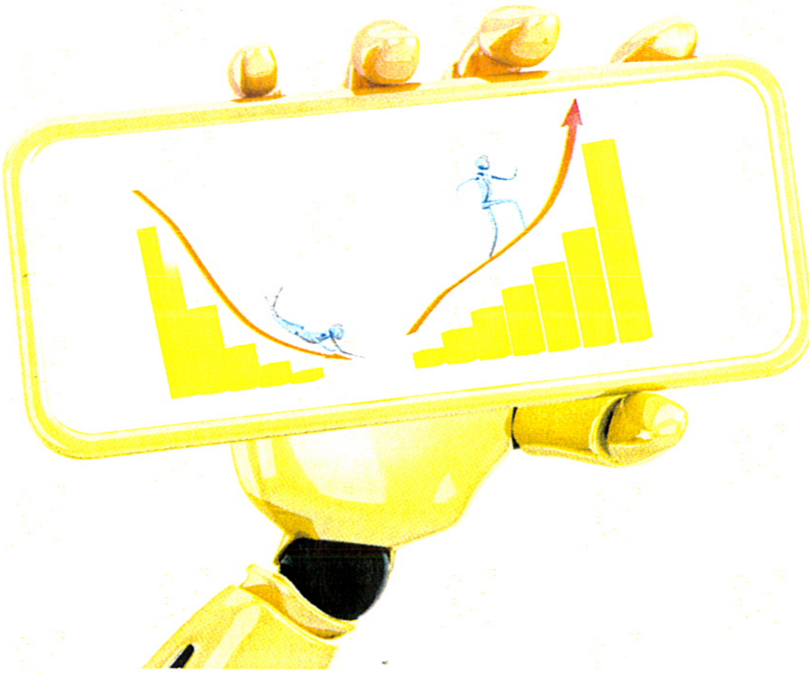

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The Rise of Biomechanical Experts at Trial

By Robert Glick and Sean O'Loughlin

The use of biomechanical experts in defending low-impact automobile cases has become, without surprise, a relatively new weapon in the arsenal of insurance defense attorneys. By and large, this type of defense seeks to establish that a plaintiff involved in an automobile accident either could not have sustained the magnitude of force necessary to compromise the alleged injured body parts or could not have physically moved in a manner that would have caused his or her alleged injured body parts to exceed their natural physiological ranges of motion. However, since most biomechanical experts are not licensed medical doctors, many plaintiffs' attorneys are mounting challenges to discredit the very essence of the science as a whole. With the judiciary divided over whether to allow biomechanical experts to testify, defense attorneys are now faced with the unique challenge of convincing the courts as to the legitimacy of biomechanics as an established science.

A biomechanical expert is one who reconstructs an automobile accident using physics and mechanical engineering principles. Using their understanding of human anatomy and physiology, how the human body functions, and what types of forces and motions the body undergoes daily, experts can determine whether the forces involved in an accident were of the magnitude to compromise the alleged injured body parts in a manner that would result in the injuries claimed or whether the resulting motions sustained by the vehicle occupants were such that the alleged injured body parts exceeded their natural physiological ranges of motion.

The biomechanical expert's inquiry begins with an accident reconstruction; the reconstruction will reveal sudden velocity changes of the vehicles during the accident. Sudden velocity changes of a vehicle will cause the sudden and unexpected motion of the occupants inside, and this sudden and unexpected motion can serve as a basis for a claim of injury.

The Physics of an Automobile Accident

During an accident, if the occupant makes contact with the vehicle's interior, it is because the occupant moved inside the vehicle compartment. If the occupant was restrained during the contact, then the basis for a claim for injury will most likely be attributed to the occupant's movement before the restraint took hold or from the restraint itself. Since the motion of an occupant inside a vehicle during a collision is the primary cause of the alleged injuries, then it is only logical that we begin by looking at what causes motion during a car accident.

Consider the following example of how people move inside a car during an accident. Two cars are traveling on a road, one in front of another, with the vehicle in the rear traveling faster than the vehicle in the front. At some point in time, the two vehicles will make contact. When this contact occurs, according to basic principles of physics and mechanical engineering, the faster car in the rear will transfer energy to the slower vehicle in the front causing this front vehicle to accelerate. As the front vehicle begins to accelerate, the occupants inside the vehicle are also affected. Prior to the impact, the occupants' velocity is the same as the vehicle they are traveling in. However, as their host vehicle suddenly changes velocity, the occupants do not. They initially continue to travel at their pre-impact velocity even though their host vehicle is accelerating beneath them, which causes the occupants to move inside the vehicle compartment. The vehicle is travelling faster than they are, which pushes them toward the rear, into their seats. Now, as their seats become loaded with force, the seat in turn becomes a spring, catapulting the occupants forward. If the occupants are wearing a restraint, the seat belt will take hold of them, to restrain them back into their seats. The sudden change in velocity of the host vehicle has caused this. The task now is to understand what causes this sudden change in velocity.

For every action, there is an equal and opposite reaction. This is Newton's Third Law. When two cars make contact, the force of the collision is equal in magnitude but opposite in direction. The reaction of the vehicles is subject to their masses, but the force is the same to both vehicles. The acceleration of each vehicle will be equal to the force of the impact divided by the vehicle's mass. This is Newton's Second Law, the famous equation being: Force equals Mass multiplied by Acceleration. Moreover, as long as an outside object does not interfere with the vehicles during and following the collision, the vehicles' total momentum must be maintained. This is the principle of Conservation of Momentum, which basically means that when two objects are travelling together, their total momentum will not change because of a collision, as long as they are not interfered with by an outside object. Thus: The momentum of each vehicle is equal to its mass multiplied by its velocity. The total momentum is equal to the sum of the momentum of both vehicles. This total momentum will not change as long as the vehicles are not interfered with by an outside object, even though both vehicles may change their velocities during the collision. Conservation of Momentum must be preserved on both the longitudinal and lateral directions of travel. In addition, a vehicle may change its velocity in both the longitudinal and lateral directions of travel.

In a collision, energy can be transferred laterally, causing lateral accelerations of the vehicles and their occupants. For example, if a car traveling north makes contact with a car that is traveling west, each vehicle will accelerate laterally because of lateral energy gained during the collision. More specifically, the north-bound vehicle will pick up west-bound energy from the west-bound vehicle, causing the north-bound vehicle to accelerate west. The west-bound vehicle will accelerate north because of energy received from the north-bound vehicle. The occupants inside both vehicles will move opposite to the accelerations or decelerations of their respective host vehicles. To understand the consequences of the impact, the practitioner needs to understand that, as a general rule, cars move away from the point of impact and people move toward the point of impact. This rule applies for both the longitudinal and lateral directions of travel. Once we understand how and why people move inside a vehicle during a car accident we can look at how engineers calculate how much energy is transferred during a collision to determine the magnitude of force imposed upon the occupants.

The Physics of Energy and Motion

The amount of energy gained or lost during a collision is directly related to how much a vehicle changes velocity. When a vehicle gains energy, the vehicle accelerates. When a vehicle loses energy, it decelerates. Vehicles can change velocity both longitudinally and laterally, energy can be gained and lost both longitudinally and laterally, and occupants can move inside a vehicle both longitudinally and laterally. The amount of energy gained or lost during a collision is determined by using standard principles of physics and by comparing the damage to the accident vehicle with an equivalent crash test vehicle that sustained damage to the same location.

The change in velocity of a vehicle during a collision can be calculated using basic physics principles. The force of an impact is the same for both vehicles, but the reaction of each vehicle to the impact will differ, subject to its mass.

Force equals Mass multiplied by Acceleration. The force to both vehicles is the same. The mass of the first vehicle multiplied by its acceleration is equal to the mass of the second vehicle multiplied by its acceleration. The mass of each vehicle is equal to its weight divided by the acceleration rate due to gravity or 32.2 feet per second squared. The acceleration for each vehicle is equal to its change in velocity. In addition, if the engineers know the closing speed of the vehicles, they can calculate the change in velocity of each vehicle using the following equation: the change in velocity for vehicle one is equal to the mass of vehicle two multiplied by the sum of one plus the Coefficient of Restitution multiplied by the closing speed divided by the total mass of both vehicles. The closing speed is the speed at which both vehicles are closing in on each other. For example, if two cars are travelling in a straight line and the car in the rear is travelling at 15 miles per hour and the car in the front is travelling at 5 miles per hour, then the closing speed is 10 miles per hour. The Coefficient of Restitution is the vehicles' separation speed (the bounce back after impact) divided by the closing speed. The math can be very complicated, but it is important to have an idea of what engineers are talking about.

The amount of energy that is gained or lost during a collision is also determined by comparing the damage to the accident vehicle with an equivalent crash test vehicle that sustained damage to the same location. Consider, for example, two identical cars. If the first car is hit in a certain manner with a certain amount of force in a certain location and a certain dent results and we hit the second car in the same manner with the same amount of force in the same location, we should end up with a comparable deformation. The deformation represents the amount of energy that the car's material could not withstand. To illustrate: If I am sitting on a chair, my weight is exerting a downward force on the chair. The chair, in turn, is exerting an upward force to hold me up. However, if my weight is too great for the chair to bear, the chair will break or deform. It follows that if a car was damaged in a certain location from an accident and we compare that vehicle to an equivalent crash test vehicle that sustained greater damage in the same location, the crash test vehicle was involved in a collision that involved a greater transfer of energy. With that basic understanding of force and motion, we can take a look at injury-causing mechanisms.

The Physics of an Occupant's Injury

The human body is made up of both rigid-type structures, such as bones, and elastic-type structures, such as tendons and ligaments. In assessing whether a force or motion could break or compromise a body part, we must determine whether the body part made contact with another object or body part with such force as to cause a break or compromise or whether the body part was stretched beyond its limits because of the force or motion. If a rigid-type structure of the body receives a force that it cannot withstand, it will fracture. If an elastic-type structure of the body is stretched too far, it will tear. We know that certain twisting motions of the knee compromise its meniscus. So, what if the accident did not produce a twisting motion? Was the accident the cause of the alleged meniscus tear? We also know that certain movements of the arm above the shoulder plane compromise the Supraspinatus Tendon of the shoulder. But what if there was no motion of the arm above the shoulder plane? Did the accident cause the Supraspinatus Tendon tear? In addition, we know that hyper-flexion and hyper-extension of lumbar and cervical spines compromise their respective intervertebral discs. Once again, what if there was no hyper-flexing or hyper-extending of either the cervical or lumbar spines? Could the accident have caused the alleged herniations in either spine?

> Since most biomechanical engineers are not licensed medical physicians, New York state courts are largely divided over the extent to which they may allow a biomechanical expert to testify.

In analyzing a car accident, a biomechanical engineer will determine whether the forces involved in the accident were of the magnitude to compromise the alleged injured body parts in a manner that would result in the injuries claimed or if the resulting motions sustained by the occupant were such as to cause the alleged injured body parts to exceed their natural physiological ranges of motion. Moreover, an engineer will look at the forces imposed upon the alleged injured body parts and compare those forces with the types of forces the body parts undergo on a daily basis to determine if the accident produced forces that exceeded the forces that the body parts regularly undergo.

Admitting and Using a Biomechanical Engineer Expert's Testimony

Although a biomechanical engineer is not a medical doctor and is not competent to opine as to a diagnosis of an injury, biomechanical engineers are engineers of the human body. From making cars safer to drive to designing artificial limbs, biomechanical engineers are experts in the application of mechanical engineering to the human anatomy and physiology. But since most biomechanical engineers are not licensed medical physicians, New York state courts are largely divided over the extent to which they may allow a biomechanical engineer to testify. The primary proceeding in New York for determining the admissibility of a biomechanical expert's testimony is a *Frye* hearing.[1] In order to have an expert admitted, during a *Frye* hearing the proponent of the expert must prove that

1. "the witness [is][] competent in the field of expertise that he purports to address at trial,"
2. the "expert testimony [is] based on scientific principle or procedure which has been sufficiently established to have gained general acceptance in the particular field in which it belongs,"
3. "the processes and methods employed by the expert in formulating his or her opinion adhere to accepted standards of reliability within the field,"

4. "the proffered testimony is beyond the ken of the jury," and
5. the expert's testimony is "relevant to the issues and facts of the individual case."[2]

The expert's education, experience, and publishing will play a role in the court's decision.

Once it is established that the scientific principles or procedures that serve as a basis for the engineer's opinions have gained general acceptance in the biomechanical engineering community – through published papers, articles and textbooks which are subject to peer-review – counsel must also prove that the processes and methods employed by the expert in arriving at his or her opinions are methods or processes deemed reliable in the biomechanical engineering community. This is usually accomplished by establishing that the methods or processes used by the engineer in formulating his or her opinion have been extensively tested under proper testing conditions and that the tests and the results have been published and peer-reviewed to the extent that these methods or processes are now deemed reliable in the biomechanical engineering community. In addition, counsel will have to prove that the testimony of the biomechanical expert is of a technical nature and beyond the basic knowledge of the jury. Last, counsel will have to establish that the biomechanical expert's testimony is probative of causation as to alleged injuries and, therefore, relevant to the issues and facts of the case.

At a *Frye* hearing, practitioners should be prepared to satisfy all five requirements. When showing that the scientific principles or procedures that serve as a basis for the engineer's opinions have gained general acceptance in the biomechanical engineering community, counsel will need to explain and prove Newton's Laws and the general principles of physics as they apply. If necessary, the expert should bring his or her textbooks used at the major universities, as well as articles and papers supporting the basis for his or her reasoning. In showing that the processes and methods employed by the expert in arriving at his or her opinions are methods or processes that are deemed reliable in the biomechanical engineering community, attorneys will need to prove that the mathematical formulas used by the engineer are those deemed reliable by the biomechanical engineering community for the purpose for which the engineer used the formulas. Attorneys must also be prepared to show how these formulas have been used in countless tests and studies, including to what extent they have been published on and peer-reviewed. If the engineer is relying on a crash test or a study, attorneys need to demonstrate that the test or study was conducted under proper testing conditions and that the test or study has been published and peer-reviewed. In addition, attorneys must be prepared to prove the entire body of science at both the *Frye* hearing and at the damages portion of a trial. There is no substitute for a thorough and complete record. Last, attorneys must be prepared to explain the science to the jury during both the opening statement and the closing argument. It is particularly important to explain, during your opening statement, what the evidence will establish so the jury is not confused when the expert engineer is testifying. And during summation, it is imperative to remind the jury what was proved through the expert's testimony.

The testimony of a biomechanical engineer can be a very effective weapon for cross-examining a plaintiff's treating physician on how little he or she understands about the energy involved in a collision, the amount of force imposed on the alleged injured body parts during the collision, or the body moving during the accident in such a manner as to cause the injuries alleged. This can be particularly useful in disproving the medical argument that because a vehicle occupant was asymptomatic before the accident and is now symptomatic after the accident, the accident must have caused the occupant's injury. In addition, biomechanics can be used to support the defense's medical experts. If a medical doctor reconfirms his or her findings based upon the biomechanical engineer's findings, an attorney now has both a medical doctor and a biomechanical engineer testifying that the accident could not have caused the alleged injuries because the necessary injury-causing mechanisms were not present in the accident. This is why strategically it is best to put a biomechanical expert on the stand before the medical expert. Whatever the biomechanical expert cannot say, the medical doctor can.

Conclusion

It is important to remember that biomechanical experts reconstruct automobile accidents using physics and mechanical engineering principles. Using their knowledge of human anatomical and physiological functions and what types of forces and motions the body undergoes daily, they determine whether the forces involved in an accident were of the magnitude to compromise the alleged injured body parts and result in the injuries claimed or if the resulting motions sustained by the occupants were such as to cause the alleged injured body parts to exceed their natural physiological ranges of motion. Armed with the knowledge that the accident did not contain the magnitude of force necessary to compromise the alleged injured body parts or that the alleged injured body parts could not have moved in a manner that would have caused them to become compromised, defense counsel will have a much better chance convincing a jury the accident did not cause the alleged injuries. ■

1. *Frye v. United States*, 293 F. 1013 (D.C. Cir. 1923); *People v. Legrand*, 196 Misc. 2d 179, 747 N.Y.S.2d 733 (Sup. Ct., N.Y. Co. 2002), *rev'd on other grounds*, 8 N.Y.3d 449, 835 N.Y.S.2d 523 (2007).

2. *Borzacchiello v. Bousbaci*, Index No. 4875/04 (Sup. Ct., Queens Co. 2006), *available at* http://decisions.courts.state.ny.us/fcas/fcas_docs/2006mar/40000487520041sciv.pdf.