

## OCCUPANT KINEMATIC ANALYSIS OF AN UNBELTED MINIVAN PASSENGER: A FREE BODY APPROACH

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### INTRODUCTION

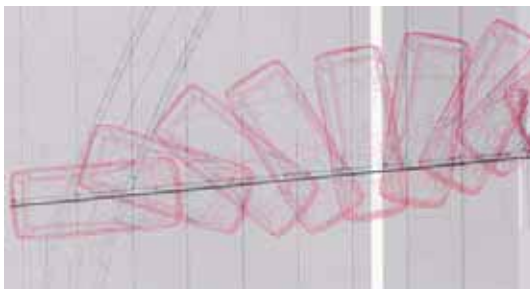
A case analysis is presented where an unbelted second row passenger of a minivan claimed to have been ejected through the second row passenger side window when his vehicle was struck on the passenger side at an intersection. A vehicle dynamics analysis, occupant kinematic analysis, and vehicle interior dimensional analysis, were utilized to develop an understanding of the occupant kinematics.

### METHODS

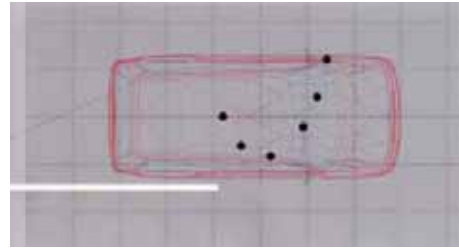
Medical records were reviewed that revealed a minor laceration to the right cheek and minor knee contusions. Examination of an exemplar minivan was also carried out. Geometric measurements of the vehicle were recorded for use in analysis. Occupant kinematics were based on results of vehicle collision dynamics along with pre-impact body position evidence. Vehicle dynamics were determined using accident reconstruction engineering techniques and analysis. Occupant kinematics were determined using methods outline by Bready et al. and interior dimensional analysis [1].

### RESULTS AND DISCUSSION

Vehicle kinematics were used to establish the pre-impact heading of the unbelted second row occupant. Since the occupant was unbelted the assumption was made that the second row occupant would act as an uncoupled body in the crash and continue along his pre-impact heading until acted on by an interior vehicle component. Once the heading was determined, the occupant position at coincidental time intervals as the vehicle dynamics data was determined and plotted. Once this was done the two are merged to give gross occupant kinematics assuming no interior contacts. Offset of the occupant initial position was made based on testimony of the occupant and interior vehicle measurements of the second row bench seat.



Once this was done, the coordinates were transformed into the vehicle coordinates system.



This trajectory was used to then render a 3-D drawing of occupant motion relative to vehicle interior components.



An 11-14 inch offset existed between the top of the bench seat and the bottom of the passenger side second row window. 3-D analysis revealed that the occupant would not have ejected out of the side window but rather contacted the front passenger seat as shown below. This is mostly due to the rotation of the minivan upon impact. The occupant is shown in a position close to the floor of the van which is an effect of both gravity and ramp effect of the seat back. The occupant presented with a facial laceration to the right cheek that coincided with contact of the right front seat inboard armrest as shown below.



### SUMMARY

An occupant kinematics study was undertaken to investigate whether an unbelted second row occupant in the prone position, would eject through the passenger side window during a side impact. Published methods of occupant kinematic analysis, vehicle reconstruction techniques, and 3-D rendering were used to determine that the occupant would not have ejected through the passenger side window.

### REFERENCES

1. Bready, J.E., et al. (2002). *SAE Technical Paper Series, 2002-01-0536*.