ATF; FBI Crime Laboratory Digest;* and the *Proceedings of Saratov University (Russia).*

Raymond Valerio (Moderator, Legal Aspects Panel)

Raymond Valerio has been an assistant district attorney since 2004 for the Bronx and then Queens District Attorney's Offices. Currently, he is the Director of Forensic Sciences, overseeing forensic science–based prosecutions across all divisions within the Office. In this capacity, he collaborates with the Conviction Integrity Unit and the Cold Case Unit and acts as a liaison to the Office of Chief Medical Examiner Forensic Biology and Toxicology Laboratories, New York City Police Department (NYPD) Laboratory, NYPD Crime Scene Unit, New York State Commission on Forensic Science, and the American Academy of Forensic Sciences. Mr. Valerio was the 2018 Thomas E. Dewey Medal recipient for outstanding prosecutor from the New York City Bar Association. *Wiley Interdisciplinary Reviews Forensic Science*, a peer-reviewed scientific journal, recently published Mr. Valerio's article titled "Likelihood ratios for lawyers…I didn't go to law school for this." Mr. Valerio has taught for or at the National District Attorney's Association, the American Academy of Forensic Sciences Annual Conference, the National Association of Attorneys General National Forensic Science Symposium, the U.S. Attorney's Offices, the Bronx and Queens District Attorney's Offices, the NYPD Police Academy, and the Association of Prosecuting Attorneys Innovation in Prosecution Summit. Mr. Valerio received his BA from the University of Pennsylvania in 2001 and his JD from Temple University School of Law in 2004.

Theodore Vorburger (Keynote Speaker)



Theodore Vorburger is a physicist and a guest researcher in the Surface Science Division at the National Institute of Standards and Technology (NIST) and a former group leader there. He earned his BS from Manhattan College in 1965; he graduated with his MS and PhD from Yale University in 1966 and 1969, respectively. After graduation, he was a postdoctoral research associate at the University of Delaware, then assistant professor of physics at Delaware State College. During his tenure as a NIST employee from 1972 to 2009, Dr. Vorburger's group was responsible for surface roughness and step height calibrations, which underpin the U.S. measurement system for surface finish and for traceable linewidth measurements using critical dimension atomic force microscopes. Dr. Vorburger was co-leader of a project to develop standard bullets and cartridge cases for forensic laboratories and of a team to assess the feasibility of a National Ballistics Imaging Database of new firearms under a National Academies Project. He also led the development of a calibrated atomic force microscope for calibrations of surface nanoscale-length specimens, the application of atom-based step height standards for nanoscale dimensional calibrations, and the development of a light-scattering system for measuring surface roughness, and he collaborated in the development of the world's first sinusoidal-roughness Standard Reference Materials. He is a member and former chair of the American Society of Mechanical Engineers National (ASME) Standards Committee B46 on the Classification and Designation of Surface Qualities, a subject matter expert for the equivalent Working Group under the International Organization for Standardization, and a member and former task group leader of the Organization of Scientific Area Committees for Forensic Science's Firearms & Tool Marks Subcommittee. In 1992, Dr. Vorburger was a recipient of a Department of Commerce Silver Medal for his work in surface metrology. He was also co-recipient of a NIST Bronze Medal and two major NIST awards, the William P. Slichter award and the Edward Bennett Rosa award. He has also been formally

recognized for his standards committee work by ASME on two occasions. Dr. Vorburger has been working in surface metrology since 1976 and is the principal author or co-author of more than 200 publications on surface metrology, nanometrology, surface physics, atomic physics, and chemical physics, including 38 publications on firearm examination. He currently leads a collaborative project to review the scientific foundations for firearm examination.

Todd J. Weller

Todd J. Weller has been a criminalist for over 21 years. He worked for the Oakland Police Department (CA) for 16 years and is now in private practice. He has performed casework in drug analysis, forensic biology (DNA), and crime scenes and has primarily worked in the firearms identification specialty since 2008. He graduated from the Bureau of Alcohol, Tobacco, Firearms and Explosives' (ATF) National Firearms Examiner Academy (NFEA) in 2009 and is now an instructor at the NFEA. Mr. Weller has a BA in biochemistry/molecular biology from Dartmouth College and an MS in forensic science from the University of California, Davis. For his master's thesis, Mr. Weller collaborated with the National Institute of Standards and Technology (NIST) to study confocal microscopy on test fires from consecutively manufactured Ruger firearms. This research was published in the *Journal of Forensic Sciences*. He has also collaborated with Cadre Research Labs to help study novel 3D measurement technology and machine-learning algorithms. This research has resulted in peer-reviewed publications in the *AFTE Journal* and the *Journal of Forensic Sciences*. Mr. Weller is certified by the American Board of Criminalistics. He has served as the President of the California Association of Criminalistics (CAC) and is currently a co-chair for the CAC's Firearms Study Group. He has also served as the Chair of the Organization of Scientific Area Committees for Forensic Science's Subcommittee on Firearms & Toolmarks and is currently the Vice Chair of that same subcommittee.

Xiaoyu Alan Zheng

Xiaoyu Alan Zheng is a mechanical engineer in Sensor Science Division of the National Institute of Standards and Technology (NIST). He has a BS and an MS in mechanical engineering and focuses his research on objective measurements, comparisons, and statistical weight of evidence reporting of 2D/3D firearm toolmarks. He is currently a member of the Subcommittee on Firearms & Toolmarks in the NIST Organization of Scientific Area Committees for Forensic Science, the Chair of the Technical Advisor committee for The Association of Firearm and Tool Mark Examiners, and a co-chair of the Technical Working Group for 3D Toolmark Technologies.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