Crash Testing: Actual and Computer Simulated to Undermine Plaintiff's Case and Prove Your Defense

by Richard B. Watson

He had been a trial lawyer for fourteen years. He had participated in over one hundred jury trials, first as an associate in the second chair, then during recent years, as either sole or lead counsel. This case was different, though. Edward Bailey, a father of three, had been a successful orthodontist prior to his accident. Now he was a quadriplegic. The accident sequence seemed straightforward enough: a stolen car running a red light at an intersection, T-boning Bailey's vehicle. Some eyewitnesses remembered the speed of the stolen car as significant, but others felt it had been moving only moderately fast; the teenager at the wheel had been barely injured. Plaintiff had retained a national expert who had concluded that, given the moderate impact, Bailey's vehicle should have protected its driver from significant injury. Unfortunately, the theory made some sense.

After several sleepless nights, he again made the trip that he had made so many times before, down the Old Man's office on the second floor. The small office was dim and dusty; faded certificates and mementos from an earlier era hung crookedly on the walls. The Old Man's tweeds were rumpled, and his white hair disheveled, but his eyes were piercing, clear and bright. He listened quietly as the younger man summarized plaintiff's evidence. At times the Old Man almost seemed to be asleep. When the younger man had finished, the Old Man beckoned him closer. "I have just one word of advice for you," he said, speaking in a hoarse voice just above a whisper. "Crashtesting."

I. Why Test? What Are We Trying to Prove?

Why would we recommend to our clients that they invest the time and expense that it takes to design and accomplish a one-of-a-kind crash test? In recent years haven't they already invested millions in crash tests of various types to demonstrate compliance with the various Federal Motor Vehicle Safety Standards?[1] Haven't all manufacturers in recent years been required to crash their vehicles into barriers,[2] roll them over,[3] crush their roofs,[4] hit them from the side[5] and abuse them in numerous other ways? Can't we show all this at trial? Isn't this enough? In many cases it may be. But in certain cases, the big ones, the ones that must be won, a real world crash test showing that plaintiff's catastrophic injuries could not have happened the way he contends is likely to be so convincing as to be outcome-determinative.

In a crashworthiness case, plaintiff must prove not only what happened, but what would have happened without the purported defect. In such a case, of course, plaintiff begins with the proposition that the defect did not cause or initiate the accident. Although he may take the position that there would have been *no* injury absent the design defect, in a significant crash he will be more often forced to admit that there probably would have been some injury anyway. He will attempt to prove that absent the defect, the nature or degree of injury would have much less; hence the term "enhanced injury" is often applied to crashworthiness litigation.

A. Alternatives to Testing

Plaintiff's case may be so weak and contrary to common sense that defendant could decide to attempt to prove nothing affirmatively except that his

[1]49 C.F.R. Part 571 (hereinafter FMVSS).
[2]FMVSS 208S5.1 and 301.
[3]FMVSS 208S5.3, 208S8.3.
[4]FMVSS 216.
[5]FMVSS 208S5.2.1, 208S8.2 and 301.

client builds a good product. Counsel would then simply rebut plaintiff's case with existing evidence and logic. In a case of any significance, this is a dangerous course. Although plaintiff has the burden of proof on the issues of both defect and causation, defendant cannot afford to sit on his hands and depend upon a strong argument that plaintiff has not met that burden. As a practical matter, the manufacturer defendant *must* offer a rational alternative explanation. He must prove how and why plaintiff received his injuries.

One approach short of a crash test or computer simulation would be a purely biomechanical approach. A biomechanical engineer or forensic pathologist may, without an accident reconstruction, be able to explain the source of a particular injury based purely upon an examination of the injury itself and the environment surrounding it. However, such an opinion could well be subject to the challenge that, in the absence of a reconstruction, the forensic pathologist could not possibly know the environment.

Thus, in most cases, defendant will have to prove the accident sequence itself. This will necessarily be accomplished through expert testimony; that testimony, to be accepted by the jury, will have to rest on a credible recreation that will convincingly prove defendant's version of the accident and his explanation for the plaintiff's injuries. In doing so, it will disprove plaintiff's theory of causation and perhaps his theory of defect.

The simplest reconstruction would be to have the expert take the known facts and measurements, do a few calculations, perhaps draw a diagram or two, and go directly to his opinions. In an earlier era, when an expert was anyone from out of town carrying a briefcase and a sliderule, such a presentation might have been sufficient. Today, something more is required. Two methods are computer simulation and real-world crash testing.

B. Actual Crash Test or Computer Simulation?

The choice between a computer simulation and a crash test involves, obviously, a balancing of the factors of cost versus persuasiveness. If the amount at stake does not warrant a full-blown real-world test, or if plaintiff's theory is relatively weak, or if the defense theory is already strong or self-evident, a computer simulation may be a reasonable choice. Counsel must realize that computer simulation has its limitations. Typically, computer simulation does not adapt well to vehicle sideswipes or to impacts at odd angles.

Even more importantly, in crashworthiness litigation, although occupant kinematics programs are available,[6] some engineers feel that computer simulation is not sufficiently accurate to predict occupant kinematics.[7] In a collision where an occupant may have sustained multiple impacts during an accident sequence, the nature of each impact is determined by the outcome of those that precede it. Often these multiple occurrences occur so close together in time that it is impossible to determine which happens first.

Thus, while a computer may be very accurate in simulating the first impact, or even the first few impacts, soon any minor inaccuracy is magnified and the ultimate result may be totally inaccurate. Terry Thomas, of Failure Analysis Associates in Phoenix, Arizona, describes this as the "Butterfly Effect," after an old Chinese theory about the effect of the past on the future. The theory states that if our past had been disrupted to the extent of a single butterfly being killed one thousand years ago, due to the ever-magnified causes and effects resonating down through the centuries, our world today would be entirely different. In any event, occupant kinematics are typically tested with real world tests.

Finally, a computer simulation will almost invariably be subject to the criticism that it was manipulated, while a real world test that convincingly demonstrates that an accident did not happen the way plaintiff contends or that the mechanism of injury was something other than the claimed defect may well be outcome-determinative.

II. Can We Get It into Evidence? Considerations of Admissibility

A. Scientific Evidence in General and Tests in Particular

Frye v. United States,[8] established a widely followed standard for the admissibility of evidence based on scientific techniques:

[6]*See e.g.*, B. Bowman, R. Bennett, and D. Robbins, MVMA Two-Dimensional Crash Victim Simulation, Version 4, Volume 2, University of Michigan, UM-HSRI-79-5-2, Ann Arbor, MI, (1979); J. Fleck, and F. Butler, Validation of the Crash Victim Simulator, Volume 3, User's Manual Calspan Corp. Report No. ZS-5881-V-3, NHTSA Contract No. Dot-HS-6-01300, (1982); K. Digges, Reconstruction of Frontal Accidents Using the CVS-3D Model, SAE 840869 (1984); *Vehicle Analysis Package — EDHIS Program Manual*, Engineering Dynamics Corporation, Beaverton, OR (under development).

[7]Conversation with Terry M. Thomas, Failure Analysis Associates, 1850 W. Pinnacle Peak Road, Phoenix, AZ 85027. (602) 582-6949. The author acknowledges the assistance of Mr. Thomas in the preparation of portions of this article. *See* note 42, *infra* and accompanying text.

[8]293 F. 1013, 1014 (D.C. Cir. 1923).

> Just when a scientific principle or discovery crosses the line between the experimental and demonstrable stages is difficult to define. Somewhere in this twilight zone the evidential force of the principle must be recognized, and while courts will go a long way in admitting expert testimony deduced from a well-recognized 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.* [emphasis added]

Thus, *Frye* requires that the particular technique, such as a crash test or computer simulation, be generally accepted in the relevant scientific community, This standard is designed to screen out "junk science" or other unreliable evidence, thus providing for greater accuracy and fairness at trial. One can readily envision the problems that arise in applying *Frye* to highly specialized technology. "General acceptance" is hard to define when only a handful of scientists are versed in a particular technique in a limited or obscure technical area. Thus, while the rule tends to exclude "junk science," it may also exclude valuable, reliable evidence based on novel scientific techniques until such techniques gain "general acceptance."

The Federal Rules of Evidence relating to expert testimony, in particular Rules 702 and 703, seem to establish a less demanding standard than does *Frye* for the admission for scientific evidence. For example, it would seem that under Rule 703 an expert could reasonably rely on certain facts or data as the basis for his opinions even before it could be said that the utility of the facts or data are generally accepted in a particular field.[9]

In *Mustafa v. United States,*[10] Justice White, dissenting from a denial of *certiorari,* pointed to a conflict among the circuits. It appears that the Second and Third Circuits have explicitly rejected the *Frye* standard.

Some commentators have urged a rejection of the *Frye* test in favor of the adoption of a "relevance" analysis.[11] However, what *Frye* recognized, and what any court attempting a relevance analysis should recognize, is that a trier of fact must be in a position to evaluate the weight of evidence. A novel scientific test, particularly one devised by one or two people, poses problems. For example, in a situation where a novel testing approach has been engaged in specifically for a particular case in litigation, trial judges and appellate courts should justifiably be concerned. There may be very few experts available to examine a novel test from the opposite viewpoint. The ultimate question for the trial judge under either the *Frye* standard or a "relevance" analysis should be whether both sides will have a fair opportunity to test the validity of scientific results. If not, those results should not be admissible.[12]

A review of the case law suggests exactly what logic would tell us: the admissibility of crash tests or computer simulations turns on whether the tests were conducted under circumstances sufficiently similar to the accident at issue. So, for example, in *Barnes v. General Motors Corp.,*[13] the court held that it was error to allow plaintiff's expert to testify about an experiment he conducted on another automobile under significantly different circumstances from those existing at the time of the accident at issue. Similarly, the Court of Appeals in *Hall v. General Motors Corp.,*[14] upheld the trial judge's ruling excluding defendant's experimental test results as not having been conducted under sufficiently similar circumstances. Conversely, *Young v. Illinois Central Gulf Railroad Company,*[15] reversed a defense verdict because the trial judge erroneously excluded a motion picture experiment and expert testimony offered to prove the danger of a particular railroad crossing, and *Bauman v. Volkswagenwerk A.G.,*[16] approved the introduction of expert testimony based on simulated reproductions of an accident. The *Bauman* court observed that, in some cases, expert testimony might be the only way to establish the defectiveness of a product.

As a fallback position to offering a particular test or simulation as a substantially similar recreation of the accident at issue, defense counsel might consider offering it as a demonstration of a particular point made by his expert witness. The foundational requirements for merely demonstrative evidence are not rigorous. McCormick tells us that demonstrative evidence is evidence offered for the purpose of illustration and clarification. The theory justifying admission of this type of evidence requires only that the item be sufficiently explanatory or illustrative of relevant testimony to be of potential help to the trier of fact.[17] So, for example, even if a videotape or other documentation of a test

[9] S. Saltzburg & K. Redden, Federal Rules of Evidence Manual 633 (4th ed. 1986).

[10] 479 U.S. 953 (1986).

[11] *Id.* Saltzburg & Redden, *supra.*

[12] *Id.*

[13] 547 F.2d 275 (5th Cir. 1977).

[14] 647 F.2d 175 (D.C. Cir. 1980).

[15] 618 F.2d 332 (5th Cir. 1980).

[16] 621 F.2d 230 (6th Cir. 1980).

[17] E. Cleary, McCormick on Evidence, § 212, 668 (3rd ed. 1984).

or experiment does not meet the threshold of sufficient substantial similarity, it might be received into evidence as mere demonstrative evidence or it might be utilized without being admitted into evidence as a "demonstrative aid."[18]

B. Admissibility of Computer Simulations

Additional considerations attach to the admissibility of computer simulations or computer-generated trial aids. Many of these admissibility considerations also run to the weight or persuasiveness that the jury will attach to the evidence. Even people who are relatively unsophisticated as to computers have heard of the phenomenon, "garbage in, garbage out." Common sense tells us that the result of a computer simulation is absolutely dependent upon the input. Moreover, judges and juries alike can identify with the sentiments expressed by Judge Van Graafeiland (542 F.2d at 121) in his dissent in *Perma Research and Development v. Singer Co.*:[19]

> As one of the many who have received computerized bills and dunning letters for accounts long since paid, I am not prepared to accept the product of a computer as the equivalent of Holy Writ.

Nonetheless, the *Perma Research* majority approved of allowing the expert to testify to his ultimate conclusion based on his computer simulation, but expressed concern that the delivery of details of the underlying data and programs employed in these simulations had not been made available to opposing counsel in advance of trial.

Indeed, this concern as to the authenticity and discovery of both the underlying data and the reliability of the program itself is a thread running through most of the decisions on the admissibility of computer-generated evidence.[20] Federal Rule of Evidence 901(b)(9) provides for authentication of a system or process by evidence describing a process or system used to produce a result and showing that the process or system produces an accurate result. Thus, the expert will have to testify regarding the inherent reliability of the system used. One expert who frequently testifies in the computer simulation of vehicle accidents suggests a five-step qualification process:

> *Qualify the Expert.* Using the computer does not make you an expert. In fact, it places additional demands on your expertise. Qualifications for expert testimony vary from state to state, and it is up to the individual to demonstrate a true knowledge and experience in the field of accident reconstruction, as well as understanding of the use of computers.
>
> *Qualify the Hardware.* Although not generally necessary, it does no harm if you state the results were obtained using recognized brand-name hardware. However, if the results were obtained using an untested prototype computer, it will be necessary to show that the computer produces valid results.
>
> *Qualify the Software.* The third step is to show that the computer program is valid, usually through the use of a study comparing the computer results with actual test data.
>
> *Qualify the Input.* Each input variable is subject to scrutiny. You must be able to explain the source of the data.
>
> *Qualify the Output.* The final step is to explain how the results were obtained and what they mean. This step is required for any technical presentation of findings, and provides the basis for your opinions.[21]

The program itself as well as the input data will be subject to discovery well in advance of trial. The *Manual for Complex and Multi-District Litigation* contemplates this:

> The proponent of computerized evidence has the burden of laying a proper foundation by establishing its accuracy. Exploring matters relating to the reliability of such data for the first time at trial, however, may waste time and either be unfair to the parties against whom they are offered or result in elimination of evidence that (had problems been identified and corrected earlier) would have been beneficial in expediting trial and understanding the issues. Therefore, well in advance of trial, appropriate discovery should be undertaken concerning the reliability of computerized evidence that may be used later. This will usually include inquiry into the accuracy of the underlying source materials, the procedures for storage and processing, and some testing of the reliability of the results obtained. If it is impracticable to identify and correct all errors, counsel should nevertheless attempt to ascertain and stipulate the statistical probability of the range of error.[22]

Additionally, several cases since the *Perma Research* case have confirmed the discoverabilty of the bases of computer-generated evidence.[23]

[18] *See, e.g.,* Carson v. Polley, 689 F.2d 562, 579 (5th Cir. 1982).

[19] 542 F.2d 111 (2d Cir. 1976).

[20] *See also,* Manual for Complex Litigation, Second, § 21.446.

[21] *See generally,* T. Day & R. Hargens, *The Use of Computers in Traffic Accident Reconstruction,* Northwestern University Traffic Inst., Evanston, Ill. (1989).

[22] Manual for Complex Litigation, Second, § 21.446.

[23] United States v. Cepeda Penes, 577 F.2d 754 (1st Cir. 1978); City of Cleveland v. Cleveland Electric Illuminating Company, 538 F. Supp. 1227 (N.D. Ohio 1980).

III. Computer Simulation and Reconstruction

A. Computer Simulation or Reconstruction vs. Computer Animation

Counsel needs to understand the difference between computer simulation, computer reconstruction and computer-generated animation. *Animations*, which can be very expensive and very compelling, are merely illustrations and, therefore, really prove nothing more than does a diagram of an accident scene, or an artist's conception of an accident sequence. An animation may be exactly what you want to convincingly illustrate an opinion already developed by your expert. Necessarily, however, this animation cannot serve as a *basis* for your expert's opinion.

A *reconstruction* program will take known values and data such as positions at impact, positions at rest, vehicle damage data and other accident-scene data and will apply the laws of physics working backwards to calculate initial (pre-crash) unknowns including vehicle speeds, directions and positions.[24]

A *simulation* program asks the user for initial positions and velocities, as well as vehicle weights and other properties. It then calculates the predicted vehicle paths and damage throughout the accident sequence until the vehicles come to rest. This time-based sequence is one thing that makes simulations so useful: they can be used as the basis for an accurate animation of the accident sequence.[25]

Typically, an expert will reconstruct an accident before simulating it. This order is fundamentally necessary, since a simulation asks for initial speeds as *input*; these speeds are the *output* of a reconstruction.

B. Computer Simulation Programs

The complex dynamics of vehicle accidents have been studied since the 1920s.[26] It was not until 1968, however that a simple computer program was advanced which attempted to model vehicle impacts.[27] In 1971, Raymond R. McHenry, of Calspan Corporation of Buffalo, NY, developed a program known as SMAC. This was the first of the modern vehicle accident programs. McHenry's two programs, developed under contract for the National Highway Traffic Safety Administration (NHTSA) are still among the most widely used computer accident programs:

> CRASH — Calspan Reconstruction of Accident Speeds on the Highways. CRASH has been superseded by CRASH2 and CRASH3. The CRASH programs are simpler programs than IMPACT. CRASH, a reconstruction program, asks for measurements of the scene and of vehicle crush and from these estimates vehicle speeds. CRASH cannot deal with angular speed (vehicle spin).
>
> SMAC — Simulation Model of Automobile Collision. SMAC is a computer simulation program and is a more complicated and sophisticated program than CRASH. It asks for speed and geometry and predicts the results of the accident.

Access to both of these programs is available through numerous commercial[28] and research-oriented computer centers.[29] Direct telephone connection is possible via modem to home PC's. The programs are reported to be user-friendly.[30]

Versions of these programs have been adapted for use on personal computers by Terry Day of Engineering Dynamics Corporation of Beaverton, Oregon.[31] Day has created EDSMAC and EDCRASH, which are available to purchasers on floppy disks. Day states that his programs are virtually the same as the original SMAC and CRASH programs, but are somewhat easier to use. Although the programs can be run on a basic IBM clone, Day would prefer a 286 or a 386 PC with RAM of 640 K. A 486 PC would be preferable for the full EDSMAC computer simulation. Day suggests that since EDCRASH and EDSMAC utilize opposite approaches and sets of input data in reconstructing an accident, the two be used in conjunction to validate each other. Engineering Dynamics also offers EDCAD, which is a computer aided drafting program that will create a diagram of the accident scene and sequence.

In recent years there has been a growing recognition that the relationship between vehicle "crush" and speed is not necessarily linear, particularly so given the variety of construction materials utilized

---

[24] Day & Hargens, *supra*.

[25] *Id.*

[26] Y. Wu, *Accident Reconstruction Models*, in 1 Automotive Engineering and Litigation (1984).

[27] *Id.*

[28] CAAAM, P.O. Box 40489, Pasadena, CA 91104

[29] MCAUTO, 2990 Telestar Court, Falls Church, VA 22042; GTE Telenet Communications Corp., 8229 Boone Blvd., Vienna, VA 22180.

[30] R. Jablonsky, *Computer Assisted Accident Analysis*, in 1 Automotive Engineering and Litigation (1984).

[31] Engineering Dynamics Corp. 8625 S.W. Cascade Blvd., Suite 200, Beaverton OR 97005. (503) 644-4500. The author thanks Terry Day of Engineering Dynamics Corp. for his assistance in preparing portions of this article.

in modern vehicles[32] and particularly at speeds in excess of forty miles per hour. Continuing efforts are being made to improve the essentially linear crush/speed values of NHTSA's CRASH3 model.[33] Yau Wu of Dynamic Analysis Corporation, Concord, Massachusetts, has developed a more general linear and non-linear "ansiopathic" model, IMPACT.[34] Ron Woolley of Collision Safety Engineering of Orem, Utah, has approached the problem with yet another program, IMPAC, which is available for PC.[35] A very recent development, ADAMS[36] permits a three dimensional analysis which takes into account such factors as the behavior of suspension systems, tire/pavement friction and wind.

In summary, while it would seem that the defense could enhance credibility by utilizing SMAC or CRASH, both of which can be argued to have the NHTSA imprimatur, these models may actually be less accurate than some of those developed more recently, particularly for simulation of accidents at higher speeds, when the speed/crush relationship ceases to remain linear. Finally, counsel must keep in mind that when occupant kinematics are a factor, as they are in most crashworthiness cases, computer simulation may not be a viable option. (See Section I, above.)

IV. The Real-World Crash Test

A. Initial Considerations

Once counsel and client have made the decision to engage in a real world test, there are further decisions to be made. These will involve a balancing of economic considerations against the factors affecting admissibility, discussed *supra*. These are generally, but not always precisely, the same factors that determine persuasiveness. Will the entire accident sequence be duplicated, or just a part of it? Should the entire vehicle be crashed or just the portion or component that defense contends (or the parties agree) is relevant? Will the exact surface of the road be duplicated? Its coefficient of friction? The precise slope? The size, weight, material strength, and density of any obstacles? Does plaintiff contend that these factors are relevant, or has his expert already conceded that they are not? How will the victim and other occupants be accurately simulated? If a dummy is to be used, of what type? Obviously, admissibility cannot be compromised. Otherwise, the investment in the test, to say nothing of the entire defense, is jeopardized.

As noted above, the Federal Motor Vehicle Safety Standards (FMVSS)[37] contain numerous standardized crash test procedures for demonstrating compliance. In particular FMVSS 208 (Occupant Crash Protection), 216 (Roof Crush Resistance — Passenger Cars) and 301 (Fuel System Integrity) prescribe various types of moving rigid barrier, fixed rigid barrier, roof crush, and rollover tests, as well as requirements for anthropomorphic test dummies,[38] to be utilized by manufacturers in demonstrating compliance with the FMVSS. The Society of Automotive Engineers, Inc. (SAE) publishes a series of Recommended Practices[39] for conducting specific tests complying with the FMVSS requirements; generally these SAE Recommended Practices elaborate upon the tests described in the FMVSS. In several instances, the FMVSS references the SAE Recommended Practice.

While such standardized tests could not prove what happened in any particular accident, they may suggest methods of conducting real-world tests. In the real world, however, most impacts are not symmetrical or against a solid, uniform surface.[40] When one vehicle strikes another, the results are very different from and significantly more complex than those obtained in a fixed or moving barrier test. For example, the rigid parts of one vehicle will penetrate the "soft" parts of the other and vice versa.[41] Thus, while the defense may wish to demonstrate compliance with the FMVSS, any test prescribed therein is far too simple to serve as a judicially admissible recreation of even the simplest of real world accidents.

[32] A. Prasad, *Energy Dissipated in Vehicle Crash — A Study Using the Repeated Test Technique*, SAE 900412 (1990).

[33] *Id.*

[34] Y. Wu, Accident Reconstruction Models, in 1 Automotive Engineering and Litigation (1984).

[35] R. Woolley, IMPAC User's Guide and Technical Manual, Version R84L12W03, Collision Safety Engineering, Orem, UT (1985).

[36] Mechanical Dynamics, Inc., Ann Arbor, MI.

[37] 49 C.F.R. 571.

[38] The characteristics of anthropomorphic test dummies for use in FMVSS tests are specified in 49 C.F.R.572. These types of dummies are also typically used in real-world crash tests. For an interesting discussion of the use of such dummies and related politics between the National Highway Traffic Safety Administration and some of the automobile manufacturers, *see* "The Head-On Debate Over Crash Safety," Los Angeles Times, January 5, 1992. (Available on LEXIS/NEXIS).

[39] 4 SAE Handbook, *On-Highway Vehicles and Off-Highway Machinery*, Ch. 34. (1991).

[40] B. Pletschen, R. Herrmann & F. Zeidler, *The Significance of Frontal Offset Collisions in Real World Accidents*, SAE 900411 (1990).

[41] Hobbs, *Essential Requirements for an Effective Full Scale Frontal Impact Test*, SAE 900410 (1990).

B. Selection of Experts and Test Facilities

An expert should be brought into this decision making process at this point if not already involved. In addition to all of the factors which go into the selection of any expert, counsel must consider whether that expert has access to a facility that can conduct the type of tests counsel thinks she wants. In order to duplicate a real accident, a sophisticated facility will have to be utilized that can accommodate the variety of factors that went into that accident. Can the facility perform anything but direct front and rear impact tests? Can it handle two moving vehicles or will the target vehicle need to be parked? Can sidewipes be accurately duplicated? Skids? Rollovers? Vehicle tripping? Yawing? Steering inputs?

Although a real-world duplication of an accident will necessarily go far beyond the compliance tests prescribed by the FMVSS, credibility might be enhanced by utilizing a test laboratory that has performed FMVSS testing, particularly under government contract. Such an engineering laboratory may or may not have the facilities necessary to duplicate real world accidents. Such facilities might include a racetrack-like driving oval, a monorail track, sled impact and declaration facility, drop tower, and test dollies for propelling, releasing and throwing vehicles into obstacles or initiating rollovers.[42]

C. Other Considerations

With an expert on board, what is desirable must be compared with what is economically and scientifically feasible. Once counsel, client and expert agree on a concept for the real-world test, specific parameters — speeds, angles, etc., will have to be developed. A good investigation of the accident, the injuries, and the anthropomorphic characteristics of the victim on the order of one conducted as suggested elsewhere in this monograph will provide much of the input.[43] If actual vehicle weight is not available through investigation, every effort should be made to duplicate it through information from the manufacturer. Normally, since there will be no reliable evidence as to speed except impact damage, speeds will have to be developed by working backwards from crush measurements on the vehicle. This is, of course, classic reconstruction technique. Even in what will ultimately be a real-world test, these values will typically be developed by computer. Significantly, at this early stage, a computer reconstruction and simulation may give a dependable indication as to the probable result of the real thing and whether the expense of a real-world attempt is even warranted. Whether these preliminary calculations are made by hand or computer, care should be taken during this planning process to use real-world values for such vehicle parameters as weight, geometry, inertia, overhang and crush, as opposed to the computer program's "default" values.

Finally, thorough consideration must be given to instrumentation, documentation and preservation of evidence. The SAE recommended practices provide some guidance.[44] Provisions will have to be made for fabrication and installation of on-board camera and instrumentation mounts, remote recording of numerous measurements and the like. Typical methods include video and still photography, but authenticity may additionally necessitate the tracking of speed, acceleration, regular momentum, impact forces and other parameters in such a way as to be converted into part of a convincing courtroom presentation.

> His final argument was brief, by "big-case" standards. It took about forty-five minutes. It went smoothly. His arguments always did when he had strong evidence from which to argue. The expressions on the faces of most of the jurors gave him added confidence. These were the same expressions he had seen yesterday when the jurors watched in rapt attention while his engineering expert presented the videotapes of the crash test. As he revisited the crash test now, in final argument, he felt almost eloquent. . . .

[42] One such facility is that maintained by Failure Analysis Associates in Phoenix, Arizona. *See* note 7, *supra*.

[43] *See also*, Tumbas, Gilberg & Fricke, *Minimum Guidelines for Efficiency Acquiring or Preserving Basic Information in a Motor Vehicle Accident*, SAE 880067 (1988).

[44] 4 SAE Handbook, *On-Highway Vehicles and Off-Highway Machinery*, Ch. 34. (1991).

Richard B. Watson is managing partner of the Charleston office of Nelson, Mullins, Riley & Scarborough, with a practice emphasis on product liability, particularly aviation products. Mr. Watson is a member of the Lawyer-Pilots Bar Association, South Carolina Defense Trial Attorneys Association, and the Defense Research Institute Product Liability Committee.

The jury was out for thirty-five minutes. Slowly, they filed back into the box. The judge cleared his throat. "Madam Forelady, have you reached a verdict?" "We have, your honor." "Hand it up." The judge's face registered no emotion as he scanned the verdict form. He handed it back to the clerk. "Publish the verdict," he said. The clerk paused, then read, "In the case of Edward Bailey versus Universal Motors, we find for the defendant."

Richard B. Watson, Crash Testing: Actual and Computer Simulated to Undermine Plaintiff's Case and Prove Your Defense, The Crashworthiness Doctrine in Products Liability, (DRI, 1992)