

Science of Forensic Investigation – part two

Sheila Willis: "The scientific theorem that we use to do this probabilistic stuff is Bay's Theorem and there's a lot of maths in the background to that that is not used much in court but is used a lot in the laboratory to help us evaluate our findings.

"The scientist, because they're at the interface between the investigation and the eventual evaluation in court, is sometimes working in one role and sometimes in another. At an early stage in the investigation they're working as an investigator where they're helping the Gardaí develop leads and develop lines of investigation and they may not have absolute certainty, well they'll never have absolute certainty, but they may not be right even with the leads they're supplying at that stage. By the time it actually comes to deliver the evidence at a court stage, the scientist has to have weighed up what is the probability of this evidence and be in a position to assist the court in saying what value is there to what they've found or what they're producing.

"Other aspects that make forensic science a little bit different from other areas of analytical chemistry, although I think as time goes on people realise that although we don't talk about it as the chain of custody that it's also relevant in lots of other fields. It's very important that when the samples come to the laboratory, that we can be clear that they are the ones that everybody identifies as coming from a particular part of the scene. That might seem a trivial point but actually can be a cause of great confusion and the law is quite strict in how that's carried out and causes a lot of difficulty.

"I thought for the next couple of slides what I'd do is try to park that sort of general stuff and talk a little bit about case histories that might give you some idea of how the science is actually used.

"I put the slides together before we had that dreadful tragedy recently in a fire. The first one I chose anyway was a fire case. If you can imagine a situation where a suspect is apprehended by the Gardaí, maybe fleeing away from a fire or maybe soon afterwards. In that situation their clothing would be seized and packed in a particular type of nylon bag that has the ability of trapping

any volatile material that might be associated with the clothing. The scene itself, of course, would be examined and samples of debris would be recovered from the scene as well. Those samples are heated up such that the volatile material goes into the atmosphere of the bag, sample extracted and put into a gas chromatograph or GC/MS, where, if there are accelerants such as petrol or paraffin or diesel or any other accelerants present, they can be identified because they vary in their pattern in the chromatography as seen there, I have a petrol and a paraffin sample up. And if you wanted further discrimination you could go and look at each of those peaks using mass spectroscopy.

"I did mention earlier on that the position of trace evidence is important but if we talk a little bit about a case where trace evidence might be relevant: I can think of one I dealt with myself where there was a robbery at, not a bank but a similar kind of money institution anyway, the glass was broken in the getaway car and later the raiders moved from the car to a motorbike which crashed with an innocent party, they abandoned the motorbike, discarded their outer clothing and were later apprehended some distance away.

"So in that scenario, samples from the various scenes would be transmitted to the laboratory: the clothing that were recovered, and indeed the clothing that the guys were in when they were arrested. So the possible evidence is the possibility of glass fragments on the clothing, but remember now we're dealing with, there's a set of clothing discarded, so the chance of glass on the clothing of the actual suspects is much less and what we've got to consider is how do we look for links that might suggest – we first of all have to check that we think we have the right guys and if we have the right guys what kind of evidence would we expect?

"And in that instance there was impacted paint on the knees of the trousers where the motorbike crashed into the car, on the discarded clothing that is. The discarded clothing also had fibres on the inside that matched and linked with the fibres that the suspects were wearing at the time they were picked up. That's typical of the kind of case that might happen.

"There were shots fired in that case as well and in that instance what we'd look for is firearm residue. When a gun is discharged there is the equivalent of a mini explosion which generates a

range of particles that fall back on the hands or the clothing of the person who either fired the gun or is nearby. One of the tests that is possible is to use a scanning electron microscope to look for these particles. There is another case in the media at the moment with this very type of evidence, not used well in my opinion, but that's a different story.

"With the glass, the test that we use is quite a, almost a trivial one, which is to measure the refractive index of the glass and it's a useful technique because the refractive index varies with very, very small variations in the composition of the glass. It is particularly useful because it has the ability to enable us to measure very, very small fragments. If I were to, God forbid, go and break a window in this historic room, although a percentage of the glass would fall back away from me, about twenty per cent would fall back in the direction of the blow, so that the person delivering the blow would have very minute fragments of glass on their clothing. We search clothing and recover those small fragments and measure their refractive index.

"The next slide is a lead in to cause me to talk about what I consider to be essentially what has been a paradigm shift in forensic science. The use of DNA in solving crime has really changed the world of forensic science.

"People may be familiar with the early story associated with it, but I think it's worth retelling because the first time DNA was used by Alec Jeffries in the investigation of two murders on the Welsh-English borders, it was used to actually exonerate a suspect. I think it continues to be used in this very, very powerful way right today through all different countries. My presentation tends to be concentrating on cases where there are links but it's vitally important that we realise that showing where there are not links, when that's significant, is very important as well. And that was the first case.

"DNA is in the nucleus of every cell except red blood cells. We get half of it from – I'm sure everybody in the audience knows this kind of stuff, but just to kind of settle me down – half from our mother and half from our father. We use it in forensic science whether to compare two samples or to help identify human remains, or it's also used, not in Ireland but in other countries, as an intelligence tool, as a database, which I'll come back to again.

"The process of how it's used... the first thing is the location of the evidence. If you remember back to the early part of the talk when I said in the biology section actually identifying where the samples might be, it's not a trivial question, that can take quite a lot of time. Then the DNA is extracted and amplified, a profile generated and the profile compared with reference samples. If ten loci match we consider it's a match and the rarity or not of the match is judged according to how frequent those numbers are in a population database.

"So you were right and wrong, David, in terms of when it was first used. Marilyn Rynn was the first case where it was done here in Ireland but there was a case prior to that. The early work, the analytical work was done in England. We're operating here in Ireland since '94 and during that period different technologies are used. The present one of SGM Plus, with ten loci plus a sex gene, is the one that's in routine use in Ireland and a lot of other European countries and it's in use in the UK database, which means it's likely to last quite a while because there's been a lot of money pumped into that.

"So how would that operate in a case? It's not really that unexpected. Something like a murder happens and the investigating Gardaí will, either based on information they have from elsewhere or their enquiries, develop a suspect in some shape or form, which can often involve large, large volumes of material being submitted to the laboratory. Sometimes the challenge is to identify where you are going to start on what comes in. Inevitably it will include some samples from houses or cars or clothing belonging to the suspect. In the example I have here on the screen, the small picture on the bottom left hand side as I look at it is a wheel brace and in the inside of the wheel brace there are tiny splashes of blood. That's from a real case. That would be highly significant because that turned out to match the victim in a particular case. And I use it to show that, as I've said before, finding the material can actually be as challenging as carrying out the analytical work afterwards.

"DNA databases as an intelligence tool are, in my opinion, one of the most powerful ways where science can be used in a robust way to provide intelligence to the Gardaí. And if I could speak to it for a little while; different countries have decided different segments of the population should be put on a database. In the UK it's almost anyone who brushes up beside a policeman. In other

countries it might be people involved in serious crime. Other countries somewhere in between. The Law Reform Commission here in Ireland have published a report on this and they are recommending a limited database in Ireland. In other words they are recommending not that the whole population would be analysed, which is one option, but that a limited percentage of it and it's yet to be clarified what level of crime will dictate whether or not someone goes on the database.

"So, what are the advantages? If the crime scene samples are put on a database you can establish links between different crimes, whether it's a selection of burglaries, or an armed robbery could be linked with a rape case, or a suspect in a rape case identified with a burglary some time ago, that sort of link. It has the facility of excluding a large number of suspects, and I'd emphasise that exclusion capability of DNA again as being very powerful. The one that probably gets talked about most is where there is what's called 'cold hit' where a sample from a crime scene is loaded onto the database, and matches a person who's there from some previous case. In most countries the need to resample, once that hit is identified, the Gardaí would then be left with investigating the crime with this information that there's been a hit on the database and then they would have to resample.

"I don't think I intend to go into this, this is some definitions of forensic science that kind of interest me but I think I'll finish at that and thank you very much for your very good attention. Thank you."