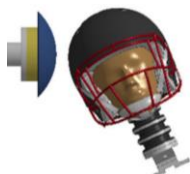


## Modeling Brain Damage in Football Impacts in Full Body Physics-Based Simulations

Caleb Cassidy and Advisor Dr. M.F. Horstemeyer

### What is a concussion?

Result of biomechanical forces transmitted to the head which will result in symptoms ranging from drowsiness and irritability to amnesia or loss of consciousness.



Side Upper Impact (SU)

### Why does it matter?

1.6 - 3.8 million Sports-Related Concussions (SRC) annually

### What is CAVEMAN?

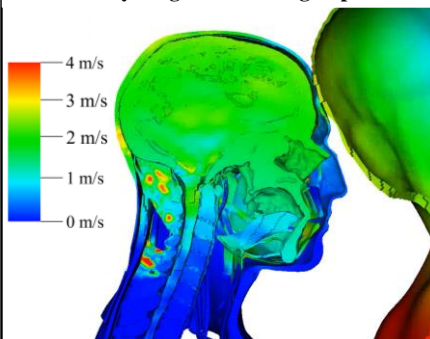
Computational Anthropomorphic Virtual Experiment MAN



### What is the goal?

The overall goal is to quantify brain damage.

### Velocity Magnitude During Impact



Simulation using CAVEMAN of a Face Mask Central Front Impact without helmet

Citations – Notes Done By sections from top to bottom

-1<sup>st</sup> – Helmet to Helmet Impact

Battista, Judy. “N.F.L. Fines Players for Hits to Head.” *The New York Times*, The New York Times, 20 Oct. 2010,

<https://www.nytimes.com/2010/10/20/sports/football/20hits.html>.

-2<sup>nd</sup> Head Impactor FEA Simulation

Bailey, Ann M., et al. “Characterization of Concussive Events in Professional American Football Using Videogrammetry.” *Annals of Biomedical Engineering*, vol. 48, no. 11, 2020, pp. 2678–2690., <https://doi.org/10.1007/s10439-020-02637-3>.

-3<sup>rd</sup> – CAVEMAN Skinless Image

Lister, Kevin, and Allen Shirly. “Evolution of a CAVEMAN.” *Computational Anthropomorphic Virtual Experiment Man (CAVEMAN) Model for Injury Assessment in Kinetic Events*, Corvid Technologies,

[https://media.defense.gov/2022/Nov/09/2003112566/-1/-1/0/CORVID\\_STORY.PDF](https://media.defense.gov/2022/Nov/09/2003112566/-1/-1/0/CORVID_STORY.PDF).

-4<sup>th</sup> – CAVEMAN Simulation of a central Front Impact

Figure 1. Central Front Head-to-Head Impact Without Helmet (Figure by Caleb Cassidy.)