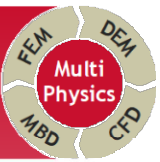


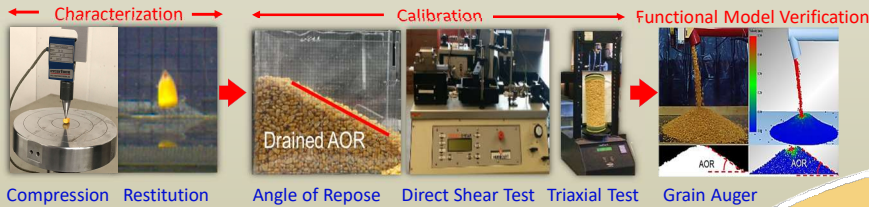
Physical Systems Modeling and Simulation of Agricultural and Off-Road Machinery Systems



Dr. Tekeste's Lab

Development of Experimental Tests for DEM Calibration

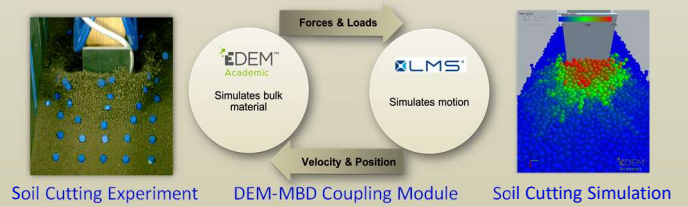
Researchers: Mohammad Mousaviraad (PhD), Dr. Shun Zhang



- Calibration of micro-mechanics contact models requires physics-based bulk material tests fit for application
- Our DEM methodology involves design of experiment (DOE), stochastic surrogate fitting for DEM parameters & multi-response optimization algorithms (Mousaviraad et al., 2017; Tekeste et al., 2018)

DEM-Multibody Dynamics (MBD) Coupling for Soil-Tool Interaction

Researcher: Sadaf Ghorbani (MSc)



- Coupling of DEM & MBD is essential to simulate the soil-to-tool interaction to obtain accurate loads for complex materials & different machine motions
- In coupling simulation, velocity & position of the machine parts are calculated in MBD software (LMS) then transferred to DEM (EDEM) in which reaction forces from soil particles are updated & sent back to LMS (Ghorbani et al., 2018)

Soil-Machine Dynamics Laboratory

Laboratory: Jacob Mason, Lucas Roe, Cole Schlup

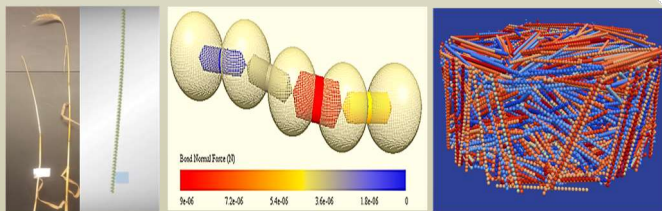


Circular Soil Bin Cultivator Sweep

- Perform controlled wear tests of soil-engaging tools
- Face hardening (CADEN) design evaluation for wear

Modeling Flexible Fibers Using DEM

Researcher: Mathew Schramm (PhD)



DEM Simulation Cantilever Beam & Uniaxial Compression Flexible Fibers

- DEM can create bonds between specific spheres, representing flexible fibers
- Experiment measurements of wheat straw fiber material performed to obtain property values such as diameters, weights, lengths, and mechanical responses (Schramm et al., 2018)

Methodology & Test Development

Develop testing methodology for high-fidelity calibration of soil & biomass materials

Integrate into simulation-based design

Technology development for off-road & agricultural machinery equipment
Our methodology development is based on systematic design of experiment (DOE), laboratory testing & evaluation of industrial applications

Testing (soil-machine systems)

- Soil-to-machine interaction (tire, blade)
- Soil stress for performance testing
- Data for model validation
- Soil cutting forces
- Tire/track forces



Mobility Soil Bin

Multi-Physics

Modeling

Physical systems modeling of material-to-machine interactions using:

- Finite element method (FEM)
- Computational Fluid Dynamics (CFD)
- Discrete Element Method (DEM)
- Multi-Body Dynamics (MBD)

Data Analytics for Precision Tillage & Soil Compaction

Measurement & prediction of soil compaction & its relationship to yield

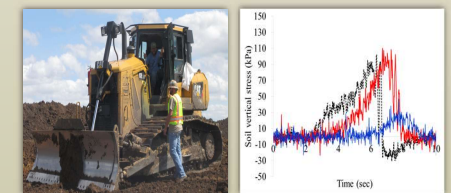


Soil Tilt Map

Prescription tillage mapping using multisensory soil fusion

Machine Traffic Induced Soil Compaction & Its Impact on Long Term Yield

Researcher: Dr. Elnaz Ebrahimi

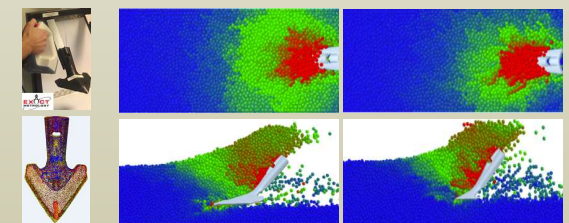


Heavy Equipment Traffic Soil Stress from Traffic Pass

- Eco-physiological response of soybean & corn to compacted soil in root zone
- Deep tillage management to alleviate deep soil compaction from construction activities (Tekeste et al., 2019)

DEM Simulation for Worn Tool Analysis

Researcher: Dr. Mehari Tekeste



New Sweep Worn Sweep
Experimental testing & 3D scanned sweeps DEM simulation

- Apply 3D scanning & reverse engineering to integrate worn tools into simulation work flow
- DEM simulation of soil-to-tool interaction to virtually analyze the performance of tillage tools from field service (worn vs. new) (Tekeste et al., 2018)