A Crash Course on Crashworthiness

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INTRODUCTION

A case involving severe injuries and death is referred to you. It appears that a vehicle has left the roadway and crashed head-on into a tree. The tree was located an ample distance from the roadway. The driver of the vehicle was killed. One of her daughters, in the front passenger seat, was also killed. The other daughter, in the rear seat, was severely injured.

You find that there were no problems with the design, construction or maintenance of the roadway and there were no mechanical defects in the vehicle. It appears that the young mother simply fell asleep at the wheel. The family's automobile insurance excludes coverage for injuries to an insured or members of an insured's household, thus excluding coverage for all the occupants of the vehicle.

You are explaining the facts and injuries to an eager young law clerk over a beer, as you reluctantly prepare to decline the case. The law clerk tells you that it sounds to him as if car was not very "crashworthy." Your ears perk up and you wonder what the law clerk is talking about, but you don't want to admit your ignorance. So you say: "Yes, that is what I was thinking too, but why do you think so?"

WHAT IS THIS CONCEPT OF "CRASHWORTHINESS?"

When a vehicle crashes, an investigation will invariably attempt to determine if there was any mechanical problem with the car that caused it to crash. For instance, did a brake failure, steering lock-up, or stuck accelerator cause it to go out of control? Frequently, investigations will go beyond mechanical defects, to attempt to determine whether a design problem may have caused or contributed to the crash. For instance, did the design of the vehicle cause it to be unstable?

Unfortunately, investigations of the vehicle will frequently end after the search for mechanical or design defects that could have caused or contributed to the collision. Instead of ending there, the investigation should focus on what may be the more important issue: Did the design of the vehicle contribute to the injuries?

In any given collision, there are two impacts. The first is the impact of the vehicle with something, such as another vehicle or a fixed object. The second impact is that

which occurs between the occupants of the vehicle and the interior of the vehicle itself. It is the second impact which causes the occupants' injuries.

Since manufacturers know that vehicles are going to be involved in accidents, and since a variety of accidents are foreseeable, it is the obligation of the manufacturer to design the vehicle in such a way as to protect the occupants, to the extent possible, from foreseeable collisions. This protection from the second impact or second collision is what is known as the doctrine of crashworthiness. The vehicle should be designed to be crashworthy.

Many needless deaths and severe injuries have resulted from automobile interiors that were not friendly, and did not take into account the safety of the occupants.

WHAT TO LOOK FOR IN A POTENTIAL CRASHWORTHINESS CASE

The following sets forth a checklist of considerations for use in evaluating a potential crashworthiness case.

A. THE AUTOMOBILE BODY

1. The lack of a crashbar. Federal Motor Vehicle Safety Standards require that automobiles sold in the United States meet minimal side impact Federal standards. Manufacturers meet the standards by installing a steel bar, called a crashbar, inside each door. If the case involves severe side intrusion, the presence of a crashbar should be verified and then consideration should be given as to whether a better designed and stronger crashbar should have been present.

2. The roof strength. In a rollover, there may be excessive roof crush resulting from inadequate roof design, lack of roof supports, improper welding or a lack of roof strength. Compliance with the minimal Federal Motor Vehicle Safety Standards should not be a deterrent, since the current standards with regard to roof strength are negligible.

3. The pillar strength. As is the case with roof crush, occupant compartment intrusion may have been caused by the collapse or partial collapse of the A, B, or C pillars. The A pillars are the steel supports on each side of the windshield. The B pillars are those between the front and back seats. The C pillars are those on each side of the back window.

4. The lack of adequate occupant space. Some vehicles are designed with roofs that slope to the rear to such an extent that the roof is nearly touching the head of an

average sized occupant in the rear seat. Other vehicles are designed with inadequate space for the front seat occupants to "ride down" or decelerate, even with restraints, in frontal collisions. All vehicles should be designed to allow adequate room for occupant flailing and deceleration in foreseeable collisions.

B. SPECIFIC VEHICLE PARTS

1. Door latches. In cases involving ejection from the vehicle through a door, the door latch should always be suspect. A properly designed door latch should not open in foreseeable collisions.

2. Lack of laminated windows. It is without dispute that an occupant has a better chance of survival if he or she remains in the vehicle. Laminated window glass incorporates a sheet of plastic in the center of the glass. The plastic helps the windshield maintain its integrity and provides some barrier to the exit of an occupant in some collisions. Current Federal Motor Vehicle Safety Standards only require that front windshields be laminated. Most side and rear windows are tempered, so that they break into fragments upon sufficient impact. A case involving an ejection through a side or rear window should be investigated for the possibility that that ejection could have been prevented had the vehicle been equipped with laminated side windows or a laminated rear window.

C. THE AUTOMOBILE INTERIOR

1. The lack of roof padding. In a rollover situation, an inspection should be made as to whether the vehicle had roof padding. Such specialized padding has been proven effective in reducing the severity of injuries incurred in rollover collisions.

2. Steering columns that do not properly collapse. In frontal impacts, steering columns are supposed to be designed to collapse, rather than shoot into the occupant's space like a projectile. Unfortunately, some steering wheels do not collapse as they should, resulting in serious injury or death to an occupant, that could and should have been avoided.

3. Dashboard/glove box design. Dashboards should be padded and should be designed in a way that will lessen impact injuries. Protrusions should be minimal and should be padded. Glove boxes should be designed so that knobs are not protruding and so that the glove boxes do not flop open as potential sources of injuries upon impact.

4. Seat strength.

a. The seatback. The seatback is an integral part of the restraint system. A seatback that collapses may allow the occupant to be injured when coming into contact with the rear seat or the rear seat passenger, or to be ejected out of the rear window of the vehicle. A seatback that bends or deforms excessively can injure the occupant in several ways, including by rebound into the loose restraints. Some vehicles are known to have design and/or metallurgical problems with the seat brackets or recliner mechanisms, causing the seatbacks to break off or come loose in a collision.

b. The seat anchorage. The same considerations set forth above with regard to seatback failures, apply to inadequate or improper anchorage of the seats to the floor or the adjustable track. Loose seats can cause injuries by introducing slack into the restraint system, even if the seats themselves do not completely fail.

c. The seat bottom cushion and frame. The seat cushion and frame should be designed to be comfortable, yet should also be designed to reduce the possibility of "submarining" under the restraints in a frontal collision. An improperly designed seat cushion and frame may also result in too much slack in the lap belt, which results in increased vertical excursion in a rollover.

d. The seatback latch design. The seatback latching mechanism is designed to prevent the seatback from propelling the occupant forward in a frontal collision. Similarly, it serves to restrain the movement of an unrestrained rear seat occupant in a frontal collision. If a rear passenger, who is unrestrained or whose restraints fail, is ejected between the front bucket seats through the front windshield or into the dashboard, and if the front bucket seats show inward bending or deformation on the inboard sides, then there is a good chance that the seat latch was designed to lock only one side of the seat frame (the outboard side). A latch that only locks one side of the seat frame will simply not provide the same amount of protection to the seat occupant or passengers in the rear.

e. Lack of head restraints. Some vehicles, such as older pick-up trucks, do not incorporate head restraints. When such restraints are absent or are present but not properly adjusted, cervical fractures, resulting in paralysis can result from neck extension over the seatback. On vehicles that do have head restraints, adequate instructions should

be provided as to the adjustment of the head restraint to ensure safe and proper positioning.

5. Restraints.

a. The total absence of a restraint. In vehicles with rear bench seats, the manufacturer will sometimes not put in a center rear lap belt under the rational that it was not designating the center position as a seating position. The upholstery may be designed to look like bucket seats or the rear seat may be narrower than most, making it somewhat uncomfortable for a third passenger. The automobile manufacturers know that the majority of rear seat passengers are children and women. The smaller bodies can easily fit three-across. Thus, unless a console is placed between the two rear seats, people will use the third position and be injured or killed without a restraint. Australia, for instance, requires a restraint in the rear seats for every sixteen inches of hip space. The U.S. National Highway Traffic Administration has looked into the problem and established guidelines requiring a manufacturer to prominently warn against sitting in any position that is not a "designated" seating position. NHTSA has also established a presumption that any rear seat with a bench seatback having fifty inches or more of hip space, will be presumed to seat three people regardless of whether the manufacturer designates it as such, unless there is a console effectively precluding someone from sitting in the third position.

b. The lap-only belt. Since the 1990 model year, three-point restraint systems have been required in the rear outboard positions of all U.S. passenger cars. There are a lot of vehicles still remaining on the road, including minivans and utility vehicles, which only have lap belts in the rear. The lap belts will actually cause severe injury or death in some frontal collisions in which minimal or no injuries would have occurred with a three-point restraint system. This safety defect has been known to manufacturers for many years.

c. The "windowshade" feature. For a number of years, some manufacturers incorporated a "comfort feature" into the shoulder restraint that allowed slack to be introduced and maintained. If an operator leaned forward to adjust the radio or reach to the glove box, for instance, upon returning to the upright, seated position, the shoulder harness would retain the slack introduced by the forward movement. This works much

like a windowshade, which, when pulled down and released, stays down. The slack introduced intentionally or unintentionally by the occupant, may make the shoulder harness completely worthless. When the Federal Government indicated that it was going to conduct its testing with the maximum slack in the shoulder harness, the manufacturers discontinued making the "comfort feature," because the more slack, the less protection to the occupant. Thus, none of the vehicles could pass the government standard with the maximumslack available in the windowshade design.

d. Passive systems. There are a number of passive restraint systems that are dangerously flawed. They were put in by manufacturers to avoid having to use the more expensive airbag technology. Some of the systems are as follows:

(i) The automatic shoulder harness with manual lap belt. This system uses a motorized or a non-motorized automatic shoulder harness which requires that the operator manually attach a lap belt. Without the lap belt attached, the system allows the occupant to submarine under the shoulder belt or get "clotheslined" by the shoulder harness. Because of the secure sensation one gets as the shoulder belt automatically locks, the occupant forgets to manually attach the lap belt. Studies have shown that only twenty- five to thirty percent of the users of such a passive restraint system remember to put their lap belts on. One manufacturer which did pre-market testing knew that this situation would occur and avoided those systems for that very reason.

(ii) The bandolier belt. Suffering the same defects as the automatic shoulder harness with the manual belt, the bandolier belt is simply an automatic shoulder harness without even a manual belt. Volkswagen and Hyundai have used such a dangerous restraint in some models. Years ago, Volvo determined that such restraints were dangerous and discontinued their use. They have since been banned throughout Europe. Unfortunately, a letter from one official at NHTSA opining that the bandolier belt complied with Federal Motor Vehicle Safety Standards, allowed the dangerous design to be incorporated on some vehicles sold in this country.

(iii) The three-point automatic restraint. General Motors developed a three-point automatic restraint affixed to the door. The big problem with this system is that in a collision, if the door opens, there is nothing to keep the occupant from being ejected. In that situation, the restraint becomes totally worthless.

(iv) Anchorage points on automatic restraint systems. Several of the automatic restraint systems have the anchorage points for the shoulder harnesses in locations that will allow too much movement by the occupant in a collision. The automatic restraints that are located forward of the B pillar, will allow an occupant to be thrown into the shoulder harness, resulting in severe internal injuries and sometimes death. Similarly, most shoulder harnesses located high on the B pillar, allow the torso of the occupant to stretch vertically toward the roof in a rollover. This vertical excursion could be reduced or eliminated by a properly designed restraint system (see f, below).

e. Inadequate warning regarding reclined seats. Many vehicles do not adequately warn the users of the dangers of having the seats reclined while the vehicle is in motion. Often, there is some brief, small mention made of the danger in the owners' manual. Yet, few people read or understand the warning and there are not many people on the highways today who realize that it is dangerous to have the seat reclined while the vehicle is in motion. With the seat reclined, slack is introduced into the restraint system, so that in a frontal collision, the reclined occupant may be thrown into the shoulder restraint with such force as to tear apart and rupture the chest and internal organs. In a frontal or rear end collision, the occupant may submarine under the lap belt. Proper warnings should be placed in the occupant compartment and a warning signal should sound when the seat is reclined beyond a certain point while the vehicle is in motion.

f. The lack of an integrated restraint system. An integrated restraint system is one in which the belts are incorporated into the seat structure (i.e. integrated into the seat). This requires a stronger seat, and tremendously improves the effectiveness of the restraints. The fit of the restraints is much better, for all size occupants. Moreover, since the shoulder portion of the belt comes out of the seatback, vertical excursion in a rollover is reduced.

g. Lack of "pre-tensioners." Devices that retract or pull-in the restraints in a collision are currently being provided by most manufacturers. In a frontal collision, for instance, the pre-tensioners reduce the frontal movement of the occupants, lessening the possibility of contact with the steering wheel or dashboard. If the pre-tensioners, some of which pull the shoulder belt in four to five inches, were designed to operate in a rollover collision, then vertical excursion toward the roof would be virtually eliminated.

h. Lack of airbags. The benefits of airbags are well known and have been known to manufacturers for many years. The first patents appeared in the 1950 and General Motors was producing airbags as an option in the mid-1970's. A claim against a manufacturer for the failure to provide an airbag is precluded on the basis of Federal Preemption.

i. Asymmetrical anchor points. Some injuries may be caused because the anchor points of the restraint system in the floor of the vehicle are not properly aligned, thereby shifling or throwing the passenger's weight in such a way as to allow the belt to directly cause injury or allow it to direct the occupant's body into some other portion of the vehicle.

j. Inertial unlatching. Some belt designs have a buckle with a latch that does not contain a lock. During a collision, the latch may be released and the belt will come off. This phenomenon can be demonstrated, and can be seen in the crash test films of several manufacturers. It is sometimes the obvious explanation for why an occupant who habitually wears the available restraints is ejected from the vehicle or found unrestrained after the collision.

k. Lack of dual inertial retractors. Restraint retractors are designed to "lock-up" in a collision or upon strong deceleration. Most retractors are designed to lock when the vehicle deceleration in any direction exceeds .4 g's. However, retractors can also be designed to be "webbing sensitive," so that they lock-up upon sensing quick movement of the belt itself. Mercedes, for instance, has retractors that are both sensitive to webbing and vehicle deceleration. In some collision sequences, such as rollovers and rear impacts with occupant rebounding, a restraint can be freed or "spool out." Retractors that are sensitive to both webbing and vehicle deceleration should preclude that dangerous phenomenon.

D. LACK OF FUEL INTEGRITY

If there is a fire following the collision, the fuel system should be investigated. The investigation should explore the gas tank location, to determine whether it was in a position that protected it from rupture in the event of a foreseeable collision. The investigation should further focus on the design of the vehicle surrounding a properly

positioned gas tank, to determine if bolts, hinges or other objects protruded in a fashion that would allow puncture of the gas tank.

The filler neck, going from the gas tank to the filler cap, should also be investigated. A proper design of the filler neck including its connections at the gas tank and at the body of the vehicle, should allow for it to move rather than break off in a collision.

Other issues involve the design of the gas tank itself, the gas cap and its seal, the filler neck insert, which should not allow spillage, fire walls protecting the interior of the vehicle, flame retardant materials in the interior, and other potential design flaws which allow the escape of fuels in a collision or a hasty intrusion of the fire into the occupant compartment.

CONCLUSION

The above sets forth some specific areas to investigate in the course of attempting to determine why certain injuries occurred. The concept of crashworthiness is akin to "packaging." If one thinks about wrapping and boxing a vase to send across the country, knowing that it may be dropped and bounced around in the course of transportation, one can envision the same kinds of considerations that should go into packaging a vehicle occupant. If an investigation of injuries reveals that they occurred as a result of a foreseeable type of collision and could have been lessened or prevented with a more forgiving vehicle design, then there may very well be a crashworthiness case.