

This piece has been written at the request of the editors, mainly I believe as an invited response to unsupported comments picked up from a journalist's blog. The comments were in relation to a presentation and participation in a panel discussion by me during the 3rd Annual Conference on Actual Innocence "Establishing Innocence or Guilt" held at the Center for American and International Law, Plano, Texas, on April 14-15, 2008. Blogs can be fun but are not authoritative sources for anything, and it might be worthwhile comparing what was purported to have been said with the following - my words, my views, unadorned and unedited. The titled theme of the presentation was "DNA 201" and was a review of mitochondrial and Y-chromosome DNA for an audience consisting mainly of attorneys and law enforcement officers. However, the organizers responded positively to a suggestion from me that the talk included commentary on Daubert.

Science, Law and Daubert

The Supreme Court's decision in Daubert may be the de facto standard regarding the gatekeeper role for forensic science evidence, but that does not mean that it is right, just that it is the standard until a better one comes along. The presentation in Plano argued that we would all have been better served if the court had focused on the objective question of "how do we identify reliable expert evidence?" rather than the abstract one of "what is scientific expertise?".

There is a huge difference between expert and scientific. Federal Rule of Evidence 702 states:

If scientific, technical, or other specialized knowledge will assist the trier of fact to understand the evidence or to determine a fact in issue, a witness qualified as an expert by knowledge, skill, experience, training, or education, may testify thereto in the form of an opinion or otherwise, if (1) the testimony is based upon sufficient facts or data, (2) the testimony is the product of reliable principles and methods, and (3) the witness has applied the principles and methods reliably to the facts of the case.

The elements in the Rule are:

- The knowledge, skill, experience, training, or education of the witness. Note that there is nothing in the Rule or in its application over many years that says the witness must be a scientist or have a science degree, and that the rule specifically mentions technical and other specialized knowledge.
- The testimony is based upon sufficient facts or data. This implies that the witness can produce the data that supports the testimony.
- The testimony is the product of reliable principles and methods. This requires that the witness can demonstrate that the technique has been validated.
- The witness has applied the principles and methods reliably to the facts of the case. This is similar to the second point and the witness should be able to produce data on the reliability of the test and its actual application by the witness in the case in question.

So what about science? Even if we give the Supreme Court the benefit of the doubt and accept that they believed they were dealing with testimony that was in some way "science" and were correct in questioning what it should look like, they missed several important issues. The first is that scientists have been exploring the concept of science for centuries and the idea that the justices could answer the question "what is science" is flawed. The second is that even if they were right and even if the evidence passed their test of is it science, it matters nothing if there are not sufficient supporting facts or if the evidence is not the product of the reliable application of methods that are themselves reliable. The third is that the law is a tiny part of the user community in regard to testing. The Supreme Court missed an opportunity to explore the concepts of practitioner competency and operational standards as they are applied in hundreds if not thousands of specialized applications, from aerospace to road and building construction to the food industry. Hopefully the National Academy of Sciences panel will make a better job of it.

Objective evidence

Expert evidence in the context of forensic science is provided mainly by two groups: we can label one as "Scientists" and these are classically the white-coated laboratory workers who have 4-year science degrees; and "Technologists" who are typically law enforcement officers conducting examinations in latent prints, firearms and tool marks, and crime scenes, and whose formal qualifications range from graduate degrees to extensive on-the-job training and experience. (And yes, I do know that these classifications are arbitrary and general, but they will serve the purpose for what follows).

The core of 702 is the reliability of the testing and the evidence provided. "Objective evidence" is a simple concept that unites scientists and technologists in how to provide reliable expert evidence to the courts. Objective evidence is defined as ¹:

A test which having been documented and validated is under control so that it can be demonstrated that all appropriately trained staff will obtain the same results within defined limits

"Documented and validated" means that the test procedure has been proven to be capable of application to case samples and to operate to a known and sufficient degree of reliability, and that the procedure and its validation has been written down. Documentation is as important the mechanisms to ensure consistent implementation of the validated method. "Appropriately trained" is situational - in some circumstances a graduate degree might be appropriate and in others rigorous and recorded on the job training of someone with a 2-year degree or high school diploma would be entirely appropriate. "Under control" requires that there is an effective quality control procedure in place. "Defined limits" recognizes that the exact same result will not be obtained every time. This is self-evident in quantitative procedures such as some drug chemistry tests but it could be argued that it also applies to aspects of qualitative testing such as whether impression evidence marks are called as present, absent or inconclusive. The issue is that the uncertainty has to be defined and established during validation.

Impression evidence

Impression evidence such as fingerprints, tool marks and firearms examinations falls comfortably into the category of objective evidence and comfortably meets the demands of Rule 702. Arguing about whether or not it is science at all, far less whether it is "real science" or "junk science" is irrelevant. It is 150 years since William Herschel, a senior civil servant working in Bengal, India, required people to "sign" for their pensions by leaving their fingerprint. It is not much less since Galton proposed his classification system and almost 100 years since Locard set down his tripartite rules for interpretation of Galton points. A century has passed since firearms testing was the subject of reports in the US ("The Missile and the Weapon" by Dr Albert Llewellyn Hall published in the Buffalo Medical Journal in 1900, and the official report "Study of the fired Bullets and Shells in Brownsville, Texas, Riot" included in the annual report of the Chief of Ordnance, U.S. Army in 1907) and 85 years since the establishment of the Bureau of Forensic Ballistics in New York. If impression evidence were based on a fundamentally unsound basis it would have been discovered long ago.

(While it can be argued that a history of doing something for 100 years is not in itself proof of reliability, the counter is that over such a long period an area subject to scrutiny such as that in the adversarial justice system would have been more likely than not to have revealed any fundamental errors. However, see the paragraph on Thomas Kuhn and paradigms below).

However, none of this means that we can ignore challenges to our work. New techniques mean, for example, that it is possible to develop partial latent prints to a degree that permits comparisons to be made where just a few years ago this would not have been possible. Impression evidence testing is being conducted in an environment quite different from that which prevailed at the end of

the 20th century. Users expect that the same precision that is applied to information in DNA data bases can be applied to fingerprint, firearms and footwear data bases. Failing to respond to questions on reliability because we know from 100 years of experience is never going to win us the professional credibility that we need at the end of the first decade of the 21st century. Only by responding to challenges by regarding them as opportunities for improvement - whether improved techniques, improved population data, or improved relationships with users - will be accepted by the justice system and the public as satisfactory. So no, we are not providing junk science, and no, expert evidence does not have to wear the clothes of science, but yes, we must do more to demonstrate the validity of what we do as we push for more and more information from less and less in regard to the quality and quantity of evidence submitted.

Back to science

Ask ten scientists what science is and you'll get 10 different answers, some overlap, but different nonetheless. I have done that regularly with staff and students and there is little consistency and often little that is unique to science in the responses. "Care" usually features, but bank tellers, pilots and engravers all must be error-free in their work. "Publish" is another, but theologians, linguists and even lawyers publish.

Bacon (1561 - 1626) may have been the first to enunciate anything specific about science when he wrote about the scientific method of observation -> hypothesis formulation -> testing -> refinement of the theory. (This is not too far away from how case law affects us: the court makes a decision, and that decision stays until experience and understanding grows to the point at which it is necessary to overturn or modify the original decision and leave us with new defining case law, as happened with Daubert and Kumho Tires).

The modern doyen of scientific philosophy was Karl Popper (1902 - 1994) who emphasized the importance of falsification as part of the scientific method. Popper argued that a good hypothesis must prohibit something; testing of the hypothesis is based on finding evidence of the prohibited event. If it is found, the theory must be abandoned or refined. The more a hypothesis is tested and the more it remains un-falsified then the more reasonable it is to accept it, but no amount of testing can ever absolutely prove a hypothesis to be correct. An important aspect of Popper's approach is that the method used to test the theory or hypothesis matters too: a failure to falsify in an experiment using a method or technique that is not very likely to find a difference if one exists is not a very good experiment.

There are significant implications for those of us working in forensic science in what Popper has to say. We must use methods designed to detect differences where these exist; and if none are found perhaps we should be careful how we express our conclusions, taking into consideration the nature of the evidence and the tests.

A real-world consequence of falsification is that what we do has a more definitive impact on users like the Innocence Project than on prosecutors. The case review may be able to apply new technologies or test previously untested materials and find an exclusion to the hypothesis that there was contact between the convicted and the scene or victim. This certainty is not available to the prosecution - even when testing is conducted flawlessly, even when data base information shows the evidence is well-nigh unique; the forensic work says nothing about the actual circumstances of the association.

The last science philosopher I'd like to discuss is Thomas Kuhn (1922 - 1996). Kuhn was a physicist who became interested in the philosophy of science and developed a sociologic model which focussed on the behaviors and internal rules of those who conducted "science". Kuhn is well-known for his concept of paradigm shifts: he recognized that real advancement in science comes about by revolution rather than evolution and that the status quo will prevail because that's the way practitioners like it - the way things are reflects the way that those at the top of the profession made them. Challenging the top dogs is ... well, a challenge. However, things can get

to the point where it is obvious that the old way and the old, long-accepted rules, are no longer valid.

Some closing thoughts

The image of science as absolute and providing a gold standard is wrong. Science is about knowledge and is conducted by humans. Knowledge advances as more and more information becomes available, and humans, whether they be expert witnesses or judges, will make mistakes somewhere at sometime. It is up to us all to continually work to increase our knowledge and deliver our testing and its interpretation from within a framework of individual competence and systemic quality system implementation that does all possible to ensure the honor of the profession and the value of our services to public safety.

Bibliography:

1. ILAC G19:2002 Guidelines for Forensic Science Laboratories, see <http://www.ilac.org/guidanceseries.html>

For an easy to read but comprehensive guide to the philosophy of science see: A F Chalmers "What is this thing called science?" (Hackett Publishing Co, ISBN 0872204529)