Conference Proceedings: 2015 Impression, Pattern, and Trace Evidence Symposium

Jeri D. Ropero-Miller, Crystal M. Daye, and Heidi Eldridge, Editors

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Jeri Ropero-Miller, PhD, is a principal investigator (PI) and Senior Research Forensic Scientist in RTI International's Center for Forensic Sciences. She is a board-certified forensic toxicologist with Fellow status on the American Board of Forensic Toxicology (F-ABFT). She has more than 20 years of experience conducting research, training, technology transfer, and evaluations in forensic science and criminal justice.

Crystal M. Daye, MPA, is a Research Associate in RTI's Center for Justice, Safety and Resilience. Through the Center's Policing, Security, and Investigative Science Program, she's worked on a number of projects focused on emerging topics in law enforcement strategies and operations and forensics.

Heidi Eldridge, MS, is a Research Forensic Scientist in the Center for Forensic Sciences at RTI. Ms. Eldridge has over 11 years' experience in forensic science in the domains of latent prints, crime scene analysis and reconstruction, and controlled substances.

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Acknowledgments

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Introduction

On behalf of RTI International, the National Institute of Justice (NIJ) and the Forensic Technology Center of Excellence (FTCoE), we would like to present the proceedings from the 2015 Impression, Pattern and Trace Evidence Symposium (IPTES). The IPTES was held August 25–27th in San Antonio, Texas, as the first joint symposium to promote collaboration, enhance knowledge transfer, and share best practices and policies for the impression, pattern, and trace evidence forensic science communities.

NIJ and FTCoE are committed to improving the practice of forensic science and strengthening its impact through support of research and development, rigorous technology evaluation and adoption, effective knowledge transfer and education, and comprehensive dissemination of best practices and guidelines to agencies dedicated to combating crime. The future of forensic sciences and its contribution to the public and criminal justice community is a motivating topic to gather expertise in a forum to discuss, learn, and share ideas. It's about becoming part of an essential and historic movement as the forensic sciences continue to advance.

The IPTES was specifically designed to bring together practitioners and researchers to enhance information-sharing and promote collaboration among the impression, pattern, and trace evidence analysts, law enforcement, and legal communities. During this 3-day event, leading experts in their respective fields presented to an audience of nearly 600 attendees. This was truly an international symposium with participants recognized from 22 countries (17 countries represented for onsite participants; and 16 countries represented for online participants): Australia, Brazil, Canada, France, Greece, India, Israel, Liberia, Malaysia, Mexico, Nigeria, Pakistan, the Philippines, Portugal, Singapore, Switzerland, Taiwan, Trinidad and Tobago, Turkey, the United Arab Emirates, the United Kingdom, and the United States, including Puerto Rico and Washington, DC.

The IPTES included opening remarks by Heather Waltke, Associate Director of the National Institute of Justice Office of Investigative and Forensic Sciences, followed by nine half- and full-day workshops on the first day, and by two more full days of information: 2 keynote addresses, 4 plenary sessions, 36 posters, and 52 oral presentations—totaling over 100 presenters. The IPTES was a unique forum that blended onsite participation with an online, interactive presence during some of the sessions. The workshops and posters were available only to participants attending onsite. The FTCoE continues to provide access to the keynote, plenary, and oral presentations through archived recordings available at https://forensiccoe.org/Community-Involvement/NIJ-IPTE-Symposium-2015. The presentations focused on topics that included the latest developments and novel approaches to fingerprint, shoeprint, and tire tread evidence; questioned documents; bloodstain pattern analysis; biometrics; firearms and toolmarks; digital photography; and fibers, paint, tape, and other types of evidence and addressed error rates, testimony, interpretation and reporting, case studies, and technology applications.

The preparation of the IPTES was greatly enhanced by the support of the volunteer steering committee whose dedication to and teamwork in peer-reviewing the abstracts, setting the agenda, and ensuring the scientific integrity of the symposium led to a solid program of innovative science and best practices. Our intent is that the 2015 IPTES Proceedings will be a valuable and enduring resource to the forensic sciences and criminal justice communities and the public they serve.

WORKSHOPS

Getting More from Your Polarized Light and IR Microscopes

Mary W. Carrabba*, PhD, Rogue Spectroscopy, LLC; **Barbara Foster***, Microscopy/Microscopy Education, Inc.

Abstract: Winning a court case often hinges on presenting highly visual, unambiguous images to the judge and jury. A picture is worth a thousand spectra in jury presentations, but having spectra to accompany a picture strengthens the case. The Polarizing (Pol) and Infrared (IR) microscopes have long been workhorses in this arena. This course will enable the participant to use an expanded arsenal of visible and IR microscopy techniques to best advantage, to elucidate trace evidence, to document and present the story that the evidence tells, and to defend that position in court.

The morning begins with a review of microscopy fundamentals, then moves on to a variety of contrast enhancement techniques used to image key information (axial, oblique, darkfield, dispersion staining, phase contrast, Hoffman Modulation Contrast, Pol, differential interference contrast [DIC], and fluorescence). Proper alignment and fine-tuning, image interpretation, and performance monitoring protocols (How do you know that an image is a good image?) will be presented for each technique. Throughout the discussion, specific analyses will be used for illustration, including glass, hair, fibers, polymer matrices, and paint cross-sections.

The afternoon discussion of IR microscopy begins with a comparison between an IR microscope and a polarized light microscope, highlighting both the similarities and differences. Options available for IR microscopes are presented, including several of the contrast techniques discussed in the morning session. The diffraction consequences of using longer wavelengths than visible light are explored, pitfalls highlighted, and corrective approaches presented. Proper alignment of the Fourier transform infrared (FTIR) microscope is reviewed and performance monitoring protocols suggested. What constitutes good data is discussed.

General IR sample preparation is reviewed before transmission and reflection techniques are presented. The three common transmission sample configurations are discussed and compared as to their pros and cons. The effects of spherical aberration and internal reflection will be highlighted and suggestions for minimizing them presented. Reflection techniques commonly used with an IR microscope—specular, reflection-absorption, diffuse, and attenuated total reflection (ATR)—will also be presented. Numerous case examples will be used throughout the discussion to illustrate the application of the various techniques.

Keywords: microscopy, IR spectroscopy, education

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Development of a Reasonable Minimum Documentation Standard in Latent Prints

Abstract: Critics, courts, and researchers alike have been clamoring for increased documentation requirements for latent print comparison work. Accreditation standards support it and good scientific practice requires it, yet surprisingly few forensic laboratories even have a minimum documentation policy. Typically, the amount of documentation done is either minimal in the extreme or left entirely to the discretion of the individual examiner.

Heidi Eldridge, MS,
RTI International

It seems that many labs don't see the value in something that is seen as a great deal more work, without any real benefit, while it also seems to be that labs simply don't know how to go about designing and implementing such a policy. Part of the problem is that a sensible documentation policy should be predicated on the difficulty of the images in question—easy latents should require very little documentation, while more difficult latents should be subject to enhanced documentation. But, as there are no generally accepted criteria for defining complex prints, it becomes difficult to determine when to apply these different policies.

This workshop will begin with a lecture on the philosophy of documentation— why do we document? who are we doing it for? what makes it good scientific practice?—then, we will dive into some exercises looking at actual latent prints and making quick, gut-reaction determinations about the quality of each image. Each image will be sorted into one of three bins based on perceived quality level, and we will look for consensus among participants on these determinations.

Following the first exercise, we will discuss the attributes of a latent image that make it more or less difficult, and will go over some visual training on what each attribute looks like, in order to minimize variability between analysts in interpreting the criteria.

Then, a second exercise will be done in which the participants grade a set of latents according to the attributes that each displays. We will review the results of this exercise as a group, once again looking to see what sort of consistency can be reached among the members of the group.

Once the exercises are complete, we will return to philosophy, engaging in a roundtable discussion of what people feel would be useful features of a documentation policy and what they see as the challenges to its implementation.

Finally, I will present some suggestions on policies that could be implemented that will fulfill the goals of documentation, while having as small an impact on operations as possible.

Status: Ongoing (NIJ 2011-DN-BX-K564)

Keywords: documentation, complexity, SOPs

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Probability and Statistics for Forensics

Abstract: This workshop will explain the role of probability and statistics for the quantification of evidence and assessments of uncertainty in the interpretation of crime scene data. Special emphasis will be given to definition, calculation, and interpretation of likelihood ratios and Bayes factors in the context of pattern impression evidence. Receiver operating characteristic curves (ROC) will be introduced and explained, and their use in evaluating competing approaches will be illustrated with hands-on activities.

The workshop will explain basic probability calculations, conditional probabilities, event trees, Bayes formula and will include illustrations of statistical concepts such as the effect of averaging on uncertainty and the central limit theorem. Sample size determination will be addressed. Hands-on examples and exercises will be used to reinforce the concepts discussed in the workshop.

Additional topics that will be covered include data types, numerical and graphical summaries of data, standard probability distribution models, t-tests, and chi-square tests.

Status: Ongoing (NIST)

Keywords: pattern evidence, probability and statistics, likelihood ratio

Research Proposal Writing: Bridging the Gap Between Great Ideas and Funded Projects

Abstract: This workshop will help participants become more familiar with forensic science research funding opportunities and learn how to effectively communicate their research ideas through grant writing. In the forensic science community, more research is needed—this workshop will help bridge the gap between great ideas and funded research projects. Participants will learn how to effectively interpret research solicitations; understand how peer review processes work; and ultimately, write competitive research proposals.

Keywords: proposal writing, research solicitation, federal grants

Henry Maynard* and Defense Forensic Science Center;
Danielle McLeod-Henning*, National Institute of Justice

Addressing Cognitive Bias in Forensic Examinations

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Abstract: Scientific disciplines have long recognized the influence cognitive bias has upon both analytical testing and interpretation of the results from this testing. Although the majority of scientific and medical disciplines have recognized the potential for bias and have incorporated procedures to minimize the effect bias has upon the ultimate conclusions, crime labs have generally not addressed bias in their examinations. A growing body of research, as well as anecdotal stories, have demonstrated forensic scientists are susceptible to having their decisions affected by cognitive biases of various forms. Many forensic scientists have a misconception of what causes cognitive bias and appropriate means to address these biases. Cognitive bias is not an issue of ethics or competency, but the result of subconscious mental processes which have been developed over time to more efficiently process information provided to scientists. This workshop will provide an introduction into the mind of the expert; how we make decisions; how we process information; mental shortcuts our minds use; and the four major categories of cognitive bias: motivational, expectation, contextual, and confirmatory. The workshop will demonstrate, through case studies and interactive exercises, how these forms of cognitive bias can adversely affect the forensic processes from crime scene collection to courtroom testimony. The workshop will also provide possible solutions to assist in minimizing the effect bias ultimately has upon the conclusions made by forensic scientists. Workshop attendees will then work together to apply possible solutions to their specific discipline to determine pros and cons to each approach.

Keywords: forensic science, cognitive bias, human factors

Petrographic Identification of Soil Minerals

Abstract: This 1-day workshop will introduce the trace evidence analyst to the technique of identifying both light and heavy mineral grains from soil using the polarizing microscope as it applies to forensic soil analysis. The workshop will begin with a presentation covering the forensic examination of soil by means of particle analysis, which will include the methods currently available for the isolation and concentration of particular fractions. The role of mineral identification in soil comparisons will be described, and the importance of mineral varieties will be discussed. The identification of minerals will be performed on mineral grains from light and heavy mineral fractions separated from actual soil samples. The students will work through prepared microscope slides of mineral grains together with the instructor and then on their own, with instructor assistance.

Keywords: polarizing microscope, soil, geological materials

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Forensic Examination of Fabric Impressions

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Jennifer Tripoli*,
Suffolk County (New York) Crime Lab

Abstract: Fabric impressions are produced when textile materials come in contact with various surfaces. They can be observed as two-dimensional patterns in dust, blood, or other materials at a crime scene. Additionally, they are sometimes present as indentations on various surfaces of a hit-and-run vehicle. They are often overlooked and sometimes mistaken for footwear or friction ridge impressions.

This workshop will cover several important aspects of fabric impressions. Topics will include: how fabric impressions are produced and where they are typically encountered; fabric construction; the detection, documentation, enhancement, and collection of fabric impressions at the crime scene; the production of test impressions; and comparison techniques. Hands-on exercises will be conducted, and case examples will be presented. Suggestions for report writing and courtroom testimony will be discussed.

The workshop would be beneficial to impression evidence examiners, crime scene investigators, blood pattern analysts, general forensic evidence examiners, and anyone else interested in learning about this very important type of impression evidence.

The objectives of the workshop are to increase the participants' awareness of fabric impressions, and to supply the participants with the knowledge to properly carry out examinations regarding these patterns.

Keywords: impressions, fabric, patterns

Expert Witness Testimony Techniques for Forensic Examiners in a Post-Daubert/NAS Report and Current NCFS Environment

Ron Smith,
Ron Smith and Associates

Abstract: Contrary to the public's perception, the majority of crime laboratories and forensic units do not have a formal and comprehensive expert witness testimony training program. This leaves the newly trained forensic examiner in the precarious position of learning to testify by attending the "School of Hard Knocks." Compound this lack of standardized training with the challenges to the forensic sciences since the Daubert decision and the National Academy of Sciences (NAS) report, and the courtroom environment becomes a potential mine field for the unprepared expert witness.

Add to that the upcoming recommendations of the National Commission on Forensic Science (NCFS) regarding terms to be used or not used in testimony, and we find ourselves in the position to rethink how we testify and how we teach our trainees to succeed on the witness stand.

This 4-hour workshop will focus on one basic premise: jurors do not vote on the truth! They can only vote on their perception of the truth that day in court. It certainly is not our job as expert witnesses to convict, but it is incumbent upon us to testify in a manner which is believable and understandable, regardless of the verdict.

It is up to you, as an unbiased forensic expert witness, to instill within them what is termed "forensic trust." Trust of the forensic discipline you practice and trust in you as the practitioner. This workshop is designed to teach the student the methodology necessary to foster that level of trust, regardless of the challenges presented by legal counsel. This workshop is fun, interactive, and highly energetic. Those faint of heart need not attend!

Keywords: forensic science, expert testimony, juror

Juror-Centric Approach to Expert Testimony

Alicia Wilcox,
University of Dundee, Scotland

Abstract: Over the past 12 months, Alicia Wilcox, as a PhD student, has been surveying jurors after homicide trials to gain insight into how they weigh and interpret expert testimony. Jurors have filled out paper surveys and responded to phone interviews. This research is important as it gives insight into how jurors evaluate and interpret forensic evidence presented in court.

There are workshops on expert testimony offered at many of the educational conferences for impressions, pattern, and trace examiners. However, this workshop is different, as the objective is to bridge the gap between what we think the jurors need to interpret the evidence and what the jurors themselves report they need. The workshop participants will learn criteria that are important to jurors in evaluating an expert's reliability and, in turn, the reliability of the evidence they present. Participants will be encouraged to share their own experiences, both good and bad, and develop methods to incorporate the research findings into their mock testimony.

It is anticipated that attendees will leave the workshop with a new juror-focused approach to testimony. Participants will give each other feedback and workshop attendees will have hands-on experience implementing the newly learned strategies.

The workshop will begin with an overview of the background of the role of the expert witness and the judge. Prior to the mock trial portion of this workshop, attendees will have an opportunity to discuss challenges they have had while testifying and how this may have influenced the jury. We will brainstorm approaches to avoiding these pitfalls. Ms. Wilcox will present the quantitative and qualitative results (to date) of her research. Best practices, based on this data, will be discussed to improve credibility and reliability of the expert in the jury's mind.

After a short break, participants will all have a chance to practice the newly learned techniques. Participant, peer, and instructor feedback will round out the workshop. The participants will feel empowered after learning the new skills and, when called to testify in the future, should have a more juror-centric approach to explaining scientific testimony.

Keywords: forensic science, juror, expert testimony

SCIENTIFIC PLATFORM PRESENTATIONS

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Indiana State Police
Laboratory;
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Iowa State University

Quantitative Examination of Microscopic Fracture Surface Topology for Physical Match Analysis

Abstract: Our hypothesis is that the microscopic features of fracture surfaces possess unique attributes at some relevant length scale that arise from the interaction of the propagating crack-tip process zone and microstructure details. These microscopic feature signatures provide premise of uniqueness and exist on the entire fracture surface. They could be utilized for forensic comparison, especially in the absence of any direct one-to-one spatial relationship.

This presentation will summarize a framework for objectively matching fracture surfaces of brittle materials. The proposed framework investigates the fundamental scientific basis for forensic analysis of fractured and torn surfaces— derived from the quantitative details of the material microstructure and the established concepts of deformation mechanisms—fracture process zones, and their scaling, in the field of fracture mechanics. Spectral analysis of 3D fracture surface–topography measurements is employed to associate or to differentiate fracture surfaces in the performance of physical comparisons. We incorporated an understanding of material failure mechanisms (developed in the field of fracture mechanics), with digital image analysis, to construct protocols for the association (or exclusion) of pairs of surfaces.

This research study establishes a quantitative figure of merit (FOM) and acceptance or rejection criteria based on variance of spectral distributions of fracture surface features relative to reference spectral distributions that can be used in the comparison of two fracture surfaces. For a true match, the FOM < 1. For non-match cases, the FOM ranged from 1.5 to 21. When compared with a sample from a different class, such as fractured aluminum surface with different fracture pattern and grain size, the FOM has two orders of magnitude increase and ranged from 360 to 880. It is clear that the FOM can clearly distinguish the main class of the fracture surface with high fidelity. This is in addition to differentiating the individuality of the fracture surface.

The proposed 3D Match technique has the potential to be applied in (i) evaluating the 3D surface characterization for representative metal, glass, and plastic fragments and (ii) analyzing fracture fragments at different spatial locations on the pair of fracture surfaces, when a one-to-one spatial relation cannot be established. This research was conducted in response to the National Institute of Justice's expressed need for knowledge underlying forensic science disciplines and in collaboration with forensic scientists working in a forensic laboratory.

After attending this presentation, attendees will be exposed to a new quantitative approach that has the potential to enhance the ability of forensic scientists to capture, visualize, and objectively analyze fracture patterns and possibly provide new methodologies for trace evidence. Attendees will be exposed to a quantitative tool supporting the forensic examiner's decision and, in some cases, turning an inconclusive result into a conclusive match when the presented evidence could not support a direct one-to-one spatial relationship.

Status: Completed (NIJ 2011-DN-R-0230)

Keywords: firearms and toolmark identification, fracture mechanics, 3D microscopic surface characterization

* Throughout this
proceedings, where there
are multiple authors,
an asterisk after a name
indicates the presenter(s).

Proficiency Testing in Trace Evidence: Is There a Correlation to Error Rates in the Discipline?

Christopher R. Bommarito, MS, Forensic Science Consultants/ Forensic Testing Services

Abstract: While known proficiency tests are a poor method of estimating error rates, some correlations may exist between error rates in proficiency tests and the subjectivity of the forensic discipline. Known or potential error rate is one of the factors for establishing the validity of scientific testimony specified by the Supreme Court in *Daubert v. Merrell Dow Pharmaceuticals*. This presentation will describe the difficulties in estimating error rate in the trace evidence disciplines and the hazards and limitations of using proficiency test results as a measurement of error rate and will provide an overview of errors found in various forensic proficiency tests in the last few years.

After attending this presentation, attendees will have gained knowledge regarding the process of a Daubert admissibility hearing and addressing of the factor of known or potential error rate. Attendees will also become more knowledgeable in regards to errors made in proficiency tests in trace evidence and other forensic disciplines. The presenter will also suggest methods that could be explored to provide a better estimate of error rate in forensic disciplines.

Status: Ongoing

Keywords: Daubert admissibility, error rate, proficiency testing

Pattern Misidentification and Odontology: Who Decides What To Do?

C. Michael Bowers*, DDS, JD, Ventura County Medical Examiner-Coroner's Office, US; **Iain Pretty**, BDS, PhD, University of Manchester, UK

Abstract: The legal concept of scientific admissibility via "stare decisis" is not sufficient to either monitor or meet the demands of change occurring within forensic sciences. This presentation utilizes the historical and current legal and scientific literature available on the subject of pattern interpretation of skin injury patterns as a metaphor for why forensic reform (in its various types) is necessary.

Excessive expert disagreement in any pattern analysis admitted as evidence reflects on poor reliability performance among its practitioners. DNA disagreement with opinions on the dental source of skin patterns reflects on poor validity of bitemark methods and their accompanying assumptions. Significant research not supporting skin as an accurate pattern substrate conflicts with practitioners of the field which creates serious consequences in criminal proceedings. Case outcome studies indicate that 24 instances of wrongful convictions and incarcerations have been assisted by prosecutors' use of bitemark pattern opinions To date, the US courts have been unable to keep up with the rise and fall of 40 years of stare decisis holdings on bitemark matching.. This is despite Frye, Daubert, Kumho, and judicial college courses on "science." This gap has very recently resulted in forensic reform advocates successfully advancing new legislation to educate and mandate courts to recognize and "weigh" (unfortunately a non-science approach) empirical evidence-based paradigm shifts in forensic practice. In a sense, politicians are creating their own piecemeal, state-by-state reform of forensics (i.e., "junk science" bills) outside the hallowed halls of the practitioners, forensic science organization and their committees.

Keywords: forensic science reform, misidentification, bitemarks, junk science legislation

Please Can You Phorensicate This Paint and Tell Me Its DNA? Issues Faced by the New South Wales FASS Chemical Criminalistics Unit and the Fight Back to Raise the Profile of Trace Evidence Within the State and in Australia

Abstract: This presentation will describe the opening of a new AU$3,000,000 facility, the Chemical Criminalistics Unit, at the NSW FASS. The facility has been specifically designed to undertake analysis of a variety of trace evidence types including ignitable liquids, gunshot residue, paint, fibers, glass, miscellaneous, explosives, and chemical warfare agents. New staff have also been employed to increase the laboratory's capacity to undertake work in these areas. However, the Chemical Criminalistics Unit still faces the pressures seen by other modern forensic facilities, particularly those undertaking trace evidence examinations. This presentation aims to show the development of the new facility and the efforts to increase visibility and collaboration, improve submission quality, improve the training of staff presenting in court, and raise the profile of trace evidence.

After viewing the presentation, the attendees will be aware of the issues facing trace evidence examiners in NSW FASS and the efforts being made to improve awareness, training, and delivery of a high-quality and accredited trace evidence analysis service to the criminal justice system in the State and Australia.

Status: Ongoing

Keywords: trace evidence, Australia, development, paint analysis

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A Statistical Analysis of Trends in the Evaluation of Mass Spectral Data

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Khoa Nguyen, BS,
Georgia State University; and
Michael J. Salyards, PhD,
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Abstract: Factors that influence the assessment of mass spectral data quality can be elucidated by evaluating rejection criteria from a broad base of forensic practitioners using ground truth data. This project was designed to evaluate factors that affect the interpretation of mass spectral data and to better understand how full scan electron ionization mass spectrometry (EI-MS) is applied in forensic casework. Ground truth data were generated consisting of mass spectra for serial dilutions of forensically significant compounds. The data were provided to forensic practitioners across several organizations (n=53) and the practitioners were tasked with assigning the point in the dilution at which the data was of insufficient quality to identify the compound. They were asked to provide their rationale for the assessment, as well as census data. The results were scrubbed of all identifiable information before treatment to prevent bias in data interpretation. The results were collated and statistical treatments applied to evaluate trends and assess factors which affected the assignments. The trends were evaluated in light of factors such as: examiner experience, certification, laboratory policies, absence or loss of specific peaks, loss of ion clusters, relative ratios, total number of ions present, and general spectral quality.

In general, the examiner's assessments were consistent across different compounds, though some differences were observed based on various factors. The examiners' assessments were also generally consistent within a range of concentrations for each compound data set. This indicates two factors of note. First, forensic practitioners are reasonably consistent across organizations and experience levels with regard to the acceptance/rejection of data though differences observed demonstrate a lack of absolute consensus. Second, measurable and reproducible criteria may exist for the evaluation of full scan EI-MS data quality. An evaluation of criteria selected for rejection has informed areas for further study. Future phases of this study will seek to more clearly identify the critical factors in data evaluation. An evaluation of outlier data will also be presented. The results of this study will provide a basis for further developing publishable criteria for the interpretation of mass spectral data.

After attending this presentation, attendees will have an understanding of factors that affect the evaluation of mass spectral data quality. Attendees will be introduced to some of the factors affecting qualitative uncertainty in evaluating full-scan EI-MS data.

Status: Ongoing, Phase 1 complete

Keywords: data interpretation, mass spectra, reporting

Cows, Pigs, and Dogs: Some Possible Paths for Sustaining Trace Evidence as a Viable Forensic Discipline (or How Not to Be a Dog)

Abstract: Several years ago, I was having a discussion about the value that I thought trace evidence brought to forensic investigations with a highly esteemed medical examiner colleague. Having a strong DNA background, this colleague strongly disagreed with my assessment and proceeded to provide me with a lecture on a certain business model. In this model, there are cows, pigs, and dogs. The cows were to be cherished as they provided a steady supply of milk, the pigs should be nourished and raised as they will eventually provide a source of food, and the dog should be killed as it provides no useful value either short or long term. This was a very enlightening conversation as the dog that he was referring to in this situation was unfortunately trace evidence.

Although I strongly disagreed with this assessment and was disheartened to realize how deep this sentiment ran amongst our non-trace evidence peers, the points that were discussed during this conversation have left a deep impression ever since. Agree or disagree, there are many people in the forensic field that view trace evidence as a dog that, serving no useful purpose, should be put down. For our discipline to remain viable, this is a perception that needs to change.

As practitioners within this field, we are keenly aware of the value that our work holds. We know that it provides important results that, when properly used and interpreted, can establish links and/or feed critical information into investigations. However, there is no arguing that there is some merit to the dog analogy. From a business perspective, we are not doing a great job of proving our worth. We are expensive, our analyses are time consuming, the development of our practitioners is a painfully slow process, and our current interpretation schemes are highly subjective. In comparison to the typical DNA (and now digital evidence laboratory), which can provide highly compelling, quantitative information in a shorter period of time; the typical trace evidence laboratory is no longer providing a good return on investment.

This presentation will discuss four areas that the field of trace evidence needs to develop to remain a viable forensic discipline. This presentation will impact the field by providing a thought-provoking look at the weaknesses of the trace evidence field and offering some suggestions on how we might be able to address some of those weaknesses.

Status: Complete

Keywords: trace evidence, forensic science management, return on investment

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A Collaborative Approach to the Forensic Examination of an Improvised Explosive Device

Abstract: In April, 2013, a suspicious package addressed to a high-profile public figure was left in a rural collection box in Flagstaff, Arizona. An inspector from the US Postal Inspection Service's Dangerous Mail Investigation Team (DMI) was called to investigate, and possible smokeless powder was observed to be leaking from the box. A local bomb squad was called in, and x-ray imaging disclosed that it contained various components consistent with an improvised explosive device. The suspect device was rendered safe and an investigation was initiated.

The materials recovered from the render safe procedure were submitted to the US Postal Inspection Service's National Forensic Laboratory for examination. Over the course of the first 2 months of the investigation, a collaborative laboratory approach was used to extract information from the remnants of the device. This process included examination for the presence of latent fingerprints, examination for the presence of explosives/explosive residues, identification of device components and device reconstruction, questioned document examination, examination of footwear impressions found at the scene, and DNA analysis.

Soon after the event, a suspect was developed and additional evidence that was tied to other incidents related to this individual was submitted for examination. Based on the examinations performed, in conjunction with strong investigative information, a search warrant was issued in March 2014 (approximately 1 year after the initial discovery of the device) and a search was executed at the suspect's residence which provided additional physical evidence. This evidence was submitted to the laboratory for analysis and various physical links were established. In September 2014, the suspect was brought to trial and convicted based partially on the physical evidence that was presented.

This presentation will highlight the multi-disciplinary laboratory approach that was applied to provide both investigative and associative support to the investigation outlined above. In some instances, the information that was uncovered during one type of examination led to additional examinations by a different operational unit. For example, the location of partial ridge detail that was insufficient for fingerprint comparisons led to the development of a partial DNA profile, and the investigation of an unknown mixture that had been mailed in a threat letter disclosed the presence of a controlled substance. In other instances, examinations that were performed by one examiner led to additional examinations by another examiner in the same unit. For example, during the device reconstruction phase, hairs that had been found embedded in glue inside the box were passed to the resident hair and fiber expert for characterization.

In the instances cited, the work that was performed led to relevant results that were either useful during the investigation or provided compelling evidence during the trial. Had this case been worked in a vacuum with little to no

communication between otherwise specialized units, it is possible that much of the probative information that was developed would have never come to light.

Status: Complete

Keywords: explosives, trace evidence, impression evidence

Understanding and Calculating Error Rates in Pattern Evidence

Heidi Eldridge, CLPE, MS, PhD candidate, RTI International

Abstract: One of the Daubert prongs of admissibility for scientific expert testimony is the known or potential error rate of a technique. Thus, examiners are often asked about the discipline error rate on the stand. Numerous error rate studies have been undertaken in an attempt to provide this number. But just what is really sought? What are the different types of error rates? How are they calculated and what do they mean? This lecture will describe some commonly reported error rates for pattern evidence and will demonstrate how to calculate them.

After attending this presentation, attendees will understand the most commonly calculated error rates and will be able to calculate them themselves. They will also be able to read error rate studies in the literature and have a better understanding of what is being reported and how it should be appropriately used in the courtroom.

Status: Completed (NIJ 2011-DN-BX-K564)

Keywords: error rate, testimony, Daubert

Suitability and Sufficiency: One Size Fits All?

Abstract: While these terms are often used interchangeably, suitability is the determination that a friction ridge impression contains enough reliable data to continue to the comparison process, while sufficiency is a threshold that must be met to reach a conclusion (such as identification). But are these binary decisions? Is a latent only suitable or not suitable, or are there shades of grey? A comparison is either sufficient or not sufficient to reach an identification decision, but what about something less than identification? Is it still probative? This lecture will explore the idea of gradations of suitability and sufficiency in different contexts.

After attending this presentation, attendees will be able to consider suitability and sufficiency decisions separately and will understand some arguments for why gradations in these categories may be desirable.

Heidi Eldridge, CLPE, MS, PhD candidate, RTI International

Articulating the Identification Decision

Heidi Eldridge, CLPE, MS, PhD candidate, RTI International

Abstract: New expectations in friction ridge comparison testimony have left examiners unsure of the best way to articulate their conclusions. The landscape is still changing; probabilities may be included and the comparison process can be explained without reliance on the Analysis, Comparison, Evaluation, and Verification (ACE-V) terminology. The Scientific Working Group on Friction Ridge Analysis, Study, and Technology offered a draft document on articulating the identification decision, but this incomplete document is somewhat confusing to many examiners. This presentation will provide a clear way to describe the basis for the identification decision that emphasizes the discriminating power of the data available and consideration of the likely sources of observed variability in the context of hypothesis testing.

After attending this presentation, attendees will understand that the identification decision is based, not on the certainty that they have identified a source to the exclusion of all others, but on a conclusion that the data in agreement they have observed is more likely to be the result of two impressions made by the same source than two impressions made by different sources. They will have the tools to articulate this concept in a way that is open and transparent, yet will not leave them feeling exposed on the stand. They will also be able to describe the comparison process without needing to rely on the oft-criticized ACE-V terminology.

Status: Completed (NIJ 2011-DN-BX-K564)

Keywords: identification, testimony, articulation

How Forensic Impression and Trace Evidence Helped Secure the Conviction of Family Annihilator Christopher Vaughn

Abstract: In June 2007, police discovered the bodies of a mother and her three children sitting in an SUV on the side of the road in rural Channahon, Illinois. The mother and her children died as a result of gunshot wounds. The father of the family, Christopher Vaughn, was found by a passing motorist on the side of the road with gunshot wounds to the thigh and wrist. It was either a case of a murder-suicide inside the SUV or a case of the outright murder of four family members by the husband and father of the victims. The forensic evidence gathered from the scene and from the clothes of the defendant played a significant role in cracking the case. The evidence included fingerprint evidence, bloodstain evidence, ballistic evidence, and gunshot residue evidence. The evidence recovered contradicted the defendant's story about what occurred inside the SUV in the early morning hours of June 14, 2007, and helped lead to his conviction for the murders of his wife and three children.

Michael J. Fitzgerald, Will County (Illinois) State's Attorney's Office

The scope of this presentation is a case study about a mass murder that occurred in June 2007, and went to trial in the summer of 2012. The objective is to show how forensic and trace evidence helped convict the killer. The evidence that was used included fingerprint evidence, blood stain pattern evidence, ballistics evidence, and gunshot residue evidence. One of the key issues that arose in the case was how certain holes appeared in the defendant's jacket. The work of two forensic analysts at the Illinois State Police Crime Laboratory helped resolve the issue. One forensic analyst worked to recreate the holes in the jacket using various techniques with the placement of the firearm inside the jacket. The other forensic analyst worked with gunshot residue found in the holes of the jacket to confirm the findings made by the firearms analyst's work on the jacket.

Keywords: forensics, evidence, presentation

Forensic Science Community Updates Plenary Session: Updates on National Commission on Forensic Science

Jonathan G. McGrath, PhD, MSFS, NIJ, Office of Investigative and Forensic Sciences

Abstract: The Department of Justice (DOJ) established the National Commission on Forensic Science (NCFS), in partnership with the National Institute of Standards and Technology, to enhance the practice and improve the reliability of forensic science. This unique partnership draws upon each agency's core strengths to promote scientific validity, reduce fragmentation, and improve federal coordination of forensic science.

The charter of the NCFS defines the objective of the NCFS "to provide recommendations and advice to DOJ concerning national methods and strategies for: strengthening the validity and reliability of the forensic sciences, enhancing quality assurance and quality control in forensic science laboratories and units, identifying and recommending scientific guidance and protocols for evidence seizure, testing, analysis, and other needs of the forensic science communities to strengthen their disciplines and meet the increasing demands generated by the criminal and civil justice systems at all levels of government." The Commission includes federal, state, and local forensic science service providers; research scientists and academics; law enforcement officials; prosecutors, defense attorneys, and judges; and other stakeholders from across the country. This presentation will give an overview of the activities of the NCFS and updates from the recent August 2015 Commission meeting.

Keywords: National Commission on Forensic Science; forensic science policy; Department of Justice; National Institute of Standards and Technology

National Institute of Justice Forensic Technology Center of Excellence

Abstract: The National Institute of Justice Forensic Science Technology Center of Excellence (FTCOE) partnership, administrated by RTI International, contributes to improvements in the field by 1) serving as a partner for the criminal justice community and for NIJ, 2) raising the level of functioning of forensic science in the criminal justice community, 3) quickly identifying the changing needs and capabilities of the criminal justice community with respect to the forensic sciences, 4) bridging the disconnect between criminal justice practitioners and the available technology, and 5) preventing "unproven" technologies from being used in the field and presented in court.

Jeri D. Ropero-Miller, PhD, RTI International

The FTCOE works to fulfill the objectives set forth by NIJ through facilitation of technical working group (TWG) meetings, conducting gap analyses to identify technology needs, improving dissemination and support of NIJ funded research and provides effective in-person technology-transition workshop content that will be accessible to individuals online. The FTCOE also leverages the experience and infrastructure of RTI's Web-based training program as a foundation for training and outreach proven to reach tens of thousands of stakeholders, both domestically and internationally. This presentation will give an overview of the activities of the FTCOE.

Status: Ongoing; www.forensiccoe.org

Keywords: technology, federal update, forensic science

Organization of Scientific Area Committees: How You Can Impact the Forensic Science Community

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National Institute of
Standards and Technology

Abstract: The National Institute of Standards and Technology launched the Organization of Scientific Area Committees (OSAC) on February 4, 2014, after conducting an extensive outreach campaign. The OSAC structure consists of 542 members that populate a Forensic Science Standards Board, 3 resource committees, 5 scientific area committees, and 24 forensic science discipline specific subcommittees. Since the launch of OSAC, over 100 task groups have been created and numerous affiliates appointed to participate with OSAC members on these task groups. OSAC executed 24 subcommittee meetings during January 2015 where each subcommittee identified its priorities for the coming year and five public Scientific Area Committee Meetings on February 16–17, 2015, where the subcommittee chairs presented these priorities to the public. Over the months since the public presentations, OSAC has finalized its "Registry Approval Process" and is now considering specific standards to add to the Registry of Approved Guidelines and Registry of Approve Standards. This presentation will highlight the activities completed during the most recent OSAC meetings and explain how individuals that are not OSAC members or affiliates can have a direct impact on standards and guidelines under consideration by OSAC.

Status: Ongoing; http://www.nist.gov/forensics/osac/

Keywords: OSAC, standards, federal update

National Institute of Standards and Technology Forensic Science Centers of Excellence

Abstract: The newly developed FSCOE supports NIST's efforts to strengthen forensic science through the development and delivery of improved measurement and analysis technologies and the development of best practices and standardized methodologies to improve evidence interpretation and reporting.

David Baldwin, PhD, Midwest Forensics Resource Center, Iowa State University

NIST and scientists working within the new center will develop tools to evaluate pattern and digital evidence analysis methods for how well they consider statistical modeling errors and uncertainties in measurement. This will allow forensic scientists to quantify the level of confidence they have in statistical computations made with these methods and the conclusions reached from those analyses. The center is also tasked with the development and implementation of an education and training program to ensure that judges, lawyers, and forensic science investigators can effectively decipher the results of statistical analyses on pattern and digital evidence. This presentation will give an overview of the activities of the FSCOE.

Status: Ongoing; http://www.nist.gov/coe/forensics/

Keywords: forensic science, technology, federal updates

Conducting a Retroactive Review of Hair Microscopy Cases as a Matter of Shared Ethical and Professional Duty

Lynn García, JD,
Texas Forensic Science
Commission

Abstract: On July 18, 2013, the US Department of Justice (DOJ) announced it would review certain cases involving hair microscopy analysis, testimony, and reports provided by the US Federal Bureau of Investigations (FBI) examiners before December 31, 1999. On April 20, 2015, national media reported the FBI case review found 26 of 28 hair examiners overstated the extent to which an association may be made between a questioned hair and a known hair sample in "ways that favored prosecutors." Media reports further indicate that the overstatements were concerns in at least 90 percent of the cases.

In the wake of the DOJ announcement in July 2013, many stakeholders questioned what could be done to review microscopic hair examinations performed by state and local laboratories beyond the jurisdiction of the FBI. For several decades, the FBI assisted state and local laboratories in training hair examiners by providing a 1-week course on microscopic hair analysis to supplement their agency-based training. Many questioned whether the testimony practices of concern to the FBI were passed on to state and local examiners through these training programs.

On April 21, 2013, the American Society of Crime Laboratory Directors/ Laboratory Accreditation Board (ASCLD/LAB) released a memorandum to all of its accredited crime laboratories encouraging (but not requiring) its laboratories to review microscopic hair comparison reports and associated testimony made by their examiners. ASCLD/LAB noted the forensic science community's ethical obligation to "take appropriate action if there is potential for, or there has been, a miscarriage of justice due to circumstances that have come to light, incompetent practice or malpractice."

The Texas Association of Crime Laboratory Directors responded by publicly acknowledging their shared "ethical and professional duty, as scientists, to take appropriate action if there has been a miscarriage of justice." This presentation will address how the laboratories, with financial and administrative assistance from the Texas Forensic Science Commission, identified hundreds of cases for review pursuant to a subsampling approach. Participants will discuss the technology challenges and stumbling blocks associated with the case identification and retrieval process.

Attendees will also learn how the review team's approach to case analysis is similar to and different from the FBI's approach, focusing on the team's shift away from "error categories" and toward a holistic discussion of common testimony pitfalls. Participants will also address the difficulty of considering the context of an examiner's testimony and the role of attorneys in communicating—or in some cases, misconstruing—scientific concepts before the trier of fact. The team will share the tremendous benefits of bringing stakeholders together over an extended period to tackle tough issues in an environment of trust and respect, and ensuring robust training resources are

available going forward. For participants interested in conducting a similar review in their home states, discussion will include strategies for moving stakeholders from theoretical agreement to the practical implementation of a case review, including the importance of collaboration and compromise among participants.

Finally, the presentation will address the importance of proactive notification strategies for affected prosecutors and defendants and access to mtDNA testing for affected cases.

Status: Ongoing; internally funded

Keywords: hair, microscopy, review

Prosecutorial Misconduct: What Could Happen When Prosecutors Don't Follow the Rules

Anthony Graves,
Anthony Graves Foundation

Abstract: Anthony Graves is also known as Death Row Exoneree 138. Anthony spent 18 and a half years in prison, 16 of those in solitary confinement, 12 on Texas Death Row with two execution dates, for a crime he did not commit. With Anthony's steadfast focus on his innocence and the tireless work of The Innocence Network, he was vindicated and released in 2010.

Since then, he has spoken at prestigious universities and organizations all over the world, including the American Bar Association Death Penalty Representation Project's 25th Anniversary with retired Supreme Court Justice John Paul Stevens, the Anti-Defamation League's Summer Associate Program, and he testified at the US Senate Judiciary Hearing on Solitary Confinement led by Senator Dick Durbin.

Anthony started the Anthony Graves Foundation to give children left behind by the criminal justice system a choice and a chance to live happy, productive lives and help them become the powerful, new foundation of our communities.

Error Rates and Random Match Probabilities Based on the 10-Barrel Test and the GLOCK Cartridge Cases Test

Abstract: This presentation reports on the most recent findings of research conducted over the course of nearly a quarter century for both the 10-barrel test and the GLOCK cartridge case test. Both studies establish base error rates for our field as concerns our two most important sources of evidence, bullets and cartridge cases. The 10-barrel test involved 624 participants world-wide and had exactly zero errors of identification.

The GLOCK cartridge case test was actually conducted as two studies, the ability of a machine (the IBIS) to discriminate between cartridge cases fired from different 9mm GLOCK pistols and the ability of trained firearms examiners to carry out the same task. Again, zero errors of identification were made. From these empirical findings, we were able to estimate the true error rates using advanced Bayesian techniques.

Considering the 10-barrel test findings, the actual examiner population error rate is miniscule: less than 0.01 percent (conservatively). The GLOCK cartridge case test findings are better expressed as a random match probability estimate than an error rate per se. Given our findings for the GLOCK cartridge case studies, both IBIS and examiner-based results indicate that the probability of two different 9mm GLOCKS generating identical cartridge cases is conservatively less than 10^{-6} (~1 in a million).

The studies and all of our data and computations are publically available. This research supports open access, reproducible, peer reviewed research as well as the concept of individualizing fired cartridge cases to the firearm that fired them. Our conclusions are of value in supporting the criteria for identification for firearm and toolmark identification.

Status: Self-funded; ongoing

Keywords: consecutive, random match, Bayes

James E. Hamby, PhD*;
David J. Brundage, MS;
Stephen Norris, BS;
Nicholas D. K. Petraco, PhD;
and **James W. Thorpe**, PhD

Examination and Comparison of Footwear Impressions on Skin

Lesley Hammer, MSFS,
Hammer Forensics

Abstract: Footwear impressions may be left on skin as a result of injury and/or through the transfer of a substance from an outsole to the skin. Examination of these types of impressions considers many variables including the flexibility of skin and the type of detail expected from injury impressions. This presentation will include; examples of footwear impressions on skin, discussion of the considerations for examination based on experience, and cites for other published and presented research.

Keywords: impressions, forensic, skin

Report Writing for Footwear and Tire Examiners: Being Clear and Communicating Value

Abstract: Writing reports is an ever-evolving process for most examiners, and this presentation aims to assist this process. Requirements such as those set by laboratory guidelines, accreditation, and discipline standards, may be met with minimalistic reports that are limited to brief statements, cut-and-paste findings, or drop down menus. However, one of the most important qualities of a report is that it clearly conveys findings to the users or readers of the reports. To achieve this takes additional explanations such as explanations of the characteristics observed, their value and degree of correspondence, the provision of relevant background or foundational information, and in some cases, the use of photographs and attachments. This presentation will provide examples and ideas for writing complete and understandable reports for footwear and tire impression evidence.

Keywords: report, forensic, conclusions

Lesley Hammer, MSFS, Hammer Forensics

R. Austin Hicklin*, MS,
Noblis;
JoAnn Buscaglia*, PhD,
Federal Bureau of
Investigation (FBI) Laboratory
Counterterrorism and Forensic
Science Research Unit

Implications of the Quality, Black Box, and White Box Studies

Abstract: Since 2007, the FBI Laboratory and Noblis have engaged in a research program evaluating the latent print examination process, resulting in seven journal publications to date, and more forthcoming. This series of studies included analyses of latent fingerprint quality, analyses of how examiners make value determinations, analyses of the accuracy and reliability of examiners' analysis and comparison determinations, analyses of the sufficiency of information for individualizations, analyses of how examiners revise their analysis of a latent after comparison with an exemplar, and analyses of inter-examiner variation of minutia markup.

This presentation will provide summaries and a synthesis of these studies, discuss their implications, and discuss the authors' recommendations on how the results of these studies and their implications may be used to enhance the field of latent print examination. After attending this presentation, attendees will understand the implications of this influential series of studies.

The presentation will discuss the implications of these studies:

Hicklin, R. A., et al. (2011). Latent fingerprint quality: A survey of examiners. Journal of Forensic Identification, 61(4): 385–419.

Ulery, B. T., Hicklin, R. A., Buscaglia, J., & Roberts, M. A. (2011). Accuracy and reliability of forensic latent fingerprint decisions. Proceedings of the National Academy of Sciences, 108(19): 7733–7738.

Ulery, B. T., Hicklin, R. A., Buscaglia, J., & Roberts, M. A. (2012). Repeatability and reproducibility of decisions by latent fingerprint examiners. PloS ONE, 7(3), e32800.

Hicklin, R. A., Buscaglia, J., & Roberts, M. A. (2013). Assessing the clarity of friction ridge impressions. Forensic Science International, 226(1):106–117.

Ulery, B. T., Hicklin, R. A., Kiebuzinski, G. I., Roberts, M. A., & Buscaglia, J. (2013). Understanding the sufficiency of information for latent fingerprint value determinations. Forensic Science International, 230(1): 99–106.

Ulery, B. T., Hicklin, R. A., Buscaglia, J., & Roberts, M. A. (2014). Measuring what latent fingerprint examiners consider sufficient information for individualization determinations. PLoS ONE, 9(11), e110179.

Ulery, B. T., Hicklin, R. A., Buscaglia, J., & Roberts, M. A. (2014). Changes in latent fingerprint examiners' markup between Analysis and Comparison. Forensic Science International, 247: 54–61.

Status: Complete; funded by the FBI Laboratory and FBI Biometric Center of Excellence.

Keywords: latent fingerprints, errors, decisions

Physics and Pattern Evidence Scientific Area Committee

Abstract: The Scientific Area Committee (SAC) for Physics and Pattern Evidence is one of five SACs that form the Organization of Scientific Area Committees (OSAC), which is a National Institute of Standards and Technology–funded collaborative body of more than 500 forensic science experts. The intent of the Physics and Pattern Evidence SAC and subcommittees is to foster the development of rigorous standards and guidelines within and across these disciplines, to assist in the adoption and enforcement of these standards and guidelines, and to encourage research and evaluation to test and validate these methods. The ultimate purpose is to enhance the actual and perceived rigor of these disciplines through transparent, accurate, and reliable processes.

R. Austin Hicklin, MS, Noblis

This presentation will discuss the Physics and Pattern Evidence SAC, which includes the disciplines of friction ridge, firearms and toolmarks, forensic document examination, footwear and tire tread, and blood stain pattern analysis. The Physics and Pattern Evidence SAC provides direction and oversight for five subcommittees that oversee standards and guideline development for the disciplines; interfaces with the resource committees (Human Factors, Legal Resource, and Quality Infrastructure); communicates activities, progress, and recommendations; reviews, facilitates public comment, and approves standards and guidelines; and coordinates research priorities. These subcommittees include subject-matter experts who are working to develop and vet standards and guidelines regarding that discipline's techniques, protocols, validation of new techniques, test methods and materials, terminology, and training; define requirements for accreditation and certification; develop research priorities; and coordinate the transition of existing Scientific Working Group documents into approved standards or guidelines. These subcommittees nominally correspond to the scientific working groups SWGFAST, SWGGUN, SWGDOC, SWGTREAD, and SWGSTAIN.

Keywords: standards, OSAC

Characterization of Vectran LCP Fibers

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Abstract: Vectran liquid-crystal polymer (LCP) fiber is a relatively new commercially produced aromatic polyester fiber first developed by Celanese Acetate LLC in the 1990s and now manufactured by the Kuraray Co., Ltd. Liquid crystals (LCs) are a state of matter that have properties between a crystalline solid and a conventional liquid. LCPs in the liquid state (either dissolved in a solvent or melted) also have highly oriented anisotropic-molecular domains like a crystal but they flow like a liquid. Kevlar, a para-substituted aromatic polyamide, is an LCP fiber in the solid state and is wet spun from a highly ordered LC dissolved in a solvent (lyotropic LCP). Unlike conventional polyester that is melt spun from randomly oriented and fixable molecules, Vectran fibers are LCPs in the solid state and are the only LCP fibers being produced today that are melt spun from a highly ordered LC (thermotropic LCP). Since Vectran fibers, like Kevlar fibers, are spun from an LCP, it locks in the oriented crystalline nature and provides the exceptionally high-performance characteristics of strength, rigidity, and chemical resistance.

Both Kevlar and Vectran LCP fibers, as well as several other fibers, fall into the class of "high-performance fibers." High-performance fibers, as compared to commodity fibers, are "fibers that fall into special technical functions that require special properties unique to these fibers." These special functions may include chemical resistance, tensile strength, operating temperature, limiting oxygen index, and a high modulus value. There are three types of Vectran fibers being commercially produced by Kuraray Co, Ltd.: Vectran HT, Vectran NT, and Vectran UM. Airbags made with Vectran woven fabric were used by NASA on the Mars Pathfinder spacecraft. More down-to-earth uses of Vectran fibers in everyday products include rope/cordage made of Vectran HT fiber or Vectran NT fiber; protective clothing made from Vectran NT fiber, which is sometimes blended with another type of fiber; and fiber optic cables reinforced with Vectran UM fibers.

Therefore, Vectran fibers, especially HT and NT, may be encountered in forensic fiber evidence in casework. A review of literature commonly relied on by forensic fiber analysts failed to find identification characteristics for Vectran fibers. To fill this void, the microscopical optical properties, physical characteristics, and infrared spectra will be presented for the characterization and identification of Vectran fibers.

Status: To be published

Keywords: Vectran, liquid-crystal polymers, polarized light microscopy

On the Differences of Refractive Index Measurements between External Surfaces and the Bulk of Container Glass

Abstract: Refractive index (RI) is known to be a highly discriminatory property of glass used in forensic comparative examinations. A critical aspect of RI measurements is the evaluation of intra-source variation. Indeed, RI is known to vary at different locations of a given glass object. In addition to spatial heterogeneity, early studies in the eighties indicate that differences in RI measurements could be observed between the external surface and the bulk of a glass object.

Considering the improvements of modern glass manufacturing processes, this study aims to compare RI data from the external surfaces of glass containers to those collected from their bulk to determine if a significant difference exists. This study intends to provide objective information to glass examiners concerned with understanding the variation that could be expected between bulk and external surface for container glass, while interpreting potential differences observed during comparative examinations or while attempting to explain the dispersion of RI data as a consequence of a sampling method.

The body areas of eight glass containers were selected as initial samples for this study. A simple and fast methodology was developed to isolate the surface layer of glass fragments from their bulk. The GRIM 3 was used to take 560 measurements. Significant differences between refractive index values from bulk and exterior areas were observed for three of the eight glass containers examined. These differences were observed between glass objects of the same type and manufacturer.

Keywords: glass, container, refractive index, sampling

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On the Use of Likelihood Ratios for Evidence Quantification in Forensic Applications

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National Institute of Standards
and Technology

Abstract: In many forensic applications involving impression patterns, an examiner is asked to compare an artifact or impression recovered at a crime scene with a potential source of the impression recovered from a suspect and arrive at an opinion as to the likelihood of the suspect being the source of the crime scene evidence. The subjective nature of this practice has come under scrutiny, and efforts are under way to develop objective methods of numerical quantification of crime scene evidence. There is currently growing support for the use of a Likelihood Ratio (more properly referred to as Bayes Factor) as a measure of the strength of the evidence rather than making definitive statements such as, "In my expert opinion, the suspect is the source of the crime scene impression."

The justification for the use of the Bayes Factor is based on the odds form of Bayes Rule usually written as

Posterior Odds = Bayes Factor × Prior Odds.

The argument in favor of the use of the Bayes Factor is often articulated in a manner similar to the following: the calculation of prior odds, and hence the posterior odds, is outside the domain of expertise of the forensic examiner; however, the calculation of Bayes Factor is within the examiner's domain of expertise. Knowing the numerical value of the Bayes Factor, the judge and/or members of the jury can each update their own prior odds of the proposition Hp that the suspect is the source of the crime scene evidence by multiplying it by the Bayes Factor and obtaining their own posterior odds.

Superficial considerations lead one to accept such an argument for the use of Bayes Factors for reporting the strength of forensic evidence. What is not widely known is the fact that there are fundamental concerns associated with viewing the Bayes Factor as strength of evidence. This presentation will explain what these concerns are and provide illustrative examples to explain the corresponding consequences. The presentation will also point to alternative approaches for quantification of forensic evidence.

Status: Ongoing funded by NIST

Keywords: pattern evidence, likelihood ratio, Bayes Factor

Examining the Effects of Environmental Degradation on the Optical Properties of Manufactured Fibers of Natural Origin

Abstract: Beginning in 2012, McCrone Research Institute was awarded federal monies to conduct a research study investigating the effects of environmental degradation on the optical properties of selected fibers: polylactic acid (PLA), azlon, and rayon. These fibers are produced from naturally occurring polymers (proteins, sugars, or cellulose), and little is known about the changes occurring in their optical and physical properties as an effect of moisture, sunlight exposure, and exposure to various temperatures. For the past 2 years, fabric swatches representing each fiber type have been exposed to freshwater, saltwater, heat, cold, ultraviolet light, and composter conditions.

Every 8 weeks, over a 2-year period, the swatches were analyzed via polarized light microscopy, and various observations were made, including morphology, pleochroism, refractive index, birefringence, extinction characteristics, and signs of elongation. Infrared spectra were also collected as part of this analysis. In addition, solubility and melting point behavior were assessed every 6 months. Ion milling and imaging under the scanning electron microscope were performed on several fibers when necessary.

In general, little change was seen to the fibers in many of the environments, suggesting that these "eco-friendly" fibers are relatively robust. The greatest degradation was seen in the viscose fabrics in the composter, the freshwater, and the saltwater environments: viscose fibers were completely gone between 4 and 16 weeks, depending on the fabric content. Two of five viscose swatches under the ultraviolet light developed "freckles," minute air pockets which varied in density and uniformity within the fibers. Two PLA swatches under ultraviolet light also developed air pockets, though these were larger than those seen in the viscose, and it is likely an effect of uncoated titanium dioxide delusterant. The fibers within one azlon fabric in each of the water environments became streaky in appearance as its characteristic rectangular inclusions collapsed. No significant changes were seen in optical properties, infrared spectra, melting points, or solubility behavior over the 2-year period.

Status: Completed (NIJ-2011-DN-BX-K548)

Keywords: fibers, environmental degradation, polarized light microscopy, viscose rayon, polylactic acid, azlon, infrared microspectroscopy, melting point, solubility

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A General Framework for the Estimation of "Likelihood Ratios" with Application to Pattern Evidence in Forensics

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and Technology

Abstract: At their core, source attribution problems, forensic or otherwise, are no different from the most basic statistical inference problems. We have some data E and would like to make inference about the stochastic mechanism from which it was generated. In simpler language, we have some evidence E (say a latent fingerprint) acquired at a crime scene, and we would like to make inference about the source of the evidence. In particular, we would like to know whether the suspect is the source of the latent print (prosecution hypothesis Hp) or someone else is the source (defense hypothesis Hd).

In source attribution problems involving impression patterns, the data are acquired either as 2 dimensional patterns (e.g., fingerprint images, shoe print images) or 3-dimensional patterns (e.g., shoe print molds). A comparison is made of the crime scene pattern with an exemplar pattern associated with a suspect and an opinion is formulated as to the truth of the statement (Hp) that the suspect is the source of the crime scene evidence. Although the current practice in the United States is for a human expert examiner to make such an evaluation, there is a growing sentiment in favor of adopting the use of Likelihood Ratios (more appropriately, Bayes Factors) as an objective method of quantifying the value of the evidence from crime scenes.

Calculation of likelihood ratios may be accomplished using standard univariate or multivariate statistical approaches when the evidence is expressible using numerical values, for instance, refractive indices of glass fragments or elemental constituents of glass fragments. In the case of impression patterns, such a direct approach requires implementation of the following steps:

1. Represent a pattern using a set of well-defined features extracted from the pattern.

2. Develop and validate statistical distributional models capable of describing the probability of observing the crime scene impression E given that it was made by a particular source.

A likelihood ratio can then be calculated from its definition. However, this is easier said than done, especially for step 2, where the development and validation of statistical models that can withstand the scrutiny that they would be subjected to before use by the criminal justice system may be considered intractable for all practical purposes. Neumann et al. have made pioneering contributions along these lines (e.g. JRSS-A, 2012).

Recognizing the practical difficulties associated with this direct approach, some authors (e.g., Saunders and Buscaglia) have proposed the use of match scores, either scores obtained from Automated Fingerprint Identification System (AFIS) or other custom measures of similarity or dissimilarity, for calculating the so-called score based likelihood ratios (SLR). To our knowledge, no score-based likelihood ratio approach has been shown to be satisfactory for actual use. Gantz and Saunders (2014 Department of Justice Report) have highlighted some of the

issues associated with different definitions of SLRs. A fundamental shortcoming of existing SLRs appears to be their failure to adequately approximate the classical likelihood ratio.

In this presentation, we provide a very general framework for the estimation of likelihood ratios using similarity or dissimilarity scores resulting from a comparison of two patterns that overcomes this deficiency for suitably chosen similarity measures. In such instances, the likelihood ratio estimate we define is, in fact, a good approximation for the classical likelihood ratio. Moreover, the quality of the approximation improves with increasing empirical information. Our approach can be applied even when the data are numbers or vectors or attributes such as color. We illustrate our approach using examples involving glass fragments, fingerprint comparisons, bullet casing marks, and DNA profiles.

Status: Ongoing; NIST funding

Keywords: Bayes Factor, kernel density estimation, nonparametric statistics

The Evolution of Individuality: A 3-Year Comprehensive Footwear Study

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Services Bureau

Abstract: This study tracks the wear pattern and changing individual characteristics of a pair of Rockport casual shoes over the course of a year. Three pairs of shoes were used in the course of this study. Inkless impressions were made during set time periods throughout the year to track the progress and durability of the outsole characteristics. Observations of the outsoles and impressions revealed the presence of notable features in the areas of subclass, wear and individual characteristics over time. After attending this presentation, attendees will understand the genesis and development of class, sub-class, wear, and individual characteristics in footwear impressions.

Status: Complete

The Characterization of Personal Lubricants Using Direct Analysis in Real-Time Time-of-Flight Mass Spectrometry

Abstract: Sexual assaults are an unfortunate reality in modern society, meaning increased emphasis must be placed in identifying novel techniques that will assist forensic investigators in characterizing lubricant evidence. In comparison to other trace evidence disciplines, the analysis of lubricants is a relatively new concept in sexual assault investigations. Consequently, this project intends to utilize high mass resolution direct analysis in real-time time-of-flight mass spectrometry (DART-TOF-MS) to determine whether it is possible to create a rapid screening technique for lubricant samples, which may ultimately facilitate the creation of a lubricant database.

Mark Maric*, PhD,
Lauren Harvey, and
Candice Bridge, PhD,
Department of Chemistry and National Center for Forensic Science, University of Central Florida

This presentation will cover the analysis of personal sexual lubricants by DART-TOF-MS. This technique has demonstrated potential in the rapid screening and identification of lubricants into their broad respective lubricant types, such as water- or silicone-based lubricants. Furthermore, DART-TOF-MS has shown to be capable of detecting aesthetics and other additives in select lubricant samples, thereby allowing for even greater discrimination between lubricant types.

After attending this presentation, attendees will understand the importance of lubricant analysis as it pertains to the investigation of sexual assaults, the basic operational features of DART-TOF-MS and its capabilities in the analysis of lubricants and the potential benefits of this technique over conventional instrumental techniques for the characterization of lubricant evidence.

Status of the Project: Ongoing

Keywords: lubricants, trace evidence, DART-TOF-MS

The Prevalence of "Forcibly Removed" Hairs Produced by Hair Combing

Christine McCarthy, MS,
Centre of Forensic Sciences,
Toronto, Ontario

Abstract: Does the finding of hairs that show the characteristics of forcible removal on clothing or on an object at a scene indicate that a violent struggle has occurred? Is it possible that these hairs were present due to a transfer prior to the incident, and in fact, were deposited during normal daily activities?

This study investigated the frequency with which combing hair produced hairs with the characteristics of forcible removal. It was found that in 30 hair-combing sessions, 25 had less than five hairs with the appearance of forcible removal. In the other five sessions, we observed 10 to 26 hairs were "forcibly removed" per session. Therefore, the detection of "forcibly removed" hairs on clothing could arise from normal activities, and caution is warranted when interpreting the presence of such hairs in casework, being mindful of the principles of hair transfer and its persistence relative to the case history.

Status: Complete; not yet published

Keywords: anagen hair roots, combing

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An Attempted Bombing: Sample Selection and Interpretation of the Tape Evidence

Abstract: This presentation will describe the tape evidence examined from the 2011 attempted bombing of a parade route in Spokane, WA. Because of the large amount and types of tape present, a sample selection plan was developed to reduce the total number of examinations conducted, while maximizing information obtained. The conclusions reached and the verbal scale used for describing the significance of the results will also be discussed.

Andria Mehltretter, MS, F-ABC, Chemistry Unit, Federal Bureau of Investigation Laboratory

After attending this presentation, attendees will be aware of considerations in developing a sample selection plan for a mass-produced manufactured material and will have an example of a trace evidence report interpretation scale.

Methods: Both duct tape and electrical tape items were received. All were first visually and stereomicroscopically examined. Based on the results, selected samples were further analyzed by Fourier transform infrared spectroscopy (FTIR). Through a combination of these examinations, a sample selection plan was developed for each type of tape, in which representative samples were examined and compared. In addition to FTIR and scanning electron microscopy with energy dispersive spectroscopy, X-ray diffractometry was also used for the duct tapesm and pyrolysis-gas chromatography/mass spectrometry was used for the electrical tapes. These combinations of examinations result in high degrees of discrimination between tape products and support the types of conclusions reported.

Summary of the Results and Conclusions: As a result of the examinations conducted, multiple associations were reported between the tapes used in construction of the device and items from various locations connected to the suspect. The combination of associations reported increases the significance of the individual associations reported. Ultimately, testimony was not requested because the suspect pled guilty and is serving a 32-year sentence.

Status: Complete

Keywords: tape, sample selection, interpretation

Changes in Latent Print Examinations as a Result of Technical Review

Marcus Montooth,
Indiana State Police

Abstract: Errors in latent print examinations are typically uncovered by defense review of a case. What types of errors are made by latent print examiners in all types of cases? Could these errors have been mitigated by technical review?

In 2012, the Indiana State Police latent print unit began 100% technical review of cases. This presentation will explore data collected from 2½ years of technical reviews. Both significant and non-significant changes were made to cases as a result of the technical review, with some having a significant impact on cases.

As a result of this presentation, attendees will better understand the types and number of mistakes made by latent print examiners. Possible trends of mistakes and suggestions for improving the process will be provided in the presentation, and the attendees will be better equipped to evaluate the value of technical reviews.

Status: Ongoing

Keywords: error, review, latent

Spray Paints Examination and Multivariate Statistics: The Benefits of a Common Approach

Abstract: Infrared spectroscopy is a technique of choice for analyzing paint samples. However, the spectra comparison is currently carried out visually and suffers from limitations, such as its subjectivity, because it mostly relies on experience and training. Statistics can provide the required objectivity and transparency in the decision process.

This presentation proposes to statistically study the different sources of variability observed in infrared spectra, identify them, understand them, and try to minimize them. The second goal is to propose a procedure for spectra comparison that is more transparent and allows obtaining reproducible answers being independent from the expert. After attending this presentation, attendees will understand the usefulness (as well as the few risks) of using multivariate statistics as a tool for expert decision making in forensic paint analysis.

An optimization of the infrared spectra acquisition was performed, together with assessment of the best pre-treatment (correction) procedures to minimize the unwanted variation. Other sources of variability associated with the production (batches), the degradation, and the contamination were also evaluated. Finally, a procedure is proposed for an objective assessment of the spectra similarity and illustrated with case examples.

The procedure allowed to efficiently minimize the unwanted variability and increase the chemical information (wanted variability). Statistics have shown an important gain of time and provided a transparent procedure less sensitive to the expert opinion. Others sources of variability such as contamination and degradation were, however, difficult to be accounted for by statistics itself and illustrate the need for a joint expert-statistics procedure.

Status: Complete

Keywords: chemometrics, comparison, graffiti

Cyril Muehlethaler*, PhD, City College of New York, Department of Chemistry and Metropolitan Museum of Art, Department of Scientific Research;
Geneviève Massonnet, University of Lausanne, School of Criminal Science

Decreasing the Scale and Increasing the Scope of Trace Evidence

Christopher S. Palenik, PhD,
Microtrace LLC

Abstract: While trace evidence analysis is hardly a novel concept in itself, four specific factors have caused us to explore and consider the significance of increasingly smaller particles and features in trace evidence analysis. The first is a consequence of the CSI-effect. Savvy criminals are more aware of trace evidence and, in some instances, make active efforts to minimize these contacts. Second, as our society enters the age of nanotechnology, highly engineered particles, layers, and features of materials are becoming increasingly smaller, more complex, and more common. Paint layers less than 10 micrometers are commonly observed, multilayer films may contain nanoscale layers, and free nanoparticles are being commercially utilized in a wide range of consumer products including cosmetics, glass, fibers, and paint. Third, robust microanalytical methods such as light and electron microscopy combined with vibrational microspectroscopy provide a means by which these particles and features can be detected, identified, and compared on a practical basis. Finally, despite the claim that "DNA analyzes one molecule while trace evidence handles the rest," the scope of many, if not most, trace evidence laboratories around the country have contracted to an increasingly smaller span of materials that typically includes some subset of hair, fibers, paint, and glass evidence.

This represents only a fraction of the particle types actually encountered in evidence. This presentation explores the considerations required to exploit both an expanded range and the scale of materials in a trace evidence laboratory, which include finding, identifying, and interpreting the significance of such evidence.

Through a combination of research and casework, this presentation will illustrate various means by which modern microanalytical methods can be used to improve the resolution and scope of trace evidence.

Status: Complete

Keywords: microscopy, trace evidence, nanoparticles, nanomaterials, fiber, paint, cosmetics

Frequentist and Bayesian Measures of Association Quality in Algorithmic Toolmark Identification

Abstract: Over the last several years, forensic firearm and toolmark examiners have encountered harsh criticism that there is no accepted methodology to generate numerical "proof" that independently corroborates their morphological conclusions. The focus of our research has thus been to investigate the validity of toolmark pattern analysis from an objective, algorithmic, and numerical perspective that can ultimately withstand the scrutiny of the adversarial legal system. We have successfully exploited 3D microscopy and applied various machine-learning techniques as a step towards accomplishing this goal.

Nicholas D. K. Petraco*, MS, D-ABC;
Brooke Kammrath, PhD;
Peter Shenkin, PhD;
Carol Gambino, MS;
James Hamby, PhD

The most interesting research question we have from an applied statistics point of view is how to estimate the "quality" of a machine-made association between a tool and a toolmark in a falsifiable way. In our strong opinion, there is no consensus in the general scientific community as to how to do this, such that practical applications will withstand long-term scrutiny in the cauldrons of US courtrooms. Our approach thus far is twofold and will be the focus of this talk.

All machine-made identifications first begin with the fit of a principal component analysis (PCA) support vector machines (SVM) multiclass discrimination model. As a "frequentist"-based approach to association quality, conformal prediction theory is used to assign orthodox confidence levels to each toolmark identification. This is accomplished via Vovk, Gammerman, and Shafer's (2005) formula for a nonconformity measure using the SVM Lagrange multipliers (Gambino et al., 2011; Petraco et al., 2012). As a test of the method's validity, on-line prediction plots are constructed for successive toolmark identifications. Slopes of such plots should be near the chosen level of significance.

For a Bayes-oriented approach, we are pursuing Efron's local false discovery rate methodology. Modern machine learning methods output a voluminous amount of information when executing a discrimination task. This massive amount of output allows one to leverage Efron's (2010) empirical Bayes' model for an estimate of the posterior error probability (PEP) of a toolmark ID (Kall et al., 2008). All probability densities required of Efron's (2007) method are univariate. We fit them from a histogram of statistics derived from SVM-generated Platt (1999) scores and a slight modification of a method proposed by Storey and Tibshirani (2003). As a measure of testability, fits are assessed using standard methodology. With the knowledge that there is some dependence among the Platt scores used in the fits, and to more fully "Bayes-ify" the method, a straightforward multilevel over-dispersed Poisson regression extension of Efron's fit procedure will be discussed for the computation of credibility intervals around PEP point estimates.

Technically, the posterior error probability gives an estimate that the tool truly did not generate the toolmark. This is interesting from a philosophical point of view; however, we are strong believers in Gelman and Shalizi's statement that

"posterior model probabilities …[are]… useful as tools for prediction and for understanding structure in data, as long as these probabilities are not taken too seriously" (Gelman & Shalizi, 2012). Thus, we interpret a PEP value associated with the algorithmic association between a tool and toolmark as the algorithm's degree of belief in the "match" it outputs.

Status: Ongoing, no funding agency

Keywords: toolmarks, Bayesian, frequentist

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The Use of Trace Evidence to Establish that a Suspected Painting by Jackson Pollock Was Made at the Pollock-Krasner Home and Studio, a National Historic Landmark Located in Springs, New York

Abstract: An artist's intimate contact with his or her work permits the primary, secondary, and tertiary transfer of trace materials between the artist, the environment within which the work is created, and the work itself. Materials such as hairs, fibers, skin cells, fluid droplets, soil, dust, mineral fragments, glass fragments, seeds, plant materials, and other debris can be intentionally or inadvertently transferred and subsequently embedded into the work. This can occur in a variety of ways: from the artist to the painting, the painting to the artist, the environment to the artist, the environment to the painting, the environment to the artist then to the painting, and so on. These tiny traces of particulate matter, hairs, fibers, and fluid droplets can be a valuable source of unbiased scientific data and proof relating to who created the work, the time period the work was created, and where the work was created.

In this study, a painting believed to be the last known work of Jackson Pollock was forensically examined and processed for trace evidence. Items of trace evidence were removed from the painting and compared to materials obtained from Pollock's home and personal property. Hairs, fibers, and other particles of trace evidence collected from the painting provided unbiased scientific data and proof that the work was produced at the Pollock compound.

After attending this presentation, attendees will understand the enormous potential trace evidence provides to the forensic investigator for reconstructing events. Each participant will thoroughly understand the powerful efficacy common forms of microscopic traces (i.e., human and animal hair, natural and synthetic fibers, soil, minerals) provide the forensic scientist in establishing Locardian-type associations between the people, places, and things involved in all types of everyday human activities and events.

Status: Ongoing, no funding agency

Keywords: Jackson Pollock, trace evidence, fine art

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Enhancing Transparency in Forensic Science

Darrell Stein,
Ramit Plushnick-Masti*,
Houston Forensic Science
Center

Abstract: A great deal of attention has been paid in recent years to how to improve forensic science, as far as reform, technology, best practices, reviewing past mistakes, learning lessons, discussing new management, leadership and oversight possibilities, and really looking at how this field might be overhauled and adapted both to meet the needs of the future and to improve the science. However, in all this discussion, we appear to be neglecting an element that could be key to this transformation: the public and its perception of forensic science.

If, as a group, we fail to convince the public that forensic science is credible, reliable, and effective, then all the change will have been for naught. A key element of this is to become more transparent, sharing with the public not only our successes, but also our mistakes, the steps we take to correct them, and the lessons we learn in the process. It requires an evolution from reactive to proactive and means that, in many cases, a cultural transformation needs to occur within the different organizations and agencies.

The Houston Forensic Science Center, now a corporation independent of law enforcement and prosecutorial branches of government, is actively going through that evolution. We have learned some lessons about transparency, the good that can come from it and the respect we are slowly earning from the public, and about some of the limitations that we have since we still need to respect our sensitive casework and lab environments.

Status: Ongoing

Keywords: transparency, independence, Houston Forensic Science Center

Importance of Fibres Population Studies to Forensic Science: A Perspective Based on a Population Study from London Metropolitan Area

Abstract: If fibres can be used to help the investigation in contact crimes, fibre population studies are fundamental to forensic science. These studies must be performed frequently because fashion is always changing and it is important to follow it.

Cátia Pontedeira*, MS,
London South Bank University

This presentation will focus the importance of fibres to forensic science and to crime reconstruction. In crimes that involve direct contact between victim and offender, there is high probability that clothes' fibres are exchanged, which would be used as proof of contact. This presentation is based on a fibre population study carried in the centre of London, and its conclusions ground the need of these types of studies to forensic investigations. With them, it is possible to find if a certain fibre is very common or not and estimate the likelihood of that fibre coming from someone other than the offender.

This research was carried in the centre of London, at London South Bank University (LSBU). Around 3,000 fibres were tapped from LSBU seats and analysed with different techniques. This place (a university) was chosen because it is very representative of European fibres' population due to foreign students.

Each fibre was analysed individually and classified accordingly. Fibres were analysed using low-power microscope, high-power microscope, comparison microscope (using different light sources), Fourier transform infrared spectroscopy and Microspectrophotometry. Fibres from seats were also analysed, classified, and used as controls. Then, all fibres similar to the controls were exclude from this fibre population study. After classification of all fibres, a fibre population was performed with the use of statistics

From the population study, it was possible to conclude that the majority were natural fibres (82%), most of them of blue-coloured cotton. Other characteristics such as presence of delustrant on man-made fibres were also observed.

The importance of this type of study is verified by their statistic value: the frequency of fibers will help in casework and will help forensic scientists to make a correct assessment about the case. The more common the fiber is, the less evidential value it will have in casework as opposed to fibres that are considered rare, by its differential characteristics, which will have strong evidential value (Watt, Roux, & Robertson, 2005). In this presentation, a perspective from Europe will be presented and will bring to debate results from all around the world.

Status: Completed; waiting for publication

Keywords: fibre population, fibre transfer, fibre persistence, criminal investigation

Reference

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Discrimination Power of Automotive Paint Comparisons using a Paint Analytical Scheme

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Crime Laboratory;
Kevin Roberts,
New Hampshire State Police
Forensic Laboratory;
Alex Thompson, MS,
Vermont Forensic Laboratory

Abstract: Since the publication of the National Academy of Sciences report *Strengthening Forensic Science in the United States: A Path Forward* in 2009, there has been a huge push in the forensic science field to determine the statistical significance of the conclusions stated within all forensic disciplines. This study will show the statistical significance of an automotive paint comparison based on the study of 236 automotive paint samples.

Previous work by others has established the discrimination power of specific combinations of instrumental analysis methods for the examination of automotive paint evidence. This type of study bears repeating, as discrimination power may vary when different combinations of analysis techniques are used, new manufactured paint chemistries are applied to the vehicles, or different populations of automotive paints are sampled.

The Boston Police Department Crime Laboratory, along with student interns, examined 236 automotive paint samples, applying an analytical scheme of stereomicroscopy and comparison microscopy with reflected light of cross-sections. Following these steps in the analytical scheme, the remaining consistent pair cross-sections were examined with fluorescence microscopy and, if necessary, instrumentally analyzed with Fourier transform infrared spectroscopy.

Mathematically, 236 samples represented 27,730 possible pair combinations. With this analytical scheme, only two pairs of the 27,730 possible pair combinations could not be distinguished. Therefore, 99.993% of the pairs are distinguishable using this analytical scheme. The two indistinguishable pairs were from vehicles of the same make and model, manufactured within two years of each other in the same assembly plant. This high discrimination power of 99.993% was consistent with previous studies.

This presentation reinforces the discrimination power of the analytical scheme used in automotive paint analysis and the evidential value of a paint comparison in the trace evidence field. The information gained from this presentation can be used during testimony to assist the trier of fact in court cases for determining the significance of an automotive paint comparison.

The Houston Forensic Science Center's Path to a Novel Model for Independence

Irma Rios*, MBA,
Houston Forensic Science
Center

Abstract: The former Houston Police Department (HPD) Crime Lab, like many other forensic operations across the nation, had its share of challenges. After a series of investigative reports by a local TV station in 2002, the DNA unit closed its operation. A full-scale, early 2-year-long review of the entire operation culminated in a final report by an independent investigator and his team. They identified several root causes for the crime lab's problems. The city spent more than $5 million on this detailed independent review and assessment of the lab. The investigators had the full cooperation of the lab and the police department. Four themes emerged, and HPD took systematic action.

There has been significant progress in the forensic operation that included the identification division and the crime lab. The city of Houston undertook significant expense and effort to transform the HPD Crime Lab and Identification Division. In 2005, the lab became accredited in controlled substances, biology, trace, firearms, questioned documents, and toxicology by the American Society of Crime Lab Directors–Laboratory Accreditation Board (ASCLD-LAB). In 2006, the DNA unit became fully operational and accredited.

The lab implemented a comprehensive and rigorous quality assurance program. Quality of staffing improved dramatically. Recruitment emphasized experience, certifications, and educational credentials. Managers were recruited with experience in laboratory management and expertise in forensic science. Rigorous training requirements were imposed.

According to national reports, including the 2009 National Academy of Sciences report, Strengthening Forensic Science in the United States: A Path Forward, there is a need to remove public forensic labs from the administrative control of law enforcement agencies or prosecutor's offices. An informal survey indicates that few public crime labs have such a model at this time. Such independence removes the perception of bias and allows a forensic operation to employ extensive checks and balances to identify potential conflicts.

The City of Houston sought an innovative model for ensuring independence of its forensic operation and established a local government corporation. This presentation will summarize Houston's work to develop a model forensic operation overseen by a board of directors that is advised by a technical advisory group. The operation is managed by a CEO and president. A year after the official handover, we can discuss the progress and plans for the future of the Houston Forensic Science Center.

Status: Ongoing; funded by the City of Houston

Developing the Techniques Available for the Collection and Analysis of Forensic Trace Evidence in Freshwater Crime Scene Environments

Kirstie Scott*, PhD, and **Ruth Morgan**, PhD, Centre for the Forensic Sciences, Department of Security and Crime Science, University College London; **Christopher Palenik**, PhD, and **Skip Palenik**, Microtrace LLC; **Vivienne J. Jones**, PhD, Environmental Change Research Centre, Department of Geography, University College London

Abstract: This presentation will introduce various trace evidence indicators in aquatic environments and highlight the efficiency of three recovery techniques for the collection of an optimal sample for forensic comparison. A range of techniques frequently used to collect trace particulates including paint, fibers, and glass fragments will be compared within an environmental freshwater context. Although this study was primarily directed towards the recovery and assessment of diatom traces from previously submerged clothing, alternative indicators including pollen, algae, and fluvial sediments were also noted when observed.

Environmental trace evidence often transfers to a recipient surface during a criminal event, providing valuable circumstantial evidence for forensic reconstruction. While casework and empirical studies consider the collection (and later analysis) of terrestrial soils and sediments from clothing and footwear, little published research has thus far been directed towards the consideration of marine and freshwater particulates such as algae, diatoms, and waterborne pollen. This paper will therefore compare the capabilities of three frequently used forensic techniques (taping, vacuuming, and chemical digestion) for the effective collection of diatom traces from evidential clothing substrates for microscopic analyses.

After attending this presentation, attendees will understand the range of particulate evidence available for forensic reconstruction in freshwater environments and the valuable contextual information provided following their transfer and persistence. This study will impact the trace evidence community by providing a series of recommendations highlighting best practice for the collection and analysis of algal (particularly diatom) evidence from clothing and footwear exhibits in contact with freshwater scenes of forensic interest. Such knowledge will contribute to the interpretation of limnological evidence in a range of forensic contexts including the comparison and exclusion of known samples and the profiling of an undetermined location.

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The Need and Characteristics of a New Approach to Forensic Trace Evidence Analysis

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Abstract: It is possible to develop an approach where trace evidence analysis can be a major problem-solving tool. It can be efficient and cost effective, utilizing new technologies to improve effectiveness while exploiting all available and potentially useful particle types. Findings can be timely, relevant, and directly integrated with case-specific problems.

Trace evidence analysis has the potential to be a major problem-solving tool. Yet, as repeatedly remarked in these symposia, the discipline has faced a confounding set of difficulties, resulting in high costs and limited use. To better understand these difficulties and work toward addressing them, this presentation will examine the historical development, contributions, and limitations of traditional and emerging approaches to forensic trace evidence analysis. Based on this analysis, the essential characteristics and key elements needed to develop trace evidence as a major problem-solving tool will be defined and discussed.

After attending this presentation, attendees will have (1) well-defined sets of contributions and limitations for existing approaches to trace evidence analysis, (2) understanding of these limitations and appreciation of why a new approach is required, (3) a well-defined set of requirements for an effective trace evidence capability, and (4) a set of key elements that are necessary characteristics of the approach.

In Situ Differentiation and Identification of Perylene Pigments in Automotive Finishes Using Extended Range (4000–250cm⁻¹) Fourier Transform Infrared Spectroscopy

Edward M. Suzuki, PhD, Washington State Crime Laboratory

Abstract: The perylenes are a family of high-performance organic pigments with high color strengths, good thermal stabilities, and excellent lightfastness and weather fastness properties. They are common in automotive finishes, and seven have been cited as having such applications. The purpose of this study was to determine which were actually used in original equipment manufacturer (OEM) finishes (1974–2015) and how they can be differentiated and identified based on their infrared absorptions in paint spectra. Usage information, including commonalities, types of paints they are found in, pigment combinations, and timeframes of use, was then sought.

Extended range (4000–250 cm⁻¹) infrared spectra of pigments and paints were collected. Data for 397 red or maroon metallic and nonmetallic finishes from the Reference Collection of Automotive Paints (1974–1989) and 119 more recent such finishes (1990–2015) were examined for absorptions of perylenes. These finishes included both monocoats and basecoat/clearcoat systems.

Based on this survey, four perylenes, Perylene Maroon (PR179), Perylene Red Y (PR224), Perylene Red (PR178) and Perylene Bordeaux (PV29), were identified. Perylene Maroon was, by far, the most common and was found in over 80% of the 143 red or maroon metallic basecoats examined. Three of the perylenes are diimides, but Perylene Red Y is a dianhydride, and it is the only such commercial pigment. This moiety produces a carbonyl stretching vibration at 1774 cm⁻¹ which—because it occurs at a higher frequency than the binder ester carbonyl stretch—is usually quite conspicuous. This perylene was identified in 13 of the 143 (9%) metallic basecoats examined. Its use has been declining because the dianhydride group is susceptible to chemical attack in alkaline solutions, so this pigment is not formulated into waterborne basecoats.

Perylene Red does not appear to be have been used until 1984, when it was then formulated into half of the Reference Collection red nonmetallic basecoats (1984–1989). Molybdate Orange, a very common lead-containing pigment, was being phased out then, and Perylene Red was one of its main replacements. This perylene, in turn, was supplanted by a newer pigment, DPP Red BO, which was first used in 1988. Perylene Red was not identified in any OEM finishes used on 1993 or later vehicles, so identification of this pigment in an unknown basecoat suggests that it most likely originated from a 1984 to 1992 vehicle.

Perylene Bordeaux was identified in mostly maroon metallic basecoats and was frequently used with Perylene Maroon. When significant loads of both perylenes are present, a prominent broad absorption centered near 1691 cm⁻¹ results. This feature appears very similar to that of a urethane, and it may prevent determination of the presence or absence of this binder component in certain basecoats.

A large number of different pigment combinations involving the four perylene were identified, involving combinations with each other, quinacridones, various red micas, and other pigments. Spectra of some of these are presented to illustrate the wide diversity of resulting absorption patterns.

After attending this presentation, attendees should be able to identify perylene pigments in automotive paint using infrared spectroscopy. This presentation will impact the forensic science community by providing forensic paint examiners with data that may allow them to interpret better spectra of paint evidence.

Status: Completed

Keywords: paint analysis, infrared spectroscopy, perylene pigments

Fingerprint Examination and the Epistemic Rationale of Claims to Single Source Attribution

Henry Swofford, Chief, US Army Criminal Investigation Laboratory, Latent Print Branch

Abstract: For over 100 years, fingerprint evidence has been used as a valuable tool for the criminal justice system. Relying on the generalized premise of "uniqueness," the forensic and legal communities have regarded fingerprint evidence as nearly infallible, having the capacity to "individualize" the source of a fingerprint impression to a single individual. While the uniqueness of a complete record of friction ridge skin detail is generally undisputed, the extension of that premise to partial and degraded impressions has become a central issue of debate. As a result, the traditional paradigm of reporting latent fingerprint conclusions with absolute certainty to a single source has been challenged. The underlying basis for the challenge pertains to the mathematical logic applied and the manner in which the evidence is articulated. By recognizing the subtle, yet nontrivial differences in the mathematical logic, the fingerprint community may consider an alternative framework to report fingerprint evidence to ensure the statistical certainties are not over- or understated.

This presentation will discuss the logic largely subscribed to by the fingerprint community along with the underlying basis to why it is the focus of challenge; present an alternative framework for the community to consider adopting, which is epistemologically more compatible and defensible; and recommend suggestions for how this transition can be practically achieved without minimizing the value of fingerprint evidence. After attending this presentation, attendees will have a better understanding of the difficulties with supporting claims of single-source attribution (e.g., individualization) and be introduced to an alternative framework for reporting and testifying to such evidence in a more scientifically defensible manner.

Disclaimer: The opinions or assertions contained herein are the private views of the authors and are not to be construed as official or as reflecting the views of the US Department of the Army or US Department of Defense.

Status: Complete

Keywords: fingerprint, identification, individualization

Objective Classification of Fingerprint Image Complexity

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Abstract: Fingerprint impressions are often considered a reliable source of forensic evidence. While studies have demonstrated exceedingly low rates of error by fingerprint analysts, these findings must be carefully evaluated in light of the quality of the fingerprint samples used for the evaluations. Recognizing that fingerprint examinations rely on human interpretation and the quality of fingerprint impressions vary significantly, examination results are subject to variation, and the risk of error is not a uniformly distributed characteristic. The issue, however, is not necessarily the mere existence of error in fingerprint examination, but more understanding and estimating the risk of error as a function of the quality of the impression. Having such a metric would allow quality assurance programs within forensic laboratories to classify the complexity of fingerprint impressions a priori based on an objective and measurable metric related to the perceived risk of error.

In an effort to accomplish this objective, this presentation will discuss novel fingerprint image quality assessment software which has been developed to automatically analyze the clarity and quantity of friction skin detail available for comparison and associate quality scores to analyst performance metrics during comparison exercises. Having such a capability may not only provide a means of predicting the complexity/difficulty of the comparison and associated risk of error, but also provide a more objective and transparent framework for assessing the value of fingerprint impressions in a standardized and empirical manner versus the subjective nature of examiner intuition. The results of preliminary evaluations and policy guidelines which may be developed from these data will be presented along with the potential for transferring this type of technology into practice.

After attending this presentation, attendees will understand the mathematical concepts by which this method was developed, results of preliminary evaluation data against prints having varying levels of quality, and ongoing validation efforts to facilitate the transition of this technology into practice.

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Status: Ongoing

Keywords: fingerprints, quality, sufficiency

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A Novel Approach for Quantifying the Weight of Fingerprint Evidence

Abstract: Fingerprint analysts are faced with tremendous challenges when performing fingerprint comparisons and evaluating the significance of their findings. Not only are their analyses and comparisons typically performed visually without any tools capable of producing quantitative and statistically relevant data to assist in their interpretation of the evidence, but they must render and defend conclusions of source attribution based solely on their individual training and experience. Furthermore, these decisions are made without any formal or nationally accepted criteria or thresholds. Without tools capable of assisting the analysts with their interpretation of the evidence and standardized criteria by which decisions can be based, analysts have no internal quality assurance mechanism to protect them from making erroneous decisions, especially when faced with comparisons from large database searches, other than the subjective examination of other analysts, which is valuable but not perfect, having similar limitations.

This presentation will discuss a novel, empirically derived approach for evaluating and quantifying the weight of fingerprint evidence based on the geospatial arrangement of friction skin features. Preliminary evaluations of the software against the most similar feature configurations detected by Automated Fingerprint Identification System demonstrate the technology's capability to distinguish between similar non-mated fingerprints derived from database searches and mated fingerprints. These results along with policy guidelines which may be developed from these data will be presented along with the potential for transferring this technology into practice. After attending this presentation, attendees will understand the mathematical concepts by which this method was developed, results of preliminary evaluation data against mated and non-mated fingerprints obtained from a database of several million fingerprints, and ongoing validation efforts to facilitate the transition of this technology into practice.

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Status: Ongoing

Keywords: fingerprints, probability, model

Dimensional Review of Scales for Forensic Photography

Abstract: Forensic photography employs scales to provide a geometrical reference in the photographic documentation of a crime scene, pattern, or item of evidence. The ABFO No. 2 Standard Reference Scale is considered by the forensic science community as a reliable and accurate photographic scale.

We conducted a survey of commercially available scales and exposed a lack of consistency in the manufacturing processes that resulted in a lack of strict adherence to the published standard by Huzer and Krauss. These specifications dictated the size, shape, position, and chromic attributes of the scale. In this study, we investigated the specifications that would affect the quantitative accuracy in photographs, the major centimeter graduations, internal/external diameters of the circles, error in placement of the circle centers, and leg perpendicularity.

Four vendors were selected as commonly available sources for the scales. The scales were measured on a vision-based coordinate measurement system that had an uncertainty less than 0.002 mm over the range of measurements in this study. All four vendors were well within the specified tolerance for the length. The circle diameter specifications were not met; however, each vendor demonstrated a consistent manufacturing process. One vendor achieved the center-to-center segments distance requirement; however, all the vendors were again consistent with their own process. The perpendicularity tolerance was variable within and between scales from the vendors.

The very same scales were measured after 4 years to determine what changes, if any, could be measured in the length scales, center-to-center measurements, and perpendicularity. Acceptable stability in the scale length and center-to-center measurements; however, the perpendicularity exhibited considerable change. It is recommended that manufacturer scale quality checks for measurement accuracy using certified metal rulers are good practice and have been since instituted by the manufacturers.

Status: Completed, National Institute of Justice Report published: https://www.ncjrs.gov/pdffiles1/nij/grants/243213.pdf

Keywords: photo scales, photography, accuracy, ABFO

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A Novel Approach for the Analysis and Interpretation of the Elemental Composition of Tape by LA-ICP-MS and LIBS

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Abstract: The current study evaluates the utility of laser-induced breakdown spectroscopy (LIBS) and laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) as novel methods for the chemical characterization of electrical tapes. The results for method development and validation are presented here, including the reporting of their analytical performance, discrimination potential, informing power, uncertainties, and error rates.

The hypotheses of this study are: a) inter-roll variations of the elemental composition of electrical tapes originating from different rolls is greater than the intra-roll variation within a source providing discrimination between sources; b) the elemental composition of electrical tapes analyzed by LA-ICP-MS and/or LIBS provides enhanced discrimination and improved characterization capabilities over conventional methods; c) the statistical methods that were selected and are recommended produce estimated of the type I and type II errors for discrimination between different sources and for the association of tapes originating from the same source; and d) this information can be used, when a database is available, as an effective tool in investigations to provide leads and potential sources and manufacturers of tapes.

The current study uses a collection of over 100 electrical tapes to evaluate the utility of LA-ICP-MS and LIBS in tape examinations. Samples originating from different known sources were used to study inter-roll variations of elements. Moreover, intra-roll variations and inter-day variations were evaluated to make informed decisions about sampling strategies and interpretation of the data collected. The proposed methods are compared to scanning electron microscope (SEM) Energy Dispersive Spectroscopy (EDS) in terms of the relevant analytical figures of merit and parameters of forensic interest such as reproducibility, repeatability, sensitivity, selectivity, discriminating power, and error rates. Different statistical tools were evaluated to determine which are suitable to the particular sensitivity and precision levels of the proposed methods including spectral comparisons, Hotellings T2, confidence intervals, principal component analysis, discriminant analysis, partial least square discriminant analysis, and agglomerative hierarchical clustering. Moreover, an in-house automated searchable database that uses machine-learning algorithms is evaluated for these data sets as a promising tool to assist forensic investigations and intelligence investigations. The performance and grouping/predictive power of the proposed methods is compared to that obtained by different conventional organic and inorganic methods alone and in combination to ultimately evaluate the overall value of incorporating these novel methods to current analytical schemes.

The results show that LA-ICP-MS and LIBS add value to the overall significance of an association among tapes, when one is found. These methods provide enhanced discrimination compared to SEM-EDS elemental analysis. They also provide further discrimination and add valuable information to the chemical characterization obtained by Fourier transform intrared spectroscopy (FTIR) and pyrolysis–gas chromatography–mass spectrometry (Py-GC-MS), offering

additional lead information, enhanced characterization capabilities and stronger conclusions. The inter-roll and intra-roll variations observed in the population under study were appropriate for the sensitivity of the method.

After attending this presentation, attendees will have a better understanding of the capabilities of these laser-based spectrochemical methods for the chemical characterization and comparison of electrical tapes. The attendees will be able to critically evaluate and compare the performance of the proposed method to other conventional methods and form their opinion about the value of incorporating these orthogonal and complementary methods into the current analytical protocols used by the forensic community. Moreover, the presentation will describe the relative performance of different statistical tools used for assisting the interpretation of the data.

Status: Ongoing research.

Keywords: tape, trace evidence, LIBS, elemental analysis, error rates

The Impact of Fatigue on Latent Print Examinations as Revealed by Behavioral and Eye Gaze Testing

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Abstract: The Expert Working Group on Human Factors identified fatigue among several factors to contribute to adverse mental states of fingerprint examiners. Furthermore, the Working Group report specifically identified several factors that could contribute to fatigue, including being on call for crime scene investigation, working through backlogs, and long hours as practices that could reduce performance (e.g., extended durations of fingerprint examinations)—many of which are commonplace within agencies conducting fingerprint examinations. However, the literature contains relatively little direct evidence of the effects of fatigue on latent print examination. This presentation will discuss the impact of fatigue on latent print examinations as revealed by behavioral and eye gaze testing. Results from a preliminary study suggest that both behavioral performance and working memory capacity declined with fatigue, thus impacting the accuracy of fingerprint conclusions. In light of these findings, fingerprint examiners and supervisors should promote open discussion of situations within their own workplaces that may lead to fatigue and identify strategies to overcome it before performance is negatively impacted.

After attending this presentation, attendees will be aware of fatigue implications as related to casework. Because the casework of various laboratories may differ, we are reluctant to offer one set of proscriptive remedies. However, we do feel that the lab environment may benefit from an open discussion of those situations that may lead to fatigue, as well as strategies to overcome it. This may lead to individual experimentation that could lead each examiner to explore the amount of time they are capable of sustained attention before a break is necessary. We will discuss possible individualized self-monitoring protocols.

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Keywords: fatigue, examinations, performance

Court Testimony and Trace Evidence Examiners

Abstract: Even with the full understanding of the scope and limitations of their field does not necessarily guarantee that forensic analysts will not overstate the certainty of their conclusions, make exaggerated claims ("indeed and without a doubt" bias), and provide testimony that may constitute "material misrepresentation of data" in violation of the American Academy of Forensic Sciences brief passage enunciating a code of ethics.

Mool S. Verma, MS, Denver Crime Laboratory

The Federal Bureau of Investigation stunned the legal and forensic sciences community in April 20, 2015, with its acknowledgement that testimony of their forensic scientists about hair identification was scientifically indefensible in nearly every one of the more than 250 cases reviewed. But the conclusion should come as no surprise to scientists. Such a problem is not unique and has no single cause.

The exercise of human judgment is an essential element of practice of many scientific disciplines including forensic sciences and subjectivity plays an important role in the decision-making process. This is not to say that objective tools for measurements are absent in these fields. On the contrary, attempts have been made to increase the sophistication and precision in this area. Nevertheless, in finality, integration of information obtained by decision makers in these fields, no matter how objective its basic character, remains a subjective process. For such integration, the decision-maker must rely on his or her judgment process.

But what if the forensic scientist's judgment is flawed either due to systemic bias, lack of proper training, or institutional failures (management's lack of oversight in monitoring court testimony by analysts). Unfortunately, if these issues are not addressed and debated regularly, these problems will continue.

These systemic biases, however, in short, are not explicit but implied from relationships, from actions undertaken or from controls imposed by or upon forensic scientists. Being implied, however, they are no less likely to compromise the integrity of a forensic scientist or his or her work product than more overt or express biases. They infect the judgment of forensic scientists who often do not recognize the influences these biases bring to bear upon them. They are or have the potential to be an unseen or unacknowledged menace destructing the reliability and validity of forensic scientist's testing and opinion and may even taint the reputation of the entire field.

This presentation brings to the forefront biases as a menace in an effort to address those instances where they are most in controversy. The biases that will be discussed are those that are not deliberate or intentional. On the contrary, at issue are those which are uninvited and unwelcome guests in the house of forensic scientists.

Keywords: biases, court testimony, subjectivity

Within-Roll and Between-Roll Variability in Duct Tape Physical Characteristics

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Abstract: Fifty-five rolls of duct tape were obtained and sampled at 10 equally spaced distances down the length of the roll. The following physical characteristics were measured or recorded: backing color, backing texture, adhesive color, tape width, total tape thickness, scrim pattern, scrim count, warp yarn offsets, backing-only thickness, number of backing layers, and backing layer structure. The variation of each characteristic was evaluated and the tolerances were calculated which include at least 95% or 99% of samples from the same roll. For example, the following tolerances are recommended based on their ability to include at least 99% of within-roll samples: width ±0.13 mm, total thickness ±11%, scrim count ±1, and warp yarn offset ±0.57 mm. Using R Statistical Software, a statistically significant relationship was found between backing texture and backing-only thickness variations, resulting in the following backing-only thickness tolerances: smooth backing texture ±26%, dimpled backing texture ±11%. Using the tolerances recommended, the discrimination power (DP) was calculated for each characteristic. Warp yarn offset was found to be an insignificant physical characteristic with regards to discriminating between duct tape rolls. Additionally, a DP of at least 99.12% was calculated for the collective analysis of duct tape roll physical characteristics.

This presentation will help examiners to better evaluate differences in physical properties between questioned and known tape samples. Tolerances are provided, which have not been calculated previously, to provide a reference as to the variability possible down the length of a tape roll. More physical characteristics were recorded in this study than any previous similar study, which allowed the relative discrimination power of each characteristic to be evaluated as to its efficacy both alone and in combination with other characteristics. The discrimination power of warp yarn offset, for example, demonstrated the insignificance of this property and suggests it should not be used for nonphysical reconstruction comparisons.

Status: Complete, with plans to publish

Keywords: duct tape, variability, discrimination power

Frequency of OEM Automotive Refinishes

Diana M. Wright*, PhD, Chemistry Unit, Federal Bureau of Investigation Laboratory

Abstract: This study was conducted to enhance the ability of trace evidence examiners to include interpretative statements in comparative examinations, using automotive paint as an illustrative example. Some comparisons of mass-produced man-made materials are straightforward. However, it is not uncommon to encounter samples that require further discussion to convey the degree to which two or more items are concluded to be "associated." As an example, it is appropriate to question the significance of an original equipment manufacturer (OEM) factory repair paint chip comparison between a known source and an unknown paint chip.

To gain some knowledge of the frequency with which OEM repairs occur, approximately 1,000 physical samples representing model years 2000–2013 were microscopically examined for OEM factory repairs. Samples containing factory repair topcoat layers (e.g., clear/ basecoat layers over a typical 4-layer OEM system) were noted. The repair rate in this study was on par or lower than reported industry expectations or standards for OEM factory repairs of topcoat systems. However, the number of permissible OEM topcoat layers was observed to be greater than expected based on discussions with industry contacts. Based on these two factors, the presence of an OEM factory repair in comparative paint examinations is noteworthy with respect to the interpretative language that should be used to describe an association. It is hoped that this work will provide a talking point as to how a non-routine occurrence can be handled in the context of report writing and interpretation.

Organization of Scientific Area Committees (OSAC)/Chemistry Scientific Area Committee (SAC)/Trace-Related Subcommittee Updates

Diana M. Wright, PhD, Chemistry Unit, Federal Bureau of Investigation Laboratory

Abstract: The subcommittee on materials (trace) is working on the development or revision of standards and guidelines related to examination and interpretation of physical evidence that may result from the transfer of small or minute quantities of materials (e.g., hairs, fibers, paint, tape, glass). Specific task groups have been established to address several of the key issues facing the trace evidence community with respect to interpretation, training, and outreach to trace evidence customers. Each of these priorities has been identified as necessary to ensure that there is an awareness and consensus of the capabilities and limitations that exist in the analysis of the materials that comprise these trace evidence disciplines.

This presentation will update the audience as to the progress of each of the materials (trace) task groups: interpretation, outreach, fibers, glass, hair, paint/tape, tape training guide, and research. Specific updates will be reported for the development of an interpretation scale, the various discipline-specific training guides, how the subcommittee plans to publicize the capabilities of these trace disciplines, how research needs are being identified, and the status of submission of new standards to the American Society for Testing and Materials (ASTM) and revision of existing ASTM documents.

Status: ongoing; funding source: National Institute of Standards and Technology (NIST)

Keywords: OSAC, chemistry SAC, trace disciplines

NIST Research Ballistics Toolmark Database

Abstract: The project objective is an open-access research database of bullet and cartridge case reference data, consisting of traditional reflectance microscopy images and 3-dimensional surface topography. The database will foster the development and validation of advanced algorithms, mathematical similarity criteria, and quantitative confidence limits for objective ballistics identification.

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In 2009, a report by the National Academies called into question, amongst other issues, the objectivity of visual toolmark identification by firearms examiners. The National Academies recommended development of a precisely specified, and scientifically justified, identification process that leads to results with well-characterized confidence limits. Industry, academia, and government laboratories are pursuing two promising approaches towards this goal: 1) development of mathematical criteria and advanced algorithms for the objective and automated classification of potential matches and estimation of associated error rates and 2) supplementing traditional reflectance microscopy images with 3-dimensional surface topography measurement data.

Development and validation of both these approaches to objective toolmark identification are hindered by a lack of access to toolmark data sets that 1) represent the large variety of ballistic toolmarks encountered by forensic examiners and 2) represent challenging identification scenarios, such as those posed by consecutively manufactured firearms components. It is not economically feasible for individual companies or institutions to generate their own data sets. This makes it difficult for these entities to develop and evaluate solutions applicable to a broad range of scenarios, and makes the development of a statistical foundation for confidence limits (error rates) difficult.

During a symposium held at National Institute of Standards and Technology (NIST) entitled "Measurement Science and Standards in Forensic Firearms Analysis 2012," one of the priority requests from the attendees was the construction of a database where bullet and cartridge case surface data can be shared between researchers to facilitate testing, refinement, and comparison of new systems, methods, and algorithms.

The proposed database will provide the representative variety of toolmark data required. The database will consist of indexed surface data acquired at NIST using state-of-the-art instruments and measurement procedures.

Brief Methodology: The project collected over 1,700 test fires during 2014. Also established was the standard data exchange format, metadata specifications, as well as the database structure. In 2015, the Office of Information Systems Management at NIST will develop an interactive website to house the database. This website will allow users to search, sort, and download data based on their individual research objectives. It will also allow users to upload their own measurements to the database. During the development of the website, NIST will continue to collect and measure additional crime lab test fires to further increase the diversity of the database. This will allow future identification

algorithms to be validated with a real world test. Beta testing will occur with the help of interested examiners, researchers, and industry partners.

Summary of Results: Phase one of the project has been completed successfully. NIST collected over 1,700 test fires to populate the database. These include test fires generated from consecutively manufactured slides/barrels, persistence studies, gun/ammo effects, and representative crime lab reference sets. Below is a list of the collected studies:

- Consecutively manufactured (or close proximity) slides:
  - Thomas Fadul: 10 Ruger slides, 40 cartridge cases
  - Todd Weller: 10 Ruger slides, 90 cartridge cases
  - James Hamby: 10 Hi-Point slides, 30 cartridge cases
  - Laura Lightstone: 10 S&W40 slides, 30 cartridge cases
  - Howard Kong: 10 S&W 10-10 Revolvers, 30 cartridge cases
  - John Murdoch: 10 Glock slides, 40 cartridge cases
- Consecutively manufactured (or close proximity) barrels:
  - James Hamby: 10 Ruger barrels, 70 bullets
  - Evan Thompson: 10 Hi-Point barrels, 42 bullets
  - Scott McVeigh: 30 Beretta barrels, 90 bullets
  - Howard Kong: 10 Model 10-10 Revolvers, 30 bullets
- Persistence/decay studies:
  - Cary Wong: Ruger P89 9 mm handgun, 2,000 firings, first 10 and every 25th firing, 91 bullets and 91 cartridge cases
  - Mark Keisler: Three Beretta 96G pistols, 10,000 firings each, 189 bullets and 189 cartridge cases
- Different firearms and ammunitions:
  - NIST national ballistics imaging database study:
    - twelve 9 mm handguns: Sig Sauer, Ruger, and Winchester
    - three brands of ammunition: PMC, Remington, and Winchester
    - 144 cartridge cases
  - De Kinder/Tullener:
    - Sig Sauer 9 mm handguns.
    - six types of ammunition: CCI, Winchester, Remington, Speer, Wolf, and Federal
    - 4200 cartridge cases. A subset of 70 have been measured
  - Cadre:
    - 24 cartridge cases from Oakland PD. Various guns and ammunition types
  - Scott McVeigh:
    - 118 crime lab firearms of various calibers
    - 236 cartridge cases, 236 bullets

A website (http://www.nist.gov/forensics/ballisticsdb) has been created describing the project goals, technical details, and download links for the collected data. The data is organized as batched study sets currently but will be customizable after phase two of the project has been completed.

General Conclusions: Phase one of the project successfully acquired a diverse population of test fires that represent challenging identification scenarios. These include test fires generated from consecutively manufactured slides/barrels, persistence studies, gun/ammo effects, and representative crime lab reference sets. Also established in phase one was a standard data exchange format, metadata specification, database structure, and website. Phase two of the project will create an interactive website for users to search, sort, upload, and download customized data sets based on their research objectives.

The database will provide a foundation for a scientific knowledge base on the degree of similarity that can be found between marks made by different firearms and the variability in marks made by an individual firearm. The current, "fairly limited" knowledge base is a fundamental barrier to the development and validation of objective mathematical similarity criteria, and associated confidence limits, applicable to a broad range of firearms and ammunition brands.

Status: Ongoing; funded by National Institute of Justice (NIJ-2013-R2R-4843)

Keywords: 3D topography, toolmarks, objective identification

POSTERS

Detection of Forged Inked Thumb Impressions on Property Documents

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Abstract: The use of thumb impressions on agreements, important documents, etc. along with signatures, or in place of signatures, is common in Asian countries like Pakistan, India, and Bangladesh. The forgery of fingerprints is not common, and many fingerprint experts might not have come across forged fingerprints. There are not many examples reported in the literature related to forged inked fingerprints. This study presents a good example for the detection of forged inked thumb impressions on property documents. Different parameters used to detect such impressions are discussed here.

Status: Completed

Keywords: fingerprints, fingerprint forgery, fingerprint forgery detection

* Throughout this
  proceedings, where there
  are multiple authors,
  an asterisk after a name
  indicates the presenter(s).

The Fabrication of Latent Prints and How a Latent Print Examiner Can Detect the "Red Flags" of Fabricated Impressions During His or Her Analysis

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Abstract: This presentation explores the fabrication of latent prints and how a latent print examiner can detect the red flags of fabricated impressions during his or her analysis. It is a serious issue that examiners must be aware of during their examination in order to stop this unethical activity.

History has shown that fabricated prints are typically made by law enforcement personnel. In addition to defining fabrication and forgery and outlining the difference between the two, several case reviews and recommendations for training and standard operating procedures are presented.

Characterization of Aluminum Powders in Explosives Utilizing Particle Micromorphometry

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Abstract: This presentation will discuss the automated analysis of particle micromorphometry to characterize aluminum (Al) powders in explosives. Al powders are used as fuels in improvised explosives to increase the heat of explosion (Kubota, 2002). These powders can be bought from industrial manufacturers or produced in-house rather inexpensively. The goal of this research is to investigate the potential to link questioned and known sources of Al powder as well as to provide an investigative lead into the manufacturing method of the Al powder.

Automated transmitted light microscope images of the Al samples were acquired and then batch processed using commercial image analysis software with customized code. Dimensional analysis was calibrated using a National Institute of Standards and Technology (NIST)–traceable stage micrometer; polystyrene spheres of 100 μm, 50 μm, and 10 μm were used as secondary standards to assess linear calibration. The customized code pre-filtered each image using a high-pass filter to enhance edge detection and converted it to a binary image. Seventeen parameters were measured for each particle within the image field of view including: area, aspect ratio, perimeter, roundness, mean diameter, mean feret, radii (maximum and minimum distance from particle centroid to edge), radius ratio, box height, box width, and fractal dimension. The large multidimensional datasets were analyzed using an open-source statistical package. The results from the multivariate statistical methods will be presented. Initial results from the pilot study, which included 23 Al powders, showed a classification success rate ranging from 81–94% depending on particle size fraction.

Status: Ongoing, supported in part by an appointment to the Visiting Scientist Program at the Federal Bureau of Investigation Laboratory Division, administered by the Oak Ridge Institute for Science and Education, through an interagency agreement between the US Department of Energy and the FBI.

Keywords: aluminum powder, particle micromorphometry, automated image analysis

Reference:

Kubota, N., 2002. Propellants and explosives: Thermochemical aspects of combustion. Wiley-VCH Verlag GmbH, Weinheim.

Application of X-Ray Photoelectron Spectroscopy to Trace Evidence

Abstract: X-ray photoelectron spectroscopy (XPS) is a method of surface analysis. This presentation will introduce the audience to the basic principles of XPS, followed by examples of its use in characterizing/distinguishing surface-modified fibers, gunshot residue, glass fragments bearing surface coatings, hair chalk on human hairs, and hair chalk transfers to fabrics. Today, many trace evidence types encountered have one or more thin surface layers. Full characterization of these thin layers using instrumentation and methods found in most crime labs is not possible. A fully capable XPS system costs around $500,000, and to our knowledge, no forensic laboratories have XPS instrumentation. It would not make sense for forensic laboratories to purchase expensive instruments when there are insufficient cases requiring their full-time use.

However, XPS instrumentation and experienced users are present in the chemistry and physics departments of many research universities. Why not make use of these resources? When warranted, forensic laboratories do not hesitate to send off physical evidence to commercial labs for examination by specialized methods of DNA (touch), MtDNA, and micro RNA analysis, or to send off unusual types of trace evidence to commercial labs such as McCrone, Microtrace, and Stoney Laboratories.

Status: Ongoing

Keywords: x-ray photoelectron spectroscopy (XPS), surface analysis

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Evaluation of the Efficiency of Recovery Methods of Trace Evidence for Pollen Particles

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Science;
Jack Hietpas, PhD

Abstract: This presentation will compare various collection methods that are currently used for gathering trace evidence and how these methods can be used to collect pollen grains. The efficiency of the recovery methods will be established by measuring the amount of pollen that is recovered from various surfaces.

In this research, pine pollen was incorporated into a "test dust" consisting of pollen and fluorescent calcite and applied to five different forensically relevant surfaces: two brands of cotton-knit clothing items, 100% nylon stockings, a paint can, and tennis shoes. There are several methods in trace evidence that were implemented for the recovery of the test dust off of the selected surfaces: vacuum sweeping, tape lifting, and sonication.

At this time, it can be noted that the sonication method is the most time consuming and may not be applicable with larger pieces of evidence. Moreover, the sonication method proves to be the most difficult in terms of counting the pollen grains due to the fact that the samples must be filtered when wet and grain differentiation is tedious on dried samples. The tape lifts are extremely rapid and are able to be directly visualized under the microscope with no post-processing necessary, meaning that it is not necessary to make slide preparations. Furthermore the tape-lift method seems to rank highest in terms of recovering the greatest amount of dust from the surfaces, but at this time, it is solely a visual observation. The vacuum method seems to fall in the middle of the sonication and the tape-lift methods, meaning that the visualization and recovery of the test dust surpasses that seen with the sonication; however, it seems to be slightly less than the tape lifts.

Status: Ongoing

Keywords: pollen, recovery techniques, surfaces

Performance and Ricochet Characteristics of Frangible Ammunition

Abstract: This presentation will explore the ingredients of the frangible ammunition examined, whether fired bullets are amenable to comparison microscopy, and how they behave upon impact. After attending this presentation, attendees will become familiar with several types of frangible ammunition, whether these types of bullets acquire individual markings after being fired, and how some break apart into fragments that bear little resemblance to a bullet if found at a shooting scene.

Peter Diaczuk*, MFS, PhD, Xiao Shan Law, John Jay College of Criminal Justice; **Jack Hietpas**, MS, MSFS, PhD, D&H Criminalistics Agency

Several types of frangible ammunition were analyzed that included a variety of construction methods and constituents. The cartridges were disassembled and the bullets cross-sectioned to gain an understanding of their construction. Stereomicroscopy was used to assess the constituents and scanning electron microscope energy dispersive spectroscopy (SEM-EDS) was used to identify the elements present. These bullets were compared to traditional full metal-jacketed bullets in both impact dynamics and for their ability to accept individual markings (i.e., striae) from passage down the barrel of the firearm.

High-speed photography was used to determine their performance characteristics on common yielding and unyielding materials.

Recovered bullet or jacket fragments were examined microscopically to determine if striae were present and if so, were they useful for comparison purposes. Frangible bullets that were encased within a traditional jacket did retain striae from the barrel and were able to be compared successfully to other test-fired bullets from the same firearm. Those that were not jacketed and were made of composites of powdered metal and adhesive only had class characteristics imparted from the firearm. Most frangible bullets broke up into fragments upon impact with unyielding substrates. Some of these bullet fragments were still relatively large and retained enough energy to pose a danger at close range.

Status: Ongoing

Keywords: frangible bullets, ricochet, microscopy

Using Fetal Pigs as Medium for Test Impressions

Kelly Donaldson,
Maricopa County (Arizona)
Sheriff's Office

Abstract: This was a homicide investigation involving the death of an inmate housed with 33 other inmates. Inmates who had footwear when booked into jail were allowed to continue wearing their own footwear, and those who did not were given jail-issued footwear. This poster presentation will show pattern impression evidence on skin, specifically the neck area, and the comparison of multiple known footwear examples from the 33 inmates housed within the same pod as the victim.

To duplicate the questioned impression for test purposes, fetal pigs were used to make test impressions to duplicate the soft tissue of human skin. Printer's ink and synthetic blood (one at a time) were applied to the Known shoes. The shoes were worn by an adult male employee of the crime lab, and four test impressions were made of the heel area of each shoe by stepping on the shoulder and rear flank areas of each side of the pigs. These areas of the pigs had some curve to them, simulating the curve of the human neck. The employee added slight pressure when stepping on the areas, but did not use his full or even substantial weight when doing the test impressions. As each impression was made, photographs were taken of them. Photographic documentation was also made of the overall process.

In this case, the use of fetal pigs to simulate the soft tissue of a human was a viable method of collecting test impressions for use in the comparison. The partial bloody pattern impression on the left side of the victim's neck was found to correspond to the outsoles of the left and right heels of one pair of shoes submitted for examination in design and size; however, it lacked sufficient detail for an identification or exclusion. All of the other shoes submitted for comparison in this case were excluded as the source of the impression due to dissimilar outsole design. No other instrument found in the jail cell was found to be similar to the pattern impression on the victim's neck.

Status: Completed

Keywords: alternative impression medium

Trash Marks: The Patterns Reveal the Real Ricin Culprit

Lindsey N. Dyn, MFS, Federal Bureau of Investigation Laboratory

Abstract: This presentation will highlight the impact questioned document examinations had in helping solve the 2013 investigation into the ricin letters sent to President Obama and Senator Wicker.

Cases involving weapons of mass destruction, real or perceived, are becoming an ever-growing reality in today's criminal landscape. With the popularity of such shows as AMC's Breaking Bad, the ease of accessibility of ingredients and equipment, and simple instructions that can be found online, ricin has become a popular choice for inclusion in threatening letters. In 2013, the use of ricin as a poison took center stage when ricin-laced threat letters were mailed to President Barack Obama, Mississippi Senator Roger Wicker, and Judge Sadie Holland. The vast quantity of evidence, the high-profile nature of the case, and immediate deadlines required a streamlined approach and prioritization of key pieces of evidence. One type of examination in particular was especially probative, as there was a correspondence between trash marks observed on the threat letters with the suspect's printer. The evidence examined at the Federal Bureau of Investigation Laboratory was pivotal in furthering the investigation and ultimately assisted in securing a plea deal.

Status: Completed

Keywords: questioned documents, trash marks, ricin

Jute and Its Substitutes in Commercial Goods

Christopher Palenik*, MS, PhD,
Skip Palenik, Microtrace LLC;
Barbara Fallon, MSFS, MS,
Michigan State University
Forensic Science Program

Abstract: Natural fibers from jute (*Corchorus capsularis* and *C. olitorius*) are common in commodities such as cordage, sacking, and textiles. Currently, neither chemical nor microscopic methods exist to differentiate fibers from these two species. In this presentation, methods currently being investigated to discriminate the two species will be described. These methods include measurement of ultimate dimensions and confocal Raman microscopy of the ultimates. Furthermore, this work also uses polarized light microscopy to determine the incidence of natural and synthetic fibers being substituted in commercial goods advertised as jute. A database of these results will ultimately be available to the public.

Measurements of fiber ultimate dimensions (area, length, and average width) were used to compare ultimates from each jute species. Subsequently, confocal Raman spectroscopy was used to characterize the angle of cellulose microfibril spiraling in the secondary cell wall in each species. In the second part of the study, the presence of jute and potential substituted fibers was identified using polarized light microscopy in a variety of commercial jute goods (e.g., burlap textiles, cordage).

Measurement of ultimate dimensions is not sufficient to distinguish between *C. capsularis* and *C. olitorius*. Characterization of secondary cell wall cellulose spiraling has not yet been completed but shows promise in distinguishing the two species. Finally, an online database of the tested commercial goods will compile the list of jute products containing true jute or jute substitute.

Status: Ongoing, Microtrace LLC and Michigan State University Forensic Science Program

Comparison of Enhancing Agents in Aged Eccrine and Eccrine/Sebaceous Prints prior to Development by the Cyanoacrylate Fuming Method

Abstract: Prior research by several groups has shown that pretreating fingerprints by exposure to acid or base fumes will increase the mass of cyanoacrylate polymer formed on the ridges of prints aged for 1–42 days. In this project, eccrine and eccrine/sebaceous prints aged for 1 day to 6 months were pretreated with acetic acid or ammonia and developed with cyanoacrylate fuming. The prints were scanned using AFIX software. The quality of the print was measured as the percent of minutiae identified in a defined area of the print. Both subjective, the minutiae identified by the researcher, and objective data, the minutiae called by the AFIX program, were recorded.

After attending this presentation, attendees will be able to evaluate the potential of acid/base pretreatment of prints prior to cyanoacrylate fuming.

Status: Completed

Keywords: fingerprint, cyanoacrylate fuming, pretreatment

Elizabeth Gardner*, PhD, University of Alabama at Birmingham;
Samara Hunter, Birmingham Police Department

A Novel Method for Fingerprints on Absorbent Surfaces—Contact Ninhydrin

Howard A. Harris, PhD, JD, University of New Haven

Abstract: This project is to develop a novel method for rapidly visualizing fingerprints on absorbent surfaces. The method is free of organic solvents, highly portable, and rapid and produces high-quality fingerprints on absorbent surfaces. This is done in one step that involves a Ninhydrin development sheet, a dry portable moisture source, and the use of microwave energy to speed the usually slow Ninhydrin/amino acid reaction. The treated paper containing Ninhydrin and additives is placed in contact with the substrate enclosed in a microwaveable sandwich containing a moisture source (i.e., two rigid boards that readily pass microwave energy and hold the materials in intimate contact with heavy rubber bands). The sandwich holds the reactant materials together under pressure to facilitate the two-phase reaction.

It was found that when the sandwich is placed in a microwave oven that is set on defrost or low power and microwaved for a short time (2 to 6 minutes), when it is opened after cooling, strong fingerprint visualization is observed. This research has worked toward optimizing this process and developing methods for producing the Ninhydrin sheets and moisture carriers efficiently. Combination of the above improvements makes the Contact Ninhydrin method a viable method for producing fingerprints in a prompt manner and doing so in a non-laboratory setting with highly portable materials. This new method has significant advantages of speed and portability over the solution methods currently widely used.

Status: Ongoing

Keywords: fingerprints, Ninhydrin, paper

Forensic Light Field Photography—The Advantages of Using a Plenoptic Camera to Capture Latent Fingerprint Images at the Crime Scene

Jason Howe, JD, MSFS,
Roxboro (North Carolina)
Police Department

Abstract: Light field photography is an emerging photographic technique, which has had limited exposure in the realm of fingerprint macro photography. Post-photographic processing of light field photography may allow for greater improvement of fingerprint images, especially those images photographed on difficult surfaces (e.g., curved or textured surfaces). Traditional photography has a fixed focal length, which allows for a specific portion of the image to be in focus. In traditional macro photography, the focused portion of the image changes greatly with depth. This means that the photographer has to choose which portion of the image they want in focus and then which part of the image to sacrifice to blurriness. Plenoptic cameras, however, capture all the light information that is available within the picture. Therefore, the entire image, or at least a greater portion of it, can be refocused even after the photograph is taken.

The benefits of light field photography, when used for macro photography, are two-fold. First, the camera allows the operator more room for error with their focus. An example of this would be a crime scene photographer who believes the image they have taken in the field is a good quality image by viewing the small camera LCD screen. The photographer returns to the lab only to find that the image is actually blurred. The light field processing allows for refocusing the photograph even after the image has been taken. Second, the plenoptic camera allows for a greater depth of field, which, as mentioned previously, is more versatile for photographing fingerprint images on difficult surfaces.

The initial results of the camera's use in the field have been promising, but the program is new and the results have not yet been fully evaluated.

Status: Ongoing

Keywords: light-field, plenoptic, fingerprint

Discrimination and Classification of Nail and Gel Polishes by Microscopic and Spectroscopic Analytical Methods

Brooke Kammrath*, PhD,
Henry C. Lee College of
Criminal Justice and Forensic
Sciences;
Nicole Bois, MS,
Kaitlyn Clement, BS, and
Elaine Pagliaro, JD

Abstract: This presentation will report on research about the characterization of nail and gel polishes by microscopic and spectroscopic analytical methods in addition to the evaluation of the discriminating potential of each technique for type, brand, and bottle classification.

Nail polish is a popular type of cosmetic evidence that is analyzed by trace evidence examiners with a similar methodology as paint evidence. Although there have been many studies to understand the evidentiary significance of paint evidence, the same cannot be said for nail polishes. Still, nail polish identification and discrimination has played a role in criminal cases, most notably the infamous woodchipper murder. Nail polish is a quick-drying lacquer, either clear or colored, used to paint fingernails or toenails. It contains multiple materials and is relatively complex.

This study focused on the characterization and discrimination of both traditional nail polishes and the more modern gel polishes. For both types of polishes, color (pink and red) and clear (top and bottom) coats were studied. All of the color coats were chosen to be as similar in color as possible for the same brand as well as between brands. The brands used were a mix of salon quality and those intended for at-home use.

Raman, FTIR and UV-Vis microspectroscopy in addition to stereomicroscopy, brightfield, and polarized light microscopy were used to analyze the samples and gain information on their physical, optical, and chemical properties. Multivariate statistical analysis methods, specifically principle component analysis (PCA) and canonical variate analysis (CVA), were used to assess the discrimination ability of the Raman and FTIR spectroscopic methods. The combination of light microscopy, Raman microspectroscopy, and FTIR microspectroscopy proved to be a reliable method for the type, brand, and bottle identification of nail and gel color polishes. Using light microscopy alone, 97 of the 98 samples were able to be distinguished from each other. The two samples that could not be differentiated were the same color from the same brand, but they were from different batches. Using PCA-CVA with leave-one-out cross validation on the FTIR spectral data, there was a 0.0% error rate for type classification (traditional nail vs. gel), 0.0% error rate for brand identification, and a 1.8% error rate for bottle identification. Raman analysis proved to be the most useful for pigment identification, with the two most common pigments being Pigment White 6 and Pigment Red 57:1.

UV-Vis microspectroscopy proved to be the most useful at differentiating between the clear coats. There were observable differences between the UV-Vis spectra of traditional nail and gel polishes, thus allowing for type identification. The traditional nail polish top and bottom coats could be differentiated from one another; however, all seven gel basecoats had the same UV- Vis spectra, and three of the seven topcoats were indistinguishable.

Status: Ongoing

Keywords: polish, microscopy, spectroscopy

The Physics of Nanolayer Metal Deposition as a Visualization Method to Resolve Latent Fingerprints

Abstract: Numerous techniques have been studied and later employed to visualize and preserve latent fingerprints. While several techniques that have withstood the test of time are preferred, one technique is casually mentioned in textbooks, but is rarely discussed or employed as a viable method to visualize fingerprints contained on surfaces of small evidentiary objects. The commonly used methods employ dry powders, cyanoacrylate vapors, or wet chemistry to visualize human friction ridge patterns.

Martin Kocanda, PhD, Northern Illinois University, College of Engineering and Engineering Technology

This work examines the physical vapor deposition process of silver nanolayers sublimed on glass, plastic, paper, and metal substrates and also describes the physics of the process and observed optical properties of the metallic thin films. Varying thicknesses of silver ranging from 1.0 to 10.0 nanometers were deposited on substrates and examined for optimal spectral, transmittance, and reflectance signals. Subsequent analyses of latent fingerprints imprinted on surfaces were performed after vapor deposition of silver addressing the optical properties, visualization, and optical tuning for optimal resolution and contrast.

Status: Completed

Using the Mideo Systems CASEWORKSeis (CWS) System, Images Can Be Entered and Recorded into the System Digitally

Gregory E. Laskowski, MPA, Kern County District Attorney Forensic Science Division (retired)

Abstract: Standard methods for evaluating and comparing impression evidence case samples such as footwear and tire track imprints and impressions generally require hard-copy photographs and control inked imprints either on opaque material or transparent media. Using the Mideo Systems CWS system, images can be entered and recorded into the system digitally. These digital images, whether they be photographs, imprints on opaque media, or transparencies, can be stored and adjusted for size so long as a proper scale is present. Large format digital images (e.g., raw, bitmap, jpeg) can be sized, enhanced, and compared either in side-by-side mode on a single screen or multiple screens or as transparencies. The degree of transparency of the control imprint or the question imprint/impression can be dynamically adjusted, rotated, and enhanced for contrast and size . Each step of image adjustment is recorded and stored as a metadata file to ensure security and record any photo manipulation. Images can be marked up using a variety of markup tools. Images can be printed in any size or retained for onscreen viewing.

The system is compatible with most Laboratory Information Management Systems and meets the ever evolving standards for the International Organization for Standardization (ISO), American Society of Crime Laboratory Directors/Laboratory Accreditation Board (ASCLD/LAB), Scientific Working Group on Imaging Technologies (SWIGIT), and Scientific Working Group on Friction Ridge Analysis, Study and Technology (SWGFAST). The examiner has total control of how to prepare, evaluate, and compare evidence to evidence and evidence to knowns. All this can be done in real time, thus saving photo developing costs, printing costs, and most important, the examiner's time.

Demonstration of the Mideo Systems CWS system using real images will be presented.

Keywords: footwear impressions, Mideo Systems, CASEWORKSeis

Improving Investigative Lead Information and Evidential Significance Assessment in the Forensic Examination of Automotive Paints from Infrared Spectral Searches of the PDQ Database

Abstract: This presentation will describe a prototype pattern recognition library search system to identify the assembly plant of a vehicle from a paint chip or smear. The library search system consists of two components: prefilters to cull the library spectra in PDQ to a specific plant(s) and a cross correlation library search algorithm to identify infrared (IR) spectra most similar to the unknown in the set identified by the prefilters. Even in challenging trials where the automotive paint samples evaluated were from the same manufacturer within a limited production year range, the prototype system outperformed commercial library search algorithms.

Barry K. Lavine*, MS, PhD, **Collin White**, **Matthew Allen**, and **Nuwan Perera**, PhD, Department of Chemistry, Oklahoma State University; **Mark Sandercock**, MS, PhD, Royal Canadian Mounted Police, Forensic Science and Identification Services

Applying wavelets to resolve absorption bands in IR spectra of individual layers (e.g., clear coat) or multiple layers (clear coat and undercoat layers) by decomposing each spectrum into wavelet coefficients, a genetic algorithm for pattern recognition analysis identified wavelet coefficients characteristic of the assembly plant using 379 Chrysler, 429 General Motors, and 375 Ford manufacturers' paint systems as the training set. These coefficients were formulated into search prefilters, which in turn were validated for manufacturer and assembly plant using an external prediction set. Library matching was performed by cross correlating the unknown with each spectrum in the set of library spectra identified by the search prefilters and comparing each cross correlated spectra with the corresponding autocorrelated library spectra. Cross correlation allowed for identification of the model and line of the vehicle from individual or multiple layers of automotive paint, even in challenging trials involving the same manufacturer within a limited production year range (2000–2006).

Chemical information derived solely from the infrared spectrum of an individual layer (clear coat) or multiple layers (clear coat and undercoats) in many forensic automotive paint comparisons was sufficient to obtain the correct match using the prototype pattern recognition library search system.

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http://dx.doi.org/10.3768/rtipress.2015.cp.0001.1512

Color Management Improves Comparison of Hair Color

Gina Londino, MS,
Indiana University-Purdue
University Indianapolis

Abstract: This poster will display the use of a color management system that allows for images magnified by a brightfield microscope to be displayed with true color to the material. This technique was able to produce images that accurately reflect the color of the original specimens in order to compare forensic hair samples accurately. The calibration of the computer monitor as well as the camera images will be shared. Images of hair will be seen before and after calibration. Difference in color from an image captured without calibration and calibrated images displaying true color of the hair will be visualized.

The calibration of the computer monitor, including gamma, white point, and brightness, as well as calibration of the camera images, which includes exposure, contrast, and saturation settings, was done. The slide image is put into the color management program under "Color Brightfield Mode." For the program to accept the slide image, good matrix alignment, linearity, and exposure must be obtained. All parameters and settings, on the camera software and the microscope, need to be maintained at the same values for the calibration slide and when the image is captured. The calibration process was completed four separate times, and each time the calibrated images were the same, even with different exposure times. The exposures ranged from 16.0 milliseconds to 19.4 milliseconds. Ten different undyed hair samples ranging from dark to light in color were imaged at multiple dates and compared.

The calibrated images produced were identical to what was viewed under the microscope. Any exposures within the range of 16.0–19.4 ms are good for calibration, giving an accurate and reproducible image. This system works for the potential of color correction for the analysis of hair samples.

Status: Completed

Keywords: microscopy, imaging, color

Recovery of Erased Markings in Firearms Utilizing Magneto-Optical Sensor Technology

Abstract: Magneto-Optical (MO) sensor technology is a new and innovative technology that has been successfully used in electronics (superconductor quality assurance), automotive (permanent magnet analysis), and biomedical engineering (magnetic marker monitoring). The technology has recently been adapted for use in forensics. This project targets the recovery of erased markings in firearms.

Rudi Luyendijk,
Midwest Forensics Resource Center, US Department of Energy, Ames Laboratory

MO sensor technology is a non-destructive technology capable of detecting and visualizing magnetic fields in ferrous and para-magnetic metals in real time. It has been used in Germany to image erased markings and has the potential to detect and visualize obliterated serial numbers and VIN-numbers in ferrous and paramagnetic metals and latent prints on non-porous media. It also has potential to authenticate questioned documents and banknotes.

MO sensor technology is an easy-to-use imaging technology that requires little to no sample preparation to recover obliterated serial numbers in firearms non-destructively and in real time. Four technical performance factors were examined to determine the effectiveness and efficiency of the MO sensor technology for recovering obliterated serial numbers in firearms. Tests were performed on actual firearms by experienced firearm examiners.

Recovery rates of more than 50% were obtained for Stamping, Laser Etching, and Dot Peening applied, and hand-filing and Dremel-grinding removed serial numbers. The recovery rate for Stamping-applied serial numbers is significantly higher than what has been reported in the literature, while the recovery rates for Dot Peening-applied, and Laser Etching-applied serial numbers are the first to be recorded.

Status: Completed (NIJ 2011-DN-BX-K564)

Keywords: Firearm markings, serial number recovery, Magneto-Optical sensor

A Fracture Match Case Involving a Hit & Run Fatality

John M. Mancini, Miami-Dade (Florida) Police Department, Forensic Services Bureau

Abstract: A hit and run fatality occurred on a Florida highway. The side-view mirror was found at the scene along with the body. The suspect car was recovered, and a fracture-match examination was performed in the Firearm and Toolmark Unit with success. After observing this poster, attendees will be able to visualize and understand the techniques and aspects utilized in the examination of a fracture match.

On the Use of Surface-Enhanced Raman Spectroscopy (SERS) in Forensic Science

Abstract: This presentation will focus on present and future applications of SERS for samples of forensic interest. The presentation will cover a wide range of forensic examples (inks, paints, fibers, drugs), as well as practical considerations for a forensic use such as method validation, development of a comprehensive database, and the assessment of spectral comparison.

Cyril Muehlethaler*, MS, PhD, City College of New York, Department of Chemistry, and Metropolitan Museum of Art, Department of Scientific Research;
John R. Lombardi, PhD, City College of New York, Department of Chemistry;
Marco Leona, PhD, Metropolitan Museum of Art, Department of Scientific Research

SERS is an ultra-sensitive technique that can be combined with very specific substrates to target molecules of forensic interest. It will provide an alternative to other analytical techniques for which either the sampling (collection, extraction, or separation); the sensitivity; or the limit of detection present some limitations. Likewise, it also needs to be fully validated to be accepted for reporting in court.

Silver colloids (prepared by microwave synthesis) were used as SERS substrate for analyzing various forensic samples such as dyes/colorants from inks, paints or fibers, and illicit drugs (amphetamines species, cannabinoids). To validate the procedure for a forensic use, reproducibility and repeatability were statistically evaluated with different samples.

Compared to standard Raman measurement, SERS provided very intense and well-resolved peaks. The quenching of background fluorescence together with increase of signal intensity provided very sensitive ways of identifying unknown molecules. Associated with a homemade online database of SERS spectra actually comprising around 250 compounds, it provides an efficient way of identifying unknown samples. The repeatability of the proposed procedure was very satisfactory for a qualitative assessment of the results.

Status: Ongoing (NSF CHE-1402750)

Keywords: Raman, SERS, forensic

Two Shoes, One Car, and Four Tires: An Interesting Homicide Case Involving Differences in Half Shoe Sizes and the Remarkable Coincidence of Having Four Different Tires on One Car

Kyle Mueller,
Phoenix Police Department
Crime Laboratory

Abstract: This poster will describe the footwear and tire track analysis performed in a double homicide case that occurred in Phoenix, AZ in December 2010. A total of 1,182 comparative photos were taken depicting both footwear and tire track impressions located in an alley where one of the victims was found. The analysis involved comparing two pairs of Nike Air Jordan Flight shoes with similar outsole designs but that differed in a half size (10.5 versus 11) and the processes involved that led to excluding the size 11 shoe. Additionally, exemplars from four different vehicles were compared to numerous tire tracks found at the scene and a description of the processes involved that led to excluding three of the four vehicles and the interesting aspect(s) of the remaining vehicle. The suspect's shoes (Nike size 10.5) and vehicle tires were found to correspond in class characteristics with several impressions depicted at the scene.

Status: Completed

Keywords: shoe, tire, comparison

By Using the Hanging Drop Technique It Is Possible to Differentiate Between Single- and Double-Base Smokeless Powders

Abstract: Bulk smokeless gunpowder is manufactured in a large variety of shapes, sizes, and textures, making it challenging to differentiate between types of powders. One chemical discriminating parameter is the presence of nitroglycerin, which often requires expensive instrumentation to be detected. By using the hanging drop technique, it is possible to differentiate between single- and double-base smokeless powders. The method resulted in a successful time-effective and non-destructive result for the detection of nitroglycerin.

Marcel Roberts, PhD,
John Jay College

Casting of 3-Dimensional Questioned and Known Footwear Prints in Snow and Dried Soil with Foam Sprays and Foam Blocks

Hal Sherman,
Forensic Evidence Analysis and
Reconstruction Consultant;
Nicholas Petraco, MS,
Forensic Consultant

Abstract: Various foams are presented as alternative materials for the casting and preservation of 3-dimensional footwear impressions located in snow and dried soil. These methods generate detailed, 1:1 foam cast of questioned footwear imprints in snow and dried soil. The resulting casts can be directly compared to the known outsole of suspected footwear. Application of Bio-Foam blocks as well as other readily commercially available foam materials is simple and fast. Foam preparations are either sprayed and allowed to harden or placed in block foam directly into the questioned impressions. The set spray foam casts are carefully removed and packaged in a small box, while the Bio-Foam block casts are placed back into their original boxes. Each is marked appropriately for identification, sealed, and stored until needed. When required for examination and/or comparison the form casts of the questioned impressions are carefully removed from their storage containers and directly compared to the outsole of known suspected item(s) of footwear or known casts of the suspected footwear.

Status: Ongoing

SESA (Statistical Evaluation of Shoeprint Accidentals) Software: A Scientific Base for Shoeprint Evaluation

Yaron Shor*, MS, MBA, and
Sarena Wiesner, MS,
Israel Police Headquarters,
Toolmarks and Materials
Labboratory;
Yoram Yekutieli, MS, PhD,
Hadassah Academic College

Abstract: An extensive research project on the statistics of shoeprint accidentals is presented, including a description of software tools that enable the shoeprint expert to estimate the evidential value of shoeprint accidentals in a quantitative, scientific way.

Currently, when a shoeprint expert evaluates accidental characteristics in shoeprints, the evaluation process and its conclusions are performed in a qualitative manner, without any statistical aid. The expert stating "uniqueness" of an accidental is actually claiming that he never saw another similar characteristic. But such a statement is not supported scientifically (experimentally or mathematically). To overcome this difficulty, it is necessary to collect a large data set of accidentals.

To create such a data set for statistical calculations, we need more than just photographs or scans of accidentals. All the information must be digitized objectively. Collection of digitalized data for a large number of accidentals enables reliable statistical calculations.

In our research, we produced a large data set, based on hundreds of shoe-sole test impressions with a collection of more than 12,000 accidentals. Marking the accidentals was done using a semi-automatic software tool aiding the expert in detection of the contour of a given accidental objectively. For each of the accidentals, its features (location, orientation, and shape) were determined. SESA software was developed to calculate the probability that a specific accidental will appear on another shoe sole. This calculation is performed by multiplying the probabilities of the location, orientation, and shape for the specific accidental. The software is capable of finding the most similar accidentals and calculates the overall chance to find a combination of accidentals on another shoe. The results are received automatically, and the process is simple, yet powerful in demonstrating the scientific base of the expert's conclusions.

Developing Fingerprints on Clothing

Ruben Sousa, MFS, London South Bank University

Abstract: This presentation will explore a branch untapped in the fingerprints field. It will prospect the work done in the fingerprint field: the development of fingerprint on clothing. This presentation explores two different techniques (Lumicyano Fumes and Ninhydrin) and 13 different types of fabrics (used in clothing) of two different colours (black and white) to test if it is possible to develop fingerprints on fabrics. This development and posterior visualisation is very important to help solve contact crimes like rape.

Conclusions on this study are clear; it is possible to obtain good results using both techniques for fingerprint development. Fingerprints deposited on white samples were more easily developed with Ninhydrin and dark samples with Lumicyano Fumes. Fingerprints' quality was good and ridge details were possible to observe (including some distinctive features). With these techniques of development, fingerprints can be used to be compared and eventually, to reach a conclusion.

Status: Completed

Keywords: fingerprints, Ninhydrin, Lumicyano

Application and Analysis of Chemical Testing on Regenerated Cellulose Fibers

Abstract: Fibers can be key pieces of associative evidence. One method that can be used in fiber analysis is chemical testing, a quick, easy, and relatively cheap presumptive method. Chemical tests such as zinc chloro-iodide, based on color change, and cupriethylenediamine hydroxide, based on solubility, are known tests for cellulose. These chemical tests were applied to different classes of modern regenerated cellulose samples, such as viscose rayon, cuprammonium rayon, modal, and acetate, with different dyes, textures, and manufacturers to test if actual results were consistent with expected results. A compound light microscope was used to observe color and solubility changes. Samples were compared within classes and between classes. Synthetic fibers, polyester, acrylic, and nylon, which contain no cellulose, were also tested for observation of false positives. The method was repeated for all samples in three separate trials for an evaluation of reproducibility.

Linda M. Steidler*, MSFS, and **Heather Harris**, MFS, JD, Arcadia University

Most zinc chloro-iodide results were consistent with the expected results; however, there were also variations within and across the classes for color change. False positives were observed in polyester and acrylic samples. Nylon samples were observed as behaving like the negative control in parts of the fibers, while other parts of the fibers had a color change similar to acetate. Solubility of viscose, modal, and rayon were consistent with the expected results for cupriethylenediamine hydroxide; however, acetate had a more distinct variation. Acetate fibers only had slight solubility and dissolved much slower than the other regenerated cellulose fiber types. As presumptive tests, zinc chloro-iodide and cupriethylenediamine hydroxide are beneficial for the quick classification of unknown fibers, but other tests are still needed to confirm fiber identities.

Status: Completed, Arcadia University

Keywords: forensic science, regenerated cellulose fibers, fiber chemical testing

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Comparing 6000 Consecutively Fired .40 S&W Bullets and Cartridge Cases from a Sig Sauer P320 Pistol Utilizing 3-Dimensional Imaging and Objective Comparative Analysis

Jennifer L. Stephenson*, MSFS, and **Erich Smith**, MS, Federal Bureau of Investigation, Laboratory Division

Abstract: This study was conducted to determine the persistence and variation of individual characteristics on test fired bullets and cartridge cases selected from 6,000 cartridges fired from a Sig Sauer P320 .40 S&W semiautomatic pistol. The pistol was purchased new and had only been fired by the manufacturer for a standard function test prior to this study. The ammunition selected for this study contained brass jacketed hollow-point bullets and nickel cartridge cases with nickel primers. To provide a worst-case scenario for comparative analysis, the pistol was not cleaned at any point during the study.

The first test fire was used as the reference sample for comparative analysis against all of the subsequent test fires. Images of land impressions on the bullets were acquired using confocal microscopy and analyzed with the application of a cross-correlation function. Images of breechface marks on the cartridge cases were acquired using photometric stereo and analyzed with the application of a bidirectional reflectance distribution function. Both the cross-correlation and bidirectional reflectance distribution functions provided objective numerical values representing the similarity between two samples' topography. The numerical values were used to determine if there was a significant variation of individual topographies over the sequence of test fires and whether or not the variations in the numerical values would prevent a result of identification from being rendered. Additionally, the bullets and cartridge cases were examined by qualified examiners from the FBI Laboratory's Firearms/Toolmarks Unit (FTU) to determine if individual characteristics still persist to render a conclusion of identification by traditional means. Photographs of the pistol's barrel and breechface were taken prior to firing and after each 1,000-cartridge interval. These photographs served as an indication of variation of individual characteristics over the sequence of test fires due to wear. The photographs also indicated the extent of buildup of brass, lead, and other residues that occurred during the sequence of test fires without cleaning the pistol.

Status: Ongoing

Keywords: firearms, comparative analysis, confocal microscopy, optical topography

Stamped Impressions: A Case Study of Fingerprint Forgery

Abstract: There are three types of fingerprints with respect to nature of deposition viz. latent prints, patent prints, and plastic prints. Inked impressions on legal documents are one of the most common types of patent prints in the Indian subcontinent, which are sometimes unnaturally produced in the form of stamps; a type of fingerprint forgery. In the present case study stamped fingerprint impressions were examined, reported, and testified to in a court of law. Experiments were also conducted to evaluate the features of natural and unnatural fingerprint impressions. The general contour of fingerprint impressions and the absence of natural variation in multiple impressions of the same source were the key factors in detecting stamped impressions.

Status: Completed

Keywords: fingerprints, stamped impressions, forgery

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Gun Crime in Pakistan: Identification Difficulties Due to Primer Flow Back and Possible Identification Techniques

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Abstract: The first portion of this presentation will introduce the audience to the dimensions of gun crime in Pakistan. In the second portion, this presentation will discuss difficulties in the comparison of cartridge cases that get primer flow back during firing. There has been a tremendous tendency of false eliminations while working with cartridge cases. In this presentation, some cautions will be provided to the firearms examiners for the case in which they encounter any cartridge cases with primer flow back and finally techniques of casting and using different viewing angles will be illustrated to avoid false elimination.

After attending this presentation, attendees will be more aware of the primer flow back phenomenon and better mentally equipped to deal with such cartridge cases during firearms identification.

Status: Ongoing

Keywords: firearm, gun crime, primer flow back

Latent Print Image with No Scale and/or Blurred for Automated Fingerprint Identification System (AFIS) searches....NO PROBLEM!

Abstract: This poster will present three methods showing how to calibrate an image of a latent print photographed without a scale using Adobe Photoshop. A case scenario is presented when a latent in digital format was submitted without a scale, and it was run into the AFIS system after it was calibrated based on the ridge count method. The estimated real size of the latent image was increased with 10% and 20% in size and decreased with the same values. These images were searched in two different AFIS systems. Lastly, the results of three different filters (high pass, smart sharpen, and camera shake reduction filters) used on two blurred images (out of focus and camera shake), will be shown.

Keywords: AFIS, calibrate, Photoshop

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Fingerprint Dyes Compatible with a Variety of Surface Colors and Morphologies

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Abstract: This poster highlights a study that determined that the proposed dyes improved upon the current fluorescin/fluorescein and luminol systems in many respects. The reagents and protocols developed preserved detail for substantially longer periods than fluorescein; and solubility and fluorescence under acidic conditions and peroxidase-specific chemistry were all successfully achieved. The oxidation reaction of the proposed dyes mediated by Horseradish Peroxidase/H_2O_2, produced fluorescent products in acidic media. The use of sodium acetate and polyethylene glycol (MW 35000) as additives on the reaction mixture accelerated the oxidation reaction. While the reduced form of the proposed dyes is soluble at acidic pH (2–5) and is also compatible with strong protein denaturing solutions, the oxidized forms have diminished solubility. Formation of colloidal-type precipitates were observed for oxidations conducted in solution at acidic pH.

Because of their broad absorption range, fingerprints developed with these dyes were visualized over the range of 400–570 nm, using alternative light sources equivalent to several dye laser excitation wavelengths. Thus, the use of UV-light for visualization, which can damage DNA, can be avoided. The oxidation products are stable, which allows the capture of detailed images after long periods of time (at least 3 months). Improvement in the fluorescence emission is obtained by spraying the treated fingerprint with a solution of higher pH. Promising results were obtained on pig blood fingerprint trials on glass and colored paper board, using the newly created dyes.

Thus, improvement in detail preservation may be possible. Because of their broad absorption range, fingerprints developed with these dyes were visualized over the range of 400–570 nm, using alternative light sources equivalent to several dye laser excitation wavelengths. Thus, the use of UV-light for visualization, which can damage DNA, can be avoided. The oxidation products are stable, which allows the capture of detailed images after long periods of time (at least 10 months). Improvement in the fluorescence emission is obtained by spraying the treated fingerprint with a solution of higher pH. Promising results were obtained on pig blood fingerprint trials on glass and colored board, using the newly created dyes.

Fingerprint Fragment Fusion: A New Method for Mining for Identity in Fingerprints

Mark A. Walch*, MArch, and **Daniel Gantz**, Sciometrics LLC; **Donald Gantz**, PhD, Department of Applied Information Technology, Volgenau School of Engineering, George Mason University; **JoAnn Buscaglia**, PhD, FBI Laboratory Division

Abstract: As the breadth of biometric identification expands, fingerprints continue to be a prime source of identity data. However, many latent fingerprints confound automated identification systems because they lack sufficient minutiae (ridge bifurcations and endings) or are highly distorted. Law enforcement agencies have collected numerous low-quality latent fingerprints where identification could assist in solving crimes and preventing acts of terrorism, but many of these prints remain unidentified. This presentation discusses a novel approach to biometric fusion within the fingerprint modality, "Fingerprint Fragment Fusion," which could potentially assist with the identification of low-quality latents.

"Fingerprint Fragment Fusion" uses multiple fingerprints and resolves them to a single identity; it can be performed on latent fragments from the same finger or from different fingers. If taken from the same finger, the fragments can be assembled into a composite image suitable for Automated Fingerprint Identification System (AFIS) submission. If fragments are from multiple fingers, the fragments can individually be rendered to identity and the identity results for each of the fragments can be fused into a single identity. This novel biometric solution could potentially assist in solving crimes with unsolved, low-quality latent prints.

The matching method underlying Fingerprint Fragment Fusion creates surrogates for minutiae by using ridge geometry to create a new class of feature that supplements the lack of bifurcations and ridge endings. This method captures ridge and furrow information in a fingerprint via ridge-specific markers (RSMs; Gantz et al., 2014). RSMs are exploited to produce invertible overlays between a latent and a reference print that removes the local non-linear distortion between the prints. Each overlay is scored at the pixel level by an algorithm that evaluates the accuracy of the overlay at the pixel level within ridges and furrows. These new RSMs can be uniquely and reliably associated with a specific section of a ridge using the geometric information available from the ridge. Furthermore, the information extracted from sections of ridge flow can be fused among the same or multiple fingers from the same person assembling a "mosaic of identity" from sparse fingerprint data. Fingerprint Fragment Fusion leverages the information extracted from multiple fingerprint fragments and aggregates these "parts" into a "whole" picture of identity.

Status: Ongoing, initially funded under contract by the FBI Laboratory, with additional funding provided under contract by the Biometric Identity Management Activity

Reference

Gantz, D. T., et al. (2014). A novel approach for latent print identification using accurate overlays to prioritize reference prints. Forensic Science International, 245, 62–170.

Statistical Validation of Error Rates Reported from Conclusive Ballistic Identification Software—CaseHitter

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Abstract: A conclusive ballistic identification software, called CaseHitter, has been developed at X-wave Innovations, Inc. for cartridge case identification. This CaseHitter software is based on the congruent matching cells (CMC) method, which was invented by Mr. John (Jun-Feng) Song at the National Institute of Standards and Technology (NIST) in 2011. Unlike conventional automated cartridge case identification systems that only give a rank list of similarity, the CaseHitter software provides a conclusive decision with error rates whether two compared cartridge cases match or not. To statistically validate the error rates reported by the CaseHitter software, experimental data acquisition and analysis have been conducted.

Two sets of cartridge cases were used to statistically validate the error rates. The first set of images of 40 cartridge cases fired by 10 consecutively manufactured slides, which were collected at Miami-Dade Police Department Crime Laboratory, were captured using Leeds Forensic Science's comparison microscope. CaseHitter software was used to conduct correlation between each two of them and that makes total 780 comparisons, including 717 known non-matching (KNM) and 63 known matching (KM). According to statistical population, statistical parameters were calculated and CMC histogram distributions were established for KM and KNM from it. Probabilities of false identification for a KNM and false exclusion for matching were calculated depending on the obtained CMC numbers. The accumulated error rate for whole matching population and whole non-matching population were derived. The second sets of images contained 270 cartridge cases, which were provided by California Criminalistics Institute (CCI) using Leeds's comparison microscope. This set of images were tested to validate the statistical model and error rate calculation reported by the CaseHitter.

The test results show no false positive in the correlation between KNM cartridge cases, which is important for forensic identification. For the dataset of KM, false negatives may happen for multiple reasons, including poor contact between the slide and the breech face during firing and unsatisfied image acquisition.

The test results of 40 Miami-Dade and 270 CCI data sets demonstrates that the CaseHitter software developed based on NIST CMC concept and method is capable of providing high accuracy and quantitative error rates for cartridge case identification. This software can make conclusive decision of whether two compared cartridge cases match or not with scientifically validated error rates. The CaseHitter has potential to support a firearm examiner's testimony in court.

The Evidential Value of the Orientation of Stamp Impressions in Tampered Documents

Abstract: In suspected tampering cases involving company official documents, the forensic scientist is usually required to determine the authenticity of the signature on a questioned document. At times, the company stamp is present on the same page as the disputed signature. The duality of a disputed signature and a disputed stamp impression are synergistic in their probative value for indicating signs of tampering.

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The Forensic Experts Group

The authors of this paper were involved in a case of a disputed signature on a company contract. We pointed out to the client that besides the disputed signature, the stamp impression could have been reproduced from one of the undisputed documents submitted as reference for comparison with the disputed document.

As the original questioned document was not available, scanned copies or photocopies of the questioned and reference documents were submitted instead. The examination of the signatures was more straightforward compared to the stamp impressions due to the principle of forensic handwriting identification, which states that no one person writes exactly the same way twice, and that no two signatures by a single person will be identical due to inherent natural variation in handwriting. Examination of the stamp impressions was more challenging because they were of poor quality after repeated reproductions and lacked the clarity of the fine features and details found in original stamp impressions. They also lacked distinguishing defects or trash marks for association with the stamp impression in the reference document.

We decided to investigate the evidential value of the orientation of the stamp impression as it was circular with no obvious "upright" or "correct" position. Considering that a circular stamp can be rotated 360 degrees and the large number of orientations in which a circular stamp impression can be made, what is the probability of obtaining two independent stamp impressions with an identical orientation? The answer to this question would affect the significance and evidential value of the stamp impression on the disputed document.

The experiments in this study were conducted in two different ways to take into consideration the habitual aspects of individuals:

- consciously and deliberately positioning the stamp in a particular orientation to make the impressions
- randomly positioning the stamp to make the impressions

The findings of this study provide more information to the examiner and enable a more objective interpretation to be made for such cases.

It is also noteworthy that the initial request was to only ascertain the authenticity of the signature on the questioned document. As forensic scientists, we understand that the duality of evidence holds more probative value than a single piece of evidence. Hence, we are of the opinion that it is the responsibility of the

forensic scientist to point out areas of examination which may have evidential value, but are not immediately apparent to the client.

Status: Completed

Keywords: stamp impressions, tampering, documents