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A Conversation with José Almirall

Louisa Dalton

The forensic chemist talks about fire investigations and standardization in forensic science.

José Almirall started his career 31 years ago in the forensic science laboratory of the Miami-Dade police department. Now a professor at Florida International University, he develops analytical tools for forensic investigators, including matching broken glass shards to their source using trace-element analysis and detecting crime-related volatiles, such as those found in drugs or gunshot residue. Almirall is a leader in standardizing and improving the methods used in many types of forensic science. He recently chaired an American Association for the Advancement of Science (AAAS) working group on the current quality of fire scene investigations and fire debris analysis. He talked with Louisa Dalton about the complex chemistry of fire and about what forensic tools and standards are needed to safeguard justice in courts.

The AAAS working group you chaired set out to identify critical issues in the field of fire investigations. What are some unique challenges of fire investigations?

Fire is a very complicated process. We don't have a complete understanding of fire chemistry and the physics involved. It is uncontrolled. Every scene is different, every house is different, every building is different. And there is extensive destruction of the evidence by the fire or the firefighters. They pour water over everything—so there goes your evidence. It is not surprising that just slightly over 20% of all arson cases ever eventually find some resolution in court. Of all major crimes, arson has the lowest rate of conclusion.

A very good guide exists, the National Fire Protection Association (NFPA) 921 Guide for Fire and Explosion Investigations. However, not all fire investigators follow it. A major problem is that a lot of people rely on subjective determinations and judgments—things that have been passed down from generation to generation of fire investigators. And some of those things are wrong.

Credit: Florida International University

What are fire investigators looking for at a fire scene?

Fire investigators determine the cause and origin of a fire. They are often first responders, part of law enforcement or fire departments. They determine whether it was intentionally set or whether it was an accident.

If they suspect that there has been an intentionally set fire, they want to locate any evidence of an ignitable liquid residue. Locating the origin of the fire helps them to collect debris that may contain certain compounds that are indicative of, say, gasoline or isoparaffinic products.

How do they know what to look for?

Canine detection teams help. They are trained to alert to the presence of ignitable liquid residues in debris from a fire.

Later, fire debris analysis takes place in the laboratory by scientists, chemists usually. Examiners liberate all the volatiles that adhered to the surface of the debris and inject that into a gas chromatograph–mass spectrometer.

Fire debris analysis is fairly mature, but still incomplete. As you can imagine, there is a whole universe of possible flammable liquids that somebody could use to intentionally

Published: August 11, 2017

DOI: 10.1021/acscentsci.7b00357
ACS Cent. Sci. 2017, 3, 812−813

set a fire. Between 70 and 80% of all fires set by ignitable liquids are set by gasoline. But there are other things—diesel fuel, paint thinners. A fire debris examiner has to be able to identify that in the midst of burned material.

We have done a lot of research in my group looking at chemical markers to differentiate between ignitable liquids and pyrolysis products—combustion products from burning plastic, burning foam, or burning furniture.

If you find trace evidence of an ignitable liquid, how certain are you that the fire was intentionally set?

Well, it depends. If you find it on the 19th floor in a penthouse in the middle of the living room, that would be an unusual find. But if you find it in my garage, maybe that is not so unusual. There is a lot that goes on in an investigation to look for context. It also really depends on the nature of the fire: How hot was it, how long did it burn, and where were those accelerants? If they were in an area that got really, really hot, then you won't expect to find any residues. But most of the time, you do, because a lot of these residues adsorb onto the surfaces of burned debris. They stick around. We have very good techniques to liberate and detect them. One method used in fire analysis detects 0.1 μL of gasoline left at the scene of a fire, even if that gasoline is weathered and burned.

Do any cases stick in your mind where this was particularly challenging?

I investigated a fire from a home in rural Florida. The owner of the house decided to make his two children some french fries. He fell asleep on the sofa watching TV while the oil was heating up. Eventually the oil caught fire. It burned down his house. The fire department came to investigate. After listening to his story, they put the pan outside, where it sat for 3 days. Eventually, the insurance investigator took the pan and found some isoparaffinic products, which are indicative of many ignitable liquids. Those shouldn't be in a frying pan. By that determination, the laboratory determined there was ignitable liquid residue and the investigators determined that it was intentionally set. The homeowner was criminally charged. He said, "No! I would not set my house on fire." I looked at the analytical results and, sure enough, there were some isoparaffinic products.

After looking at that evidence, I couldn't sleep that night. "This doesn't make sense", I thought. Then it came to me: This is summertime in Florida, and they spray for mosquitoes. You can smell it in the air. Those mosquito sprays contain isoparaffinic products. It is entirely plausible that, during one of those sprays, enough pesticide spray could deposit and adhere to the frying pan. Once they got my report and my possible explanation, the insurance company decided to pay the claim and the criminal case was dropped on the homeowner.

Can a fire analysis standard require scientists to look for other possible explanations like you did in that case?

What you have to do is use the scientific method and say, "This explanation is left when you exclude every other possibility." So you have a hypothesis—this was set intentionally. Then, you have to eliminate all the other alternative hypotheses. That is really difficult to do.

That is what NFPA-921 advises that you do—consider all the alternative hypotheses.

In order to do that, you really have to have good training and good background knowledge.

Louisa Dalton is a freelance contributor to Chemical & Engineering News, the weekly newsmagazine of the American Chemical Society. Center Stage interviews are edited for length and clarity.

DOI: 10.1021/acscentsci.7b00357
ACS Cent. Sci. 2017, 3, 812−813