ENGINEERING LABS:

WHAT IS THE PARADIGM?

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Over the last 25 years, the author has had the chance to attend many multi-party evidence inspections. During that time, many inspections were carried out in storage units. Other inspections took place in crowded garages. Some inspections took place out of doors. One inspection set for an engineer's office in a nice bank building actually took place in a basement with one table. Very few have taken place in adequate facilities. The author describes here what should be taking place, and what in reality is taking place.

HISTORY

Forensic engineering is a subset of engineering. Forensic engineering is merely the application of engineering principles to a legal forum. Forensic engineers are attracted to the profession for many reasons, and these include short project lengths, varied assignments, and problem solving. We are all aware, however, that some engineers may be technically very competent, but are not comfortable in what is by necessity an adversarial setting.

An additional reason for the fascination with forensic engineering is that it is perceived to be a highly profitable venture. In a recent case the author was involved in, one of the engineers was being compensated at the rate of $400 per hour. To those new to the field, this sounds very lucrative. A similarly credentialed and experienced engineer could also be charging the same $400 hourly fee. And, if the same engineer is working out of his garage, overhead is minimal and profits are maximized.

The astute reader is already seeing what is occasionally happening. In a desire to increase profits, overhead *(ie, facilities and lab equipment)* is reduced. The sole proprietor can benefit financially by making spending very little on equipment. Large multi-state investigative firms often work similarly; there are numerous field offices in nice buildings, but inadequate ***(or no)*** lab facilities in some offices.

THE PARADIGM

It is no secret that people work better when they are working in facilities that are clean, well ventilated, and adequate for the task. *Oxford's English Dictionary* defines a paradigm as *"A pattern or model, an exemplar"*. As forensic scientists, we should be seeking to do things in an **exemplary** fashion. So what is the paradigm in terms of an engineering facility used for forensic inspections?

FACILITIES

Facilities for examining evidence should be well lit and climate controlled. In addition to fixed lighting, the lab should have drop lights available for examination of inner parts of appliances. Climate control is also a must. In South Texas, it is just as unreasonable to have a summer inspection in an uncooled garage as it is to have a February inspection in an unheated building in Minnesota. Those who are new to the profession may laugh, but engineers and investigative companies are routinely holding evidence inspections in less than ideal facilities.

A lack of capital equipment hinders many facilities. Capital equipment is expensive, but it is also necessary to do an adequate investigation. Listed in **Table I** below are the kinds of instruments that should be readily available at a good engineering facility. In going through Table I, it should be noted that not every piece of equipment will be needed at every exam. But fire damage is very unpredictable, and it is often necessary to use tools or techniques that were not anticipated when the original protocol was developed. There have been numerous inspections that have had to be halted because inadequate equipment was readily available when the protocol required *'tweaking.'* The key to Table I is *'readily available.'* As an example, not every facility will have in-house x-ray. That is acceptable if x-ray facilities are readily available *(i.e. very close by and can be accessed with a minimum of trouble)*. We also note by way of example that if a lab is doing only electrical work, flow gauges and a combustion analyzer are not necessary. Likewise, gas labs will not usually require sophisticated electrical test equipment.

What is not mentioned in Table I is that there must also be a good selection of hand tools available. It is not unreasonable to expect that a lab will have screwdrivers, wrenches, a socket set, nut drivers and other hand tools, work benches and a vise.

Adequate work space, mentioned earlier, also refers to work tables and proper seating. A few labs have gone as far as to install small conference rooms, suitable for each *'side'* at a multi party exam to caucus in. Some facilities have installed WiFi, such that visiting engineers and attorneys can use e-mail, etc. while an exam is on going. Some have also installed a computer and projection system for viewing fire scene photos while conducting the exam. These types of actions benefit all who are in attendance.

A small *'machine shop'* is also desirable at an engineering facility. A grinder, band saw, arbor press, and drill press will suffice for many inspections.

A question is sometimes raised regarding *'calibration'* of equipment, particularly meters. This writer has failed to see one fire case where the outcome was even close to being decided based on the presence of a *'cal'* sticker. With 6 - digit DVMs being quite common, a few millivolts of drift on a 120 VAC (nominal) power line is truly nothing to be excited about. If, however, exact measurements are critical, then a cal sticker is desired.

SECURITY OF EVIDENCE

Evidence security and storage are important factors when looking for a paradigm. Fire evidence should be stored in a neat and orderly fashion, and not just stuck in a corner. The lab should have adequate shelving for such storage. At one lab visited by the author, dirt from a nearby cornfield had severely contaminated the evidence being stored. Another huge *'disconnect'* the writer has seen comes to the issue of fire protection – as professionals who investigate fires, we know what a destructive force that fire can be. Is evidence stored in a facility that is sprinkled per NFPA 13, or in a building with firewalls? Normally, the answer is **NO**.

SAFETY

Lab exams can involve some amount of danger. Investigators who are PE's know that their first obligation is to safety. Here again, there are disparities between the paradigm and what is occurring. Some facilities do not have rubber gloves available to be used during inspections. Anytime a Dremel is used, safety glasses must be worn or the observers should leave the area. Occasionally, it is necessary to test something electrically hot. The tester(s) should be wearing hot gloves or other PPE *(personal protective equipment)*, as is necessary.

The use of videographers has become very common, and very problematic. On more than one instance, the videographers have strayed very near live equipment while testing was going on. No liability release form is going to bring back to life the videographer who, for the sake of a better shot, has strayed into live parts.

Sign-in sheets are also a must at every inspection. One clever attorney tried to *'hide'* her experts by refusing to identify them, claiming that they were consultants. While that may be true, it is not unreasonable for us to know the names of those visiting our facility.

While restroom facilities are required by law at indoor facilities, the *'usual'* storage unit favored by some has no such conveniences. Likewise, cold and hot water, soap and handwipes are essential for both cleanliness and hygiene.

WHAT CAN BE DONE?

In this the year 2007, case work on complex assignments is still being done with equipment and facilities that are much less than ideal. Parties to litigation that sometimes involves tens of millions of dollars are at the mercy of poor to mediocre lab facilities. Frankly, this is unacceptable in a field where professionalism and adherence to the **Scientific Method** should be paramount.

Some appliance manufacturers are starting to get very serious on the issue of lab facilities. Not surprisingly, manufacturers are often sued by a party(s) seeking damages. In situations where claimants desire lab exams of fire damaged equipment and appliances, the manufacturers have one trump card, so to speak. The manufacturer can send a letter to the claimant, agreeing to an inspection of the alleged defective product. In the same letter, the claimant is told that certain equipment must be available at whatever facility is used for any inspections. If the claimant wants to use Engineer X's garage, the manufacturer will be agreeable as long as equipment requirements are met. If the claimant balks, the manufacturer has a very simple reply

TABLE I

DVM – A must, needs 4 wire capability
Circuit breaker tester – Testing both thermal and magnetic portions of breakers
Megger – 500 and 1000 volt ranges, at a minimum
High voltage probe – Neon sign transformers
High current source – Accurate testing of low resistance connections
Four wire (Kelvin) clips – Accurate testing of contact resistances
X-ray – Examining fuses, circuit breakers, molten masses, thermal fuses, small appliances
Current shunts, wattmeter, and / or power quality analyzer – Determine motor and appliance operating characteristics
Ground resistance meter – Really a field tool, but necessary to determine compliance with NEC Article 250
Microscope – Must have real time image capture
Thermocouples and scanner – Real time temperature measurement
Heat gun – Testing thermal switches, removing line cords from molten masses
Oven – Testing thermal switches
Compressed air – Has numerous uses
Flow gauges – Measuring gas flow rates
Manometer – Measuring gas pressures
Natural gas and propane – Very hard to test a gas appliance without them
Dial calipers – Accurate measurements of dimensions
Hoses and fittings – Testing of gas systems
Three phase power – Testing motors
Variac – Testing of appliances at different voltages
Dremel tool and safety glasses – Always useful
Ultrasonic cleaner, Alconox and Branson OR detergents – for cleaning small parts
Differential probes - Measuring differential voltages
Electron microscope with EDX – Invaluable for examining wires and switch contacts, as well as mechanical devices
Borescope – Examining appliances and piping internally
Dielectric analyzer – Analyzing leakage in insulation
Tachometer – Measuring rotating devices
Oscilloscope – Electrical analysis
Hardness tester - Rockwell or Brinell hardness
Impedance meter – Ballasts, transformers, motors, capacitors
Combustion analyzer – Measuring combustion parameters

… *'You want money from us. In that case, the inspection must be done in a lab that is properly equipped. Anything else falls short and does not get us the information we need to properly evaluate this claim.'* While this may seem to be *'hard ball'* tactics, in fact it represents the paradigm—equipment and facilities must be available to do the job correctly.

A statement often made by claimants is that they do not want the evidence shipped or hand carried to another facility, fearing some kind of damage or intentional tampering. This is of course a legitimate concern. In the end, however, the evidence must be properly evaluated, using proper equipment and techniques. If a lab in a given location does not have the proper equipment, no amount of rationalization will change that problem.

Another potential way to *'clean up'* the shoddiness in the engineering arena is for insurers to visit the facilities of their vendors. We routinely are asked to send a copy of our E&O policy to clients, but we have rarely had facilities inspected by clients. To make matters worse, some engineers try and deceive their clients, as witnessed by the following typical recitation from a report:

> *After the scene examination, the evidence was moved to the XYZ laboratory for in-depth engineering analysis.*

In many cases, the author has seen numerous *'XYZ'* labs that are nothing more than a table, inspection lamp, and several chairs. These types of labs are inadequate for the task at hand. If the insurance carriers knew that there are differences in lab facilities, we would perhaps see a shake-up in how assignments are doled out.

It is also up to the engineers to police themselves. The engineering laws in many states, as well as the ethical rules of many professional societies, call for the engineer's actions to be competent. The author questions how competency can be achieved with less than acceptable facilities and equipment.

IN SUMMATION

We are routinely called to inspections of fire damaged remains where facilities and equipment are inadequate. In these situations, vociferous complaints are lodged. There is a right way to do things, and any attempt to lessen or *'dumb down'* an inspection because of improper equipment is not acceptable, and is certainly not the paradigm. The profession and our clients deserve better than what is currently happening.

MARK GOODSON is the principal of Goodson Engineering of Denton, Texas. He is a PE licensed in multiple states. Formerly an engineer with both Rockwell and TRW, he has been consulting in electrical and mechanical matters since 1984. He holds a BSEE from Texas A&M, and then trained in forensics at University of Texas Southwestern. From 1989-1991 he served as a Court Special Master in Dallas. His specializations include electrical, mechanical, and electrical shock issues.

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"I witnessed it in their faces. It was as if the calvary had arrived...It was comforting to me when I was trapped in the north tower to know that they were coming to save me and my men..."

IAFC Second Vice President Larry Grorud said the monument will help lift the spirit of the American people, just as the gesture did in 2001.

Norman Hoeft, representing the National Volunteer Fire Council, said the Lift a Nation monument will compliment the memorial park. He congratulated those involved for chosing the site.

Kim Corpany, associate sculptor, said it was gratifying to see the project unveiled. But, more importantly, to see what it means to the nation's firefighters. She said all the long hours were well worth it.

Sculptor Stan Watts said he, as all Americans, was moved the instant he saw the photograph. When his wife suggested the project, he first thought it was an endeavor he didn't want to tackle. "Sometimes, your projects chose you," he said. He recalled meeting the three firefighters and their attorney. To his dismay, they asked him not to do it. Watts told them it was not for them. "It's for us and for generations to come..."

FEMA Director R. David Paulison said the three firefighters raising the flag sent a powerful message to everyone - Never Give Up."

West Virginia and Virginia Chapter members of the IAAI at the 9/11 Monument in Emmitsburg, Maryland

Pictured above: James Archer(Avondale PD), Paul Arthur(Vicenza CID Office), David Asmus(Leavonworth Co Fire Dept.), Michael Baledge(Hailey Fire Dept.), Michelle Colehour(Mankato Fire Dept.), William Conallen(Philadelphia Fire Dept), Christopher Connelly Sr.(Wilmington Police Dept.), Peter Dziuk(Lubbock Fire Dept.), Steven Fabry (West Allis Police Dept.), Jonathan Fink(Martinsburg Fire Dept.), Donald Fletcher(Yakima Co Fire Pro Bureau), John Ford(Raleigh Fire Dept), Jonathan Garcia(Bernalillo Co Fire and Rescue), Leo Gildea(Allegheny Co Dept of Emergency Service), Ronald Jarocha(PA State Police), Douglas Jones(US Mint Ofc of Protection), Deborah Knupp(St Lucie Co Fire Dept.), Patrick Mulholland(Exeter Police Dept.), Rickey Naccarato(CES CEFT), Valarie O'Connell(Sydney Dept Fire/ES), Damon Robbins(Lincoln Bureau of Fire), Michael Shawley(Allegheny County Fire Marshal), Charlie Simmons(W Monroe City Fire Dept.), Stanley Spradlin(Broken Arrow Fire Dept.), Mark Stephens(Cheyenne Fire and Rescue), Jason Sundbakken(Minot Police Dept.), Michael Vaughan(Vail Fire and EMS).