THE CHEMISTRY OF Forensics

By Allison Byrum Proffitt

TODAY, G. MICHELE YEZZO'S SAMPLE COMES IN A paper bag — no sterile reagent bottles for her. "Unlike other areas of chemistry, much of our evidence is not nice, pristine pieces of metal or paper or chemicals in test tubes or bottles," she says.

Yezzo is a forensic scientist in the Trace Evidence Analysis Unit of the State of Ohio Bureau of Criminal Identification and Investigation (a section of the Ohio Attorney General's Office). In the case of a hit-and-run fatality, Yezzo mentions as an example, "someone's clothing has been submitted and their clothing may have a clue as to who hit them."

Collecting and analyzing these clues from clothing, weapons, or other samples found at a crime scene is the job of a forensic chemist. The term 'forensics' encompasses many different areas and types of work. Forensic chemists (as opposed to forensic psychologists, anthropologists, digital experts, or other professionals) analyze evidence using chemistry.

This time, Yezzo's bag of clothing contains the uniform of a police officer who was struck and killed by a vehicle. Yezzo gathered evidence from the clothing and used it to provide detectives with information useful to their investigation.

Chipping away at the evidence

Yezzo collected paint chips from the victim's clothing and analyzed her findings using an international database of vehicular paint samples called Paint Data Query (PDQ). "The analysis involves microscopic examination of the samples to determine color, layer structure, and appearance," she says. Paint chips are analyzed via Fourier Transform Infrared Spectrometry (FTIR). "This process involves identifying organic and inorganic components of the paint." By searching for this information in the PDQ database, the analysis yields the manufacturer, model(s), and year(s) of vehicles that are possible matches for the paint sample.

A good deal of a forensic chemist's work is instrumental analysis, says Darrell Davis, laboratory director at the Drug Enforcement Administration's (DEA) South Central Laboratory in Dallas, Texas. Davis has been a forensic chemist for over 29 years with DEA, originally on the bench analyzing samples for the presence of controlled substances at the Southwest Laboratory in San Diego, and later managing the DEA lab in Dallas.

COURTESY OF DEA LABORATORY, DALLAS

Forensic chemists Dale Norwood, Kiana Hamlet, Angel Ramirez, and Darrell Davis at the DEA Laboratory in Dallas, TX.

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Davis says that the DEA's work is "mostly analytical [chemistry], both qualitative and quantitative. We not only identify the controlled substance and its constituents … we also quantitate the controlled substance to let the courts and special agents know how pure the sample is. For example, we might analyze a kilogram of a cocaine-like substance and determine that 80% of that weight is pure cocaine."

In order to do these analyses, the chemists in Davis' lab use mass spectrometry, infrared spectroscopy (IR), gas chromatography (GC), and liquid chromatography (LC). "We also use NMR [nuclear magnetic resonance] on the more complex types of samples."

Jennifer Bresett is a serologist at the Baltimore City Police Department and her job consists of analyzing evidence from cases for biological fluids — blood, saliva, semen — to be tested for DNA. "We do chemical tests; we test to see if the evidence is actually blood, or if there is seminal fluid present, or if microscopically we can identify sperm. A lot of [the tests] are color change tests. We do an LMG [leucomalachite green] test, which is a presumptive test for blood; we do HemaTrace and p30 cards, which are confirmatory tests for blood and seminal fluid… We have reagents that are specifically made to identify what type of fluid or biological material you have." Once Bresett has identified any biological fluids, she packages the sample and sends it to the DNA lab.

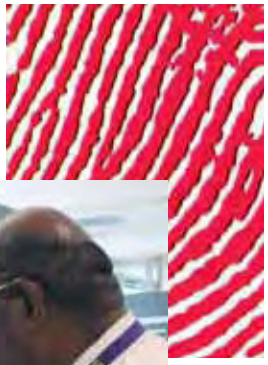
Taking the forensic path

All of these individuals graduated with degrees in chemistry, and later found their way into forensics. Davis interviewed with DEA at a National Organization for the Professional Advancement of Black Chemists and Chemical Engineers (NOBCChE) conference in 1979 and began work after graduation. Yezzo earned a bachelor's degree in comprehensive sciences with a concentration in chemistry and biology and a minor in criminal justice. Originally, Bresett was enrolled in a chemistry/pre-pharmacy program. However, after hearing a forensic chemist speak at an ACS meeting and trying a forensics internship, she kept a major in chemistry, tailored her coursework toward forensics, and completed an internship at the Baltimore City Police Department. Recently, she finished her master's in forensic science.

Each of these professionals stresses the importance of having both a strong science background and an internship in forensics. In fact, a chemistry-heavy background is often required. DEA requires at least 30 semester hours of chemistry, and most other laboratories are similar. DNA departments often require additional coursework in genetics, molecular biology, biochemistry, and statistics. "Not everyone understands how much science is involved in forensics," says Bresett. "[Students] need to be in a strong science program."

Hands-on experience is also crucial. Yezzo, who has been a forensic scientist for over 30 years, highly recommends internships. She points out that forensics isn't for everyone: "People may decide, 'Gee, I'm scared of blood,' or 'Gee, I don't want to handle firearms.'" She believes internships prevent these sorts of surprises for both the employee and employer.

Internships or job shadowing also help students identify which areas of forensics they may want to pursue. Jimmie Oxley, a professor of chemistry at the University of Rhode Island and the head of its forensics program, encourages students to think outside the box, and consider the many possibilities beyond crime labs. "They often think that doing forensics means only one thing: working in a crime lab.



COURTESY OF DEA LABORATORY, DALLAS

Forensic chemist Norwood and laboratory director Davis review IR spectra.

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Yet there are only about 400 crime labs in the nation. So students need to know that forensic scientists also work in many other settings." She reels off the list: private firms, paternity suits, drug testing, and "determining why this bridge fell down and whose fault it is." "I try to help students realize that 'this, too, is forensics,'" she says.

Bresett agrees. "[Students] need to [be] checking out different labs, talking to different units… Forensics is so wide; you can go into serology, drugs, latents [analyzing fingerprints left at a crime scene], so you need to go and see what each one's like and what you think you'd like to do."

Communicating and cooperating

Of course, forensics doesn't all happen in the laboratory. Forensic chemists are also asked to communicate with detectives and law enforcement officers, and testify in court. "It's probably 80% in the lab," Bresett says of her time, "and then you write your reports and distribute them and spend the rest of the time talking with people to learn more about the cases you're working on. After you send in your report, you may be asked to go to court to testify."

"The job's never finished until the paperwork's done," Yezzo jokes. "Take copious notes," she advises. "Working in this field, there are a few important keys to success: good note-taking, communication, and science. I can't say one over the other... It's a combination; you've got to have all three."

Yezzo says cooperation is essential to forensics. "Unlike Grissom [from the TV show CSI], we do rely on people with expertise in other areas, and it's a team approach. I can't stress enough the fact that in forensics we rely on people from other specialties and work together. [It] creates a much better situation as far as the potential for solving any given case."

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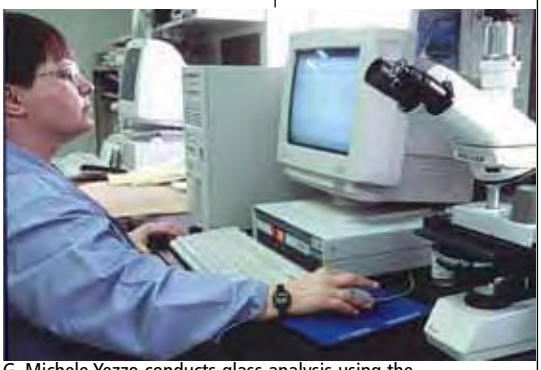
Closing the case

The joy of solving the case is what really captures the forensic scientist's excitement. "Truthfully, I never have a boring day, and there are not many people who can say that," says Yezzo. "Sometimes it's difficult because you look at the downside of life and what people can do to one another. But the upside is that if you help solve a crime, then that person's not going to go out and commit that act on someone else."

The heart of criminal forensics is solving cases based on the science. "We've had cases where detectives submit the evidence, clearly expecting us to prove that a certain individual did it," says Yezzo. "In fact, we sometimes end up proving that the individual under suspicion didn't do it. That's a really good part of our job as well. Using our scientific knowledge and methods, we can not only confirm the guilty, but also exonerate the innocent."

Maintaining high standards

But with knowledge comes responsibility. Davis believes that especially since the 1994 O.J. Simpson trial, forensics is under a microscope (no pun intended). "Our field is being scrutinized more and more by the court systems and by the general public because we represent 'truth and justice' in our findings. Because of the nature of the job, forensic scientists are held to a high standard."



G. Michele Yezzo conducts glass analysis using the Glass Refractive Index Measurement instrument.

Consequently, Davis believes integrity to be essential to the job. "We have to know that our chemists are following the policies and procedures that are set forth in the best practices of analyzing controlled substances," he says. "You want to make sure you get people who don't take shortcuts. It always comes back to integrity."

"In our job, the drugs have no face, no ethnicity to them whatsoever. It's white powder; it's brown powder; it's red tablets; it's clear liquid. We analyze it for the presence of controlled substances, pure and simple," says Davis. "We have a mission and we can see the end result. That's the plus that I enjoy about it: looking for the unknown and then finding it and reporting it. This is a great career."

Filling the pipeline

"Unfortunately or fortunately," Davis says, "there is job stability working with forensics, because crime is not going away." But he welcomes company in his quest. "I don't believe we have enough candidates for all the jobs we have in forensics," he says.

The field is still certainly accessible to graduates with bachelor's degrees, and it's seeing an influx of master's degrees and even Ph.D.s. The requirements are still the same: "We're looking for people who have the science background," says Davis.

While Bresett was finishing her science-heavy, forensic science professional master's program at Towson University, she was working full time as a serologist. At Towson, "There were two adjunct professors from the crime lab, which was nice because it made the coursework more hands-on. They know what you're going to do, so they prepare you for it," she says.

Though her schedule was incredibly busy, Bresett found that her coursework and lab work complemented each other. "I think it was great because everything went hand-in-hand… I would leave work and rather than go home and study what I'd learned, I'd go to school and learn more."

Bresett took microscopy and serology classes that are enhancing her current job, and DNA classes that will help her move into a DNA position in the future. She's preparing for a career of growth. With so many different types of forensic work and such a rapidly-growing field, the opportunities are endless – even if they aren't always true to TV.

"Almost every speaker we have says, 'Unlike CSI…,' but CSI does accomplish something very good in that it gets [students] interested in the first place," says Oxley. And that interest, coupled with a strong chemistry background, opens many doors. IC

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