Forensic Engineering

Part 1 of a two-part series. Look for Part II in the next issue of the Review

By Jim Drebelbis, Kan64

Dangerous Construction
The owner was injured when this disappearing attic stair fell from the ceilin, just missing

Engineers sifting through the debris of the World Trade Center and the recent popularity of the CSI programs on TV pushed forensic investigation into the publics' awareness. As a student and as an engineer and architect in traditional design roles, I never considered forensic engineering as a career path…I had never even heard of it.

While I will always love technology, after 25 years of practicing traditional engineering and architecture, the endeavor was losing its charm. It was the early 90's when I learned that some engineers performed technical investigations for insurance adjusters and attorneys. I thought that I might try it …I'd start out working on a contract basis for firms that provided that service…just for a little while. Looking back on it, when I took off my tie and got my hands dirty doing engineering investigations, the technology and practice of my chosen profession came sharply into focus. But, the practice of forensic engineering is radically different from traditional engineering, so for those who think that you may want to pursue this work, I offer this evaluation.

While forensic engineering is never dull, the work ranges from the exotic to the infuriating. For individuals who crave routine, process, and structure, the absence of definition can be maddening. My forensic engineering work took me to the Virgin Islands and to nowhere in the middle of Texas. I have testified in trial and deposition, met famous people, worked on projects that made the news, dealt with individuals committing fraud, condemned a building, and prevailed against competing professionals. Least you think that this work is all glory: I also was bitten by a brown recluse, hit by an irate building owner, insulted by attorneys and other professionals, crawled through mud beneath crumbling buildings, suffered heat exhaustion, testified when I was ill, and worked in dangerous settings. Like many intense endeavors, you either love this niche of the engineering profession, or you will soon hate it.

As a process, forensic investigation is a case study. It is similar to the game we played as kids: "What's wrong with this picture?" The work often entails sifting through volumes of data, much having little bearing on the problem you must address, in an effort to find relevant technical information. I constantly look for patterns and connections to find the aberrant condition.

There are few established rules, but the ones that do exist can make or break your career. The irony is that non-engineers make most of the rules of this game, for the forensic engineering game is played in the arena of law and insurance. Unlike most engineering projects, there are no industry established and commonly accepted processes. You

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must frequently invent your own process and presentation format. Sometimes you feel like a high-wire artist working without a net.

Since no one else volunteered, I offer the following rules for this forensic engineering game:

Rule 1: **Do not advocate for either side.** That is not your job. You are only a technical advisor. To advocate you must set aside technology and logic (see Rule #2 and #3). Advocating leads to silly arguments, and engineers who haven't learned this lesson are easy opponents.

Rule 2: **Base your work, analysis and conclusions on solid engineering and scientific theory.** If you do not, you will be challenged and the court will eliminate your work. These are called Daubert Challenges. I have been challenged but fortunately never successfully. I have, however, provided the basis for my clients to dismiss opposing attorney engineers, usually because they forgot Rule #2 and #3.

Rule 3: **Use sound, consistent, and thorough logic.** Carl Sagan's *Baloney Detection Kit* provides an excellent primer of logic errors. Use this guide to keep your logic straight and to attack the opposing engineers' logic.

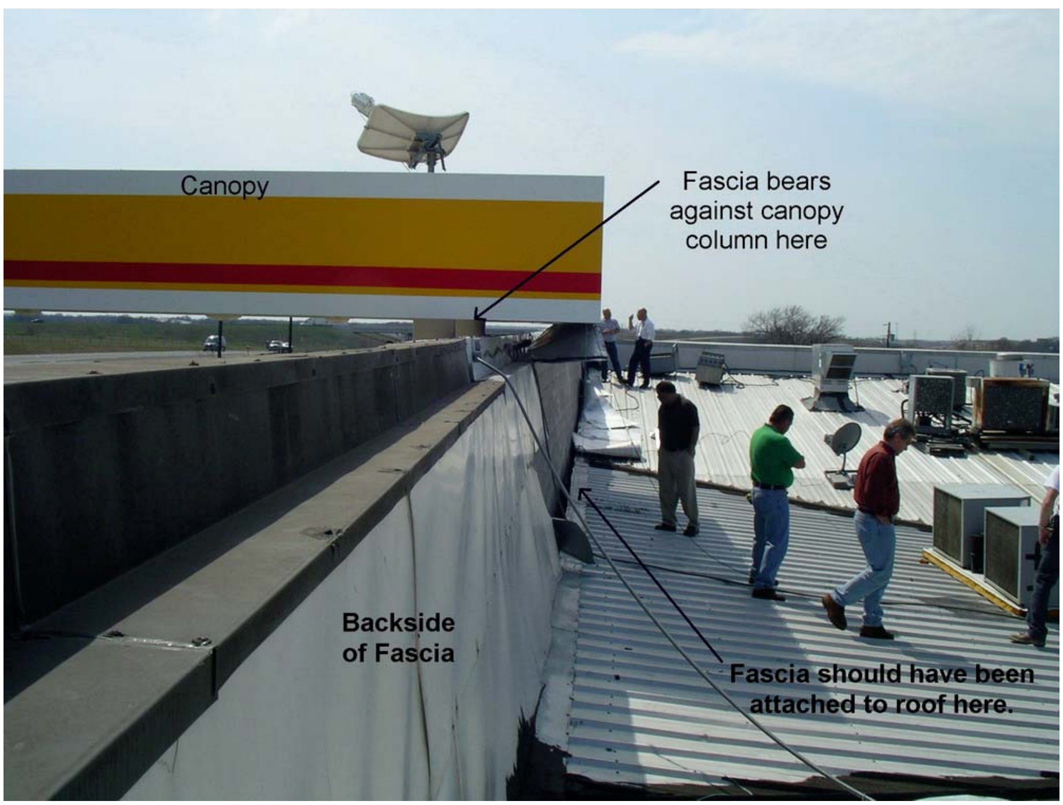
Rule 4: **Stay curious, be open, and keep testing your position.** This is not design. It is an adversarial endeavor, and your adversaries are there to challenge you. It is your job to be prepared.

Rule 5: **Gather as much information as you can and don't discard it prematurely.** You never know what will be important. Most engineers have no problem with this. We tend to be anal-retentive. And, yes, it *is* hyphenated.

Rule 6: **Remember the words of the immortal philosopher, *Dirty Harry Callahan*, "A man has to know his limits."** Being an engineer doesn't mean you know everything. Don't make up stuff just to have an answer. A reasonable and acceptable answer can be "I don't know".

Rule 7: **Never confuse simplistic with simple.** Your job is to explain difficult concepts in a clear and easy manner. But, don't give into the temptation to abbreviate or distort complex issues. People like to believe a singular event caused a system to perform badly. Despite this, few things in life, or forensic engineering, are simple. And, no one promised you that you have only one problem. Failure to realize this fact violates Rules #2 through #5.

***Parapet failure**. You see the 6' high backside of the 12-foot high masonry fascia of a service station. The columns supporting the canopy over the gas pumps arrested its outward rotation. Someone forgot to attach the wall at the roofline.*



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Rule 8: Never take your technical position or anything about this work personally. If you do, when you are challenged, you will react emotionally and inappropriately. When being challenged, you need clear, impartial, unemotional thinking. In forensic engineering everything you do and say is open to challenge. That even includes this article.

Rule 9: Adhere to codes of professional practice, especially those concerning maintaining confidences and avoiding conflicts of interest. There are many opportunities here to violate these codes. If you do you can lose more than a client.

Rule 10: Forensic engineering is a zero-sum game. Because forensic engineering occurs in an adversarial environment, someone usually loses, so someone will be unhappy with you. Good forensic work often results in aggravated opponents, and some engineers find this disturbing.

A friend of mine, an excellent engineer, left the field of forensic engineering after several years because he took the attacks on his work and himself personally.

He forgot Rule #8.

Rule 11: Maintain a sense of humor. Making light of a situation doesn't mean that you have no reverence for it. It means that you understand the irony or the lack of logic. Taking this work too seriously is unhealthy and a lot less fun.

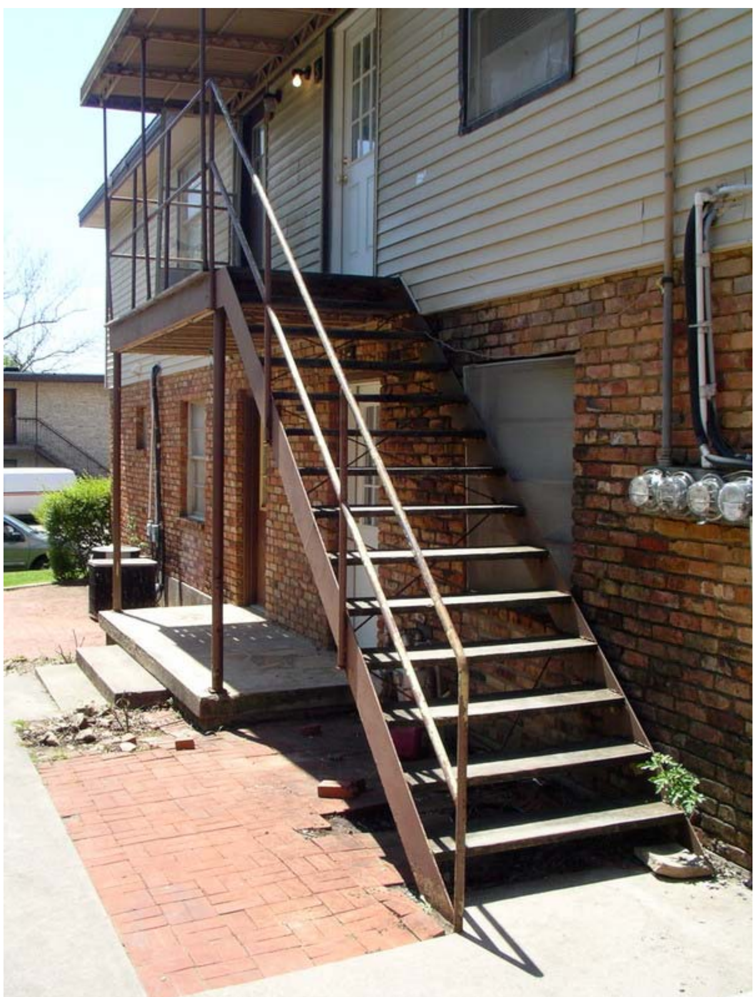
Those who get bored working endlessly on a single project might find forensic work a refreshing change. The projects are usually short in duration compared to design projects. However, it helps to have a good memory, or a good assistant who can put the right file in your hands. My list of active projects usually numbers between 50 and 80. They rarely require constant attention but after lying dormant for a few months, they have a nasty habit of waking up…usually when a dozen other projects also need attention. That is when the ability to juggle comes in handy. Remember that the trick to running a small business is making clients feel that *their* project is *your* most important project.

To be effective at this work, depth of understanding and a multi-faceted background are invaluable. These can only be gained with maturity in one's field. Engineers who enter forensic engineering early in their careers deny themselves the experience of working on design projects, dealing with contractors, and coordinating with other disciplines. Experience is a valuable resource.

The danger is that long-term experience can also produce rigid approaches to problem solving. The engineering process usually involves linear problem-solving: applying iterative cycles of analysis and design that consider smaller and smaller parts of the system, one-by-one until all problems are addressed and solved. By contrast, forensic engineering requires lateral thinking: expanding one's concept of the problem, delaying analysis and understanding the interrelation of interacting technologies.

Investigations concerning moisture intrusion exemplify this. They notoriously test your knowledge of construction, thermo-dynamics, wind loading, and materials. Not every building leaks because the roof fails, so determining the cause or causes of

Code Violations
This stair was constructed in 1974 under the 1970 Uniform Building Code. How many code violations can you see in this photo? Hint: There are at least 9.



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moisture intrusion results in controversy. Opposing positions result in lawsuits. Elements in a building or any engineering system are often interrelated. Failure to put the problem into perspective reminds me of the blind men describing an elephant by what they touch.

Technical competence, good investigative methods, logical arguments, and lateral thinking are useless unless you can write and speak clearly, concisely, and accurately. Unfortunately engineers are often inarticulate. As a forensic engineer, your job is to explain, counsel, and teach. On the witness stand or in deposition, you may be asked to explain concepts such as thermodynamics, soil mechanics, or building components to people who hate technology and think the world is only 6000 years old. For example, I was once asked in deposition how deflection of the structure could be related to the loading. Even though college professors delight in confusing students with pompous pedantry, the lay audience is less tolerant. Almost anything can be simplified and expressed in terms anyone can understand. The public favors those who offer clear, simple explanations of complex issues. The ability to crystallize and simplifying issues can be a powerful tool. In one case, opposing engineers failed to prove how water moved through the soil to cause foundation movement in nearby houses. They used technical data and arcane analysis to blur the fact they had proved nothing. A number of the plaintiffs settled out of the case after I pointed out that their consultants failed to prove water could or did move through the ground, that water collected beneath the houses, or even that active clay existed beneath the houses. Moreover, they did not know if the foundations of the houses had risen as they would if affected by active clay. The attorney who engaged me successfully challenged their experts; the opposing attorneys were left without expert witnesses.

So, what charm can forensic engineering hold? For those considering a career move into forensic engineering, it could breath new life into your chosen field. Or, it may just be a novel interlude. For me, forensic engineering exercises all the aspects of my background: math, engineering, architecture, construction and business. But mostly, I love solving puzzles and I'm offered this opportunity on a variety of interesting projects. Why did that structure fall? How does moisture get into that building? Does the opposing engineer's analysis make sense? Or, the mother of all challenges: "No one seem to know why this is happening." Once again I move onto the high wire, using only my senses and my knowledge of science, materials, and construction, another elegant puzzle is mine to unravel.

Answers to the stair quiz:

1. *There is a handrail on only one side.*
2. *The 38" vertical distance between nosing and top of handrail exceeds the allowable range of 30" to 34".*
3. *The handrail assembly cannot prevent a 9" diameter ball from passing between the handrail and the stringer.*
4. *Handrail support structure would fail if subjected to the design load of 20 plf (an aggregate load of 350 lbs)*
5. *The riser heights within the stair flight vary more than 3/16 inch.*
6. *The maximum riser height exceeds 8 inches.*
7. *The tread depths within the stair flight vary more than 3/16 inch.*
8. *The minimum tread width is less than 9 inches.*
9. *The elevation of the floor at the top riser changes abruptly without a ramp.*

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