COMPLETING THE PUZZLE

THE BENEFITS OF SIMULATION IN ACCIDENT RECONSTRUCTION

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INTRODUCTION

First responders arrive to a routine accident scene. Three vehicles are strewn about on the roadway, each with heavy damage on multiple sides. Tire marks paint the pavement while the debris is scattered, illuminated by the flashing lights of emergency vehicles.

As paramedics get to work ensuring the safety and care for each passenger, the police attempt to make sense of the scene. As they interview each driver, no one can seem to recall coherently how the accident started and who could have caused it. The officers believe one vehicle was speeding, but that vehicle also had the right-of-way. In the midst of the confusion and uncertainty, they decide not to issue any citations.

The injuries are treated, the cars are towed, and the insurance companies are notified. Yet, in the wake of the accident, we are left with a police report with limited data, conflicting stories from each driver, and no clear party at fault. How can we make sense of this chaos? What can be used to understand this incident, and moreover, can we trust it? Let us examine the evidence.

The vehicle damage, final resting positions, available electronic data, and tire marks are all pieces of the puzzle, but this is just the start. With these pieces, we can begin to reconstruct the puzzle, matching inter-vehicle damage patterns and placing cars on tire marks. Skilled reconstructionists can place the vehicles in their pre-impact lane positions in the moments leading up to the accident. But how can we get from these pre-impact conditions to understanding what actually happened? One answer is physics-based modeling, or as it is commonly called, simulation. Simulation allows an objective process of testing in order to scientifically validate how the laws of physics correspond with the available physical and testimonial evidence.

WHAT IS A SIMULATION

Intrinsically, simulation offers a mathematical approach that evaluates different parameters to see how the physics play out. Specifically, accident reconstruction simulation packages are based on Newtonian laws of motion as well as scientific principles, including the conservation of energy and the conservation of momentum. In the case of motor vehicle accident reconstruction, much like the incident outlined above, a scenario can be evaluated based on available evidence known by the reconstructionist. From here, with data like scene roadway evidence, 3D scan measurements, and vehicle EDR (Event Data Recorder) information, the simulation can be run and the results evaluated. These results can then be compared to the known conditions of the subject incident, and through an iterative process, a series of hypotheses are tested and considered. What changes is the sequence most sensitive to? Are there parameters that have less influence on the outcome?

All these questions can be answered with the use of simulation. In the end, the test series should develop into a chain of reliable scientific conclusions. In the case of an accident scenario, reconstructionists can utilize evidence determined from camera-matching techniques and 3D data taken from the site inspection. Simulation iterations can then be performed to determine initial vehicle positions, headings, and speeds that match the final rest positions and damage profiles of the subject vehicles. Performing simulations that match vehicle pre-impact positions, roadway evidence such as tire marks and gouges, vehicle damage profiles, final rest positions, EDR data, and testimonial evidence from drivers and witnesses, give reconstructionists a high level of confidence that their reconstruction is accurate and consistent with the available evidence. This further allows them to perform avoidance and alternate scenarios to answer many questions surrounding an investigation.

Different simulation software can make use of different mathematical models. These models are extensively validated before they are accepted for the court. However, there are instances where results can be misleading or simply, the models disagree. For example, when dissecting a simulation, it may be found that it requires a rate of acceleration on par with a Ferrari, but the vehicle is a loaded tractor trailer. This is a clear indicator that the approach taken by the expert should be questioned. Was the loaded tractor trailer electric? Was it traveling down a hill without brakes? Why, and how, was the acceleration rate chosen? The idea also extends to braking capabilities, steering inputs, and any other physical parameter related to the sequence. A steering input that, on the surface exceeds human capability, should be explored and questioned. Ensuring this type of continuity throughout a simulation can assist in scrutinizing the conclusions proposed and help make certain, or at least less likely, that a dubious result is believed. Whether it is a simulation on your side or the opposing side, scientific principles must be applied and followed.

SIMULATION V ANIMATION

It is important to note that while animations are a sister to simulations, they do not always provide the same value to a case. A simulation must rely on a proven mathematical model, and in the case of accident reconstruction, to the laws of physics. While in contrast, an animation does not have the same requirement. It is possible to animate a sequence that looks realistic enough to persuade a jury, however, violates the laws of physics and contains no scientific integrity. That is not to say that all animations are lacking scientific integrity, however, physics-based simulations are bound by scientific principles and result in confidence that can be conveyed to your client and to a jury.

Animations are developed by the hands and mind of the designer and can be operated without constraints to physical reality. Simulations, specifically ones like HVE or PC Crash, are programmed to operate within these constraints. The person operating the program can only manipulate parameters (speed, direction location, etc.), but not the way the vehicles move. The program moves them based on the mathematical parameters that govern vehicle motion. Thus, as it relates to vehicle accident reconstruction, animations are strongest when underpinned by a sound scientific simulation. Without this foundation, an animation is an artistic rendering, susceptible to being questioned and challenged by opposing counsel. Conversely, an animation based on physics-based simulation packages can accurately and easily explain and demonstrate complex accident situations with clarity and confidence.

CONCLUSION

The simulations for the crash scenario outlined in the opening provided a valuable result for our case which showed that the vehicle with the right-of-way was speeding and traveling 65 mph in a 35-mph zone. The reconstructionist was able to provide opinions regarding the perception and response for the other drivers and determined that had the speeding vehicle been abiding by the limit, there would have been an additional 150 feet available for the drivers to avoid the collision.

There are many unknown parameters when evaluating an accident, but the value of an experienced reconstructionist utilizing the tool of simulation can help make the picture clearer. To begin with chaos and end with an understanding of any incident offers the confidence of being informed based on a scientific methodology to formulate valid conclusions.

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