Forensic Engineering Investigations

Crispin Hales, PhD, FIMechE, CEng.
Hales & Gooch Ltd.

Forensic engineering, or the application of engineering knowledge to problems involving legal issues, is a well-established field with highly developed techniques available for gathering of evidence, analysing failures, investigating accidents, reviewing safety issues and presenting conclusions in the form of opinions. “Opinions” in the sense of a forensic engineering case are concise summary statements of conclusion developed from review and analysis of all the available evidence at the time. They are likely to be challenged, word by word, not only during the course of the particular case but also every time the issue arises in future cases. A set of opinions therefore represents a personal position which needs substantial evidentiary support to survive.

Forensic engineering investigations cover a huge variety of unusual and peculiar circumstances where a number of factors happen to coincide in an unforeseen way, creating a major problem or accident. Although the cause may at first sight seem straightforward, and indeed the claim may well be that if only the lever went up instead of down the person would not have died, investigation often reveals a complex interplay of engineering and human issues not easily unravelled.

In many engineering failure and accident investigations a seemingly insignificant or overlooked piece of physical evidence, engineering data or witness information holds the key to what happened. Unless the analysis of such situations is carried out in a meticulous way, based on the application of extensive practical experience, it is likely that erroneous conclusions will be drawn as to the root cause of the problem. Often one party or another puts forward a causation theory prematurely in the discovery phase of an investigation, and this becomes the basis for deposition questioning, testing programs, preliminary expert opinions and the development of alternative theories. Instead of following along the path of the first theory it is essential to break away by gathering all the available evidence and reviewing it carefully from different perspectives. Such a review may well lead to a different theory, better supported by the evidence and perhaps changing the course of the whole investigation. In some cases this “moves the goal posts”, and can result in early resolution of the matter without the need for endless further dispute or a trial.

Experience has shown that a combination of particular techniques form a useful set of guidelines for those involved in forensic investigations. This set of guidelines is summarized below and case examples are used in the oral presentation to illustrate their application in practice.

1. Bring all the pieces together again

The most critical task at the beginning of an investigation is to bring as much of the physical evidence back together again as possible. The reason for this is to carry out a very careful inspection of how things fitted together and interacted at the time of the event. If this is done in a systematic fashion, it provides a level of personal understanding and insight that cannot be obtained in any other way. It usually takes some persuasion and effort on the part of the investigator to be allowed to do this, especially when individual parts, pieces or units are already under the control of different parties. However, it is well worth the time and cost of getting it done before the artifacts deteriorate or destructive examination is carried out. Often it can reveal the key to what happened.

The reverse is also true. As soon as things are moved, disassembled and taken from the scene, the chance of reconstructing “what happened” decreases dramatically, unless the overall cause of the problem has already been established and documented. Once any destructive activities, such as metallurgical examination, have been carried out, the chance of putting everything back together has gone. Only the residual evidence remains for analysis, and the cost of such analysis can be enormous.

2. Question all assumptions

It is common for a notion of causation to develop early in an investigation, and to take hold as a basic assumption. In order for the budding theory to fit the facts understood at the time, additional assumptions may creep in. It then becomes very difficult to break the developing line of thought when new evidence comes to light that does not fit the pattern. For example, when a fracture occurs in a piece of metal there is a natural assumption that it should not have broken, and that the cause of the problem lies right there with the fractured pieces. Rather than reverse the thought process by considering the context in which the fracture occurred, the tendency is to think of getting a stress analysis or metallurgical analysis done to check the material composition, quality and loading at the fracture site. It is at this point that all such preliminary assumptions should be reconsidered, in case the whole investigation is heading down the wrong path.

3. Think through the logic

It is rare for a failure or accident to be caused by one single problem. Usually the event occurs as a result of multiple contributors coming together at one time to create a unique set of circumstances. Once the set of circumstances has been identified, it is helpful to compile a logic diagram, sequence diagram or an equivalent summary of how things had to interact in order to create the accident or failure situation. This helps to clarify the various issues involved, and to identify the further evidence needed to establish causation with certainty. It also can provide a summary of the investigation on a single sheet of paper. This is helpful as a visual aid during presentations and can become a key document during negotiations or depositions.

4. Explain the unusual

There is always a tendency not to worry about seemingly minor details, or to gloss over the fact that a piece of evidence or testimony somehow doesn’t fit with the rest. It is critical that all the evidence can be explained in a rational way, with special attention given to unusual damage, peculiar phenomena or unexpected findings. Often this requires engineering analysis and "scoping" calculations to identify what may be possible and what is not possible. As a simple illustration, consider the case of two plaintiffs trying to claim insurance by insisting that their van was struck on the side by a "phantom" truck going the other way in the middle of the night. They testified that the truck forced them off the road and on to the front lawn of a large corporation, where they most definitely collided head-on with a large ornamental "moon rock". One side of the van was covered with numerous dents, scrape marks and other damage. All of this was carefully studied and documented during a lengthy inspection. An analysis of every mark showed that none of them could possibly have matched up with any part of such a phantom truck. Indeed, many were in recessed areas protected by otherwise undamaged bodywork. In the middle of one side panel was a large "half-moon" black mark that, on first sight, appeared consistent with contact from a large rubber tire. However, the mark was too great in radius to be made by a truck wheel and the side trim strip was "feathered" by rubbing in a direction opposite to that of a wheel rolling on the road. Of course, in this case it was not possible to determine from the inspection how all the various types of damage had been caused. However, what could be concluded with certainty was that not one iota of the damage had been made by a truck travelling in the opposite direction!

5. Demonstrate results clearly

An otherwise excellent investigation may be discredited, rendered ineffective or sidelined by others unless the presentation of results is clear and convincing. In particular there is likely to be aggressive resistance to any change in the mainstream thinking of the parties involved, even if it is on the wrong track. The way to overcome this is by a persuasive presentation or demonstration of the results, based on all the evidence and analysis. This may be in the form of a test, a model, engineering analysis, an oral presentation, a report, or something else, but whatever is appropriate it must do the job! The test must not fail, the model must work, the analysis must be correct, the presentation must be convincing and the report must be definitive. Usually the aim is to summarize the opinions and conclusions with the evidence on which they are based. The more effectively this is done the more likely it will help in promoting a settlement between the parties in dispute.

www.halesgooch.com

Crispin Hales, PhD, CEng.
Hales & Gooch Ltd.
1000 Sheridan Road,
Winnetka, IL 60093
U.S.A.
Phone: +1-847-501-3765
Fax: +1-847-501-3765
E-mail: crispin@halesgooch.com

Shayne Gooch, PhD.
Hales & Gooch (NZ) Ltd.
30 Wetherfield Lane, RD 2,
Kaiapoi 7692
NEW ZEALAND.
Phone/Fax: +64-3-312-0343
Mobile: +64-21-056-0576
E-mail: shayne@halesgooch.com