Technology Integration

Observations from the 2008 Triennial Meeting of the International Association of Forensic Sciences (IAFS)

New Orleans, LA
July 21-26, 2008

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Introduction

In partnership with the Bureau of Justice Assistance (BJA), the National Forensic Science Technology Center (NFSTC) provided scholarships to select members of the forensic science and justice communities to explore new technologies at the triennial meeting of the International Association of Forensic Sciences (IAFS), held in New Orleans, LA from July 21-26, 2008.

Established in 1957, the IAFS is the only worldwide association to bring together academics and practicing professionals of various disciplines in forensic science. The objective of the IAFS is to develop the forensic sciences and assist forensic scientists and others to exchange scientific and technical information.

The following document assembles the observations of seventy (70) professionals from twenty-six (26) States, selected from a broad cross-section, including: medical examination, law enforcement, forensic chemistry, forensic odontology, latent print examination, physical anthropology, photographic laboratory analysis, and more. These professionals attended oral presentations, poster presentations, or technology demonstrations in the exposition hall at the IAFS meeting. This publication provides a unique opportunity for forensic science practitioners to gain insight into the benefits and limitations of applying these new technologies.

The content of the following synopses represents the observations of the authors, presented in their own words. Neither the BJA nor the NFSTC are responsible for the accuracy of the content. The abstracts included in this document were provided to the IAFS by the conference presenters.

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Computer Forensics and Digital Evidence

Cyberspace: Civil & Criminal Collaboration & Enforcement

Type of Presentation: Special Session

Presenter: Don P. Colcolough, Director, Investigations & Global Security, AOL LLC

IAFS Website Description: The increased dependence on the Internet for daily activities has steered wrongdoers online to engage in their illegal conduct. Such conduct includes not only traditional illegal activities, but increasingly new forms of crime and fraud, through unsolicited e-mail, phishing, and spyware. The lack of jurisdictional boundaries and the ease in which one can conceal oneself on the Internet has created new difficulties for law enforcement in their pursuit of these wrongdoers. As a result, industry and law enforcement from throughout the world have come together to jointly combat this growing phenomena.

The purpose of this seminar is to inform the audience of the ongoing collaborative efforts, identify the specific tools and resources available to law enforcement, and suggest how law enforcement can best use those resources. Representatives from eBay and AOL will share their available assistance in forensic investigations in both civil and criminal enforcement, and law enforcement official will provide details of success and pitfalls in enforcement efforts.

Synopsis Author: C. Brad Schuelke

Position/Profession: Assistant Attorney General / Attorney

Agency: Texas Attorney General's Office (TX)

Synopsis Technology: America OnLine (AOL) "Easter Eggs"—Connectivity Summary and .BAG file

How Technology Works: AOL has several "Easter Eggs"—hidden sources of information—built into its software platform. The first is a connectivity summary that shows every geographic location from which the computer has connected to the AOL network. The connectivity summary is stored on the hard drive of the computer and can be accessed by going to Help > About > Ctrl I. The AOL software also stores a .BAG file on the user's hard drive. The .BAG file is a text version of the user's Instant Message Buddy List. The file shows the screen names of everyone who has been on the user's Buddy List.

How Technology Used in Attendee's Profession: The AOL "Easter Eggs" can be used in any case where the suspect has an AOL account and law enforcement has obtained possession of the suspect's hard drive.

Technology Benefits: The "Easter Eggs" can help to establish that a subject was in a particular geographic area at the time of a crime. For example, if a crime was committed in Dallas, Texas, but the suspect is from New Orleans, LA, the connectivity summary may be used to establish that the suspect connected to AOL while in Dallas, TX around the time of the crime. The .BAG file can be used to establish that the subject is an acquaintance of other potential suspects or to identify possible witnesses.

Technology Limitations: The connectivity summary and .BAG file are stored only on the user's hard drive; if the user's hard drive is not available, the information cannot be obtained. AOL may have other useful information in its records, but it will not have the information from those two files.

Crime Scene Investigation and Police Science

Bloodstained Footwear Impression Enhancement: Comparison of Infrared Photography to Diaminobenzidine (DAB) Treatment

Type of Presentation: Scientific Session

Authors: *James A. Bailey, PhD*, Minnesota State University, Mankato, Political Science and Law Enforcement Department, 109 Morris Hall, Mankato, MN 56001; and Daniel J. Swart, PhD, Minnesota State University, Mankato, 357 Trafton Science Center N, Mankato, MN 56001*

Abstract: The purpose of this study is to compare bloodstained footwear impressions recorded with infrared photography to impressions treated with Diaminobenzidine (DAB). The comparison was made to determine which method provides superior enhancements.

In this experiment, 30 footwear impressions were prepared for infrared photography and subsequently treated with a solution of DAB. Components of the blood catalyze the oxidation of DAB with peroxide and change to a blue-black color. A variety of multi-colored fabrics were selected for testing. Fabric samples were cut into pieces approximately 15.24 cm by 35.56 cm (6 in x 14 in) in size. The samples included ten 100% cotton, ten 100% polyester and ten mixed blend fabrics.

To produce bloodstained shoe impressions, two layers of 100% cotton fabric were placed in a glass dish approximately 22.86 cm by 33.02 cm (9 in x 13 in) and saturated with bovine blood. Shoe impression samples were produced by stepping onto a piece of fabric presoaked with bovine blood in the glass dish and then by stepping onto a precut sample of fabric.

Once the sample impressions dried, color photographs were taken to illustrate the condition of the impression prior to treatment. Next, infrared photographs were taken to obtain an enhanced impression of each footprint. Fabric samples were then processed with the DAB treatment. The DAB treatment required mixing 4 solutions. Solution A, the fixer, was prepared by adding 1000 mL of distilled water to 20.0 g of5-sulfosalicyic acid. Solution B, the buffer, was prepared by mixing 100 mL of 1M phosphate buffer solution (pH 7.4) to 800 mL of distilled water. Solution C, DAB, was prepared by adding 100 mL of distilled water to 1.0 g of 3, 3'-diaminobenzidine tetrahydrochloride. Solution D, the DAB developer solution, is prepared by mixing 180 mL of solution B, 20 mL of solution C to 1 mL of 30% hydrogen peroxide.

The bloodstained samples photographed with infrared photography produced 9 (30%) superior enhanced impressions. No impressions were enhanced on the 100% cotton fabrics, 6 (20%) were enhanced on 100% polyester, and 3 (10%) were enhanced on the fabric blends.

When the DAB treatment was applied to the bloodstained samples, 21 (70.0%) were enhanced. Ten (33.3%) were on 100% cotton, 4 (13.3%) on 100% polyester, and 7 (23.3%) on fabric blends.

In conclusion, DAB was more effective than infrared photography for enhancing bloodstained impressions on the 30 fabrics tested. On the 100% cotton samples, the DAB treatment produced more superior images than infrared photography. Infrared produced more superior images on 100% polyester

and fabric blends than DAB produced. It is important, however, to note that investigators should exercise caution when applying the DAB treatment because diaminobenzidine is a hazardous chemical.

Synopsis Author: Kristen Groff

Position/Profession: Crime Scene Analyst II / Crime Scene Investigation

Agency: Pensacola Police Department (FL)

Synopsis Technology: The use of Diaminobenzidine (DAB) as a blood enhancement chemical on shoe impressions.

How Technology Works: When collecting an area with a suspected bloody shoe impression, the impression should be photographed prior to any enhancement techniques with and without scale upon returning to the lab. After achieving a true and accurate representation of the un-enhanced shoe impression, treat the impression with the Diaminobenzidine, which is a four-solution process. The DAB undergoes an oxidation reaction with the proteins of the blood with the addition of the hydrogen peroxide present in the mixture. This is similar to the reaction that results when using phenolphthalein. The result is a dark brown color that is visible on many printed fabrics. Once the development takes place, re-photograph the enhanced area with and without scale.

How Technology Used in Attendee's Profession: When at a crime scene, there are times when the suspect has walked through the victim's blood and tracked the blood through the scene on the bottom of their shoes. In a perfect world, the bloody shoe impressions would be on smooth white tile; but chances are the bloody shoe impressions have been left on carpeting or some other fabric that has a pattern. Trying to photograph and capture the detail necessary for a shoe examiner to observe individual characteristics is a very difficult task. The pattern of the surface conflicts with the bloodstain and could hide crucial characteristics. The enhancement of the bloodstain would increase the chances of locating identifying characteristics.

Technology Benefits: The benefits of using DAB are shown in the experiments performed for the purpose of the attended session. The application of DAB, as opposed to using infrared photography, resulted in the DAB enhancing 70% of the bloodstains. The infrared photography enhanced only 30% of the bloodstains. The experiments were performed on thirty (30) different types of fabric with different patterns. The different blood-enhancing chemicals that I have used in the past resulted in considerable background staining, making the impression less visible than it was originally. In the photographs shown in this session, there was very little background staining.

Technology Limitations: One major downfall of this process are the health hazards associated with using Diaminobenzidine. If extreme caution is used and the application takes place under a fume hood, the health risks are diminished drastically.

Another limitation is the shelf life of DAB. The working solution has a shelf life of just 48 hours if it is refrigerated. Cyanoacrylate fuming will affect the enhancement. DAB is a protein stain that is not specific to blood proteins. DAB will also enhance palmar sweat. DAB is better suited for use in a

controlled environment, such as a crime laboratory, versus being used at a crime scene. Therefore, more samples need to be collected from the scene and brought into the crime laboratory.

Synopsis Author: Whitney Stout

Position/Profession: Forensic Crime Unit Sergeant

Agency: Gainesville Police Department (FL)

Synopsis Technology: The study compared two processes, infrared (IR) photography and application of Diaminobenzidine (DAB), used to enhance the appearance of bloody footwear impressions on different types of fabric.

How Technology Works: The study is applicable to the crime scene work we regularly conduct as we frequently have footwear impressions that we would like to enhance. Although they may not often be in blood, we now have different methodologies we can use when they are in blood. I believe that we can apply these methodologies or slight variations of them to enhance footwear impressions on other surfaces.

The study utilized the same moderately worn shoe, bovine blood, and a wide variety of fabrics including cottons, polyesters, and blended fabrics, all of which came in a variety of colors: light, dark, and patterned. Dr. Bailey made parallel impressions on the fabric and treated each with either the DAB or the IR photography and viewed which could be seen more clearly.

To capture the IR print, Dr. Bailey:

- used an IR filter on a digital single lens reflex (SLR) camera
- set both the camera and the lens on the manual setting
- set the camera to a low ISO with no auto focus
- left the F-Stop open to about 4 and then opened the exposure for about four seconds.

This produced an IR image of the untreated impression that sometimes removed the background on the fabrics and sometimes did not.

When the DAB was used, it was applied to the stain and a more conventional photograph (auto focus) was taken of the impression. Dr. Bailey explained the chemical makeup of the DAB (he went through this slide very quickly so I could not write down the recipe, but he assured us that it is available on the Internet). He explained that his application used a fix application to the stain, a wash after the fix, an application of the DAB solution followed by a second wash.

Dr. Bailey cautioned that DAB is a carcinogen and should be handled and disposed of accordingly. His findings were inconclusive. He found that generally speaking, the DAB worked better on cotton fabrics

and IR photography worked better on the polyester or blended fabrics. However, he also noted that often the naked, untreated impression was just as good as or better than either prepped impression. He also explained that use of Amidoblack (which my agency currently uses) is often the best option.

How Technology Used in Attendee's Profession: Either the use of IR photography or DAB to enhance a bloody footwear impression would have a limited application for my agency as a practical matter. However, we occasionally come across that one crucial piece of evidence that we know we can't mess up and we now have two other possible options for addressing that type of item, should we find it on a scene. Additionally, we will experiment with both the use of DAB and IR photography in other applications and assess how those may be more readily applied in our day-to-day workings.

Technology Benefits: We do not currently use IR photography for any application. I would like to see it used with a little more regularity with other applications. Our unit will begin to use IR photography to see if bruises, latent tool marks, latent prints, or other trace marks can be enhanced or better viewed with the use of IR photography on a variety of surfaces.

Technology Limitations: We currently have many of the required supplies for the use of both IR photography and DAB. We may require a few additional items, but those will be of small incidental expense. However, the time expense needed to perform either of these procedures may preclude its use on the day-to-day scenes that we process. For example, we might not apply these methods on car burglaries or shopliftings; we would reserve either application for more serious crimes.

In addition to a concern that DAB is a carcinogen, I would also like to know more about how either application may or may not preclude additional further testing, such as , " Does IR kill DNA?" and "Will DAB deteriorate and not have visibility after 20 minutes?" I believe that other questions such as this need to be answered before application in our laboratory could occur.

Bluestar USAinc

Type of Presentation: Exhibition Booth

Synopsis Author: Donald G. Stanley

Position/Profession: Detective / Law Enforcement

Agency: Charleston County Sheriff's Office (SC)

Synopsis Technology: Latent bloodstain reagent

How Technology Works: Bluestar's forensic latent bloodstain reagent is a luminol-based product that is utilized in indentifying bloodstains. The process is conducted by adding the company's fast dissolving tablets to a pre-measured amount of distilled water. The product is then sprayed on the designated area(s), readily identifying human blood stains with a very strong luminescence pattern. The product

outperforms the standard luminol currently utilized by my agency. The item was demonstrated to have a higher sensitivity than standard luminol and total darkness was not required as with standard luminol. The product is also stated to be non-toxic, which is an added benefit. In addition, the product preserves the DNA within the blood without degrading or destroying any potential DNA evidence.

How Technology Used in Attendee's Profession: This technology would be useful at a variety of crime scenes or suspected crime scenes involving homicides or suspected homicide. The technology would greatly aid in identifying potential evidence in many cases.

Technology Benefits: The product has a long lasting reaction. Total darkness is not required, as with other processes. Photographs can be taken with ordinary cameras and lenses; colored lenses are not necessary. The product is non-toxic and preserves the DNA within the bloodstain with no occurrence of degradation. It is pre-mixed in water-soluble tablets that are added to distilled water; the tablets have a long shelf life.

Technology Limitations: No limitations noted at this time.

Crime Scene Search Theory

Type of Presentation: Scientific Session

Authors: *H. Dale Nute, PhD*, and Mark Feulner, MA, Florida State University Panama City, 4750 Collegiate Drive, Panama City, FL 32405*

Abstract: After attending this presentation, attendees will increase their understanding of the factors involved in a complex crime scene search. This presentation will impact the forensic community and/or humanity by providing an awareness of a theoretical basis for crime scene search by increasing their understanding of the factors involved in a complex crime scene search.

The discipline of crime scene investigation (CSI) like the rest of forensic science has focused predominately on technology rather than theory. For most crime scenes, this has worked, however, for the more complex scenes, scenes some methodological approach is required rather than just "do what worked last time." In this vein, a theory for crime scene search is explored.

Search theory was worked out fairly extensively for naval purposes in World War II and subsequently applied to marine search-and-rescue (SAR) operations. The marine SAR procedures are currently being expanded for land SAR operations, particularly for remote, rural areas. This paper makes some suggesting for adapting these SAR procedures for evidential searches.

Breaking the search down into its parts allows each to be examined for improvement. This analysis includes both the theoretical components and the technological methodology. A crime scene search begins with the theory: "A crime is the intersection of a criminal with his target in time and space." This intersection causes changes in the space that we call evidence. The crime scene obviously is the space

but the evidence in that space is determined by the impacts of the criminal, the victim, and the time of occurrence against what was there, i.e., the changes in the scene. In order to get the most from a crime scene search, the crime scene investigator must make a time-space-psyche analysis. Such an analysis combines the art of the investigator and the craft of the scientist and focuses on three factors – Purpose, Probability, and Procedures.

The Purpose has two aspects – to reconstruct what happened, when, where, and how; and to associate the culpable individual with the event, if not its cause. Reconstruction depends on the type of crime as that determines what information is required and thus what types of evidence needs to be located to provide that information. Association depends more on locating and evaluating materials that originate from any individual that had means, motive, and opportunity.

Probability also has two aspects – the probability that the evidence of interest is in a particular location; and the probability that it will be found in that location with a particular search methodology. The first is based on applying investigative information and the second is based on error analyses of the various search methodologies under the particular conditions of the search area.

The Procedures are of two types – those for calculating the evidence location probabilities and those for executing the search. Both are based on subjective information but still need to be methodological. Investigative probability calculations are based on knowledge of people and how they act in various situations. Search methodology probability calculations are based on protocol development. The search procedures include techniques for controlling the search and methods for detecting the evidence during the search. Both are highly situation dependent and the variety of situations requires a range of protocols. Based on the replicate testing used when developing the protocols, one can calculate the probabilities used both to make decisions about managing the search and for evaluating the results.

This paper describes how the analysis of these three factors – purpose, probability, and procedures – may be combined to provide the investigator with the means of scientifically guiding, evaluating, and directing crime scene searches.

Synopsis Author: Paula Quynn

Position/Profession: Criminalist / Crime Scene Investigator and Laboratory Technician

Agency: Brighton Police Department (CO)

Synopsis Technology: The theory of probability and how it can be applied when searching a complex crime scene.

How Technology Works: The theory of probability is based on a methodical approach to a complex crime scene, rather than an educated guess. The methodical approach is based on three factors – purpose, probability, and procedures. Each factor is twofold by nature and can be used to discriminate between conflicting hypotheses.

The first phase of the purpose would be to determine the necessary elements of the crime – who, when, where, and how. These elements assist the investigator in determining what types of evidence need to be located. The second phase of the purpose would be to associate items in the scene that could have originated from persons having motive, means, and opportunity.

The second factor involved in this approach is probability. The first phase is to determine the probability that evidence will be found in a particular location. This probability, called Probability of Containment (or POC), utilizes components such as surveillance, accessibility, and concealment. Each component is assigned a value based on the likelihood that something of evidentiary value will be found in that specific location. The second phase is evaluating the probability that evidence will be found using a particular search method for that specific location. Again, a value is assigned to each location. These values are placed on a chart; the location with the highest value is designated as the first to be searched using a specific method. Each location thereafter is searched in order of the highest value to the lowest value.

The third factor, procedure, is commonly based on subjective information and can differ from one investigator to the next. Regardless of the investigator, all procedures should be based on a methodical approach and calculated means.

The scene is then systematically searched starting with the highest probability regions and working down to the lowest probability regions.

How Technology Used in Attendee's Profession: One of my job responsibilities is to search crime scenes. This tool provides a methodical approach to an outdoor crime scene, allowing me to process the scene more effectively than using a blind search method. This methodology would also allow me to direct others on my team to conduct a more thorough and complete search, providing me with the confidence that, as a supervisor, the results we are getting are more consistent.

Technology Benefits: This tool would be very beneficial for outdoor remote and rural locations within our jurisdiction. If all departments used such a method, it would provide guidelines that facilitate cooperation as multiple departments work the same scene, possibly producing better results. This tool does not require extensive training, is easy to interpret, and can be used at any type of outdoor or large indoor crime scene. It can be used by a variety of searching entities including crime scene personnel and missing person rescue/recovery units.

This "new" tool costs nothing and there are no additional supplies required to use it.

Technology Limitations: The only downfall to using this technique is that it is most effective when used at a large scene. The department I work for is very small and the occurrence of a crime at a large scene is very rare in our city. Without constant training or usage of the technique, it could be hard to apply for that "once in a lifetime" scene.

Demonstration Using Sirchie Fingerprint Taking Binder

Type of Presentation: Exhibition Booth

Synopsis Author: Karen D. Jeffery

Position/Profession: Police Services Supervisor / Fingerprint (10-print) Verification

Agency: Jacksonville Sheriff's Office (FL)

Synopsis Technology: The Fingerprint Taking Binder (FPB100) manufactured by Sirchie Fingerprint Laboratories, Inc.

How Technology Works: The Fingerprint Taking Binder (FPB100) is a one-inch, three-ring binder used to fingerprint individuals. The binder comes equipped with a fingerprint card holder, a KlearInk ceramic fingerprint pad, a holding pouch for extra fingerprint cards, and fingerprint cleansing wipes, which are also stored in a convenient holding pouch.

The binder is placed on a flat surface, a blank fingerprint card is inserted in the holder and fingerprints are taken from the individual. Once complete, the individual uses a cleansing wipe to clear any remaining ink from his/her fingers. The holding pouch intended for extra fingerprint cards could also be used to safely keep the printed card until the time of verification or comparison.

How Technology Used in Attendee's Profession: As a former fingerprint technician, this binder would be used to fingerprint suspects in the courtroom. Police officers assigned to the street could also use this binder to safely and adequately collect fingerprints used to verify the identity of possible suspects.

Technology Benefits: When used in the courtroom and on the street, the fingerprint taking binder will be much easier to clean up after use. Currently, the staff at the Jacksonville Sheriff's Office uses a portable case with black fingerprint ink that requires the use of a roller. The ink comes in a small tube, similar to toothpaste. Also, the fingerprint taking binder is half the size of the fingerprint portable case. Therefore, the fingerprint taking binder is more convenient to use.

The binder is also more convenient than the current practice employed when officers find it necessary to fingerprint a suspect while riding during his/her tour of duty. Currently, officers use any form of ink they can find and roll the inked prints on any available type of blank paper (e.g., index cards, note pads, copier paper, etc.). The binder provides the officer with a flat, sturdy surface and makes all of the necessary equipment readily available to print the suspect. More importantly, the portability of the binder may reduce the need for officers to transport suspects to facilities where the fingerprinting can be performed, thus saving money on gas and vehicle maintenance.

Nevertheless, the officer may still be required to drive to the station to have the fingerprints verified. If this is the case, the fingerprint taking binder is still a better choice because the officer can hand deliver the fingerprint card to the fingerprint technician which is safer than removing the suspect from the vehicle so he/she can be fingerprinted. In addition, with the traditional technique, if there are a large

number of inmates waiting to be fingerprinted, the officer would be required to wait. Therefore he would not be available for service calls. In essence, the fingerprint taking binder also saves time.

Technology Limitations: The only limitations I would foresee if the Jacksonville Sheriff's Office decided to use the fingerprint taking binder is cost. With close to 1500 sworn officers on the street, it would be too costly to supply each officer with their own fingerprint taking binder, even at the mere cost of $73.00 each.

An alternative would be to provide the binders to primary officers on each squad, possibly a sergeant or lead officer. When there is a need to use the binder, the officer would request that the primary person meet with him for the purpose of printing a suspect. This scenario would still be less costly than driving to the jail for the same service.

The cost for supplying the fingerprint taking binder to courtroom personnel would be a little less expensive. There are approximately ten to fifteen criminal case courtrooms. Assigning one binder to each courtroom could be done fairly affordably. Using the binder requires little to no training and would serve as a valuable tool when attempting to identify suspects.

Demonstration of Crime Scene Reconstruction Software

Type of Presentation: Exhibition Booth

Synopsis Author: Anthony Campbell

Position/Profession: Chief / Law Enforcement

Agency: Somerdale Police Department (NJ)

Synopsis Technology: DeltaSphere 3D Laser Scanner by 3rd Tech

How Technology Works: Using laser technology, the DeltaSphere 3D Laser Scanner equipment rests on a tripod and rotates 360 degrees while measuring millions of 3D points and taking dozens of color digital photographs automatically in minutes. With the collected data, a detailed 3D model of a crime scene can be created.

How Technology Used in Attendee's Profession: This technology would come into use in multiple functions within my profession, including the recreation of accurate "to scale" drawings of crime scenes. For case preparation and presentation for the prosecution, utilizing the 3D drawings and scene walk-throughs would be very effective for presentation to a jury.

Technology Benefits: The DeltaSphere 3D Laser Scanner automatically measures and photographs crime scenes quickly, accurately, and thoroughly. This technology can save an investigator's hours of measuring and drawing time. Even though investigators try to be as thorough as possible, some measurements can be overlooked. With this technology, investigators can return to the model and

record the missing measurements. In reference to cold case investigations, cold case investigators can effectively revisit the crime scene just as the original investigators did, rather than merely looking at photographs and reviewing reports.

Technology Limitations: A limitation of this technology is that it can only measure what it can see; it cannot see behind objects, so the investigator has to move the laser multiple times to accurately recreate the scene. The laser's components are similar to a computer and therefore must not get wet. It cannot be used when it is raining, even if it's covered; if rain droplets are measured, this will distort the recreated drawing. It has a maximum useable measuring distance of 30 feet and could be difficult to use in large crime scenes. The complete cost is $51,000, including training, therefore making it difficult for small- to medium-sized departments to acquire the technology.

Forensic Science Competence in the Police Service - Building Knowledge to Reduce Crime

Type of Presentation: Scientific Session

Authors: *Samantha Frost*, NPIA, National Policing Improvement Agency, Forensic Centre, Harperley Hall, Crook, Co. Durham DL15 8DS, United Kingdom*

Abstract: The aim of this presentation is to discuss how the National Policing Improvement Agency (NPIA) is working with the Police Service to improve the level of forensic competence across all policing roles and ranks. The NPIA Forensic Centre is leading a three year project which will aim to improve forensic skills and knowledge for all Police Officers and Staff at all levels to promote more effective and efficient use of forensic science in the investigation of crime. The objectives of this project will be achieved through a series of work streams which will address all aspects of forensic science learning and competence across the entire spectrum of policing.

In the specialist field these include:

- The Crime Scene Investigator Learning Program which will provide a single, defined route to registration as a Crime Scene Investigator. It will provide an effective and efficient learning solution appropriate for modern policing.
- The Fingerprint Competence & Continued Professional Development will provide a process of competence testing and a structured program of Continued Professional Development to ensure professional standards are maintained by all fingerprint officers.
- The Footwear Specialist Learning Program will deliver a structured learning program for individuals working in footwear roles. It will ensure these individuals achieve competence in the workplace to maximize the use of footwear evidence and intelligence.

All learning programs will be structured within a framework which will support an individual from recruitment to retirement ensuring appropriate training for their role, continuous professional

development, and maintenance of role competence. This will include a cyclical process of performance monitoring through competence testing at agreed, specified intervals. A process of registration will be developed to support this process and give confidence to the police service and justice sector that those in role are competent.

The project will also develop forensic competence across other policing roles, the majority of which require some level of forensic awareness. This will start with an audit of current NPIA learning programs and skills gap analysis for all policing roles. Supported by the Skills for Justice Integrated Competency Framework and National Occupational Standards this will aim to maintain levels of competence throughout an individual's career. This is not just about training but making sure learned skills are successfully transferred to and applied in the workplace.

This is an ambitious program of work but is seen as a key part of the commitment to use forensic science more effectively and efficiently within the modern policing environment.

Synopsis Author: Dawn McDonald

Position/Profession: Crime Scene Technician

Agency: Boca Raton Police Department (FL)

Synopsis Technology: National Learning Program used in the United Kingdom

How Technology Works: The National Policing Improvement Agency (NPIA) has put together a CSI Learning Program that starts every new employee at the same level, training them in a systematic manner through various levels of achievement. The employee receives a certification at each completed level.

The program was created "to ensure that all forensic practitioners have the necessary competence on entering professional practice and maintain this throughout their career" and "to ensure that all police officers and staff involved in the use of forensic science have an appropriate level of knowledge".

The NPIA training begins with a recruitment and induction phase. Subsequent training program phases in the CSI Learning Program include:

- Stage One — includes the "Foundation Module" and "Evidential Portfolio". Upon completion of this stage, the employee is certified as a Registered Practitioner at this level.
- Stage Two — includes the "Development Module" and "Evidential Portfolio". Upon completion of this stage, the employee is certified as a Registered Practitioner at this level.
- Stage Three — consists of the "Professional Development Module". Upon completion of this stage, the employee is certified as a Registered Practitioner at this level.

The employee trains with a Registered Practitioner. After the employee is certified as a Registered Practitioner in a particular level, they can then respond to crime scenes without the trainer.

The NPIA has also put together a National Footwear Learning Program that is designed in the same manner.

- Stage One — includes the "Coding & Intelligence Course" and "Evidential Portfolio". Upon completion of this stage, the employee is certified as a Footwear Coding Officer at this level.
- Stage Two — includes the "Screening Module" and "Evidential Portfolio". Upon completion of this stage, the employee is certified as a Footwear Screening Officer at this level.
- Stage Three — includes the "Development Modules", "Evidential Portfolio", and a "Final Assessment". Upon completion of this stage, the employee is certified as a Footwear Specialist.

This training program also includes cross training for everyone, including call handlers, first attending officers, the police Investigators, the crime scene investigators, and footwear officers so that all participants have an understanding of each department's responsibilities. For example: This helps ensure that call handlers are better trained to ask specific questions so that they are better able to pass crucial information to the first attending officers and give instructions to the victims in reference to avoiding the destruction of potential evidence. The more questions the first responding officer asks, the better able the officer is to help the police investigator, the crime scene investigator, and the footwear officer with their investigations.

The improved outcomes include:

- Increased forensic opportunities
- Enhanced understanding of forensic evidence
- More effective use of forensic evidence
- Improved satisfaction of Criminal Justice System requirements
- Increased public confidence in the criminal justice system

How Technology Used in Attendee's Profession: This is an excellent program for all forensic units to follow.

Technology Benefits: Having a training program that is consistent for all employees in that field will ensure that anyone who has reached the Registered Practitioner certification in any level has been trained under the same guidelines as all other employees. With many states (or countries) having different districts, counties, towns, and agencies, this would ensure that everyone is trained at the same level. Thus, if numerous agencies had to work together on the same case, the various participants would know that the forensic experts were trained in the same manner.

Technology Limitations: The only limitations would be getting all agencies to agree on and follow the same program.

Synopsis Author: Lori Ohrt

Position/Profession: Crime Scene Specialist / Criminal Justice

Agency: City of Goodyear Police Department (AZ)

Synopsis Technology: The importance of education to all who participate in effectively and efficiently preserving evidence.

How Technology Works: The National Policing Improvement Agency (NPIA): "The forensic program aims to challenge, enable, and improve forensic services to make society safer and deliver an effective police-led forensic service fit for the 21st century."

The United Kingdom is changing how forensic education is being taught. Ms. Frost explains that the education needs to start from when the first call to dispatch comes in to the call center. Our operators need to be educated on what kinds of questions need to be asked and how to explain those answers to the victims to preserve possible evidence.

First responding officers, including police and/or fire personnel, also need to be educated on what potential evidence may be important when responding to a scene.

By making education and/or certifications a requirement, it will potentially reduce recidivism; personnel will be more efficient by working together employing the same general knowledge; and there will be consistencies in how a case is handled with the end result that the offender(s) will be brought to justice.

How Technology Used in Attendee's Profession: When a new crime scene specialist is hired as a city employee, it will be mandatory for that employee to be certified within six months regarding procedures for properly processing a crime scene.

I also feel that all dispatchers, firefighters, and police officers should attend training on how to identify evidence and the importance of preserving evidence.

Technology in the forensic world is changing continuously so I feel it is also important to maintain refresher classes throughout their careers with the city.

Technology Benefits: As a crime scene specialist arriving at a scene, I would feel confident knowing that the scene has been preserved properly.

For example, knowing that the fire personnel provided me with information on potential evidence from the scene that either I or other police personnel may not otherwise know about, could potentially make or break a case.

Technology Limitations: The cost for the training may limit the implementation of this program. Costs include: personnel to teach the class, and equipment and facilities.

As the only crime scene specialist for my department, it would be very difficult to commit to educating our personnel without it affecting my job duties. This would mean we would have to hire outside public and/or private contractors to teach, which would add to the cost of the program.

The department that I work for does not have a lab or other means to be able to properly communicate why it is so important to know forensics. Seeing results on a PowerPoint is helpful, but being able to show the results "hands on" is even better.

Synopsis Author: M. Frank Shonberger

Position/Profession: Senior Crime Scene Technician / Crime Scene Investigator

Agency: Coral Gables Police Department (FL)

Synopsis Technology: The National Police Improvement Agency (NPIA) training program.

How Technology Works: The National Policing Improvement Agency is working with all levels of the Police Service to improve the level of forensic competence.

The program will assure that the knowledge of crime scene preservation and the capability of forensic evidence is integrated into every aspect of personnel that interact with the scene of a crime. This will start with the person who receives the phone call from a victim reporting a crime. That person will be trained to ask the correct questions and offer advice regarding crime scene preservation. The first arriving officer will be the next level of police service. He will be similarly trained and shown additional scene-preservation techniques. The police investigator will be trained to work closer with the crime scene investigators in coordination of the evidence collected from the scene. The crime scene investigators will be integrated into this team policing concept. And additional training will be provided, including:

- The Crime Scene Investigator Learning Program, which will provide a single, defined route to registration as a crime scene investigator. It will provide an effective and efficient learning solution appropriate for modern policing.

- The fingerprint competence and continued professional development will provide a process of competence testing and a structured program of continued professional development to ensure professional standards are maintained by all fingerprint officers.

- The footwear specialist learning program will deliver a structured learning program for individuals working in footwear roles. It will ensure these individuals achieve competence in the workplace to maximize the use of footwear evidence and intelligence.

How Technology Used in Attendee's Profession: Our profession is moving toward these concepts. Police departments are becoming more aware of the importance of crime scene investigation's role in solving crime.

The ultimate goal of the NPIA training is to ensure that, with the assistance of all components of the Department, the crime scene unit is capable of gathering and preserving physical evidence that may be found at the scene of a crime. This capability requires highly trained crime scene investigators. The police department must be capable of providing proper protection to crime scenes; gathering physical evidence; charting the evidence; photographing, identifying, and properly preserving specimen; and retaining the legal chain of control.

The courts are constantly placing increased pressure on police officials to make greater use of physical evidence in the prosecution of cases. The trend is clearly away from convicting suspects of crimes on the basis of confessions alone. Reliance is placed more and more on objective evidentiary materials. Thus, the police department must have personnel with the capability of protecting crime scenes, gathering evidence, packaging and protecting evidence, and providing expert testimony in court. By nature, a crime scene is delicate and can be severely impacted by environmental conditions causing the loss of valuable evidence. It is imperative that crime scene investigators respond to, identify, and secure items of physical evidence before they are destroyed.

Technology Benefits: The benefits of training all members in a department are that the perpetrators of crimes will be convicted and not released to commit more crimes. This will reduce the crime rate.

Technology Limitations: Extensive training will be required to bring this concept to agencies in this country and internationally. Other countries have programs for accreditation and the International Association for Identification has a program for certification for the individual crime scene investigator. To overcome what has come to be known as the “CSI Effect”, law enforcement agencies throughout the world will have to demonstrate to the persons seated on juries that they have secured all the evidence that can be secured from the scene and all necessary testing has been accomplished.

Criminal Profiling

Deciphering Who Killed the Prostitute Utilizing Keppel and Walter's Revised Classification Model for Understanding Sexual Murder

Type of Presentation: Scientific Session

Authors: *James M. Adcock, PhD*, University of New Haven, 1 Campbell Avenue, Apt 54, West, CT 06516*

Abstract: In the fall of 2007, through the guidance of the Henry C. Lee Institute of Forensic Science, located at the University of New Haven, a process was started whereby teams of hand-picked Forensic Science graduate students were selected to review and evaluate unresolved homicides from local police departments.

One case in particular was a ten-year-old investigation that involved the murder of a prostitute who was strangled and posed nude in a sexually suggestive position at the end of a fairly secluded dead-end road where it was common knowledge that uniformed police officers would park to write reports, drink coffee, etc. Five years after her death a suspect was arrested for the murder of a prostitute in a nearby town. This prompted the primary agency to investigate this person for the murder. During this effort they determined during that five year period there were two other prostitute murders, one being out of state but within 50 miles. This common factor caused the lead agency to concentrate on the convicted murderer as they believed him to be a serial killer of prostitutes.

The evaluation process of the investigation conducted by the students consisted of making determinations as to victimology, timelines, evidentiary issues, relationship studies, pros and cons as to the persons of interest, interrogation strategies and a detailed investigative plan. It also included a comparison of the victims, suspects and characteristics of all four crime scenes utilizing Keppel and Walter's revised classification model as described in their article Profiling Killers: A Revised Classification Model for Understanding Sexual Murder(The International Journal of Offender Therapy and Comparative Criminology, 43(4),417-437, 1999.)

In the opinion of this author, the Keppel and Walter classification model clearly shifts the primary person of interest from the incarcerated killer to another person. Like many perpetrators this person not only appears in the case file numerous times, but showed up at the remote crime scene without any bona-fide reason for being there. However, he was eliminated due to no physical evidence tying him to the murder without any consideration for the behavioral issues as outlined by Keppel and Walter.

Synopsis Author: Bill J. Brown

Position/Profession: Criminal Unit Supervisor / Criminal Investigations

Agency: Pennsylvania State Police (PA)

Synopsis Technology: Criminal Profiling

How Technology Works: Criminal profiling consists of analyzing crime scenes and using the evidence, or lack thereof, to attempt to determine the identity of the perpetrator. Profiling will rarely reveal the perpetrator's name; however it is very helpful in narrowing down suspects. For example, a profile based on a crime scene provides information that may include the perpetrator's personality, sex, age, possible ethnic background, and possible physical features, such as height and weight. This information can then be used to identify possible suspects, depending on who fits the profile. Personality is one of the most important parts of a criminal profile. The concept that "behavior reflects personality" is largely what profiling is all about.

How Technology Used in Attendee's Profession: Criminal profiling is routinely used in cases that are considered "cold cases", unsolved homicides, and sexual assaults.

Technology Benefits: The benefit of using criminal profiling is that it takes into consideration the behavioral aspects of the crime, the victim, and the offender, and not simply the physical evidence that is present. Criminal profiling can lead to the development or elimination of possible suspects.

Technology Limitations: Some of the limitations of criminal profiling are that it is largely an inexact science. There is much debate over the qualifications of individuals that are profilers and what their role in law enforcement should be. Although criminal profiling is based on behavioral studies of hundreds, if not thousands of individuals and offenders, no two people are truly identical in their behavior. This factor, along with the fact that profiling is very much a matter of interpretation of the individual examiner, can lead to legal challenges of conclusions that are reached utilizing criminal profiling.

Criminalistics

A New Statistical Method to Assess the Number of Fibers Transferred by a Textile on Car Seats

Type of Presentation: Scientific Session

Authors: *Genevieve Massonnet*, and Florence Monard Sermier, University Lausanne, ESC, Quartier UNIL - Sorge, Batochime, Lausanne, 1015, Switzerland*

Abstract: The transfer of fibers during criminal action is very common. However, fiber transfer is a very complex phenomenon. Many authors studied fiber transfer mechanisms but no model has been created to predict the number of fibers transferred in a given situation. Actually it is still necessary to simulate real contacts in order to know the number of fiber transferred in a given situation. This procedure is difficult and time consuming.

The main purpose of this research is to create a model to predict the number of fibers transferred during real contacts based on a few parameters of the donor textile. The study is limited to the action of driving a car and 36 knitted wool and acrylic pullovers. Several characteristics of the donor textiles were considered and statistical tools were used to assess their relative importance concerning the number of fibers transferred.

Two parameters of the donor textiles were found to be important: the shedding capacity of the textile surfaces and the length of the fibers. The shedding capacity is a parameter which estimates the quantity of fibers that are not or slightly attached to the structure of the textile. These fibers are easily transferred during a contact. The length of the fibers is also an important parameter. If the fibers are short, they are more easily transferred.

This survey shows that it is possible to predict the number of fibers transferred on a car seat by an acrylic or wool pullover given only two parameters of the donor textile: the shedding capacity and the fiber length. This approach is totally innovative and will considerably simplify the work of fiber experts.

Synopsis Author: Jacob Kishter

Position/Profession: Director, Forensic Science Services Division / Law Enforcement

Agency: Metropolitan Police Department (DC)

Synopsis Technology: The tool that was highlighted is the MAXICAN Fiber Finder, which is used to establish the transfer of fibers from object to object.

How Technology Works: The MAXICAN Fiber Finder is used to count the number of fibers that are transferred from a source (e.g., from a person to the seats in a vehicle during a real contact).

How Technology Used in Attendee's Profession: This tool would be used to compare a source sample to a contact object in criminal offenses. For example, it would be used to compare suspect clothing to the car seats in a vehicle that was used in the commission of a criminal offense.

Technology Benefits: This tool would be beneficial because it would assist law enforcement in conducting their investigations. Forensically, this evidence would place a suspect in a vehicle, which could be used by a detective to corroborate any other evidence or eyewitness testimony.

Technology Limitations: There are definite sample type and size restrictions. For example, if a suspect is not apprehended and clothing items are not recovered, then a known sample cannot be compared with a recovered sample from a vehicle. Additionally, certain materials and clothing do not transfer fibers easily, so unless there is an adequate transfer of fibers, there would not be a sample to test. Furthermore, there is currently no model in the world of forensics that can be used as an example. This is a very difficult and time-consuming process.

Blood on Black - Using Polarized Light to Enhance Bloodstains on Dark Surfaces

Type of Presentation: Scientific Session

Authors: *Rebecca Bucht*, Peter R. De Forest, DCrim, Frani Kammerman, and Brooke Weinger, John Jay College of Criminal Justice/CUNY, 445 West 59th Street, New York, NY 10019*

Abstract: This presentation will introduce an improved method of photographing dark, bloodstained substrates without the use of chemical enhancement techniques, specialized film needs or digital imaging operations.

Accurately visualizing and documenting bloodstains and patterns is an integral part of crime scene processing and provide crucial information for both the analysis of evidence in the laboratory and crime scene reconstruction efforts.

During the course of examining evidence in cases, we did some exploratory work using polarizing filters over the light source and the camera lens and observed stunningly dramatic improvement in the contrast between the otherwise subtle bloodstains and the dark or black background.

NIJ funding was granted for research into the optimum conditions and limits for this polarized light photography of bloodstains. This presentation will showcase the results of that project.

Accurately visualizing and documenting bloodstains and patterns is an integral part of crime scene processing and can provide crucial information for both the analysis of evidence in the laboratory and crime scene reconstruction efforts.

Visualization of bloodstains is trivial for bloodstains on white or lightly colored surfaces. However, on darkly colored or black surfaces, this visualization can be extremely difficult. The failure to visualize and thereby recognize blood and bloodstain patterns on darkly colored surfaces has had seriously adverse consequences for important criminal investigations.

There are two aspects to the problem. First, the presence of blood may not be recognized at critical stages in the investigation. Second, where the presence of blood is recognized, the pattern of blood-staining may not be appreciated. Sampling of bloodstains for DNA typing and other analyses must take place with knowledge of the bloodstain patterns. Otherwise important information may be destroyed. In a significant number of cases knowing how the bloodstains were formed is more important than knowing the biological source of the stains. In most cases the two types of information are complementary.

Photography represents a nondestructive method of documenting stains. Traditionally, black and white photography uses color filters to either lighten or darken a stain against the surrounding background to elucidate the forensic information contained on a difficult substrate. This technique, however, provides little benefit with bloodstains on very dark and reflective surfaces. Observing and documenting bloodstains on these surfaces is problematic due to the glare reflected off of the surface as well as the lack of contrast between the stain and substrate.

Previous studies have shown the usefulness of chemical enhancement techniques on bloodstain patterns, with the drawback of potentially compromising DNA analysis and altering the stains. Performing background corrections on digital images and the combination of digital photographs taken at two or three wavelengths have also been shown to lead to enhanced visualization of blood on some strong colored substrates.

During the course of examining evidence in cases, we have done some exploratory work using polarizing filters over the light source and the camera lens. We have observed stunningly dramatic improvement in the contrast between the otherwise subtle bloodstains and the dark or black background. This presentation will introduce results from NIJ funded research into identifying the optimum conditions and limits for this polarized light photographic method.

Synopsis Author: Elissa Mayo

Position/Profession: Assistant Laboratory Director / Criminalistics

Agency: California Department of Justice (CA)

Synopsis Technology: A non-destructive technique used to search for and enhance bloodstains on dark surfaces.

How Technology Works: Polarized filters (polarizer/analyzer) are rotated over a potentially bloodstained surface. Enhancement of bloodstains may occur at a particular point of rotation that increases the contrast of the stain against the substrate. The result can be documented photographically and used as a stain map to guide evidence collection.

How Technology Used in Attendee's Profession: Although the technique was demonstrated as a laboratory method to screen evidence for potential bloodstains, it could also be easily used in a field laboratory setting.

Technology Benefits: This non-destructive blood screening method is recordable, reproducible, and provides increased sensitivity for assessing the presence of non-visible or weakly visible bloodstains. The required equipment is minimal and readily available in most crime laboratories. The purchase of polarizing filters is a minimal, non-recurring cost.

Technology Limitations: The main limitation of this technique is that it may not provide useful results in all situations. Like infrared and other blood visualizing/screening techniques, it may provide enhancement of non-bloodstains (high sensitivity, low selectivity) and produce insufficient contrast between certain substrates and bloodstains. Diluted blood, admixtures, aged stains, etc., may yield variable results.

Synopsis Author: Charles K. Williams

Position/Profession: Forensic Scientist II

Agency: New Jersey State Police (NJ)

Synopsis Technology: Polarized light photography utilizing the RGB light system.

How Technology Works: The work on this project has shown that polarized light photography is useful in the field of forensic science when polarizing filters are placed over both the light source and the camera lens in order to capture an image with improved contrast between the stain and the background or substrate.

Basic method:

- Intense collimated light source
- Polarizing filter in front of the light source
- Photography using a camera with polarized light

How Technology Used in Attendee's Profession: This technology would aid in locating stains on darker surfaces as well as documenting the location of the stains for later review or testimony.

Technology Benefits: It is often difficult to locate bloodstains on darkly colored or black surfaces, which may lead to stains being overlooked during the examination of evidence. Additionally, the inability to accurately locate stains on those surfaces may lead to crucial patterns not being appreciated. Better visualization of the stain will aid the examination by allowing the examiner to locate stains and any recognizable patterns. Better recognition of stain patterns will assist the examiner in selecting those stains that may have the most probative value.

Technology Limitations: The presenter has found that the technique works best when RGB light systems are used. RGB systems produce white light by mixing light from multiple monochromatic LEDs (red, green, and blue, hence the name RGB). The RGB system is preferred over the use of phosphor coated

lens. Although both enable better visualization than that seen with the naked eye, the RGB system yielded a more vivid photograph, which made the stain patterns more apparent when photographed. Although the technique is fairly simple, to take full advantage of the polarizing filters, an interested laboratory would have to invest in RGB light systems. In selecting the RGB system, the presenter also indicated a preference for a collimated light source over one that emits dispersed light. These are the only limitations observed with the technique, but it may be a cost that a laboratory is not ready to incur.

The Applications of Raman Spectroscopy in Forensic Science

Type of Presentation: Workshop

Authors: Patrick Buzzini*, West Virginia University, 304 Oglebay Hall, 1600 University Avenue - PO Box 6121, Morgantown, WV 26506-6121; and Genevieve Massonnet, PhD*, Ecole des Sciences Criminelles - University of Lausanne, Le Batochime, Quartier Sorge, Dorigny-Lausanne,VD CH-1015, Switzerland

Abstract: Raman spectroscopy has recently become more popular for the chemical analysis of several types of materials of forensic interest. The Raman technique allows for the measurement of the inelastic scattering of light due to the vibrational modes of a molecule when irradiated by an intense monochromatic source such as a laser. Thanks to important technological progress, modern Raman spectrometers have increased their sensitivity necessary to detect the weak signal called Raman scattering.

The workshop on the application of Raman spectroscopy is aimed to familiarize interested forensic scientists with this technique. The advantages and limitations of the Raman technique will be emphasized. Amongst the advantages, figures its non-destructive nature, short analysis time, and the possibility of performing microscopic in situ analyses.

Several distinguished guests will be present to share their experience and expertise in different area of forensic sciences. The first part of the workshop will present some theory on Raman spectroscopy and highlight the application of this technique on different types of forensic samples. A state-of-the-art concerning the use of Raman spectroscopy will be presented on drugs of abuse, questioned documents and ink analysis, explosives and trace evidence.

Practical training is also provided and will allow the participants to become familiar with the latest versions of commercially available instruments, their components, their functions, and their manipulations. Several instruments of different manufacturers will be presented. The second part of the workshop will allow the participants to do some practical work on Raman instruments. The advantages and disadvantages of the analysis for several types of materials and the problems linked to the interpretation of results will be shown and discussed.

Synopsis Author: Vincent J. Desiderio

Position/Profession: Forensic Scientist I / Trace Evidence Examiner

Agency: New Jersey State Police Office of Forensic Sciences (NJ)

Synopsis Technology: Raman Spectroscopy

How Technology Works: Although it was discovered by C.V. Raman in 1928 (who incidentally won the 1931 Nobel Prize in Physics for this discovery), Raman scattering was not routinely utilized for structural characterization of compounds until sometime later. With the advent of lasers and new detection technologies, the use of Raman scattering has become indispensible in both academic and analytical laboratories. Primarily due to cost, it has not yet found its way into forensic laboratories to any significant extent. However, due to decreases in cost, wider availability of instrumentation, and the recognition of numerous applications, this is rapidly changing.

The basis of the technique is the irradiation of a sample using a laser of a specified wavelength. The interaction of the laser with the sample results in either inelastic or elastic scattering of the impinging radiation. For the purpose of structural elucidation and sample characterization, it is the inelastic scattering that is of interest to the analytical chemist. The interaction of the laser with the sample results in quantum transitions whereby energy is either lost (Stokes shift: more probable) or gained (Anti-stokes shift: less probable). As the changes in energy are quantized, they are useful for obtaining structural information from the sample. The observed changes in energy can be measured in the infrared region of the electromagnetic spectrum and a Raman spectrum can be obtained.

The instrumentation available for this type of spectroscopy consists of two types: 1) dispersive instrumentation and 2) Fourier transform instrumentation. Both types have various advantages and disadvantages. The choice between the two would depend on the specific applications required, the sample types available, and the funds available for purchasing the instrumentation.

How Technology Used in Attendee's Profession: Raman spectroscopy is useful for a host of forensic sample types. It has applications in drug identification, explosives analysis, pigment identification, ink comparisons, and paint comparisons. As discussed in more detail below, Raman spectroscopy is a versatile, non-destructive technique that provides valuable structural information that is complementary in nature to that obtained using Fourier Transform Infrared spectroscopy (FTIR).

Technology Benefits: Raman spectroscopy has numerous advantages that make it useful in forensic laboratories. It is a relatively simple, non-destructive technique that is capable of analyzing very small amounts of samples. In addition, the data that are obtained are easily amenable to library searching. The molecular information that is provided by this technique is complementary to that obtained via FTIR in that vibrational stretches that are inactive in one method are active in the other. By taking advantage of this complementarity, one can easily identify both organic and inorganic pigments in paints that are typically overwhelmed by the signal from binders when using FTIR. An additional advantage along these lines is the capability to perform in-situ analysis of samples that are contained in plastic bags or glass vials; this presents obvious benefits for HAZMAT response situations. The relative ease of use of this instrumentation has led to its incorporation in field portable devices. When such devices are equipped with a quality library, they can be easily employed in the field for the rapid tentative identification of unknown substances.

Technology Limitations: One major limitation of this technology is fluorescence of samples. Many compounds will strongly fluoresce and may completely overwhelm relevant Raman active vibrations. This can be compensated for by irradiating the sample with different laser wavelengths. This would, of course, add significant costs to the instrumentation as each laser must be purchased as an addition to the instrumentation. It may also be necessary to purchase an additional system if a significantly longer or shorter wavelength is desired (e.g., longer wavelengths in the near infrared region typically require Fourier transform instrumentation to compensate for lower energy throughput). The addition of cost due to laser requirements only amplifies the major limitation of this instrumentation, which is its overall cost. Raman instrumentation is still on the expensive side for forensic laboratories. However, as mentioned above, this is rapidly changing. With new instrument development and a broader market, the cost of Raman instrumentation has decreased. When such lower costs are combined with abundant research and an increasing number of applications, it should not be too long before Raman spectroscopy is routinely utilized for the identification and comparison of samples in the forensic sciences.

UV-Visible-NIR, IR, and Raman Microspectroscopy for Forensic Science

Type of Presentation: Workshop

Authors: Paul Martin, PhD, MS*, CRAIC Technologies, 948 North Amelia Avenue, San Dimas, CA 91773; Mary Carrabba, PhD, MS*, Rogue River Spectroscopy, LLC, 508 Gold Terrace, Rogue River, OR 97537; and Mike Carrabba, PhD, MS*, Hach Homeland Security Technologies,481 California Avenue, Grants Pass, OR 97526

Abstract: Most forensic laboratories use an FT-IR microscope for the analysis of trace evidence. In addition, many forensic labs also have (or are budgeting for) a UV-visible-NIR microspectrophotometer and a Raman microspectrometer for the analysis of fibers and paints. There are, however, many more applications for molecular microspectroscopy in the forensic sciences. These include inks, paper, soils, glass, and drugs of abuse.

This workshop will cover the types of samples that can be analyzed, basic optics and spectroscopic techniques, sample preparation techniques for each of the methods, advanced instrument usage techniques, and advanced data analysis techniques. While this class is designed for the forensic practitioner, others interested in molecular microspectroscopy will find the material of benefit as well.

Synopsis Author: Jodie Clements

Position/Profession: Criminalist I / Serology and Trace Evidence

Agency: New Orleans Police Department Crime Laboratory (LA)

Synopsis Technology: UV-Visible-NIR Microspectroscopy

How Technology Works: Spectroscopy instrumentation measures the energy transfer that occurs when radiation interacts with matter. As an electron absorbs radiation, a transition occurs in the electron's quantum level. The energy of the photon absorbed correlates with this difference in energy between the ground state and excited state of the electron. Since the energy required to excite an electron is dependent on the structure of the molecule, the atoms present in the molecule, and the molecules in the immediate environment, the measurement of this energy absorption can provide a wealth of information.

UV-VIS-NIR spectroscopy identifies variations in color based on how light interacts with the pigments and dyes of a particular substrate. Pigments and dyes are manufactured to absorb in the visible range of the spectrum to produce a desired color using organic compounds that commonly absorb UV-VIS-NIR photons. The tendency of these compounds to absorb radiation of certain wavelengths facilitates the ease at which colors can be identified using spectrometers. Adding the viewing capabilities of the microscope with the UV-VIS-NIR spectrometer's ability to discern minute variations in energy absorption, results in a tool capable of providing quantified measurements of color of microscopic samples.

The UV-Visible-NIR microspectroscopy instrumentation works on the same principles as other spectrometer devices. A light source is focused on the sample, which absorbs some of the light. A monochromator separates the wavelengths of light that are transmitted through the sample and a CCD measures the resulting intensity of each wavelength. The information is then plotted as an XY chart resulting in spectra that indicates variations in color that may not have been detected with the human eye.

How Technology Used in Attendee's Profession: A UV-VIS-NIR microspectrophotometer would be used in conjunction with other analytical techniques to further discriminate between questioned and known samples (most commonly ink, paint, and fiber evidence).

Technology Benefits: The technique is non-destructive, can be utilized on microscopic samples with very little sample preparation, and allows color analysis into ranges outside the visible spectrum. In addition, having objective data to substantiate a visual comparison by an examiner diminishes the probability of error caused by an individual's perception of color.

Technology Limitations: Unlike IR spectroscopy, the spectrum is not a "fingerprint" of the substance. Unfortunately, the information gained from a UV-VIS-NIR microspectrophotometer is class characteristic information as it is strictly analyzing the color of a substance. Although acquiring the spectra is relatively easy, understanding spectra takes practice and can also require knowledge of certain mathematical tools that manipulate the data to aid in interpretation.

Drugs of Abuse

Analysis of Designer Drugs of the Amphetamine Type by Fast Gas Chromatography-Mass Spectrometry

Type of Presentation: Scientific Session

Authors: Dariusz Zuba*, and Dogumi'a Byrska, MSc, Institute of Forensic Research, Westerplatte 9, Krakow, 31033, Poland

Abstract: From the early 1990s, many so-called 'designer drugs' were regularly discovered. Over 30 new synthetic drugs were found in police or customs seizures or identified in biological samples in the last 10 years. The drugs identified were largely phenethylamines and other amphetamine-like substances. The studies were aimed at development of simple and efficient screening method of identification of psychotropic substances related to amphetamine.

The study covered broad range of designer drugs of the amphetamine type, including 2,5-dimethoxyphenethylamine (2C-H), 2,5-dimethoxy-4-bromophenethylamine (2C-B), 2,5-dimethoxy-4-iodophenylethylamine (2C-I), 2,5-dimethoxy-4-methylphenylethylamine (2C-D), 2,5-dimethoxy-4-ethylthiophenethylamine (2C-T-2), 2,5-dimethoxy-4-(n)-propylthiophenethylamine (2C-T-7), 2,5-dimethoxyam-phetamine (DMA), 2,4,5-trimethoxyamphetamine (TMA-2), 3,4,5-trimethoxy-amphetamine (TMA), 2,5-dimethoxy-4-bromoamphetamine(DOB), 2,5-dimethoxy-4-iodoamphetamine (DOI), 2,5-dimethoxy-4-methylamphetamine (DOM), 4-methoxyamphetamine (PMA) and 4-methylthioamphetamine (4-MTA). Crude and distilled products of these substances prepared in the laboratory, common drugs (amphetamine, methamphetamine), precursors (ephedrine, pseudoephedrine) and common diluents (caffeine, paracetamol, acetylsalicylic acid) were analyzed.

Sample preparation step was optimized. The final procedure started from dissolution of 50 mg of the powder in 1 ml of carbonate buffer (pH 9). The obtained solution was mixed on a rolling extractor for 30 min at 2000 rpm. Then, 1 ml of ethyl acetate was added and it was mixed for another 30 min. The solution was centrifuged for five min at 3000 rpm. After centrifugation, the organic layer was subjected to analysis. DB-5 column (10m x 0.10 mm m) was applied for separation□x 0.17 of the substances. Helium at a flow rate of0.4 ml/min was used as a carrier gas. Oven temperature program started from 100ºC (maintained for 0.57 min), than ramped at 30ºC/min to 275ºC (maintained for 5.5 min), then ramped at 10ºC/min to 280ºC (maintained for 6.28 min). Mass spectrometer was operated in electron ionization mode (EI). Mass spectra were recorded in a range from 10 to 450 amu. The method turned out to be efficient. It enables separation of more than twenty substances within 15 min with a separation factor higher than 1.5. The method is useful for both routine screening for unknown substances in powders or tablets (after their preliminary crushing) and the analysis of their impurities, which is of a great importance in comparative analysis of seized drugs.

The study was supported by the grant O N204 0060 33 of the Ministry of Science and Higher Education, Warsaw, Poland.

Synopsis Author: Michael M. Healy, F-ABC

Position/Profession: Forensic Chemist / Drug Analysis

Agency: Manatee County Sheriff's Office (FL)

Synopsis Technology: Fast Gas Chromatography-Mass Spectrometry

How Technology Works: A shorter and thinner gas chromatography column is used in lieu of traditional size columns. The software that runs the instrument has a built-in program to adjust for the dimensional changes in the column and allows the improvement of current instrumental methods.

How Technology Used in Attendee's Profession: This technology could be applied to everyday use in the analysis of solid dosage drug evidence. The presenter demonstrates application with amphetamine drugs, but this technology can be designed to handle additional classes of controlled substances.

Technology Benefits: The presenter documented shorter analysis times, better sensitivity for the analyzed compounds, and the observation of improved detection limits.

Technology Limitations: There are no apparent limitations to this technology, other than potential sample overload. This technology is very cost effective and readily available.

Analyzing Salvia Divinorum and its Active Ingredient Salvinorin A Utilizing Thin Layer Chromatography and Gas Chromatography / Mass Spectrometry

Type of Presentation: Scientific Session

Authors: *John D. Jermain, MS*, San Bernardino County Sheriff's Crime Lab, 200 South Lena, San Bernardino, CA 92415*

Abstract: In recent years, Salvia divinorum has become a major focus by state legislatures throughout the United States looking to prohibit the sale of the psychoactive plant. While still legal to purchase in California and the majority of states throughout the country, Salvia divinorum will most likely become a Schedule I Controlled Substance within the next few years, as expressed by a Drug Enforcement Administration Chief (1). Because of this statement and current California Assembly Bill 259 (2), the San Bernardino County Sheriff's Department's Scientific Investigations Division has taken steps to insure proper testing procedures are available to analyze Salvia divinorum and its active chemical ingredient salvinorin A.

After researching testing procedures presented in the literature and those employed by other crime laboratories throughout the country, it was decided that Thin Layer Chromatography (TLC) and Gas Chromatography / Mass Spectrometry (GC/MS) were the methods to use in order to analyze for

salvinorin A. With Thin Layer Chromatography, salvinorin A was detected from extracted plant material and was easily distinguishable from thirteen other Salvia species as well as Cannabis sativa L. (marijuana). When using GC/MS, salvinorin A was best extracted from plant material with chloroform at an ambient temperature when using a non-polar solvent and acetone at an ambient temperature when using a polar solvent. By utilizing these two techniques, criminalists are now able to confirm the presence of salvinorin A in a submitted plant material suspected to be Salvia divinorum.

Synopsis Author: Michael M. Healy, F-ABC

Position/Profession: Forensic Chemist / Drug Analysis

Agency: Manatee County Sheriff's Office (FL)

Synopsis Technology: Gas Chromatography / Mass Spectrometry and Thin Layer Chromatography

How Technology Works: A gas chromatography column in an oven is used to separate the compounds. The separated compounds are then bombarded with electrons in the mass spectrometer producing fragmentation patterns that can be used to identify compounds. Thin Layer Chromatography is a separation technique commonly used in chemistry labs and can provide tentative identification if a standard is applied next to a sample being analyzed.

How Technology Used in Attendee's Profession: This technology could be applied to everyday use in the analysis of Salvia divinorum, which contains the psychoactive drug Salvinorin A. This is especially important since there is the possibility that this plant may become a controlled substance. The compound of interest is easily extracted from the host plant material using chloroform. The chloroform extract is directly subjected to Gas Chromatography / Mass Spectroscopy analysis. A solvent mixture for the Thin Layer Chromatography mobile phase is also identified and easily prepared.

Technology Benefits: The presenter documented a simple analysis scheme to identify a psychoactive drug found in a specific type of plant material. The analysis scheme also demonstrates the ability to differentiate between other compounds that could possibly be mistaken for Salvinorin A.

Technology Limitations: There are no apparent limitations to this technology. This technology is very cost effective and readily available. The analysis scheme conforms to SWGDRUG guidelines.

Synopsis Author: Judith L. Hoffmann

Position/Profession: Forensic Scientist / Chemist

Agency: Montana Forensic Science Division (MT)

Synopsis Technology: The identification of Salvinorin A, the active alkaloid in Salvia divinorum, utilizing instrumentation and materials already available in most laboratories.

How Technology Works: Evaluation of extraction solvents determined that methanol extracted numerous undesired alkaloids from the plant material. Chloroform extracts were much cleaner, while still extracting Salvinorin A, B, C, and D. Acetone extracts exhibited good recovery of the Salvinorin A, but poorer recovery of Salvinorin B, C, and D. The plant extract was then ready for analysis by gas chromatography / mass selective detector. All the Salvinorin compounds separated chromatographically under the instrumental conditions used.

The authors used Thin Layer Chromatography (TLC) as a second analytical technique, as most laboratories possess the required equipment and supplies. Utilizing a 1:1 mixture of hexane and ethyl acetate as a developing solvent and a visualization spray of 50 milliliters (mL) of ethanol, 0.03 mL of sulfuric acid, and 1 gram of vanillin, Salvinorin A, B, C, and D could be separated from each other and from tetrahydrocannabinol as well. The combination of techniques provides identification, satisfying SWGDRUG guidelines.

How Technology Used in Attendee's Profession: This analytical protocol can be used to confirm or eliminate Salvia divinorum in suspicious plant material samples or extracts.

Technology Benefits: This analytical protocol provides a quick and definitive identification of Salvinorin A with equipment readily available at most laboratories. Little or no training or additional expenditures are required. Interpretation is simple and the selectivity is sufficient to distinguish Salvinorin A from Salvinorin B, C, D and tetrahydrocannabinol.

Technology Limitations: No information regarding sensitivity limits was given.

Synopsis Author: Nellie Mayo

Position/Profession: Drug Analysis Laboratory Manager / Forensic Chemist

Agency: Prince George's County Police (MD)

Synopsis Technology: Gas Chromatography / Mass Spectrometry

How Technology Works: The gas chromatograph/mass spectrometer, also known as GC/MS, is a powerful analytical instrument that utilizes two techniques, gas chromatography and mass spectrometry, for the identification of unknown compounds.

Gas Chromatography (GC) is a separation technique that allows a mixture of compounds dissolved in a suitable solvent to be separated into its component parts. The basic principle involves the volatile mixture going through a heated capillary column. Based on the molecular weights and differing reactivities of the components relative to the column, each component will travel through the column in varying speeds, propelled by an inert gas like helium, acting as a carrier. The smaller molecules will travel faster than the larger ones.

Mass spectrometry enables the chemical identification of compounds. As molecules come out of the GC column and enter a mass selective detector, electron bombardment occurs, causing fragmentation of the molecules and producing positive ions. The ions are deflected through an electromagnetic field acting as a filter. Relative abundances of the resulting ions, together with their mass-to-charge ratios, are recorded by a computer and converted into a graph called a mass spectrum.

Application: In California, a bill was proposed to place a soft-leaved green plant called Salvia divinorum, together with its psychoactive ingredient Salvinorin A, under Schedule I. The author, Mr. John Jermain, sought to develop the most effective method of analysis for Salvia divinorum, a hallucinogen, and its primary active ingredient, Salvinorin A. His preliminary research included a survey of the literature and of the analytical techniques used by different forensic laboratories in the United States. In the experimental portion of his research project, he applied and compared the different analytical techniques reported in the literature, as well as those used by the different forensic laboratories. He determined that acetone or chloroform worked well as an extraction solvent and that a combination of Thin Layer Chromatography (TLC) and gas chromatography/mass spectrometry (GC / MS) provided the two most effective techniques for the analysis and identification of Salvinorin A. The details and results of his research will be published in the March 2009 issue of the *Journal of Forensic Science*.

How Technology Used in Attendee's Profession: GC/MS is widely used in forensic drug chemistry and is considered a "gold standard" in the identification and confirmation of unknown drugs. Together with FTIR, it is a valuable tool in confirming the identity of unknown chemicals.

Technology Benefits: The application of this technology is widespread. It is used in many industries, in the forensic field especially in the chemistry laboratory, and now even at airports during security processing.

Technology Limitations: The regular GC/MS instrument is quite expensive depending upon the selection of additional features. However, the invaluable technology offered by this instrument goes beyond dollars and cents.

Synopsis Author: Robert Oliver

Position/Profession: Forensic Scientist / Forensic Chemistry

Agency: Montgomery County Police Department Crime Laboratory (MD)

Synopsis Technology: Thin Layer Chromatography and Gas Chromatography/Mass Spectrometry

How Technology Works: Thin Layer Chromatography: Salvinorin A is detected by performing a chloroform extraction of a plant material sample and using an ethyl acetate:hexane (1:1) solvent system.

Gas Chromatography/Mass Spectrometry: salvinorin A is best extracted from a plant material sample with chloroform at an ambient temperature when using a non-polar solvent, and acetone at an ambient temperature when using a polar solvent.

The presence of Salvinorin A in plant material suspected to be Salvia divinorum is confirmed using Salvinorin A, B, C, and D standards purchased from Sigma-Aldrich.

How Technology Used in Attendee's Profession: If a plant material sample suspected to be marihuana was submitted to the laboratory for analysis and was determined to be negative for marihuana (tetrahydrocannabinol) the sample could then be analyzed for the presence of Salvinorin A. By utilizing thin layer chromatography and gas chromatography/mass spectrometry, forensic scientists are now able to confirm the presence of Salvinorin A in plant material.

Technology Benefits: Salvinorin A is the active component of Salvia divinorum. Other plants with similar properties include Cannabis sativa, which contains tetrahydrocannabinol, the primary psychoactive compound in marihuana and Artemisia absinthium, known as wormwood and used to make absinthe. Utilizing thin layer chromatography and gas chromatography/mass spectrometry Salvinorin A is easily distinguishable from thirteen other Salvia species, in addition to Cannabis sativa. Even though Salvia divinorum and Salvinorin A are not currently controlled under the Federal Controlled Substances Act, an unknown plant material sample may be positively identified.

Technology Limitations: Without the Salvinorin A, B, C, and D standards, it is not possible to properly confirm the presence of Salvinorin A in an unknown plant material sample. An unknown spectrum may be compared to a known Salvinorin spectrum in the literature for identification but for forensic purposes confirmation is based on the Salvinorin standard being analyzed on the same instrument under the same conditions as the unknown sample.

Synopsis Author: Irma Rios

Position/Profession: Crime Laboratory Director/ Forensic Chemist

Agency: Houston Police Department (TX)

Synopsis Technology: Analysis of substance Salvia divinorum, using Thin Layer Chromatography (TLC) and Gas Chromatography/Mass Spectrometry (GC/MS).

How Technology Works: This presentation addressed various methods used by laboratories contacted by the presenter, including labs in the states of Missouri, Oklahoma, Tennessee, Louisiana, as well as the DEA Lab. It was determined that this herb was easy to extract. Solvents used included methanol, chloroform, and acetone. The GC/MS was used as the confirmatory test, while the TLC was used as the presumptive test. Using TLC, one could distinguish the A, B, C and salvia mix as well as tetrahydrocannabinol (THC).

How Technology Used in Attendee's Profession: The identification of Salvia divinorum will be used when legislation is passed in which this substance becomes controlled and/or classified as a dangerous drug in the State of Texas.

Technology Benefits: The benefits of using TLC , GC/MS, and the methods presented is that one could use previously validated methods, as long as results are reproducible in the laboratory.

Technology Limitations: As with any instrument and methodology, one must be trained. The methods presented were simple to use and robust. There was no indication that a large sample size was needed. Standards were easy to locate for comparison as well. There were no limitations noted on method; it was easy to use; and sample preparation time was quick. The information provided by the presenter will be published in the March 2009 *Journal of Forensic Science*.

DESI-MS: A New Tool for Forensic Chemistry Laboratories

Type of Presentation: Scientific Session

Authors: Sandra E. Rodriguez-Cruz, PhD*, Drug Enforcement Administration, Southwest Laboratory, 2815 Scott Street, Vista, CA 92081

Abstract: New atmospheric pressure ionization interfaces have expanded the applications and use of mass spectrometry (MS) in the crime laboratory. Desorption electrospray ionization (DESI), an extension of the electrospray ionization technique, is one of the latest techniques developed in this area, and it has recently been applied to the analysis of controlled substances in the forensic chemistry laboratory. The most valuable application of the technique is during the pre-analysis or screening of multi-unit exhibits. Here, the application of DESI-MS and DESI-MS/MS experiments to the rapid analysis of controlled substances will be presented.

The DESI-MS technique can provide reproducible molecular weight information with a high degree of sensitivity. It reduces analysis times without interferences or cross-contamination. Its applicability, as a presumptive test will be discussed. DESI-MS/MS experiments are appropriate for the rapid confirmatory screening of multiple-unit exhibits, adding another tool to today's forensic analysts by providing structural information via fragmentation data that can be directly compared with standard reference spectra. Initial studies performed in our laboratory will be summarized, and more recent applications of DESI-MS will be discussed. Examples will include the identification of active ingredient(s) contained in counterfeiting formulations, analysis of liquids, "medical" marijuana items, chocolate-covered opium, and multi-component Ecstasy exhibits.

Synopsis Author: Annecia Martin

Position/Profession: Laboratory Program Scientist / Forensic Science

0 **Agency:** Philadelphia Police Department (PA)

Synopsis Technology: DESI-MS or Desorption Electrospray Ionization

How Technology Works: This is a recently developed technique that provides the ability to presumptively identify and confirm the presence of controlled substances, both legitimate and counterfeit. It is an extension of the electrospray ionization technique, and is accomplished by providing reproducible molecular weight information with a high degree of sensitivity, as well as structural information via fragmentation data which can be directly compared with standard reference spectra. It is this molecular weight information that provides the ability to make a presumptive identification, and the structural information provided can be used to make a confirmatory identification. DESI involves the interaction of an electrospray ionization plume on a surface, thereby generating positive molecular ions. This technique allows the analyst to view the spectrum in both positive and negative ion modes. DESI is useful not only on samples with a significant amount of drug present but can also be used on samples which contain only trace amounts of the drug of interest.

How Technology Used in Attendee's Profession: This technology would be useful in the area of forensic science, specifically in the area of drug analysis, as laboratories regularly encounter a variety of illegal and legitimate substances, such as cocaine, marijuana, oxycodone, etc.

Technology Benefits: The benefits of this technology are listed below.

- Faster turnaround time. Run time of samples is drastically reduced.
- Useful as both a presumptive and confirmatory method.
- Useful for the detection of trace elements.
- Can be used directly on the sample of interest without any prior sample preparation.
- Provides rapid confirmatory testing on multi-unit exhibits without any interference or cross contamination.
- Can detect the target controlled substance present in matrix components.
- Is able to detect the presence of a controlled substance in plant material.
- Can detect both legitimate and counterfeit substances.

Technology Limitations: The only limitation noted with the DESI-MS technique is that the samples have to be loaded manually. With the large volume of drug cases and limited equipment and staff of many crime laboratories, this might limit the benefits of using DESI-MS in the field.

Synopsis Author: Margaret Steele

Position/Profession: Forensic Analyst / Forensic Chemist

Agency: Southwest Louisiana Criminalistics Laboratory (LA)

Synopsis Technology: Desorption Electrospray Ionization (DESI)

How Technology Works: Desorption electrospray ionization (DESI) is a new method for analyzing samples with minimized sample preparation in which the sample remains in its original state. [1,] Charged solvent droplets and ions produced from the electrospray are directed by a high velocity gas jet towards the sample's surface. The charged droplets impact the surface and cause singly or multiply charged species of the analyte to be dissolved into the electrically charged droplets. These highly charged ions can be analyzed directly or after deposition on the surface by sampling them in a mass spectrometer, which allows the identification of the sample giving the molecular weight and structural information.[1, 2] There are three proposed mechanisms for the ion formation process during DESI. A molecule-pick-up process that results from the impact of charged solvent droplets on the sample surface is the first proposed mechanism. The second mechanism has the occurrence of desorption due to charge and momentum transfers. The final mechanism is a desorption of neutral species followed by gas-phase ionization through ion or molecule reactions.[2]

How Technology Used in Attendee's Profession: Desorption electrospray ionization (DESI) could be used in the forensic drug chemistry field for rapid analysis of samples. It would allow an analyst to detect multiple controlled substances within a single sample such as Ecstasy which may contain a mixture of MDMA, methamphetamine, and/or other substances. DESI would be useful in targeting controlled substances when they are in a complex matrix, much like pharmaceutical drugs. Other uses for this technology in a criminalistics laboratory would be having the ability to distinguish between counterfeit and legitimate substances such as medical marijuana, sildenafil and opium.

Technology Benefits: Desorption Electrospray Ionization (DESI) has many benefits for a forensic lab because of its ability to distinguish between samples without interferences or cross contamination. As well as its ability to detect trace compounds or components in a sample. DESI also provides rapid presumptive tests and confirmation screening because measurements are made in less than one (1) second at a resolution of 60, 000.[3] It can provide molecular weight information with a high degree of sensitivity which is reproducible.[4] Another benefit of DESI is its ability to connect with a portable gas chromatograph (GC) for testing in the field. DESI-MS/MS data can be directly compared with lab generated ESI-MS/MS library in some situations, thus a specific DESI library is not required. No sample preparation is needed and DESI operates under ambient conditions. DESI is effective for organic and biological compounds as well as polar and non-polar molecules.

Technology Limitations: The limitations of Desorption Electrospray Ionization (DESI) include its irreproducibility of handheld sampling which will be reflected by spectral variations. To overcome this, a DESI source would be optimal to minimize sample variation. This irreproducibility is due to the non-reproducible positioning of the samples within the ESI plume.[2] This can be observed by analyzing two or more tablets with the same components in succession. Not all MS/MS spectra will have a direct comparison to ESI-generated MS/MS spectra due to differences in their respective ion generation processing which may result in different ion structures and internal energies.[2] Definitive identification of a plant or compound may not be obtained such as with the cannabis compound with MS/MS. This is due

to the molecular ion m/z 315 which could be indicative of cannabidiol, delta-9-tetrahydrocannabinol, or cannabichromene. [2]

Resources

1. Wiseman Justin M., Laughlin Brian C. *Desorption Electrospray Ionization (DESI) Mass Spectrometry: A brief introduction and overview*. Prosolia, Inc. http://www.currentseparations.com/issues/22-1/CS22-1c.pdf

2. Rodriguez-Cruz Sandra E. Rapid analysis of controlled substances using desorption electrospray ionization mass spectrometry. *Rapid Communications in Mass Spectrometry*. Vol 20, Issue 1 Pages 53-60.

3. Hu Qizhi, Talaty Nari, Noll Robert J., Cooks R. Graham. Desorption electrospray ionization using an Orbitrap mass spectrometer: exact mass measurements on drugs and peptides. *Rapid Communications in Mass Spectrometry.* Vol 20, Issue 22 Pages 3403 - 3408.

4. Rodriguez-Cruz Sandra E. DESI-MS: A New Tool for Forensic Chemistry Laboratories. *Book of Abstracts. International Association of Forensic Sciences.* 2008. Page 52.

Methods for the Detection of Illicit Substances in Latent Fingerprints by Infrared Spectral Imaging

Type of Presentation: Scientific Session

Authors: Ping Hei Ng, BSc, Sarah Walker, BSc, Mark Tahtouh, BSc, and Brian J. Reedy, BSc, PhD*, Centre for Forensic Science, University of Technology Sydney, PO Box 123, Broadway, NSW 2007, Australia

Abstract: Infrared spectral (or chemical) imaging enables the simultaneous collection of thousands of infrared spectra across a sample. This information can be used to map the location of chemical species in the sample, and has led to the infrared spectral imaging of latent and cyanoacrylate-developed fingerprints, as demonstrated previously. This work focuses on the use of spectral searching algorithms to locate and identify the spectra of illicit substances within fingerprints deposited by suspects in custody. Unlike conventional spectral searching applications, where a sample spectrum is searched against a library of high quality reference spectra, searching for illicit substances in the spectral image of a fingerprint involves comparing one high quality reference spectrum with a large number of poor quality and /or “empty” spectra. This is because the illicit substance may contribute to a very small number of the spectra in the image, and so the use of commercial searching software may not be appropriate. The work described in this presentation compared the performance of common(and less common) spectral search algorithms, along with different spectral pre-processing techniques, in their ability to rank the spectra in a fingerprint image according to their similarity to one or more reference spectra of substances such as illicit drugs, explosives and pharmaceuticals. The recommendations made are applicable to spectral imaging in other frequency ranges, such as the UV-visible and near infrared.

Synopsis Author: Michael M. Healy, F-ABC

Position/Profession: Forensic Chemist / Drug Analysis

Agency: Manatee County Sheriff's Office (FL)

Synopsis Technology: Infrared Spectral Imaging

How Technology Works: The entire fingerprint is subjected to infrared analysis and all of the infrared spectra are collected using this hyperspectral technique. By looking at each pixel of collected infrared spectra, and the second derivative of each spectra, a search algorithm can be used to extract and identify different compounds in the fingerprint.

How Technology Used in Attendee's Profession: This technology could be applied to everyday use in the analysis of fingerprints for the detection of drugs, explosives or building materials to directly connect the suspect with the actual illicit substance or place them in the area of the crime scene. It has the potential to illustrate the Locard Exchange principle perfectly, by connecting a suspect with material used in the crime or found at the crime scene.

Technology Benefits: The presenter documented a potential method to detect other compounds from fingerprints left on surfaces, or compounds still on a suspect's fingers. This could be useful in connecting materials of a crime with the individual suspect's unique fingerprints.

Technology Limitations: There are significant limitations with this technology. There has been limited testing on actual surfaces and for only a small number of illicit compounds. In addition, ruggedness and portability are issues for the technology. A significant amount of training is required, and interpretation is still an issue since a major thrust of this project was the evaluation of spectral search algorithms. There is potential, but this technology application is still in its infancy.

Proteomics-Based Method for the Identification of Human Growth Hormone (HGH)

Type of Presentation: Scientific Session

Authors: Eric S. Wisniewski, PhD*, David K. Rees, MS, and Esther W. Chege, MS, United States Drug Enforcement Administration, 1440 McCormick Drive, Largo, MD 20774

Abstract: Recent publicity surrounding the purported use of performance-enhancing drugs such as steroids and Human Growth Hormone (HGH) by professional athletes has focused on the need for more stringent anti-doping testing protocols and the ability to identify unusual substances. HGH is often seized and submitted to forensic laboratories in conjunction with steroids. The analysis of steroids is relatively straightforward; however, most forensic laboratories are not familiar with analyzing exhibits of HGH, and qualitative methods are needed to perform these analyses. Addressing this issue will enable

accurate and consistent reporting of HGH and provide valuable intelligence as to the frequency in which it is encountered by law enforcement personnel. HGH is a small protein, but it is still approximately 50 times larger than regularly encountered drug substances, and it therefore cannot be identified using the instrumentation and methodologies typically utilized in a common forensic drug laboratory. Herein, the analysis of HGH using a proteomics approach is presented that meets the SWGDRUG recommendations for the identification of unknown substances.

Synopsis Author: Alan Gallaspy

Position/Profession: Forensic Chemist / Crime Laboratory Scientist

Agency: Henderson Police Department (NV)

Synopsis Technology: Liquid Chromatography-Mass Spectrometry (LC-MS)

How Technology Works: Human Growth Hormone (HGH) is a Schedule III controlled substance in some jurisdictions in the United States. Because it is a protein of substantial molecular weight, traditional small-molecule methods of identification of drugs are not appropriate. Some crime labs have analytical equipment such as LC-MS that can be employed for the analysis of HGH, although such labs may have limited experience with the characterization and unambiguous definitive identification of protein macromolecules. Methods adopted from the field of proteomics can be used in the HGH analysis.

The initial identification is via the retention time characterization of the intact protein on an LC-MS. Because most mass spectrometers used in this application do not have sufficiently high mass range to detect the singly charged (m/z where z=1) molecular ion, the method must detect the z greater than one multiply charged species. Standard mathematical methods can calculate the estimated molecular weight of the analyte based on the mass difference between two or more multiple-charged species.

Additional characterization of protein macromolecules is obtained by enzymatically cleaving the protein into smaller analytes amenable to a standard LC-MS analysis in a reproducible fashion. In this particular method, a porcine trypsin digestion is used, with the fragments separated on a standard C-18 column with a TFA/H_2O mobile phase. The resulting digest can be characterized for a particular larger protein, such as HGH. In principle, any protein with at least one amino acid difference can be differentiated with an enzymatic-digestion method.

How Technology Used in Attendee's Profession: Local labs frequently perform analysis of suspected drugs and controlled substances on a routine basis. With the advent of large molecules being employed as therapeutic drugs, many labs have not been able to keep pace with the introduction of new and analytically difficult drugs. In particular, the protein HGH is widely abused, and is classified a Controlled Substance in Nevada. Because of its legal status and known abuse in the community, a lab performing drug analysis should be prepared to analyze this substance.

Technology Benefits: LC-MS can be used to analyze larger and more complicated molecules and mixtures than other methods typically employed in crime labs. The use of standard proteomics techniques allows for the analysis of therapeutic protein drugs in a manner that can be legally defended.

Technology Limitations: The author did not explicitly report on limitations. Like any lab method of analysis, factors such as operator training, maintenance, capital equipment costs, and expense of consumables should be taken into consideration when deploying any new technology.

Fingerprint Detection and Identification

A Long Afterglow Phosphor Powder for Fingerprint Detection

Type of Presentation: Scientific Session

Authors: Li Liu*, and Zhongliang Zhang, MS, Department of Forensic Science & Technology, China Criminal Police University, Shenyang, Liaoning 110035, China

Abstract: Many types of fluorescence fingerprint powders or reagents are useful for the visualization of latent fingerprints deposited on multicolored surfaces that would present a contrast problem if developed with regular fingerprint powder. The developed fingerprints show bright fluorescence upon the exposure to laser, ultraviolet light and other light resources. However, these kinds of methods share a common concern, which is the surfaces of the substrates may fluoresce also. To solve this concern, a new long afterglow phosphor powder for fingerprint detection was studied. No special devices are needed it. Good results have been reported for the development of latent prints left on nonporous surfaces, as well as porous ones. The fluorescence afterglow can last several hours with recognizable intensity after the removal of excitation light. Lift and photography procedures of the developed fingerprints are also provided.

Synopsis Author: Jheri Cabral

Position/Profession: Latent Print Analyst / Law Enforcement

Agency: Seminole County Sheriff's Office (FL)

Synopsis Technology: Phosphor powder, a fluorescent fingerprint powder used in the development of latent prints.

How Technology Works: This lecture described phosphor powder, a fluorescent fingerprint powder with a long afterglow that is used in the development of latent prints. To make phosphor powder, lab technicians utilize the combustion method. This powder is created by mixing strontium carbonate, aluminum oxide and europium oxide, grinding the mixture together, and heating it in a molybdenum disilicide oven at 1200 ºC – 1400ºC in the hydric atmosphere for two to four hours. Once the sample has cooled, it is ball-ground into a fine powder.

The phosphor powder is able to develop fresh fingerprints, as well as prints that are a couple of days old. The powder is effective on most non-porous, semi-porous or porous surfaces. As with most powders, it is most effective on non-porous surfaces.

Traditional fluorescent fingerprint powders are used with alternate light sources. However, the phosphor powder has a long afterglow effect that is visible without the use of alternate light sources. After exposure to excitable light, latent prints glow in the dark. The latent prints can be viewed in the dark for days, weeks, or even months later. The prints will continue to glow after they have been first re-exposed to excitable light. The developed latent prints can be preserved using standard lifting tape and black backing cards. They can also be photographed.

How Technology Used in Attendee's Profession: This fluorescent fingerprint powder would be used in the field of law enforcement for crime scene investigation on a routine basis. Due to the ability to use this powder without the need for alternate light sources, it could be used in the field, as well as in the laboratory. It is used in the same manner as conventional fingerprint powders.

Fluorescent fingerprint powders have increased in popularity over the years due to the more frequent use of alternate light sources. These lights are helping to find prints that in the past were missed by conventional powders. Fluorescent powders can be detected with a low-power UV lamp or an alternate light source. Fluorescent powders are much lighter than standard powders due to their smaller particle size. This very fine powder is effective on multi-colored surfaces, which would otherwise present a contrast problem. However, some backgrounds fluoresce when exposed to alternate light sources and this can be a problem. The powder can be applied with conventional brushes, but using feather brushes is recommended.

The phosphor powder can be used in the same manner as fluorescent powders without the need of an alternate light source, thus avoiding the fluorescence of some backgrounds.

Technology Benefits: The benefits of phosphor powder are listed below.

- Eliminates the need for alternate light sources.
- Eliminates the need for special photography.
- Requires no special training, as it is used in the same manner as conventional fingerprint powders.
- Can be used in the field, as well as in the laboratory.
- Eliminates the background on multi-colored surfaces.
- Can be utilized at crime scenes at night, under poor lighting conditions.
- Provides an easy and efficient latent print development technique.

Technology Limitations: The limitations of phosphor powder are listed below.

- Developed prints can be viewed only in the dark; therefore, it would not be practical to use it at crime scenes during the day.
- Product is not commercially available at this time.
- Product will most likely be more expensive than conventional powders when it becomes commercially available.
- Powder may be difficult to make if you do not have access to the proper materials and equipment.

- Research indicates that phosphor powder is most effective on newly deposited fingerprints. It may not be as successful with older latent prints.
- The lecture did not discuss any problems, but there may be a concern with areas surrounding the latent prints also having the afterglow if an item is over-powdered. This could interfere with focusing on the latent prints.
- Since the powder is very fine, clean up could be a problem.
- Safety concerns and hazards of the phosphor powder were not discussed. It was recommended that a mask be worn, just as in conventional powder methods.

Synopsis Author: Cynthia C. Oteri

Position/Profession: Identification Technician / Latent Print Examiner

Agency: Daytona Beach Police Department (FL)

Synopsis Technology: Fingerprint Detection and Identification

How Technology Works: The fingerprint detection and identification technique is designed for use on patterned and/or semi-fluorescent substrates. This technique works well on porous as well as non-porous surfaces. These prints can be lifted by regular means using tape applied to black paper. The prints developed are best used with no light or UV light. The powder (doped strontium aluminate phosphor) is a combination of two powders that have been heated to 1200 degrees.

How Technology Used in Attendee's Profession: This technology could be beneficial when processing items from a crime scene with patterned or complex substrates. It is also affordable and easy to use.

Technology Benefits: The key benefits are affordability, ease of use, and high rate of success on all types of surfaces.

Technology Limitations: There are no real limitations to this tool for crime laboratories. It seems to be very usable and simple.

Digital Measuring Fingerprint and Palmprint Details: A New Technique of Digital Identification

Type of Presentation: Scientific Session

Authors: John Wang, PhD*, Forensic Studies Program, Department of Criminal Justice, California State University-Long Beach, 1250 Bellflower Boulevard, Long Beach, CA 90840

Abstract: AFIS can compare fingerprints only through digital images of ridge ending and bifurcation. A new technique of digital measuring can allow comparison of fingerprint and palmprint details in several new dimensions. Further, two digital magnification scopes can be selected at two levels: 0 ~ 250x and fixed 500x. This hand-held digital device can also examine partial details for a comparison and it can be connected to a laptop and a projector for a live examination at the scene, in the DA's office and for the courtroom testimony. It is suggested that this new digital measuring technique will provide an additional capacity to forensic identification of trace evidence.

Synopsis Author: Jon K. Stiner

Position/Profession: Chief of Police / Police Officer

Agency: Tipton Police Department (IN)

Synopsis Technology: Handheld digital magnification scopes

How Technology Works: This technology provides the ability to take latent prints lifted from a crime scene, and compare and measure them at the scene with a known suspect and/or victims. Comparisons can be made by taking digital measurements between ridge endings and bifurcations. The device can be connected to a laptop and a projector for live examination at the crime scene, prosecuting attorney's office, or in the courtroom.

How Technology Used in Attendee's Profession: This technology allows investigators to compare prints at the scene instead of bringing them back to the lab for analysis. This provides the ability to quickly eliminate prints that would not be of any value to the case.

Technology Benefits: The handheld digital magnification scope is small, light weight, and easy to transport. The technology has the potential to save time in the elimination process, and help investigators develop suspects earlier in the case. The price of the digital scope is fairly inexpensive, usually under $400. The technology could also be used for court presentation and for probable cause hearings with the prosecuting attorney.

Technology Limitations: The only limitations may be the cost of the equipment and the expense of having a dedicated laptop computer. However, there appears to be minimal training required to operate the device. Another possible disadvantage would be the storage or retrieval of known suspect prints; however, the investigator may be able to access the department or state fingerprint database from the field.

Synopsis Author: Natasha Wheatley

Position/Profession: Forensic Scientist / Latent Print Examiner

Agency: Idaho State Police (ID)

Synopsis Technology: Utilizing a magnifying device with the means to digitally capture an image to compare friction ridge prints.

How Technology Works: According to Dr. Wang, a microscope can be used to effect fingerprint comparison identifications. Wang states that by using the line probe (a measurement in millimeters between two points of minutia) and angle probe (the angle measurement in degrees created by three points of minutia), an identification can be made quickly, even in the field. Essentially, an identification is made using only three points of minutia. Wang's theory is that if a single distal measurement and a single angle measurement are in agreement between the known print and the unknown print then the two prints are from the same source.

How Technology Used in Attendee's Profession: There is a danger that law enforcement may try to utilize this tool in its preliminary stages. Dr. Wang states that an individualization can be made based on two numerical values; however, Wang conducted his research on eight prints that were digitally captured, and has not included any discussion of distortions. There are multiple aspects of this theory that should be examined before law enforcement could consider using this method.

Technology Benefits: The ability to state unbiased, objective results with a numerical value is a benefit of this technology.

Technology Limitations: There are several limitations for this model. One is the lack of consideration for distortion that occurs in both known prints and unknown prints. In the paper "Movement of Friction Ridge Skin: A Visualisation," by Lissa Dinning, friction ridge skin is shown to move in several different ways. Dinning presents that friction ridge movement changes the distances of minutia with reference to each other. One point of minutia can stay fixed while another point is stretched or compressed, changing the distance between the two points. This is due to the flexibility of skin. In Wang's model of comparison, he does not take into account varying degrees of movement or varying degrees of pressure, which can occur in latent deposition. This is an extremely important oversight that creates the possibility of stating a false negative.

Once the change of distance between points caused by distortion is taken into account, there is also the consideration of the probability that two completely different prints can have three points with approximately the same distances. Wang needs to explore examples of close non-matches to verify that a false positive will not occur given only two numerical values of distance and angle. By conducting research using only eight prints, Wang's model is very limited as to how close a distance can be coming from two entirely different prints. AFIS and other fingerprint search engines currently use varying forms of algorithms to generate identifications. One such algorithm, the string algorithm, uses multiple measurements between points to generate candidates. Any latent examiner can attest to AFIS generating highly scored candidates (prints that have multiple measurements between minutia points that are close), which are actually false positives.

The error rate also needs to be explored in reference to the actual placement of the points on the minutia. Dependent upon the person placing the minutia, what differences in measurement are acceptable?

Synopsis Author: Lori Wright

Position/Profession: Latent Fingerprint Examiner (LPE)

Agency: Gainesville Police Department (FL)

Synopsis Technology: Digital Measuring

How Technology Works: An image of the latent is captured using a digital scope. Three (3) minutia are plotted, creating a baseline. The computer calculates the degree measurement of the plotted angle. The procedure is repeated using a second latent or known standard for comparison (plotting three (3) minutia in the same relative position). The degree measurements are compared, and if the difference is within 0.05, the prints are a match.

How Technology Used in Attendee's Profession: Digital measuring could be used as an additional comparison tool/technique. Its portability (handheld) would allow it to be used at crime scenes, in the courtroom, and to assist in demonstrations and lectures—places inaccessible to other lab-based comparison equipment (e.g., AFIS).

Technology Benefits: Digital measuring was shown to have several benefits compared to AFIS. These include: portability, increased magnification (~250x), and better image quality (~2 megapixel).

Technology Limitations: A few limitations were discussed: (1) both prints are required to have basic minutia (3 points); (2) baseline set-up is challenging; and (3) the error rate is a suggested 0.05. Limitations not discussed: (4) lengthy overall set-up time (the time needed to connect the device to a laptop, scan the latent, plot the minutia, calculate the angle, and repeat the process; an experienced LPE would most likely have been able to complete several manual comparisons in the same time frame); and (5) target market—this device was presented as a statistics-based (not experience-based) crime scene tool. There does not appear to be an obvious benefit to an experienced LPE; however, it might appeal to those individuals not practicing latent print examinations on a full-time basis.

Human Identification by Means of Sweat

Type of Presentation: Scientific Session

Authors: PoresCarlos E. Alvarez Cruz*, National Police-Direction of Criminal Investigation, Casa Transversal 77 No. 51-17 barrio San Ignacio Normandia, Bogota, Cundinamarca , Colombia

Abstract: The major objective of this research is to implement human identification through pore analysis in Colombia. The study of pore shape, size, and distribution is called poroscopy. This method supplements traditional fingerprint examination. Criminals have found away to bypass the law through identity theft. Some of the most relevant cases detected by the Colombian authorities involve taking

fingerprint impressions from documents, scanning those fingerprints, and then making stamps of the fingerprints. Criminals use biographical information of identity theft victims to carry out their criminal activities, such as bank fraud. In one case, the index finger of a dead person was amputated to collect pension benefits.

What can be done? Can fingerprints provide any additional information?

Since 2000, identity theft has become a frequent crime. There is no system currently available in Colombia to counter this type of activity. Therefore, the Colombian National Police has allocated resources to train its fingerprint analysts in the area of poroscopy.

In theory, a fingerprint fragment can provide a large amount of information. For example, the fingerprint examiner is able to determine whether a fingerprint was made directly by an individual or if a mechanical tool was used, e.g. a stamp, digital impression, etc. Additionally, pore distribution, size, and morphology can help determine if the fingerprint was produced by a living or a dead individual.

In Colombia, a relevant case was solved by a fingerprint analyst and medical examiner based on pore analysis. Consequently, fingerprint examiners should be capable of performing this type of analysis together with fingerprint examination.

To conclude, poroscopy is a fundamental identification method that supplements fingerprinting as a means to identify and individualize a person that steals someone else's identity.

This technique is widely accepted by the scientific community. Colombia has no history of using poroscopy as a human identification method. However, this technique has proven to be a reliable human identification method. Consequently, the Colombian National Police is planning on implementing its use.

Synopsis Author: Dyna Osuna

Position/Profession: Latent Print Technician / Latent Print Examination

Agency: Fort Worth Police Department (TX)

Synopsis Technology: Poroscopy

How Technology Works: Poroscopy is a method of identification through the comparison of the impressions of sweat pores.

How Technology Used in Attendee's Profession: To establish identity of individuals when ridge characteristics alone are not suitable for comparison.

Technology Benefits: This is another useful method of identification when ridge characteristics are not sufficient for identification. Also, it is a great tool for determining if the fingerprint impression is premortem or postmortem.

Technology Limitations: Extensive training would be required to learn the science of poroscopy, as with any other discipline. Another limitation of poroscopy is that sweat pores may not always appear on latent impressions, which prohibits the use for identification. Furthermore, it is difficult to see this type of detail without special magnification to use for comparison.

Introduction to AFIS System

Type of Presentation: Workshop

Authors: Keith B. Morris, PhD*, Forensic & Investigative Science, West Virginia University, PO Box 6121, Morgantown, WV 26506-6121

Abstract: This workshop will demonstrate the applicability of Automated Fingerprint Systems (AFIS) in a small agency. Attendees will gain hands-on experience in the utilization of a system which will include the entry of both ten-prints and latents. The searching against the AFIS database and the evaluation of results will also be introduced.

The target audience is for all levels who are contemplating the introduction of small AFIS systems or those who would like to hone their skills on AFIS Systems.

Techniques for the improvement of searching criteria and evaluation of the system stability will also be introduced.

Interested persons may bring electronic versions of their ten-prints and latents for testing purposes.

Synopsis Author: Michael Halter

Position/Profession: Deputy / Law Enforcement

Agency: Beauregard Parish Sheriff's Department (LA)

Synopsis Technology: Automated Fingerprint Identification System (AFIS) Technology

How Technology Works: This technology is used to electronically capture tenprint fingerprints as well as latent fingerprints for storage in a database. The database can then be accessed for matching, comparison, and identification purposes in civil and criminal cases.

How Technology Used in Attendee's Profession: The AFIS can be used for criminal arrests and civil applications when identity is required. The AFIS can also be used to process latent fingerprints retrieved from crime scenes. Databases can be established, and used not only to prove identity, but to help identify suspects of crimes.

Technology Benefits: The greatest benefits of this technology are the ability to maintain a database and to check and match fingerprints in a much shorter time period than the old manual system. The system is very easy for operators to learn and does not require any special skills. In addition, there are many different models of AFIS machines and computers that run the database. The one used for this presentation was the Automated Fingerprint Identification System (AFIX) Tracker system. While we had a database that was pre-determined, it would have been more beneficial to be able to access other federal, state or local databases online.

Technology Limitations: The basic operation of the AFIS system is very easy to learn. However, to be able to use the latent applications, a trained latent print examiner would be required, The operator would need the expertise to classify, as well as understand, how minutia is used and marked. The second portion of this presentation focused on marking minutia and plotting pixel location and orientation. After plotting was completed, the cases were submitted to the database for identification. Several cases were identified, and the training proved very worthwhile. As stated earlier, there are many different AFIS systems. Most departments are limited by how much resources can be allocated, and to what level the unit may have for search capabilities. The FBI offers a system called the Universal Latent Workstation (ULW). The software is free to law enforcement agencies. The only cost incurred is to buy a computer and a scanner. -. This system also provides the capability to search the FBI IAFIS database.

Subsequent Chemical Treatment for the Enhancement of Latent Prints Developed with Silver Physical Developer

Type of Presentation: Scientific Session

Authors: David E. Burow, BS, MSFS*, United States Secret Service, Communications Center (FSD), PO Box 6500, Springfield, VA 21150

Abstract: Silver physical developer is one of the many chemical processes available for developing latent prints on porous surfaces. It does this by depositing silver particles onto the non-water soluble components of fingerprint residue. The amount of silver deposited is dependent on the amount of non-water soluble residue present. Therefore, developed latent prints vary in color from light gray to dark gray. Light gray prints can be visually optimized by turning into a darker gray with the application of a sodium hypochlorite solution.

Hypochlorite converts the silver (Ag) particles, which are present after the physical developer process, to silver oxide (Ag2O) particles; this makes the particles darker and the overall latent print easier to visualize. However, a common occurrence with this chemical process is background interference from the porous surface. The interfering background is typically the printed material on the item (e.g. the portraiture on the front of genuine currency). When the surface background and the developed latent print are of the same color, there is insufficient contrast to differentiate the background from the developed latent print.

This lecture will describe the general chemistry regarding a subsequent chemical treatment using potassium iodide to chemically darken the background and lighten the silver physically developed latent print. This enhances the contrast between the two to allow for the visualization of the latent print.

Synopsis Author: Amanda Clark

Position/Profession: Forensic Investigator / Crime Scene Investigations

Agency: West Valley City Police Department (UT)

Synopsis Technology: The application of potassium iodide to further enhance the contrast of silver physically developed latent prints.

How Technology Works: Silver physically developed prints are gray-black in appearance, which often makes them difficult to discern on a highly patterned background. These prints are then lightened and the background is darkened by first treating them with a 25% solution of household bleach, and then washing them with a working solution made using potassium iodide and the standard ferrous-ferric redox solution.

How Technology Used in Attendee's Profession: The application would be used as an additional chemical treatment on porous surfaces in order to further develop and enhance latent print evidence submitted for processing.

Technology Benefits: This application is beneficial in that it provides an additional chemical process that can be used to darken the background and lighten the silver physically developed latent print on a porous surface in order to increase the visibility of the characteristics needed for a latent print comparison. Specific documentation was presented to demonstrate the results of this process when applied to counterfeit currency which has a heavily patterned background that often hinders the visualization and ability to photograph a developed latent print. This process was successful in increasing the contrast between the background and the print, making it easier to document and examine.

Technology Limitations: The application has restrictions on the types of evidence on which it can be applied--it is only useful on porous surfaces that contain starch. In addition, it can take up to 30 minutes to fully develop, and the evidence must remain in the potassium iodide solution while being photographed to prevent the latent print from overdeveloping or fading.

Synopsis Author: Karen Heard

Position/Profession: Forensic Scientist III / Latent Print Examination

Agency: Illinois State Police (IL)

Synopsis Technology: The application of potassium iodide to porous evidence processed with silver physical developer.

How Technology Works: Prints visualized with silver physical developer can be optimized with the application of a bleaching solution (sodium hypochlorite) producing darkened latent prints. A subsequent treatment using a 20% KI solution not only lightens the developed prints, but also suppresses the backgrounds of porous substrates that contain starch (as confirmed by tincture of iodine).

The process works by bleaching silver oxide to silver iodide.

The KI processing method is displayed below:

- Process the porous substrate in silver developer, followed by dilute bleach.
- Agitate in KI solution for fifteen (15) minutes.
- Photographically preserve latent prints while in solution.
- Photograph in reverse color, because latent prints will be white.

How Technology Used in Attendee's Profession: Currently, physical developer is the final process for porous evidence. This additional chemical process should be considered an option in major operational cases.

Technology Benefits: This application has casework success in visualizing identifiable latent impressions.

- Procedure requires no additional machinery
- Reagent costs are reasonable

Technology Limitations: Test strips used,-gold chloride solution on starch-free, calcium-free paper (Whatman paper)—are relatively costly. Additional limitations are listed below.

- Many porous items do not contain starch (e.g., newspaper, currency).
- There are mixed results with "fringe" prints, according to the presenter.

Synopsis Author: Greta I. Moreau

Position/Profession: Photo Laboratory Technician / Photography

Agency: Gainesville Police Department (FL)

Synopsis Technology: Subsequent Chemical Treatment for the Enhancement of Latent Prints Developed with Silver Physical Developer. Potassium iodide (PI) is a subsequent chemical treatment to the Silver Physical Developer (PD), which will darken the background and lighten the PD print.

How Technology Works: Silver Physical Developer is the most powerful method used for visualizing latent prints on paper. This method develops the fats, oils, or lipids left on the paper, and allows the silver particles to adhere to the fingerprint residue. However, prints found on areas with heavy or patterned printing makes the latent print difficult to see, due to its gray-black appearance. Potassium iodide is a subsequent chemical treatment that enhances the silver PD print and suppresses the background.

The PD is mixed with a 25% solution of household bleach, in case there is no starch in the paper (starch is needed to react with the iodide ions). The paper is placed in the PD solution, and then placed into the potassium iodide solution. Then the print is photographed in reverse color, while in the PI solution. This technique enhances the contrast between the two solutions, allowing the visualization of the latent print. No over-developing will occur in this solution. When the paper is removed from the solution, the print disappears and reverts back to its original appearance.

How Technology Used in Attendee's Profession: This process will allow investigators to leave the evidence inside the solution, providing a technician additional time to download and verify that the photographs taken are viable. If the photographs are not sufficient, they can be returned to the solution, so the photographs can be retaken. This also provides a latent print examiner with an opportunity to view the photographs, prior to the evidence being packaged and placed into evidence storage. If the latent print examiner observes something of interest, the investigator can return to the solution and photograph a specific site. In fact, the paper can remain in the solution for several days, without fear of destroying the evidence.

Technology Benefits: This technique allows investigators to develop instant latent fingerprints along with the ability to photograph the evidence numerous times, if necessary. With the current method, investigators often process a piece of evidence, photograph it, and then place the item into secured evidence storage, prior to reviewing the photographs.

Technology Limitations: There are no obvious limitations to implementing this process into existing lab procedures. Potassium iodide is fairly inexpensive, and the training required is minimal. Most laboratories should have adequate space to store the chemical, and the equipment to utilize it.

Synopsis Author: Bradford A. Putnam

Position/Profession: Lieutenant, Laboratory Director / Forensic Scientist

Agency: Oregon State Police (OR)

Synopsis Technology: Chemically processing latent print evidence to improve contrast for visualization purposes.

How Technology Works: The process works by the catalytic reduction of silver particles that have attached to the non-water soluble portion of fingerprint residue. This colored catalytic reaction is

dependent on the amount of fingerprint residue and thus can vary in intensity. To increase intensity, the examiner can choose to further enhance the reaction with sodium hypochlorite solution; however, this process often creates a background interference of the porous substrate. The presentation discussed the post-processing enhancement of the material with potassium iodine. The application of potassium iodine darkens the background and lightens the latent print developed with silver, thus improving contrast.

How Technology Used in Attendee's Profession: This methodology may be employed by the latent print examiner on a number of situations to assist in the imaging and comparing of latent print evidence.

Technology Benefits: Improves contrast of latent print development on complicated backgrounds.

Technology Limitations: One of the biggest limitations of this technique is that the substrate must contain starch. Starch allows the potassium iodine to darken the background and lighten the fingerprint. The presenter is working on a method to introduce the starch to the substrate, but this is still in the developmental stage.

Synopsis Author: David B. Young

Position/Profession: Laboratory Supervisor/ AFIS Administration / Latent Print Examination

Agency: Fort Wayne Police Department (IN)

Synopsis Technology: Fingerprint Detection and Identification

How Technology Works: Porous items of evidence would undergo normal processing using the Silver Physical Developer (PD) method. The items would be rinsed in tap water and dried during this process and any latent prints of value noted at this time would be photographed as per normal procedures. If it is determined that there may be latent prints of value that cannot be adequately viewed due to background interference, the Potassium Iodide (KI) method can be utilized. However, in order for the Potassium Iodide (KI) method to work, the porous item must contain starch. The items can be checked for the presence of starch by applying a drop of tincture of iodine to the surface. If the surface turns black, the paper item contains starch and can be processed using the Potassium Iodide method.

The Potassium Iodide solution is made by adding 20 mg. of Potassium Iodide (KI) to 100 ml. of distilled or deionized water. The Potassium Iodide (KI) solution is then added to stock Physical Developer (PD) solution at a ratio of one (1) part Potassium Iodide (KI) solution to nineteen (19) parts physical developer (PD) stock solution. Prior to submersion in the KI / PD mixture, the item should be placed in a diluted (50:50 or less) bleach/water solution to help lighten the background. The item is then transferred to the Potassium Iodide/Physical Developer mixture and allowed to sit (with light agitation) for approximately 15 to 30 minutes. The background will turn black and the friction ridge detail will lighten to a light silver color thus eliminating any background interference. Photography of any latent prints that are

determined to be of potential value should occur while the item of evidence is still in the solution. The item of evidence can then be rinsed in tap water, dried and placed back into evidence storage.

How Technology Used in Attendee's Profession: This technique would be used as a final processing method for latent print enhancement on porous material when background interference is present.

Technology Benefits: Background interference is usually caused by the printed material on the item and tends to block the visualization of a latent print. By eliminating background interference, latent prints of value are easier to view, examine and compare.

Technology Limitations: This processing technique can only be used on porous items (such as paper) that contain starch. Items such as newspaper and U. S. currency do not contain starch in the material. The starch allows the darkening of the background to take place. This method should be used only as a final processing technique to enhance latent prints previously developed with physical developer. Any latent prints that are determined to be of value must be photographed while still in the potassium iodide solution.

Synopsis Author: Nicole F. Zabik

Position/Profession: Crime Scene Analyst

Agency: Seminole County Sheriff's Office (FL)

Synopsis Technology: Chemical processing with Potassium Iodide after Physical Developer

How Technology Works: When processing an item with silver physical developer, the silver particles adhere to the lipid/fat content of the fingerprint. Follow-up treatment of these papers includes the use of 25% bleach solution, which turns the silver particles to silver oxide. Potassium iodide can be used to "bleach" the silver oxide particles back to silver. The iodide ions react to starches in the paper, which darkens the background. This forms a light colored fingerprint on a dark surface, which can suppress interfering backgrounds and improve the contrast of the fingerprint.

How Technology Used in Attendee's Profession: The technology would be used when processing papers with a dark or interfering background, in order to improve the contrast of the latent print.

Technology Benefits: Unlike other methods, with this technique, the age of the fingerprint is not a factor. The papers can be left in the solution for a period of time (at least a week) with no ill effects. The background elimination from the chemical process may work better than some software programs. There are methods for validating that the chemicals are working properly (for ASCLD-certified labs). Some items can be successfully reprocessed if necessary. This is a process that can be added to the usual sequential processing.

Technology Limitations: The developed fingerprint must be photographed in the solution—it will fade when removed from the solution. The paper onto which the print is deposited must contain starch for

the background suppression to work (the iodide reacts with starch). In addition, if the print was overdeveloped with physical developer, it will have the same appearance with Potassium Iodide.

Validation and Implementation of Probabilistic Based Fingerprint Evidence

Type of Presentation: Scientific Session

Authors: Cedric Neumann, MSc*, Nicole Egli, MSc, David Reynolds, BSc, and Paul Chamberlain, BSc*, The Forensic Science Service Ltd, 2920 Trident Court, Birmingham, B377YN, United Kingdom

Abstract: Recent challenges have highlighted the need for statistical research on fingerprint identification. Several United States and European organizations are currently funding and/or undertaking such research, leading to prototype systems for the statistical assessment of the evidential value of fingerprint comparisons in case work. These tools will change the way fingerprint evidence is viewed by criminal justice systems. Fingerprint examiners are raising concerns regarding this approach.

The presentation will focus on the model developed by the Forensic Science Service (UK) for the statistical evaluation of fingerprint comparison. The development of this model was started four years ago. For the past 18 months, this model has been validated with a view to report statistically fingerprint evidence in Court.

In this presentation, the development and the validation of this statistical model will be outlined. The various benefits and challenges that have been identified in the UK criminal justice system during field studies will be present and the presenters will engage the audience on their perspective of the application of this framework in their respective criminal justice system.

Synopsis Author: Dustin L. Anderson

Position/Profession: Forensic Scientist

Agency: Minneapolis Police Department (MN)

Synopsis Technology: Fingerprint examinations

How Technology Works: The tool described in this presentation is a prototype of a computer system that builds off AFIS technology. As a result, the details of the creation of the computer model were not provided in the presentation. With that said, the presentation did convey that the computer system will incorporate advanced algorithms to further analyze ridge detail beyond AFIS technology. The advanced analysis will take in to consideration distortion issues that can be very problematic and additional measurements that are not utilized by AFIS systems. The result of this improved system will enable likelihood ratios to be established for fingerprint identifications.

How Technology Used in Attendee's Profession: The tool described by the presenter should be used on every fingerprint case.

Technology Benefits: This tool will ensure that fingerprint evidence has the ability to withstand the scrutiny of the courts for years to come by providing statistical data. In addition, this tool will help to address problems that can be created by distortion of known or unknown fingerprint evidence.

Technology Limitations: This tool requires a robust computer system and certainly the software will be costly, so initially, this system would be available only to large agencies or grant-funded programs.

Firearm/Toolmark Examination and Identification

Digital Measuring Rifling Angle: A New Technique of Digital Identification

Type of Presentation: Scientific Session

Authors: John Wang, PhD*, Forensic Studies Program, Department of Criminal Justice, California State University-Long Beach, 1250 Bellflower Boulevard., Long Beach, CA 90840

Abstract: Integrated Ballistics Identification System (IBIS) compares expended bullets and cartridge casings only through digital microscopic images. A new technique of digital measuring can allow a comparison of bullet and casing details in several new dimensions, including the angle of rifling lines. Further, two digital magnification scopes can be selected at two levels: 0 ~ 250x and fixed 500x. In addition, this hand-held digital device can examine even fragmented bullets and casings for comparison purposes. Finally, this new device can be connected to a laptop and a projector for a live examination at the scene, in the DA's office and for the courtroom testimony. It is suggested that this new digital measuring technique will provide an additional capacity to forensic identification of firearm evidence.

Synopsis Author: Nell G. Hidalgo

Position/Profession: Forensic Specialist / Forensic Scientist

Agency: Public Defender Service for the District of Columbia (DC)

Synopsis Technology: Digital Measuring of Rifling Angle

How Technology Works: Dr. Wang described a new technique in which firearms examiners could use a digital scope. He has devised a method to measure the rifling angle or pitch that could be used to compare either two bullets in a scene, or an evidence bullet to a reference bullet.

This technique is performed by first finding the base of the bullet and a rifling line. These two lines are marked on the digital image. The acute angle formed between the baseline and the rifling line is measured. This serves as one measurement that is used to compare bullets.

Additionally, a line can be drawn on the adjacent rifling line to the one used in the first measurement. The distance between adjacent parallel rifling lines is measured, serving as another measurement that can be used to compare bullets.

How Technology Used in Attendee's Profession: A portable device, such as the digital scope, might make it easier for toolmark examiners to look at evidence and reference bullets if they do not have access to a comparison microscope. The portability of the device is of particular interest to the defendant because ballistics evidence is often only viewable in the government facility and cannot be delivered to outside experts. Furthermore, quantitative measurements and the image of the angles on the bullets would make it easier for the examiner to explain the similarities and differences of the bullets to attorneys and jurors.

Technology Benefits: Unlike the traditional comparison microscope, the digital scope is portable, so it could allow for preliminary testing to be performed at the crime scene. Also, the level of magnification goes to 250x while the comparison microscope goes only up to 50x.

This method relies on statistics rather than experience and subjective determinations through pattern matching. With additional research on measurements using a digital scope, this method has the potential to provide a statistical and probabilistic basis for toolmark examination and would therefore be less vulnerable to criticism regarding its scientific reliability.

Dr. Wang proposed other measurements that can be researched, including contouring shapes such as the arc of the bullet nose, and measuring the width of the rifling within the barrel.

Technology Limitations: According to Dr. Wang, the limitations of digital measuring of rifling angle include the following:

- Requires both bullets to have at least one visible rifling line
- Requires both bullets to have at least a partial base
- Setting up the baseline is very challenging
- Error rate is suggested at 0.05
- Digital measuring should be considered as a supplementary method

Because evidence bullets are often highly distorted, it could be very difficult to find both the baseline and a visible rifling line in order to take measurements using the digital scope. Bullets found in poor condition could be unmeasurable, or measurements of the bullets could be inaccurate and cause analytical errors. Therefore, research on highly deformed bullets needs to be conducted.

Synopsis Author: Bethany P. Pridgen, MFS

Position/Profession: Criminalist / Crime Scene Investigation

Agency: Wilmington Police Department (NC)

Synopsis Technology: Digital Scope (Digital Measurement)

How Technology Works: The digital scope displays a microscopic image of a spent bullet or cartridge with magnification range from 10x to 250x. This magnification creates a detailed image that allows the measurement of rifling angles or pitch, widths of lands and grooves, lengths of striations, angle of curvature of the bullethead, and measurements of any other unusual markings believed to have been created by the firearm rifling through the barrel. A baseline must be created along the bullet so that measurements and angles can be determined from that baseline.

How Technology Used in Attendee's Profession: The digital scope can be used in the laboratory, in the field, at the crime scene, at the DA's office or at court, as it is portable, small and connected using a USB cable with a laptop. Primarily, this tool can be used to measure key data and make comparisons between two or more bullets at a crime scene or a bullet from the scene with a test-fired bullet.

Technology Benefits: The greatest benefits of this scope includes its ease of use, portability, and ability to serve as an addition to traditional visual comparisons methods., In addition, the technology attaches geometric statistics to markings and other visible striations for comparison. Some advantages the digital scope has over the traditionally used comparison microscope are listed below.

- Provides magnification from 10x-250x, where the comparison microscope magnifications vary from 3x, 10x, 25x, and 50x.
- Provides portability – it can be used in the laboratory or brought out into the crime scene for use, where the comparison microscope is a laboratory-based instrument.
- Relies on numbers and statistics and uses geometric tools to make its comparisons, where the comparison microscope relies heavily on the individual examiner's experience.
- Produces better digital images of 1.5-2 megapixels, while the comparison microscope produces 0.5-1.0 megapixel images.

The use of a digital scope at a crime scene, especially when there is more than one spent bullet or projectile, allows a quick determination to be made as to whether or not investigators should be looking for more than one weapon.

Technology Limitations: Although this tool has relative ease of use, there are some limitations involved. First, it relies on images, so each bullet to be compared must have at least one visible rifling line and at least a partial baseline. Setting up a baseline can often be challenging as oftentimes spent bullets can be drastically deformed or misshapen after being fired. There is a suggested error rate of 0.05, meaning that the rifling angle/pitch, or width of a land or groove and any other measurements must be +/- 0.05 the measurement from the other bullet to be considered a match. At this time, although the benefits of using this tool are apparent, it is important to note that this technique should still be used as a supplementary tool to the use of the NIBIN/IBIS database and traditional firearms examination methods.

Forensic Anthropology and Human Identification

AgEstimation Project

Type of Presentation: Workshop

Authors: Roberto Cameriere, PhD*, Danilo De Angelis, MD*, and Francesco Scarpino, MD, Institute of Legal Medicine, University of Macerata,Via Don Minzono, Macerata, 62010, Italy

Abstract: Ageing is an important problem both in living and dead, young and adult, subjects. In the last years, Cameriere and all have published several papers about ageing methods. This workshop is an aid in the knowledge and understanding of the techniques used with an easy and fast visualization of all the necessary points for their application.

Adobe® Photoshop is used for this method to determinate the area of the pulp chamber of a canine and its entire area. This two variable, together with the sex variable, are inserted in the regression formulae to evaluate chronological age of a living or dead adult subject.

Synopsis Author: Ronald A. Brunelli

Position/Profession: Forensic Investigator / Medical Death Investigation

Agency: Onondaga County Medical Examiner's Office (NY)

Synopsis Technology: The AgEstimation Project requires the use of Adobe® Photoshop to determine the area of the pulp chamber of a human canine tooth and its entire area. This, along with a sex variable, are put into a formula to evaluate age of the living or dead adult human.

How Technology Works: Cameriere uses Adobe® Photoshop CS2 to extract biological quantitative variables from radiographs of the upper or lower human canine teeth to estimate the age of a living or dead human. Adobe® Photoshop is an image editing software that enables the manipulation of visual images on a computer. According to Cameriere, images downloaded into Adobe® Photoshop must be in digital format; classical x-rays must be scanned or photographed with digital photography, not in a compressed file (e.g., bmp, tiff).

The x-rays of the canines can either be vestibular periapical, or lateral. Once downloaded into Photoshop, the use of various tools in the program allows the investigator to determine the area of the canine's pulp chamber and its entire area. These variables will be put into a formula to estimate the living or perimortem age of human or human remains.

Cameriere's regression formulae to determine estimated age are as follows:

- For the upper canine in the vestibular periapical x-ray:
  99.937-532.775 X (pulp area/tooth area)
- For lateral x-ray 111.75-373.78 X (pulp area/tooth area).

The Photoshop technology is used in the following fashion:

Once the image is downloaded in Photoshop, the image file is opened and the working area enlarged. The image can be enlarged by zooming in on it. If necessary, the brightness/contrast and sharpness can be adjusted.

Using the polygonal lasso tool, the entire canine image can be selected. The cursor is moved in on a close point of the canine profile. Upon clicking, a straight line is drawn at that first point. Continue clicking around the canine profile to the starting point then click. This will close the canine area selection.

Copy and paste the selected area: in the menu bar click edit>copy then click edit>paste. This will add a new layer. This layer will be added in the layers palette. The layer should be renamed "canine".

Now the canine pulp chamber will be outlined the same way the entire canine area was by using the polygonal lasso tool. Copy and paste the pulp chamber and rename this layer "pulp chamber".

Both of these layers contain their own area pixels. Now activate the histogram palette (windows>histogram) for each layer. Then click on the selected layer. Then double click on the histogram image to get the pixel numbers.

The pixel numbers for "pulp chamber" and "canine" are added in the above-mentioned formulas. Always, pulp area divided by canine area.

How Technology Used in Attendee's Profession: The evaluation of the human canine teeth through Adobe® Photoshop would add additional ageing data to any already established forensic anthropological information. This is particularly helpful if only a skull and few other bones are found. This technology could also be useful in mass fatality incidents to aid in identifying the dead.

Technology Benefits: Cameriere uses the canine teeth because the canines are usually the last to be lost and they undergo less wear and tear. He also noted that the canines are the best single rooted teeth to analyze because they have the largest pulp chamber.

While at the AgEstimation Project workshop, I worked with several canine radiographs in Adobe® Photoshop. After getting used to the polygonal lasso tool to outline the canine and pulp areas, I found this method to be an easy and fast way to get an ageing. Although I am not a forensic odontologist or forensic anthropologist, I believe this method in age estimation can be used by not only the aforementioned professionals, but also by other forensic professionals, such as medicolegal death investigators. For example, during a mass fatality incident, the medicolegal death investigator, (who is trained to use Adobe® Photoshop) could help to identify the dead.

Technology Limitations: The only limitation with the AgEstimation project is that at this point, it is largely a European concept that is being applied in countries such as India, South Africa, Australia, Japan, and Brazil. The only North American country that is applying this tool/technology is Canada; it is currently not well known in the United States. Odontologists and forensic anthropologists in the United

States should study and apply this method. As with any digital files, particularly images used in forensic sciences, there is a potential for manipulation of these files if appropriate safeguards are not in place.

Synopsis Author: Kenneth Cohrn, DDS, DABFO

Position/Profession: Forensic Odontologist

Agency: Office of the Medical Examiner (FL)

Synopsis Technology: Adult and subadult ageing utilizing Adobe® Photoshop

How Technology Works: Age estimation using teeth has been around since 1837 when it was used in the United Kingdom to first age children before it became obligatory to register births. Use of x-rays allowed for more accurate estimation of the development of the dentition and correlated with skeletal ossification centers. Similar research by Schour and Massler, Ubelaker, Moorees, Gustafson, Demirjian and Mincer are variations on tooth development and the ageing process for dental ageing. Beginning in 2006, Cameriere developed methods for ageing in subadults using teeth along with ossification of the hand and wrist in adults living and deceased.

Ageing in Children

The variables of gender (g), postmortem normalized apex opening (x5), sum of normalized open apices (s) and number of closed apices (no) are entered in a linear regression formula.

Photoshop tools are used to detect the normalized open apices values x5 and s. These values are the ratios between the measurement of the apex opening and the height of the developing tooth linear measurement taken on an orthopanograph x-ray.

1. Open, enlarge, and enhance one half of the mandibular arch. Using the measurement tool, measure the apex opening and height for both 1st and 2nd premolars. Divide the apex opening number by the tooth height value to get the x5 variable.

2. To determine the s variable, calculate the first seven (7) permanent mandibular teeth normalized apex openings and sum them. Plug the values into the regular formula for the ageing.

Ageing in Adults Using Canine Radiographs

This method uses Photoshop to detect both the area of the pulp chamber and the entire tooth area of a canine tooth. These two (2) variables, along with a sex variable, are inserted into a regression equation to provide an ageing.

1. Zoom in on the image of the canine. Using the polygonal lasso tool, outline the entire tooth. Copy and paste the selected area on a new layer.

2. Repeat the process, outlining just the pulp chamber. To establish the number of pixels contained in each layer, activate the histogram palette (Windows>histogram>selected layer>pixels). Plug both pixel values into the regression formula.

The same methodology for the Age Estimation in Sub Adults is accomplished using wrist radiographs.

How Technology Used in Attendee's Profession: Dental ageing, immigration status, identification, and archeology are all utilized in forensic odontology.

Technology Benefits: Because this technology can be applied to both living and deceased individuals, it offers an additional tool for use by medical examiners, forensic odontologists, and anthropologists for ageing, immigration issues, and identification purposes.

Technology Limitations: As with most ageing techniques, additional population studies would be beneficial. This application should be used in conjunction with other accepted ageing methods. Basic knowledge of Photoshop is required.

Synopsis Author: Matthew J. Davis

Position/Profession: Physical Anthropologist / Crime Scene Investigator

Agency: Illinois State Police (IL)

Synopsis Technology: The AgEstimation Project is based out of the University of Macerata in Macerata, Italy and was founded to provide accurate age estimates of juveniles and adults based on analysis of radiographs taken of the teeth and wrist. This workshop introduced attendees to the methodology of data collection and three ageing formulas developed by the presenters. The three formulas represent only a few of the available AgEstimation Project regression formulas. The presenters are currently increasing both the size and diversity of the reference samples in order to develop regional and population-specific formulas. The three formulas presented were based on Italian samples, but data is currently being compiled from other countries such as Canada, Japan, Brazil, South Africa, and Australia. The data collection methodology presented employs Adobe® Photoshop CS2 to collect both linear measurements and two-dimensional area measurements from radiographs of the teeth and wrist. The measurements are then converted to ratios and entered into the regression formulas to arrive at age estimates. A list of AgEstimation Project's publications and a Microsoft Excel workbook containing the various regression formulas is available on-line at: http://agestimation.unimc.it. This synopsis will evaluate only the methods and formulas presented at the workshop.

How Technology Works: The need to determine a living or deceased person's age arises in a variety of contexts. Establishing an accurate age for individuals lacking proper documentation of their birth may impact their access to government benefits or determine whether they should be treated as a juvenile or an adult under the law. When confronted with an unidentified decedent, accurate age estimates can contribute to a positive identification. The basic demographic information that makes up the biological

profile (e.g., sex, age, and ancestry) is searched against missing person records or compared to the demographic information of individuals to whom the remains are suspected to belong. In any event, given the impact that the age estimate may have on an individual's rights or the outcome of an investigation to determine a decedent's identity, it is essential that the age estimates are derived from scientifically sound methods.

For over 100 years, the fields of dentistry, pathology, anthropology, and radiology have studied how the growth and development of human bones and teeth correlate to chronological age. Throughout life, bone tissue is constantly changing. These changes manifest through the development of centers of ossification, dental development, dental eruption, skeletal growth, fusion of skeletal elements, morphological changes to bone, histological changes, fusion of skeletal elements, and bone degeneration. This vast body of research typically employs known reference samples (i.e., sample of individuals whose sex, age, and ancestry are known) and analyzes the respective skeletal and dental traits to better understand how age-related phases of growth and development relate to chronological age.

All of the ageing techniques developed over the years essentially fall into one of three categories. Atlas techniques document a continuum of growth and development and identify a standard for each phase. An analyst using this type of technique compares an unknown with a series of standards and assigns the unknown to the age phase of the standard to which it is most similar. The second category of ageing techniques relies on scoring systems. Here, an analyst examines a bone or tooth and indicates whether a certain trait is present or to what degree the trait is expressed. These methods usually score several traits, tabulate the scores, and compare the tabulated scores to the known reference samples to arrive at the age estimate. The final category of ageing techniques relies on the collection of metric data. Regression equations based on the known reference sample are then used to provide an age estimate based on the measurements collected from the unknown. Advances in radiology, digital imaging, and computer software have facilitated the development of methods applying all three of the above-mentioned techniques. The metric techniques have been especially helped by these technological advances. Metric techniques essentially allow for a more quantitative approach to be taken with the collection of data. This approach to data collection contributes to the reduction of scoring errors or classification discrepancies between analysts.

The methods presented in the AgEstimation Project are metric techniques that rely on the collection of linear and two-dimensional area measurements from radiographs taken of the wrist and teeth. These measurements are then entered into specific equations developed by the presenters.

The three equations presented were:

1. Estimating sub-adult age from wrist radiographs
2. Estimating sub-adult age from orthopantomogram (OPG) radiographs of the left mandible
3. Estimating adult age from a periapical radiograph of the canines

AgEstimation Technique for Sub-Adult Wrist

Capture of radiographic images from individual of unknown age

The AgeEstimation Project wrist technique requires that a radiograph be taken that depicts the hand (metacarpals and phalanges), wrist (carpals), and distal radius and ulna. If handedness is known, the radiograph should be taken of the individual's other hand. If handedness is not known, the left hand should be used. The individual's palm should be facing the radiographic film with the fingers extended and the middle finger in line with the forearm. The fingers should be close to each other, but not in contact. The thumb should form a 30° angle with the second finger. The x-ray beam should be centered on the third metacarpal. Finally, the length of the film tube should be 76cm when capturing the radiographic image.

Suitable (i.e., in-focus and uncompressed digital image) radiographs must be used for this and all other techniques. Classic analog radiographs can be converted to digital by a scanner or by using a digital camera, light box, and photo stand. Digital radiographs should be stored in a file format without any data compression (e.g., RAW, TIFF). Blurred images should be avoided; however, Photoshop does permit adjustments to contrast and sharpness to aid in the tracing and measuring of relevant features on the digital radiograph. The analyst should keep in mind that although Photoshop does permit some image corrections, it cannot compensate for image data that is captured.

This technique can be used only on living subjects or decedents who have not undergone significant decomposition. If significant soft tissue loss or modification is present on the wrist and hand, this method should not be used. The method is not applicable to completely skeletonized remains. Proper orientation for a deceased individual's hand and wrist can be achieved when the individual has come out of rigor mortis. If the individual exhibits any indication of congenital malformations or pathologies to the wrist or hand, the hand should not be used.

Data collection from radiograph

Once an appropriate radiograph has been obtained and it has been determined that the wrist age regression formula is appropriate, the digital image is viewed in Adobe® Photoshop CS2. The software is used to collect the metric data from the digital radiographic image. The ageing regression formulas developed by the presenters are based on ratios; therefore, the size of the image and units of measurement are not a concern so long as consistent units are used for both measurements in the ratio. The presenters recommend permanently setting Photoshop's units to "pixels".

Once the image is correctly imported into Adobe® Photoshop, the "polygonal lasso" tool is used to trace the perimeter of the overall carpal area (Ca) of the wrist. The perimeter should include the epiphyses of the radius, ulna, and the carpal bones. Once the area has been traced, it should be copied to a new layer in Photoshop. The area of the overall carpal area is then obtained in pixels by using the Photoshop's "histogram palette". This value in pixels is then entered into a Microsoft Excel spreadsheet designed by the presenters containing the age estimate equation for the wrist.

Next, each carpal bone and the distal epiphyses of the radius and ulna are traced using the “polygonal lasso” tool. If carpal bones overlap in the image, they should be traced as one structure. Once this is completed, the total area of all traced bones (Bo) is obtained in pixels by using Photoshop’s "histogram palette". This value in pixels is also entered into the same Microsoft Excel spreadsheet for the wrist.

Reference sample data and calculation of regression equation

The wrist technique is based on the growth and development of the carpal bones and distal epiphyses of the radius and ulna (p.97). The ages of individuals in the reference samples range from 5 to 17 years old from a modern Italian (n=150, 89 boys, 61 girls) population (p.97). If growth and development in this region has completed or the individual is younger than 5 years old, the technique may not produce probative results. Also, population variation between the unknown and the reference samples as well as nutritional stress on the unknown may have an impact on results. It should be noted that the presenters have developed additional equations for different populations and a larger sub-adult age group.

Analysis of covariance was applied to the population to investigate the influence of sex on the bone area (Bo) and carpal area (Ca) and a simple linear regression was used to examine the relationship between chronological age and the Bo/Ca ratio (p.97).

The entire data set was fitted to the following linear model:

$$Age = \beta 0 + \beta 1(g) + \beta 2\ (Bo/Ca)$$

g=0 for boy, 1 for girl (p.97)

The afore-mentioned model was used to test the hypothesis of equal intercepts ($\beta 1=0$) and the slopes $\beta 2$ between male and female groups. Confidence interval for all tests was set at 95% (p.97).

The F test revealed that the difference of slope in the regressions for boys and girls was not significant (p=0.95). The resulting formula explained 83% of total variance ($r2=0.83$) with the median of the absolute values of residuals (observed age minus predicted age) was 0.08 years with a quartile deviation of 1.59 years and a standard error estimate of 1.19 years (p.98).

The regression model yielded the following formula:

$$Age = -3.253 + 0.719\ g + 20.610\ (Bo/Ca)$$

g=0 for boy, 1 for girl (p.98)

<u>AgEstimation Methodology and Formula for Sub-Adult Teeth</u>

Capture of radiographic image from individual of unknown age

This Ageing Project dental technique requires a suitable orthopantomogram (OPG) radiograph be taken of the dentition. The presenters stated that radiograph orientation does not affect the analysis so long

as the OPG images are captured periapical (i.e., the film/sensor is parallel to the canine major and orthogonal to the x-ray beam). The same issues related to digital image quality and file compression that were previously mentioned for wrist radiographs must also be followed here (i.e., digital image must be in focus and captured in uncompressed file format).

This technique can be used on living subjects or decedents. It is applicable to decedents who are in the advanced stages of decomposition, burned, or completely skeletonized. If the teeth exhibit any indication of congenital malformations, pathologies, or dental restorations, those teeth should not be used.

Data collection from radiograph

Once an appropriate OPG radiograph has been obtained and it has been determined that the sub-adult dental age technique is appropriate, then the digital image is viewed in Adobe® Photoshop CS2. The age equations here are also based on ratios, therefore the size of the image and units of measurement are not a concern so long as consistent units are used for both measurements in the ratio. As mentioned above, the presenters recommend permanently setting Photoshop's units to "pixels".

Once the image is correctly imported into Adobe® Photoshop, the "measure" tool is used to measure the distance between the open apices for each root of the permanent (non-deciduous) mandibular teeth. The distance is measured by clicking the "measure" tool on the inner margin of each open apex for that tooth. For a tooth with two open root apices, the width is measured from the inner sides of each apex and the sum of each apex opening is used. Once recorded, the measurement is then obtained in pixels by using the Photoshop's "info palette". The "D" value in the "info palette" represents the linear measurement in pixels. This value is then entered into a Microsoft Excel spreadsheet designed by the presenters containing the age estimate equation for the appropriate sub-adult tooth.

Next, the overall tooth height is measured. Using the "measure" tool, click on the most coronal point of the crown to the most apical, parallel to the major tooth axis. This measurement, again the "D" value in Photoshop's "info palette", is then entered into the appropriate Microsoft Excel spreadsheet designed by the presenters.

Reference sample data and calculation of regression equation

This age technique evaluates chronological age as it relates to dental development, specifically the metric dimensions of permanent teeth exhibiting open apices (p.83). This technique can be used on the seven left mandibular teeth. The individuals in the reference samples range from 5 to 15 years old from modern Italian (n=455, 213 boys, 242 girls) population. If the individual is younger than 5 or older than 15 years old, the technique may not produce probative results. Also, population variation between the unknown and the reference samples, as well as nutritional stress on the unknown, may have an impact on results. Here, too, the presenters have developed additional equations for different populations and a larger sub-adult age group.

Analysis of covariance was applied to the population to investigate the influence of sex on the tooth dimensions and a multiple linear regression was used to examine the relationship between chronological age and tooth dimensions (p.83). Stepwise variable selection was employed to a multiple linear regression model with first order interactions to obtain the ageing formula and confidence intervals for all tests was set at 95% (p.83-84).

The resulting formula, explained 83.6% of total variance (r2=0.836) with the median of the residuals (observed age minus predicted age) was -0.035 years with a quartile deviation of 1.18 years (p.84). In addition to the above-described measurements of the second premolar, the formula also requires the sum of open apices of the permanent teeth and the number of teeth with complete root development (p.83).

The regression model yielded the following formula:

Age = 8.971 + 0.375 (g) + 1.631 (X5) + 0.674 (N0) – 1.034 (s) -0.176 (s) (N0)

g=0 for boy, 1 for girl

s=sum of the normalized open apices

N0 = number of teeth with complete root development

X5 = second premolar (p.84)

AgEstimation Methodology and Formula for Adult Teeth

Capture of radiographic image from individual of unknown age

This AgEstimation Project dental technique provides ageings from adult canine teeth. Here, periapical (labio-lingual and mesial position) radiographs of the canines may be used. This can be accomplished by both an OPG radiograph or a radiograph of a single, loose canine. This technique can be used on living subjects or decedents. It is applicable to decedents in advanced stages of decomposition, burned, or completely skeletonized. If the teeth exhibit any indication of congenital malformations, pathologies, or dental restorations, those teeth should not be used.

Data collection from radiograph

Once the image is correctly imported into Adobe® Photoshop, the “polygonal lasso” tool is used to trace the overall perimeter of the canine. Once the area has been traced, it should be copied to a new layer in Photoshop. The canine’s overall area is then obtained in pixels by using the Photoshop’s “histogram palette”. This pixels value is then entered into a Microsoft Excel spreadsheet containing the appropriate age estimate equation.

Next, the interior pulp cavity of the canine is traced using the “polygonal lasso” tool. The cavity’s area is obtained in pixels by viewing the Photoshop’s histogram palette. This value in pixels is also then entered into the Microsoft Excel spreadsheet containing the appropriate age estimate equation.

Reference sample data and calculation of regression equation

This technique estimates chronological age by comparing the relationship of the overall area of the tooth to the area of the pulp cavity. As an individual ages, the deposition of secondary dentin occurs and as a result the pulp cavity contracts (p.20). This technique was developed to be used on adult canine teeth. The individuals in the reference sample are drawn from an osteological collection from the first half of the 20th century housed at the University of Bologna. The sample consisted of individuals ranging from 20 to 79 years old who had at least one upper and lower canine present (n=200, 114 males, 86 females) (p. 108).

Multiple linear regression was used for age prediction and analysis of covariance (ANCOVA) illustrated that gender did not significantly influence the regression model so it was applied for both males and females. (p.109) The resulting regression formula explained 86% of total sample variance; the median of the residuals was 0.512 years, with a quartile deviation of 7.54 years. (p.109)

Age = 89.456-461.873(X1)

X1 = ratio of lower canine (p.109)

How Technology Used in Attendee's Profession: The utility of these ageing techniques would be useful in two contexts of forensic science. First, with respect to living individuals, it may become necessary to arrive at ageing for an individual whose actual date of birth is not known. For example, an offender may state their age to be younger in order to avoid being placed into the adult justice system. Also legal inquiries may be necessary to verify the age of older individuals seeking benefits commensurate with their age (e.g., pension status). These situations have a tendency to occur among undocumented immigrant populations in developed countries or in populations lacking legal documents (e.g., government identification, birth certificates). These methods are conducive for application to these situations because of the availability and ease of collecting radiographs. It should be noted that these types of situations will have significant ramifications on the lives and rights of the individual whose age is in question. The presenters provided two actual case examples of how these methods were successfully applied.

Second, these methods have the potential to provide an additional ageing technique when dealing with unidentified decedents. The various methods are applicable to juvenile and adult remains discovered shortly after death, in advanced stages of decomposition, or even completely skeletonized.

Technology Benefits: There are several benefits of the techniques developed by the AgEstimation Project. First, their techniques are based on radiographic images. Radiographic technology is widely available in both clinical and morgue settings. After consent or court order is obtained, a radiograph from a living individual can be obtained simply by taking the individual to a medical facility and explaining to the technician how the image must be captured. In addition, the use of radiographs is cost effective. Digital radiographs also permit investigators to share the images with an expert examiner, which can facilitate obtaining a scientific age estimate in a short amount of time.

In the event of a decomposed or burned decedent, a dental age estimate could be obtained without having to extract and macerate other parts of the skeleton commonly used for age determinations (i.e., pubic symphysis, sternal rib ends, etc.). However, multiple age indicators should still be analyzed by an anthropologist prior to ageing. Their techniques require no special preparation of teeth or bones and are not invasive or destructive (e.g., thin sectioning, biopsies, etc.)

The techniques were specifically designed to incorporate ratios into the calculation of the regression equations. This factor is extremely beneficial because it does not require that an analyst control for scale on a radiographic image. For example, if a radiographic film is being photographed by a digital camera, the photographer does not have to worry about creating a 1:1 image of the file or even need to place a scale in the image, so long as the digital image's aspect ratio is not altered. The use of ratios enables accurate measurements to be collected from old radiographic film. This feature also permits the development of larger reference samples because the presenters are not limited to certain vendors, collection conditions, or other proprietary issues related to the production of radiographic images.

The use of Adobe® Photoshop CS2 as the measurement and recording tool is a convenient and cost effective solution. This software is already in use at most forensic laboratories and would not represent a significant equipment or training impediment. The underlying principles of bone and dental biology (i.e., age-based etiology of these traits) are well accepted in the current literature to provide chronological age estimates for both adults and children.

These techniques appear very promising and warrant further validation and adoption into forensic anthropology casework.

Technology Limitations: The main limitation of these techniques is related to the reference samples upon which they are based. The sample sizes are large enough for viable results, but in order to apply them to forensic casework it would be beneficial to have larger samples sizes (e.g., >1000). The presenters are aware of this and are working toward a remedy.

Population specificity is another significant factor in forensic anthropology. Nutritional, genetic, and environmental factors vary among and between populations and must be controlled. It would be desirable to have a large, modern, geographically and biologically diverse reference sample if this technique were to be employed in casework. One of these equations was based on 20th century osteological collection and that factor could prove problematic in forensic casework. Again, the AgEstimation project members report that they are currently attempting to obtain larger and more representative reference samples for forensic casework.

A possible collaboration between the presenters and the National Dental Image Repository (NDIR) could help facilitate the creation of large population-specific reference samples that could be directly applied to forensic casework in the United States.

Reference cited:

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Anthropologic and Photographic Identification Process of Fragmented Bodies

Type of Presentation: Scientific Session

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The following case studies show the importance of using Anthropology as a supplement of Forensic Photography in cases where dismembered or even decomposed bodies are found. The morphological characterization of bone components, together with the photographic record of human parts, allows the reconstruction of dismembered parts using software. This tool is vital to day-to-day forensic work, particularly for those who work at the autopsy room, where forensic scientists are frequently faced with the victims of illegal groups whose intimidation techniques include mutilation and dismemberment of human beings.

Dismemberment is an example of the inhumane practices of the Colombian domestic conflict. It is normally used as an intimidation technique because of the aggressiveness of mutilation. This horrendous act gets rid of the victim, both physically and symbolically. It is also used as an initiation ritual for young illegal combatants and allows the perpetrators to bury the bodies in shallow graves. The slang expression used by paramilitary groups is "a shovel and a half", which means that a grave approximately 60-centimeter deep is enough to bury a dismembered body.

These cases highlight the importance of incorporating basic face reconstruction techniques and image processing to forensic recovery of decomposed, mutilated, or dismembered bodies. These methods are valuable tools that help narrow the search when a large number of body parts are found. It provides positive and sometimes circumstantial information when other methods (e.g. dental charts or fingerprints) are not available.

Visual and photographic comparisons provide enough evidence to determine the consistency of recovered body parts. Discrepancies between bone segments may be solved through the morphological features of the normal anatomic areas or structures. Photographic records remind us of the skeletal morphology and specific features or references of the vertebrae, femurs, humeri, etc. that are preserved in time and do not suffer vital age changes. This is due to the fact that each bone has a sequential model that provides a broad range of evidence and helps resolve inconsistencies when bones are extensively fragmented.

Synopsis Author: Elayne Pope

Position/Profession: Forensic Anthropologist

Agency: University of West Florida (FL))

Synopsis Technology: The combined use of photographic and anthropological/osteological methods for examining the body as evidence in cases of mass graves/disasters involving dismemberment/ disfigurement of the victim(s).

How Technology Works: The technology presented is a database that combines photographic documentation of the condition and state of preservation of the human remains as they are found in shallow and/or mass graves with the osteological profile of the fragmentary/dismembered human remains. The database functions as an MNI (minimum number of individuals) reference that documents the presence/absence/fragmentation/type/duplications of body parts.

One thing that American forensic scientists (forensic anthropologists, odontologists, pathologists) take for granted is that there is likely an antemortem record of the victim out there somewhere, be it in the form of dental or hospital radiographs for comparison. As outlined in Columbia, there are not always antemortem records of those who fall victim to such violent crimes (or even mass disasters as we saw with the Tsunami victims), thus other methods of identification are given more weight in the absence of more traditional methods, including recognition of the victim's clothing, approximate facial/body features, and/or other characteristics of personal identification.

How Technology Used in Attendee's Profession: This approach is ideal for emergency disaster mortuary operations where a large number of bodies are evaluated in a thorough and expedient manner. We have seen similar models employed with mass fatalities of the World Trade Center 2001, Tsunami victims, Hurricane Katrina, and other natural or man-made disasters where the victims are fragmentary/decomposed/scavenged and discovered in areas close or unrelated to the original disaster scene. On a smaller scale, we have difficult cases of victim identification that persists with Jane and John Does, unidentified border crossings into the United States, subadult victims (who may not have any antemortem comparative records available to use for traditional methods of identification), intentional dismemberment, extensive animal scavenging, or cases where the bodies are extremely fragmented from mass disasters (transportation accidents or explosions). This method of inventorying and collecting data on dismembered parts, particularly with multiple victims, is a necessary tool for managing such large scale, difficult information. It also maximizes the potential to identify and return more of the victim's remains to be laid to rest by their families. Anthropologists with osteological training are a necessary component of the medicolegal investigative team, especially when body parts and bones are fragmentary. In addition to traditional anthropological examinations of the victim's age and sex, the proper identification of fragmentary bone, especially with multiple victims, provides valuable information to the examiner.

Technology Benefits: There can never be too many photographs or information collected about the condition of the victim at a death scene and during the medicolegal investigation of the body. This

concept was well illustrated during this presentation. The overall concept is that a multidisciplinary approach involving forensic pathologists, anthropologists, odontologists, and criminalists should be utilized in the medicolegal analysis of fragmentary/dismembered remains, whether involving single or multiple fatalities. The benefit is a more holistic approach to death investigation, which draws from the strengths of different scientific tools that combines professional training and technology (digital and photographic) for victim identification, and to provide objective evidence for the legal system, should the perpetrator(s) be tried in a court of law. Realistically, there is a small window of opportunity to investigate the body as evidence; therefore the body must be examined as thoroughly as possible, which includes properly documenting and collecting the victim's vital information.

Technology Limitations: There is rarely enough time or money to properly investigate such difficult cases, particularly if the mortuary facilities are remote, makeshift, underfunded, understaffed, or operated under political bias. The tools and techniques advocated by this presentation will need to be adapted to suit these varying environments. Applying these strategies will help to improve the window of opportunity to collect vital information about the victim(s).

Mass Fatality Response Preparation Workshop

Type of Presentation: Workshop

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Abstract: A mass fatality is situation where there are multiple deaths exceeding the routine capability of local resources. The mass fatality will vary in size based on the capacity of the local resources. If requested, the Federal Government may provide limited assistance but the local jurisdiction(s) is/are still in charge and must manage the incident. History has shown that families want answers immediately. Does your jurisdiction have a comprehensive and effective Mass Fatality Response Plan?

A team of experienced professionals will assist you in understanding the need for mass fatality planning. Topics will include body recovery, morgue operations, Victim Identification Program (VIP) software and integration, family assistance center operations, DNA collection, testing and identification operations and funding challenges.

Introductory presentations will be followed by a brief tabletop exercise which will effectively raise the level of awareness as to the actual state of readiness within the participant's organization/jurisdiction.

Synopsis Author: Kevin Biggs

Position/Profession: Senior Latent Print Examiner

Agency: Mesa Police Department (AZ)

Synopsis Technology: Preplanning in the event of mass fatalities.

How Technology Works: Imagine an event in your area, such as a concert, game or county fair, and a portion of a structure collapses in which several thousand people were located. After the medical response personnel have removed the survivors and injured, then what? Who takes responsibility for the deceased? What is the cause of the tragedy? How do you remove and identify the deceased? How do you return the deceased to their families? How much documentation do you take at the scene? Where do you put items/evidence that you collect? How do you support the people that respond to assist you? These are some of the questions that were brought up during the Mass Fatality Response Preparation Workshop (Workshop #8) at the 2008 IAFS conference in New Orleans.

This workshop peaked my interest because it addressed issues such as what is the ultimate purpose of the personnel working the incident? How do you reach that purpose? How do you handle the surviving family members? What are the resources that may be available and needed?

A mass fatality is defined as a situation with deaths that exceed local available resources. It is key to note that the definition is not reliant on a certain number, but on the ability and capacity of what the local area can handle. I was then surprised to learn that the responsibility and management of processing a mass fatality scene begins and ends with the local agency. I had always assumed there must be some type of a crisis group with training to handle such a scene, and that our agency would just wait to receive instruction. My attention was caught when I learned that it is the responsibility of the local agency, and I wanted to learn more about pre-planning and also if anyone in my agency had experience with a mass fatality.

The workshop continued with a number of considerations:

- Is the disaster "open", meaning the deceased are unknown (like in hurricane Katrina) or "closed", meaning the deceased are known (such as a plane registry in event of a plane accident)?
- What is the scope of disaster? Is it contained in a relatively small area, such as a building collapse or scattered out over a large area like a hurricane?
- How was the infrastructure affected? Has everyday living been affected in the area that might hamper efforts such as communications, law enforcement and water supply?
- What is the rate of recovery? How long will it take to recover the deceased?
- What is the condition of the deceased—whole or fragmented? Are they newly deceased or decomposing?

The ultimate goal in a mass fatality is to reunite the deceased with their family. A three-fold process was presented: Body Recovery, Morgue Operation, and Family Assistance Center Operations.

Body Recovery:

In order to keep rescue personnel out of harm's way, the Body Recovery portion of the three-fold mission cannot begin until the location of the incident has been deemed safe. Samples of reports were given at the workshop that assisted in the documentation of where the body was found, what items were located near the body and the condition of the body. This report was designed to fit the needs of a particular incident. The Body Recovery team is responsible for the proper and dignified recovery of the remains. They work to get as much information about the deceased as possible in order to help the coordinated efforts of the other two folds and return the deceased to the surviving family members.

Morgue Operation:

The Morgue should be located in an appropriately sized, and preferably permanent, facility. The Morgue should be conveniently located where the privacy and respect of the dead can be secured, but not near the Family Assistance Center. Morgue personnel process the remains in an effort to group fragmented remains to a common source, identify the remains and return them to the family. The ante mortem information collected at the Family Assistance Center is used to aid in that effort. Different organizations, agencies, and disciplines may be used to staff the morgue.

Family Assistance Center:

The exchange of information between the authorities and family members of the missing is the responsibility of the Family Assistance Center. Again, the location of the Family Assistance Center should be at a safe and secure location with the appropriate facilities such as parking, dining, restrooms and lodging. Those who staff the center might include translators, faith-based organizations, American Red Cross, morticians and others who can be empathetic to the families and can assist in the collection of the ante mortem data.

Reunification is the ultimate goal of this operation. Once families accept the fact that their loved ones have perished they want more than anything else to have the bodies of those loved ones returned to them. Although this process sounds simple, many things need to be considered: Has the documentation been completed? Who notifies the family that the body is ready for release? Does the funeral home know where to pick up the body? The release of the bodies must not occur prematurely but as soon as possible when approved by the medical examiner/coroner and other authorities.

By having a three-fold process for mass fatality response, it enables agencies to break down the responsibilities in a time of crisis. There are organizations available for assistance in instances of a mass fatality, but understanding that the organizing and coordinating responsibilities belongs to the local agency helped me realize that knowing in advance what your available resources are would be of great importance. Getting people and organizations in the community to understand how they might assist in an emergency would be helpful. For instance, a telephone company could set up an emergency 800 number and a hotel might be able to designate rooms and locations for morgues of various sizes. In conclusion, I feel I now have a better understanding of the magnitude of responsibility in the event of a mass fatality.

How Technology Used in Attendee's Profession: In the event of a mass fatality.

Technology Benefits: Preplanning assists local agencies by preparing a list of people, organizations and resources that could be used in such an event.

Technology Limitations: Extensive planning, training and organization would need to be completed to prepare an emergency plan of action, followed by regularly scheduled meetings to remain up to date on changing resources.

Synopsis Author: Liza M. Phillips

Position/Profession: Detective - Forensic Technician / Crime Scene Investigation

Agency: College Station Police Department (TX)

Synopsis Technology: The importance of preplanning with other agencies in the community for a mass fatality incident. Proper preparation allows agencies to identify the steps that need to be taken and the resources that will be available to assist in the initial stages of a mass fatality incident.

How Technology Works: In order to facilitate an efficient response to a mass fatality incident, preplanning is essential. Planning for a response to a mass fatality could mean the difference between order and chaos in the community. Networking with local emergency management teams, fire and rescue, surrounding law enforcement agencies, hospitals and morgues is the basis for preplanning.

How Technology Used in Attendee's Profession: My profession is municipal law enforcement, specifically crime scene investigation. We are the first line of defense in the event of a mass fatality situation. In my community, we have a large university with 45,000 students and a university football stadium with the potential to hold 85,000 fans. There are two municipal airports with express jet flights to larger cities and a large-capacity arena which hosts sporting events, music concerts, exhibitions, and trade shows. This facility holds up to 12,500 people. In the event of a mass fatality, several surrounding agencies would respond including at least two municipal police agencies, county sheriff's department, state troopers, constable departments, campus police, municipal and volunteer fire agencies, and municipal and private ambulance services.

Technology Benefits: The main benefit of this type of tool is preparedness. In the past, public safety entities have been somewhat reactive. We must put ourselves in a proactive position so that in the event of a mass fatality the community is not paralyzed. Public safety will always be the priority and preplanning will maintain order and safety.

Preplanning for a mass fatality would greatly improve mutual aid efficiency and solidify responsibilities for all agencies involved. Of course, the initial stages in a mass fatality incident could seem overwhelming, but once the pre-set plan is in motion, a potentially chaotic situation is quelled.

The main issues in pre-planning are victim rescue, body recovery, morgue operations, victim identifications through DNA collection, and funding challenges. With these main functions identified from the onset, the planning is halfway completed.

Technology Limitations: Financial and scheduling issues would be prevalent in this training. Collaborative decisions would have to be made regarding who funds the training and when it will occur.

The environmental issues in this part of Texas would be seasonal. If the event occurred in the summer months, heat could be a huge hazard and create possible health issues for everyone involved.

The biggest issue that would need to be addressed by the local community would be communications. As learned during Katrina, and some active-shooter situations resulting in mass fatalities, radio communication was a problem. Even if the agencies could talk to each other, radio traffic codes were not the same. The police and military use different codes to refer to active calls. Thus, if the pre-planning does not include a universal code and verbiage plan then communication will fail. If communication fails, then the preplanning is rendered useless.

New Directions in Forensic Taphonomy — Life After Death

Type of Presentation: Workshop

Authors: Miranda ME Jans, PhD*, Institute for Geo and Bioarchaeology, Vrije Universiteit, De Boelelaan 1085, Amsterdam, Noord Holland1081HV, The Netherlands; David O. Carter, PhD*, Department of Entomology, University of Nebraska-Lincoln, 12D Plant Industry Building, Lincoln, Nebraska 68583-0816; Matthew J. Collins, PhD*, BioArCh, University of York, Biology, PO Box 373, York, YO10 5YW,United Kingdom; Franklin E. Damann, MA*, National Museum of Health and Medicine, Walter Reed Army Medical Center, 6825 16th St. NW, Bldg. 54, Washington, DC 20306-6000; Eva-Maria Geigl, PhD*, Institut Jacques MONOD, CNRS, Universities Paris 6 & 7, Tour 43 2 Place Jussieu, Paris Cedex 05, 75251, France; Thomas M. Gilbert, PhD*, Department of Biology, University of Copenhagen, Universitetsparken 15, Copenhagen, DK-2100, Denmark; Hannah E. Koon, PhD*, BioArCh, University of York, Biology, S Block, PO Box 373, York, YO10 5YW, United Kingdom; Odile Loreille, PhD*, Armed Forces DNA Identification Laboratory, 1413 Research Boulevard, Building 101, Rockville, Maryland 20850; Gordon Turner-Walker, PhD*, School of Cultural Heritage Conservation, Yunlin National University of Science & Technology, 123 University Road Sector 3, Douliou, Yunlin, 640, Taiwan

Abstract: After attending this workshop, attendees will have a better understanding of new developments in forensic taphonomy, specifically early postmortem decomposition, microbially-mediated processes, and the influence of environmental parameters. Furthermore, understanding the influence of taphonomy on the quality of biomolecules, and interpretation of taphonomic signals in osseous material can help improve future sample selection. Strategies for dealing with taphonomically compromised samples will be discussed.

This workshop will impact the forensic community and/or humanity by informing attendees on the wide-ranging possibilities of new taphonomic research in the forensic setting, including the relationships between decomposition, soils, and soil microorganisms.

Forensic taphonomy has been established as a valuable tool in forensic research. Recent studies both in forensic and archaeological taphonomy aim to expand the current knowledge to reveal perimortem history, offer new tools for estimating the post mortem interval and improve sample selection for and recovery of biomolecular information (e.g. DNA).

Decomposition is a vital, yet often overlooked, process for life on Earth. This process contributes to the cycling of carbon and nutrients in all terrestrial ecosystems and is primarily biologically mediated. Several recent studies have shown that the behavior and development of some of the organisms involved in decomposition can contribute to the estimation of post mortem interval, location of clandestine graves, and determination of cause of death. The main factors that regulate decomposition and how they relate to forensic taphonomy will be discussed.

After death, bones and teeth are most resistant to decay and usually survive longest. Studies in archaeological bone decay have shown that biological alteration of the bone structure can already occur within years postmortem, which makes it an interesting subject for forensic taphonomy. Of course, environmental and edaphic parameters influence the (biological) degradation of bone as well, such as rapidly fluctuating water levels and acid soils in a burial site, as will be shown in several case studies and experimental field burials in terrestrial and marine environments.

Enclosed and relatively protected within mineralized tissues are biomolecules, like DNA and proteins. Obviously, the processes that alter bone also influence the preservation and quality of these biomolecules. Biomolecular archaeologists have made progress in their attempts to understand the limits to survival of DNA, lipids and proteins in a variety of different settings and have developed tools to use this information to assess age at death (from the states of protein decay) and predict the likelihood of DNA amplification success. The usefulness of this knowledge for the forensic community will be discussed. Understanding the way in which collagen - the most important protein in bone - breaks down can help to predict the fate of bones in different burial environments. Using TEM, DSC, and amino acid analysis, decomposition of collagen is described, as well as how different burial environments will affect the rate of this process. Forensic research will benefit from what biomolecular archaeologists have learnt about the taphonomy of nucleic acids, lipids, and proteins and the role played by their local and wider survival.

DNA preservation will also be discussed in detail. It can vary as a function of the taphonomical context, but the anatomical location it is extracted from also plays a role. Post recovery DNA degradation is an important factor that must be taken into account, especially in samples that have been stored for a while. However, DNA may well be preserved in molecular niches in degraded samples, where traditional analytical methods fail to recover it. Several approaches, such as high throughput sequencing methods, are described, which enhance reliability and recovery of DNA from degraded forensic or ancient samples, allowing the yield of maximal information of degraded tissue.

Humans are important taphonomic agents, for example through embalming. The goal of embalming is to retard the processes associated with decomposition. Pre-burial treatments, such as synthetic cross-linking and heat treatment, will dramatically alter bone collagen and in doing so not only change the diagenetic trajectory of bone but also influence chances of DNA recovery. A case study, where865 soldiers from the Korean War were embalmed in the 1950's will be discussed, describing the current state of the remains and the consequences for their identification. Arguably, the traditional view of decomposition is that it results in the loss of information on different levels, ranging from macroscopic to molecular. However, we argue that taphonomy also adds valuable information. Deciphering early postmortem history and time since death from these indicators is a valuable approach in forensic research. Moreover increased knowledge of taphonomy in forensic studies can inform about the quality of DNA results, aid in sample selection and improve recovery of biomolecular information.

Synopsis Author: Joan A. Bytheway

Position/Profession: Forensic Anthropologist Consultant / Forensic Anthropologist

Agency: Galveston County Medical Examiner's Office (TX)

Synopsis Technology: Early post-mortem changes in bone microstructure

How Technology Works: Multiple guest speakers covered various taphonomic issues that interest forensic anthropologists. The "Early Post-mortem Changes in Bone Microstructure" presentation was very useful to me, and was applicable to a recent case on which I consulted. I have since contacted Miranda Jans for assistance on this case.

The presentation focused on microscopic taphonomic changes that occur early post-mortem and the ability to detect and identify microbial alterations in terrestrial or marine environments. Four microscopic taphonomic alterations were identified: (1) cracking – small cracks throughout the bone; (2) infiltration – discoloration of bone due to bone in contact with metal objects; (3) inclusion – fungal and bacterial detection in bone; and (4) bioerosion – environmental influence on bone. Both fungi and bacteria can infiltrate bone or teeth and enter by tunneling in or entering through the vascular system. The microscopic detection of the presence of fungi and/or bacteria in bone is differentiated by the appearance of tunneling, leaving spaces in the bone by the former and granular potato-shaped with a distinct border by the latter.

Results of the research showed:

- Embalming arrests microbial alteration.
- If bone is preserved above ground, it will have less bacterial inclusion.
- Bacterial alteration occurs early post-mortem.
- Bacteria is bound by the cement lines in bone.
- The central portion of bone can still be used for histology.

- If decomposition occurs rapidly, within the first ten days, bone is less likely to have bacteria infiltration.
- Saprophytic fungi need water and oxygen to infiltrate bone.

How Technology Used in Attendee's Profession: When bone is fractured or damaged beyond identification, but some type of identification is needed, most analysts will prepare a microscopic slide of a bone section prior to submitting for DNA testing. The ability to differentiate between abnormal and normal osteon patterns, detect microbial alterations, and then choose the best central area for analysis is useful information.

Technology Benefits: In a recent case, an eroded bone, attached to a compression plate used for fracture repairs in humans, dogs, and horses, was brought to my lab for analysis to determine if the remains were human. The bone was quite eroded from environmental exposure over a period of time. The bone could not be identified as human or non-human by macroscopic analysis. Other than running a time-consuming and expensive DNA test, I made a slide of a bone section. Under microscopic examination it still was not clear if the osteons were human or not due to alterations to the bone that I could not identify. The images presented in this workshop looked similar to the alterations I was seeing in the slide. These alterations could be ruled out as normal osteon patterns of a particular animal species and could be excluded from the osteon characteristics present.

The ability to detect and identify microbial alterations in bone and the timing of their appearance post-mortem can help determine the bone origin and post-mortem interval.

Technology Limitations: The present limitation is that there is not a bone histology data bank for human or non-human specimens. This needs to be developed. Also, one must know how to make a bone slide. Some of the equipment is expensive, and you don't always know if your results will be analyzable due to microbial alterations. Manual procedures are an option and there is a variety of literature on bone slide preparation. But, manual processing takes some practice to obtain a good clear slide.

Forensic Biology, DNA Profiling, and Serology

Analytical Principals in the Interpretation of DNA Profiles

Type of Presentation: Scientific Session

Authors: Bruce R. McCord, PhD*, Florida International University, 11200 SW 8th St, CP304, Miami, FL 33199

Abstract: A major issue in DNA typing is the interpretation of electropherograms resulting from low level and degraded DNA templates. This presentation will discuss the principles of the analysis of electrophoretic data from the standpoint of capillary genotyping systems. The discussion will detail the application of signal to noise ratios, limits of detection, stochastic thresholds, and dynamic range to assist the examiner in screening results and interpreting data. An overview of how real time PCR can be used in combination with these data will also be included.

The application of these principles in the analysis of poor quality DNA template will then be discussed. Specific examples will be used to explore data interpretation involving electropherograms resulting from degraded, inhibited, and low copy DNA. The presentation will include results from the literature as well as the author's own research into the use of miniSTRs.

Synopsis Author: Bharat Lakhkar

Position/Profession: Assistant Director / Forensic Science

Agency: Westchester County Forensic Laboratory (NY)

Synopsis Technology: The use of common analytical chemistry concepts for the interpretation of capillary electrophoresis data resulting from low level or degraded DNA templates.

How Technology Works: Two commonly used analytical chemistry concepts can be used to aid in the interpretation of electrophoretic data, the LOD (limit of detection) and LOQ (limit of quantitation). LOD is recognized as three (3) times the noise and LOQ as ten (10) times the noise. When applying these concepts to data interpretation, it becomes clear that no alleles can be conclusively distinguished below LOD (commonly referred to as "threshold") and therefore no meaningful conclusions should be drawn.

However, there is another effect that must be considered while interpreting DNA data from low level or degraded DNA templates. When DNA template levels are low, stochastic amplification may occur, resulting in either a substantial imbalance of two alleles at a given heterozygous locus or allelic dropout. Generally, with sufficient DNA template, heterozygous alleles are well balanced; the ratios of the peak heights of the two alleles are generally around 80%-90%, and rarely ever below 60%. However, with low DNA template, this ratio can fall below 60%. The maximum peak heights of the alleles (each allele) at which this ratio drops below 60% was introduced as stochastic threshold (this will naturally be higher than LOQ).

All the above concepts (detection threshold/LOD, LOQ, and stochastic threshold) need to be considered while interpreting DNA profiles. All DNA laboratories need to establish these values as a part of their validation process. It is important to establish independent values for each instrument to allow for operational variances.

For 310's, the three values are generally within the following ranges:

- LOD : 50 to 100 rfu
- LOQ: 150 to 200 rfu
- Stochastic threshold: 150 to 200 rfu (always higher than LOQ)

With low levels of DNA template, the peak height ratio of a heterozygote may fall below 60% due to stochastic effects. When attempting to deduce mixture profiles, if a heterozygote is possibly at a locus and the height of each peak of the heterozygote profile is less than the stochastic threshold established for that instrument, the locus should not be used for mixture interpretation.

How Technology Used in Attendee's Profession: These concepts can be readily applied in the field of DNA profile interpretation. Since all laboratories have established their interpretation thresholds (similar to LOD), the determination of LOQ should not be a problem. For determining stochastic threshold, serial dilutions (also generally carried out as part of validations) data will require review. The level of signals at which the ratios of peak heights of heterozygotes start approaching 60% will need to be identified. This level is the stochastic threshold.

Technology Benefits: Interpretations will be more consistent (within and between various laboratories), objective, and reliable if all laboratories apply these analytical chemistry concepts.

Technology Limitations: The obvious limitation is the absence of any guidance about how to determine the noise level. Laboratories may develop noise levels using different methods (some statistically and some merely by observing the signal levels in blanks); therefore the much desired consistency between laboratories may be difficult to achieve.

Comparison of Five Fabric Types as a Swabbing Medium for the Removal of DNA From a Glass Surface

Type of Presentation: Scientific Session

Authors: Stacie Kaufman*, Christina Mulligan*, and Lawrence A. Quarino, PhD, Cedar Crest College, Forensic Science Program, 100 College Drive, Allentown, PA 18104

Abstract: The ability to extract and subsequently type low copy number (touch) DNA may depend on the ability to maximize the removal of DNA from surfaces. The ability to remove DNA from surfaces may

depend on the type of swabbing material used. In order to see if differences in the quantity of touch DNA can vary with the type of swab, five common materials (nylon, acrylic, wool, polyester felt, and cotton) were used to respectively swab glass surfaces containing two ul of whole saliva diluted 1:10 with saline. Eight replicates of each swab type were tested and subjected to three common DNA typing techniques: Chelex® (Biorad) extraction, ChargeSwitch® Forensic DNA Purification (Invitrogen), and low-copy number DNA extraction using proteinase K and carrier RNA. DNA quantity for each extracted sample was determined by real-time PCR employing SYBR Green® using a Corbett Rotorgene 6000. For both the Chelex® extraction and the ChargeSwitch® method, no notable difference in the quantity of DNA was determined between the two methods and between fabric types. The Chelex® extraction yielded mean values from 8 pg/ul (cotton) to 28 pg/ul (nylon) while the ChargeSwitch® method yielded mean values from 10 pg/ul (nylon and wool) to 34 pg/ul (polyester felt). There was significant overlap in quantitation values between the five fabric types for both methods. However, the low-copy procedure showed substantially higher values for four of the five sample types than the other two methods (the one exception being wool which yielded a mean value of 8 pg/ul). Cotton showed a mean value of 68 pg/ul (8.5 fold larger than Chelex® extraction and 2.5 fold larger than the ChargeSwitch® method), acrylic yielded a mean value of 79 pg/ul (3 fold larger than both the ChargeSwitch® method and Chelex® extraction), nylon produced a mean value of 122 pg/ul (4fold larger than Chelex® extraction and 12 fold larger than the ChargeSwitch® method), and polyester felt yielded a mean value of 144ng/ul (9.5 fold larger than Chelex® extraction and four fold larger than the ChargeSwitch® method). Polyester felt showed a minimal value of 115 pg/ul, compared to minimal values of 51 pg/ul for acrylic, 41 pg/ul for nylon, and 38 pg/ul for cotton. Based on these preliminary results, polyester felt appears to have a preferential ability to remove DNA from surfaces as compared to the other four fabrics used in the study. Future work will focus on testing additional fabrics as well as testing smaller quantities of DNA on substrates.

Synopsis Author: William G. Hebard

Position/Profession: Quality Assurance Manager - Laboratory Supervisor / Forensic Chemist

Agency: Massachusetts Department of State Police Crime Laboratory (MA)

Synopsis Technology: Using a foam tipped mini-popule with isopropanol to recover "touch DNA" from evidence.

How Technology Works: The recovery and analysis of "touch DNA" from evidence involves many factors, as described below:

- Factors responsible for breaking the forces causing cells or DNA molecules to adhere to the crime scene evidence by mechanical and/or chemical means.
    - Mechanical aspect supplied by technician as the surface is wiped with fabric.
    - Chemical aspect supplied by the solvent. Common solvents include water or isopropanol.

- Factors responsible for forces causing cells or DNA molecules to preferentially adhere to the swab.
- Factors allowing swabs to release cells or DNA molecules during extraction.

This technology attempts to optimize these factors so that the highest possible amount of DNA is recovered and analyzed. Both the swab tip and the solvent have been tested. The work by Kaufman et al., indicates that for at least one type of extraction, polyester felt is the preferred material for DNA recovery. Representatives from Puritan proposed that the highest recovery for "touch DNA" is a foam material with an isopropanol solvent. The isopropanol is contained within the handle of the swab and is released onto the tip by squeezing the handle during the swabbing process.

How Technology Used in Attendee's Profession: Every time touch DNA is collected from evidence. Cases range from vandalism (from a rock thrown through a windshield) to homicide (from a knife handle).

Technology Benefits:

- Supplying the DNA laboratory with the maximum amount of recovered "touch DNA" greatly increases the possibility of generating a full profile and subsequent successful prosecution.
- Using isopropanol as a solvent adds the advantage of eliminating the bacterial prohibiting "drying step" involved in an aqueous DNA swab collection since isopropanol itself prohibits the growth of bacteria. Eliminating this step also minimizes the possibility of contamination.
- Design of the foam tip allows swab to be placed without prep work onto the robotic extraction, thus saving time and avoiding contamination.

Technology Limitations: The main disadvantage is cost. Currently the MA Department of State Police Crime Laboratory uses cotton tipped sterile swabs and distilled water. Both are inexpensive with no environmental considerations. A second disadvantage involves the collection of blood for DNA. In this situation, the use of isopropanol will adversely affect the DNA analysis. This could be handled by having both types of swabs available for use.

Synopsis Author: Winnie Kurowski

Position/Profession: Forensic Chemist / DNA Analyst

Agency: Acadiana Criminalistics Laboratory (LA)

Synopsis Technology: Comparing types of swabbing material to aid in recovering evidentiary DNA, especially in cases of low copy number or contact/touch DNA. This study also compares the extraction methods of Chelex, ChargeSwitch Forensic DNA Purification, and low copy number extraction with proteinase K and carrier RNA.

How Technology Works: This study compares the different materials (cotton, nylon, polyester felt, acrylic, and wool) as they collect dried diluted saliva on a glass substrate. The authors then extracted the DNA off the different materials and quantified the DNA using real-time PCR with SYBR Green. When collecting low copy number or contact DNA, it is important to use a technique that can collect the most amount of DNA to provide the best DNA profile possible. There are many types of swabs of different materials available on the market; however, there has been little comparative data showing which swabs will give the highest DNA yield. The authors found that polyester felt appears to have the best ability to remove DNA from the glass surface compared to the other four fabrics.

The authors also compared common DNA extraction methods: Chelex, ChargeSwitch Forensic DNA Purification, and low copy number extraction with proteinase K and carrier RNA.

How Technology Used in Attendee's Profession: Identifying the ideal swab material will assist in the complete collection of contact DNA or low-level DNA samples from forensic evidence. At this stage of forensic DNA analysis, many labs process contact/trace DNA samples. A potential limitation is obtaining a profile from a swab that did not collect enough evidentiary DNA. The swab material that proves to recover the most amount of DNA will help increase the sensitivity of the general DNA typing system.

The DNA extraction method that yields the highest amount of recovered DNA and does not require an overhaul of lab equipment would aid in increasing the sensitivity, efficiency, and success rate of generating a DNA profile.

Technology Benefits: Identifying the best tool that can collect the most amount of cellular material specifically in low-level DNA evidence would increase the chance of obtaining a full DNA profile for that sample. Confidence in the collection method would then lead to confidence that most of the DNA was collected at the first swabbing.

Comparing different DNA extraction techniques also helps with the successful extraction of other low-level DNA sample types, such as small amounts of blood, hair roots, or seminal fluid samples. The best extraction method will increase DNA recovery leading to a better chance of obtaining a full DNA profile. There are many amplification kits that are designed to work with degraded or compromised samples; however, the maximum amount of DNA entered into the system (i.e., collected) would be the limiting factor to obtaining a full profile.

Technology Limitations: It was determined that a polyester felt swatch has the best capability to remove DNA compared to the other four fabrics. The fabric sample in a swatch form is a limitation because using swatches at the bench or at a crime scene is not efficient. It requires cleaning tweezers between samples, and minimal training with the tweezers to collect DNA onto the swatch. The swatches must be "DNA-free" so great care is needed to achieve and maintain its sterility. Most laboratories and crime scene teams currently use cotton swabs for its ease of handling, drying efficiency, low cost, and pre-sterilized packaging.

The authors concede that a swatch of fabric may more effective because it covers a larger surface area than a cotton swab that can only collect so much because of its limited surface area. They discussed that

the collection method of tweezers and a fabric swatch may provide an additional advantage because it allows the technician to "scrub down" harder onto the surface, therefore collecting more DNA than a less aggressive method like a swab.

The authors agree that this is an encouraging preliminary study and that they need to test additional fabrics as well as test smaller concentrations of DNA on the substrates. Some characteristics they may focus on in later studies are to compare the fabric's ability to absorb water, the electrostatic charge, and the weave and tightness of fibers. Wool does not absorb water well; this may be a reason why wool performed so poorly in the quantification values. Since this study is limited by the results of the quantification method (SYBR Green), there is no data to show the likelihood of obtaining a full or partial DNA profile. The authors are also considering amplifying the recovered DNA in the next phase of testing to determine the likelihood of obtaining a full DNA profile.

One interesting improvement in this comparison of DNA extraction techniques is the use of carrier RNA. Carrier RNA is a poly-A RNA strand which is added to the extraction tube after the lysis step. It is theorized that carrier RNA blocks the DNA binding sites inherent on the plastic tubes allowing the DNA to remain unbound and therefore extracted. The authors found the low copy number extraction method with proteinase K and carrier RNA had quantitation results substantially higher than the other two extraction methods. The extraction method that gave the best yield was using a standard low copy number extraction along with proteinase K and carrier RNA.

Genebench-FX™: Towards Sample-in to Results-out Analysis of Forensic Samples in Under 45 Minutes

Type of Presentation: Scientific Session

Authors: Eugene Tan, PhD*, Network Biosystems, 1B Gill Street, Woburn, MA 01801

Abstract: NetBio's major goal is to develop a fully integrated system that enables rapid sample-in to results-out functionality for human identification from forensic samples. This integrated system is based on microfluidic technologies which provide performance advantages through miniaturization and automation by ease of integrating fluidic components. The system is divided into three modules: DNA extraction, purification and quantitation, multiplexed short tandem repeat (STR) amplification, and separation and detection.

This presentation will focus primarily on the performance of the separation and detection module which is now completed. The Genebench FXTM instrument is based on electrophoretic separation and laser-induced fluorescence detection. Separation takes place in a microfluidic biochip which can process 16-samples simultaneously. The biochip accepts samples of DNA that have been extracted and amplified using conventional technologies. The instrument works with commercially available four and five color STR amplification kits, is designed to be operated in a forensic laboratory, and has been ruggedized for

optional field use. Data presented will include representative results from commercial STR kits, including resolution, sensitivity, and precision, to show the system meets or exceeds all the requirements for analysis of STRs with respect to both technical operation, reproducibility, and interpretation guidelines. Taken together, these results demonstrate accurate and reproducible STR separations with better than single base pair resolution, suggesting that Genebench-FX™ is well suited for integration of the sample preparation and amplification modules.

The ability to analyze DNA evidence rapidly, both in the forensic laboratory and at the crime scene, has the potential to dramatically reduce the time between sample collection and generation of a fully characterized STR profile. This capability would impact an investigation from the outset by allowing suspects to be apprehended more quickly, reducing the time and costs of criminal investigations, and even more importantly, rapid apprehension which would limit recidivism and significantly improving public safety. The completion of Genebench FXTM represents a major step towards the development of a fully integrated instrument that will perform sample-in to results-out analysis of forensic samples in less than 45 minutes.

Synopsis Author: Sara E. Hochendoner

Position/Profession: Scientist / Serology/DNA

Agency: Allegheny County Medical Examiner, Forensic Laboratory Division (PA)

Synopsis Technology: Genebench-FX, a microfluidic instrument intended to process samples in the field or in the laboratory, from extraction through detection, in under 45 minutes.

How Technology Works: The instrument utilizes microfluidics to take 16 samples loaded onto "smart cartridges" through three separate module steps. Module 1 consists of extraction, purification, and quantitation; this step is accomplished in approximately 15 minutes. Module 2 is a fast multiplex PCR cycle and requires 17.5 minutes of processing time. The system is compatible with the common kits, including MiniFiler®. Module 3 is comprised of separation and detection of the DNA in the sample and requires approximately 12.5 minutes. In this step, the samples are separated electrophoretically and detected with the aid of a laser, similar to the larger instruments already used in forensic laboratories. The specific details on the microfluidic technologies are unavailable due to the proprietary nature of the information.

How Technology Used in Attendee's Profession: This instrument can be utilized in the laboratory; with its fast analysis time it would increase the efficiency of any DNA lab. But its true potential would best be realized in the field where fast results from a closed system would aid in the collection of the most forensically significant samples. Network Biosystems has field-tested the instrument to determine its ruggedness which evinced no change in the results.

Technology Benefits: In a discipline where sample analysis can commonly take days or even weeks, the reduction of time to minutes would vastly improve turnaround of cases and potentially reduce backlogs. Similarly, in the field it would aid in identifying the samples with forensic significance, reducing items brought into the laboratory for further analysis, thus reducing the backlog that is endemic in this field.

Technology Limitations: Due to the novelty of this instrument, it will take a considerable amount of time for the quality control requirements of the field to become compatible with the standards of this technology. The requirements met by forensic biology laboratories for DNA reagents will differ from the requirements from those for reagents pre-loaded onto microfluidic chips. Currently, DNA standards require that critical reagents must be identified and tested but it would be difficult to identify and individually test critical reagents in a closed system such as this one using the technique described. The approach to quality control issues will have to be re-evaluated and new standards developed to support the requirements of the closed microfluidic system.

Microfluidics: Advancing Forensic DNA Analysis

Type of Presentation: Workshop

Authors: Joan M. Bienvenue, MS, PhD*, Armed Forces DNA Identification Laboratory, 1413 Research Boulevard, Building 101, First Floor, Rockville, MD 20850; and James P. Landers, BS, PhD*, University of Virginia, Department of Chemistry, McCormick Road, Charlottesville, VA 22904

Abstract: The development of bioanalytical microdevices for genetic analysis has reached a point where the "lab-on-a-chip" (LOC) or micro-total analysis system (mTAS) concept set forth almost 20 years ago is now rapidly becoming a reality. This microfluidic technology stands to revolutionize the way forensic DNA analysis is accomplished, incorporating sample preparation steps such as cell sorting, DNA purification, and PCR amplification, with microchip electrophoresis in multi-purpose, multi-functional devices capable of total, rapid, and automated genotyping.

A fully-integrated, microchip capable of performing the steps normally carried out at the bench would not only reduce the time required to perform these tasks, but would also eliminate user intervention and potential sources of contamination, preserving more of the sample for future analysis. Optimization of these devices for forensic analyses, however, presents a distinctive set of challenges.

Due to the multi-step nature of the forensic DNA analysis process, careful consideration must be given to solution compatibility, sample size, and fluidic interfacing in order to seamlessly integrate these technologies. As the field stands on the cusp of the commercialization of microfluidic systems, the forensic community is provided with the unique opportunity to drive the final design of what promises to be a revolutionary change to the way these analyses are carried out.

This workshop will provide the attendee with a comprehensive overview of the current state of development of microfluidics for forensic DNA analysis, a foundation for understanding the principles of microfluidics and how current DNA processing methodologies are being translated to the microscale.

Additionally, the role of microfluidic systems and practical considerations for their application in forensics labs and in portable genetic analysis systems will be discussed. The attendee will also gain an appreciation of this new technology, its limitations, and the unlimited potential of its application and

use in the forensic laboratory. Finally, a view of the future of advanced microscale analytical systems their potential design and use will be presented.

Synopsis Author: David Fisher

Position/Profession: Criminalist IV / Forensic Biology

Agency: New York City Office of Chief Medical Examiner, Department of Forensic Biology (NY)

Synopsis Technology: Microfluidic total analysis systems (mTAS) for forensic DNA analysis, or "lab-on-a-chip" (LOC).

How Technology Works: This technology has the ability to incorporate multiple steps, such as cell sorting (differential extraction), DNA purification, PCR, and microelectrophoresis in a single device. The fully integrated LOC would provide complete, fast, and automated genotyping to the forensic practitioner.

Essentially, the integrated LOC would have four functional areas: extraction, amplification, injection, and separation/detection. The extraction stage operates similar to an HPLC column, crashing DNA onto silica beads using a syringe. Through the use of valves, only DNA is allowed to pass allowing for the contamination of the amplification chamber to be avoided since the chemistries of PCR and extraction are incompatible. For cell sorting/selection, acoustic technology through the use of a transducer has been shown to effectively separate cell types (e.g., sperm and epithelial cells). The mixing of reagents in such small volumes is achieved through a herringbone pattern that is etched onto the glass chip.

Microchip DNA amplification uses pyrometer technology (similar to hospital thermometers) to probe the temperature of the liquid. Non-contact heating and cooling of the liquids is achieved using a light bulb and a fan for brief exposure times. Because of the small volumes of each sample, cycle times are greatly reduced, with 35 cycles being completed in 150 seconds. One of the limiting factors with speeding up amplification, however, is the biological limit of Taq polymerase.

Finally, for separation and detection, shorter capillaries are used with an increase in voltage. Different polymers are also available to give faster separation while maintaining good resolution.

How Technology Used in Attendee's Profession: This technology has the greatest potential to be used in the field for rapid DNA typing of unknown crime scene samples and/or known suspects or victims. The LOC technology could potentially be carried to the crime scene in a format no larger than a Blackberry® to be used by trained scientists for rapid forensic DNA genotyping. Besides its obvious potential use in the field, the LOC could also be used in the laboratory for backlog elimination and more rapid case turnaround time.

Technology Benefits: The greatest benefits of this technology to the forensic community include: lower likelihood of contamination (due to a closed system), less chance of sample mix-ups (samples are not handled at each step due to complete automation), lower cost (smaller amounts of consumables are used), more rapid results than traditional analyses (small sample size allows for much quicker analysis

time), increased sensitivity, and the potential to be used in the intelligence and biometrics communities for rapid identification of persons of interest and potential terrorists. The technology could also be made disposable allowing only one sample to be used per chip.

Technology Limitations: Due to the multi-step design of these bioanalytical microdevices, compatibility between tandem steps appears difficult to achieve. Since the chemistries between DNA extraction, PCR and separation, for example, are incompatible, isolating the different steps seems necessary. There are also issues regarding the ability to handle a wide range of sample types, how to put large samples into a microdevice, ease of use, LIMS integration, QC, using commercial PCR reagents which are not optimized for microfluidics, and acceptance in the profession. Because the commercialization of these microfluidic systems is still in its infancy, their widespread use in the forensic community seems unlikely for at least another five years; nevertheless, the mTAS, or LOC, has tremendous potential to aid the forensic science community in DNA typing.

Sequential Unmasking: A Means of Minimizing Observer Effects in Forensic DNA Interpretation

Type of Presentation: Scientific Session

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Abstract: Observer effects are rooted in the universal human tendency to interpret data in a manner consistent with one's expectations. This tendency is particularly likely to distort the results of a scientific test when the underlying data are ambiguous and the scientist is exposed to domain-irrelevant information that engages emotions or desires. Despite impressions to the contrary, forensic DNA analysts often must resolve ambiguities, particularly when interpreting difficult evidence samples such as those that contain mixtures of DNA from two or more individuals, degraded or inhibited DNA, or limited quantities of DNA template. With advances in technology, DNA testing has increasingly been used to analyze marginal samples that are likely to produce ambiguous results, such as older samples, samples exposed to environmental insult, and limited samples resulting from incidental contact.

Consequently, the need for measures to minimize the consequences of observer effects in forensic DNA testing is growing.

The full potential of forensic DNA testing can only be realized if observer effects are minimized. These problems can be minimized by preventing analysts from knowing the profile of submitted references (i.e., known samples) when interpreting testing results from evidentiary (i.e., unknown or questioned) samples. The necessary filtering or masking of submitted reference profiles can be accomplished in several ways, perhaps most easily by sequencing the laboratory workflow such that evidentiary samples are interpreted, and the interpretation is fully documented, before reference samples are compared. Sequential unmasking could also be employed to combat observer effects in other areas of forensic science.

Synopsis Author: Nell G. Hidalgo

Position/Profession: Forensic Specialist / Scientist

Agency: Public Defender Service for the District of Columbia (D.C.)

Synopsis Technology: Sequential Unmasking

How Technology Works: "Sequential Unmasking" is a measure that can be taken in DNA protocols to minimize bias in the interpretation of evidentiary samples. This is achieved by arranging the workflow so that the case manager, who is knowledgeable of the facts of the case, determines what to test. However, the case manager does not share task-irrelevant information with the analyst, who interprets the results. The primary analyst interprets and documents the following, as described in Keith Inman's presentation:

- Evaluates quality and quantity of evidence
- Determines alleles present in evidence
- Determines obligate or possible allele pairings
- Determines minimum number of contributors
- Determines major/minor profiles, if possible

A second blind read of the results occurs next. The interpretation and documentation of the evidentiary samples are completed in a blind fashion before the reference samples are typed and compared. After the comparisons of the evidence and reference samples, the following types of information can be unmasked to the analyst:

- Intimate sample
- Sample of known provenance
- Prior consensual intercourse

- Physiological fluid origin
- Location on item

How Technology Used in Attendee's Profession: Sequential unmasking is particularly useful with ambiguous data, such as in cases that have DNA profiles at stochastic levels, partial profiles, or indistinguishable mixtures. Because it is often unknown before the capillary electrophoresis run whether the evidentiary profile will be in the stochastic range, or yield a partial profile or an indistinguishable mixture, the case manager can request that this type of procedure be utilized by DNA laboratories in all cases to prevent biased results.

Technology Benefits: This method could potentially minimize unintentional observer effects. The documentation of the interpretation and changes in opinions would also facilitate reviews of the data. It would also limit bias questions on cross examinations.

Technology Limitations: If such a procedure is not already utilized by a DNA laboratory, then it may take a fair amount of work to rearrange the management structure and standard operating procedures of the laboratory to accommodate this plan.

Synopsis Author: Mary Reed

Position/Profession: Forensic Biology Supervisor / Forensic Biologist

Agency: Indiana State Police (IN)

Synopsis Technology: Sequential unmasking, or revealing the profiles of submitted references when the interpretation of the unknowns is complete.

How Technology Works: As forensic technology continues to become more advanced, the DNA analyst is challenged to interpret results from degraded or marginal samples. This makes it imperative to put in place a system to obviate context bias, observer effect, and confirmation bias that is part of the human response. The scientist must provide sound scientific evidence for the criminal justice system to adapt to a particular crime or incident. In this way, the scientist can provide an independent check on the criminal justice system. The analysis and interpretation of the case data occurs in a stepwise fashion that is documented at each step as follows:

1. The primary analyst evaluates and analyzes the evidence. This scientist determines the allele calls of each sample, the number of possible contributors to the sample, and the likelihood of allelic dropout in the sample profile.
2. A second qualified analyst performs a blind read of the data in a manner similar to the primary analyst.
3. Finally, the profiles generated from reference samples are compared to the evidentiary data and the final interpretation is refined by the primary analyst with approval by the secondary analyst.

How Technology Used in Attendee's Profession: Completely objective analysis is the goal of forensic science. Therefore, observer/context/confirmation biases are dangers that must be avoided in forensic case data interpretation across all disciplines. The current analysis of cold cases (i.e., those cases without suspects), shows this outcome is achievable.

Technology Benefits: This presentation was based on a letter to the editors published in *the Journal of Forensic Science.* The eleven authors hoped to initiate conversations within the forensic DNA community to provide scientifically sound data and interpretations to the criminal justice system.

Technology Limitations: It would seem that requiring formally instituted sequential unmasking would slow the completion of forensic DNA cases. The process involving two "blind" reads of evidentiary profiles and interpretation of those followed by the two "blind" reads of the references samples and final interpretations would create longer case turnaround times. It is hoped that educated and ethical forensic DNA scientists and their labs already use this approach, though it most likely occurs in a less structured fashion. Perhaps a dialogue within the community will lead the way to an efficient methodology to address these continuing concerns.

Utility of the Quantifiler® Duo DNA Quantification Kit in Forensic Case Work

Type of Presentation: Scientific Session

Authors: Maura Barbisin, PhD, Cristin E. O'Shea, BS, Lisa M. Calandro, MPH, Jaiprakash G. Shewale, PhD, and Manohar R. Furtado, PhD*, Applied Biosystems, 850 Lincoln Centre Dr., Mail Stop 402, Foster City, CA 94404

Abstract: Forensic evidence samples vary largely within sample types, and exposure to environmental insults, contamination with PCR inhibitors often limits the available quantity of DNA. Isolation of DNA from forensic evidence samples, therefore, can be challenging, and this creates bottlenecks in the sample processing workflow. The presentation will discuss the development of a genomic DNA extraction method that enables lysis of various sample types, removal of PCR inhibitors and high recovery of DNA, particularly from samples that contain low quantities of DNA. The method employs a proprietary chemistry for sample lysis, and magnetic particles for purification of DNA. The validation studies were performed following the revised validation guidelines provided by the Scientific Working Group on DNA Analysis Methods (SWGDAM). Quality of the DNA extract was evaluated for downstream applications such as real time PCR using the Quantifiler kits and STR profiling using the AmpFℓSTR®Identifiler®. STR profiles obtained from compromised samples were devoid of any PCR artifacts. Performance of the developed method for extraction of DNA was compared to the traditional phenol/chloroform method and several commercially available kits. Sample types investigated include liquid blood, blood stains on denim, cotton fabric and FTA paper, buccal swabs, liquid saliva, saliva stains on fabric, semen stains on cotton fabric, samples exposed to environmental insults, samples spiked with PCR inhibitors and cigarette butts. DNA yields for all sample types tested were equal to or better than

both phenol/chloroform extraction method and commercial kits tested, especially for lower input amounts. The purified DNA was free of PCR inhibitors. The extraction method is suitable for manual and automated processing.

Synopsis Author: Cynthia Gutierrez

Position/Profession: Forensic Science Section Supervisor / Evidence Processing Unit -DNA

Agency: Phoenix Crime Laboratory (AZ)

Synopsis Technology: Quantifiler Duo DNA Quantification Kit

How Technology Works: The Quantifiler Duo DNA Quantification Kit simultaneously quantitates human DNA and the human male DNA. Areas targeted for amplification by the ABI 7500 real-time PCR system are the Ribonuclease P RNA component H1 (RPPH1) and the male SRY region. An internal PCR control (IPC) is included to aid in the determination of any inhibitors. CT values are determined using the SDS 1.2.3 software and concentrations of each type of DNA are determined. By analyzing the concentrations of each type of DNA and the ratio of male DNA to female DNA, the analyst can determine which amplification kit, Identifiler or YSTR, to use.

How Technology Used in Attendee's Profession: The Quantifiler Duo DNA Quantification Kit is a fast and efficient method to determine both the concentration of nuclear and Y-chromosomal DNA in a sample containing both. This will allow the analyst to evaluate which kit, Identifiler or Y-chromosomal, will be best suited for the sample.

This kit would ideally be used on a male/female mixture where it is suspected that the male DNA is low in concentration when compared to the female DNA.

Technology Benefits: Many samples, (e.g., sexual assaults), contain both male and female DNA. Generally, the female DNA is higher in concentration when compared to the male DNA (sperm) or if licking or touching by the male is involved, the female DNA may overwhelm the male DNA. The Quantifiler Duo DNA Quantification Kit quantitates both types of DNA—nuclear female and Y-chromosomal—providing information as to the concentration of each. This, in turn, will allow the analyst to evaluate the sample to immediately determine which amplification kit—Identifiler or Y-chromosomal—will be best to use on the sample. Ultimately, this will reduce required analysis time and the amount of sample consumed.

Technology Limitations: This method for quantification is new and will require time upfront to bring the technology on line. This kit will also require time for validation. Additional limitations are listed below:

- Analyst training and testing for competency will be required.
- Purchase of new equipment is needed as this method will not work on current instrumentation.

- Because this is a new technology, updates to the software may be required.

Forensic Entomology

Two Forensic Entomology Case Studies Where Temperature Thresholds Were Used to Identify Precise and Specific Times of Insect Activity on the Victims

Type of Presentation: Scientific Session

Authors: Neal H. Haskell, PhD*, Saint Joseph's College, 425 Kannal Avenue, Rensselaer, IN 47978

Abstract: The primary application for using entomological evidence recovered from a death scene is to estimate a likely range of the postmortem interval (PMI) or time since death. While it is recognized there are other uses for this evidence, placing a reasonable time when the victim died is by far, the most utilized. This is most often accomplished by tracking the known development of a carrion insect: identifying the species, determining the oldest life stage, and then consulting climatological data to determine energy units available for the species growth requirements. Less used is the succession model approach. Two case studies from the Midwest United States illustrate additional techniques available for assessing the time since death. In the first case a college student attending a major university in Indiana went missing on the late evening or early morning hours of January 12/13, 2007. Police and university employees conducted an intensive cam-pus wide search of all university facilities. In addition, thousands of man-hours of police time were devoted to running down leads regarding his disappearance. On March 19, 2007, while doing routine maintenance in an electrical transformer room, the remains were discovered. This area had originally been "searched" on January 14, 2007. The young man had crawled among the transformers and had been electrocuted. Entomological evidence was collected and provided two distinct sets of specimens, one set was eggs and 1st instar larvae (Calliphora vicina), the other set was three 3rdinstar larvae (Calliphora coloradensis). The temperature threshold for flight and oviposition of the Calliphorasp is around 6ºC. Temperature data for development of the small specimens were consistent with warming trends between March 10 and March 19. However, temperatures were below the lower limit activity threshold for the entire period of March 9, back to January 12/13 with the exception of only one day, January 13, where the daily maximum reached above 16ºC. The brick transformer building modified the ambient temperatures due to the huge transformers creating heat (4ºC increase). The lengthy duration and minimal growth temperatures was consistent with the colonization of the older larvae during the daylight after he had crawled into the transformer building (January 13) in the early morning hours of darkness. In the second case, the remains of a fully clothed female were discovered lying face down in an open field in southern Wisconsin on January 10, 2006. At autopsy, two adult insects were recovered tangled in the victim's hair. The woman was last known alive on November 21, 2005. The two specimens, Hymenoptera: Formicasp (ant) and Coleoptera: Staphylinidae (beetle) are both ground dwellers, neither of these specimens are known to frequent carrion. The reactivity threshold is around 10ºC, below which they will not be active. Upon daily temperature analysis from January 10, 2006 back to November 21, 2005 daily maximums did not reach near 10ºC until November 28 and 27 respectively. In addition, temperatures between November 21 and 26 were well below the activity threshold temperature. The two insects could only have become entangled in her hair on either November 27 or 28, thus placing her body at the site on these two dates

as a minimum PMI. However she could have been there longer. Her husband stated that she had died after drinking and doing drugs. He panicked and dumped her body on the evening of November 21, 2005. Autopsy injuries to her neck suggest an alternative cause of death. These two cases illustrate how rigorous study of the climatological data can pinpoint a time of insect activity, thus illuminating the PMI.

Synopsis Author: Regina Foreman

Position/Profession: Criminalist I / Forensic Scientist

Agency: San Bernardino County Sheriff's Department (CA)

Synopsis Technology: The use of entomological evidence in determining the postmortem interval (PMI) or time since death.

How Technology Works: The postmortem interval can be determined two different ways. The first is the insect succession model; however, this approach is not used often. The second approach works by tracking the known development of a carrion insect. Once the insects are collected, the species and oldest life stage need to be determined. By consulting climate data for the time period in question, the scientist can determine how many energy units would be available for the species of insect. By comparing the growth requirements of the insect species and the temperatures available, a scientist can determine the time periods that would have been appropriate for the insect activity. Thus a minimum time period can be determined in which the body was at a specific location.

How Technology Used in Attendee's Profession: This approach is useful when trying to narrow a timeline down for the time of death of a victim when the body is found months after being missing. This could be of importance when comparing it with the time periods that suspects would have had access to the body.

Technology Benefits: The benefit of postmortem interval determination is that it can assist investigators in determining the minimum time period a body was at a specific location. This information could help eliminate possible suspects based upon the time periods identified.

Technology Limitations: There are some limitations to using this technology. First, the insects need to be properly collected from the scene and documented with the correct dates, times, and collection location. The scientist examining the insects requires this information in order to gather the appropriate climate data for comparison with the insect growth data. Second, the climate data may not be available for the area the body was found. Although data can be used from a surrounding area and be extrapolated to another area, any change in climate can negate such an extrapolation.

Synopsis Author: Lisa Hughey

Position/Profession: Crime Scene Investigator / Crime Scene Investigations

Agency: Okaloosa County Sheriff's Office (FL)

Synopsis Technology: Meteorological data can be used as a tool to help determine an estimated time of death in conjunction with the appearance of insects. Insects appear on the body at different intervals and they are usually all directed by temperature.

How Technology Works: When trying to determine an estimated time of death, use the Post Mortem Interval approach by:

- Identifying insects
- Determining the oldest life stage
- Using known development data sheets for species
- Collecting meteorological data

Certain insects arrive at different intervals and all are directed by temperature. Usually, the first to arrive are the blowflies followed by beetles. Blowflies will lay their eggs at different times, thus creating areas with different stages of growth. The initial crime scene investigator should complete specific steps to ensure proper data collection. The investigator should measure the ambient air temperature, body temperature, temperature of the maggot mass, temperature of the area under the body, as well as collect all the different stages of maggot growth, and any flies or other insects present. Meteorological data must also be obtained because environment plays a crucial role when analyzing the data.

Unless the investigator has training in entomology and knows how to chart meteorological data, a forensic entomologist will need to be consulted to evaluate the information collected and complete a visual examination of the insect samples.

An entomologist will determine how old the insect samples are by analyzing the data and the minimum and maximum temperatures and comparing these results to the established growth data charts for each species. This information will allow the entomologist to arrive at the date which matches the oldest stage of insects/maggots collected. The chart for the date range for temperature starts with the date that the samples are collected and works backwards until you reach a match with the growth stage of the sample. This will provide an estimated day that this particular insect arrived on the body which can lead to an estimated time of death.

How Technology Used in Attendee's Profession:

This is technology that could be applied any time there is an unattended death and the stage of decomposition is in question. As a crime scene investigator, when investigating an outdoor death scene, the insect activity present, or lack thereof, along with current and past weather information will help determine when the first stage of insect activity started, thus providing an estimated time of death. This is a useful tool which can aid the law enforcement agency in other areas of their investigation.

Technology Benefits: This technique can be utilized by any crime scene investigator, as it only requires recording temperatures and collecting insects at the scene. This technique requires little to no expense

to the agency. When a body has been exposed to the elements and there is no known time that the person was last seen, this will help make a determination of an estimated time of death. This is possible by using meteorological data along with insect/maggot development. As certain insects appear at certain times in the cycle, their arrival and departure can be effected by temperature. Even if the research cannot be performed at the facility, the specimens and weather information can always be sent to a board-certified entomologist for their assistance.

Technology Limitations: There are limitations to the use of this technology. When the information is retrieved from the National Weather Service and other sources, the data might deviate based on the geographical area from which the information was collected. For example, the distance between the weather source and the scene of the crime may impact the data. Another limitation to consider is if the crime scene investigator did not record all necessary data or collect all necessary insects present. Nevertheless, this technology is one of the best ways to arrive at a date range for estimated time of death.

Forensic Pathology

Forensic Investigation of Fire Deaths- Accidental and Homicide

Type of Presentation: Workshop

Authors: Elayne J. Pope, PhD*, University of Arkansas, 330 Old Main, Fayetteville, AR 72701

Abstract: This presentation will illustrate how the human body burns for arson and death investigators. The lecture will cover topics of accidental fires and normal burn patterns as it applies to forensic casework, and features of homicide, particularly identification of traumatic injury (ballistic, blunt force, and sharp force trauma) for differentiating manner of death between accidental or criminal attempts to destroy evidence of the body with fire.

Dr. Pope has lectured to state chapters of the International Association of Arson Investigators for New York, Florida, Arizona, Oregon, Connecticut, South Carolina, North Carolina, Indiana, Colorado, and Arkansas. She has taught Forensic Anthropology, Criminalistics, and Forensic Taphonomy at the University of Arkansas in the Anthropology Department, Northwest Arkansas Community College, and consults on forensic cases involving skeletal or burned human remains for the Arkansas State Medical Examiner's Office.

Synopsis Author: Scott M. Grim, D-ABMDI

Position/Profession: Coroner / Medicolegal Death Investigations

Agency: Lehigh County Coroner's Office (PA)

Synopsis Technology: Determining burn patterns versus traumatic fractures in a fire-related death.

How Technology Works: Bone or bone fragments can be examined visually, microscopically, and/or with the use of x-ray technology. During the initial examination of the body at the scene, a visual examination will take place. As protocol, my office performs a full skeletal survey on the remains to properly document the injuries and fractures and to determine if the fractures were due to trauma or heat.

Heat Fractures versus Traumatic Fractures

Heat fractures appear quite differently than those of traumatic injury. Heat fractures do not blacken the bone as do those caused by traumatic fractures. Due to the heat of the fire, traumatic fractures will deform and warp unlike heat-related fractures. Also, unlike heat fractures, traumatic fractures will extend into the unburned areas of the body. One red flag to look for during the physical examination of the body is when a burn pattern is discovered from the center out, this is a good indication that the injury is due to a traumatic event, such as a stab or gunshot wound.

How Technology Used in Attendee's Profession: When a death occurs due to fire, the coroner's office investigates the facts and circumstances surrounding the death. This is most important when the fire-related death occurs on-scene. It is the responsibility of the coroner to determine whether the decedent died as a result of the fire and/or by suspicious circumstances prior to the fire starting, such as in arson-

related cases, where fire may be used to cover up the initial crime. Understanding, identifying, and interpreting the burn patterns and what constitutes a heat fracture versus a traumatic fracture definitively assists with the final determination of the cause and manner of death and therefore if the fractures occurred due to accident or homicide.

Technology Benefits: The knowledge and expertise needed to determine burn patterns on the decedent provides the advantage to properly investigate the facts and circumstances of the death. With the information gathered during this workshop, I can define and notate the burn patterns of the body, such as burning, charring, and calcination. For example, calcine fractures indicate the directionality of the burn pattern. In the calcine stage, bones become very brittle and white in color due to the exposure to heat. As the soft tissue on the body retracts, calcine begins.

Technology Limitations: As long as a complete and thorough scene and death investigation is performed, I do not foresee any limitations in determining burn patterns on a body whether fractures are due to trauma or heat/fire.

The Boiling Technique: A Method for Obtaining Quality Postmortem Impressions From Deteriorating Friction Ridge Skin

Type of Presentation: Scientific Session

Authors: Aaron Uhle, MS*, FBI Laboratory, Latent Print Support Unit, Major Incident Program Manager, Quantico, VA 22135; and Richard Leas, Oak Ridge Associated Universities, Latent Fingerprint Examiner, Oak Ridge, TN 37831

Abstract: After attending this presentation, attendees will understand the boiling technique and the necessary elements for successfully performing the technique. An example of the practical application of the boiling technique to obtain quality postmortem friction ridge impressions will be addressed as well.

This presentation will discuss the boiling technique, which is a specialized procedure that uses boiling water to recondition friction ridge skin. This reconditioning process rehydrates the skin, enhancing and exposing friction ridge detail. As a result, quality impressions, even from the most distressed bodies, can be recorded and compared to a known antemortem standard or searched through an automated fingerprint/palm print system to verify or establish identity.

Friction ridge impressions are instrumental in establishing the identity of deceased individuals. The forensic examiner must consider the condition of the body and the fact that damage to the friction ridge skin may prevent the effective recording of quality prints using standard fingerprint procedures. The boiling technique is presented as a significant advancement in the recording of quality postmortem impressions particularly in the area of disaster victim identification.

The authors will present their experiences utilizing the boiling technique in Phuket, Thailand after the 2004 South Asian Tsunami as an example of the practical application of the technique. The impact of the presented information on the forensic sciences and/or humanity is the introduction of a fingerprint technique that can be used by medicolegal professionals to record quality impressions from deteriorating friction ridge skin for the identification of deceased persons.

Synopsis Author: Jacquelyn Belden

Position/Profession: Forensic Specialist / Crime Scene Investigator

Agency: Sioux Falls Police Department (SD)

Synopsis Technology: A simple method for collecting postmortem prints to identify deceased individuals whose friction skin has become unidentifiable through traditional means.

How Technology Works: This simple process of obtaining postmortem prints can be completed in three easy steps. First, one must inspect and clean the friction ridge skin to determine if damage has occurred. The type of accident that occurred determines the damage (e.g., fire, drowning, etc.). Second, one must then use proper techniques to recondition the friction skin. This technique is an attempt to return the skin as close to the natural state as possible. Finally, the goal is to obtain identifiable postmortem prints with sufficient quality to complete a manual and Automated Fingerprint Identification System (AFIS) comparison.

This procedure works best on friction skin in an advanced stage of decomposition that is generally caused by maceration (e.g., drowning deaths). The technique is most effective when applied to fingers that have severely damaged epidermal skin, yet the dermal skin is intact with little to no friction skin visible.

This technique begins by visually examining the friction skin and by removing all loose contaminants with warm, soapy water. Use caution to not damage the skin any further. Decayed hands will often show no ridge detail, which is to be expected. When no detail is present, it is a sign that one is working with dermal skin.

To use the boiling technique to obtain postmortem impressions, follow these steps:

1. Fill an electric pot half-full with tap water (enough so that when the hand is submerged it does not overflow).

2. After the water is boiling, unplug the pot and place the hand in the water for five seconds.

3. Remove the hand and check the friction ridge skin. If there is no detail, repeat for an additional five seconds. [Note: Do not repeat more than three times, as damage will occur. If there are cuts present on the hands, sticking the hand in the boiling water will only further damage the hands. In such cases, one can control the development by using a sponge and applying the boiling water to the hands.]

4. Dry the friction skin. Suggested drying methods include using a blow dryer on a warm setting or by pouring isopropyl alcohol on the hands. Blot dry.

5. At this point, one should be able to use traditional means to collect the postmortem prints. An easy way is to use black fingerprint powder applied to the friction skin, lift with a Handi_Lifts™, and apply on the back of a transparent fingerprint card.

How Technology Used in Attendee's Profession: Unfortunately, dealing with decomposed bodies is not uncommon in crime scene investigation. It can be extremely challenging and at times almost impossible to collect quality postmortem prints. This technology provides investigators with another tool to identify the deceased. The presenter, Aaron Uhle, spoke specifically of the Tsunami victims and the difficult challenges involved with the process of identification. Once this technique was developed, they were able to make great strides in their identification process. He stated that they were able to produce ridge detail on bodies in the worst conditions they had ever seen.

Technology Benefits: Regardless of budget constraints, any agency should be able to easily acquire the tools necessary to perform this technique. It is simple and does not require extensive training. It does not seem overly time-consuming and produces excellent results.

Technology Limitations: It seems the only caution is to be aware of the condition of the hands and to be conservative when applying this technique.

Synopsis Author: Owen M. McDonnell, Jr.

Position/Profession: Lieutenant /Crime Scene Investigations Division

Agency: Caddo Sheriff's Office (LA)

Synopsis Technology: The use of five second submersion of decomposed or macerated hands in boiling water to recondition the dermal and epidermal layers of friction skin for identification purposes.

How Technology Works: The hand is first inspected to determine the type of damage present. Loose contaminants are removed using sponge and warm soapy water. The absence of visible ridge detail is often a sign that the epidermal layer is missing.

An electric hot pot of sufficient size to accommodate submersion of the hand is filled half-full and brought to a boil. The hand is placed in the pot of water for five seconds and then examined for usable ridge detail. The process can be repeated but should not exceed three exposures to the boiling water. In the event that cuts or abrasions are present, exposure to the boiling water can increase the size of the damaged area. When this type of damage is observed during the inspection period, an alternate sponge technique can be used. A sponge is soaked in the boiling water and squeezed over the hand allowing the water to wash over the non-damaged area of the palmar side of the hand and fingers.

This exposure to boiling water causes the hand to become taut and should cause the ridges to become clearly visible. The hand is dried using a blow dryer or a cloth dampened with isopropyl alcohol (paper towels may leave fiber traces on the skin surface).

Once dry, the friction skin is brushed with conventional black fingerprint powder and lifted using an adhesive white lifter (e.g., Handi_Lifts™ or mailing labels applied to the back of a clear acetate fingerprint or palm print card).

The resulting impressions can be utilized for direct comparison to known exemplars or searched through available automated fingerprint identification systems.

This technique will work on both epidermal and dermal skin. However, the examiner should be aware that an enlargement of up to 30% in the epidermal skin pattern area has been observed. This can be corrected in a photo editing program or Automated Fingerprint Identification System (AFIS). If entered into an AFIS, the examiner should be aware of the possibility of enlargement as failure to correct the sizing may result in missed identifications.

How Technology Used in Attendee's Profession: This method could be used when deceased individuals are in advanced stages of decomposition or maceration, and friction skin detail is needed for identification or comparison to either known antemortem exemplars or unknown source friction skin impressions.

Technology Benefits: Previous methods have centered around reconditioning the friction skin detail on the hands through prolonged soaking in re-hydration solutions or through injection of saline solutions beneath the dermal layer to compensate for the loss of size. This convenient method can be applied to the entire hand without amputation.

Technology Limitations: This technique has limited application to field usage due to requirements of heat source for boiling water and is best utilized in a laboratory or temporary morgue facility. Additionally, the user should be well versed in fingerprint and palmprint comparison to adequately determine the quality of the obtained samples.

Synopsis Author: Kimberly H. Ryan

Position/Profession: Latent Print Examiner / Forensic Scientist

Agency: Illinois State Police (IL)

Synopsis Technology: Development of usable prints from postmortem friction ridge skin.

How Technology Works: The technique, as described by Mr. Uhle, focuses on recovering fingerprint impressions from the dermal layer of skin.

The first step is to examine the friction ridge skin portion of a hand. The technique works best on skin that is decomposed or macerated, yet intact. If, during the evaluation process, the skin is found to be incised or cut, then boiling water can be applied by sponge or by pouring directly over the area.

Skin on the hand that is suitable for the boiling technique is first cleaned. The hand is then dipped in a pot of boiling water for five to ten seconds and evaluated for ridge detail. If no ridge detail is visible, the dipping processes may be repeated. According to Mr. Uhle, if dipped more than three times, the process may cause the skin to slough. The skin is then dried by applying alcohol or using a blow dryer.

A Handi_Lifts™ is applied to the ridged skin and then rolled onto a transparent fingerprint card. The dermal impression, which consists of two rows of papillae pegs, is revealed.

How Technology Used in Attendee's Profession: This technology would be extremely beneficial to forensic scientists specializing in latent prints. My laboratory often receives hands from unidentified subjects. In most cases, the skin on the hands is decomposed to the point where there is very little that can be done to improve the friction ridge skin for identification purposes.

Technology Benefits: The boiling technique allows fingerprint examiners to tremendously increase the chances of identifying an unknown body. The process is performed at little to no cost to the laboratory and requires no additional training to perform. It is also much faster to utilize than current procedures for rehydrating deteriorated friction ridge skin. With our current procedure, we may have to soak the fingers for 24 to 48 hours with little success. The boiling technique can be completed within minutes with great success.

Technology Limitations: I find no limitations whatsoever in utilizing the boiling technique.

Synopsis Author: Marc D. Woodmansee

Position/Profession: Crime Scene Investigator / Police Officer

Agency: Gainesville Police Department (FL)

Synopsis Technology: Utilizing a boiling technique for recovering finger and palm print impressions from the deceased who are in a decomposed state or are macerated from submersion in water. This method is also effective for charred remains and remains that have been exposed to extreme weather.

How Technology Works: The technique described by Mr. Uhle involves immersing the friction ridge skin, usually the area of the hands and fingers, in boiling water to rehydrate the dermal layer of skin to produce fingerprints for identification.

Mr. Uhle described a detailed method for preparation of the postmortem skin, including inspection and cleaning the skin to be submerged in the boiling water. An electric hot pot is the recommended vessel for boiling the water, as it requires no other method of heating, is easily transportable to a temporary morgue, and utilizes standard electrical service. The decedent's hands and fingers are prepared by

cleaning with soapy water and a soft sponge, being careful not to further damage the skin. The next step is to fill the electric hot pot half-full of tap water and plug it in. When the water begins to boil, unplug it and immediately immerse the hand into the pot for five to ten seconds and visually inspect the results. If sufficient ridge detail is not present, resubmerge the hand for another five seconds. Mr. Uhle cautions against submerging the hand more than three times, because overexposure to the boiling water can potentially damage the skin. Mr. Uhle recommends standing at the head of the victim and bending the arm upward, towards the top of the victim's head to avoid potentially burning the person performing the method. Mr. Uhle also recommended using two persons to perform the method for victims exhibiting rigor mortis.

Mr. Uhle recommended a slightly different method for subjects with cuts or abrasions on their hands, as submersion can cause a cut or laceration to tear or become enlarged. The method used under these circumstances employs applying the boiling water by squeezing a soaked sponge over the friction ridge skin.

After the boiling method has been employed to enhance and develop the friction ridge skin, the skin must be dried in preparation for collection. Mr. Uhle recommends drying with a blow dryer set on the lowest setting and pouring isopropyl alcohol on the hands and blotting them dry with towels, being careful not to damage the skin. He does not recommend using paper towels because lint and fiber may adhere to the adhesive lifters used to collect the prints.

After the preparation of the friction ridge skin is complete, the skin is lightly dusted using standard black fingerprint powder and a short hair brush. The prints are collected from the skin using an adhesive lifter placed on a clear backing so that the print does not need to be reversed for examination. Mr. Uhle recommended a specific vendor for the adhesive lifters, but said that white mailing labels could also be used. Once collected, these prints can be placed on a clear fingerprint card made with clear acetate and a standard computer printer.

How Technology Used in Attendee's Profession: This technique for recovery of dermal layer skin friction ridge prints will be invaluable, both for my agency and the medical examiner's office that serves our community. The medical examiner's office jurisdiction encompasses a large rural area, with a large portion of the coast of the Gulf of Mexico. The medical examiner's office frequently makes requests of our agency for fingerprint identification of macerated and decomposed bodies. The investigators and staff at the medical examiner's office have minimal training on fingerprint recovery and identification and call upon my agency to assist in fingerprint recovery and identification of these unidentified bodies. Over the past year, I have had several cases where this technique would have aided in the recovery of identifiable fingerprints and I anticipate that this technique will greatly aid in future identifications. **Technology Benefits**: The boiling of dermal friction ridge skin produces identifiable fingerprints from macerated or decomposed skin that was previously considered too badly damaged to develop identifiable prints. While other methods are available to identify decomposing remains, fingerprints are usually the fastest and most reliable method employed by our agency. The exigency of identifying a homicide victim is paramount in the initial stages of any murder investigation. Our jurisdiction has access to a forensic odontologist, but does not have immediate access to the Florida Department of Law

Enforcement (FDLE) crime laboratory, which is approximately two hours away. This method does not require any special equipment, other than an inexpensive electric hot pot, which is commonly available in many retail stores. The other required equipment is simple fingerprinting equipment, which is already employed by my agency.

Technology Limitations: This technique is optimal in the restoration of the dermal layer of skin, which produces a double ridge. Latent print examiners primarily examine and compare the epidermal layer of skin, which produces a single ridge. This could potentially create confusion with the latent examiner, if the examiner was not familiar with dermal friction ridge prints. Another potential limitation involves the method of recovery of the prints after boiling of the friction ridge dermal skin. This method produces a negative (mirror) image and must be placed on a clear backing to view the positive image or reversed photographically for comparison with fingerprint standards. This concern, however, is standard to the commonly used adhesive lifter method, which our agency employs frequently. The only other limitation would be a source of power to operate the hot pot to boil water. This limitation is easily overcome with a portable generator, which our agency frequently uses for crime scenes without existing power. I anticipate using this method in the near future and believe it will enhance my agency's ability to recover finger and palm prints from the deceased who are in advanced decomposition or macerated from submersion in water.

Video File Recovery and Playback

Type of Presentation: Scientific Session

Authors: Rikkert Zoun, MS*, and Zeno J. Geradts, PhD, Netherlands Forensic Institute, Laan van Ypenburg 6, The Hague, 2497 GB, The Netherlands

Abstract: The use of digital video is rapidly increasing. Analogue CCTV systems are replaced by digital systems, digital cameras are increasingly popular and affordable, many mobile phones now come equipped with a camera and high-bandwidth internet allows home users to share their recordings and download video material in larger quantities than ever before. When digital video content is an important part of case evidence, such as in cases of recorded child pornography or other recordable crimes, finding every last bit of video data and making it viewable can be crucial to the investigation. This is however not always as easy as simply searching the data carriers using regular operating system functionality. Deleted files can usually be found with typical forensic software, if they are not yet overwritten and still reside intact on an undamaged data carrier. In some cases, however, the deleted video files may be partly overwritten or file systems maybe damaged, leaving the investigator only with fragments of files. Recognizing such fragments and rebuilding them to valid files that can be viewed using video playback software requires thorough knowledge of file format specifications and laborious manual data editing. Many digital forensic investigators lack the time to get into such details. NFI developed Defraser, an open source software tool to help the investigator by searching for video file fragments and analyzing their integrity. It allows drag-and-drop combining of video file elements to

create playable video files. The tool is plug-in-based, allowing users to store and share their knowledge of particular file formats by programming their own plug-ins.

Synopsis Author: Paul Singer

Position/Profession: Assistant Attorney General / Attorney

Agency: Office of the Texas Attorney General (TX)

Synopsis Technology: Defraser—forensic analysis software application

How Technology Works: Defraser is a software application designed to locate, edit, and restore multimedia file fragments from recovered data sources. In other words, when partial data is recovered from a computer hard drive, flash drive, cell phone, etc., sometimes only fragments of a video remain. As such, the video may not be playable in a standard media player. Defraser allows law enforcement to examine the details of the fragments, and manipulate them by adding the missing pieces back into the file — which can easily be cut from known working media files recovered on the data source.

How Technology Used in Attendee's Profession: The Texas Attorney General has both a criminal cyber crimes division and a civil Internet enforcement unit. In both contexts, our office must physically examine data sources that can be compromised by either normal wear and tear or deliberate destruction. For example, in our criminal prosecution of individuals in possession of child pornography, such individuals may attempt to delete incriminating evidence from their computer prior to the execution of a search warrant. In these situations, remnants of video files may remain and Defraser could help restore those videos.

Technology Benefits: As an open source product, this tool allows law enforcement to reconstruct partial video with a free and easy-to-use application. Given the budget restraints facing many offices and the difficulties in using more complex programs, this alternative should allow any size agency to work in this field.

Technology Limitations: Since it is still a work in progress, the program has some limitations on file type – not all video is supported yet. In addition, the program does not include a built-in player, which adds an additional step for investigators to examine if their efforts in rebuilding a file worked.

Law and Ethics

Ethics in the Forensic Sciences — When is the Line Crossed?

Type of Presentation: Workshop

Authors: Robin Bowen, MA*, West Virginia University Forensic Science Initiative, 1600 University Avenue, Room 208, Oglebay Hall, Morgantown, WV 26505; JC Upshaw Downs, MD*, Georgia Bureau of Investigations, 925 A Mohawk Drive, Savannah, GA 31419; Max M. Houck, MA*, West Virginia University Forensic Science Initiative, 3040 University Avenue, PO Box 6217, Morgantown, WV26506; Haskell Pitluck, JD*, 573 Lake Avenue, Crystal Lake, IL 60014; Anjali R. Swienton, MFS, JD*, SciLawForensics, Ltd, 25 Walnutwood Court, Germantown, MD 20874; Richard Vorder Bruegge, PhD*, Federal Bureau of Investigations, Engineering Research Facility, Building 27958A, Pod E, Quantico, VA 22135; Michael Welner, MD*, The Forensic Panel, 224 West 30th Street, #807, New York, NY 10001

Abstract: "Tainted Science and Testimony Leads to Re-opening of 120 Cases over Last 15 years;" "Man Freed after Serving 21 years in Prison due to Lab 'Oversight?';" "State Crime Lab Employee Accused of Biased Analyses and Testimony" – all headlines that can confront, and scare, legitimately practicing forensic scientists. At the heart of this fear is wondering how such events occur since inherent in the practice of forensic science is the requirement for each practitioner to be ethical.

The word "ethical" can be defined merely as proper conduct. Tacitly, a failure of forensic scientists to act ethically results in serious adverse outcomes. However, while seemingly simple to define, the application of being "ethical" is somewhat more obscure. That is, when is ethical, ethical, and when is it not?

Clearly, as part of an adversarial legal system, there must be room for differences of opinion in the forensic sciences. What is not clear, however, is when such differences are so divergent that individuals' ethics are drawn into question. In this workshop, a diverse pool of expertise has been compiled to address the role of ethics in the forensic sciences from several different perspectives with the intent of approaching an understanding when the proverbial ethical line is crossed.

The workshop will begin with a brief introduction to ethics, the role ethics plays in society and potential outcomes of unethical behavior, especially in the forensic sciences. Results of a survey on ethics in forensic science will be discussed. Presentations will further involve comparisons to canons of ethics in the related fields of medicine and law, the expectations, and limitations of being a government scientist, and lastly, the status of ethics in forensic science education.

As we move forward into the age of globalization, the forensic sciences worldwide will be under ever-increasing scrutiny. In that respect, with the dissemination of information associated with the forensic sciences through such outlets as the internet, television and the print media, expectations and associated ethical issues will surface perhaps more than ever before. By meeting the issues of ethics in the forensic sciences head-on, we can hopefully be prepared for these challenges.

Synopsis Author: Frank Healy

Position/Profession: Criminalist / Forensic Scientist

Agency: San Diego Police Department Crime Laboratory (CA)

Synopsis Technology: Ethics training in forensic sciences

How Technology Works: The workshop focused on recognizing ethical behavior, ethics training programs for forensic scientists, and the need for ethical behavior among forensic scientists. The results of a nationwide ethics survey were also presented.

How Technology Used in Attendee's Profession: Training to educate forensic scientists on ethical standards and promote responsible ethical behavior would be used in all areas of the forensic sciences, particularly in the area of ethical behavior in case approach and analysis, reporting results, the peer review process, and court testimony as an expert witness.

Technology Benefits: The benefit of ethics training would be increased awareness of ethical behavior in the forensic science community, resulting in a higher quality and unbiased work product and improved expert testimony.

Technology Limitations: There are no limitations associated with the training. However, although ethical behavior may be defined, there is limited opportunity for specific answers on how to respond ethically in a given situation. The limit of this particular workshop was that the presenters were predominately practicing forensic scientists from different professions. Although they may be aware of what defines ethics, they are not experts in this field. This type of training should include individuals who have studied extensively the specific discipline of ethics.

Other Disciplines

National Missing and Unidentified Persons System (NamUs)

Type of Presentation: Exhibition Booth

Booth: National Forensic Science Technology Center (NFSTC)

Synopsis Author: James L. Winskey

Position/Profession: Detective Sergeant – Crime Scene Technician / Law Enforcement

Agency: Statesboro Police Department (GA)

Synopsis Technology: NamUs / National Missing and Unidentified Persons System

How Technology Works: This is a nationwide database system that is accessible, via the Internet, to medical examiners, coroners, victim advocates, law enforcement agencies, missing person clearinghouses, and the general public. The system is broken down into two separate databases. The first database is the Unidentified Decedents database that allows searches based on characteristics such as demographics, anthropologic analysis, dental information, and distinct body features. The second database is the Missing Persons database which provides a national online database to enhance reporting, investigation, and the solving of missing persons cases. Additional resources, including state clearinghouses, medical examiners, coroners, victim assistance resources, and legislation are also available. These two databases will be fully integrated to allow simultaneous searching of the Missing Persons database records against cases in the Unidentified Decedents database to identify unidentified human remains and solve missing persons cases.

How Technology Used in Attendee's Profession: As a law enforcement officer, this database system would be utilized in any missing persons case with suspicious circumstances and on any case involving the recovery of human remains.

Technology Benefits: This database will enhance the possibility of solving missing persons cases and unidentified decedents by allowing information sharing through one database. This database allows everyone involved or responsible for solving these types of cases to enter identifying information into one system and get results based on information obtained nationwide.

Technology Limitations: As with any database system, it will only be as good as the amount and quality of data entered into it. In the information that I have read on this system, there are no mandatory requirements of law to provide information into the database. There is mention of legislation supporting the database; however, no requirements of law enforcement, medical examiners, or coroners to provide data are mentioned. It appears to be a voluntary system, which I fear will limit the amount of information entered into the database.

Quality Assurance and Laboratory Management

Dry Safe Forensic Evidence Drying Cabinet Technology

Type of Presentation: Exhibition Booth

Synopsis Author: Ronald M. Morello

Position/Profession: Chief of Police / Law Enforcement

Agency: Stratford Police Department (NJ)

Synopsis Technology: Dry Safe Forensic Evidence Drying Cabinet

How Technology Works: The technology is designed to dry forensic evidence in a secure cabinet. The cabinet will protect against harmful contaminants, environmental bacteria, and cross contamination of biological and physical evidence. The system has a HEPA filtration cabinet and self-contained filtration system.

How Technology Used in Attendee's Profession: This technology would be utilized for safe keeping and storage of forensic evidence in all criminal investigative matters.

Technology Benefits: The dry storage system allows for the storage of biological and or potentially biological evidence pending transmittal to the New Jersey State Police Crime Laboratory. Conveniently, the evidence can still be viewed during the drying process as the storage containers are transparent. Additionally, the containers are completely self-contained, with climate control. The containers are portable and may be transported to and from a crime scene, headquarters, and crime laboratories.

Technology Limitations: An indentified limitation of this technology is clearly the size of the instrument. While portability provides convenience, the instrument is limited in physical storage capabilities; therefore, this would prevent the storage of larger items of evidence, e.g., automobile seats, bedding, and carpeting.

Forensic Laboratory Planning and Design

Type of Presentation: Workshop

Authors: Michael G. Mount, BA*, SmithGroup, Incorporated, 455 North Third Street, Suite 250, Phoenix, AZ 85004

Abstract: This eight hour workshop was first presented in 2003 to the European Academy of Forensic Sciences in Istanbul. The first half of the workshop covers the entire project development process for a forensic laboratory from establishing the need, design programming, and the facility design process. Critical design issues are addressed, including mechanical, electrical, plumbing, security, safety, and site requirements.

The second half of the workshop addresses the specific architectural and engineering design requirements for each of the major laboratory sections within the forensic laboratory. The presenter has been designing forensic facilities throughout the United States and abroad since 1983.

Synopsis Author: Jim M. Thomas

Position/Profession: Regional Laboratory Manager / Forensic Science

Agency: Texas Department of Public Safety – Crime Laboratory (TX)

Synopsis Technology: Forensic laboratory development and design process

How Technology Works: The process of developing a design for a new or remodeled forensic laboratory includes many steps, such as establishing the team, project delivery methods, needs assessment, the design program, casework selection, laboratory workstation options, laboratory finishes, plumbing systems, electrical systems, data and communications, mechanical systems, interstitial spaces, safety design, security design, etc. In addition, each section/discipline has unique design considerations. Necessary amenities that contribute to safety, morale, pride, public relations, health and fitness, efficiency, and productivity also need to be considered. These amenities include windows, displays, fitness center, lockers/showers, office workstations, training, and interaction spaces.

How Technology Used in Attendee's Profession: Anytime a forensic crime laboratory is considering remodeling or designing a new space or facility.

Technology Benefits: Good planning is always a benefit in the long run for efficiency of operations and cost effectiveness.

Technology Limitations: The limitations would be whatever budget the agency is required to follow in its design and construction process. Ideally, an agency could go through the design process to develop a presentation to the budget decision makers to help justify the needs for the new or remodeled facility.

Justice Trax Path Assist

Type of Presentation: Exhibition Booth

Synopsis Author: Dr. Polly L. Purcell

Position/Profession: State Medical Examiner / Forensic Pathologist

Agency: Office of the Chief Medical Examiner (KY)

Synopsis Technology: LIMS-PLUS ME

How Technology Works: This computer-based technology is designed to enable a medical examiner to access information in a more efficient and accurate manner.

How Technology Used in Attendee's Profession: I foresee that this technology would be used on a daily basis in our medical examiner's office, especially since we operate under a medical examiner/coroner system. With our current system, information can easily slip through the cracks. If this technology could be integrated among police, ME's, coroners, and even toxicology departments, our work flow would, presumably, be more efficient and accurate.

Technology Benefits: Bringing all the pieces of the puzzle together.

Technology Limitations: The greatest limitation appears to be the potential for actually *increasing* workload or time spent entering data. This would add additional stress on an already overworked and underpaid staff of people. So, while the idea of incorporating the data seems wonderful, it may be viewed in a negative light by personnel (if too much time is required for the entering of data).

Questioned Documents

Reflection Transformation Imaging (RTI) and 3D Evidence Capture

Type of Presentation: Scientific Session

Authors: Elaine X. Wooton*, Department of Homeland Security, 8000 Westpark Drive, Ste 200, McLean, VA 22102

Abstract: The Reflection Transformation Imaging (RTI) is a technique being developed and refined to create digital records of historical artifacts as well as works of art. A few seconds of viewing time immediately brings to mind numerous forensic applications for this technology. RTI uses methods developed by Hewlett Packard Labs, but that are in the public domain (for not-for-profit purposes).

"Polynomial Texture Maps (PTMs) are made from information derived from multiple digital photographs of a subject shot from a stationary camera position. In each photograph, light is projected from a different direction. This process produces a series of images of the same subject with different highlights and shadows. After the light has been projected from a representative sample of directions, all the lighting information from the images is mathematically synthesized using a method developed by Tom Malzbender and Dan Gelbat Hewlett Packard Labs."

The current presentation will provide a description of the state-of-the-art of this image capture process, as well the technology used to establish the "empirical provenance" of the final image. The presentation will feature PTMs of various types of forensic evidence from a variety of disciplines

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Synopsis Author: Linton A. Mohammed

Position/Profession: Senior Forensic Document Examiner /Forensic Document Examiner

Agency: San Diego Sheriff's Regional Crime Laboratory (CA)

Synopsis Technology: Polynomial Texture Mapping /Reflectance Transformation

How Technology Works: Polynomial Texture Maps (PTMs) are a simple representation for images of functions instead of just images of color values. In a conventional image, each pixel contains static red, green, and blue values. In a PTM, each pixel contains a simple function that specifies the red, green, and blue values of that pixel as a function of two independent parameters, lu and lv.

Typically, PTMs are used for displaying the appearance of an object under varying lighting direction, and lu, lv specify the direction of a point light source. However, other applications are possible, such as controlling the focus of a scene. PTMs can be used as light-dependent texture maps for 3-D rendering, but are typically just viewed as "adjustable images."

PTMs are typically produced with a digital camera by photographing an object multiple times with lighting direction varying between images. Even a low-end digital camera provides enough resolution to produce good PTMs, and almost any light source can be used, such as a light bulb, LED, or flash.

Given a stack of images of an object under varying lighting direction, one has collected samples of the object's reflectance function at each pixel. Independently for each pixel, the PTM fitter fits a low order polynomial to those samples to produce a PTM. The PTM viewer evaluates this polynomial in real time independently for each pixel to produce an image.

This process can be achieved at real-time rates even on low-end computers because of the simplicity of the polynomial, allowing interactive control of lighting direction. In addition, once the reflectance functions are represented in this manner, they can be transformed to make the surface detail existing on the object more apparent. We call this method reflectance transformation. (Ref: www.hpl.hp.com/research/ptm)

How Technology Used in Attendee's Profession: This technology would be useful for examinations of erased writing, line-sequencing, and indented impressions. It might also be applied for firearms examinations when looking at striations or toolmarks.

Technology Benefits: Low cost (software is free from Hewlett-Packard), fairly easy to use, great for demonstrating findings.

Technology Limitations: The software is available, but the hardware has to be designed, built, and standardized for forensic use. The hardware could be very elaborate.

Synopsis Author: Holly Plotnick

Position/Profession: Crime Scene Investigator – Evidence Supervisor

Agency: Layton City Police Department (UT)

Synopsis Technology: Poly Texture Mapping (PTM)

How Technology Works: A dome with lights is placed over the object and a series of pictures are taken (as with a stationary camera) as the lights are shined from different directions. The pictures are then loaded into a program created by Hewlett-Packard, and the object is mapped. The pictures can also be enhanced and adjustments can be made as well.

How Technology Used in Attendee's Profession: The technology could be used at crime scenes for capture of shoeprints, showing highlights and shadows. It can be also be used to locate indented writings, up to six layers down, on forged documents. "Diffuse Gain" during enhancement could be used with a flat image to locate watermarks.

Technology Benefits: It provides a 3-D image to work with, as in the case of shoeprints, and provides minute details not ordinarily acquired. It allows the perception of surface deformations and alterations.

Technology Limitations: The construction of the dome, according to the instructor, can be completed in-house with instructions or could be professionally outsourced. Unfortunately, to outsource this process

to a professional would be somewhat costly. That is the only limitation that I foresee from the presentation.

Toxicology

The Use of LC/MS in the Forensic Toxicology Laboratory

Type of Presentation: Workshop

Authors: Christopher Heartsill, BS, Dallas County Medical Examiner, 5230 Medical Center Drive, Dallas, TX 75235; Susan R. Howe, PhD, Tarrant County Medical Examiner, 200 Feliks Gwozdz Place, Fort Worth, TX 76104; Tania A. Sasaki, PhD*, Applied Biosystems, 850 Lincoln Center Drive, Foster City, CA 94404; H. Chip Walls, BS, University of Miami, Department of Pathology, Forensic Toxicology Laboratory,12500 SW 152nd Street, Building B, Miami, FL 33177; Robert D. Johnson, PhD, Federal Aviation Administration, Civil Aerospace Medical Institute, Oklahoma City, OK 73125; and Francois A. Espourteille, PhD, Thermo Fisher Scientific, 101 Constitution Boulevard, Franklin,MA02038

Abstract: Gas chromatography/mass spectrometry has long been recognized as the gold standard for drug identification in a forensic toxicology setting. Recent years, however, have seen the development of liquid chromatography/mass spectrometry (LC/MS) as a powerful new tool for both identification and quantitation of a variety of compounds. With the advent of this increasingly affordable technology, many laboratories have turned to LC/MS as an integral part of their operation.

This workshop will provide the participant with an overview of LC/MS operation, and discuss the advantages of moving from GC/MS to LC/MS/MS. It will include an overview of LC/QqQ (triple quad), LC/QTOF (time of flight), LC/TOF, LC/MS (single quad), LC/MS ion trap and DART-TOF (Direct Analysis in Real Time, Time of Flight MS) technologies. The different mass spectrometers will be discussed in light of each instrument's strengths and weaknesses for providing forensically acceptable, highly sensitive screening and identification results.

In addition, a strategy for LC/MS method development and validation will be presented. Several LC/MS applications will also be discussed, including screening biological samples for hundreds of drugs of forensic significance, as well as quantitation of several drug classes routinely encountered in the forensic toxicology laboratory. Further discussion will be provided on a software interface for LC/MS that enables users to quickly develop and implement testing methods and to train novice users in LC/MS operation.

Synopsis Author: Richard Maykoski

Position/Profession: Criminalist I / Forensic Science

Agency: Kern County Regional Crime Laboratory (CA)

Synopsis Technology: Liquid Chromatograph / Mass Spectrometer (LC/MS)

How Technology Works: In liquid chromatography, a solvent is pumped though a column packed with a stationary phase. A sample is injected into the start of a column. Compounds are separated on the column by solvent flow (instead of by heated gas as in gas chromatography) and solute/stationary phase interactions.

The solvent and sample are volatilized and compounds ionized. The ions produced are sorted and detected as in GC/MS.

How Technology Used in Attendee's Profession: Qualitative and quantitative analysis of liquid soluble compounds (typically drugs) in biological fluids (blood, urine, tissues).

Technology Benefits: Liquid chromatography is applicable to most liquid-soluble compounds. It can be used for semi-volatile and polar compounds. Compounds of interest for human toxicology are liquid (blood/urine) soluble and stable at body temperature. It can be used for semi-volatile and polar compounds which are difficult to analyze on GC/MS. There is no heat degradation of compounds as can occur in gas chromatography.

GC/MS ionization is at high vacuum and typically results in complete fragmentation of all compounds at once. Ionization can be achieved at atmospheric pressure (APCI) with LC/MS. This allows charge transfer with no or minimal fragmentation if desired. Unfragmented or parent ions can be separated and used to identify compound formula mass if used with an accurate mass detector such as a time of flight detector (TOF). Selected parent ions/masses can be subjected to secondary fragmentation (MS/MS). This reduces interferences and background resulting in lower detection limits. With this selectivity and lower detection limits compounds can be analyzed at therapeutic levels without sample concentration. For urine, it is possible to perform analysis on untreated samples for some analytes.

Technology Limitations: HPLC has lower resolution than gas chromatography. Peak width is typically 30 seconds compared to 1 second peak width possible with capillary gas chromatography. The wide varieties of stationary and mobile phases available are used instead for separation of most compounds.

Analysts unfamiliar with HPLC will require training to utilize this technology. More knowledge of liquid and stationary phases will be required to develop optimum separations. Solid phase extraction (SPE) is now a common laboratory extraction procedure. Skills learned in SPE extractions are directly applicable to HPLC.

The cost of HPLC/MS is typically higher than GC/MS. This difference has narrowed in the last few years, making the systems nearly comparable in price.