



## Engineering Sciences Section – 2004

### C23 Trailer Loading Ramp Defects Cause Scissors Lift to Tip When Unloading

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After attending this presentation, attendees will understand an application of analytical methods and simulation techniques in testing hypotheses and demonstrating a physical event where physical tests and reenactments are not feasible. Key frames can be used to demonstrate a sequence of events in a stop-action series of still images even when a scientific animation cannot be produced.

This presentation will impact the forensic community and/or humanity by demonstrating analytical methods and simulation techniques which are useful in understanding phenomena and demonstrating relevant events. They are also effective in testing hypotheses when physical tests or reenactments are not feasible.

**Background:** A self-employed drywall applicator rented a narrow slab scissors lift for a commercial building job on which he was working. When his need for the scissors lift was finished, he borrowed a flat deck trailer and pickup truck from his business partner to return the scissors lift to the rental dealership. He loaded the scissors lift onto the trailer and drove to the rental dealer accompanied by his friend as his passenger. When he arrived at his destination, he parked the pickup and trailer on the asphalt paved street in front of the rental dealer's establishment. He manually placed the portable loading ramps into position at the rear of the trailer, climbed to the operator's station of the scissors lift, and backed the scissors lift from the trailer onto the ramps. His friend was standing on the street behind the trailer near the left side ramp helping to guide him during this maneuver. While he was backing down the ramps, the left ramp dislodged from its trailer support and the scissors lift tipped onto its left side. He managed to jump from the operator's station to safety. His friend's right foot was pinned and badly crushed between the left side of the scissors lift and the street.

The subject trailer, loading ramps, and pickup truck were inspected, measured, and photographed at the rural residence of their owner. The subject scissors lift was inspected, measured, and photographed at the rental dealership. The incident scene was inspected, measured, and photographed. Since there was less than full cooperation from the owners of the equipment, the various pieces of equipment were not brought together at the incident site. It was judged to be infeasible, and probably too dangerous, to perform a physical reenactment of the incident.

Analytical methods and simulation techniques provide an alternative to physical testing for understanding and demonstrating relevant events leading to tip over. Several key frame "building blocks" used in constructing animations can be derived and demonstrated. Since the elapsed times between these key frames cannot be accurately and reliably determined from the known data, scientific animations cannot be produced to demonstrate motions of the equipment. However, these key frames can be used to demonstrate sequences of events in a stopaction series of still images format.

AUTOCAD 2000 was used to generate 3-dimensional scale drawings and images of relevant features of the equipment involved. These images were combined adhering to applicable physical constraints. Early during the trailer and ramp inspection, it was noted that the tops of the ramps rest in a shallow slot on the rear of the trailer and are held in place by gravity with no locking device. The mechanism of dislodgement became apparent only after detailed engineering analyses as demonstrated by the key frames.

The bottom ends of the ramps are shaped such that the ground support point is actually 6 ½ inches forward from the rear edge of the ramp platform. When a sufficiently heavy load is placed on the rear end of the ramp, this permits the ramp to pivot lifting the front end of the ramp from its support slot on the trailer. A small horizontal movement of the ramp front end will then cause the ramp to miss its slot and fall to the ground when the load is removed. The subject scissors lift wheelbase is 12 ½ inches longer than the length of the ramps; this was a significant feature in causing dislodgement of the ramp during unloading.

#### **Loading Ramp, Design Defect, Tipping Stability**