THE EFFECT OF DRIVER POSITIONING ON THE DYNAMIC RESPONSE TO A
POTENTIAL ACCIDENT EVENT

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IN ORDER TO IMPROVE the level of protection offered to car occupants, the development of advanced, or ‘smart’, restraint systems that adapt the system response to both impact and occupant characteristics are required. Traditionally restraint systems, such as seat belts and airbags, have been tested either in conjunction with, or independent from, the vehicle and have used a limited range of occupant or crash conditions. Inevitably this has led to systems that may be optimised for an ‘average’ occupant or a ‘typical’ impact. In reality, accidents involve a wide range of impact speeds and configurations and involve occupants with a wide range of physical characteristics. Therefore, a major challenge in the further improvement in secondary (passive) safety is to develop systems that offer improved levels of protection over a greater range of crash conditions, and for a greater range of the occupant population. The position of the driver is one of the important variables that a ‘smart’ restraint system would be required to adapt to.

The study presented in this paper was conducted in the TRL driving simulator as part of the research programme for the PRISM project (www.prismproject.com) and was a novel experiment designed to assess the driver’s positioning during the pre-crash phase of an accident. A practical study examining the pre-crash response of the front seat passenger was also conducted by the PRISM project (Morris et al., 2004). The simulator study involved forty subjects selected from TRL’s subject database. The study group was balanced for gender and age. The responses of each subject were recorded during five emergency events throughout a 27.7 km rural route.

The emergency event was created by a car emerging from a side road and stopping directly in front of the subject requiring them to brake quickly to avoid a collision. These emergency events were balanced with false events in which the emerging vehicle continued across the road. There were no forces exerted on the occupant under braking as it is the simulator image that moves rather than the vehicle, so any positional changes were due to driver reaction alone.

Immediately prior to each event, the subject was instructed to adopt an initial position in order to determine the effect of the initial position on the position at the point of impact. Throughout the route the subjects were also instructed to adopt initial positions that did not correspond to an event. The initial positions were selected based on a European-wide photographic study conducted in an earlier phase of the PRISM project and were as follows (using a right-hand drive vehicle):

- Standard driving position (comparable to FMVSS 208)
- Left hand adjusting the radio
- Mobile phone in left hand up to left ear
- Right hand adjusting the sun visor
- Right arm on the door arm rest (with right hand off the steering wheel)

The occupant positioning throughout the simulation was recorded via four video cameras that allowed key occupant positioning measurements to be obtained. Data relating to braking force and the pressure exerted on the seat back were also recorded. These results are important to the development of ‘smart’ restraint systems as they provide data on the pre-crash position of the driver and therefore information on the time and space available in which to adapt restraint system parameters. Overall, the main conclusions from this study were as follows:
1. In over 80% of emergency events, drivers kept their hands in the position they were in at the start of the event, rather than replacing both hands on the steering wheel. For example:

   - 87% kept hand on sun visor
   - 82.5% kept arm on arm rest
   - 82.5% kept hand on or near radio

   This suggests that drivers often do not return to the standard driving position before impact. A ‘smart’ restraint system that is able to adjust to the position of the occupant has the potential to improve the injury outcomes in accident scenarios such as this.

2. The realism of the simulator was good, with 97.5% of subjects rating it as realistic or very realistic, thus supporting the validity of the results for a straight line braking event of this type.

3. Each one of the forty subjects experienced five emergency events and, although the experiment was fully balanced with false initial positions and false events, subjects generally reduced the vehicle speed after the first event. The response to all five events was considered representative of an emergency situation although there were fewer collisions on events after the first. Consideration of the driver posture and back contact area found that the reactions on all events were comparable.

4. All subjects braked during all of the emergency events. Thus, it can be concluded that during an emergency event such as this, where the obstacle is visible and the driver has the opportunity to react, that the driver’s right foot will be positioned on a depressed brake pedal.

5. During the braking manoeuvre drivers tended to straighten the arms (increasing the angle at the elbow) and push the upper torso rearward into the seat. Measurements of the pressure on the seat back showed that the contact area between the occupant’s back and the seat increased by 27% during the emergency event. This increased contact occurred in the upper back and shoulder region.

6. Drivers exhibited little lateral movement, with the major motion in the fore-aft direction. There was an average rearward movement of the head of 28mm. The fore-aft response of each subject over the five initial positions was averaged and analysed against the seated height of the subject. This was then compared with the seated height of the 5th, 50th and 95th percentile Hybrid III dummies. This resulted in an average distance between the tip of the nose and steering wheel at the end of the pre-crash phase of:

   - 5th percentile – 482mm
   - 50th percentile – 561mm
   - 95th percentile – 574mm

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