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This magazine is best viewed with the pages in pairs, side by side (View menu, page display, two-up), zooming in to see details. Odd numbered pages should be on the right.
Was Lizzie Borden Guilty?
You decide!

Lizzie

Winter 2017
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By Mark Feil, Ed.D.
Skip Palenik is a trace evidence and microscopy expert who hasn’t met a speck he didn’t like. His reference collections are bigger than those of most federal agencies, and sometimes the feds turn to him for help. We talked to him to find out what makes him tick, how he got started, and what he thinks about the CSI effect.

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Getting it Yourself

This issue finds many of our readers experiencing the coldest temperatures of the year. We have two activities you can take your students outside for, despite the white stuff on the ground. If you’re reading this and you only wore a light coat or no coat outside today we still have a lot in store for you between our covers.

When we started this magazine it was with the mission of helping forensic educators share ideas and lessons. As an educator you are allowed to make copies of images and text for your students within the Fair Use provision of US Copyright Law. The idea of including lessons and labs on our pages was one with that principle in mind. We hope you make copies of what you find in each issue for your students. The only thing you can’t do as an educator is sell someone else’s materials as your own. Or publish a magazine, even a free one, even one crafted by volunteers, without obtaining permission to reproduce images or text that belongs to someone else. And that’s what makes this issue a little different.

In at least one article in this issue we ran up against a brick wall when it came to obtaining permission to reproduce someone else’s material. Many people and organizations are happy to help when we explain who we are and the purpose of The Forensic Teacher Magazine, and we’re indebted to them. Others were happy to give permission, but only if we pay licensing fees. Take, for example, the piece on Henssge’s Nomogram. The author said we could use his diagram, but the journal where it appeared wanted a tripled digit fee. Since that was beyond our means we offer a hyperlink where you can obtain a pdf of the thing. Once you have it you can photocopy it for your students to your heart’s content.

The nice thing about publishing a magazine in digital format is that links can be live. As long as you don’t mind retrieving what we can’t always include in our pages, we’re good.

My wife and I saw the musical Lizzie about the same time I stumbled across Stacy Schurtz’s excellent forensic activity on the same subject. We think your students are going to love it.

Keep sending articles and ideas. You, our readers, are wonderfully creative and it’s you who keeps us going.

Dr. Mark Feil

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What teachers are saying

• “I am delighted to have found your website. It brings all the content we teach together in such a real-life way. It’s fantastic! Thank you for an amazing resource!”

• “I found this a fascinating site. I went through the first case because I am assigning it to my students as part of a CSI unit. I can’t wait to do the other two cases. Thank you for making science fun.”

This work was supported in part by a grant from the National Science Foundation to the Fort Worth Museum of Science and History.
Mini-Mystery

The Week of the Queen Anne Festival

AH, TO BE IN ENGLAND, now that summer’s here, thought Thomas P. Stanwick as he descended to the pub for breakfast. He was beginning a two-month vacation in England with a week’s stay at the Grey Boar Inn, a few miles outside Knordwyn.

The amateur logician had first visited Knordwyn, a tiny village in Northumbria, a year earlier, and had become very fond of it and greatly intrigued by its peculiarities. Chief among these was that about half the villagers always told the truth, and the rest always lied. Stanwick thus found his conversations there wonderful challenges for his powers of deduction.

It was a beautiful Monday morning, and Stanwick gathered his thoughts over a hearty breakfast of eggs, bacon, toast, and tea. He knew that this was the week of the Queen Anne Festival, held annually in Knordwyn since Queen Anne stopped overnight in the village on her way to visit Scotland in 1702. People gathered on festival days from many surrounding towns to enjoy dancing, balladeering, cooking, racing, and other activities.

The trouble was that the festival date and the number of festival days varied from year to year, and Stanwick wasn’t sure which days this year were the festival days. He knew that today was not a festival day, and that the festival would be over before Saturday. At least one, and possibly more, of the intervening days would be festival days, and he wanted to know precisely which.

Finishing his breakfast, Stanwick lit his pipe, leaned back in his chair, and idly fingered a tip of his brown mustache as he looked slowly around the room. The other tables were empty except for one by a large window. Around that table were gathered three grizzled villagers, all cronies of the innkeeper, nursing early mugs of ale. Stanwick had seen them before and knew that their names were Chiswick, Green, and Hunter, but he didn’t know which were liars and which were truth-tellers. Well, he thought, perhaps today he would find out.

Stanwick arose and strolled over to their table.
“Good morning, gentlemen,” he said cheerfully. “I beg your pardon, but could you please tell me which days this week are festival days? Also, if you’ll excuse my asking, which of you are liars?”

The three villagers glanced at each other silently for a moment. Chiswick was the first to speak.
“We are all liars,” said he, “and Friday is a festival day.”
“He speaks the truth,” Green said. “Also, Tuesday is a festival day.”
Hunter took a gulp from his mug. “If Chiswick is lying,” he said as he set it down, “then Green is telling the truth. Also, Wednesday is a festival day.”
“Thank you, gentlemen,” said Stanwick, who turned and walked off with a delighted smile. He now knew which of the three were liars and which days that week were festival days.

Who is lying? Which days are festival days?
Solution on page 23.
Do you have a topic you’d like us to cover?
Do you have a lab you’d like to feature?
Email us, tell us about it!

admin@theforensicteacher.com

Hot Sites

http://www.forensicpage.com/new09.html
Reddy’s Forensic Page. The link above will take you to an amazing collection of links for high school forensics. Clip off the “/new09.htm” for more. Wow.

This is the first chapter of Essential Forensic Biology, 2nd Ed. by Alan Gun, The Decay, Discovery And Recovery Of Human Bodies. A succinct, but thorough treatment of the subject.

https://www.criminaljusticeprograms.com/online-criminal-justice-degrees/
If you or your students are interested in a career in criminal justice this is a good place to scope out online and traditional programs.

https://anthropology.si.edu/writteninbone/tools.html
A very nice introduction to forensic anthropology from the folks at the Smithsonian. Be sure to check out the Additional Resources tab on the left for a collection of videos.

https://www.youtube.com/watch?v=ScmJvmzDcG0
John Oliver’s take on forensics, its uses, and its abuses. He delves into how and why DNA, fingerprints, and other kinds of evidence might no longer be airtight. Warning: contains F-bombs. Very well done.

http://www.crime-scene-investigator.net/employment.html
This site is a great way to demonstrate to interested students the demand for qualified forensic investigators. Tons of resources.

www.CountyOffice.org
If you’ve ever wanted contact information for anything or anyone official near you, like the medical examiner’s office or a non-emergency number for your local police, this site appears to have it all after you enter your zip code.
Without A Trace
Skip Palenik isn’t someone you’d want to meet in a dark alley.

No, he isn’t a ninja, he doesn’t have mutant claws, and he has absolutely no skill in committing murder. However, he’s able to tell you exactly what you’re stepping in, what that crud on the garbage can lid you just touched is, and what’s left on your hands after you use that precious hand sanitizer you carry around. Lochard came up with the whole trace evidence concept, but Skip lives it. Shakespeare said, “There are more things in heaven and earth, Horatio, than are dreamt of in your philosophy.” Well, sorry, Horatio, but Skip’s identified about 99.9% of them. This is the guy the experts turn to for help when they can’t figure something out.

The Forensic Teacher Magazine: I’ve never talked to a trace evidence expert before and you came highly recommended. As part of my research; I looked at your website and, wow, you guys do everything!

Skip Palenik: Well, not exactly. If you look closely it’s all related by a common thread, which is microscopy and microchemistry. We are not serologists or firearm examiners, but we work for serologists and we work for firearms examiners and document examiners and antiquities dealers, as well as doing the usual trace analysis stuff. What we do has applications in a wide variety of fields.

FT: But when it comes to microscopy services and trace analysis, your list of services and the things you work on just blew me away.

SP: That’s because we are not a routine laboratory. We don’t do carbon hydrogen analysis–there are people who do that better than we do. We solve problems.

FT: Very well put. Once upon a time I heard about a guy who was a trace evidence and microscopy expert, and every day when he came in his mentor or his boss would leave a slide of something on his desk for him to identify.

SP: That was McCrone. Those were UFOs. When I went to work for Walter McCrone, there were three microscopists who worked for him; there would be a microscope slide on the stage when we came in every morning, and it was labeled UFO. And the only question you could ask was, “What was it mounted in?” And you had to figure out what it was, and the only obligation for the person who gave it to you was that they had to know what it was.

FT: When I read about this, I remember thinking what a great way it was to keep your skills sharp. I understood it could be as remote as a piece of pollen found only in Madagascar, or a hair from the leg of an insect found only in Peru.

SP: Yup. One time it was spider feces from a tarantula. Sometimes we do that here now that I have my own place, but we don’t do it as much as we used to under McCrone.

FT: But every day you knew there’d be a challenge for you.

SP: Well, not every single day, but sometimes you’d be the one making up the challenge. One time it was the 4th of July on the southwest side of Chicago and railroad flares were what you would use to light your fireworks with, and there would be all this slag left afterwards. So, one of my first challenges that I did was ground-up flare slag. If you’re a microscopist there is beauty in an ashtray.

FT: Was there a time limit on these challenges?

SP: No, you had your regular work to do too. If you had a few hours you would certainly take a look at it. Sometimes you’d know right away what it was. I actually de-mounted a sample one day to prove that a red smear was blood. You might get back to someone the next day or a couple days later. It wasn’t timed. It’s a fallacy that how fast you do something is a measure of how well you do something. It’s like taking tests in school. The people who finish the test first don’t always know the material the best. They haven’t thought out all the angles on things, at least that’s been my take on it throughout my life. I don’t want the fastest person—I want the person who considers their answers. There are always alternative explanations for things and you need to see what’s most likely based on the evidence. So, in our line of work it all depends on what kind of investigation we are working on,
on what is our true role in the case. Sometimes we are just
determining facts; we always look to determine facts because
we don’t feel we can say anything unless we can prove what
we say, which is in the world that we work in. And in forensic
science in criminal and civil cases a lot of people are all too
willing to say something but not to prove it. They’ll say it’s
within a certain degree of scientific certainty without proving
something. But if you look at our reports there’s always the
proof there, there’s the data there that shows it. There might
be room for interpretation in there, and we don’t look for the
one that suits our client, but the one that seems most likely
given all the facts. Interpretations are subject to human error
whereas a fact can never be in dispute.

FT: What exactly is microchemistry?

SP: It’s the application of chemical methods of investigation
on a very small scale. Today microchemistry is principally
done using instruments like infrared microspectroscopy,
mass spectroscopy, and so on. In the past it was all done by
classical chemical methods and, in fact, we still use those
in combination with everything else. We still do reactions
on microscope slides and look at the crystals that form,
not just for drugs, but for all kinds of materials, sometimes
much faster. Rather than stick something in a GC (Gas
Chromatograph) we might just distill it in a capillary tube
to separate it. Then take that droplet and smear it on a salt
plate and look at it by IR. That could be a faster, better way
to check for something. We can test for boron on the single
fiber by adding a reagent and looking at the reaction under the
scope.

FT: I did a little background work on you before I called and
I saw on your website that you looked through microscope for
the first time when you were eight. Is that right?

SP: That’s when I got my first microscope and I’ve looked
through a microscope nearly every day of my life since. Even
when I was over in Germany during my Army Intelligence
days in the ‘60s, I had a microscope in my room.

FT: A lot of classrooms today have digital microscopes, but I
remember when I was in high school and our microscope had
happy little mirrors underneath which were a pain in the butt
to use.

SP: For a microscopist that is the preferred way. That puts
you more into association with what you’re looking at, rather
than looking through electronics. You’re actually looking
at the real material, in real-time. The only things separating
you from the specimen are some small pieces of glass that
have been designed and aligned so that they give you a real,
true image of the object. There’s less in the way of seeing a
physical image than there is of seeing a digital image. You’re
right. So, there’s nothing wrong with it, and we use it on
certain instruments. So, when we are lining up an object to get
the spectrum on it, for example, using one of the micro IRs
there’s a digital image which is a very nice. But we examined
it before hand very thoroughly by eye, by stereomicroscope,
and then usually by polarizing or florescence or some other
type of light microscope. It’s the same thing as here in
our laboratory – you wouldn’t see an autosampler on our
GC because there isn’t enough to run multiple samples of
something. It may have started as a speck of something
we saw under the microscope, which we picked up with a
needle, and extracted with a drop of chloroform. There is still
material left, but that little bit of chloroform will get picked
up with a syringe and injected into a gas chromatograph to be
separated into its components and (then) those each identified
by their mass spectrum. It’s very different world from that
of a traditional chemistry laboratory, even your usual trace
evidence lab for that matter.

FT: So, as an eight-year-old kid with a microscope you pretty
much had all the motivation you ever needed for this field,
right?

SP: Well, yeah. I’ve always liked books and the book
that came with it was from Gilbert microscopes. It was a
wonderful book that had AC Gilbert’s name on it, but it was
written by Oscar Richards, whom I actually got to meet later
in life. He autographed my copy, and in the last chapter it
talks about the microscope being a detective, and he talked
about the vacuum cleaner detective. And that stuck with me
ever since I was a little kid, and it’s come to serve me well
since then. I’m looking through a dust sample right now for
a crime lab out west that’s lost its trace evidence capabilities.
But that article in the Gilbert microscope manual said to get your mom’s permission, to open the vacuum cleaner bag, spread it out, and start sorting through it using your microscope. Look, there’s your dog’s hair, there’s the fibers from the carpet, there’s fibers from the drapes. Here’s one of your mom’s hairs.

FT: That would keep you busy for hours, huh?

SP: It did, it did. It was my occupation such that my brother and myself, on the weekends, we went down to our home lab, which was a pretty incredible place. Our dad had knocked out the bricks in the wall so we could put a fume hood in, and pipes that ran over the laundry tubs. We had at least two nipple spigots to run rubber tubing to the front of the basement where our lab was so we could cool condensers and drain them so the water would go back into the laundry tubs. We had two that were water aspirators so we could filter things through a funnel. We had a tap to (a) gas (source) so we had Bunsen and micro burners. It was a great place.

FT: So, you had your life’s passion drop right into your lap when you were a kid.

SP: Yeah, I didn’t realize it until I was more grown-up, like when I was in college. I thought everybody knew what they wanted to do with the rest their lives from when they were little. I always assumed.

FT: That’s great because you didn’t just know it, you also felt it.

SP: In retrospect I guess that’s true, but I never… I’m 71 now, but I still have the same passion for it that I did when I was younger. I just wish that I could go back, knowing what I know now, about 40 or 50 years, to improve on it; it took a while to learn some things. So then I went to work for Walter McCrone. I was 23 years old.

FT: Why McCrone?

SP: Emile Chamot was the father of chemical microscopy and joined the army so I could go into Army Intelligence and hopefully, like everyone else, be sent to Vietnam. Then I got sent to Germany for the entire time.

FT: No kidding.

SP: There were millions of people who didn’t want to go there and I wanted to go, but I got sent to Germany! It was a very interesting time: Russia invaded the Warsaw Pact countries. I was stationed at the border of Czechoslovakia testing out some new equipment. But then we had a very interesting analytical opportunity at that point to reestablish what’s called the order of battle, which is where all the units were. We had to figure it out because all these units had been bivouacked in camps like we were. On the west side of the border we had to figure out where everyone was because they hadn’t used these camps since the Second World War, so the entire order of battle in Europe had changed. In fact, I got a medal for it. I started the work and it was based on a whole bunch of information including photographs. We were on the other side of Highway 14 that runs between Prague and Nuremberg, and we had to go out there after dark if I recall. The border was closed for three days and everybody started coming out and we’d interview them; we’d offer to develop their film for free. Even Shirley Temple was there–she was trapped there at the border.

Anyway, it was an interesting trip and I stayed in Europe for three years until I got a European discharge and then I studied at the University of Vienna for a while, where they had a big school of microchemistry. I also studied German. At that point the army had their own language school. To be a chemist, every chemist wants to study German. Then I came back and finished up school. I fell in love, got married, and wrote a letter to McCrone. He called me back and I went to work for him for 20 years until he sold the company.

FT: You were fresh out of college?

SP: I did have one little interlude–I dropped out of school...
in America. He used to study with Behrens over in Europe. So, he really introduced me to chemical microscopy. Every scientist or every engineer who went through Cornell in those days had to take Chamot’s course in chemical microscopy. A lot of those people went off to make big names for themselves. I’ve got all his books.

We do a microscopically oriented Christmas card every year which is a lot of fun to work on. A couple years ago we put on our card that it was the 25th anniversary of the founding of Microtrace and the 100th anniversary of the publication of Chamot’s book *Elementary Chemical Microscopy*. I have a first edition of that book, and I also collect antique polarizing microscopes. To go with the book, I actually have the original chemical microscope described in the text, which was made by Bausch & Lomb.

**FT:** This might sound like a stupid question, but what do you like best about this field?

**SP:** That’s a hard one. I think there’s a certain beauty looking at things through the microscope, to watching chemical reactions taking place. You don’t see the atoms, but you do see crystals beginning to form. That’s one of the reasons McCrone became a theorist. I like solving a problem. I like the microscopic and microchemical methods of doing it. One of my clients sent me a copy of Stephen Jay Gould’s book about the birth of shale. I don’t remember the exact title of it. In it he talks about the arrogance of a lot of scientists who only look at things mathematically. Lord Kelvin, one of our great scientists, used thermodynamics to calculate the age of the earth based on the temperature, not understanding what the source of the heat was at that time. Of course, it was totally wrong! Look at statistics and look at the total failure of people who took polls with a small margin of error during the last national election. You also have to look at things from a certain common sense point of view. Common sense without knowledge can also fail you. Our unofficial motto here was blatantly stolen from Louis Pasteur, “Chance favors the prepared mind.” So, we are always trying to get better and better at what we do.

We used to do a lot of work for a large engineering company which has since gone defunct. They were huge, and they were worldwide, and we would get invited to their Christmas party. The president would get up and talk and their idea of getting better and better meant they intended to grow the company to a $1 billion company, and then a $2 billion dollar company and so on. That’s good for them, but we just want to get better and better at what we do. We bring in experts to teach us about things we don’t know about. I mean, what do I know about wood identification? So, I studied wood identification with the chief of wood anatomy of the Forest Service, Regis Miller, and I learned how to identify woods. We bring Regis in, not as often as we should, and he teaches wood anatomy and wood identification to my staff. Don Campbell comes in to teach concrete petrography. Maria Mange, until her death, was the world’s greatest untouched mineral analysis expert. My friend Terry Fisk was the senior glass technologist at Corning Glass. He came in to teach forensic examination of glass, but to teach about glass technology. Peter Bull from Oxford, the world’s authority on quartz grain surface textures to determine their depositional environment, came in and did a workshop for us. Get people from around the world to come in and teach my staff so they get better and better at what they do. How many crime labs take the time to do that?

**FT:** You’re right. Many crime labs get an employee and they park them in their own little niche, and they get good at their specialty and that’s all they ever aspire to. Their supervisors look at them and say, “You’re my ink guy, you’re my hair lady, or you’re my fibers guy,” and everyone is fine being pigeonholed and living in their own specialized world. I think it’s great that you guys are always looking to broaden your horizons and, not just that, but to sharpen your focus.

**SP:** Well, one of the things that makes us so good at trace evidence is that we don’t work just for crime labs; we don’t just work on criminal and civil litigation. We also work for companies that make things. We’ve helped fiber companies design new fibers— we know fibers, and we know the people in the fiber industry, so we can call if something comes up.
Sometimes we are trying to figure out an unknown tablet. We know someone who’s on a committee with the US Pharmacopia who’s got other contacts and things. We can count on all those things to help us. Plus, most labs don’t have reference collections like the ones we have. We have the largest fiber reference collection in the world, and we have huge dye collections. We have sand and soil samples from all over the world. Right now we are working on our botanical collection, soap, powdered vegetable drugs, and all kinds of food products.

FT: What do you like least about the field?

SP: We are a private lab and sometimes we have to deal with the financial aspects of things as well. You have to get paid for what you do. Sometimes people are not good at paying their bills on time. Another bad thing is that we are good at what we do. I’ve been doing this for a long time; we have continuity, our staff are starting to get to midcareer, and, until some people retire, we get the benefit of having older, more experienced people here. But sometimes decisions are made about whether or not to do an analysis based on funding. If another lab charges less than us, they will get the job.

FT: How busy are you guys? Do you have a backlog of months?

SP: We’re pretty busy, but we are not like labs that have a backlog of about a year, or six months, or something like that. We also break things into smaller components rather than take on a whole big project, if I wonder if the client is going to be willing to pay what it’s going to cost them. So, we answer this one important problem, and that might make a lot of other problems go away. We do a fair amount of work for the government, and sometimes we do it straight from the organizations, but often because we’re such small potatoes, because we are not a big beltway company, we do it under contract or subcontract. And some of these people, before they even see the results, are making charts on their whiteboards. The way we approach a problem is much different. We ask

FT: That’s great because you have a cross pollination of ideas and backgrounds and perspectives going on.

SP: Exactly. And sometimes the youngest, the most inexperienced person on staff might have the best idea that you never thought of.

FT: Now, you are testifying in Los Angeles next week, right? Let me ask you about that. What do you think about the CSI effect?

SP: I’ve seen it, but we are scientists; we are specialists,
although we’ve been rubbing elbows with lawyers for 45 years now. I’m not a lawyer. I don’t know exactly what a jury expects to see. A jury does find it interesting to have a scientist come in. Both sides, both the prosecution and the defense talk about the bad effects of it. Some jurors do expect to hear from a scientist or a CSI person, whether they have something to say or not. In talking to attorneys before and after the trial, sometimes they put us on even when we have very little to say—they just want to have a scientist up there. Occasionally, you have bench trials. Watch the jury when you talk to them, seeing what their level of interest is in what you say. I know this because I’ve worked on a number of high-profile cases. Most attorneys, though not all, it depends on the attorney and their approach, many of them want the jury to hear that the witness they brought in to testify has worked on cases like the Hillside Strangler, or Jon Benet Ramsey, and other cases they’ve heard of, like the bombing of the World Trade Center.

When you talk about this kind of stuff, juries are certainly paying attention. Whether they listen to your testimony afterwards is not always certain.

**FT:** Do you have to take juries back to square one by talking about the background of your field?

**SP:** I don’t get a lot of that. It depends on the court, and how the judge runs his court. It depends on the attorneys, it depends on the attorney on the other side, and sometimes it could be the prosecution or it could be the defense. But I always make the effort during the pretrial conference to break down the evidence into what is possible because sometimes people don’t want explanations. Sometimes they will let you know; they’ll say he’s leading the witness. Sometimes they’ll just let you go. It all depends on the lawyer and how the judge runs the court room. But my druthers are to explain things. So, for example, if we have a fiber case, I might be explaining that the most important optical property of a fiber is its color. You can’t have two fibers that came from the same source if they have different colors. I like to explain how we look at color under the microscope, that we use color microspectrophotometry to get an idea which colors are metameric. So, I’ve just used a word like metameric. How do I explain it? I’d tell them how, when I was a kid, I didn’t know what metamerism was at the time. But I’d be with my mom and she’d go into a fabric store and she’d be holding a fabric she was trying to match and she’d look at it under the incandescent lights, and then she’d walk right out of the store and look at the fabrics in the sunlight. Then you see the jurors’ heads nodding, not so much the men, but the women. They understand it—they’ve seen it themselves. And so, I use little examples like that or maybe drawings. But I never take depositions or the court room for granted. I don’t really like it, but it’s part of the work where you have to explain things. It’s different on my own turf here, in the library or in my labs, but I’m not on my turf in the courtroom That’s the lawyer’s turf, the judges turf.

**FT:** What was your most memorable case?

**SP:** That’s hard. There’s been so many over the years. To be able to take a little piece of dust or soil and tell where something came from, those are fun. I love those. Those are far more challenging than comparing two things. I like taking something that nobody knows what it is and figuring it out. George Ishi, who worked the Green River murder case, head of the Washington State Crime Lab System told me if they ever got a suspect they were going to bring me in on the case so 1) the defense can’t use you, and 2) you can help us with the case. If he’d showed me the clothing at that point we could have identified these little spray paint spheres. It was hard to tell what they were because they didn’t look like any kind of paint anyone had seen. It turned out, at that point, it was a new paint. It was Imron which was developed by Dupont, which was a specialized acrylic urethane paint, which those women had no reason for having on their clothes. They were prostitutes, not members of the Seattle women’s spray paint graffiti club. But they all have this connection to Gary Ridgeway, who spent his life spraying Dupont Imron paint on vehicles.

**FT:** No kidding. Wow. You were pretty much self-motivated as a kid, but everybody had classes they liked. The classes you did well in, was it the subject matter, your own drive, or
were there teachers who made their classes come alive for you?

SP: (Laughs) There were, but they weren’t the ones I had. My adviser at the University of Illinois, it’s like we were good friends. I remember being so proud as the recent high school graduate to show him pictures of my home lab. After I started working for McCrone, I started getting some newspaper publicity. I would get a copy of the paper and bring it to him. But I really learned the stuff from the books of the great masters of microchemistry and microscopy: Chamot and Fritz Feigel’s *Spot Test Analysis* and Benedetti-Pichler’s, *Identification of Materials*. I will take those things with me and read sections that I know by heart today. I'll read Herbert Alber’s, *Microchemical Analysis of Colored Specks and Crystal occlusions in Soap Bars*. I loved that. I was just reading it again for pure enjoyment.

FT: Skip, it sounds like you’ve never worked a day in your life.

SP: (Laughs) that’s what I was trying to tell my sons. I tell my staff and I tell young people who come through our lab as technicians on their way to other things; I try to pass that on to my students as I’m teaching at various classes around the world: Love what you do.

FT: It certainly sounds like you do! I’ve never interviewed anybody so passionate about their field. I’ve heard there are three types of occupations: a job, a career, and a calling. And it sounds like you’ve definitely found yours.

SP: I think so. That’s why when somebody gets a job here it’s a pretty big deal. Somebody has to not only be able to do the job and I tell them they have to be ready to start learning now. It’s like the French Foreign Legion for people who really like solving problems based on small amounts of material. I think it’s too good to waste on people who don’t really enjoy the stuff.
He came to us at that time as a student from the community college here. He was studying chemistry and very passionate about it. He was hired as a lab technician, who is somebody who cleaned up glassware and machinery that could be salvaged from the fire. I watched him as he finished college and got his chemistry degree, and he reminds me of myself a lot. He’s really good; he’s coming along. To watch him develop, to watch others develop their skills, I love that. We’ve had other people in here who weren’t so lucky. They just couldn’t keep up with what was expected, and they were let go. They just didn’t have the drive to keep up. Everybody knows there’s no such thing as perfection, but just because you know you can’t be perfect doesn’t mean you can’t try for it.

FT: One question I ask everyone I interview is, what qualities do you think a good educator should strive for?

SP: I think you have to realize that you will not reach all of your students. That sounds pessimistic, but I’m in the fortunate position of not having to waste time with people who aren’t interested in what I do. My wife, on the other hand, taught first and second grade for her entire career. She has to teach all kinds of students. She’s seen how people’s interest in education has changed over the years, not just the students but the parents too. And there’s the increasing demand for testing versus learning, which are two different things.

FT: Don’t get me started.

SP: So, that’s different from my field. In my field people are coming to my course because they’re interested in it or because they are sent to it by their employer. My little speech at the end of the weeklong class will be something of the order of, “I hope you learned a lot, I hope you stay in touch, I hope you ask questions, and I hope I’ve managed to pass on some of my personal enthusiasm for the subject of whatever I’m teaching.” The way I try to do that during the course is to use case histories to demonstrate everything we are doing in the course, every test we do, where it came from, why, and what I understand from it. They need to understand why it’s an important test to me.

A lot of people think classical microchemistry has outlived its usefulness, but every person I’ve ever talked to who thinks that has never studied it, and they don’t know how to do it. In many cases they pulled a book off the shelf in the library, or they might have tried a quick and dirty test and it didn’t work, so they assume none of it is any good. But you can’t do it that way. You need to understand the technique of working that way. If you haven’t prepared yourself for that technique—it’s like slapping something on the IR and taking the highest hit that comes off it. Let me give you an example—we do work for the food industry, food forensics because people are always finding stuff in their foods, and did they find it there or did they put it there? And our work is trying to figure out not only what it is, but how it could have been introduced to the food. One time we were looking at an analysis from another place; it was a pill. We’re asked to look at it after another lab looked at it. They said it was lactose to 99.95%. We agreed—it was lactose. Anybody who knows anything about lactose knows it’s an excipient, a non-active ingredient. So while the API, the active pharmaceutical ingredient, was there, it was probably there in one 1/10 of 1% concentration. Well, the sensitivity of the IR spectrum is about 1%, like x-ray diffraction. They found the lactose, but what they failed to do was identify the pill. They didn’t find the pharmaceutical ingredient. If it was a placebo, there would have been nothing else in there, but they didn’t prove it was a placebo; all they did was prove that one of the ingredients was lactose. Then we analyzed the drug, and we extracted the active ingredient, which was present in about 1/10 of 1%. They said their analysis had to be right because the main hit coefficient was 99.95%. That’s the kind of stupid, non-thinking analysis that goes on out there.

FT: One of my grad school teachers always said that when
you get the answer, do a common sense, ballpark thing. Step back and ask yourself, does this answer make sense? If it doesn’t you have to go back and look at it more closely; don’t just pat yourself on the back. Ask yourself if the answer is reasonable or possible or in the ballpark of what should be expected.

SP: That’s a good piece of advice, and I’m glad you remembered it because so many times we found something, one little fact that doesn’t fit, and you want to start forgetting about the fact in order to keep your or the original theory. Every time we’ve chased that little thing down we find there’s a whole different explanation than we thought. Everything fits, but there’s this one fact, and if it’s a fact it can’t be in dispute, and therefore there’s something wrong with your theory. There is this tendency to always make your fact fit what, up to that point, is your perfect theory.

FT: I guess you’ve heard the old axiom: curses, a beautiful theory is slain by an ugly fact.

SP: (Laughs) I heard it a different way, but that’s great!

FT: Do you have any tips for students who think they might want a career doing what you do?

SP: If you want to go into forensic science make sure you understand what forensic science is. I can’t tell you how many emails I’ve gotten from students over the years going into their senior year as an undergraduate. I’m a student at XYZ University, and I’m in a forensics science program and I don’t know if the people who work in the lab are the same people who go out into the field, and I’m interested in microscopy, and I don’t know if I really want to study medicine.” Their fundamental understanding of forensic science is completely off. They don’t even have any basis to start from, and you wonder what kind of program they are going through. There are all kinds of fields that throw the modifier forensics in front of them, and you get forensic this and forensic that.

The best advice I ever got was years ago when the new Chicago crime lab opened up and they had tours for the public. I went and I stayed around to talk to them, and they were really nice to a 15-year-old kid. I wanted to go out and study with Paul Kirk at Berkeley. They told me about the importance of studying science. There is a forensic science program here at the University of Illinois and there are different tracks, and for a while I used to teach in that program. One night I was talking to some students, this was right after CSI came on TV, and hopefully this is not the case anymore, but I was teaching microchemistry so they were there from 5 PM to 9 PM. Afterwards one of the students remarked about how hard it was; they didn’t know they were expected to know chemistry. And I thought ‘hell yes this is forensic science.’ Well, chemistry is fundamental. I didn’t know what they were enrolled in or what they were doing, but I’ve seen it here too. We’ve had people come through who had undergraduate degrees and Master’s degrees in forensic science and they just didn’t work out, they were deficient. Again, their physical sciences were just awful.

Paul Kirk, in one of his letters to me, said, I can’t tell you strongly enough how important it is when you take a course in science, especially chemistry or the physical sciences, that it’s not sufficient to just study enough to pass a test.” The idea that the best person can remember something and do it fast in the 90 minutes allocated for the test is not enough. I would rather sit a person down and give them all the resources they need, give them a prompt, and see how they solve it using the subject matter that I taught.

But going back to Kirk’s advice to me—that’s how I advised my boys when they got their doctorates, to really study for the love of it. You can’t stock everything in your mind, to pull a book off the shelf in the library. I do that with my staff all the time. Everything is not on the Internet. Take a book off the shelf and find something to love in it. Not everything is on the Internet. Quick story: A good friend of mine, Johnny Kilbourn, was a forensic scientist from Alabama. He worked his way up through the field the hard way. He’s a good...
scientist with a first-rate mind. They even did autopsies in his day in the crime lab there in Alabama. And we became friends after he took a course I taught, and we stayed friends. He just retired and he sent me a whole bunch of stuff from his home lab that he wasn’t using anymore. Anyway, John was teaching a course somewhere down south on trace analysis, and everyone went out one night for drinks and dinner and as the evening wore on they started talking about cases. And John was talking about this case and that case, and I was just sitting there in awe. I asked him how he learned to do all this, where did you get all this experience?

He said, “Well, you know, I really studied. Every day after work, there’s not enough time in the day you know, I’ll take home an old book, I took home F. Donald Bloss’s, *Introduction To Optical Crystallography*, and every night I read a little bit. Whether I was alone or if my wife and kids were watching TV, I’d sit there and read. I’d work at home, every night.” And everyone stopped and looked at him. “On your own time?” It never dawned on them that the day isn’t long enough.

I go to bed every single night reading journals that came during the day. Maybe I don’t read every article, but I read the table of contents. I read every new book that comes in, and we get three or four from the library every week. I just started reading the biography of Wallace Cruthers, one of my heroes, the other being Emil Fisher, both chemists. Cruthers was involved with nylon at DuPont and was one of the guys who developed dye chemistry here in the US. You’ve probably read that during the First World War we couldn’t even dye uniforms because all the dyes available at that time came from Germany.

**FT:** I didn’t know that.

**SP:** So, you were talking about the size of the research groups at that time, all the research groups were small. And one of the most important things is that every night you go home thinking about the problem; you spend a couple hours thinking about what you did during the day. I wonder how many people do, though. But today, we live in an era for forensic labs that judge their success by the number of cases they take on…and you have to wonder about the training of the people who work in those labs. They can look at their slides and figure out what they’re looking at, but the problem comes when they go to another setting. All of a sudden, they’re thrown into a lab where they’re told to become technicians. I tell everyone who comes here a couple things. I ask if they want a career, and if they do, they have to become a technician as well as good scientist. They have to have the lab-craft and the knowledge to understand what they’re doing. But the current trend in forensic science standard methods is to dumb it down. There is a difference between technology and science, and I think the work we do has to blend both of those. But to say you have to decide before you do your analysis how you will do it with the standard method is absurd. I mean, we have to do some of the stuff because we are an ISO accredited laboratory. We had to write all our procedures in a way so that we can still do science. An example would be if something is purported to be glass. So, you need to identify it as glass first and then, if you’re going to measure its refractive index, you have to look at our protocol, like this is the way we look for trace elements by micro x-ray RAF or this is the way we use GRIM, or glass refractive index measurement system, to measure its refractive index out to the fourth or fifth decimal place. But that’s after you’ve identified it as glass.

About 35 or 40 years ago I had a case come in where I was asked to referee a dispute over a glass particle. And I remember that when I started my analysis I found there was stuff stuck to the outside of the glass particle, and the first thing we do is make sure we get to the original surface of whatever we are trying to analyze is wash it off, and you save whatever it is that washes off.

So, I started to wash it off and the glass particle started to dissolve! I tested the solution and it was sugar! It was sucrose; it wasn’t silicate glass, it wasn’t soda lime glass or crown glass or something. It was a piece of hard candy, like a clear Lifesaver.
FT: Or rock candy.

SP: Right. It’s in the glassy state, but it’s not glass. True story, but the point I’m trying to make with it is that once you know something is glass, and you have a standard protocol for analyzing it, that’s fine, but that doesn’t help you know if it’s glass in the first place. You need to be able to identify things first; then you can do other things after.

FT: I can definitely sympathize with your feelings about being lit up about something and pushing yourself farther than anyone could ever push you because the subject just won’t lie down in your mind.

SP: That’s the other thing too, the importance of other things. As much as I love science I also love certain aspects of history and things. (Laughs) I still have a thing in the back of my mind about the Foreign Legion and that kind of stuff. Two nights ago I just finished a book called Legionnaire. The author got out of the French Foreign Legion the year before I went in the army trying to get to Vietnam. It’s an incredible book! It turns out the French Foreign Legion training benefited him so much he started the Orange Cellphone Network in Europe after he got out. He’s a multi–billionaire! He was almost killed, because in those days they used to beat up on the soldiers when they hazed them. Some people just have that kind of force–I mean, I have my one little area of interest.

About a year ago I was in England at the University of Surry, and I met the former head of the Israeli crime lab. And one of the exercises they proposed was to show how one could, using modern forensic science, solve the murders in Edgar Allan Poe’s story, “The Murders in the Rue Morgue.” And one of the things everyone has to do before they walk in the door here at Microtrace, on your first day is read that story. Whether you’re a scientist, a visiting scientist, or a lab technician, everybody before they can walk through the door has to have read, and they’ll be tested on, “The Murders in the Rue Morgue” and “The Purloined Letter.” And my first question is, “Why did I have you read it?” And that tells me a lot about them right there.

FT: I understand.

SP: I was inspired when I was young, and the only forensic scientist I ever wrote to was Paul Kirk, and he was nice enough to write back. And there was a TV show on in 1960 called Checkmate which Microtrace is very much modeled after today, as my wife pointed out when they came out on video, and we watched a couple seasons. The hero was a doctor named Dr. Carl Hyatt, played by Sebastian Cabot, who had his lab in his library in his home, and he would do microchemical analysis and use a microscope and a spectroscope and all kinds of things. It was a great show. I was inspired by a fictional show that turned into a real-life career and organization, and we work on stuff all over the world, teaching and working on cases, and we have our library. My private lab is right here next-door. And we’ve got our laboratory and things and we try to do things the way they did, completely independently. We are not bound by any police force or government or anything like that. We do work for people all over the world, solving interesting problems. You never know–each day you come in you never know what it’s going to be.

Want to challenge your students? Ask them to look at the contents of a vacuum cleaner bag under a microscope. OR, mix smooth peanut butter 1:2 with water and put a drop under a cover slip on a slide. According to the FDA, peanut butter can have 30 or more insect fragments per 100 grams and one or more rodent hairs for every 100 grams.
I teach forensic science at Martin High School in Laredo, Texas and have a master’s degree in forensic science, specializing in crime scene investigations. My labs are simple due to budgetary constraints, as this is a low-income, high-risk high school. My seniors are great and love to do labs. I have to purchase the supplies we need, but I am a scientist and I really enjoy preparing my own slides and my own scenarios.

This lab is my fiber lab. I purchased at least four garments at our local Goodwill Store, specifically for their fiber weave patterns.

I ask my students to identify the weave pattern for each clothing sample and then identify an unknown. Examples of different weave patterns can be seen at the end of this article as well as at the following sites.

http://www.bbc.co.uk/schools/gcsebitesize/design/textiles/fabricsrev1.shtml


https://www.pinterest.com/pin/116389971596294836/

As an educator you are allowed to make copies of the images for your students within the Fair Use provision of US Copyright Law.

In the second part of the lab, the students must match the suspect sample fibers obtained from the back of the suspect’s van to the identified exemplars. These lab samples include an exemplar from the blanket that wrapped the body of the deceased.

For this half of the lab, I instruct the students to cut off a piece of each cloth and prepare the smallest thread strands they can separate. They will place the fibers on the microscope slide and again used transparent tape to attach the thread. They identify each slide with a number from one to four, using a Sharpie®, and the van sample is labeled “Suspect.” After the students sketch each strand with the 10X objective, they must all come to the consensus on one of the exemplars being the same as the suspect sample.

This is a simple lab but it emphasizes the delicate process of searching for the evidence, finding the evidence, identifying the evidence out in the field, and then bringing that evidence for comparison, evaluation, and investigation of said evidence to either exonerate a suspect or let the evidence find him/her guilty. The lab also strengthens team work in and outside the lab. I hope you and your students enjoy it as much as we do every year.

Materials:
- Microscope
- Microscope slides
- Transparent tape
- Four or more pieces of clothing
- Scissors
- Sharpie®
- Worksheet
Fiber lab

Name ____________________________ Date ________________

Part I

Using the patterns given to you as a guide, label the sketch of the weave patterns on the microscope slide:

SKETCH:  10X Weave Type #1 ___________ 10X Weave Type #2 ___________

SKETCH:  10X Weave Type #3 ______________ 10X Weave Type #4 ___________

SKETCH:  10X Unknown
Fiber lab

Name________________________________________ Date____________________

Part II

SKETCH THE FIBERS AT 10X

SUSPECT SAMPLE @ 10X:

Exemplar #1: Exemplar #2:

Exemplar #3: Exemplar #4:

Conclusion:
<table>
<thead>
<tr>
<th>Type of Weave</th>
<th>Diagram</th>
<th>Description</th>
<th>Characteristics</th>
</tr>
</thead>
</table>
| Plain        | ![Plain Diagram](image) | Alternating warp and weft threads | - firm and wears well  
- snag resistant  
- low tear strength  
- tends to wrinkle |
| Basket       | ![Basket Diagram](image) | Alternating pattern of two weft threads crossing two warp threads | - an open or porous weave  
- does not wrinkle  
- not very durable  
- tends to distort as yarns shift  
- shrinks when washed |
| Satin        | ![Satin Diagram](image) | One weft crosses over three or more warp threads. | - not durable  
- tends to snag and break during wear  
- shiny surface  
- high light reflectance  
- little friction with other garments |
| Twill        | ![Twill Diagram](image) | Weft is woven over three or more warps and then under one. Next row, the pattern is shifted over one to the left or right by one warp thread | - very strong  
- dense and compact  
- different faces  
- diagonal design: on surface  
- soft and pliable |
| Leno         | ![Leno Diagram](image) | This uses two warp threads and a double weft thread. The two adjacent warp threads cross over each other. The weft travels left to right and is woven between the two warp threads. | - open weave  
- easily distorted with wear and washing  
- stretches in one direction only |

The Basil Street Incident (from page 44)

Hoxton had been seated when he was stabbed. Somehow, he had dragged himself across the room to pick a flower from the vase before he died. "Why would a dying man bother to do this?" I asked myself. He must have wanted to leave a message behind. There was no pencil among the contents of his pockets. (He'd had to borrow one, as you may recall, to tot up his winnings.) Hoxton had been trying to reveal the identity of his murderer. I quickly realized that I needn't cross-examine or Seymour, but Bloom certainly deserved my full attention.

The Week of the Queen Anne Festival (page 4)

All three are lying, and Thursday alone is a festival day. If Chiswick's statement is true, then they are all liars, including Chiswick. He would thus be a liar telling the truth, which is impossible. Chiswick's statement is therefore false, and Chiswick is a liar. At least one clause of his compound statement is therefore false. Since Chiswick's statement is false, Green's claim that it is true is also false, and Green is also a liar. Thus his other statement that Tuesday is a festival day is false. Hunter's first statement is false, since Chiswick and Green are both lying. Hunter is therefore also a liar, and Wednesday is not a festival day. Thus, all three are liars. This means the first clause of Chiswick's statement is true. For the statement as a whole to be false, which it is, the remaining clause must be false, so Friday is not a festival day either. Tuesday, Wednesday, Thursday, and Friday are the only possible festival days. Since at least one must be a festival day, and Tuesday, Wednesday, and Friday are not festival days, then Thursday must be the only festival day.
Webquest: Forensics 2.0

By Bob Grant
Part I.

Meet the researchers working to untangle the mystery of a Missouri home filled with bones by bringing cutting-edge technologies into the crime lab.

Forensic anthropologist Lindsay Trammell had only just received the human remains and she already knew that she’d need help with this case. It was the summer of 2014, and 15 skeletons had arrived at the St. Louis Medical Examiner’s Office as a jumble of bones inside four wooden coffins. Some of the bones looked ancient; they were “falling apart,” Trammell recalls. But others were in relatively good shape. “There were different levels of preservation throughout the remains.”

She photographed, inventoried, and measured the skeletal elements employing the standard biological techniques typically used by forensic anthropologists, who are still by and large not regular fixtures in crime labs. Those analyses indicated that some of the skulls bore characteristics of people with African ancestry while others did not. “Just by looking at them, my inclination was that they were from different ancestral groups,” Trammell says.

Something wasn’t adding up. Earlier that summer, Tony Wheatley, then a detective at the Morgan County Sheriff’s Office, went to a home just outside of Versailles, Missouri, to investigate a reported suicide attempt. Police knocked on the door of retired archaeologist Gary Rex Walters, but no one answered. So they entered to ensure the safety of any occupants. Wheatley says that he and his fellow officers did not find any people inside, but they did spy marijuana pipes in plain view. The officers left the premises and applied for a search warrant. When they later reentered the home, they found four open wooden coffins full of human remains—bones, teeth, and skulls.

Wheatley called the Morgan Country Coroner, who indicated that the remains shouldn’t have been stored in Walters’s home. The detective confiscated the coffins and their grisly contents. “We went ahead and secured them for safe keeping until we could figure out what was going on,” Wheatley says. “I’m not trained in anthropology or anything like that, so I didn’t know how old they were or what they were.”

Walters argued that he had permission to own the skeletons contained in the coffins, saying that he had excavated the remains near Iztapa, Guatemala, sometime in the 1970s. He even produced decades-old documentation from the Guatemalan government to prove the legality of his cache.

But Wheatley says he “still wasn’t convinced that those documents covered those remains that we had seized. . . . We wanted to make sure that they weren’t newer bones that [Walters] had come across locally.” He added that there are several unmarked Native American burial sites in central Missouri and that there was a black market for items recovered from those sites. “We didn’t want him trying to sell Native American bones,” Wheatley says.

Wheatley’s concerns only grew as he looked into the archaeologist’s background. In the 1990s, Walters had been
accused of stealing human remains that he was supposed to help relocate from a historic African American cemetery in St. Louis to make room for transportation infrastructure in the city. That incident, which revolved around his insistence that he was owed money for his work on the cemetery relocation project, was apparently resolved when he returned 28 bodies and received $90,000 for his work.

As an anthropologist, our job mostly in the past was focused on creating what we call a biological profile from the skeleton to help identify them. As technology is changing, our rules are honestly shifting.—Lindsay Trammell, St. Louis Medical Examiner’s Office.

The discovery of the human skeletal remains in Walters’s home reanimated old suspicions. “[The investigators] were just trying to verify whether he was telling the truth or whether these were skeletal remains of modern individuals that had gone missing or been killed,” Trammell says. “So that was one of the reasons they called me—to see if we could discern, based on looking at the remains, were they from Guatemala, were they from this cemetery, or were they from somewhere different altogether?”

But Trammell’s preliminary work left her puzzling over what seemed like a mixed bag of remains. So she called for backup. Trammell sent samples to Cris Hughes of the University of Illinois at Urbana-Champaign and Chelsey Juarez of North Carolina State University (NCSU), who performed genome sequencing and isotope analysis, respectively, to provide more detailed information on the skeletons that would either corroborate or contradict the archaeologist’s story.

“Really, as an anthropologist, our job mostly in the past was focused on creating what we call a biological profile from the skeleton to help identify them,” Trammell says. “As technology is changing, our rules are honestly shifting, because now you do have DNA and now you do have isotopes, where these types of tests can tell you quite a bit from the skeleton.”

The archaeologist’s bizarre case is one of only a handful of examples where such techniques have been applied to criminal investigations. While searching for DNA matches to established databases or suspect samples is common practice in many crime labs, genome sequencing to establish a body’s likely ancestry and isotopic analyses to suggest its possible geographic origins remain exceptions to the rule of standard forensic workups. But as technologies mature—from single-cell sequencing to epigenetic analyses—investigators are beginning to rely more and more on advanced forensic methods, yielding unprecedented insights into victims, perpetrators, and their crimes.

“It’s taken us a while to get to this point, truthfully,” says Seth Faith, a researcher at NCSU’s Forensic Science Institute. “But now we have this wonderful technology in front of us and people who are trained in how to use it and interpret that data.”

The devil’s in the DNA

Because they had collaborated on cases before, Trammell knew that Hughes, who also serves as a deputy forensic anthropologist at the Champaign County Coroner’s Office, was clued in on the latest in genome sequencing as applied to forensics. Trammell was also aware that Hughes trained under University of Illinois ancient DNA researcher Ripan Malhi, who has used advanced sequencing techniques to recover and decode DNA from 6,000-year-old human remains. “[Hughes is] definitely the expert when it comes to DNA,” Trammell says. “I knew that she could test for mitochondrial haplogroups”—genetic signatures that are associated with geographic regions—“and [determine] whether or not they were consistent with an individual that was African or Native American.”

Trammell sent small bone and teeth samples from 10 of the crania found in the archaeologist’s wooden coffins. Of those, Hughes took subsamples from six and sequenced hypervariable region 1 (HVR1) of the mitochondrial DNA, which can help determine an individual’s haplogroup. “To jibe with [the archaeologist’s] story, I would have to see something that was a Native American haplogroup,” Hughes says. Of the four samples that yielded sequenceable DNA, three did have HVR1s consistent with Native American ancestry. However, one sample’s HVR1 placed the mitochondrial genome within West African haplogroups, suggesting that not all of the remains in the wooden coffins were from Guatemala after all. “Some of those materials in there were basically raising a red flag and were not consistent with his story,” Hughes says.

Hughes knew that Iztapa was abandoned by natives in 1350 CE, before Europeans arrived in the area, meaning that “if we’re looking at the DNA, and we’re looking at maternal ancestry, you should expect to only see Native American links,” she says. “We shouldn’t see anything that’s European or African, because there was no contact. They hadn’t come over yet.”

But Hughes knew of another analysis that could provide further evidence of the skeletons’ origins, so she suggested Trammell contact Juarez to analyze the relative abundances and ratios of isotopic forms of common elements, which can yield clues about where the deceased individual lived from birth to death.
Part II.

Isotopes tell most

Juarez also received bone and tooth samples from the same 10 crania that Trammell had sampled for Hughes. Using mass spectrometry and focusing on the crown of the first permanent molar—which starts forming in utero and finishes developing by age 3—she performed analyses that quantified the amounts of isotopic strontium in the skeletal materials. She then compared those levels with maps of known isotope distributions in both coastal Guatemala and the St. Louis region. “We did not find overlap in the Latin American region where [the archaeologist] was claiming that the bones were from,” Juarez says. “We did find overlap in the St. Louis area.”

Juarez’s results provided further support that the bones in the archaeologist’s skeletal stockpile were not all from ancient Guatemala, as he had contended. “Based on the results that we were getting, my first thought was that these remains were coming from multiple different archaeological sites from various regions,” says Trammell. “To me it seemed like this was something that he was possibly collecting throughout his career. But without testing every single element, there’s no way to prove that.”

Hughes and Juarez submitted their data and reports on their analyses to Trammell, who passed those findings onto investigators in Morgan County.

The reach of forensics

One of the best and broadest examples of applying next-gen tools and methodologies to forensic sequencing can be seen in a project at the Armed Forces DNA Identification Laboratory (AFDIL). Researchers there are using next-gen sequencing to sift through the genomes of fallen service members whose remains were recovered on foreign battlefields from World War II, the Korean War, and Vietnam.

Charla Marshall, chief of the emerging technologies section at AFDIL, headed up the validation of a sequencing protocol that investigators are now using to repatriate the remains of more than 800 Korean War veterans. The skeletal remains were buried in the National Memorial Cemetery of the Pacific in Hawaii (colloquially referred to as the “Punchbowl”) in 1953 after being disinterred from their original burial grounds near Korean battlefields, shipped to Japan, preserved in formalin, and shipped to Hawaii. In the late 1990s, the AFDIL retrieved the bodies from the Punchbowl to begin identifying the soldiers. But the bodies had been fixed in formalin, which induces DNA crosslinks that disrupt sequencing reads; so the researchers were unable to extract DNA fragments long enough to sequence with the Sanger method.

“We are using the very sensitive methods of next-gen sequencing to recover 55- to 75-base-pair fragments, which are not amenable to Sanger sequencing strategies that require 20-base-pair primers on either end.—Charla Marshall, Armed Forces DNA Identification Laboratory

“Right now we are using the very sensitive methods of [next-gen sequencing] to recover 55- to 75-base-pair fragments, which are not amenable to Sanger sequencing strategies that require 20-base-pair primers on either end,” Marshall says.

In July of this year, the Defense POW/MIA Accounting Agency (DPAA) announced that researchers at AFDIL had identified US Army Corporal Charles White, who died fighting in North Korea in 1951 at the age of 20. Using Marshall’s protocol to sequence Cpl. White’s mitochondrial genome, the team matched it to mtDNA provided by a niece, a nephew, and a sister. Last summer, his remains were returned to his family in Lexington, Ohio, and he was buried with full military honors. And Cpl. White is just one of many.

“Between March of 2016 and September 30 of 2016, we have processed 80 samples through the [sequencing] procedure,” says Tim McMahon, chief of AFDIL. “And we’re running at about a 45 percent success rate,” in terms of pulling usable sequences from the chemically degraded DNA.

Isotope analyses, which can narrow a person’s travel and life history down to a set of geographic locations, are also becoming more common in forensics labs. In 2015, scientists working on the murder of 2-year-old Bella Bond, whose virtually unidentifiable body was found in a trash bag near Boston Harbor, used isotopes to help determine where she may have lived during her tragically short life. By comparing oxygen isotopes in her hair and teeth to known values of oxygen isotopes in drinking water throughout the country, investigators suspected that she had spent most of her life in the New England area, information that helped police narrow the search for her murderers and arrest the girl’s mother and her boyfriend for the crime in September 2015.

Lesley Chesson, president of Salt Lake City–based IsoForensics, says that her company gets requests from investigators all over the country for isotope analyses like the one used in the Bella Bond case. “This application for modern casework has really been taking off in maybe the last 10 or 15 years,” she says. “We work with folks from all over the United States—police departments, state bureaus of investigation, and sheriff’s departments.”

IsoForensics was spun out of the University of Utah, where geochemist Gabe Bowen conducts research on the cutting edge of isotope analyses with an approach called isomapping or isoscapes. Isomaps are predictive maps that display the distribution of isotopes of a particular element that can be compared with isotope ratios in bones, teeth, hair, or other tissues to estimate the geographic origins, travel histories, diets, or date of death of a person.
“Isoscapes are trying to take our first-principles—understanding of the physical, biological, and chemical systems that control isotope variation—and turn those into predictive maps that provide a fingerprint for interpreting forensic data,” Bowen says. “It would be like if you wanted to know where a letter came from in the mail. It’s got a ZIP code on it. You need a map of the ZIP codes across the U.S. to interpret that to figure out where it came from.”

But building isomaps is a slow, ongoing process. “These days, we’ve got massive [DNA] databases against which you can compare a sample,” Bowen says. “We’re not at that point yet [with isomaps]. And, unfortunately, there hasn’t really been a concerted, community-wide effort to build the necessary databases.”

A lack of funding, Bowen adds, makes this a difficult proposition. “So we’re left in a situation where most applications, when they come up, involve making some measurements and then scraping to fund samples for comparison or pull together data from published sources that can provide comparators,” he says. “So that means there’s not a plug-and-play application in most cases. Each application still, at some level, involves a little bit of research. And when you start getting into operational forensic work, that’s not very attractive.”

**Outside the chalk outline**

In addition to their use in missing-person cases, next-gen sequencing approaches may extend beyond the identification of complete or partial human genomes. In 2015, Faith’s colleagues at NCSU published a paper in PLOS ONE that reported the sequencing of fungal DNA from nearly 1,000 dust samples collected from indoor environments across the U.S. (10:e0122605). The researchers identified as many as 40,000 fungal taxa in these samples, and developed an algorithm that can place a given sample of dust within a couple hundred kilometers of its geographic origin based on the signature of fungal species it contains.

“How good is that? Well, we’re still working at it,” Faith says. “Now, we’re dealing with a database that’s got 40,000 species in it. But there’s still a lot of work to be done.”

But, as Bowen says, “the world of isomapping is still nascent. We’re still building our fingerprinting databases.”

“Being able to predict within 200 kilometers where something’s come from in the United States is pretty impressive,” Faith says. “There’s no other technology to date that can get that type of precision.” High global diversity and their resistance to desiccation make fungal taxa capable geographic identifiers. Faith adds that his group has launched a larger project in concert with the US Department of Defense to create a world map of dust fungal taxa. This, Faith says, may help investigators predict the origin and travel history of samples involved in smuggling cases, port investigations, or hazardous material trafficking, among other scenarios.

Faith has also illustrated the utility of next-gen sequencing in the context of forensic epigenetics to identify individuals (Electrophoresis, 35:3096-101, 2014). “Here in the lab, we’ve done some work to look at tissue sores to establish where the DNAs come from based on the epigenetic attributes, like methylation patterns,” he says. “We’re also trying to develop an approach to differentiate identical twins based on epigenetic patterns.”

Isotope analyses are also being developed for use in food safety, wildlife forensics, poaching investigations, and in African ivory smuggling cases. And the same mass spectrometry technology that fuels isomapping and other isotope analyses is also applied to characterizing the composition of other molecules hidden away in crime scene samples. “We’re seeing folks using mass spec to identify the proteins in hairs, for example, and trying to make those attributable to individuals,” Faith explains.

Bowen says that isotope analyses are also being developed for use in food safety, wildlife forensics, poaching investigations, and in African ivory smuggling cases. “There’s a lot of different directions that people are going with it.”

**The mystery lingers**

Back at the St. Louis Medical Examiner’s Office, Lindsay Trammell is still housing piles of bones recovered from the archeologist’s home in central Missouri. No charges were filed in the case, and the wooden coffins, along with other, nonhuman artifacts contained in them, were returned to the man. According to an official with the Morgan County Sheriff’s Office, however, “there are still some people in St. Louis that are trying to trace [the skeletal remains] back to some victims.” For that reason, the official says, “we’re not at liberty to discuss it yet.”

While Trammell’s traditional biological workup and the extra analyses performed by Hughes and Juarez made a compelling case that the archeologist wasn’t completely truthful about the bones found in his house, the data generated by these forensic techniques is not yet admissible as evidence in court. (See “Challenges” below.)

“It’s a really interesting case, with three anthropologists in the youngest field of anthropology with different specialties,” Hughes says. “Then again, it’s kind of sad. No charges were filed. This is the hard part about the work. When there’s no closure or there’s no proper resolution for those individuals whose family members are kept in this guy’s house.”

**CHALLENGES**

Forensic anthropologists now have a toolbox containing advanced technologies and methodologies, so why haven’t next-gen sequencing and isotope analysis become the standard protocol at crime labs across the world?
Forensics in the courtroom

Any method used for gathering information must be heavily vetted and validated before the results are admissible as evidence. This legal bar for newer technologies to generate admissible evidence is so high, says North Carolina State University forensic anthropologist Chelsey Juarez, that her isotope analyses are typically used at the front end, rather than the back end, of criminal cases. “Most of the time, the question that I deal with in terms of isotopes and forensic science . . . it’s not necessarily something that would go to court,” she says. “It’s something that would help law enforcement try to get a lead on a case.”

Researchers are now working to codify advanced forensic techniques and make the case for the methods to be established as standard practices for generating actionable evidence. Seth Faith of North Carolina State University, for example, says that he is involved in a working group led by the FBI with the aim of bringing next-gen sequencing into broader forensic use at labs associated with the FBI’s Combined DNA Index System (CODIS). “We hear this time and time again from the laboratories: they’re not going to move forward until they see those formal guidelines and standards issued by the FBI,” Faith says. “So we’re in the process of getting those out.”

Lack of money
Getting the data generated by these forensic techniques admitted in a court of law isn’t the only challenge. Funding on the state and local levels, where many crime investigations take place, is such that buying expensive sequencers or mass spectrometers is simply out of reach. This reality makes it even more remarkable that Lindsay Trammell of the St. Louis Medical Examiner’s Office was able to enlist the help of forensic anthropologists who donated their time and analyses to the case of the archaeologist’s skeletal cache in central Missouri.

Lack of experts
Another impediment to the more widespread adoption of modern forensic techniques is the fact that practitioners of such methods are few and far between, at least those who specialize in analyzing human remains. “There are extremely few forensic anthropologists who do this even now,” says Juarez.

And until methods such as next-generation sequencing and isomapping make their way into more crime labs, it doesn’t make sense to train and fledge students in these techniques. “I guess I’m a little torn, because I applaud and I’m excited about the new technologies that we’re encountering, that we’re using on casework,” says Juarez. “But I also have great trepidation because I don’t want to encourage an explosion of forensic anthropologists doing isotopes that they can never find a job for.”

Lack of awareness
Another obstacle that may be slowing the introduction of high-tech life science tools into the criminal justice system is a level of discomfort among working forensic investigators. If researchers were better communicators, perhaps criminal investigators might be more receptive to using those tools, says Lesley Chesson of IsoForensics. “They don’t know that they understand the technique 100 percent, and so they don’t know whether it would help their case or not,” she says. “We, as forensic scientists in the academic world, need to do a better job about explaining to law enforcement and the actual users of this who would benefit from this, here’s how this can potentially help.”

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Using History to Learn Forensics

By Stacy Schurtz

Lizzie Borden
Lizzie Borden took an axe
And gave her mother forty whacks.
When she saw what she had done,
She gave her father forty-one.

Andrew Borden’s skull (left) and Abby Borden’s skull (right)
Was Lizzie Borden Guilty?

By Stacy Schurtz

Kids enter the room and notice caution tape around the room. Hideous crime scene pictures are hanging around the room. Their interest is definitely piqued! Class begins with excitement in the air. As a middle school teacher, you have just won half the battle!

In this lab, students use a variety of science processing skills to solve the cold case and decide, once and for all if Lizzie Borden was guilty of the heinous murder of her father and stepmother. I begin class by asking who has heard of Lizzie Borden and then ask what they have heard. After a short discussion, I share a clip about Lizzie Borden and the case. We discuss whether we would want to stay in her house, which is now converted into a bed and breakfast, and then I begin the lab (using the lab sheet and information below this intro). Throughout the lab, students are presented with blood samples, hair samples, DNA evidence, and fingerprints to compare to the evidence found at the scene of the crime. They must compare their evidence to figure out whom the samples belong to. The blood slides you can either prepare yourself, or if you already have prepared slides, those work too. I used prepared slides of frogs, humans, and rats. Don’t forget to cover up the names of the animals if you use prepared slides. The hair samples were from family members, as were the fingerprints. For the DNA I created slides using markers; I simply drew different patterns of lines. For each of those pieces of evidence, make sure you have two that are exactly the same so that students can find a suspect. I also provide real court documents, i.e. testimonies and the autopsy report, as well as the crime scene photos and court drawings. Students love looking at the evidence and reading the actual court documents. Reading secondary and primary sources is a huge bonus for this lab as well. Not only do they have to read the documents, but they have to examine them and infer what each could possibly mean in connection with the case.

A couple tips for the lab: if your students have never used microscopes, you may want to spend the day before discussing proper microscope usage. Some of my kids used them last year, but I still did a brief discussion the day before the lab. The day of the lab, I reminded students that there was no need to touch the scopes as they were already exactly where they needed to be. I also showed a few pictures of what the kids should see when they looked in the microscope. I set up all stations the day before we do the lab, at the end of the day. If your students have computer access within your room, you could post all documents and pictures on Google Classroom, or the tool you use for technology at your school. This limits the students from being up and moving around at the same time. I posted to Google Classroom, but also had the hard copies of all documents for my tactile learners who like the physical copy in their hands.

The setup is pretty easy. Teachers will need six different stations (blood, DNA, fingerprints, hair, court documents, and crime scene photos). For blood and hair, five microscopes are needed. For the DNA and fingerprint stations, magnifying glasses are needed. I typically group students together so that those who struggle, especially with reading, are paired with stronger students. Groups of four are best, but some class sizes are larger, so it depends on the class size. To make sure kids are engaged and on task I walk around constantly asking them to tell me what they are thinking so far, who they think killed the parents, what evidence they have to support their claim.... probing questions to keep them thinking and on task. Time at each station varies depending on student level. I typically allow five minutes at each station, and then time at the end to study the testimonies and crime scene photos in greater depth.

When I created this lab, I was looking for new ways to engage my students in real science. At times, it is a struggle to get kids interested in science and keep them interested. If we want to raise a generation of scientifically literate people, we have to engage them in exciting science! I have found that the gorier a topic, the more the kids are interested, and this is a pretty gory lab because of the actual crime scene documentation. The case piqued my interest, so I naturally gravitated towards it when brainstorming ideas. This activity coupled my love of mysteries and my love of science. The high interest level, the primary and secondary sources, the observation skills needed when viewing the evidence, and the inferring and hypothesizing are all essential to science.

Bio: I have been teaching middle school science in a public school setting for 20 years. I enjoy designing exciting curricula for my students. I have done this lab twice now, and each time, the kids are excited and engaged, and always ask me to create more labs like this.

Stacy can be reached at stacyschurtz1@gmail.com for any questions or comments.
**Purpose:** Students will use crime scene evidence to determine whether or not Lizzie Borden was guilty. They will use science processing skills to hypothesize who killed Lizzie Borden’s parents. Students will analyze evidence, collect data, and determine who was guilty of this heinous crime that shook an otherwise quiet town in 1892 Massachusetts.

**Time required:** Two 50-minute periods

**Materials needed:**
- Was Lizzie Borden Guilty? Lab sheet
- Chronology of trial worksheet
- 10 clean slides to create hair sample slide
- 10 clean slides to create DNA gels
- 5 large index cards, preferably plain
- 10 microscopes
- 10 magnifying glasses

**Preparation for teacher:** Obtain all needed sample slides.

For blood slides, you will need three different slides, and two of the same. I used FLINN Scientific slides already created. I used frog, turtle, bird and two human smear slides. You can also make your own by using the blood from your family or friends, but I chose to use the prepared slides. If you use the prepared slides, mark off any identifying information and label them with A, B, C, D and E. Slides A and D should be the same.

For hair slides, clip short pieces of hair from friends, family, pets or toys. Create three different slides and two that are from the same item/person. To create slides, place hair on bottom slide, put a slide on top of that one and then tape the sides together with clear tape. Mark slide F, G, H, I, and J. Slides F and I should be the same.

For DNA, use a small piece of paper to make random small lines in different patterns to represent DNA in gel. Label them K, L, M, N and O. Slides P and Q should be the same.

For Fingerprint cards, use a stamp pad to create a fingerprint card of four different people. Make sure that F and I are the same.

Set up four different stations around your room. Station 5 will be done at student’s own seats.

**Day 1:**

1. Ask students if anyone knows who Lizzie Borden was. Ask volunteers to share information if anyone knows of her. After a brief discussion, show the short YouTube video [https://www.youtube.com/watch?v=kB1eWr1-rZk](https://www.youtube.com/watch?v=kB1eWr1-rZk) titled Lizzie Borden: The TRUE Story and the Murder House Today.

2. Pass out, “Was Lizzie Borden Guilty?” lab sheet and read through each section so students understand their roles and the instructions.

3. Assign groups (I did randomly by counting off in groups of five) and then review the stations.

4. Once all questions have been answered, allow students to get into groups and get to work—ROTATE THROUGHOUT THE ROOM TO MAKE SURE STUDENTS ARE ON TASK AND YOU CAN ANSWER ANY QUESTIONS.

**Additional Activity:** transcripts of Lizzie, Emma, and Bridget’s testimony and cross examination can be downloaded [HERE](https://www.theforensicteacher.com) Assign your students roles to read the transcripts, and see if you can tell why, without modern forensic techniques, Lizzie was acquitted.
5. When all group members are done at their first station, have them rotate to the next one.

6. Do this until the end of the period.

Day 2:

1. Ask students, “Who is your main suspect so far?” and allow students to share their answers and reasoning.

2. Continue stations until all are completed. ROTATE THROUGHOUT THE ROOM TO MAKE SURE STUDENTS ARE ON TASK AND YOU CAN ANSWER ANY QUESTIONS.

3. All students should finish the Final Analysis by the end of the period and turn work in to the teacher.

Answer Key

Activity 1: Blood evidence
Analysis: Whose blood matches the blood found at the scene of the crime? The blood found at the scene of the crime matches Lizzie’s blood
What could this mean? Lizzie was present at the time of the murder. I can infer that Lizzie possibly cut herself while bludgeoning her parents.

Activity 2: Hair evidence
Analysis: Whose hair matches the hair found at the scene of the crime? The hair at the scene of the crime matches Lizzie’s hair
What could this mean? This could mean that Lizzie was present at the time of the murder, but since she lived in the house, it could also just be a coincidence.

Activity 3: DNA Evidence
Analysis: Whose DNA matches the DNA found at the scene of the crime? Lizzie’s DNA matches the DNA found at the scene of the crime.
What could this mean? This could mean that Lizzie was present during the murder, but since she lives in the house, it could also be a coincidence.

Activity 4: Fingerprint Evidence
Analysis: Whose fingerprints matched the fingerprints found at the scene of the crime? Lizzies fingerprints match those found at the scene of the crime.
What could this mean? It could mean that Lizzie used the ax to kill her parents.

Activity 5 (to do while waiting for evidence stations to come available): Read through The Trial of Lizzie Borden Chronology. Jot down important information that you think contradicts a not guilty verdict. In other words, write down anything you find suspicious. Answers will vary, but should include pertinent information from the document

Final analysis: you have now examined all the evidence available. Your final task is to wrap up the case by identifying the guilty person(s). You must give MUCH proof in your explanation. If you do not, the criminal will never be known and this case will go unsolved. Use your scientific knowledge and your data to prove, once and for all, who was guilty! Answers will vary, but given the evidence, students should come to the conclusion that Lizzie Borden was guilty of killing her parents.
Was Lizzie Borden Guilty?

On August 4, 1892, a terrible crime occurred in Massachusetts. A man and his wife were brutally murdered with an ax. The man was Andrew Borden and his second wife, Abby Borden, were both killed in their own home. The only people home at the time were his daughter, Lizzie, and their maid, Bridgette Sullivan. There is mounting evidence and testimonies against Lizzie, yet when she went to trial, she was found not guilty. Your job is to put yourself back in 1892 in Massachusetts to solve the crime once and for all!

**Activity 1: Blood evidence**

Slide A: Evidence found at the scene of the crime
Slide B: Blood of Alice Russell, Lizzie Borden’s friend
Slide C: Blood of Bridgette Sullivan
Slide D: Blood of Lizzie Borden
Slide E: Blood of Emma Borden

Use the microscopes to look at blood samples. Compare each slide with the evidence found at the scene of the crime. On the document below, place a check in the boxes of those samples matching Slide A. If the sample does not match Slide A, put an X.

<table>
<thead>
<tr>
<th>Slide</th>
<th>Match</th>
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<tbody>
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<td>B</td>
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<td>C</td>
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<td>D</td>
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<tr>
<td>E</td>
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</table>

Analysis: Whose blood matches the blood found at the scene of the crime?

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What could this mean?

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**Activity 2: Hair evidence**

Slide F: evidence found at the scene of the crime

Slide G: hair of John Morse, Visitor to the Borden home

Slide H: hair of Bridgette Sullivan

Slide I: Hair of Lizzie Borden

Slide J: Hair of Emma Borden

Use the microscope to look at hair samples. Compare each slide with the evidence found at the scene of the crime. On the document below, place a check in the boxes of those samples that match Slide F. If the sample does not match Slide F, put an X.

<table>
<thead>
<tr>
<th>Slide</th>
<th>Match</th>
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<tbody>
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<td>G</td>
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<td>I</td>
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<td>J</td>
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Analysis: Whose hair matches the hair found at the scene of the crime?

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What could this mean?

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Activity 3: DNA Evidence

Slide K: Evidence found at the scene of the crime
Slide L: DNA of Hannah Gifford, townsperson
Slide M: DNA of Bridgette Sullivan
Slide N: DNA of Lizzie Borden
Slide O: DNA of Emma Borden

Use the magnifying glass to look at the DNA samples. Compare each slide with the evidence found at the scene of the crime. On the document below, place a check in the boxes of those samples that match Slide K. If the sample does not match Slide K, put an X.

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<th>Slide</th>
<th>Match</th>
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<td>N</td>
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<tr>
<td>O</td>
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</tbody>
</table>

Analysis: Whose DNA matches the DNA found at the scene of the crime?
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What could this mean?
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**Activity 4: Fingerprint Evidence**

Slide P: Evidence found on the ax

Slide Q: fingerprint of Lizzie Borden

Slide R: Fingerprint of Bridgette Sullivan

Slide S: Fingerprint of John Morse

Slide T: Fingerprint of Adelaide Churchill, neighbor of the Borden’s

Use the magnifying glass to look at the fingerprint samples. Compare each slide with the evidence found at the scene of the crime. On the document below, place a check in the boxes of those samples that match Slide P. If the sample does not match Slide P, put an X.

<table>
<thead>
<tr>
<th>Slide</th>
<th>Match</th>
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<tbody>
<tr>
<td>Q</td>
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<tr>
<td>R</td>
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<td>S</td>
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Analysis: Whose fingerprints match the fingerprints found at the scene of the crime?

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What could this mean?

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Activity 5 (to do while waiting for evidence station to come available)

Read through The Trial of Lizzie Borden Chronology. Jot down important information that you think contradicts a not guilty verdict. In other words, write down anything you find suspicious.

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Final analysis: you have now examined all the evidence available. Your final task is to wrap up the case by identifying the guilty person(s). You must give SUBSTANTIAL proof in your explanation. If you do not, the criminal will never be known and this case will go unsolved. Use your scientific knowledge and your data to prove, once and for all, who was guilty!
### The Trial of Lizzie Borden: Chronology

<table>
<thead>
<tr>
<th>Date</th>
<th>Event Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>December 25, 1845</strong></td>
<td>Andrew Borden, 23, marries Sarah Morse and moves into a house on 92 Second St., Fall River, Massachusetts. (Andrew would later purchase this home in 1871).</td>
</tr>
<tr>
<td><strong>July 19, 1860</strong></td>
<td>Lizzie Andrew Borden is born.</td>
</tr>
<tr>
<td><strong>March 26, 1863</strong></td>
<td>Sarah Borden, mother of Lizzie and her older sister Emma, 12, dies.</td>
</tr>
<tr>
<td><strong>June 6, 1865</strong></td>
<td>Andrew Borden remaries. His new wife is Abby Gray, age 37.</td>
</tr>
<tr>
<td><strong>1887</strong></td>
<td>Lizzie Borden stops calling her stepmother &quot;Mother.&quot;</td>
</tr>
<tr>
<td><strong>1889</strong></td>
<td>Bridget Sullivan, an Irish immigrant, begins working at the Borden home.</td>
</tr>
<tr>
<td><strong>June 24, 1891</strong></td>
<td>Daytime robbery of cash and jewelry at the Borden home (Emma, Lizzie, and Bridget are home at the time). Lizzie, who had earlier been accused of shoplifting by a local merchant, is the family's prime suspect. From this date, doors to the Borden home--inside and out--are kept locked.</td>
</tr>
<tr>
<td><strong>April 1892</strong></td>
<td>According to Hannah Gifford, a Fall River cloakmaker, Lizzie tells Gifford that Abby &quot;is a mean old thing.&quot;</td>
</tr>
<tr>
<td><strong>May or June 1892</strong></td>
<td>Andrew Borden uses a hatchet to kill pigeons in the family barn. The pigeons roosted in a barn loft that Lizzie maintained for their benefit.</td>
</tr>
<tr>
<td><strong>July 21, 1892</strong></td>
<td>Following a family disagreement, Lizzie and Emma Borden leave Fall River and travel to New Bedford.</td>
</tr>
<tr>
<td><strong>August 2, 1892</strong></td>
<td>Abby and Andrew Borden awaken, complaining of stomach sickness. Abby visits Dr. Bowen. She suggests she might have been poisoned, but Dr. Bowen is skeptical.</td>
</tr>
<tr>
<td><strong>Aug. 3, 1892: A.M.</strong></td>
<td>Lizzie reportedly tries, unsuccessfully, to buy some poison from Eli Bence at D. R. Smith's drug store.</td>
</tr>
<tr>
<td><strong>Aug. 3, 1892: P.M.</strong></td>
<td>John Morse arrives for a stay with the Bordens. Lizzie visits Alice Russell and talks forebodingly about household activities. She says she fears poisoning, that her father has enemies, and that she has seen suspicious characters around the family house. &quot;I'm afraid but that someone will do something,&quot; she says.</td>
</tr>
<tr>
<td><strong>Aug. 4, 1892: A.M.</strong></td>
<td>About 7 A.M., Abby, Andrew, and John Morse have breakfast. Afterwards, Morse and Andrew go to the sitting room while Abby begins her house cleaning chores. Bridget Sullivan goes to the backyard to throw up. Morse leaves about 8:45. Libby has a light breakfast about 9 A.M. A few minutes later, Andrew leaves the home, taking with him some letters that Lizzie asked him to mail.</td>
</tr>
<tr>
<td>Date</td>
<td>Event Description</td>
</tr>
<tr>
<td>--------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Aug. 4, 1892: 9:30 A.M.</td>
<td>Abby goes up the stairs to continue her house cleaning on the second floor. Bridget Sullivan is outdoors cleaning windows for the next hour. Sometime during the next hour, Abby Borden is killed in the guest room by 19 hatchet blows to the back of her head.</td>
</tr>
<tr>
<td>Aug. 4, 1892: 11 A.M.</td>
<td>Andrew Borden returns home carrying a small parcel. Bridget Sullivan lets Andrew into the house as she hears a muted laugh from upstairs. Lizzie visits her father briefly in the dining room, telling him that Abby had received a message and left the house. Andrew lies down in the sitting room, and Bridget goes to rest in her attic room. Andrew Borden is murdered shortly thereafter in the sitting room sofa. Lizzie calls for Bridget, saying someone had killed her father. Lizzie tells a neighbor, Adelaide Churchill, that she had been in the barn looking for &quot;irons&quot; (sinkers for an upcoming fishing trip) at the time of the murder. Shortly after 11:15, police are notified of the murders.</td>
</tr>
<tr>
<td>Aug. 4, 1892: P.M.</td>
<td>Dozens of policemen troop in and out of the Borden home. Doctors perform a post-mortem on the bodies on the dining room table. Lizzie is interrogated by Deputy Marshal Fleet. Lizzie speaks in a detached manner and when Fleet calls Abby her mother, Lizzie insists, &quot;She is not my mother--she is my step-mother.&quot;</td>
</tr>
<tr>
<td>August 6, 1892</td>
<td>An editorial in the Fall River paper criticizes the police for inaction in the Borden case. A funeral service for Andrew and Abby is held at the Borden home.</td>
</tr>
<tr>
<td>August 7, 1892</td>
<td>Emma observes Lizzie burning her blue corduroy dress in the kitchen fire.</td>
</tr>
<tr>
<td>August 9-11, 1892</td>
<td>An inquest, closed to the public, is held to consider the murders of Andrew and Abby Borden. On August 11, Lizzie Borden is arrested by Marshal Hilliard.</td>
</tr>
<tr>
<td>August 12, 1892</td>
<td>Lizzie enters a plea of &quot;Not Guilty.&quot; Lizzie is moved to a jail in Taunton, eight miles north of Fall River.</td>
</tr>
<tr>
<td>August 22-23, 1892</td>
<td>A preliminary hearing is held. Judge Josiah Blaisdell finds that there is probable cause to try Lizzie for murder.</td>
</tr>
<tr>
<td>November 31, 1892</td>
<td>Alice Russell tells the grand jury about the visit she received from Lizzie the night before the murders. The grand jury issues an indictment against Lizzie for murder two days later.</td>
</tr>
<tr>
<td>June 5, 1893</td>
<td>The trial of Lizzie Borden opens at the New Bedford Courthouse.</td>
</tr>
<tr>
<td>June 20, 1893</td>
<td>The jury returns its verdict in the Lizzie Borden trial: &quot;Not Guilty.&quot;</td>
</tr>
<tr>
<td>June 1, 1927</td>
<td>Lizzie Borden dies at age 67. Eight days later, her sister Emma dies. Both women were buried at the family burial plot in Oak Grove Cemetery in Fall River.</td>
</tr>
</tbody>
</table>
For many of our readers, by the time this issue arrives snow will be part of their world or their forecast. It looks nice, it’s pretty, and it really adds to the holiday spirit if you’re used to that sort of thing. It can also bring on a world of hurt if you’re not used to walking or driving in it. But criminals don’t care. Many crimes committed during the snowy months call for special techniques to solve them. And nothing is more telling and fragile than a snowy footprint.

On one hand it’s hard, cold (literally) evidence. On the other it’s fragile, easily erased or altered, and all of its delicate features in real danger from any heat source. What then can an investigator, or forensics teacher, do? How does one preserve the details of a suspect’s shoe?

Fortunately, there are a number of ways to solve this problem, and they represent a wonderful opportunity to take your class outside and really get their attention.

First, you’ll need to stage a series of footprints, either your own or those of a coworker. The walker should have a fair amount of detail on the bottom of their shoes, and the snow shouldn’t be light and powdery because of the danger of snow drifting or blowing into it. You’ll need to have your materials ready and brief the class on how to lift snowprints before going out. Despite your warnings some of your students won’t wear jackets. And they’ll be among the first to complain. Make everyone bundle up.

When your students find the snowprints you’ve laid down earlier, the first step will be to photograph them with a reference ruler. Because the snow is white, the sides and bottom of the print are white, and the snow around it is white, the lack of contrast in the print will make detail hard to see. However, photos should always be taken. If a light source is available (like a flashlight), shining it into the print at an angle may help make details visible to the camera.

One way to preserve snowprints is by spraying them with any of the aerosol snowprint waxes available from forensic supply companies. The waxy spray is usually red which will aid in taking photographs later. The wax solidifies when it contacts the cold snow and details are preserved. Care should be taken to keep the snowprint and the wax out of the sun which can melt both. Once a number of coats of wax are laid down and each allowed to solidify before the next is added, the print can be filled with a stronger material to aid in lifting it out of the snow. There are two commonly used.

The first of these is plaster of Paris. You can mix it up outside, or, if you’re organized and quick, you can mix it inside and keep stirring while you carry it to the print. Pour it into the print on top of the wax and allow it 20-30 minutes to harden. Plaster is relatively weak so your students might want to add small sticks to the plaster to strengthen it.

Another substance to pour into a wax-sprayed snowprint is dental stone, which also works well on footprints in dirt, mud, and sand. While a little more expensive than plaster of Paris, it is stronger and more versatile.

Likewise, sulfur can be used to make a detailed cast of snowprints. For this procedure you’ll need a small camp burner or stove, a metal pot halfway filled with sulfur, and something to stir it with. At the print site the sulfur should be heated in the pot over the burner until it all melts at just about 240°F. At this point the pot should be placed in the snow to cool near the print, and constantly stirred. When you observe tiny crystals forming on the top of the molten sulfur you’re ready to pour. For this technique to work there should be nothing in the snowprint, but air—no wax for this one. Pour the molten sulfur into the print and wait for it to solidify before attempting to lift it out. This technique works because the crystals you observed on the molten sulfur means it is ready for a phase change to solid. When it hits the fine detail of the print it will solidify as a cast before the snow has time to melt.

The above techniques can also be applied to tire prints or animal prints. With practice you and your students will be experts. Maybe you’ll get so good, so quick, and so proficient not all of you will have to wear coats.
Footprints in the
World

By Mark Feil

One way to preserve snowprints is to shine it into the print at an angle. If a light source is available (like a flashlight), photos should always be taken. If a light is white, the lack of contrast in the print is not used to walking or driving in it. You’ll also bring on a world of hurt if you’re used to that sort of thing. It can be part of their world or their time this issue arrives snow will.

Photo Crimes

The images on the next two pages comprise a crime. The idea is to present them to your students and challenge them to solve the crime by looking at the photographs and reading the descriptions.

If you want to make a class set of the pages and have your students work on them in pairs, you’re going to need a printer (and then a copier) capable of printing in color or gray scale. A printer or copier that only turns out black and white products just isn’t going to work. OR, you could transfer the images to a projector that allows every student to see them all at once.

These pages are from Scotland Yard Photo Crimes, used with permission of Dorling Kindersley Publishers. The answers are on page 23.
THE BASIL STREET INCIDENT

Whether it is the pocket, kitchen or novelty type, a knife is a threatening instrument. It is readily available, easily concealed, and of great usefulness in the commission of crimes.

1. Kenneth Hoxton loved card games but he hated losing, so he made it a point never to lose. He had recently met a few gambling men and they were due to join him in a private room at his hotel for a quiet game. He glanced around the room with satisfaction. The hotel had even provided flowers.

2. Harry Price, the first visitor, was a young mercenary just back from the Gold Coast and ready for fun.

3. The next man to appear was Arthur Bloom, representative of a firm of shipping agents. He was reputed to be a heavy gambler. Hoxton was an excellent host, and was liberal with the alcohol. Besides, he reasoned, why not get the others in cheery moods before they lost?

That afternoon, Inspector Black, at home with flu, was visited by Sergeant Randall, who told him that Hoxton had been found dead on the floor in a private room at his hotel very early that morning. He had been stabbed. The man who had played cards with him the previous evening had been questioned, but no revealing statements had been made. No fingerprints were found in the room. He was baffled—could the inspector kindly look at a few photographs he had brought with him?

What the photographs showed

7. The first showed the body. As the men had stayed very late, and most of the guests had gone to bed, no one had heard anything.

8. The second showed the chair in which Hoxton had been seated when he was stabbed. It was obvious that he had dragged himself across the room after having been wounded.
4 They sat down to play as soon as Edmund Seymour, a retired army officer and arms dealer, rushed in. He'd had to work late on an important order.

5 As usual, Hoxton lost for a while. But by ten o'clock he was winning heavily. His guests were no longer cheerful. By midnight, no one but Hoxton was laughing.

6 The men had lost far more than they could afford. Hoxton borrowed a pencil to tot up his winnings. "If I didn't know you better," Price said, "I'd think you cheated."

After the card players left, Hoxton sat down in a large, comfortable chair, loosened his tie, and put his feet up. "Another successful evening," he thought. "But not an awfully good way to make friends. These fellows won't wish to see me again too soon." But **there he was wrong.** One did return that night... A chambermaid found his body the next morning.

9 The last picture was of the card table. Randall pointed out the positions of the players. He said that entry had been gained by a French window opening on to a paved yard. No footprints were discernible.

10 Then Randall brought out the contents of the dead man's pockets — a cigarette lighter and a clean handkerchief. Predictably, Hoxton's wallet had been found empty.

The answer is on page 23.
While the primary task of a pathologist is to determine the cause and manner of medico-legal death, estimating the time since death, the post mortem interval, can provide investigators with invaluable information at the onset of an investigation. Being able to answer the question, “What time did the victim die?” with relative certainty is often of paramount importance.

Numerous methods exist which allow one to determine an estimated time since death. While no one method can definitively determine the time since death, algor mortis, the cooling of the body after death, is viewed as a reliable tool to ascertain time since death. In environments that are cooler than human body temperature (37 degrees Celsius), the body temperature cools post mortem until the ambient temperature is matched.

Many of the algor mortis formulas in use today are based upon Newton’s Laws of Cooling and assume a loss of 0.32 to 0.78 degrees Celsius per hour post mortem. The cooling rate is relatively uniform within the body core throughout the process. However, there is little to no temperature loss the first 30 minutes after death and temperature loss gradually decreases as the temperature of the environment is approached. When estimating the time since death other variables such as amount of clothing, environmental conditions, body location, and wind speed can influence the rate of cooling dramatically. The typical algor mortis formula does not address this myriad of variables. Henssge’s Nomogram was developed to address body and environmental conditions that affect algor mortis so the percent error rate could be minimized.

Claus Henssge developed two nomograms. These diagrams represent the relationship between three or more variables by means of a simple geometrical construction. One can determine the approximate time since death using the ambient temperature at the crime scene and the rectal temperature of the victim when found. One version of the nomogram is for ambient temperatures below 23 degrees Celsius; the other is for ambient temperatures above 23 degrees Celsius. Each nomogram works in conjunction with normal environmental conditions, corrective factors, and can give a time since death with minimal error. Because of copyright issues we’re not going to present the list of corrective factors here, but they can be accessed at:

https://docs.google.com/file/d/0By2F4CLPbpKmOTJmMTYzNDItMTdMC00MzA1LWFlZmZDcyZDAvNWUxYjlyZTk4/edit

They should be given to students using the nomogram.

To use Henssge’s Nomogram, one must know a number of factors at the onset. These factors include: the ambient temperature at the crime scene, the victim’s rectal temperature, the amount of clothing on the victim, if any, the air flow and if the body is wet or submerged (see corrective factors from above.) For illustrative purposes, let’s assume a 52 Kg victim with a rectal temperature of 23 degrees Celsius with 2 layers of thick clothing was found outside in 17 degrees Celsius air with a slight breeze. In this example, one would use the nomogram for ambient temperatures for up to 23 degrees Celsius. Feel free to follow along at https://www.youtube.com/watch?v=SawVmpy4gBQ&feature=youtu.be.

IMPORTANT: For the demonstration, and for your students you’ll need copies of the nomogram for both above and below 23° C. The blurred out image below is protected by copyright and fees, which makes publication here problematic, but you can get yours to distribute to your students at a number of places on the web including https://www.rechtsmedizin.uni-bonn.de/dienstleistungen/for_Med/todeszeit.pdf or by doing a Google search.
Meanwhile, a general graphic is presented below to use with these directions to get a general idea of using the nomogram. First, a straight line (blue) is drawn between the rectal temperatures (23), found on the left of the nomogram, and the ambient temperature (17), found on the right of the nomogram. This line will cross the black diagonal of the nomogram at a special point (yellow).

Finally, depending on the body condition when discovered, one should add the correct permissible variation of 95% found on the outermost semicircle. In this example, the victim was found with clothing and corrective factors were used, so a plus or minus 4.5 hours would be added to the time since death resulting in a time since death of 20 ±4.5 Hrs (or 15.5 hrs to 24.5 hrs since time of death).

If you or your students don’t have the time or inclination to use Henssge’s Nomogram, an on-line, non-graphic version is available at: http://www.swisswuff.ch/calculators/todeszeit.php.

In addition to rectal temperature nomograms, brain nomograms have been developed and are precise in determining time since death for up to 6.5 hours post-mortem. You can learn more about the brain nomogram at: https://www.youtube.com/watch?v=FOXmfVgXb1

The Henssge Nomogram technique for estimating the time since death is a widely accepted tool used by forensic pathologists and is accessible to students. Providing a real pathology tool with realistic case descriptions allows students to assume the role of a pathologist and answer the question, “What time did the victim die?”

Next, locate the corrected mass nearest to the computed value, in this case 62 is rounded down to 60 Kg, on either side of the semicircles. Follow the corresponding semicircle around until you come to the second line you drew. Either above or just to the right of the semicircle, a number or a number marking will be present which indicates the time since death. In this example, a number marking with a value of 20 is intersected. Again, this is made clear at https://www.youtube.com/watch?v=SawVmpy4gBQ&feature=youtu.be.

Answers to practice problems

First set

1. 5± 2.8 Hrs
2. 2.2± 2.8 Hrs
3. More than 30 Hrs
4. 8.9± 2.8 Hrs
5. ~17 Hrs

Second set using corrective factors.

1. 71 x 1.1= 78.1 kg 20±4.5 Hrs
2. 52 x 2.4= 124.8 kg 12.5±2.8 Hrs
3. 100 x 0.5= 50 kg 19±7 Hrs
4. 61 x 0.7= 42.7 kg 38±2.8 Hrs
Practice Problems

Directions: Using Henssge’s nomogram compute a time since death for the following problems.

1. A female was found deceased inside her apartment. The ambient temperature is 24°C; rectal temperature is 33°C; and the body mass is 42 Kg.

2. A female was found deceased in the woods. The ambient temperature is 23°C; rectal temperature is 36°C; and the body mass is 52 Kg.

3. A male was found deceased under a vehicle. The investigating officer took the following data at the crime scene: The temperature of the rectum is 27°C; air temperature 23°C; and the body mass is 140 Kg.

4. A female was found deceased in dumpster. The ambient temperature is 29°C; rectal temperature is 34°C; and body mass is 61 Kg.

5. A deceased male was found in an alley. The ambient temperature is 24°C; rectal temperature is 30°C; and the body mass is 90 Kg.

Directions: Using Henssge’s nomogram compute a time since death for the following problems. Use corrective factors.

1. A male with one layer of cloths was found deceased inside a vehicle with the windows open. The ambient temperature is 12°C; rectal temperature is 22°C; body mass is 71 Kg.

2. A female wearing a nightgown was found deceased in her bed with a thick bedspread. The ambient temperature is 19°C; rectal temperature is 33°C; body mass is 52 Kg.

3.

4. A male was found deceased in a pool. The investigating officer took the following data at the crime scene: Temperature of the rectum 27°C; pool water temperature 23°C; body mass 100Kg.

5. A clothed female was found deceased on the edge of a river. The ambient temperature is -2°C; rectal temperature is 31°C; and body mass is 61 Kg.
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Fiber evidence can be found at crime scenes in a number of different ways. In personal contact between the clothing of a suspect and a victim, cross-transfers may occur. In a break-in, fibers can become fixed to window screens, or broken glass. If a fight occurs, fibers can become fixed to a number of objects. In an auto accident, fibers, threads, or even pieces of clothing may adhere to parts of a vehicle.

Fiber analysis does not follow any set procedure. Microscopic examination of both longitudinal and cross sectional samples is generally used. Additional tests such as burning tests and solubility tests can also determine the identity of a fiber. Solubility tests are generally beyond the capabilities of most classroom procedures due to solvents required.

Color tests for fibers are also applied using special stains. Since most fibers are colored, dyes must be stripped from the fibers before using the dyeing test. Reagents and procedures required for stripping colors from fibers are generally beyond most classroom procedures and require a laboratory.

**Materials**

- Clear tape (Scotch tape or equivalent)
- Microscope, 30x or 40x comparison microscope
- Microscope, compound, 100x, and greater magnification
- Paper, white (or dark colored paper if you are wearing white clothing.)
- Known fiber samples such as wool, cotton, nylon, etc… (easily obtainable from a thrift store)
- At least one unknown fiber sample of a different color than its known exemplar
- Forceps
- Microscope slides (plastic preferred)
- Cover slips
- Water dropper

**Procedure**

Comparing fibers from your clothing

Pick up fibers from your clothing with a piece of clear tape. Place the tape on a piece of white paper. (Note: If you are wearing white clothing, place the tape on a sheet of dark colored paper) Examine under a microscope. All 30x or 40x binocular comparison microscopes are adequate for this activity. 100x or higher power microscopes are preferred for detailed examination.

Natural fibers tend to look like hair and will often have rough external surfaces. Plant fibers, such as cotton, may be more ribbon shaped and may contain twists at irregular intervals. Synthetic fibers tend to be smooth and uniform and some may have long extrusion lines on the outer layer.

You always leave trace fibers when you are in contact with another object. Take a piece of clear tape and use it to pick up fibers from several places on your chair. Place the tape on the piece of white paper near the tape with fibers from your clothing. Use the microscope to see if you can identify fibers from your clothing that were on the chair.
Examining known fibers

Place a sample of a known fiber on a microscope slide. Examine it at 30x or 40x under a comparison microscope. Use forceps to handle the fibers. Record the name, appearance, and general properties of the fiber. Draw a sketch of the fiber structure.

For higher magnification studies, place a drop of water on the fiber and cover with a cover slip. Examine the fiber under a compound microscope with magnifications of 100x and 400x. Record the name, appearance, and general properties of the fiber. Draw a sketch of the fiber.

Better identification of fibers is obtained by microscopic examination of fiber cross sections. In this procedure, a bundle of fibers or a piece of yarn is threaded through a cork with needle. Then a very thin slice of the cork is cut using a razor blade. The fibers held in the slice of cork are then viewed under a microscope. This procedure requires advanced techniques that may not be possible in your classroom.

Place a sample of an unknown fiber on a microscope slide. Examine it at 30x or 40x under a comparison microscope. Use forceps to handle the fibers. Record the name, appearance, and general properties of the fiber. Draw a sketch of the fiber structure. Can you tell what it is?

How have fibers helped solve crimes? Ask your students to visit the websites below and find out. You have a number of options:

- Ask small groups to report on the information found at a link they’ve been assigned to. Ask the class to compare.
- Ask students to examine multiple sites and report on why and how fibers were important.
- Ask small groups to examine all the evidence found by investigators in the case and where the investigation would have gone without fiber evidence.


http://abcnews.go.com/gma/story?id=125152


Other cases can be found via a Google search.
Burning Tests for Fibers
A flame is applied to the end of the fibers, yarn, or cloth.

Materials

- Clear tape (Scotch tape or equivalent)
- Microscope, 30x or 40x comparison microscope
- Microscope, compound, 100x, and greater magnification (optional)
- Paper, white (or dark colored paper if you are wearing white clothing.)
- Known fiber samples such as wool, cotton, nylon, etc… (easily obtainable from a thrift store)
- At least one unknown fiber sample of a different color than its known exemplar
- Forceps
- Something to protect table surfaces from hot ash or residue like aluminum foil or an aluminum pie plate, both available at Dollar stores.

Safety Precautions

The forceps used will get hot. Allow the forceps to cool before handling the tips that were in the fire.

Place any hot or smoldering fibers on a flameproof surface. Allow them to cool before discarding.

Procedure

1. Light a candle or a Bunsen burner
2. Holding a fiber, bring it close, but not in direct contact, to the flame. Does the fiber melt, ignite, or curl? Record your observations.
3. Touch the fiber to the edge of the flame. Does the fiber ignite quickly or slowly? Does it sputter, melt, or drip? Record your observations.
4. Remove the fiber from the flame. Does it continue to burn? Does it glow and smolder? Does it self-extinguish? Record your observations.

- If you note the odor of burning hair: fiber is probably silk or wool.
- If you note the odor of burning paper: fiber is probably cotton, Rayon, or linen.
- If the fiber melts and forms beads: fiber is probably acetate, polyester, Dacron, Dynel, nylon, or Orlon.
- If the fiber does not burn: fiber is probably asbestos or a glass fiber.
## Burning tests for fibers

<table>
<thead>
<tr>
<th>Fiber</th>
<th>Results near flame</th>
<th>Type of burning in flame</th>
<th>Results when removed from flame</th>
<th>Odor</th>
<th>Residue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wool</td>
<td></td>
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<tr>
<td>Cotton</td>
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<tr>
<td>Silk</td>
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<tr>
<td>Rayon</td>
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<tr>
<td>Polyester</td>
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<td>acrylic</td>
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<tr>
<td>Linen</td>
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<tr>
<td>Nylon</td>
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<tr>
<td>UNKNOWN #1</td>
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<td>UNKNOWN #2</td>
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</table>
Dyeing Tests for Fibers

Dyeing tests involve the use of T.I.S. Identification stains (available from Testfabrics, Inc., www.testfabrics.com). These are special mixtures of dyes that color different fibers different colors. Since most fibers obtained from a crime scene are colored, they must be stripped of dyes before applying the dyeing tests. The stripping procedures are beyond those of most classrooms.

Materials

- Fiber samples: wool, cotton, silk, rayon, polyester, etc.
- Multifiber fabric #43, (available from Testfabrics, Inc.)
- Forceps or crucible tongs
- Beaker tongs
- Hot plate
- T.I.S. Stain No.1
- T.I.S. Stain No. 3A
- 5% acetic acid, HC₂H₃O₂, (vinegar)
- 2 beakers, 400 mL or 600 mL
- Disposable gloves

Safety Precautions

Wear safety goggles at all times in the laboratory.

The TIS stains will stain your skin and clothing. Wear disposable gloves and handle all cloth samples with forceps or tongs.

The TIS stains are used at boiling water temperature. Handle the beakers with beaker tongs.

Procedure

T.I.S. Stain no. 1 is recommended for use with natural fibers. T.I.S. Stain no. 3A is recommended for synthetic fibers. Using both stain solutions provides a better match as you will have two colors to use for fiber identification.

T.I.S. Stain no. 1:

1. To identify fibers or cloth samples, prepare a 1% solution (w/v) of T.I.S. Identification Stain No. 1. Heat the solution to boiling. Maintain a hot, but not actively boiling solution.

2. Wet the fiber or cloth, along with a strip of multifiber fabric, with distilled or de-ionized water. Squeeze out the excess liquid and place the samples in the hot dye bath for 3 to 5 minutes.

3. Remove the samples and wash out any excess dye.
4. Compare the color of the fiber or cloth samples with the multifiber fabric.

T.I.S. Stain no. 3A:

1. To identify fibers known to be synthetic, prepare a 0.05% solution of T.I.S. Identification Stain No. 3A. (0.05 g for each 100 mL water) Heat the solution to boiling and add 2 mL 5% acetic acid solution for each 100 mL of solution. Maintain a hot, but not actively boiling solution.

2. Wet the fiber or cloth, along with a strip of multifiber fabric, with distilled or de-ionized water. Squeeze out the excess liquid and place the samples in the hot dye bath for five minutes.

3. Remove the samples and wash out any excess dye.

4. Compare the color of the fiber or cloth samples with the multifiber fabric. (See Figure F-2)

Figure F-2: T.I.S. Identification stains and fiber colors.
FORENSICS

Data and Results

Name _______________________________________  Course and Section _______________

Partner(s) ________________________________________  Date _______________________

Fiber analysis

Were you able to identify fibers from your clothing that were on the chair? Explain.

Identification of known fibers – microscopic identification

<table>
<thead>
<tr>
<th>Name of fiber</th>
<th>Characteristics of the fiber</th>
<th>Sketch of the fiber</th>
</tr>
</thead>
</table>

Dyeing Tests for Fibers

Were you able to identify the fibers or fabric using the T.I.S. stains? Explain. (Tell how the colors of the dyed fibers compared with those of the reference colors (multifiber fabric)?)
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Ask the Morgue Guy

Q: I first learned about the theft when another teacher brought it to my attention. Apparently, one of my students has been dusting for fingerprints in other classrooms. But he or she didn’t do it at their own desk, which would have made identifying the culprit easy. No, they dusted a print near the door for everyone to see. The trouble was, none of the students remembered seeing anyone, or at least they weren’t talking. Now, I’ve been contacted by half a dozen teachers with similar displays in their classrooms, and I observed a couple of prints on lockers in the hallways. Any ideas on how to track down the serial finger-printer?

A: Actually, this is going to be easier than you thought. When you did your unit on fingerprints you made quite an impression on your students. You were not going to get anywhere by offering a reward because now it is a game. This isn’t like regular vandalism in the students’ eyes because nothing is being destroyed, and truth be told, making a fingerprint visible is pretty cool. But most students are wonderfully shortsighted and this is how you will nail him or her.

Graffiti artists don’t spray paint words they pick out of a hat. They use their skills to tell the world something about themselves. Usually, this is the name of their gang, where they live, or something special that makes their artwork all about them.

Hopefully, when you did your units on fingerprints, you got a 10-card from all of your students. Visit the new crime scenes and use scotch tape to lift prints before placing them on an index card. Challenge your students to look at the photocopied evidence and that class’s 10-cards, and you’ll have your thief before you know it.

Online (and otherwise) forensic education opportunities

http://projects.nfstc.org/ Free. A variety of subjects sponsored by the National Forensic Science Technology Center who works closely with the National Institute of Justice and others.

http://www.nij.gov/training/Pages/forensics.aspx No Fee for many. Sponsored by the National Institute of Justice this site features courses both online and in a classroom.

http://forensicscience.ufl.edu/ Online degree programs in forensic science from the University of Florida.

https://www.ashworthcollege.edu/career-diplomas/forensic-science-training/ An online certificate program from Ashworth College.

http://www.amu.apus.edu/lp2/forensics/undergraduate-certificate.htm/ An online certificate program from the American Military University. Some family military affiliation may be required.

http://www.bestvalueschools.com/cheap/online/forensic-science-degree-programs-bachelors/ If you’re serious about getting an online forensics degree this site breaks down five institutions by cost.

http://www.guidetoonlineschools.com/degrees/criminal-justice/forensic-science A guide to a number of online forensic science degrees with reviews, information about each, and tuition costs. Of course, it may be possible to take courses without finishing a degree for targeted, personal development.

https://www.forensicscienceeducation.org/forensic-education/courses-and-workshops/ The Center For Forensic Science Research & Education has a rolling schedule of both online and in-person courses.

https://webdata.aafs.org/public/Meetings/Listings.aspx American Academy Of Forensic Sciences Meetings Listings. Many of these meetings are open to educators.

https://www.forensiced.org/index.cfm Offers online forensic education and training.
Going On?

http://www.henryleeinstitute.com/. The Henry C. Lee Institute Of Forensic Science offers training at their location. Check back as new courses are always being added.

https://sites.uco.edu/forensics/z%20HS%20Teacher%20FSI%20training%20and%20Curriculum/index.asp. University Of Central Oklahoma Forensic Science Institute offers forensic training to middle and high school teachers during the summer.

Do you or your organization have a workshop, seminar, conference, training opportunity, or announcement you'd like to share and have included free? Please email us at admin@theforensicteacher.com and tell us about it!

Just for Fun
Go Outside

Many readers find themselves experiencing colder temperatures this time of year, and that can be a good thing. Sure, some outdoor forensic-related activities like decomposition won’t work in a snowy field, but others are full of possibilities. One of them is footwear impressions.

One doesn’t have to look too hard online to find a criminal who was caught because he left tracks in the snow. If your school has land around it and a fresh blanket of snow you’ve got everything you need to stage a crime scene. Unfortunately, the more people who examine a set of tracks, the more the evidence will be compromised. Ideally, you either have only one or a couple sections of forensics and you have the real estate to stage numerous scenes. On the other hand, a little creativity can go a long way.

An example of a scenario might go like this: one set of impressions heads across a snowy area. Another set approaches the first and they eventually meet. If you want to convey a predator the second set will become farther apart as the attacker runs down his prey. If the two knew each other the first set might stop, turn, and wait for the second. Where they meet will be a blizzard of impressions and some blood, then only the attacker’s prints leaving. You can add other impressions where the ME’s office people retrieved the body, and you can place clues from both individuals in the snow.

If you have little land and lots of students you can set up the scene and take video as an investigator walks and describes what he or she sees and finds.
Stoopid Crooks

The police just dream about geniuses like these guys...

Chandler Ridge Carlyle, 18, of Palm Beach, Florida asked a friend if he could borrow his iPhone, but somehow forgot to return it. When Carlyle went home with the phone the angry friend called 911 to report a theft. Police texted the phone asking Carlyle to return it, but when they didn’t get a response they placed a FaceTime call (like Skype for Android readers). When Carlyle answered, the deputy took a photo of him, picked him up, and charged him with grand larceny.

Law enforcement in Charlotte, North Carolina got a tip about a cockfighting operation going on at a home, so they paid the owner a visit. When they knocked on the door it was answered by Cody Xiong who had apparently never heard of lying. Xiong looked at the cops, breathed a resigned sigh, and said, “I guess you’re here about the opium.” Cockfighting forgotten, the policemen followed Xiong to the backyard where 2,000 opium plants were in full bloom. The harvest, which took cops days to collect, was worth an estimated $500 million. As a side note, a further search turned up 80 chickens which were also confiscated.

Scott Lattin, a disabled veteran, living in Whitney, Texas wrote “Police lives matter” on the rear window of his pickup truck, and tied blue ribbons to the bumper to show his support for law enforcement. Unfortunately, he was targeted by individuals who didn’t share his views and awoke one morning to find “Black lives matter” written along the length of his truck in spray paint. Lattin reported the crime and the police started an investigation. He then started a GoFundMe campaign to help pay for the damages, and hosted a TV crew from Houston who wanted to interview him. He noted the vandals had slashed the seats and ripped the door off the glove box. Unfortunately for Lattin, the damage to the truck’s interior wasn’t observed by police investigators when they inspected it, and he was quickly arrested.

A 911 operator in Volusia County, Florida answered a call from Alan McCarty of Milton, Florida who called to report a “crime that was about to happen.” He told the dispatcher he had a gun trained on the county courthouse so he could execute a particular judge when police brought her out as per his demands. Apparently, McCarty was unaware phone calls can be traced. Courthouse workers recognized his voice from threatening voicemails he’d previously made. McCarty was soon arrested at his home and is facing several charges.

In what seems to be a growing trend, Johnathan Hewett of West Palm Beach, Florida broke into a house and his face was captured on video including a distinctive neck tattoo and another on his face. The homeowner knew Hewett, which helped police identify him, as did a quick search of the county jail’s tattoo database.

Glenna Duram, 46, of White Cloud, Michigan was found guilty of shooting her husband, Martin, five times resulting in his death. Martin’s ex-wife, Christina Keller took ownership of a pet parrot after Glenna was arrested and charged with first degree murder. Keller told police the bird kept saying, “Don’t (explicative) shoot” in her husband’s voice.

Twenty six year-old Emily Morin of Concord, New Hampshire was arrested for drug possession and was released after making bail. Feeling possessive, Morin soon returned to the police station to demand the return of her drugs. She was then rearrested.
Stoopid Movies

More stoopid criminals; these guys are priceless.

Click on the cameras below to see the movies (internet connection required).