



2022 SPRING SYMPOSIUM

**This certifies that**

# **Searchin Girl**

**has completed a 5-hour webinar entitled:**

*"Can New Forensic Technology  
Solve the JonBenet Ramsey Case?"*

**April 26, 2022**



*Henry Lee*

**Dr. Henry C. Lee**

**Founder and Distinguished Professor**

# Outline

- ▶ Locard's Exchange Principle
- ▶ Traces
- ▶ Transfer of Traces
- ▶ The Physical Evidence Continuum & Record
- ▶ JonBenet Ramsey Case: Thousands of Traces
- ▶ The Potential Value of "New" Forensic Analyses of Traces
- ▶ Conclusion



# Locard's Exchange Principle

**'Every contact leaves a trace'**



Wherever he steps, whatever he touches, whatever he leaves unconsciously, will serve as a silent witness against him. Not only his fingerprints or his footprints, but his hair, the fibers from his clothes, the glass he breaks, the tool mark he leaves, the paint he scratches, the blood or semen he deposits or collects. All of these and more, bear mute witness against him. This is evidence that *does not forget*. It is *not confused* by the excitement of the moment. It is not absent because human witnesses are. It is factual evidence. *Physical evidence cannot be wrong, it cannot perjure itself, it cannot be wholly absent.*

Only human failure to find it, study and understand it, can diminish its value.

– Professor Edmond Locard

## CHAPITRE IV

### TRACES ET TACHES

J'ai longuement insisté sur les empreintes digitales parce qu'elles représentent le cas type de la preuve judiciaire susceptible de mener, à elle seule, l'enquête judiciaire à sa fin. Mais il ne faut pas croire que par l'absence de cette trace, l'expert reste désarmé. La vérité est que nul ne peut agir avec l'intensité que suppose l'action criminelle sans laisser des marques multiples de son passage. Je voudrais faire toucher du doigt l'extrême variété de ces traces, non qu'il puisse s'agir d'écrire ici un traité de l'expertise criminelle, mais dans le but de montrer la souplesse et le polymorphisme de la méthode. Les indices dont je veux montrer ici l'emploi sont de deux ordres : tantôt le malfaiteur a laissé sur les lieux les marques de son passage, tantôt, par une action inverse, il a emporté sur son corps ou sur ses vêtements les indices de son séjour ou de son geste. Laisées ou reçues, ces traces sont de sortes extrêmement diverses. Je ferai voir, à titre d'exemples le parti que l'on peut tirer des suivantes : 1° empreintes de pas ; 2° empreintes de dents ; 3° débris sous-unguéaux ; 4° poussières ; 5° objets laissés par le criminel ; 6° traces d'effraction ; 7° taches. Dans la réalité, il faudrait étudier encore tous les résultats donnés par l'examen médico-légal, comme la date de la mort, la composition du dernier repas,

*I have strongly emphasized fingerprints since they represent the typical case of evidence, which are susceptible, alone, to lead the criminal investigation to its end. But one does not have to believe that in absence of this type of evidence that the expert is disarmed.*

*The truth is that no one can act with the intensity required for criminal action without leaving multiple signs of his passage.*

*I would like to emphasize the extreme variety of these traces, not with the aim to write here a treatise on criminal expertise, but to show the flexibility and polymorphism of the method.*

*The types of clues that I want to show here are of two different kinds: sometimes the criminal has left signs of his presence at the scene, sometimes through an inverse action he has taken with him on his body or his clothes the clues of his presence or of his actions.*

*Left or taken, these traces are of extremely different sorts.*

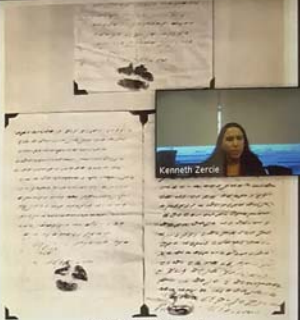
Slide prepared from materials  
from Prof. Patrick Buzzini

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# Variety of Traces



Empreinte digitale



Kenneth Zerk

Lettres de promesses criminelles signées avec les empreintes des lèvres



1. Empreinte digitale latente



2. Microphotographie d'un faux latet



3. Microphotographie de ridges de sang



4. Analyse microscopique



5. Empreinte de dents



Empreinte digitale avec ses particularités de ridges



6. Empreinte digitale de même individu prise avec un autre matériel



8. et 9. Analyse de granulation



7. Moulage à la cire de l'empreinte



1. Faux par surcharge



HENRY C. LEE  
FORENSIC SCIENCE  
UNIVERSITY OF MARYLAND

# The Exchange Principle

However, one has to acknowledge that if we have lost this acuteness of judgment deriving from intuition and more from experience, we have acquired over less than a half-century some quite new notions of fact that the human body can leave different traces.



Il faut cependant reconnaître que si nous avons perdu cette acuité du jugement, fils de l'instinct et, bien plus encore, de l'expérience, nous avons acquis depuis moins d'un demi-siècle quelques notions assez neuves sur ce que le corps humain peut laisser de traces diverses. Le principe est celui-ci. Toute action de l'homme, et *a fortiori*, l'action violente qu'est un crime, ne peut pas se dérouler sans laisser quelque marque. L'admirable est la variété de ces marques. Tantôt ce seront des empreintes, tantôt de simples traces, tantôt des taches. Distinguons.

Slide prepared by  
Prof. Patrick Buzzini

*The principle is the following one. Every human action, and a fortiori, the violent action characterizing a crime, cannot occur without leaving some signs. The admirable thing is the variety of these signs.*

THE HENRY C. LEE  
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FORENSIC SCIENCE

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# Traces

## ▶ Trace (adjective)

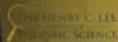
- Describes the small size of materials (often microscopic) that can be used to aid in an investigation by providing linkages, or associations, between potential suspects, victims, and scenes
- Commonly used, but too restrictive

## ▶ Trace (noun)

- remnants or signs of past activities or vestiges of the event
- "vanished without a trace" or "no trace of it could be found"

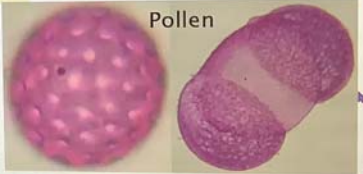
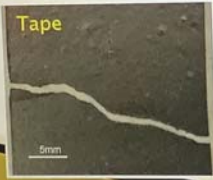
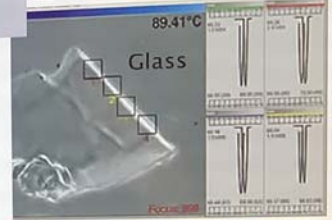
**Traces at a crime scene are not restricted to a small size.**

Buzzini, P., Kammrath, B.W., De Forest, P. (2019). Trace evidence? The term trace from adjective to noun. *WIREs Forensic Science*. DOI: 10.1002/wfs2.1342.



# Common Types of Traces

1. Fibers
2. Biological Materials
3. Wood & Paper
4. Building Materials
5. Metallic Residues
6. Paint & Other Coatings
7. Cosmetic & Beauty Products
8. Soil & Dust
9. Tape



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# Transfer of Traces: Material & Patterns

## Material Traces

- ▶ Contact Transfer of Material



- ▶ Contactless Transfer of Material



## Pattern Traces

- ▶ Contact Transfer of Pattern



- ▶ Contactless Transfer of Pattern

Distance Determination Analysis



Gasket Pattern Before and After Chemical Processing



- ▶ Independent of Transfer of Pattern



Contactless Transfer

Fibers

Dirt/  
Soil

Saliva/Sweat



Hairs

Cosmetics

Skin Cells



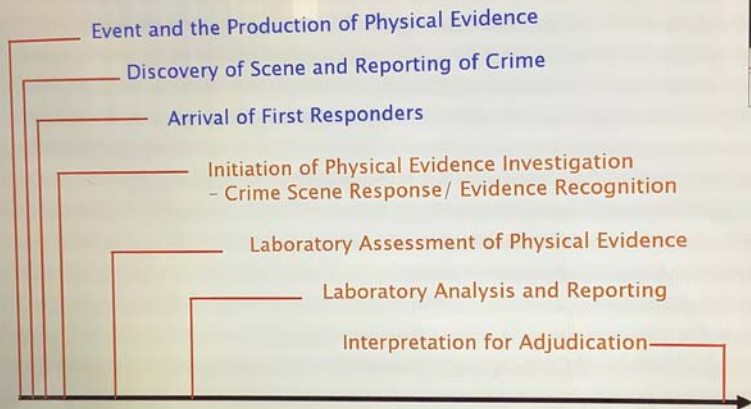
# Traces are remnants of physical activities



- ▶ With time passing and the occurrence of further activities in this environment, the physical clues of interest, meaning the footwear track, are obscured by traces resulting from subsequent activities not related to the event of interest.
  - Note that the figure does not include pre-existing background traces (i.e., noise).
- ▶ Traces of interest have to be recognized separately from preexisting ones and from those produced during post event activities.

Buzzini, P., Kammrath, B.W., De Forest, P. (2019). Trace evidence? The term trace from adjective to noun. *WIREs Forensic Science*. DOI: 10.1002/wfs2.1342.

# Physical Evidence Continuum



# The Physical Evidence Record

- ▶ The Crime Scene as a Recording Medium
- ▶ Physical Evidence: Elements of the Record
- ▶ Record of Interactions with Environment
  - Interactions Result of Human Initiated Events
  - Some Events are Defined as Crimes
  - Record is Formed According to Natural Laws
  - Most of Record is in Form of Trace Evidence
- ▶ Skilled Interpretation of Record Required
  - Currently: Detection > Understanding of Transfer & Persistence



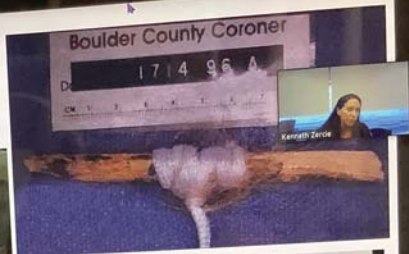
# JonBenet Ramsey Case

## Thousands of Items of Physical Evidence Collected and Analyzed

Mr. Ramsey,

Listen carefully! We are a group of individuals that represent a small African nation. We do respect your business but not the country that it serves. At this time we have your daughter in our possession. She is safe and unharmed and if you want her to see 1997, you must follow our instructions to this letter.

You will withdraw \$118,000.00 from your account. \$70,000 will be in \$100 bills and the remaining \$48,000 in \$20 bills. Make sure that you bring an adequate size suitcase to the bank. When you get home you will put the money in a brown paper bag. I will call you between 8 and 10 on tomorrow to instruct you on delivery. The delivery will be exhausting so I advise you to be rested. If we mention you getting the money early, we might call you early to arrange an earlier delivery at the



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# Physical Evidence



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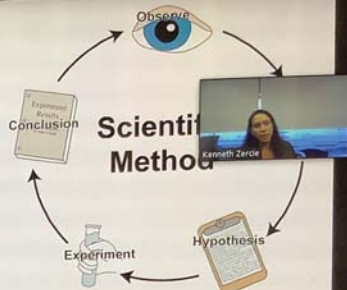
Given the major mistakes made at the initial scene, can the scientific interrogation of traces provide answers?

▶ Intruder Theory:

- Has the failure to secure the scene & other crime scene investigation issues prevented valuable traces of the perpetrator from being recognized and identified?

▶ Family Theory:

- Since traces from each family member are expected to be in the home, can they be useful in this investigation?





# Traces: Investigative Options

1. "New" Traces
  - Re-examine items of evidence for unrecognized traces
2. "New" Analysis of Traces
  - Instrumentation & Applications



Crime Scene Photo - Not For Publication



Crime Scene Photo - Not For Publication

# Fingerprint Traces

- ▶ Ransom Note
- ▶ Duct Tape
- ▶ Pineapple Bowl
- ▶ Glass found in Breakfast Room
- ▶ Wooden Handle of Garret
- ▶ Other 1/2 of Paint Brush
- ▶ Paint Tray
- ▶ Rope



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You will withdraw \$118,000.00 from your account. \$100,000 will be in \$100 bills and the remaining \$18,000 in \$20 bills. Make sure that you bring an address where you get home you will get in a brown paper call us between 8 tomorrow to instruct. The delivery will be I advise you to be early, we might call arrange an earlier de



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Lenovo

# Fingermark Traces – New Analyses

## INSTRUMENTATION

- ▶ Microscopy
  - 2D & 3D
- ▶ Gas Chromatography–Mass Spectrometry
- ▶ Infrared Spectroscopy
- ▶ Raman Spectroscopy



Souza, M. A., Santos, A. S., da Silva, S. W., Braga, J. W. B., & Sousa, M. H. (2022). Raman spectroscopy of fingerprints and chemometric analysis for forensic sex determination in humans. *Forensic Chemistry*, 27, 100395.

## NEW INFORMATION

- ▶ Time Since Deposition
- ▶ Donor Profile
  - Biological Gender
  - Age of the Donor
  - Diet (i.e. vegetarian)
  - Personal Habits (i.e., smoker)
  - Lipid Profile (classification – 86%)
- ▶ Traces in fingerprints
  - Drugs
  - Explosives or GSR
  - Cosmetics & Beauty Products



De Alcaraz-Fossoul  
(2021)

# Blood Traces - New Analyses

## INSTRUMENTATION

- ▶ Gas Chromatography–Mass Spectrometry
- ▶ Liquid Chromatography–Mass Spectrometry
- ▶ Infrared Spectroscopy
- ▶ Raman Spectroscopy

Caucasian African American



1600 1400 1200 1000 800 600 400  
Raman Shift (cm<sup>-1</sup>)

## NEW INFORMATION

- ▶ Time Since Deposition
- ▶ Donor Profile
  - Biological Gender
  - Age of the Donor
  - Race of Donor
  - Diet (i.e. vegetarian)
  - Personal Habits (i.e., medications/drug use)
  - Health Status

Mistek, E., Halámková, L., Doty, K. C., Muro, C. K., & Lednev, I. K. (2016). Race differentiation by Raman spectroscopy of a bloodstain for forensic purposes. *Analytical chemistry*, 88(15), 7453-7456.

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# Hair Traces

“Caucasian head hairs that are microscopically dissimilar to all submitted known hairs were found on the following specimen”:

- Debris from
  - blanket
  - suitcase
  - living room floor
  - black comforter
  - black velvet sheet
- Slides from
  - Blanket
  - Sheet
  - Cellar
  - Sweater



– FBI Report of Examination, October 4<sup>th</sup>, 1999 , D. Deedrick

# Hair Traces – New Analyses

## INSTRUMENTATION

- › Gas Chromatography–Mass Spectrometry
- › Liquid Chromatography–Mass Spectrometry
- › Infrared Spectroscopy
- › Raman Spectroscopy
- › Isotope Ratio Mass Spectrometry
- › Inductively Coupled Plasma Optical Emission Spectrometry
- › Laser Induced Breakdown Spectroscopy

## NEW INFORMATION

- › Biological Gender
- › Medication/Drug Use
- › Diet (i.e. vegetarian)
- › Health Status
- › Species (human vs. animal)
- › Classification
- › Source ID?
- › Provenance



Brodie, C., & Ehleringer, J. EA-IRMS: Tracing human provenance using hydrogen and oxygen isotope fingerprints.

Predicted average H isotope ratios ( $\delta^2\text{H}$ ) (A) and average O isotope ratios ( $\delta^{18}\text{O}$ ) (B) of human scalp hair across the USA based on a correlation of local tap drinking water and hair.



# Conclusion

1. There are a variety of different types of traces that can inform a homicide investigation
  - Every scene is unique, so don't expect the same traces to have value when investigating different events.
2. Recognition & preservation of valuable traces at the crime scene are critical activities
  - Otherwise lost and gone forever.
3. The forensic analysis of traces continues to evolve, with new technologies & applications being developed to provide valuable information (i.e., time since deposition & donor profile)

From Rob Fied to All panellists and moderators  
Many thanks Dr. Lee for your outstanding lecture and insightful questions!

From Whitl Brantley to All panellists and moderators  
We all want to see this case solved. Thank you, Dr. Lee.

From Melissa Egan to All panellists and moderators  
Thank you, Dr. Lee!

From Marlene S. Br., to All panellists and moderators  
Thank you Dr. Lee, I hope to talk to you in Vegas.

From Morgan Brown to All panellists and moderators  
Thank you Dr. Lee!! I graduate next week with my Master's in Forensic Science and I start my new job as a Crime Analyst at the St. Louis Crime Lab. I have enjoyed watching your symposium over the past few years; they have added so much to my education!!

From Stephen Thorpe to All panellists and moderators  
Are we on break?

From M'Linda Kula to All panellists and moderators  
Thank you, to all of the experts for your time and shared knowledge.

From Rox to All panellists and moderators  
What time does it resume?

From Kristina to All panellists and moderators  
no sound

From Haley Friesch to All panellists and moderators  
Would CSR fall under metallic residues?

From Stephen Thorpe to All panellists and moderators  
It was collected. It had been wiped up.

From Dr Robert C. E., to All panellists and moderators  
Is there tooth mark traces?

To All panellists and moderators  
Your text can only be seen by panellists



# Victim's Guide to Assist Criminalists

Prof. John A. Reffner

1. Wear clothing with unusual fibers and colors
2. Use glitter
3. Break glass
4. Bleed on perpetrator and make them bleed
5. Spitting, licking and hair pulling are good ways to transfer DNA
6. Scratch every thing
7. In the event of a hit-run, position your backside to contact the license plate

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FACULTY OF SCIENCE

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Raise Hand  
QA

Leave

Chat

Thank you Dr. Lee!

From April M to All panelists and attendees  
Thank you Dr. Lee!

From Rob Ford to All panelists and attendees  
Many thanks Dr. Lee for your  
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From What Bunley to All panelists and attendees  
We all want to see this case solved.  
Thank you, Dr. Lee!

From Malina Egan to All panelists and attendees:  
Thank you, Dr. Lee!!

From Marlene S. Be... to All panelists and attendees:  
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From Kit to All panelists and attendees:  
What time does it resume?

From Kristine to All panelists and attendees:  
no sound

From Haley Friedrich to All panelists and attendees:  
Would GSR fall under metallic residue?

From Stephen Ther... to All panelists and attendees:  
It was collected. It had been wiped clean.

From Dr Robert C. B... to All panelists and attendees:  
Is there tooth mark traces?

To: All panelists

Your text can only be seen by panelists

DELL

BEY Sunny 1:02 PM



## Finger Marks w/Scale



- ? Level 1, 2, 3 ?
- Friction Ridge Detail Present
- Glove or Material Pattern
- Physical "Finger" Characteristics
- How Much Pressure
- Location
- How does it relate to activity
- Movement
- Identity



Thank you Dr. Cullif's presentation went with my Master's in Forensic I start my new job at the St. Louis City Crime Lab. I enjoyed watching your session the past few years they level my education!

From Stephen... to All presenters Are we on break?

From SP Linda Eule to All presenters Thank you to all of the organizers and shared knowledge.

From Rex to All presenters and attendees What time does it resume?

From Kishore to All presenters and attendees no stand

From Hoby Freshick to All presenters Would GSR fall under materials?

From Stephen... to All presenters It was collected. It had been used.

From Dr Robert C.E. to All presenters Is there tooth mark transfer?

From Elaine Pagnani to All presenters Please type your questions in to chat rather than the chat room, make it easier to identify questions, comments. Thank you.

From Kishore to All presenters and attendees thank you sound is gone

From Jennifer Cong. to All presenters Sound is muted!

From Kishore to All presenters and attendees we can't hear

From Melissa Egan to All presenters and attendees the audio cut out

To: All presenters - Your host can only be seen by you

DELL

Traditional Latent Print evidence can include patterns from the palms, feet, and hand coverings (gloves).

PATENT PALM PRINT



INKED PALM PRINT



Chat

From Megan Brown to All panelsits and attendees  
Thank you Dr. Leifill I graduate next week with my Master's in Forensics and soon I start my new job as a Criminalist at the St. Louis City Crime Lab. I have enjoyed watching your symposiums in the past few years they have added to my education!!

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From Elaine Pagliaro to All panelsits and attendees  
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From Kristine to All panelsits and attendees  
thank you  
sound is gone

From Jennifer Cing... to All panelsits and attendees  
Sound is muted?

From Kristine to All panelsits and attendees  
we cant hear

From Melissa Egan to All panelsits and attendees  
the audio cut out

to All panelsits v.  
your text can only be seen by panelsits

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Chat Rate Hand Q&A



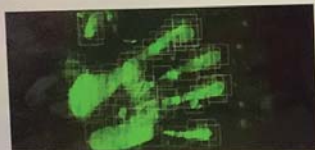
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66°C Sunny 10:41

# New Technology to Make Evidence Visible



Digital Imaging into IR and UV Ranges with Capture



High Powered ALS and Lasers for Scenes



Kenneth Zeric

From Morgan Bissell to All p...  
Thank you Dr. Law!! I gra...  
week with my Master's in...  
soon I start my new job a...  
at the St. Louis City Crim...  
enjoyed watching your sy...  
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From Roy to All paneltists and...  
What time does it resum...

From Kristine to All paneltists...  
no sound

From Haley Friedrich to All p...  
Would GSR fall under me...

From Stephen Thor... to All p...  
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From Dr Robert C. B... to All p...  
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From Elaine Pagliaro to All p...  
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tab rather than the chat...  
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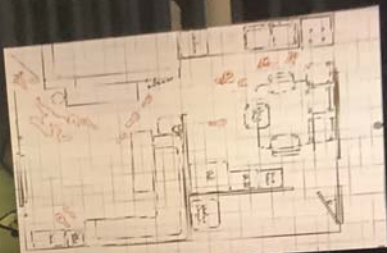
From Melissa Egan to All pan...  
the audio cut out

To: All paneltists -  
Your text can only be seen...

Leave

DELL

# Documentation - Everything needs to Match. Blood Print Chemical Enhancement



- From Stephen... Thank you Dr. Leath! I graduate next week with my Master's in Forensics and soon I start my new job as a Criminalist at the St. Louis City Crime Lab. I have enjoyed watching your symposiums over the past few years they have added to my education!
- From Stephen... to All panelists and attendees See we on break!
- From M'Linda Kula to All panelists and attendees Thank you to all of the experts for your time and shared knowledge.
- From Rae to All panelists and attendees What time does it resume?
- From Kristine to All panelists and attendees No sound
- From Haley Freshitt to All panelists and attendees Would QSR fall under metallic residues?
- From Stephen... to All panelists and attendees It was collected. It had been wiped clean.
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- To All panelists - Your text can only be seen by panelists

Leave

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