prowess. The inherent probative value of data lies not in laboratory reports, but rather within the development of hypothesis testing and data quality objectives (DQOs) upon which those samples and analysis should be based; without DQOs one does not have data, one has numbers. And those numbers, in the absence of DQOs may be the rope by which the sampler will be hanged (and it is often my job to pull the trap-door's lever).

Unreasonable expectations are similarly seen in professional circles. As a law enforcement officer, I was part of a team that investigated the death of an infant who resided in a clandestine drug lab. I was able to show that a reasonable person could conclude that the child's exposures to a variety of illegal drugs and hazardous chemicals in the drug lab would have contributed to the death of the child. However, science, good industrial hygiene exposure modeling, and fundamentals of toxicology notwithstanding, a prosecutor thought the idea was "exotic" and declined to pursue the matter. In the prosecutor's mind, the application of science should necessarily mean there is no doubt left in a conclusion – just like in the CSI TV program. Science, however, is a process, not an end. A scientist is not somebody that has merely collected a sample (no matter how incredibly sophisticated the analysis technique employed). A good scientist will characterize the uncertainty and error associated with their work, and provide that information.

"Forensic" merely implies that the work is prepared as an argument. Forensic investigations are usually less glamorous than imagined, and a far cry from the antics of the "CSI" investigators who would be sued in civil courts, criminally prosecuted for civil rights violations and probably imprisoned if they conducted their dramatic TV investigations in real life. For the private consultant, forensic investigations are more likely to be associated with civil proceedings than criminal; but cross-over is common.

In most of my criminal proceedings, I am before the court as an "agent of the State" and the evidence I present is known as "inference evidence;" a type of "substitutional" evidence, wherein legal precedence and resolved legal questions are presumed or substituted for direct evidence. I also present "direct evidence" and "real evidence" and provide that information during factual "testimony evidence" wherein I answer questions related to material fact. Seldom, during criminal proceedings, will I be asked to express "expert opinion" or provide "demonstrative evidence" although I may give "lay opinion" based on my personal experiences. During these criminal presentations, the *process* may actually more important than the *content*.

During some criminal proceedings, I am before the court as a consulting Industrial Hygienist, wherein I am usually asked to give "expert opinion." I will use available "real evidence" to prepare "expert opinion" and "demonstrative evidence." The underlying rationale of those opinions and conclusions must be based on sound science and tenable data. Samples and analysis presented under "CSI" expectations that lab results and technologically advanced tests somehow equal truth, will be quickly shot down in the legal battle that follows.

In Frye v. United States, (1923), the courts pondered the reliability of evidential force and science and recognized that while the courts will exercise great latitude in admitting

expert testimony deduced from a well-reasoned scientific principle or discovery, the thing from which the deduction is made must be sufficiently established to have gained general acceptance in the particular field in which it belongs. Deviations from established acceptability are not well tolerated.

Focusing on evidentiary relevance and reliability requires an assessment of whether the reasoning and/or methodology underlying the testimony is scientifically valid and whether that reasoning and/or methodology can reasonably be applied to the question being asked. The Courts emphasize that the focus is on the principles and methodology, and not the conclusions of the scientific evidence. In making this determination, among other things, the trier of fact, (usually the judge), is supposed to consider:

1. Whether the scientific theory or technique can be and has been tested;
2. Whether it has been subject to publication and/or peer review;
3. The known or potential rate of error:
4. The existence and maintenance of standards controlling the technique's operation; and
5. General acceptance in the scientific community.

Reference material relied upon to establish scientific acceptability or protocol can be its own pitfall. All too frequently, I see where forensic investigators wantonly cite articles from seemingly respectable journals, and, without foundation, presume that the information in the "study" is somehow unassailable. In many cases, I see practitioners cite articles that don't exist, and in a current case, the "investigator" claimed to follow protocols from organizations that don't exist.

In many cases, citations to articles are made without the investigator ever actually reading the article or protocol to determine first-hand *how* the cited information may be limited (since it is always limited) or even fatally flawed. Very frequently, an investigator will never actually read the article they cite and is unaware the article is fatally flawed in that the premise upon which the study or article is based is false, or a foundational confounder was overlooked. If the investigator has not read the study, or lacks the technical expertise to analyze the study, and answer critical questions concerning the confidence of the article and study, the reliance on the reference will undermine their entire credibility in court.

Forensic investigators, by their very nature, must be curious, resourceful, and have a thick skin and tenacious attention to detail. The ability to "connect the dots" - even where there is no apparent connection – is essential.

But to ensure that those dots result in an accurate picture, however, is incumbent on the investigator's ability to consider confounders, false positives, false negatives, scope of errors (random and systematic), and how closely the observation is to the facts, regardless of the outcome the investigator may wish to see. Forensic investigators should certainly be imaginative and resourceful but be able to articulate how that resourcefulness still lies within the context of good science and acceptable practice. You too can be a good forensic investigator in two easy lessons, each lasting ten years…(with apologies to Arnold Lehman -1955).