Using All the Evidence

Biomechanical Investigations

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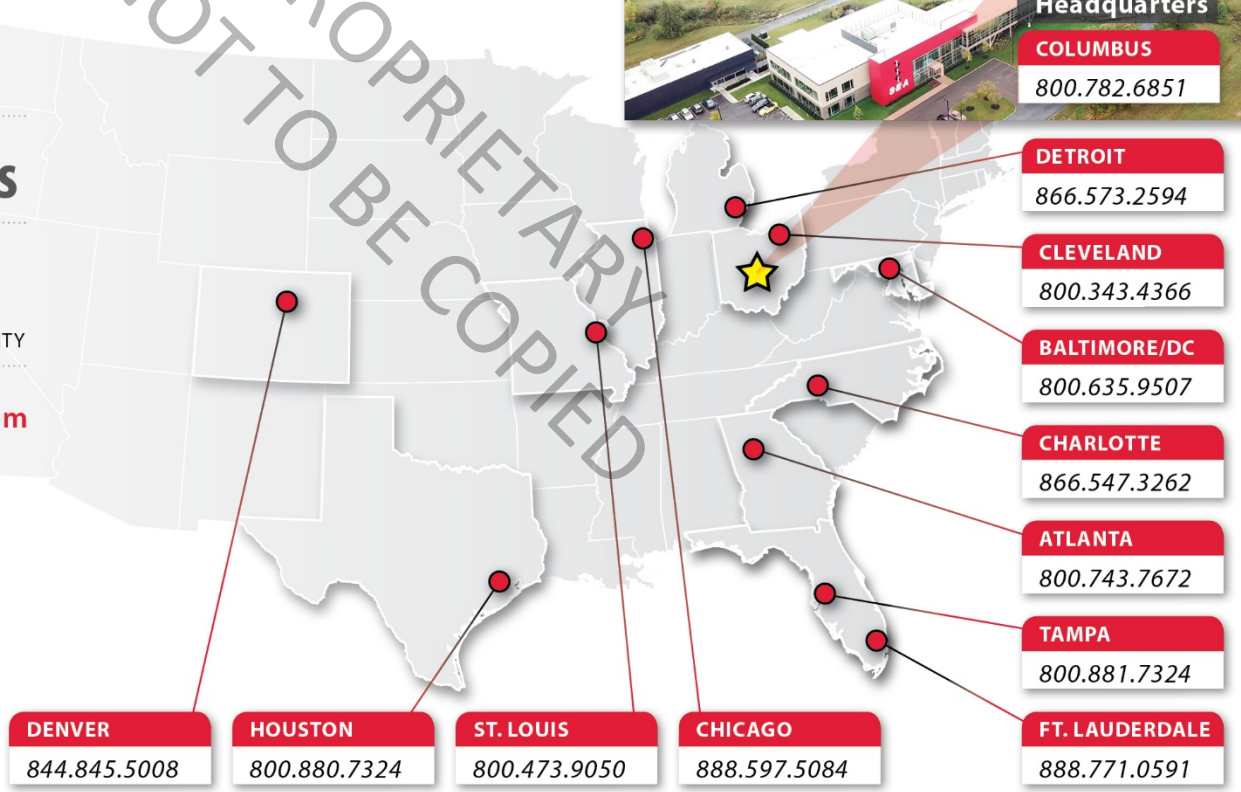


Disclaimer

All discussions, opinions, comments, photographs, images, etc., made during the presentation are meant for general training and educational purposes, and shall not be considered a professional opinion regarding any specific claim or legal matter.

They are…

- Occupants of your vehicles….
- Patrons in your stores…
- Users of your products…
- Guests in your buildings…
- Workers on your site….
- Employees in your company…

Who are they?

They are…

- Potential litigants….
  - The 3D puzzle of the allegations is formed by testimonial and physical evidence (and lack thereof)

Why not use all the available evidence?

50TH ANNIVERSARY 1970 – 2020

S-E-A Know.

Biomechanics is the application of the principles of dynamics and engineering to the human body

Not if there is a condition causing symptom…

…but what it takes to cause the injury in the first place.

Definitions

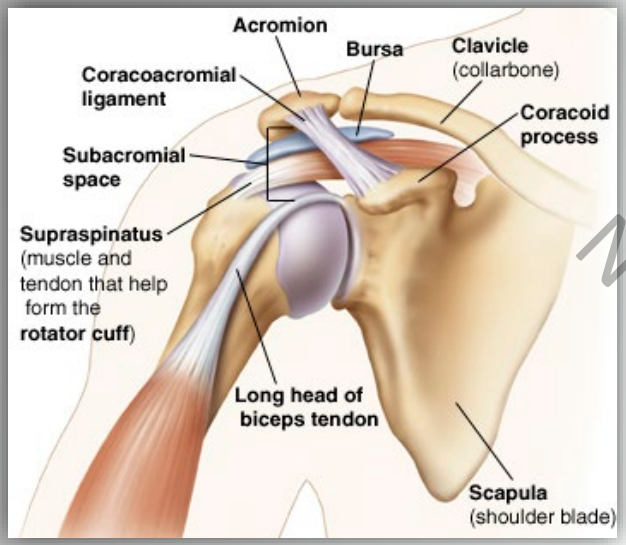
Injury results when a tissue or system is damaged or fails due to applied loading.

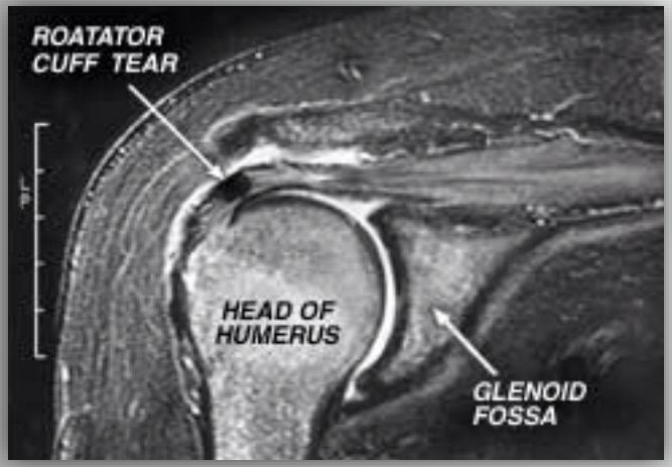
Types of Injuries

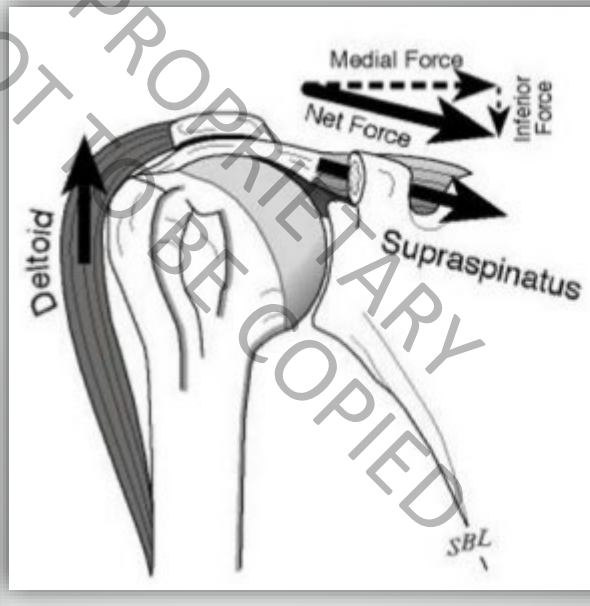
- Sprains
- Strains
- Tears
- Crushing
- Ruptures
- Bruising
- Fracture

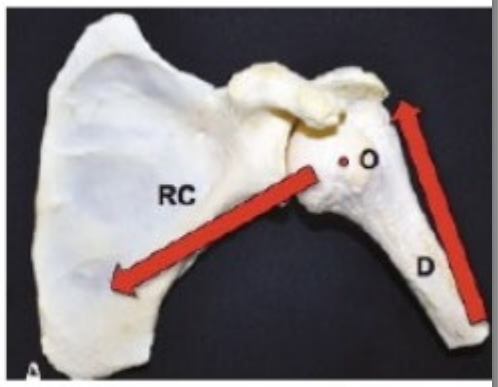
Mechanism of Injury - Bones

Mechanism of Injury – Soft Tissues



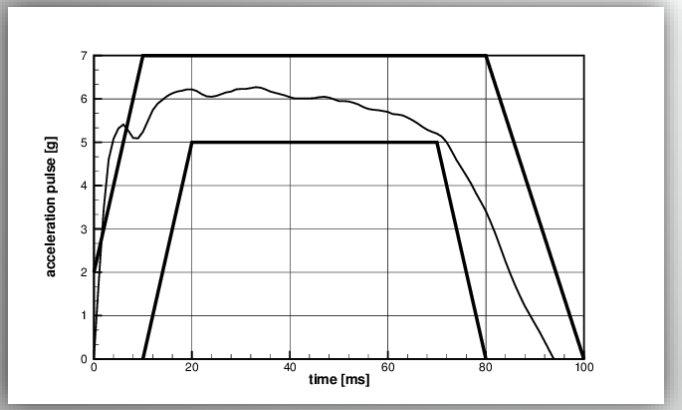






Kinematics

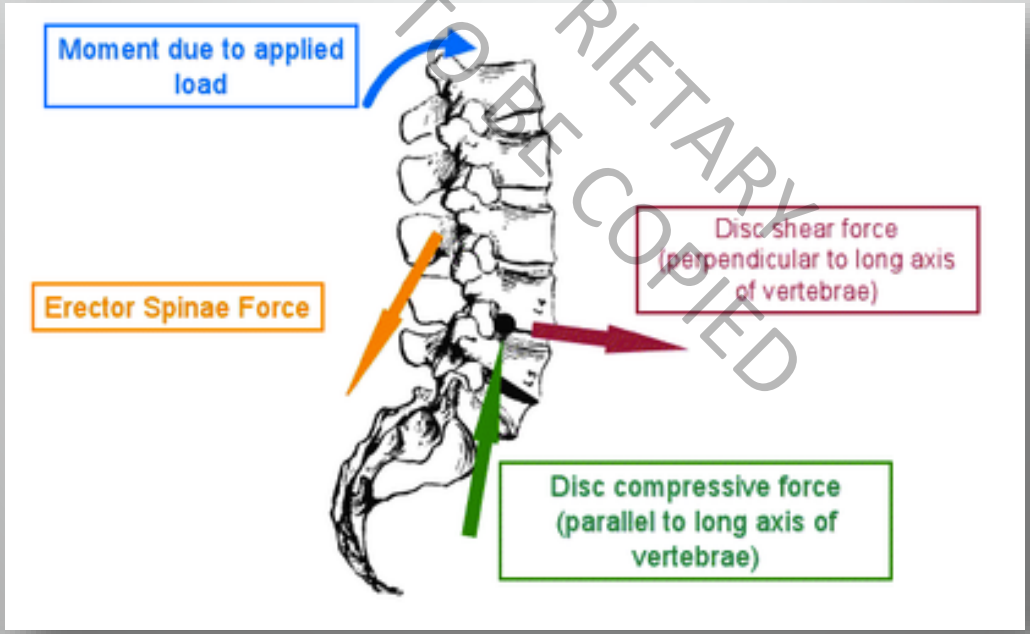
- Motion of an object
  - Newtons First Law of Physics: an object either remains at rest or continues to move at a constant velocity, unless acted upon by a force.



Seat and head restraint test performed by IIHS (12 mph Delta-V rear impact)

Kinetics

- Forces acting on objects
  - Utilize the accident reconstruction results to evaluate the loading applied to different areas of the body



Calculations

$$F_{belt} := \frac{\Delta V2}{35} \cdot \frac{4941}{4.448} = 381 \quad \text{lbf - shoulder belt force (NCAP-MGA-2017-016)}$$

$$F_{L\_shear} := \left(M_{up\_D} \cdot a_{2avg} \cdot gc\right) - F_{belt} = \begin{pmatrix} -273 \\ -222 \end{pmatrix} \text{ lbf}$$

$$M_L := F_{L\_shear} \cdot \frac{r_{cg\_eff}}{12} = \begin{pmatrix} -318 \\ -259 \end{pmatrix} \text{ ft*lbs}$$

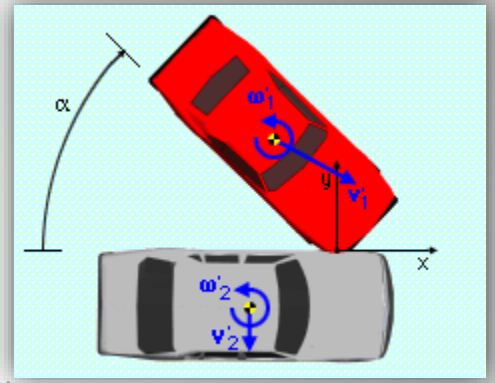
$$\theta_{flex} := 10 \cdot \frac{\pi}{180} = 0.17 \text{ rad}$$

$$F_{L\_comp} := M_{up\_D} \cdot gc \cdot \cos\left(\theta_{flex}\right) = 106 \text{ lbf}$$

Investigation

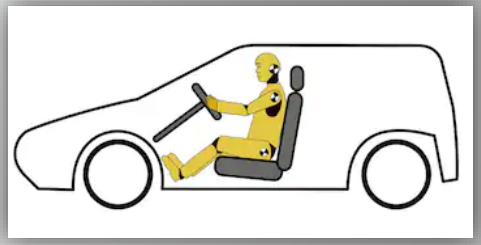
Accident Reconstruction Analysis

Delta-V Accelerations



Biomechanical Analysis

Accelerations Forces



Data collection

- Police/Incident report
- Bodycam/dashcam/surveillance footage
- Site measurements
- Witness statements
- Photographs
- Damage evidence
- Inspections/lab exams
- Deposition testimony

Calculations – Application of Physics & Dynamics

$$W_1 \cdot V_{11} + W_2 \cdot V_{21} = W_1 \cdot V_{12} + W_2 \cdot V_{22}$$

$$W_1 \cdot V_{11}^{\,2} + W_2 \cdot V_{21}^{\,2} = W_1 \cdot V_{12}^{\,2} + W_2 \cdot V_{22}^{\,2} + W_1 \cdot \left(BEV_{1_0}\right)^2 + W_2 \cdot \left(BEV_{2_0}\right)^2$$

$$res_{12_0} = \frac{V_{22} - V_{12}}{V_{11} - V_{21}}$$

"MER" Method – momentum, energy, restitution

Projectile motion equations

The forward walking speed at the time her fall began can be estimated:

$V_{walk} := \begin{pmatrix} 1 \\ 3 \end{pmatrix} \cdot mph_{fps} = \begin{pmatrix} 1.5 \\ 4.4 \end{pmatrix}$ ft/s, walking speed

The height of her center of gravity relative to the ground can be estimated:

$h_{cg} := 0.56 \cdot h_T = 3.08$ feet, height of plaintiff's center of gravity

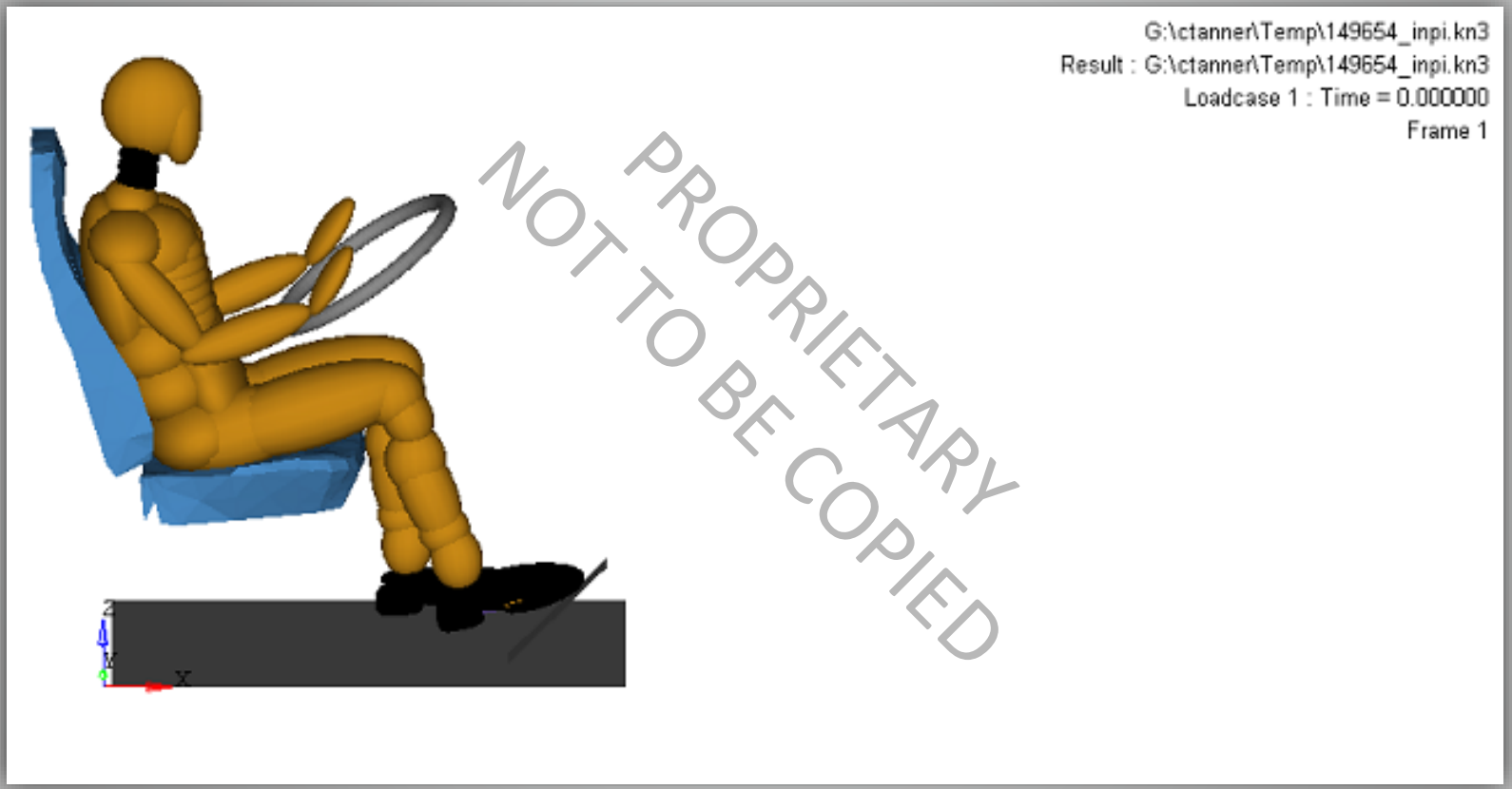
Using basic principles of physics including projectile motion equations, the time for plaintiff's CG to reach the ground can be calculated:

$t := \sqrt{2 \cdot \frac{h_{cg}}{g_c}} = 0.44$ s, time for plaintiff's center of gravity to fall to the ground

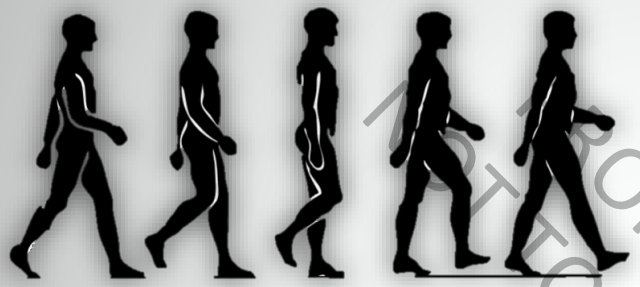
The forward travel distance of her CG during her fall can be estimated using the time to fall and her walking speed at the time the fall began:

$d := V_{walk} \cdot t = \begin{pmatrix} 0.6 \\ 1.9 \end{pmatrix}$ feet, forward distance traveled by plaintiff's center of gravity

Simulations Using MADYMO



In their condition immediately prior to the accident, what were their daily activities?



Was the Plaintiff working or participating in hobbies prior to the accident?

Physical Testing with ATDs

Common Daily Driver Exposure: *Backing to a dock*

Motion Capture

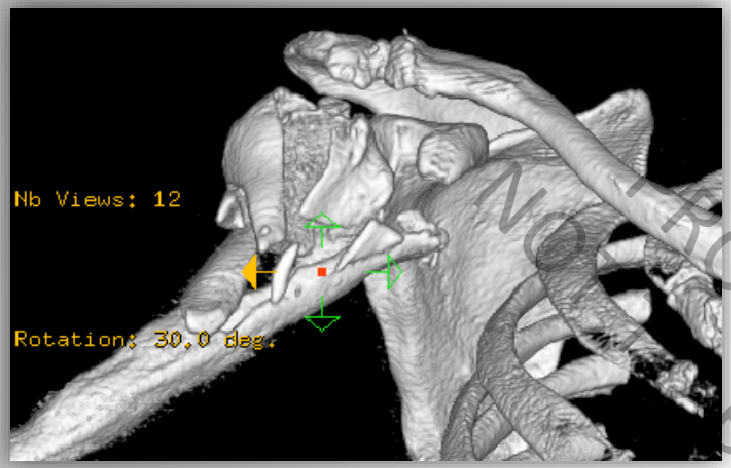
Specific activities can be evaluated using motion capture

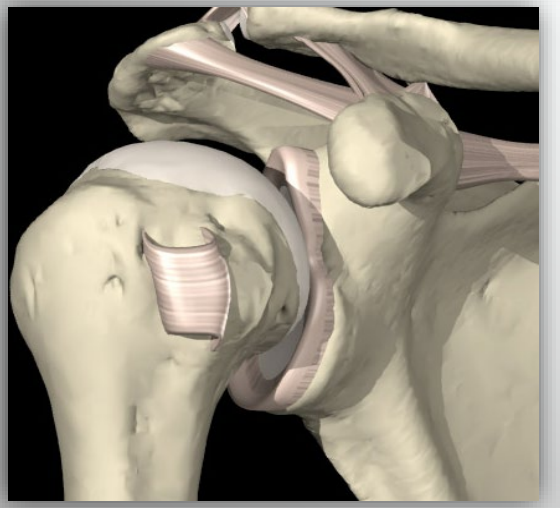
Case Studies:
Is the injury consistent with the accident?

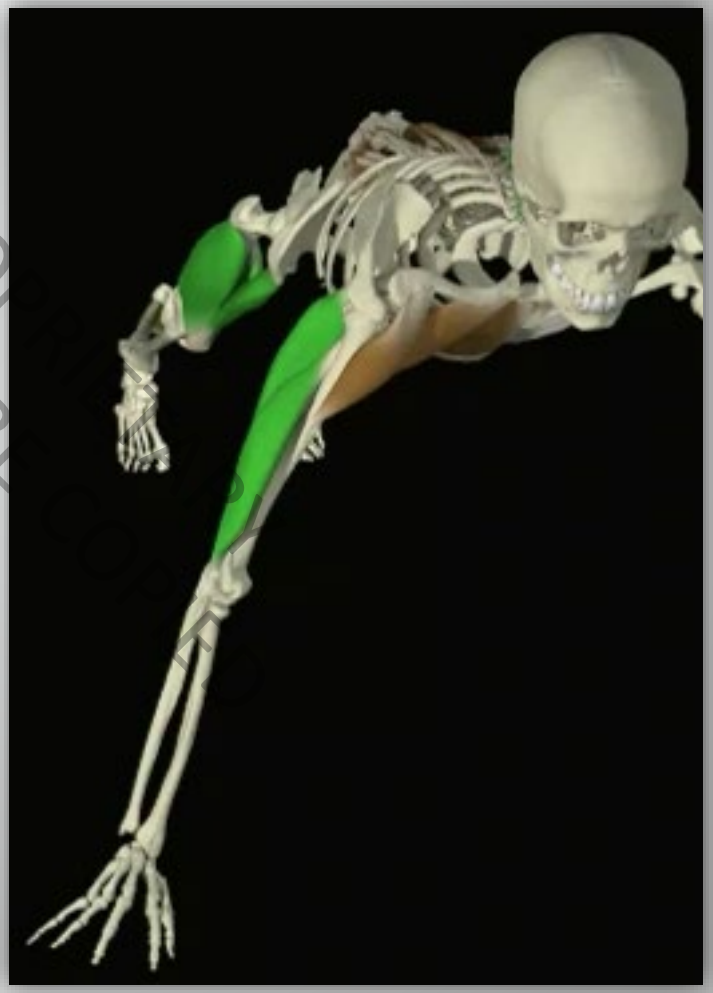
Did this accident cause ALL alleged injuries?

If a picture is worth 1000 words, what's a video worth?

Is the alleged slip and fall consistent with the diagnosed shoulder injury?







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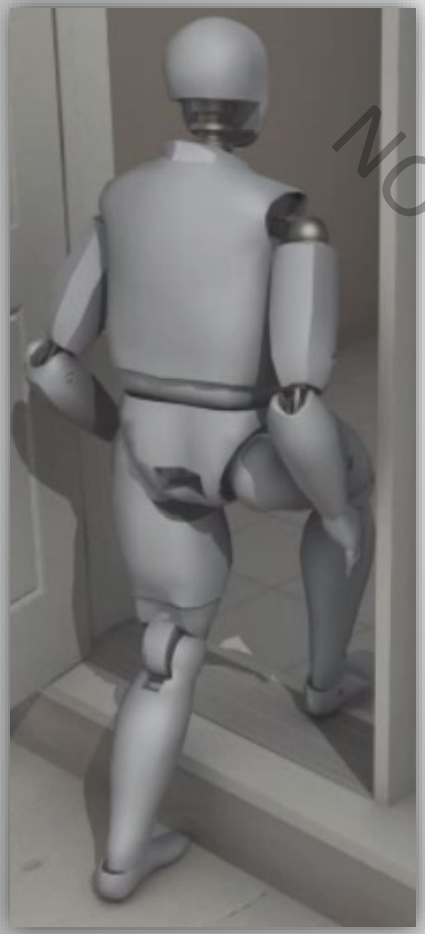
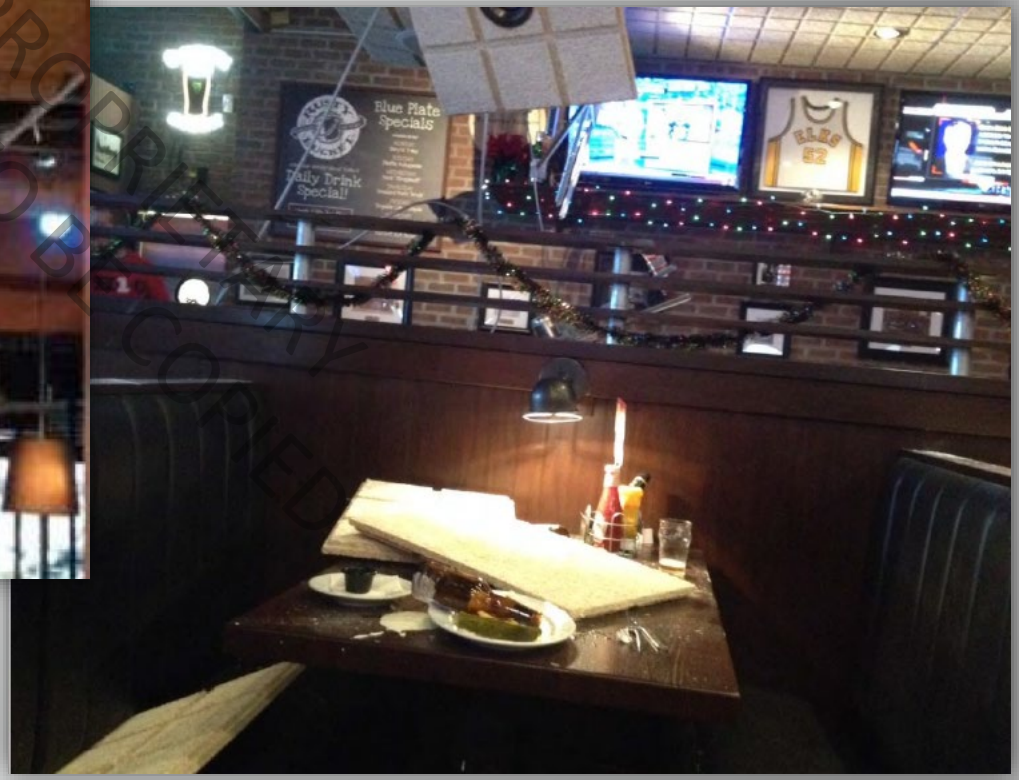


Alleged slip does NOT match…

A trip and fall incident does match

Is the impact force of the falling object consistent with causing a brain injury?



Full scale testing provides the answers

Case Studies:
What actually happened?

Did she trip on mat at door, as alleged?

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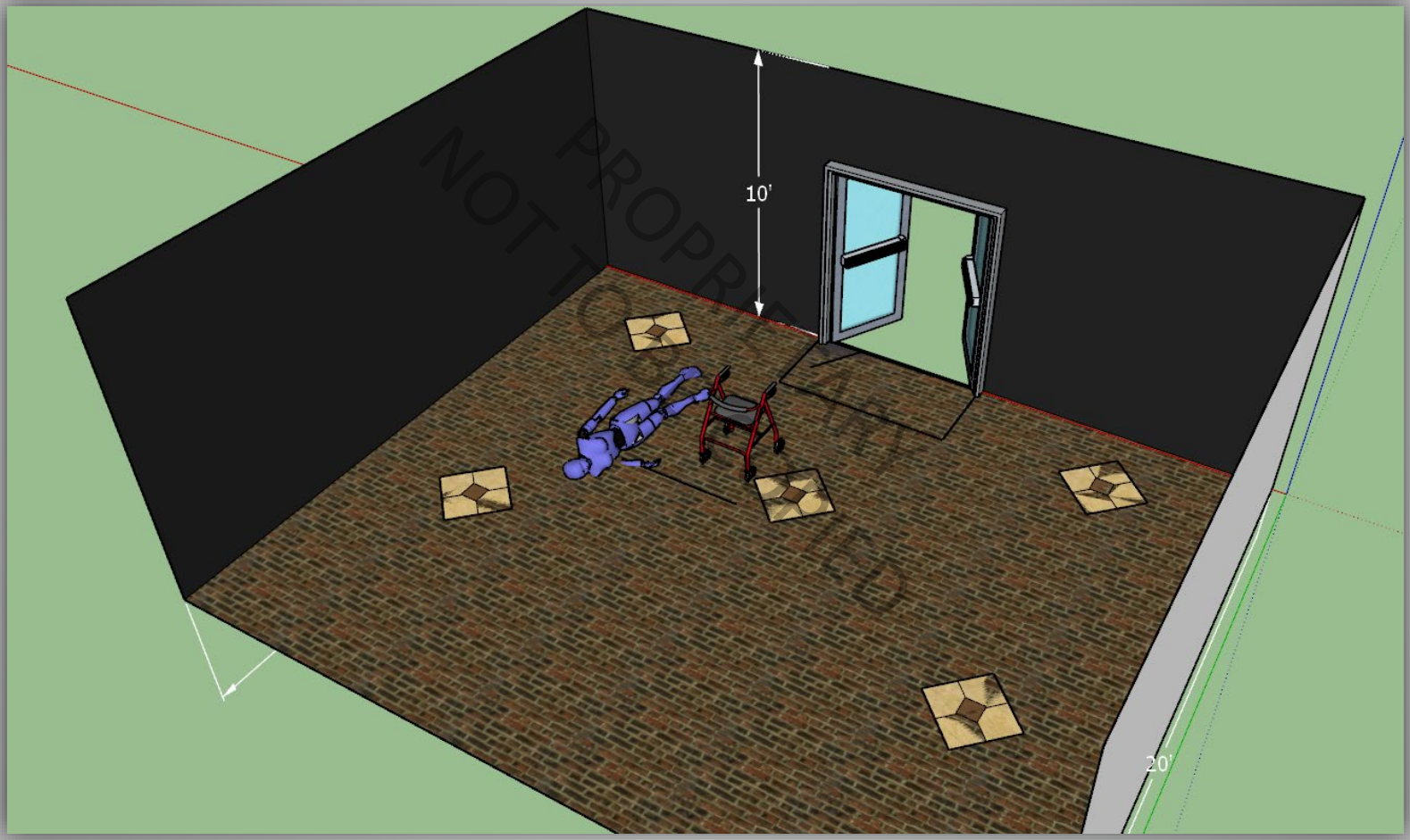

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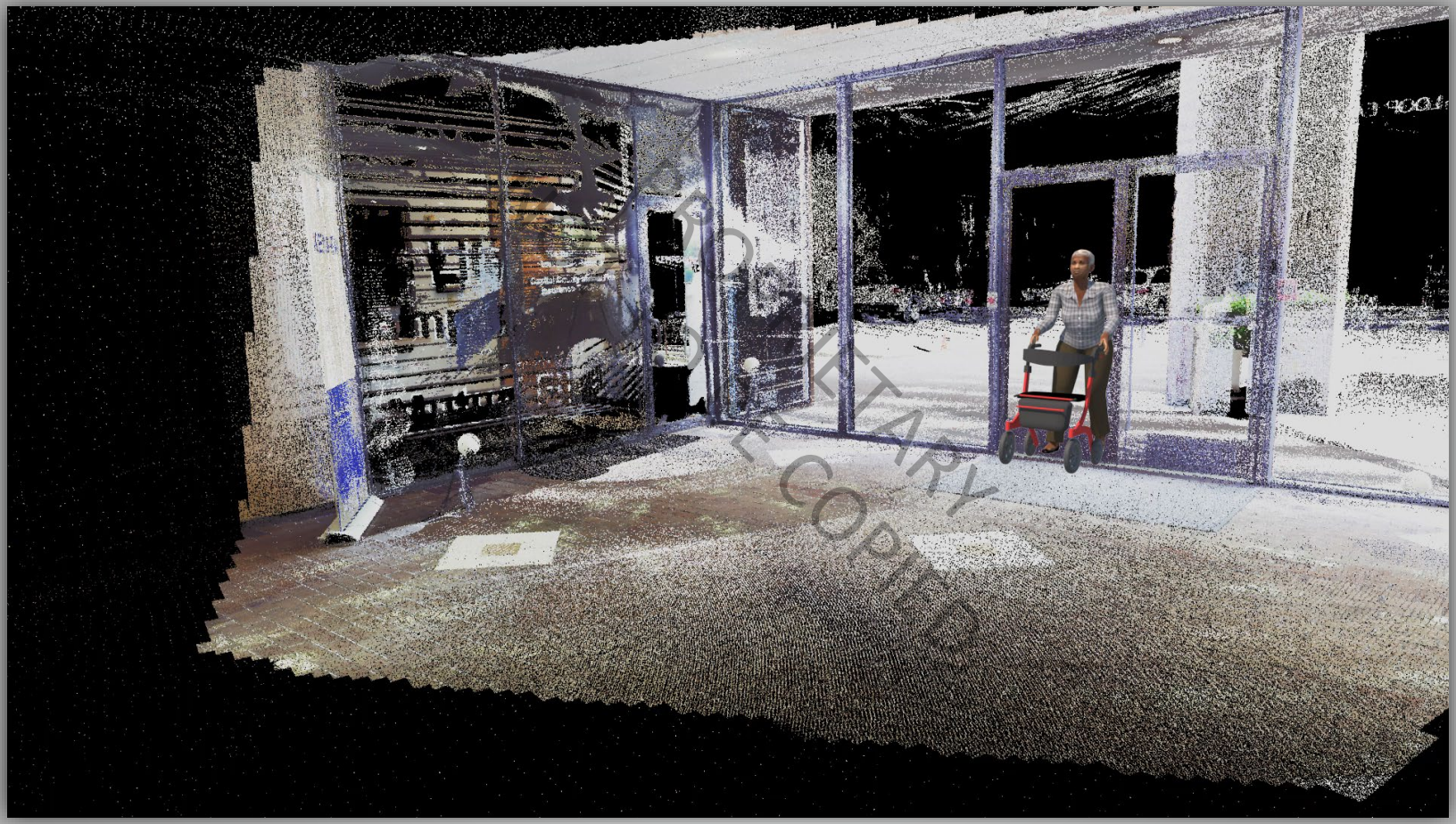

…No she did not

Who caused the accident (and responsible for injuries)?

Original surveillance footage only captures part of event

Creating all views to see what did happen

Creating all views to see what did happen

Where was the pedestrian at impact?

Using all physical evidence…

Surveillance footage frame matching low speed pedestrian animation

Case Studies:
Would proper use of safety devices have affected the outcome?

Would a helmet have made a difference?

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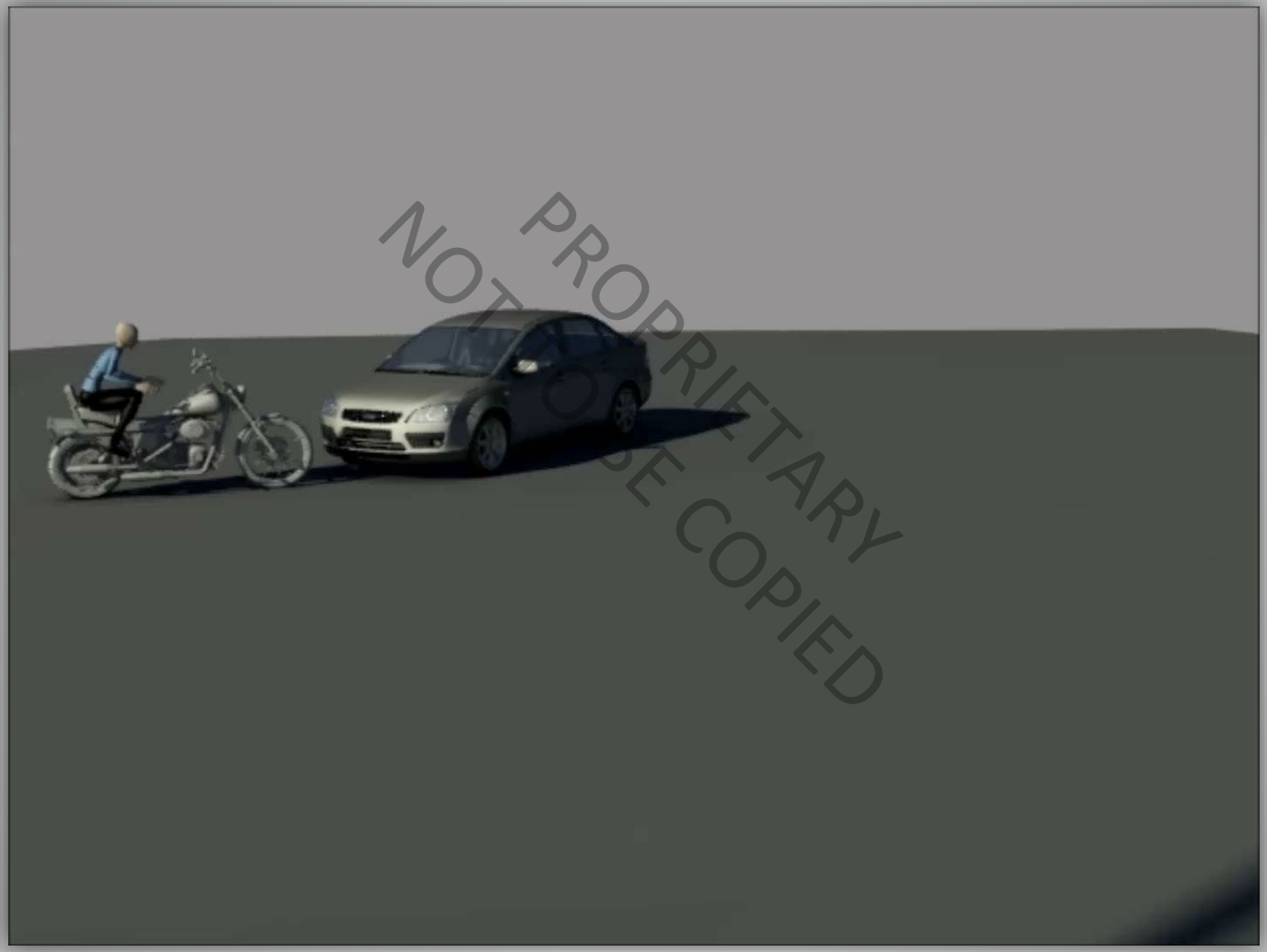

Was the driver belted?

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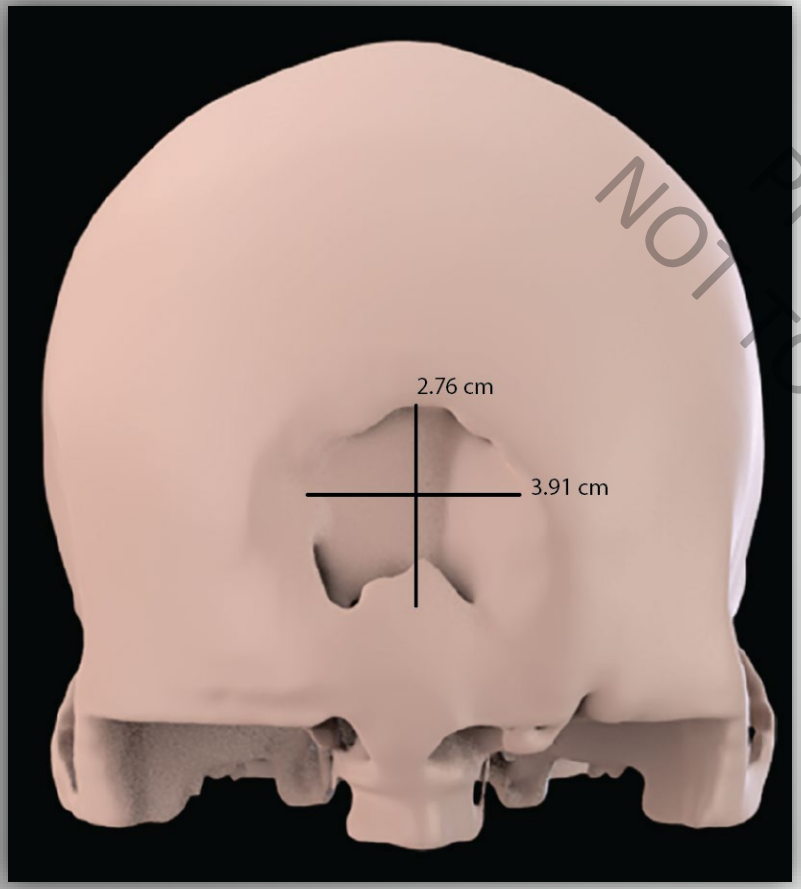

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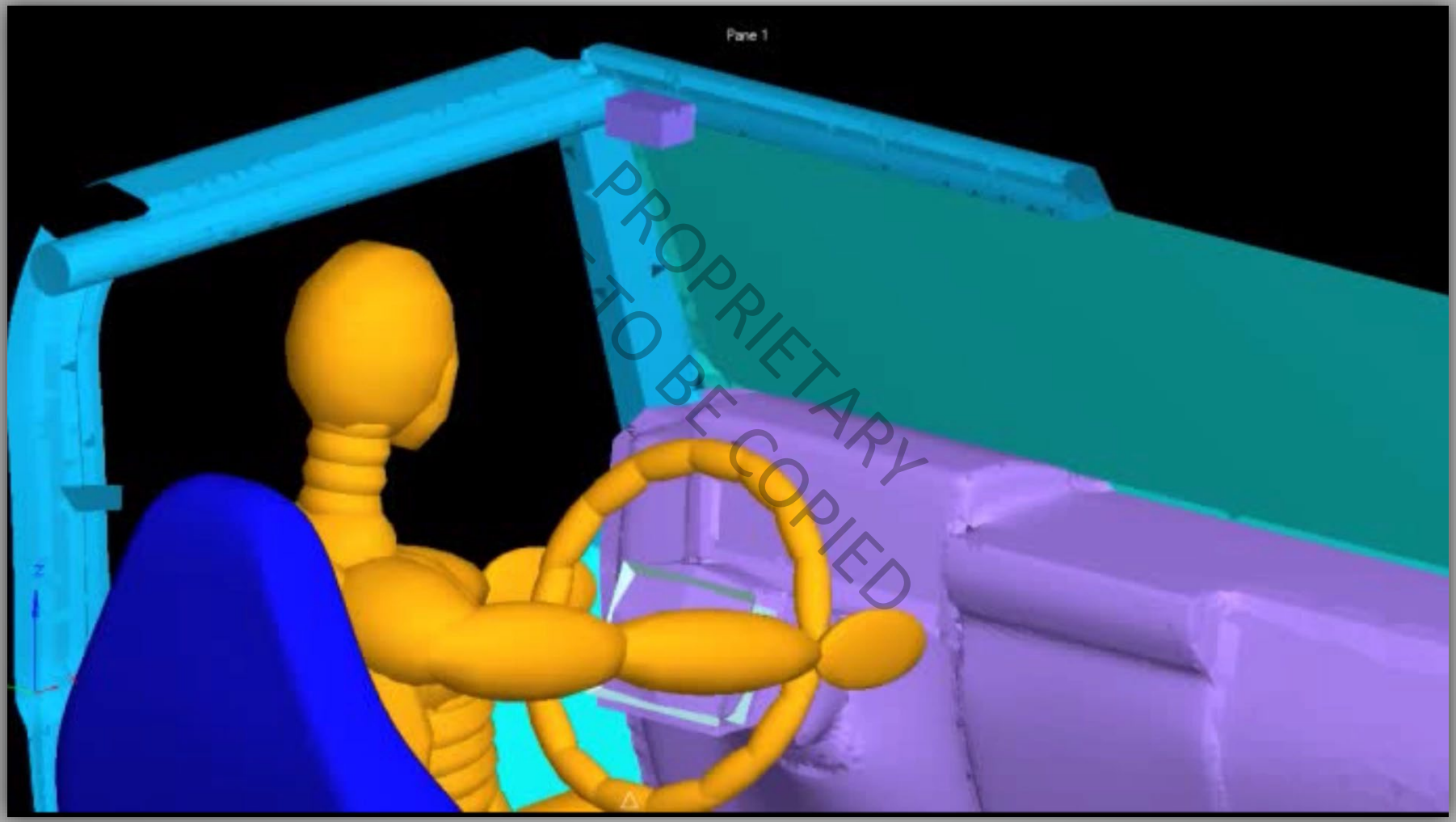

Would use of PPE have affected the outcome?

Would use of PPE have affected the outcome?

Where did she fall from? How did she fall?

…no witnesses, just injuries and scene evidence

Where did she fall from? How did she fall? Would an OSHA compliant guardrail have prevented her fall?

Thank you for your attention.

Questions?

Know.

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