MODELING AND SIMULATION CREDIBILITY ASSESSMENT OF FINITE ELEMENT MODELS FOR FALL FROM HEIGHTS INJURY SCENARIOS

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INTRODUCTION

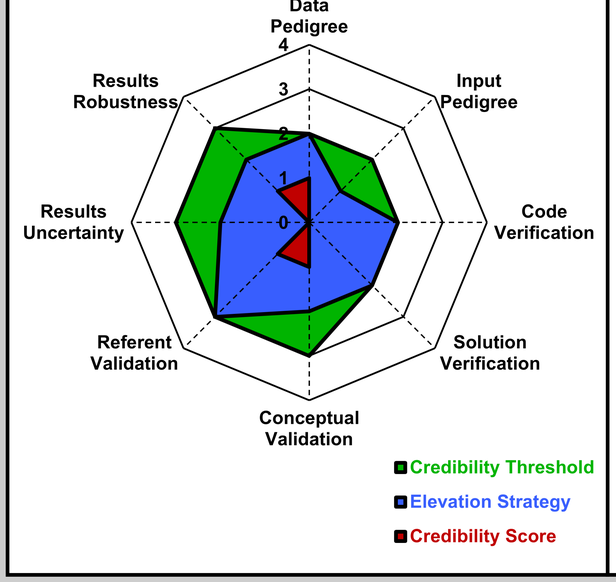
- Finite element (FE) computational models of the whole human body are being used to investigate injury modalities and mechanisms arising from suited astronauts' Extravehicular Activities (EVAs).
- Two whole body models, the simplified Elemance and THUMS pedestrian versions, have undergone a series of verification and validation assessments for automotive and contact sports applications.
- However, the FE models' Modeling and Simulation (M&S) credibility assessments for simulating suited astronaut injuries due to fall from heights in altered gravity environments are limited.
- This study evaluates the M&S credibility of the simplified Elemance and THUMS pedestrian FE models based on the eight credibility factors, data and input pedigree, code and solution verification, conceptual and referent validation, results uncertainty and results robustness.

RESULTS

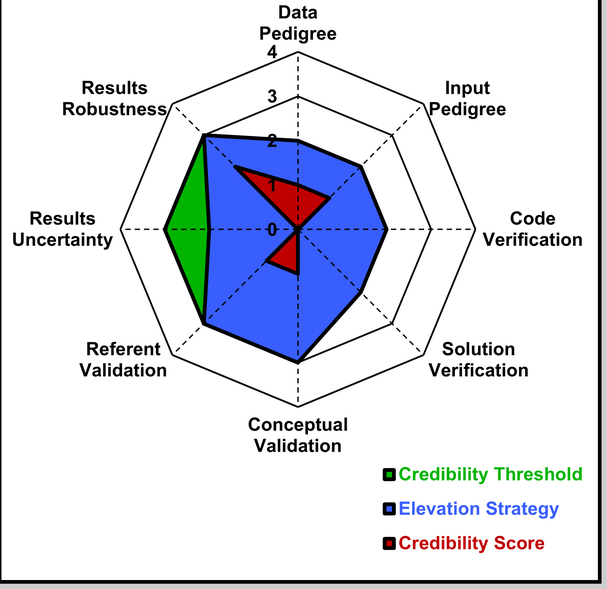
- The credibility assessment of the FE models, when used in a fall from heights injury analysis, resulted in credibility scores between 0 and 1 (Elemance) or 0 and 2 (THUMS), on a scale of 0 to 4.
  - A score of 4 identifies all necessary information and data for real-world EVA scenarios.
  - A score of 0 implies there is insufficient evidence to draw any conclusions.
- The results show that the FE models are credible for simulating fall from heights injuries in specific kinematic and kinetic ranges that correlate with automotive and sports-related external conditions.
- Multiple credibility elevation strategies are proposed to improve the Elemance and THUMS FE models' credibility for use in the EVA fall from heights injury scenario.

ELEMANCE CREDIBILITY SCORES

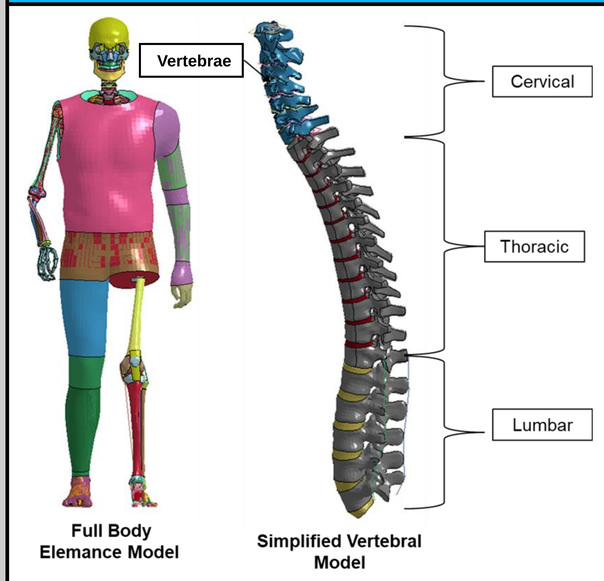
- This credibility assessment was performed per NASA-STD-7009A [1] to evaluate the Elemance [2] and THUMS [3] FE models for a fall from heights vertebral injury.
- The project defined threshold for each of the eight fall from heights injury credibility factors is set at 2 or 3 for the Elemance and THUMS FE models per guidance from NASA EVA subject matter experts.
- Model elevation strategies are recommended to improve scores up to 2 or 3, depending on the factor.



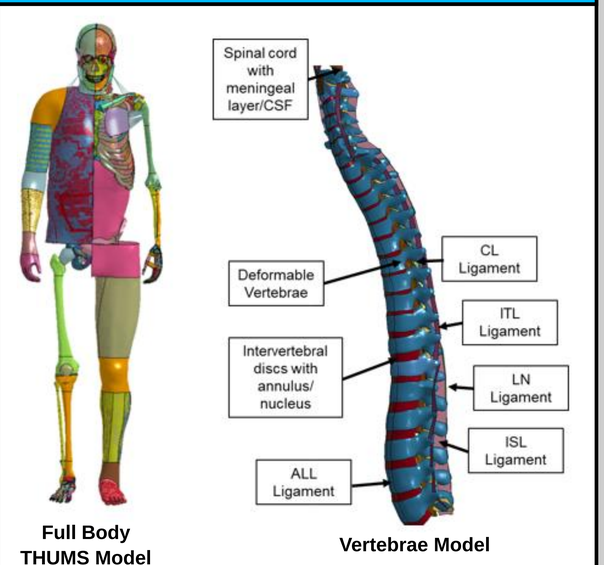
THUMS CREDIBILITY SCORES



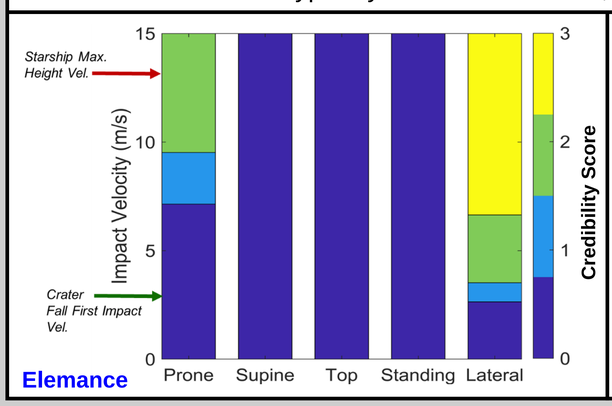
ELEMANCE FULL BODY MODEL

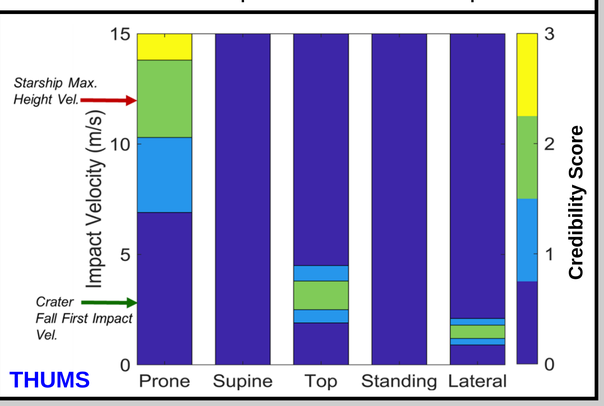


THUMS FULL BODY MODEL



- The plots below summarize the referent validation credibility scores for the fall from heights vertebral injury based on information collected from multiple literature sources for five different body postures.
- Analyzed impacts occurred at the top of the head (top), bottom of the feet while standing (standing), side of the body (lateral), front side of the body (prone), and back side of the body (supine).
- Since the models are typically for automotive use, most studies are for prone and lateral impacts.





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