ON SITE INVESTIGATION:
WHAT DOES THE BIOMECHANICS EXPERT NEED TO KNOW?

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State Bar of Texas
PROSECUTING OR DEFENDING
A TRUCKING ACCIDENT CASE
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CHAPTER 8
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RELATED PRESENTATIONS/PUBLICATIONS


“Impact Biomechanics for the Health Care Professions” Pre-Conference Seminar. 44th Association for the Advancement of Automotive Medicine Annual Scientific Conference, Chicago, IL, October 2000.


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ON SITE INVESTIGATION: WHAT DOES THE BIOMECHANICS EXPERT NEED TO KNOW?

I. INTRODUCTION

Biomechanics is the science which deals with the effects of mechanical forces on the human body, and uses the laws of physics to analyze and explain the forces encountered during life.

In the context of vehicular collisions, including those involving trucks, the biomechanic’s work involves the sequential analysis of:

- **Accident Reconstruction or Vehicle Impact** - that is, the reconstruction of event dynamics, and determination of energy and forces involved.

- **Occupant Kinematics** - that is, the evaluation of occupant movements and interactions both within the occupant compartment and with any other environmental elements during the collision.

- **Medical Records** - that is, an evaluation of the nature and character of the occupant’s injury or other medical problems, and an assessment of their potential relationship with pre-existing conditions.

- **Injury Causation** - that is, the process which combines biomechanics and medicine, and by which the causal relationship between injuries and forces is or is not established.

In events in which much damage has occurred to the vehicles and/or there are accurate and appropriate scene data, the first phase may be, and usually is, undertaken by an Accident Reconstructionist. In events where damage is slight and/or scene data are deficient, an analysis performed by the biomechanic and based on other methodology may be possible. The aims of this phase, however, are to determine the magnitude, direction and duration of the forces involved in the collision; and to quantify particularly both the impact-related change in velocity (the so-called Delta-V) and the Principal Direction of Force (PDOF). These assessments are based upon the physical Laws of Motion first expounded by Sir Isaac Newton.

II. ACCIDENT RECONSTRUCTION

If an Accident Reconstructionist is involved in the case, then his or her analysis will provide much of the initial information required by the biomechanic. Objective materials made available for, or produced by, the Accident Reconstructionist will also be reviewed by the biomechanic. Such materials, if available, should include:

- **Photographs** of the subject vehicles and collision scene, exemplar photographs,

- **Vehicle specifications** (make, model, curb weight, loads),

- The **nature and extent of vehicle damage** which is not documented photographically (that is, damage revealed by direct inspection or reflected in repair appraisals or cost estimates),

and **Statements or descriptions of the collision event**, including any Police Crash Reports. Scaled scene diagrams are especially helpful.

III. OCCUPANT KINEMATICS

These materials, and the conclusions which can be drawn from them in terms of the forces involved in the event, allow the biomechanic to progress to the next phase: that is, to the determination of the Occupant Kinematics. As do vehicles, occupants follow Newton’s Laws of Motion during a collision. Thus, the driver of a vehicle involved in a collision will obey Newton’s First Law and continue to travel in the same direction and at the same velocity as prior to the impact until his or her bracing forces and the
forces applied by the restraint system(s) decelerate and realign the individual to the vehicle’s post impact direction and velocity. The use or non-use of a restraint system will influence an occupant’s motions during a collision; and so details of such equipment usage and type should be documented (for example, two-point or three-point webbing harnesses, airbags).

IV. MEDICAL ANALYSIS

The next phase is the Medical Analysis, the aim of which is to describe the nature and character of injuries or medical problems both before and after a collision.

Pre-collision medical information will provide an indication of the subject’s clinical status vis à vis his or her post-collision medical course. This is especially relevant if pre-existing conditions have or may have been aggravated by the forces of the accident. The types and sources of pre-collision medical information may include: family and specialist physician medical records, and employment records (including those from any military service).

Post-collision medical information is clearly a vital element of the analysis, and all possible types and sources must be explored, including: police accident reports, Emergency Medical Services/Ambulance reports, Emergency Room records, immediate and remote treating physician reports/medical charts, imaging studies (x-rays, computerized tomography (CT), magnetic resonance imaging (MRI)), and witness statements. Medical records related to the acute phase are especially important, and in many cases may only comprise post-mortem documents (autopsy report, coroner’s report, and/or a death certificate).

V. INJURY CAUSATION ANALYSIS

In the final phase - Injury Causation Analysis - the conclusions reached with regard to the forces involved in the accident and the occupant’s response to them are reconciled with the subsequent clinical course as revealed by the medical analysis; and mindful of any influence the prior medical history may exert.

The interaction between the occupant and the occupant compartment and/or environmental elements imposes forces on the occupant and so create injury mechanisms (such as tension, compression, shear, bending and torsion), which can therefore be defined as physical processes which cause damage to living tissue. Such damage occurs when the mechanisms involved produce forces of sufficient magnitude and duration, and acting in such a direction and over sufficient surface area, as to exceed the tolerance of the affected tissue. Tolerance to a given force is itself a function of the nature of the anatomical structures subjected to the force. Thus, if the four-stage analysis outlined above leads to the conclusion that the forces involved in a collision were of sufficient magnitude and duration, and were acting in a direction appropriate to cause the injury or injuries diagnosed, then the matter is clear cut. This is also the case when the injuries sustained are obvious: other aspects such as product design, manufacture, and failure may then become the principle issues. Difficulties may also arise when the analysis indicates that the forces involved were not appropriate in magnitude or duration or direction to cause the injuries claimed: then a debate begins.

VI. CONCLUSION

Finally, it is intuitively obvious that any expert should be retained as soon as possible; since it is highly desirable that any physical evidence be seen while still “fresh” (rather than in a scrapyard or in the middle of a field). Otherwise, with the passage of time, evidence is lost. In addition, the records provided should be as complete as possible; this is especially important for information sources concerning the immediate post-collision period.