



Conasauga, Tennessee Railroad/Highway Grade Crossing Accident

March 28, 2000



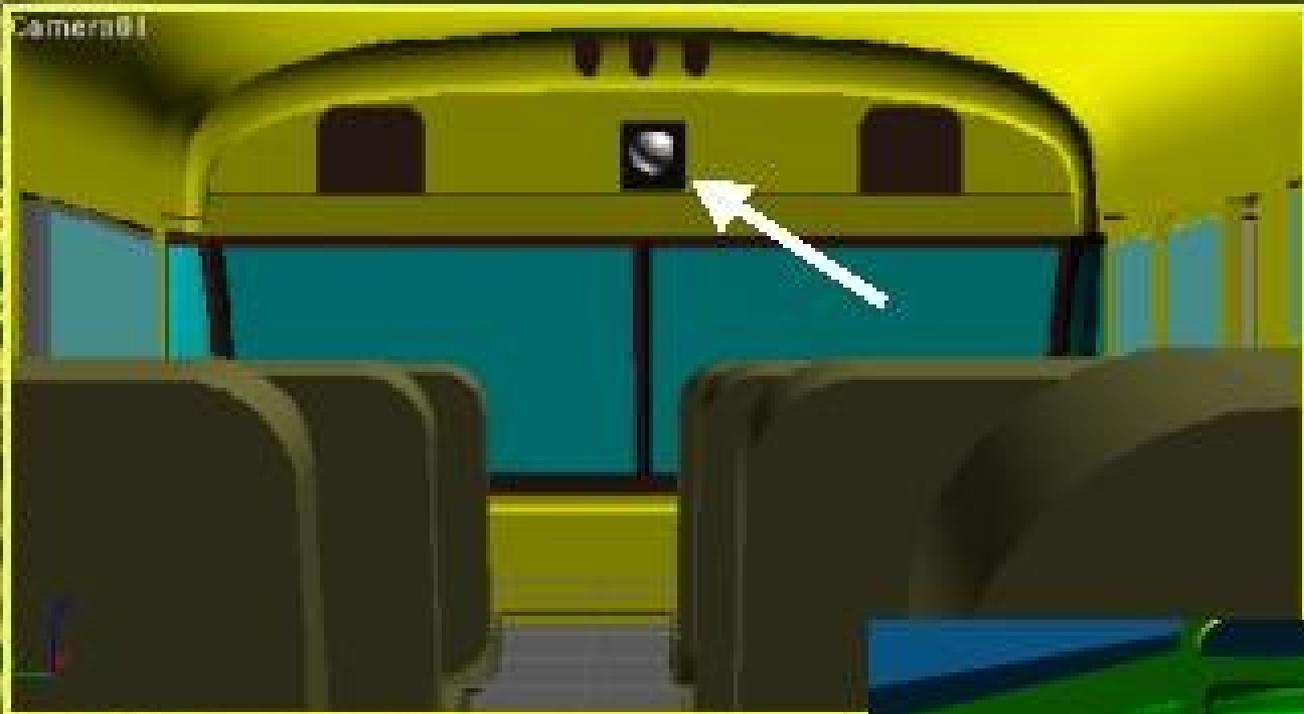
Accident Simulation



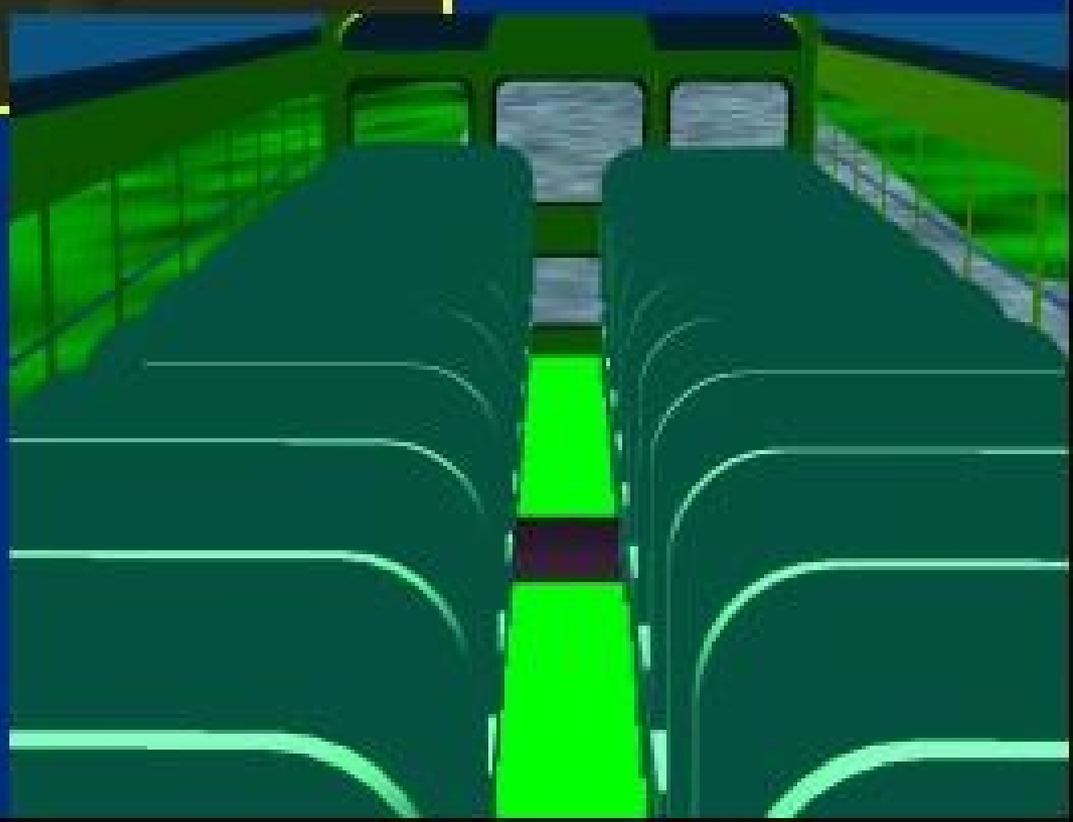








Video camera on bus





Accident Simulation



Toxicology Testing

- Bus driver tested post-accident
 - Required by Federal law
 - Negative for alcohol and illicit drugs
 - Positive for substances common in over-the-counter medications
- Train crew tested post-accident
 - Not required by Federal law
 - Negative for alcohol and illicit drugs



Vehicle Simulation





NTSB

Vehicle Simulation

- Developed based on the physical evidence and onboard recording devices
 - Bus speed based on onboard video recorder
 - Train speed based on event data recorder
 - Vehicle damage patterns
 - Final rest locations
- Characterizes the best fit to physical evidence
- Representative of the accident sequence but does not show the actual accident



Simulation Videos

- Dynamic camera view trailing school bus
- Static camera view detailing collision and motion to final rest
- School bus driver's potential view
- Train engineer's potential view





Vehicle Simulation Summary

- School bus speed at impact was about 15 mph
- Train speed at impact was about 51 mph
- Peak school bus accelerations:
 - 30 Gs lateral acceleration
 - 2500 deg/second rotational acceleration
- Peak train deceleration: less than 2 Gs



Vehicle Simulation Summary, Cont.

- Train was potentially visible for about 2 seconds from the school bus driver's side window
- School bus was potentially visible for more than 4.6 seconds prior to impact



Issues

- Driver performance
- Passive grade crossing safety
- School district oversight
- Grade crossing databases
- Audibility
- Survival factors and occupant kinematics
- Intelligent transportation systems



Parties

- National Highway Traffic Safety Administration
- Federal Motor Carrier Safety Administration
- Federal Railroad Administration
- Tennessee Highway Patrol
- Polk County District Attorney's Office
- Murray County, Georgia, School District
- CSX Transportation



Grade Crossing Safety



Grade Crossing Safety

- School bus drivers required to stop before crossing railroad tracks
- Driver stated she followed proper procedures
- Analysis of videotapes on bus indicated she did not stop
- Driver did not stop on at least eight previous occasions





Stop Signs at Passive Grade Crossings



Motor Carrier Safety



Murray County School District

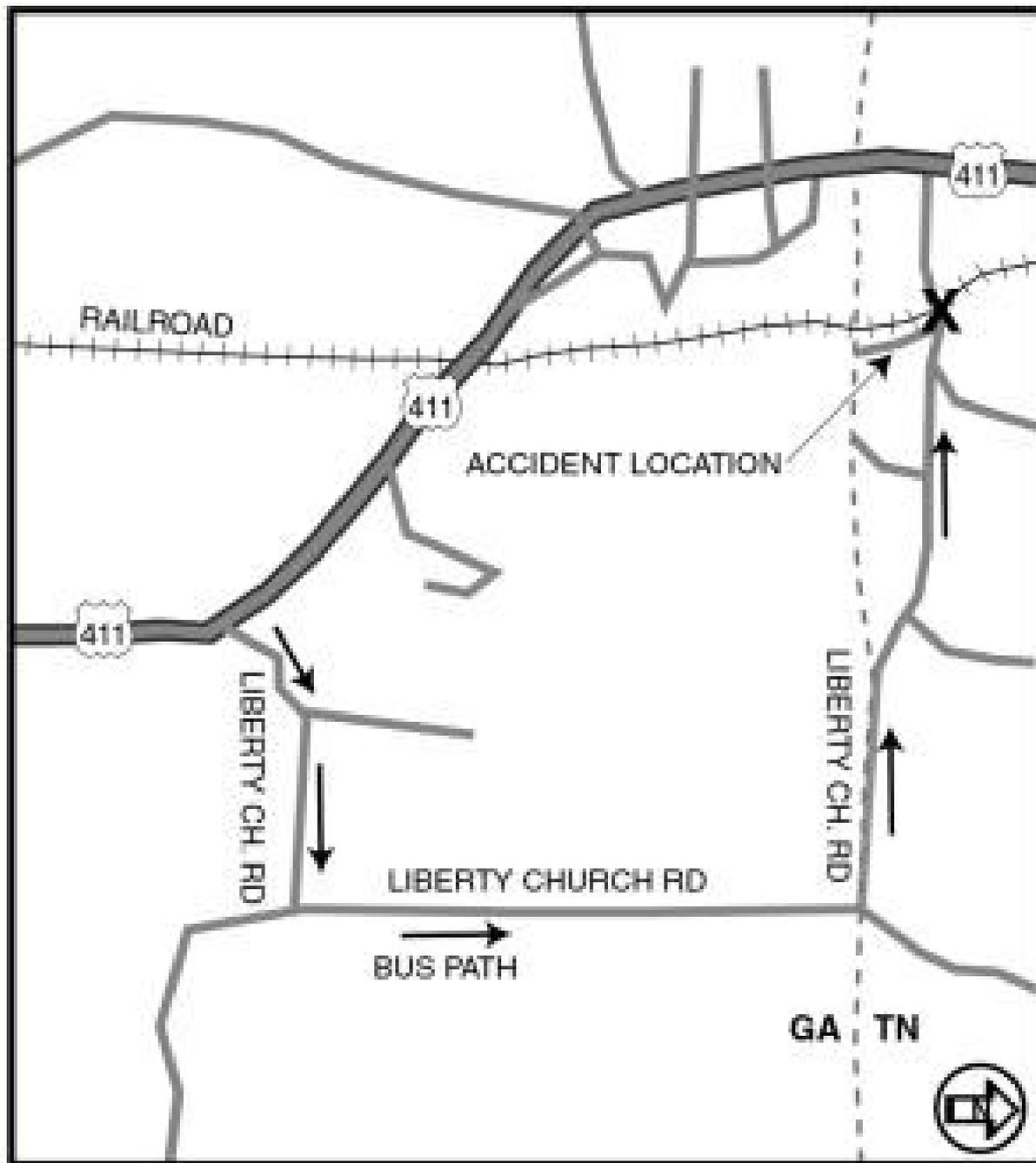
- 74 buses
- 54 full-time busdrivers
- 7 substitute drivers
- Annual mandatory training
- Operation Lifesaver classes



Murray County School District Routing

- Grade crossings
 - 18 in the school district
 - 15 crossed by school buses
 - Does not include accident crossing
- Changes in routing





School Bus Routing

- Recommended practices
 - NHTSA's Guideline 17
 - NASDPTS' *National School Transportation Specifications and Procedures*
 - Annually plan and review school bus routes for hazards
- Murray County School District practice: no hazard identification



Murray County School District Oversight

- *NASDPTS' National School Transportation Specifications and Procedures*
- *Bus Drivers Manual: Procedures and Rules*
- No documentation of performance evaluations



Fox River Grove, Illinois Recommendations

- To NASDPTS:
 - Encourage members to develop program for identification of school bus route hazards and
 - Encourage members to routinely monitor and evaluate all bus drivers (H-96-52)
- To NASDPTS:
 - Consider railroad/highway grade crossings when establishing routes (H-96-53)



Carrsville, Virginia Recommendation

- To the States:
 - Encourage local school districts to establish and enforce procedures to monitor driver compliance (H-85-4)



School Bus Routing and Driver Evaluation

- Prior to accident
 - Driver failed to stop at crossing
 - School district did not monitor drivers
 - School district missed opportunity to identify problem
 - School district did not identify route hazards
- Post-accident
 - Route hazard recognition program
 - Driver evaluation program



Grade Crossing Database



Federal Railroad Administration Grade Crossing Inventory

- Maintained by the FRA
- Includes data from two sources:
 - Grade Crossing Inventory (includes data from 1974 to latest records)
 - Accident history (includes data from 1975 to latest records)



Grade Crossing Inventory

- Inventory of Liberty Church Road crossing:

	Database Entry	Actual
Subdivision	Knoxville	Etowah
Maximum speed	50 mph	60 mph
Trains per day	13	30 – 35

- Accident history accurate



Grade Crossing Inventory

- Inventory files provided voluntarily
- Erroneous and noncurrent data will alter accident prediction values
- FRA does not have authority to require States or railroads to update information
- Data from inventory needs to be accurate



FRA's Web-based Accident Prediction System

- Ranks crossings by predicting number of collisions per year
- Raises awareness of potential danger at highway grade crossings
- Used in combination with other site-specific information in making decisions about crossing improvements



FRA's Web-based Accident Prediction System

- Uses information about crossings' physical and operational characteristics from Grade Crossing Inventory
- Uses 5 years of crossings' accident history



FRA's Web-based Accident Prediction System

- Helps school bus route planners become familiar with factors that affect crossing safety
- Helps route planners make decisions about school bus routing



School Bus Use and State Hazard Indexes

- Some States factor in school bus use
- Crossings may be upgraded more quickly if school bus use is part of hazard index



Train Horn Audibility



Audibility

- Driver required:
 - Stop the bus
 - Open loading door and driver's window
 - Turn off radio and listen
 - Look both ways
 - Proceed when clear
- Student did not hear train horn
- Driver did not turn off radio and open door or window



Testing

- Bus stopped, radio on, door closed: horn 4 decibels above ambient
- 10 decibels required for sound to reach alerting level
- Bus stopped, radio off, door open: horn 25 decibels above ambient



Speaker Placement

- Safety Board has made recommendations discouraging radio speaker placement near the driver
- Georgia informed local school districts
- Speakers still placed near the driver



Survival Factors and Occupant Kinematics



Survival Factors Issues

- School bus driver seat belt system anchor point locations
- School bus sidewall and seat frame exemption from Federal Motor Vehicle Safety Standard (FMVSS) 222





School Bus Driver Belt System



- Driver had been belted and was ejected
- Driver belt system anchor points spanned separated vehicle components
- Webbing failure occurred
- Potential for serious or fatal injury

Survival Factors

- FMVSS exemptions
 - Interior sidewalls
 - Other interior structures
- Serious or fatal injury to passengers in lateral collision; striking nonenergy-absorbing surfaces
- Focus on injury causation for passengers not directly in impact area



Passenger Injuries in Front Portion of School Bus

- Two front-row unbelted passengers were seriously injured and ejected; they impacted sidewalls and interior structures
- Second-row belted passenger not ejected; only passenger to sustain minor injury





Passenger Injuries in Rear Portion of School Bus

- One unbelted passenger on left side in last row was outside impact area
- Propelled out of seat compartment across bus width and struck right sidewall
- Fatally injured



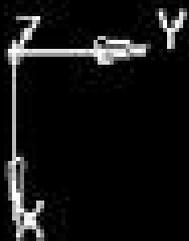
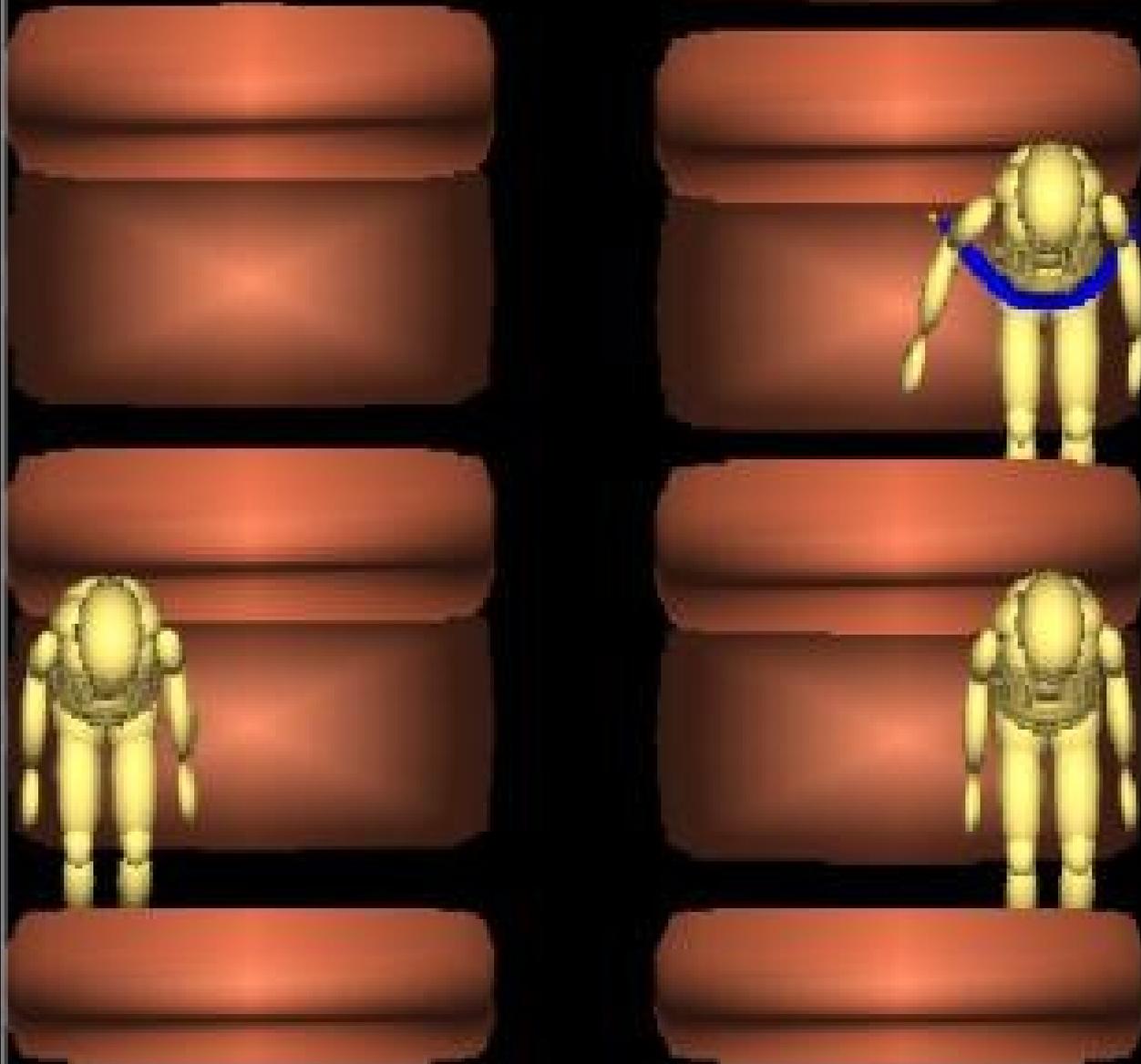
Serious and Fatal Injury Causation

- Passenger movement out of seat compartment
- Ejection
- Impact forces from collision
- Intrusion from locomotive into bus
- Impact into nonenergy-absorbing bus interior surfaces



Time = 0.014000

Occupant Simulations



Occupant Simulations

- Developed based on crash pulse from vehicle dynamics simulation
- Known initial seating positions based on onboard video recorder
- Linear contusion pattern on passenger seated in back of bus
- Representative of occupant motion but does not show actual motion; valid for comparisons



Simulations

- Actual restraint conditions: all unrestrained except occupant in second row who was restrained with lap belt
- All occupants unrestrained
- All occupants lap belt-restrained
- All occupants lap/shoulder belt-restrained



Time = 0.020000

Unrestrained



Time = 0.020000

Lap Belted



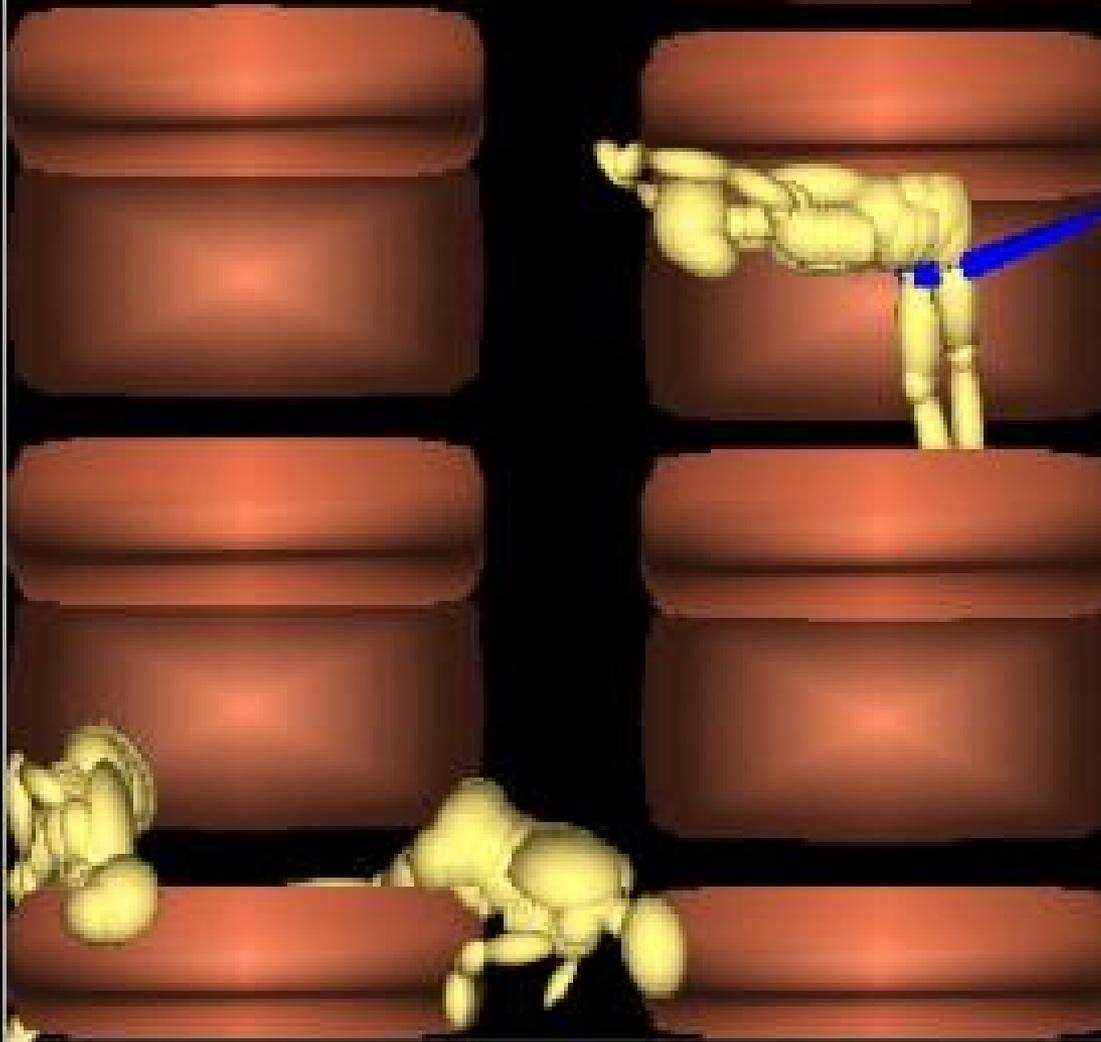
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Lap/Shoulder Belted

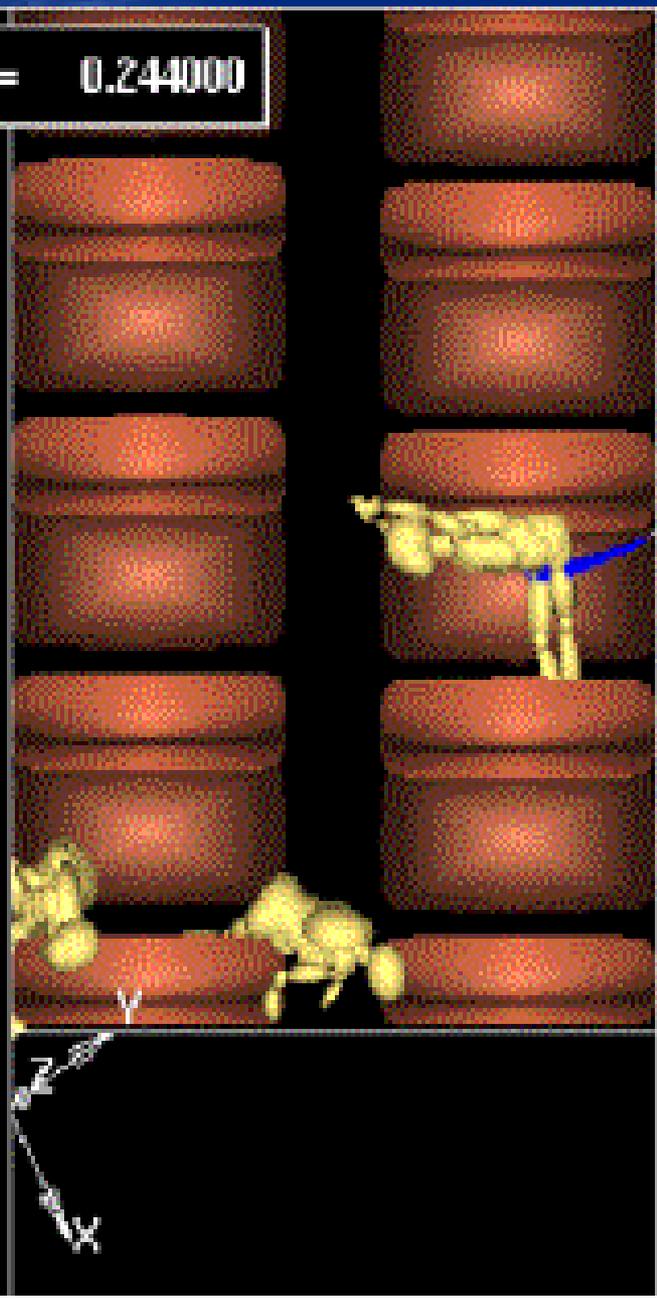


Simulation Results

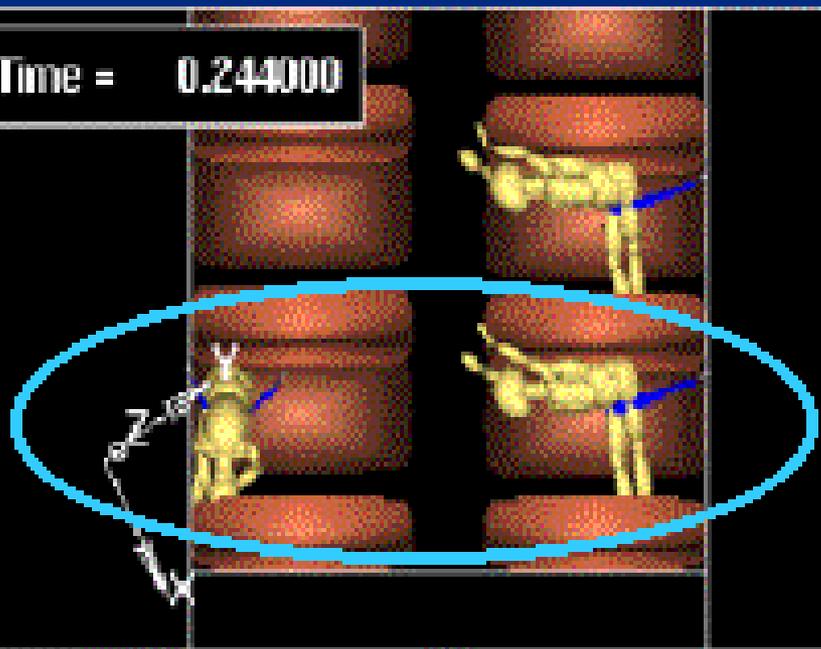
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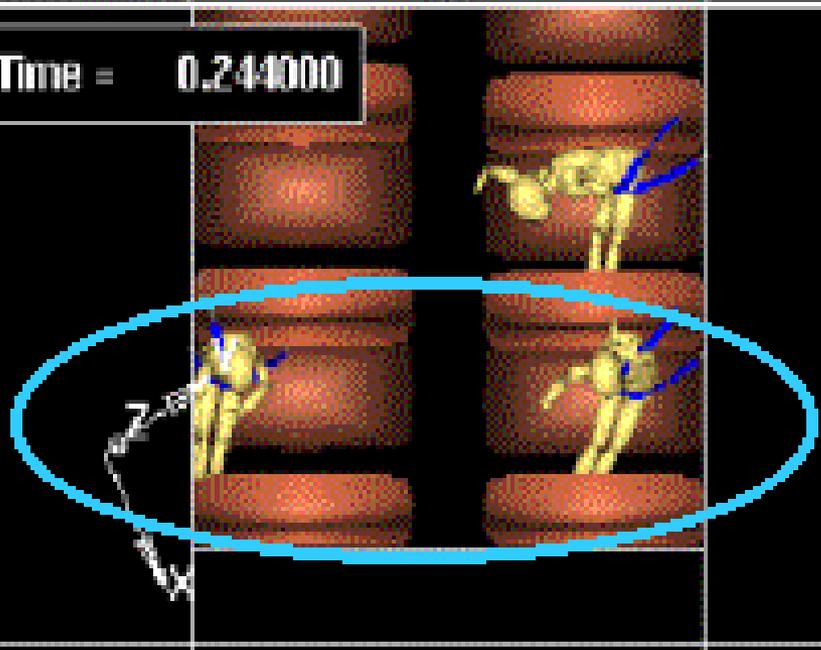
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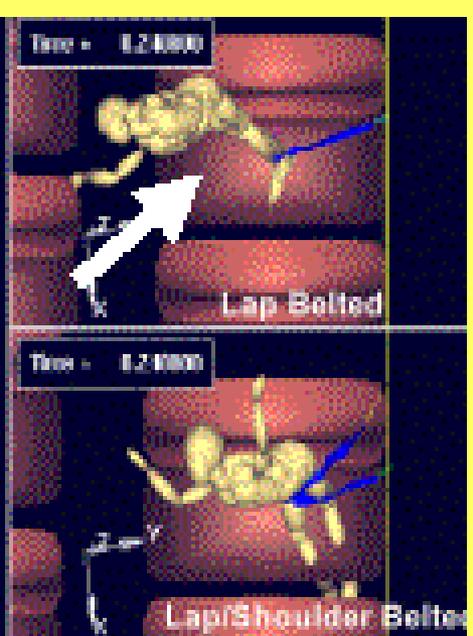
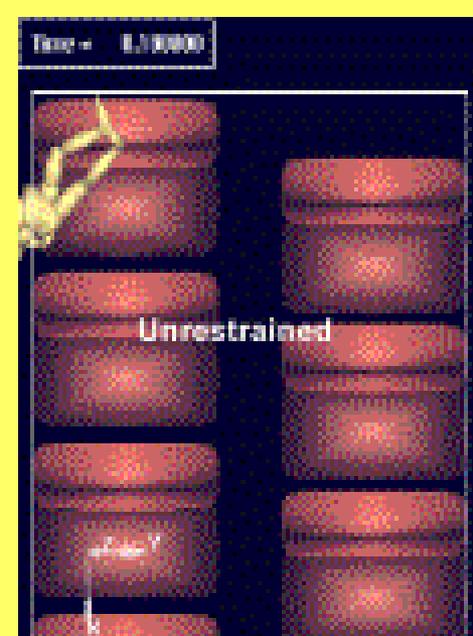
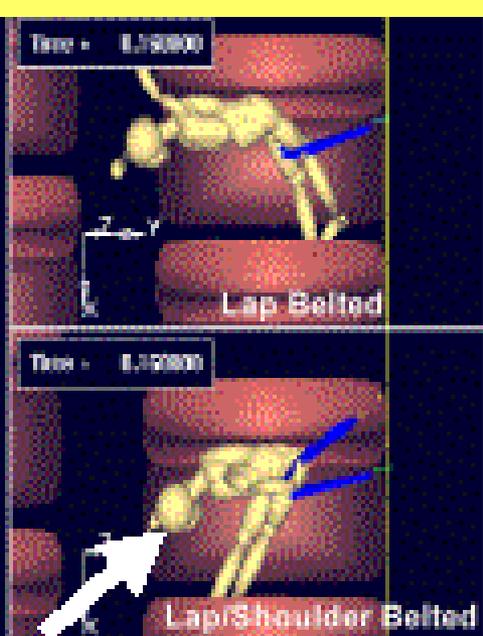
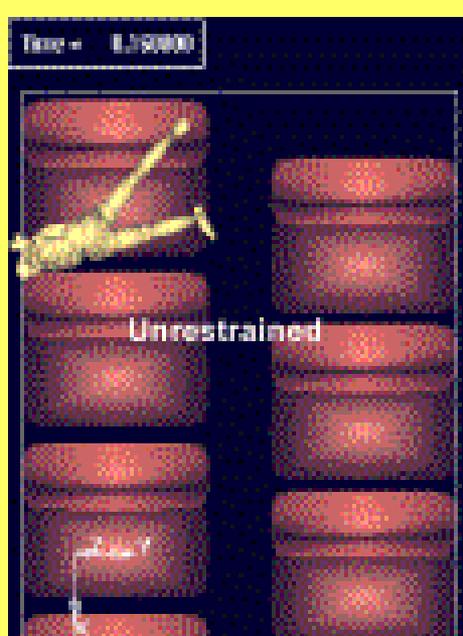
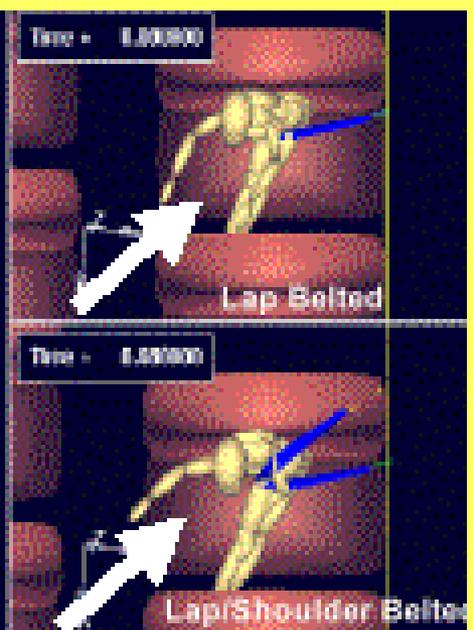
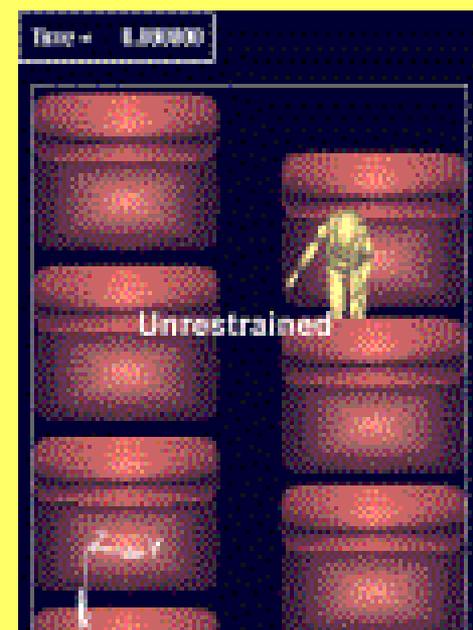
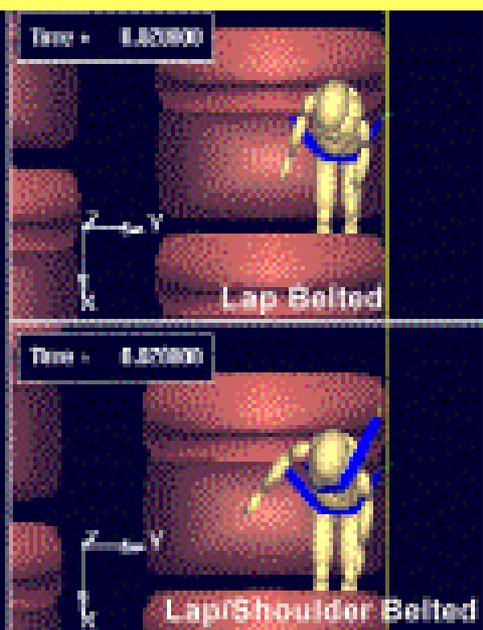
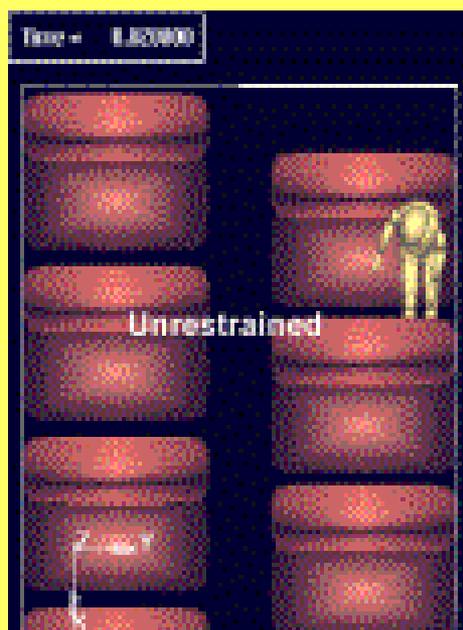


Time = 0.244000



Time = 0.244000





Occupant Simulation Summary

- Rear of bus:
 - High lateral and angular accelerations
 - Restraints not beneficial
- Front of bus:
 - Properly fitted restraints beneficial
 - When unbelted, occupants struck interior surfaces and were ejected

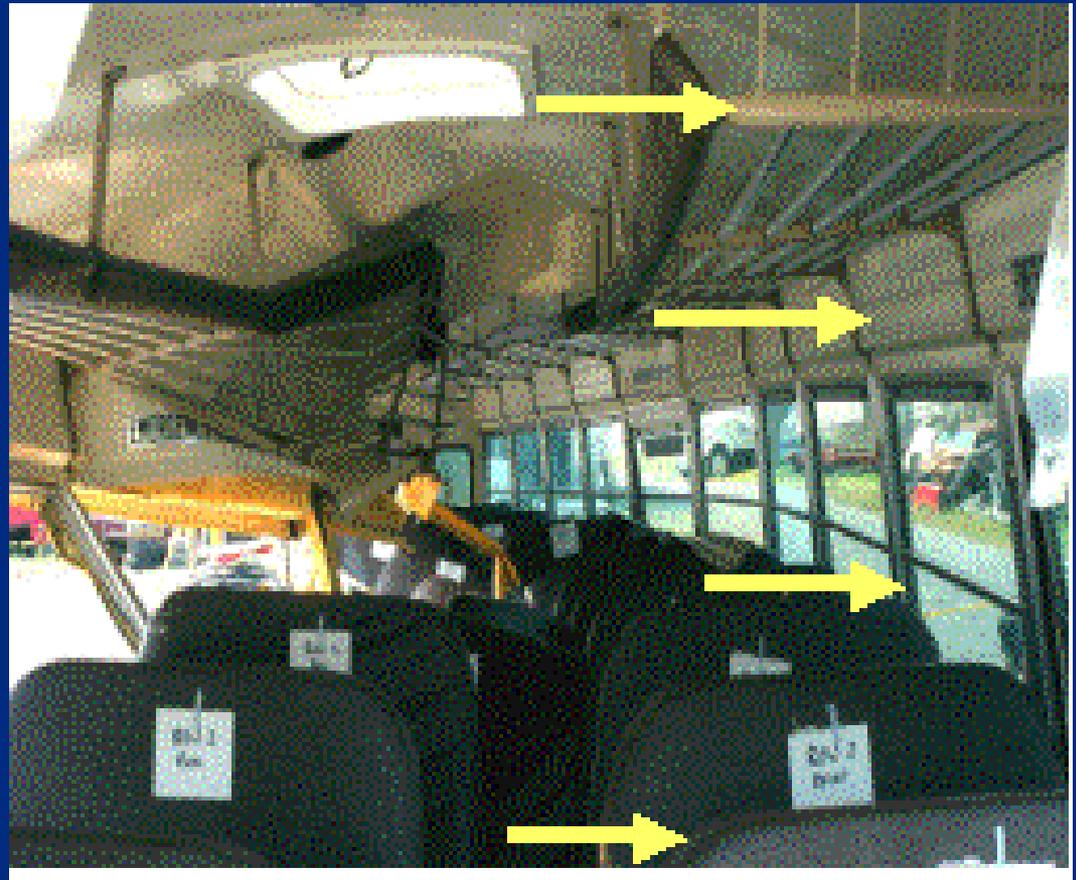


- Board has investigated numerous accidents with passengers propelled out of seating compartments and injured
- Board has also found passengers who remained within seating compartments sustained serious and fatal injuries from striking nonenergy-absorbing interior surfaces in lateral impacts



FMVSS 222

- Purpose: to reduce death and injury severity that result from impact of bus occupants against structures within vehicle during crashes and driving maneuvers
- Exempted: sidewall, window, and door structures



Intelligent Transportation Systems



In-Vehicle Warning Systems

- Alerts driver to oncoming train
- Minnesota and Illinois testing
- Previous recommendation
- DOT response
 - Not specific on guiding implementation
 - No further responses
 - No additional plans for testing



Emergency Response

- Passerby and train crew reported accident
- No delay in emergency response
- Rural area
- Driver incapacitated



Automatic Collision Notification

- ACN alerts authorities to collision
 - Detects crash
 - Transmits information to local 911 center
- Reduces notification time, particularly in rural areas
 - From 9 minutes to 1 minute
 - Could save 3,000 lives per year



Automatic Collision Notification

- Available on passenger cars
 - OnStar (GM, Acura, Saab)
 - ATX Technologies (Ford, Jaguar, Mercedes, Nissan)
- Not available on school buses
- Adequate emergency response important
- Concept same: quick and adequate response; modifications necessary

