12th Annual

FORENSIC SCIENCE RESEARCH DAY

Thursday April 16th, 2020

- Virtual Event -

OntarioTech UNIVERSITY

Ontario Tech Forensic Science Research Day 2020

Program Schedule

8:45 a.m.	Registration	Zoom Waiting Room
9:00 a.m.	Opening Remarks	Dr. Cecilia Hageman, *Associate Teaching Professor*
9:10 a.m.	Session I	Chair: Dr. Theresa Stotesbury, *Assistant Professor*
10:30 a.m.	Session II	Chair: Dr. Hélène LeBlanc, *Associate Teaching Professor*
12:15 p.m.	Closing Remarks	Dr. Cecilia Hageman, *Associate Teaching Professor*
	Debrief Session	Dr. Nelson Lafrenière, *Associate Teaching Professor* Bring your own snack for a fun and informal debrief session

The research conducted by our fourth-year students would not have been possible without the support and mentorship of our supervisors and mentors!

Thank you

Mission Statement

The Forensic Science program at Ontario Tech University strives to create an interdisciplinary learning environment dedicated to education, research, and contribution to the forensic community.

The Forensic Science program endeavours to:

- Advance the highest quality of knowledge, skills and abilities through excellence in teaching and a technologically-enhanced learning environment;
- Foster inquiry, critical thinking and scholarship in innovative research by providing access to state-of-the-art facilities and supervision by internationally recognized faculty and professional experts;
- Actively collaborate with industry to produce outstanding graduates who are consistently sought and highly valued by professional partners and employers;
- Command next-generation leaders demonstrating integrity, ethical behaviour, and professional conduct in the field of forensic science;
- Contribute to society through community participation, leadership and outreach initiatives, with the goal of inspiring youth

Forensic Science Program Accreditation

We are pleased to announce that our program was successful in obtaining re-Accreditation in February 2019. It is the second such program in Canada granted this distinction by the American Academy of Forensic Sciences' Forensic Education Programs Accreditation Commission (FEPAC).

Follow us on Social media!

 @OT_ForensicSci  @ot_forensics  UOIT Forensic Science

Schedule

9:00 **Welcome and Opening Remarks: Dr. Cecilia Hageman**

Session I Mock Crime Scene Practicum Students
Directed Studies
Chair: Dr. Theresa Stotesbury

The focus of the Mock Crime Scene Practicum is to *apply practical skills* to process a complex crime scene. This is accomplished by simulating all the associated events a person may encounter from crime scene to court. This includes extensive documentation of the scene, collection and identification of evidence, creation of detailed logs and forensic reports, and finally testifying as an expert witness in a mock court setting. Students selecting this capstone experience are expected to individually prepare a written report and collaborate on an oral presentation.

The focus of a Directed Studies Project is to *identify* gaps in the research literature. This is achieved by conducting a thorough literature review on a particular subject. Ultimately, the goal is to review the current state of the chosen field, leaving no stone unturned and putting current research into the broader context of forensic science. Students selecting this capstone experience have the opportunity to investigate more diverse subject matter where conducting original research may be difficult. Students are expected to prepare a written document and a 3-minute oral presentation.

9:10 **Ryan Chan, Candace Dawkins, Cassandra Di Mascio, Julienne Enriquez, Karah Fountain, Jennifer Lawrie, Karen Leung, Gagandeep Mundi, Angel Wang**

Mock Crime Scene Practicum Course

9:45 **Kalan Burris**

The application of chemical and physical enhancers for improving fingerprint quality on several substrates

9:50 **Tomas De Melo**

Understanding and minimizing the likelihood of trace DNA contamination from personal protective equipment in a forensic laboratory

9:55 **Mike Fewkes**

Forensic Entomotoxicology: Current Methodologies and Future Goals

10:00 **Dalton Roberts**

A Review of Different Presumptive Saliva Tests and their Application in Bloodstain Pattern Analysis

10:05 **Jathushan Vimalathasan**

Factors to Consider when Creating a Fibre Database

Session II Thesis Research Students
Chair: Dr. Hélène LeBlanc

The focus of a thesis project is to *fill the gaps* in the research literature. This is achieved by reviewing previous studies, designing an experiment and conducting original examinations. Ultimately, the goal is to contribute novel research to a relevant field of forensic science or broader natural science. Students work closely with either internal or external supervisors who mentor them throughout the course of their work. Students selecting this capstone experience are expected to prepare a written thesis and oral presentation.

10:30 **Matthew Borsodi**

The Enhancement of Footwear Impressions Containing Salt Residues Using Silver Nitrate

10:45 **Priscilla Burns**

Using Momentum to Determine Serious Bodily Injury: An Experimental Study Using Pig Eyes

11:00 **Chloe Chan**

Assessing Activity Level Propositions of Secondary Transfer of Saliva Determined by Phadebas® Press Test

11:15 **Jerika Ho**

Investigating Linkages Between Volatile Organic Compounds (VOCs), Total Body Scoring (TBS), and the Stages of Decomposition in Adult Pigs

11:30 **Priya Kundan**

Passive Drip Stain Formation on Ice Cold Surfaces

11:45 **Tania Naseer**

Determining if Reasonable Inferences can be Established About the Initial Deposition of Saliva Through Phadebas ® Press Testing

12:00 **Kyle Penny**

Comparing the Effects of Different Writing Surfaces on Indentations Developed Using the Electrostatic Detection Apparatus (ESDA)

12:15 **Jayne White**

Assessing the use of Forensic Gunshot Residue Evidence in the Ontario Criminal Court System

12:30 **Closing Remarks: Dr. Cecilia Hageman**

The Mock Crime Scene Practicum Course

Ryan Chan[1], Candace Dawkins[1], Cassandra Di Mascio[1], Julienne Enriquez[1], Karah Fountain[1], Jennifer Lawrie[1], Karen Leung[1], Gagandeep Mundi[1], Angel Wang[1], Jenna Comstock PhD[1], Kimberly Nugent, MSc[1], David Robertson[1]

[1]Faculty of Science, Ontario Tech University
ryan.chan2@ontariotechu.net; candace.dawkins@ontariotechu.net; cassandra.dimascio@ontariotechu.net; julienne.gatus@ontariotechu.net; karah.fountain@ontariotechu.net; jennifer.lawrie@ontariotechu.net; karen.leung1@ontariotechu.net; gagandeep.mundi@ontariotechu.net; yu.wang5@ontariotechu.net

---

The Mock Crime Scene Practicum was a 12-week course that provided students the opportunity to apply their acquired crime scene and laboratory knowledge to a practical scenario. Students participated in all aspects of a simulated major crime scene, an alleged bank robbery, working independently and in small teams of three, reporting to a Case Officer throughout the entirety of the investigation.

The scene examination took place at the Ontario Tech University Crime Scene House, and further analysis was conducted at the undergraduate teaching laboratory. Students maintained a paperless documentation record using both CrimePad and OneNote software. These platforms allowed real-time data entry and collaboration among team members to record the scene, track evidence and maintain information logs. Identifiable evidence varied and included; fire debris, fingerprints, body fluid collection, and weapons. Laboratory analysis included recovery of writing indentations, fingerprint enhancement and examination, footwear and ink comparisons. The investigation was culminated with a police report summarizing the actions, findings, and conclusions, followed by a case review with the Case Manager, David Robertson.

Throughout the duration of the capstone project, students honed the necessary skills required to be effective at a crime scene. Development of an individual's judgment, critical thinking, deductive reasoning skills, and teamwork, transpired through engagement with their team to solve challenges presented to them.

The application of chemical and physical enhancers for improving fingerprint quality on several substrates

Kalan Burris [1]; Theresa Stotesbury, PhD[1]

[1]Faculty of Science, Ontario Tech University
kalan.burris@ontariotechu.net

Fingerprints are common pieces of evidence found on various types of surfaces at crime scenes. Fingerprints can be seen with an unaided eye (visible and plastic) or can be invisible (latent) and require enhancement to visualize minute details. Fingerprint identification is an important tool used in an investigation as fingerprints can contain information necessary for identifying the source. Fingerprint enhancement can be divided into two categories; chemical and physical. Chemical enhancement usually involves a chemical reaction with fingerprint constituents and physical enhancement involves the direct contact with the fingerprint. Selection of the enhancer depends on several substrate considerations including substrate porosity, enhancement contrast, background staining and substrate texture. Several enhancers outlined in the literature offer enhancement on non-porous substrates while providing good quality fingerprints for possible identification. However, there is a gap in the research with the enhancement of fingerprints on porous substrates; further research is required to find enhancers that are effective on porous substrates that provide good quality fingerprints for possible identification. Several chemical and physical enhancers require further research to understand their full potential for enhancing latent and bloodied fingerprints.

Understanding and minimizing the likelihood of trace DNA contamination from personal protective equipment in a forensic laboratory

Tomas De Melo [1]; Theresa Stotesbury, PhD[1]

[1]Faculty of Science, Ontario Tech University
tomas.demelo@ontariotechu.net

Contamination in forensic laboratories has been prevalent for many years, but with the increased sensitivity of instrumentation, the implications of contamination have amplified. This review looked at personal protective equipment (PPE). It assessed the level of risk associated with each piece of standard PPE by analyzing the ability of DNA to persist and transfer based on current research. Understanding the likelihood of PPE leading to contamination is only half of what needs to be done to minimize contamination. That is why this review looked at research on conventional and proprietary decontamination procedures such as Sodium Hypochlorite, DNA Zap™ and Virkon. Additionally, to further help minimize contamination research behind evaluative reporting (specifically source-level and activity-level propositions) was reviewed. However, more research is still required to be able to assess transfer mechanisms and provide accurate activity-level proposition.

Forensic Entomotoxicology: Current Methodologies and Future Goals

Mike Fewkes [1]; Theresa Stotesbury, PhD[1]

[1]Faculty of Science, Ontario Tech University
micheal.fewkes@ontariotechu.net

This review summarizes some of the methods used in both forensic entomology and entomotoxicology, the insects used for analysis, the weakness' and strengths of those analyses and what we should learn in order to improve forensic entomotoxicology.

A Review of Different Presumptive Saliva Tests and their Application in Bloodstain Pattern Analysis

Dalton Roberts [1]; Theresa Stotesbury, PhD[1]

[1]Faculty of Science, Ontario Tech University
dalton.roberts1@ontariotechu.net

Saliva is a bodily fluid found useful in many fields of forensic science, specifically concerning testing. The enzyme α – amylase which is present in saliva is used as a marker in presumptive saliva tests for identification purposes. In recent years presumptive saliva testing has expanded into the field of bloodstain pattern analysis (BPA) in order to assist identifying expirated bloodstain patterns. The objective of this paper is to critically review two presumptive saliva tests, the Phadebas® Press test and the SALIgAE® test, in order to determine their functionality in the field of BPA. This review will cover the mechanisms, validation, ability to identify expirated bloodstain patterns, and limitations of both tests. Finally, their applicability in the field of BPA and future developments in presumptive saliva testing for BPA will be discussed.

Factors to Consider when Creating a Fibre Database

Jathushan Vimalathasan [1]; Theresa Stotesbury, PhD[1]

[1]Faculty of Science, Ontario Tech University
jathushan.vimalathasan@ontariotechu.net

The identification of fibres is a time-consuming task, especially in cases involving a large volume of fibres. To alleviate this issue, fibre databases can be implemented to reduce the amount of comparisons needed to identify a fibre. In order to create a fibre database, the properties of various fibres need to be known so that the correct database management system can be used. Fibre analysis compares the morphological, spectral and spectroscopic characteristics to identify a fibre. These characteristics are best stored in relational or document store databases since these databases allow for fibres to be searched by their properties. These databases also have the added benefit of being easily updatable with advances in fibre technology and the development of new fibres. The analysis of dyes is a growing area of study in the field of fibre identifications, which can be used in conjunction with conventional fibre analysis to further associate fibres. Therefore, future research should explore the possibilities of incorporating dye analysis into fibre databases.

The Enhancement of Footwear Impressions Containing Salt Residues Using Silver Nitrate

Matthew Borsodi [1]; Kimberly Nugent, MSc[1], Det/Cst Desiree Hamid[2]

[1]Faculty of Science, Ontario Tech University; [2]Durham Regional Police Service, FIU
matthew.borsodi@ontariotechu.net

In the winter months, salt is commonly used by municipalities and homeowners to reduce ice and snow on roads and walkways. By extension, footwear and the impressions they create are covered in salt residues. Investigators would benefit from a technique that can take advantage of the salt residues in impressions to help enhance any details of the footwear. One such technique used to enhance latent fingerprints on porous surfaces, is a silver nitrate ($AgNO_3$) solution in which silver ions react with natural salt residue deposits to develop print details. This same reaction may be applied to footwear impressions containing salt residues. This study examined the efficacy of different silver nitrate concentrations in enhancing the details of footwear impressions containing salt residue. Three salt brands were used to create depletion impressions on nylon carpet, laminated hardwood, and concrete prior to enhancing with a solution of 5% $AgNO_3$ in 10% methanol. Different parameters were altered to examine their effect on enhancement, such as the salt concentration, drying time, and substrate. Impressions on hardwood flooring were successfully enhanced to a level of detail where tread pattern and shoe size were observed. Impressions on concrete and carpet were also enhanced although with less detail, however, the shoe size and a faint tread pattern were observed. Drying time and moisture were found to have the most significant effect on the impressions. This study demonstrates the versatile use of a silver nitrate technique on multiple surfaces when enhancing footwear impressions containing salt residue.

Using Momentum to Determine Serious Bodily Injury: An Experimental Study Using Pig Eyes

Priscilla Burns [1]; Liam Hendrikse, MSc.[2], Kimberly Nugent, MSc[1]; Franco Gaspari, PhD[1]

[1]Faculty of Science, Ontario Tech University; [2]Firearms Consultant
priscilla.burns@ontariotechu.net

According to section 2 of the *Criminal Code*, a firearm is a barreled weapon that can discharge a projectile capable of causing seriously bodily injury or death to a person. Although not defined in the *Criminal Code*, serious bodily injury has been accepted in Canadian courts as the "penetration or rupture of an eye". Classifying air guns may be difficult as they are usually not categorized as a firearm, but some are capable of meeting the criteria of a firearm. In previous studies, velocity and/or energy density were used as parameters and a V50, the velocity where 50% of shots would and 50% would not penetrate a pig's eye, and a minimum energy density range where penetration could occur, were determined. This research project sought to evaluate momentum as a new parameter to determine if an air gun is capable of causing serious bodily injury. Three air guns, with five projectile types, were fired 10 times each, first using gelatin blocks as a substrate, followed by pig eyes. Results indicated that an increase in momentum correlated to an increase in damage, while this was not always the case compared to velocity. Therefore, setting a minimum momentum required for the penetration of a pig's eye, as opposed to a V50 or energy density range, would be more accurate in determining if an air gun is capable of causing serious bodily injury. Further research would explore the use of instantaneous pressure as a reliable parameter for determining an air gun's serious bodily injury capabilities.

Assessing Activity Level Propositions of Secondary Transfer of Saliva Determined by Phadebas® Press Test

Chloe Chan[1]; Stacey Sainte-Marie, MSc[1]; Cecilia Hageman PhD, LL.M[1]

[1]Faculty of Science, Ontario Tech University
chloe.chan@ontariotechu.net

Saliva is a very useful tool in forensic analysis. Saliva contains an abundance of the chemical α-amylase which is what helps to distinguish saliva from other body fluids. Activity level propositions are used in forensic science as a way to assess competing hypotheses regarding specific activities that could have caused a saliva stain to be deposited on a specific item. In this experiment, we assessed activity level propositions from the secondary transfer of saliva from skin to fabric. Using the Phadebas® Press test, fabric type, amount of transferred and time between transfer and analysis were studied see if they affect the interpretation of the Phadebas® reaction stain. This study showed that these three factors only accounted for 5.76% of the variation in the Phadebas® stain reaction area. Based on these observations, activity level propositions would be difficult to accurately assess because of these factors in addition to other factors that contribute to the variation in reaction area size.

Investigating Linkages Between Volatile Organic Compounds (VOCs), Total Body Scoring (TBS), and the Stages of Decomposition in Adult Pigs

Jerika Ho [1]; Angela Skopyk, BSc[1], Hélène LeBlanc, PhD[1]

[1]Faculty of Science, Ontario Tech University
jerika.ho@ontariotechu.net

Decomposition can be used to help determine the post-mortem interval (PMI). The complete process of decomposition has traditionally been separated into five stages; fresh, bloat, active decay, advanced decay, and dry remains/skeletonization. Due to legal or personal reasons, most studies focusing on decomposition use domestic pig cadavers as proxies for human remains. As decomposition does not always occur linearly across a body, determining the stage of decomposition can be difficult, thus a new method called total body scoring (TBS) was proposed. Total body scoring is a method used to help assess the decomposition quantitatively in humans by assigning sections of a body a score based on the progression of decomposition. Since the use of pigs in decomposition research is more prominent than humans, an initial TBS method for pigs was developed by Keough (2017) to compare to human decomposition. Keough (2017) suggested to divide the remains into three sections; the head and neck, trunk, and limbs. However, as more significant changes can be seen between the torso and rear than between the trunk and limbs, an amended TBS method was developed for the purposes of this research. This project proposed comparing the amended method to the Keough (2017) method to determine if it, or the stages of decomposition, better describes the state of the remains. Volatile organic compounds (VOCs) associated with decomposition were also compared to the stages of decomposition and TBS to determine if there were any associations.

Three pigs (45 kg each) were placed in a field at an outdoor research facility in Southern Ontario and were allowed to decompose over three months. Decompositional changes and environmental conditions were recorded. The VOCs associated with the remains were collected and processed using GC-MS. The Keough (2017) method was used along with the amended method to calculate the TBS. Significant differences were observed between the Keough (2017) method and the amended scoring system, particularly between the torso and rear sections of the remains. The analysis of the VOC patterns showed that decomposition VOCs were produced during their characteristic stages of decomposition and occurred linearly with the TBS. The combination of the amended TBS method and stages of decomposition can be used together to describe the state of the remains better than each method individually. It takes into account the variance of the sections of the body while still describing the state of the remains as a whole.

Passive Drip Stain Formation on Ice Cold Surfaces

Priya Kundan[1]; Theresa Stotesbury, PhD[1]

[1]Faculty of Science, Ontario Tech University
priya.kundan@ontariotechu.net

Bloodstain pattern analysis (BPA) uses size, shape and distribution data on observed bloodstains in order to provide criminal investigations with information about a blood source. Current literature explores the effects of extreme heat on passive drip stains characteristics; however, there is little known about stain formation on cold sub-zero substrates. Our research characterizes passive drip stain formation on ice surfaces, and we propose a new addition to the traditionally characterized stages of passive drip stain formation, freezing. We compare the traditionally observed features of stain diameter, spines and scallops and satellite spatter found on stains formed on ice (average temperature -17°C) to those observed on cardstock and acetate sheets. Passive drip stains were released in replicates of ten from various heights (0.1, 0.25, 0.5, 0.75, 1, 1.25 and 1.75)m onto each substrate and photographed. The stains were photographed and digitally analyzed using Fiji. In our experimental conditions, we observed that stain formation on fresh ice occurs similarly to that on a dry solid surfaces, in our example cardstock. Droplet spread can be modelled using a modified Scheller and Bousfield correlation with an effective viscosity term. We also observed that on our icy surfaces, the blood freezes upon impact and the stain size does not change significantly over the course of 3 minutes. There is an observable change in stain colour from red to orange with differences in intensity between the perimeter and center of the parent stain. This fundamental (and befittingly Canadian) study offers insight to future BPA considerations in cold climate conditions.

Determining if Reasonable Inferences can be Established About the Initial Deposition of Saliva Through Phadebas ® Press Testing

Tania Naseer[1]; Stacey Sainte-Marie, MSc[1]; Cecilia Hageman PhD, LL.M[1]

[1]Faculty of Science, Ontario Tech University
tania.naseer@ontariotechu.net

Forensic scientists may be asked to make statements in the courts about the activities surrounding the deposition of saliva, based on the quality and quantity of results of the Phadebas ® press test. This has not been researched in an experimental way, so the inferences they are making may not be accurate. The purpose of this study was to determine if reliable inferences could be made about the initial deposition of saliva based on the Phadebas ® press testing. This study showed that the fabric type, saliva amount, and saliva drying time were factors that affected the observed Phadebas ® reaction. This study also showed that packaging and transportation have an effect on the transfer and persistence of saliva. In conclusion, it is difficult to make reliable inferences on the initial deposition of saliva from the observed Phadebas ® reactions. More research on the factors affecting the Phadebas ® reaction needs to be completed before scientists can make inferences reliably in the courts.

Comparing the Effects of Different Writing Surfaces on Indentations Developed Using the Electrostatic Detection Apparatus (ESDA)

Kyle Penny[1]; Retired Det/Cst David Robertson1; Kimberly Nugent, MSc[1]

[1]Faculty of Science, Ontario Tech University
kyle.penny@ontariotechu.net

Questioned document examination (QDE) is a forensic discipline in which examiners compare and analyze writing to determine authorship and identify alterations to a document. When writing, indentations of words will form on sheets of paper below the top writing sheet. The Electrostatic Detection Apparatus (ESDA) is an instrument that reveals indentations on paper, without damaging evidence. While the instrument has shown to be an effective method for the development of indentations, there are a number of factors that affect the quality of the developed indentions, such as the paper's moisture content and type of paper. The goal of this study is to determine how a writing surface affects the legibility of developed indentations and if the developed indentations contain distinguishable characteristics that may be used to identify the writing surface. Among the writing surfaces examined (wood, tile, metal, carpet), nylon carpet was found to affect the legibility of developed indentations more as they were typically faded and difficult to observe. Characteristics of developed indentations that are indicative of writing surface were visible and most evident of wood, metal and tile. However, as the depth of the paper was increased, these characteristics became less evident. This research into the effects of writing surface on developed indentations serves to improve QDE by introducing the possibility of associating characteristics of developed indentations to a writing surface.

Assessing the use of Forensic Gunshot Residue Evidence in the Ontario Criminal Court System

Jayne White[1]; Cecilia Hageman PhD, LL.M[1]

[1]Faculty of Science, Ontario Tech University
jayne.white@ontariotechu.net

Forensic science plays an important role in the investigation, prosecution and defence of criminal trials. It involves not only the direct testimony of scientists, but also its subsequent interpretation, communication and comprehension by lawyers, judges and juries. While the effectiveness of expert DNA testimony has been studied previously, the understanding of scientific GSR testimony within the courts has not. To address this and assess the use of forensic GSR evidence in the Canadian criminal courts, trial transcripts of expert testimony, closing arguments and instructions to the jury were evaluated for interpretations of accuracy, limitations and proposed hypotheses associated with GSR. The trial transcripts were located by keyword searching Ontario Court of Appeal decisions via the Lexus Advance Quicklaw legal database. They were analyzed for the presentation of expert opinions and the correctness of statements made by justice system participants by totaling the number of expert statements addressed by lawyers and judges and whether they were accurate reiterations. The manner in which scientists presented their opinions using evaluative reporting as either P(H|E) or P(E|H) was also quantified. Members of the court ignored approximately 60% of the limitations presented by scientists, and while scientists cannot control what happens to their testimony in their absence, they can take care to emphasize the most important points. In general, judges were the most accurate (98%) in reiterating expert evidence while crown lawyers were the least accurate (65%). This disconnect between the expert's intentions and the lawyer's interpretation is in part attributed to the presentation of the evidence using evaluative reporting. Approximately 80% of scientific opinions were presented as P(H|E) without explicitly stated competing hypotheses. It is both the responsibility of lawyers and scientists to provide propositions when inquiring about opinions and presenting them. For forensic science to be its most effective, collaboration and standardization are necessary.

Congratulations Class of 2020!

Matthew Borsodi
Priscilla Burns
Kalan Burris
Chloe Chan
Ryan Chan
Candace Dawkins
Tomas De Melo
Cassandra Di Mascio
Julienne Enriquez
Mike Fewkes
Karah Fountain
Jerika Ho
Priya Kundan
Jennifer Lawrie
Karen Leung
Gagandeep Mundi
Tania Naseer
Kyle Penny
Dalton Roberts
Jathushan Vimalathasan
Angel Wang
Jayne White