

## Letters to the Editor

### **Forensic Engineering—A Definition**

Dear Sir:

There is a marked lack of comprehension in the legal profession, the judiciary, and the scientific and technical fields as to the scope of forensic engineering and the definition of the term "forensic engineer." The confusion arises mainly from the common concept that the forensic engineer is an "expert witness." He (or she) is, of course, that. But "that" falls far short of defining the scope of activities of the forensic engineer. The expert witness is not necessarily a forensic engineer; however, the practice of "forensic engineering" does require expertise in performance as an expert witness. To meet the definition of forensic engineer implies the full capability to perform those legal, technical, and/or administrative support services required in the investigation, analysis, reconstruction, interpretation, and presentation to the ultimate decision maker. In the courtroom, before an arbitration panel, or before an administrative or contracting officer of a regulatory agency, the forensic engineer often appears as the expert witness—thus fostering the image of the forensic engineer as an expert witness only. The legal support services that the forensic expert has rendered the "trial advocate" in the investigation, analysis, reconstruction, interpretation, and development of case strategy are not visible and are often overlooked. The trial attorney carries the ball as the quarterback, and most often he gains ground by virtue of the legal support services supplied by the forensic engineer or scientist or both. This is the scenario of the typical litigation or arbitration. Here the forensic engineer, in the aspect of an expert witness, is not an advocate, but an effective tool of advocacy needed to persuade a trier of fact. The legal support work is no less important because of its lack of visibility.

Often overlooked is the fact that the majority of the work involved in forensic engineering is performed outside of the fields of litigation and arbitration. The engineer performs forensic science work with relation to the economic, technical, or environmental feasibility of every project undertaken, whether for a private partnership or corporate business enterprise and/or government planning or regulatory body. The nature of the engineering work ordinarily falling within the scope of the average practitioner encompasses the detailed feasibility study as well as the ability to persuade the client that his opinions are the logical result of a fair and equitable interpretation of the facts revealed by a thorough investigation, study, or analysis of the assignment. The parameters for the standards of performance do not change simply because the effort is moved from the forum of the judiciary to that of private or public commercial or political commerce or vice versa. Nor is it important that the effort is directed in our case to convincing a client and, in the other case, to convincing the finder of fact (judge, jurer, or arbitrator) that the forensic engineer's support work and his final opinions were indeed honest and scientifically accurate and represent interpretations fully consistent with the facts and the expert's technical and practical experience.

Note should be taken that the services of the forensic engineer or expert witness or both are almost never rendered on a "friend of the court" basis. In the legal forum invariably the forensic engineer is retained by one or the other of the adversary parties. Reports and testimony are rendered on behalf of one (or more) of the adversary parties but almost never all of the parties, and rarely as an impartial presentation. There is always the influence of the client-expert relationship and failure to recognize this as a reality is a sham. What is important in the legal forum is that the expert recognize that it is the function of the trial attorney as advocate to convince the trier of the facts as to the merits of his case; and that the expert's function is to convince the trier of the facts of his own creditability and the merits of his opinions based on the parameters set forth above. The image of the forensic engineer must be that of an unbiased presenter of the truth based on his particular expertise. He stands

always on his creditability. If he cannot convince the tryer of the facts of his creditability he stands for naught.

With the above background let us try to define the term "forensic engineer." The term "forensic" is defined as: "1—pertaining to, connected with, or used in courts of law or public discussions and debate. 2—adapted or suited to argumentation; rhetorical." The term "public" is defined as: "1—the general body of a nation, state or community; the people as a whole; the community at large. 2—a specific part of the people; those people considered together because of some common interest or purpose." With these base definitions we can draw the logical conclusion that "forensic engineering" is the use and application of scientific or engineering skills, techniques, evaluations, and analysis to questions of civil and/or criminal law and/or public interest to be argued or debated before a judicial body, board of arbitration, corporate directors, administrative agency, and so forth; or to questions of economic, technical, or environmental feasibility for presentation to a planning agency, Board of County Commissioners, Public Service Commission, and legislative body; or matters of like concern. It would seem that the field of forensic engineering has parameters so broad as to defy definition. What manner of man, then, can presume to qualify as a "forensic engineer"?

Such a person would have to be qualified in the basic scientific and engineering skills applicable to the questions likely to be involved in the controversy; with a vast experience in the hands-on application of such skills so that his conclusions represent a certain and positive end result. But such qualifications would not, in and of itself, make the person a forensic engineer or a forensic scientist.

To qualify as a forensic engineer or a forensic scientist the person must be an investigator, an organizer, a linguist, an interpreter, a playwright, a rewrite man, an extremely qualified engineer or scientist of great experience and unquestioned integrity, a person of credibility, an evaluator, a vocabulary coach, and a support consultant. But, most of all, he must be a persuader; for without the ability to persuade, all of the other qualifications come to naught.

As an investigator, the forensic engineer must be able to identify the information parameters of the individual case. In the field of forensic engineering it is fact that there are few things that can happen without precedent; and that nothing happens which is not in concurrence with known and established scientific principles. Particularly in some areas of practice such as construction claims, building failures, automotive and marine casualties, utility rate analysis, and so forth, facts and evidence are the prime targets of the investigation. Because in these fields the end product is the result of many design elements, methods, and materials, the investigation is usually a very involved and difficult one requiring the skill and expertise of many diverse specialists.

As an organizer the burden falls on the forensic engineer rendering the legal support service to recognize the technologies involved; to gather the required team of experts; to identify, together with counsel, the specific causes of action that may apply; and to plan and implement the procedures required to gather and prepare the body of evidence needed, supported by complete documented information and sources.

As a linguist the forensic engineer must be able to translate "trade language" (either written or oral) into language that can be comprehended first by client and counsel, and above all, later by the tryer of fact, be it judge or jury.

As an interpreter, the forensic engineer must have knowledge of trade practices, not only on a general basis, but also as applied to the specific product, process, and locality of any construction or incident. For instance, is the designer's intent the same as the user's needs or the contractor's concept? If not, why not? For example, in marine accidents, which rules of the road apply? Where?

As a playwright, the forensic engineer must gather together all of the results of the investigation and write the scenerio or reconstruct the actual failure, accident, or the development of the claim, as the case may be. It has to be based on the facts, it has to be right, and it has

to be done early. In the time between the incident and the claim, facts essential to the case are often lost as memory fades; and documentation and evidence will also be lost.

The forensic engineer is a rewrite man in the sense that where the facts don't fit, it's back to square one; reinvestigate, examine, study, and rewrite the script until the story is supported by the evidence.

That the forensic engineer must be an extremely qualified engineer or scientist of great experience and unquestioned integrity and ethical standards goes without saying. His entire value to the tryer of fact is based on his ability to come up with an honest evaluation of the facts based on his best professional judgement that is creditable and believable.

The forensic engineer must also play the devil's advocate. He must be able to evaluate the adversary position from the standpoint of his own investigation, and from the claim and discovery procedures. One of the most important services a forensic engineer can render to counsel is to make a realistic statement of client's position. The expert's ability to point out weaknesses often makes settlements possible at fair levels, often without litigation.

The forensic engineer should act as a vocabulary coach to counsel, particularly in the fields of technical language and trade practices. There is a significant amount of jargon common in every industry. Learning what is meant by trade language is essential. In addition, each industry has developed rules, regulations, and standards of performance that are beyond counsel's comprehension but are part of the expert's stock in trade.

All of the foregoing is intended to point out the value of the forensic engineer as a member of the legal support team from the word go. The investigatory work or documentation must start early: with the incident, or even before in some cases. Very often the services of the forensic engineer in documenting the development, manufacturing, or construction process can help to avoid or supply meaningful input for future litigation. The use of effective construction management practices can often prevent accidents or failures and provide documentation vital to the defense of such cases.

But, most of all, the forensic engineer must be a persuader. He must be able to persuade a team of experts, himself included, to conduct a systematic and exhaustive investigation of the case. Then he must be able to persuade client and counsel of the merits of his position and opinions. Later, he must be able to persuade them to accept his evaluation of both their case and adversary position. And, finally, in the judicial forum, he must be able to convince the tryer of the fact (judge, jury, or arbitrator) that his opinions are the logical result of a thorough investigation and represent an honest interpretation fully consistent with the facts and his own technical experience and practical expertise. Further, this persuasion must be accomplished without the appearance of advocacy. In the legal forum the matter of advocacy is for the trial attorney: the matter of the expert's credibility is for the expert to establish by his testimony and his manner of presentation. In the last analysis, however, he must be able to establish and maintain his creditability, and he must use the persuasive powers available to him to that end. Often we have less limitation on our ability to be persuasive when we appear before boards of arbitration, boards of inquiry, county commissions, and other public bodies where the constraints of judicial procedure and the question and answer mode of presentation of evidence are not rigidly adhered to. Because I regard that type of presentation to be a very important part of the practice of forensic engineering I would like to make a few closing remarks about the art of persuasion.

First, remember that there are two types of communication between the persuader and the persuaded: verbal and nonverbal. You are being evaluated not only by what you say but also on how you say it. Your demeanor and body language also speak for you.

With regard to verbal communication, we must speak to the tryer of fact. In a jury case we must remember that it is the juror who will decide the case and we must speak not above them, nor below them, but to them. It is very important that we use language that is clear, precise, persuasive, and creditable. Before a board of arbitrators, planning commission, or other public body, the standard may vary considerably.

Forensic engineering is the art of effective persuasion of the fact finder that a complete and thorough investigation has been made and that the expert's testimony is an honest opinion based on his best professional judgement.

While this paper is specifically addressed toward a discussion of the definition, scope, qualifications, ethics, and practice of the forensic engineer, the principles and precepts espoused herein apply equally to the forensic scientist.

Perhaps the above will lead to a more accurate image of the forensic engineer and put in proper perspective the scope and importance of his work; to the judiciary, the commercial world, and to the public at large.

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### **Further Discussion of "Minimal Velocities Necessary for Perforation of Skin by Air Gun Pellets and Bullets"**

Dear Sir:

We have read the correction by D. C. Warniment (Vol. 28, No. 3, July 1983, p. 551) to an equation shown in an article "Minimal Velocities Necessary for Perforation of Skin by Air Gun Pellets and Bullets" by DiMaio et al (Vol. 27, No. 4, Oct 1982, pp. 894-898). At the outset, in reading DiMaio's article, it appeared that the error referred to by Warniment was really a typographical error in that the typing of the square factors for  $v^2$  and  $r^2$  had been omitted, along with the symbol for pi ( $\pi$ ). Perhaps the typewriter did not contain the proper exponential symbols nor the symbol for pi. On the other hand, the calculations were in order.

It is noted, however, that a portion of the Letter to the Editor is also in error, notably the part that states  $E/a = \text{kg} \cdot \text{m}^2/\text{s}^2 \cdot \text{cm}^2$ . Therefore, it is suggested that the simplest approach is to consider the fundamental equations, that is,  $K \cdot E = mv^2/2$  and  $K \cdot E/\text{unit area} = mv^2/2\pi r^2$ . Because  $w = mg$ ,  $K \cdot E = wv^2/2g$  and  $K \cdot E/\text{unit area} = wv^2/2g\pi r^2$ . In English units, the  $E/a$  ratio reduces to  $\text{ft} \cdot \text{lb}/\text{in}^2$  and in metric units the  $E/a$  ratio reduces to  $\text{m} \cdot \text{kg}/\text{cm}^2$ .

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