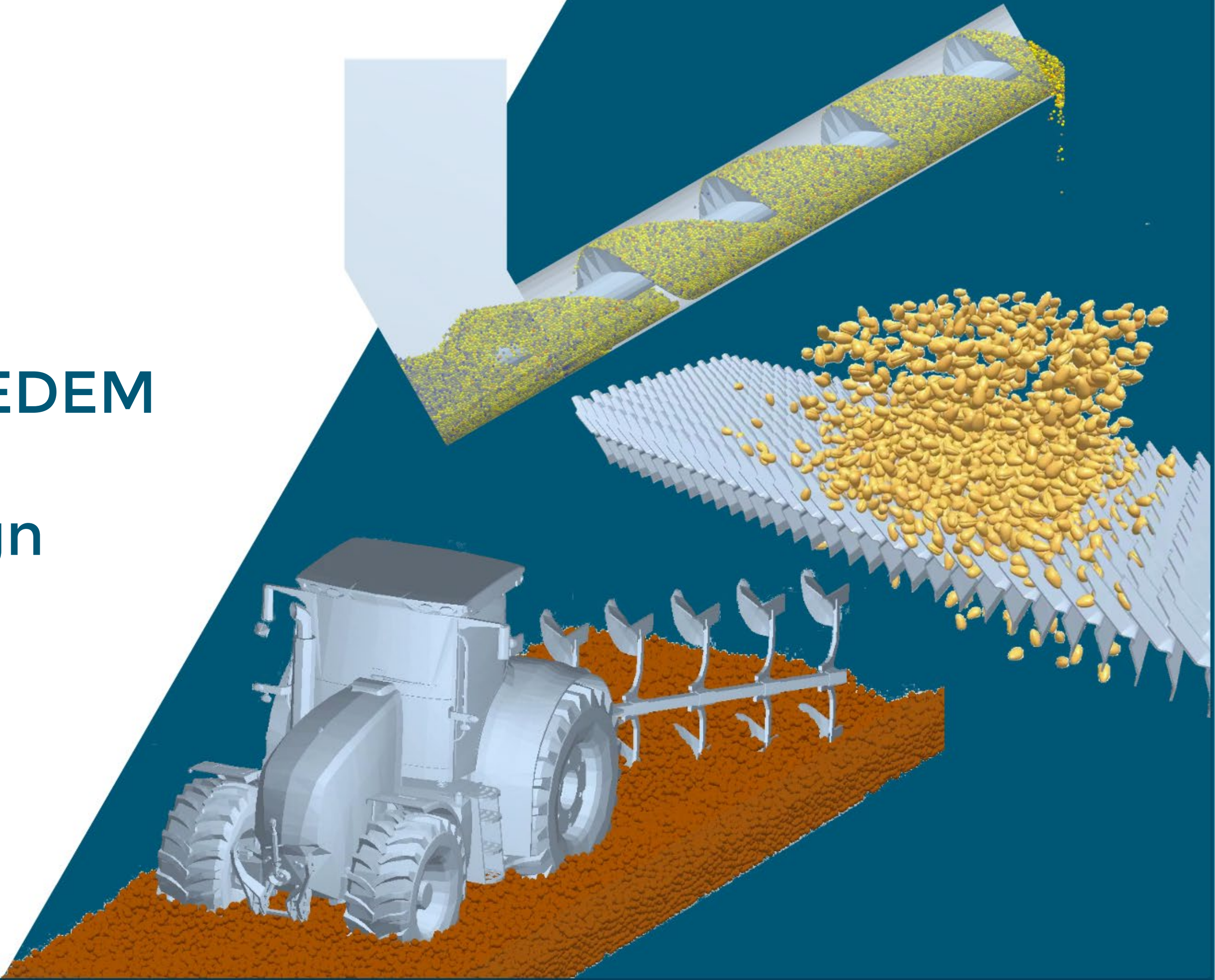
EBOOK

Applications of EDEM for Agricultural Machinery Design



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Agricultural Machinery Design Challenges

The agricultural machinery market is a highly competitive one. Manufacturers of agricultural equipment need to continuously increase the quality and reliability of their machines but also innovate and deliver solutions that are tailored to the demands of the agricultural sector.

One challenging aspect relates to the range of operations and conditions that machines have to perform in. Tractors, combines and forage harvesters are all designed to work with a range of bulk materials such as crops (in various stages of being processed), seeds and soils, all of which may vary in properties depending on the location and seasonal conditions. The variability of these materials can have a strong effect on the performance of the machines.

Combine harvesters for instance have to deal with soil, grains and also fibrous materials. The cohesive nature of the fibres could lead to blockage within the harvesting equipment and non-optimized cutting could result in poor quality crops and final product.

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Agricultural Machinery Design Challenges

In the case of tillage equipment, the blades might be interacting with a range of soils with different levels of compressibility and stickiness, or perhaps harder materials like rocks, all of which will have an impact on the machine. Being able to predict how the equipment will be affected by a specific material and identifying potential wear on tools represents a key aspect to ensure the machine will perform as expected.

Predicting the bulk behavior of materials and their impact on the machine is critical to achieve efficiency and performance; however, it is challenging due to the complexity and variability of bulk materials.

Using physical testing of new equipment designs is expensive and limiting, especially when considering testing against crops in the field where missing a seasonal testing window due to adverse weather conditions can significantly delay the time to market for new designs.

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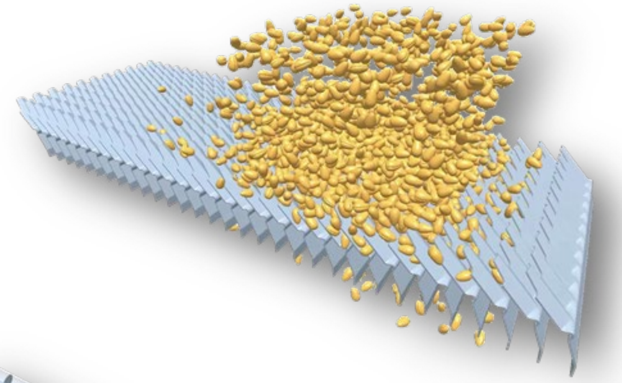
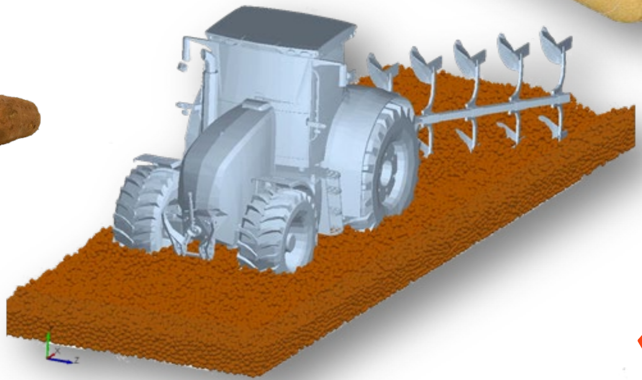
Introducing EDEM simulation technology

Powered by the Discrete Element Method (DEM), EDEM software enables engineers to simulate and analyze the behavior of granular materials such as grains, seeds, crops and soils.

EDEM simulation provides crucial insight into how those materials will interact with equipment during a range of operation and process conditions.

EDEM is used for the design, performance testing and optimization of agricultural machinery such as combine harvesters, hay and forage equipment, tillage tools, seeder/fertilizer equipment and grain handling and transport systems.





Overview of EDEM components

EDEM CREATOR

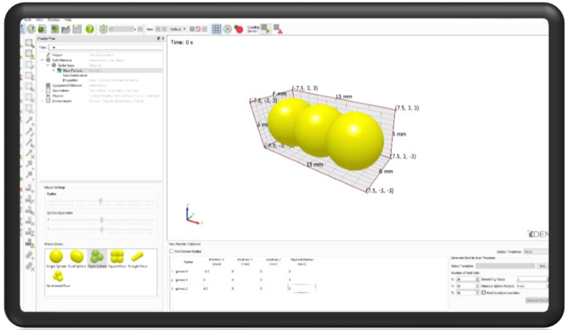
Create materials, particles, geometry and physics models

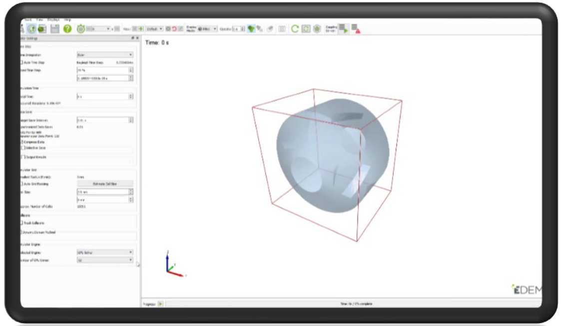
EDEM SIMULATOR

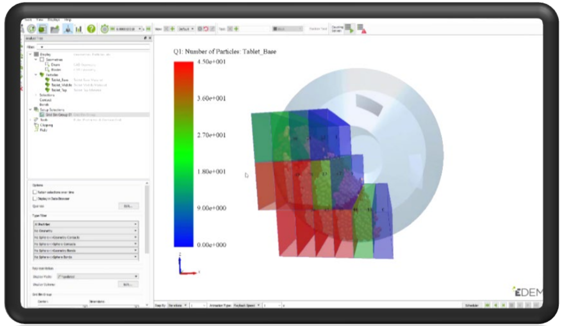
Define run-time and simulation settings and process the simulation on CPU or GPU

EDEM ANALYST

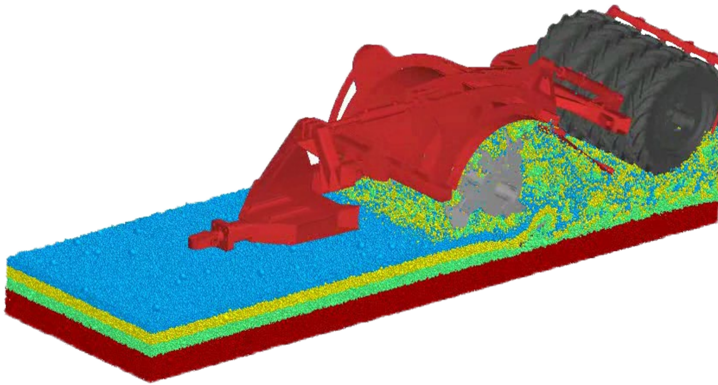
Visualize your results, create videos, graphs and export data

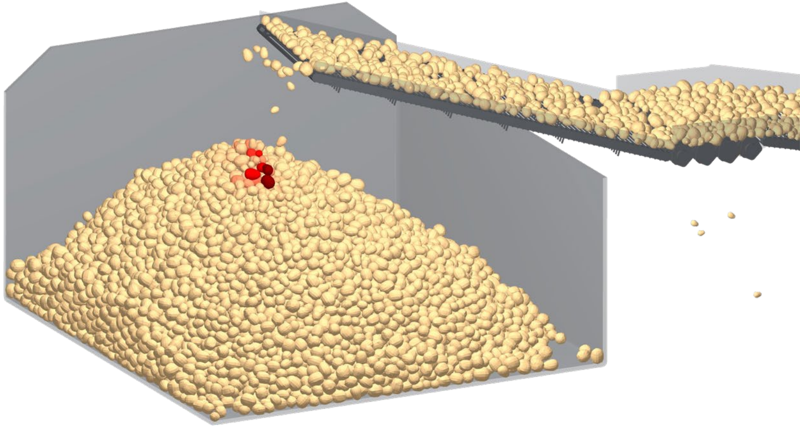






Benefits of EDEM simulation





By including EDEM in their design workflow, engineers are able to:

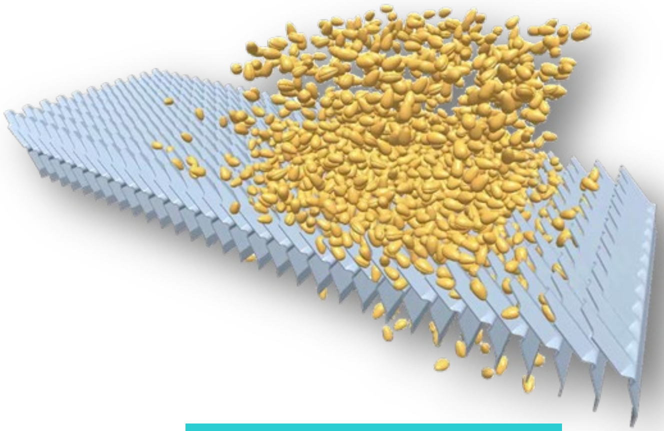
- **Predict** complicated bulk material behavior such as fibrous material cutting, transportation and bailing
- **Identify** risk of blockages in the equipment due to high flow rates, pulsing flows, cohesive/wet materials or long fibrous materials
- **Get key insight** into crop-machine and soil-machine interactions
- **Perform** testing out of season without having to ship prototypes to areas where crop is growing
- **Reduce** the need for physical prototypes

Accelerate the design process, improve machine performance and drive product innovation.

APPLICATION EXAMPLES

Grain and Crop Handling Systems

- **Investigate** screw auger forces and torques
- **Predict** auger crop flow properties
- **Quantify** grain handling system capacity and power requirements
- **Measure** performance of the system



- **Simulate** grain sieving process
- **Analyze** sieving throughput
- **Test** different operating conditions of the sieve
- **Optimize** system efficiency

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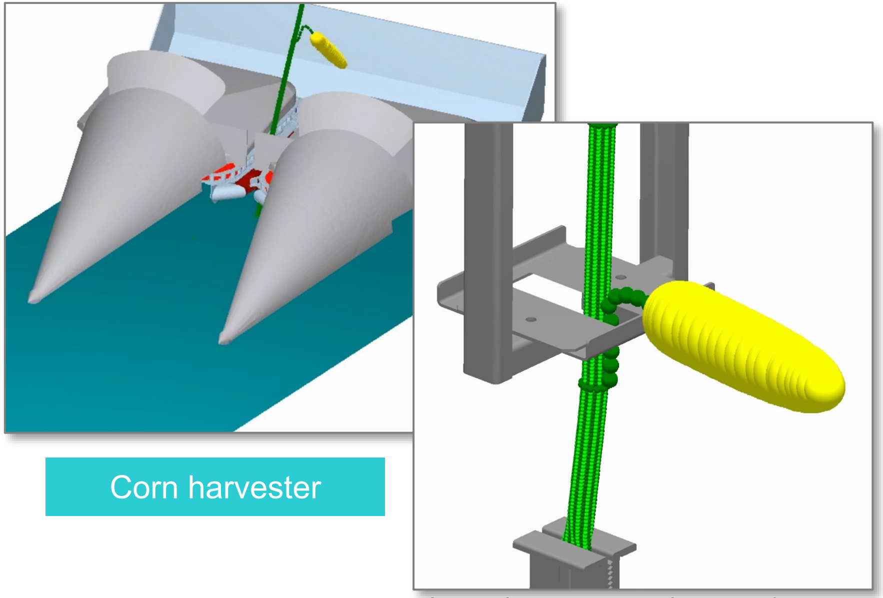
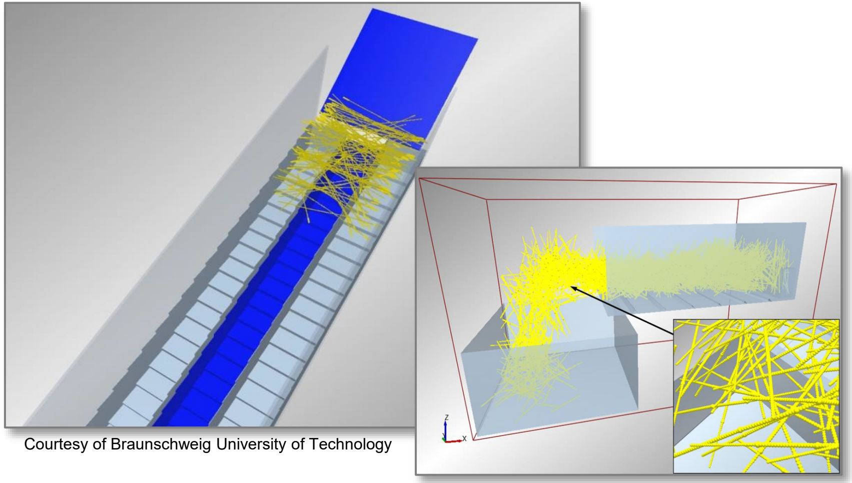
Grain and Crop Handling Systems

- **Simulate** corn harvesting process and corn ear detachment
- **Predict** the interactions among fibrous agricultural materials and machine parts



Corn harvester

Courtesy of Budapest University of Technology & Economics



Courtesy of Braunschweig University of Technology

Straw chopper

- **Compare** different designs
- **Check** influence of design on stalk orientation
- **Optimize** chopping quality

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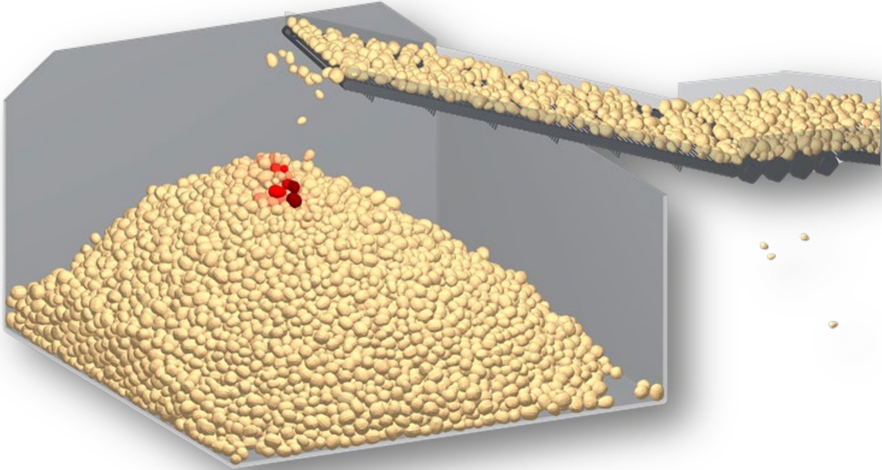
Grain and Crop Handling Systems

- **Test** different designs virtually
- **Determine** grading capabilities of potato harvester
- **Reduce** crop damage



Potato harvester

Bucket elevator

- **Predict** performance of bucket elevator
- **Understand** discharge flow profile of grains
- **Optimize** efficiency

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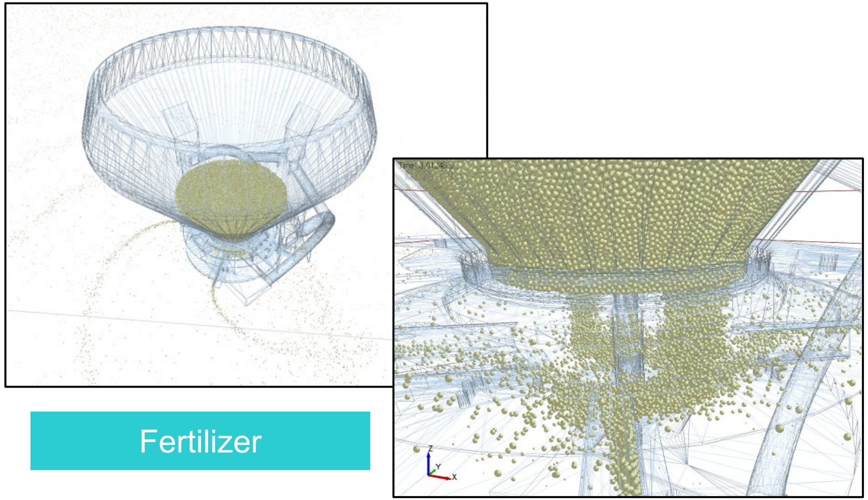
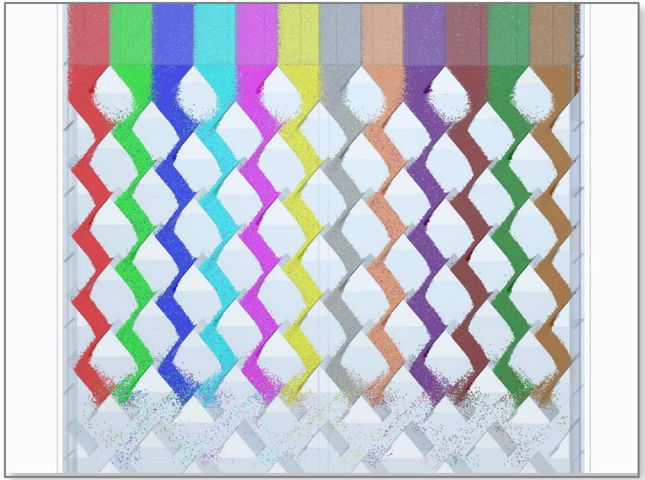
Grain and Crop Handling Systems

- **Investigate** spread pattern in fertilizer spreader
- **Predict** particle flow
- **Help** achieve uniform distribution
- **Validate** field tests



Fertilizer

Courtesy Kangwon National University



Mixed flow corn dryer

- **Determine** particle flow pattern
- **Identify** under and over drying grain portions
- **Help** obtain uniform drying
- **Minimize** the risk of quality loss and waste of energy

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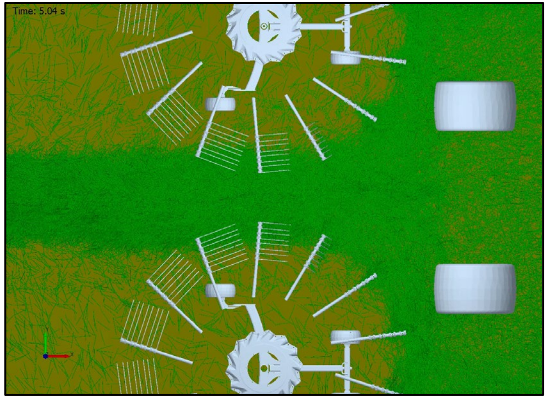
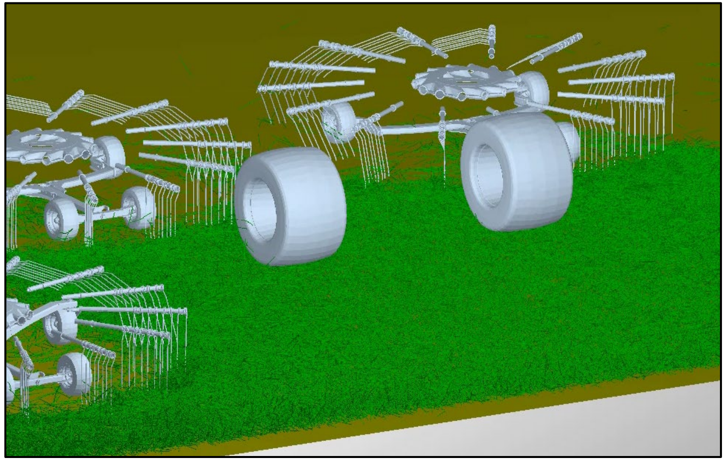
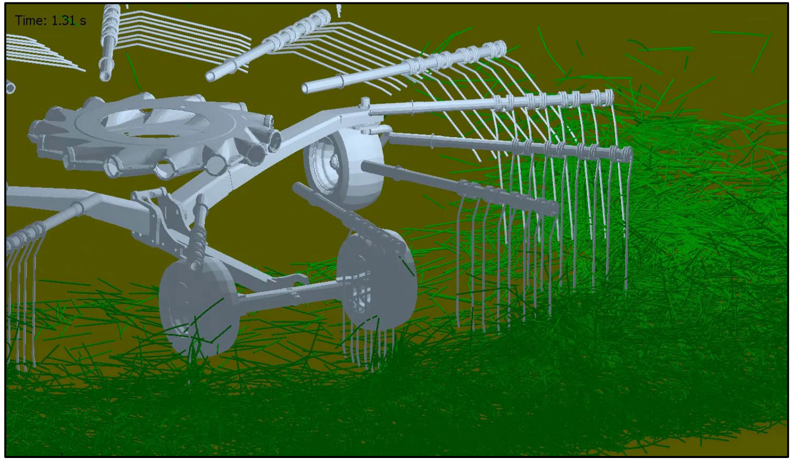
Grain and Crop Handling Systems

- **Simulate** flexible fibers (grass) and its interaction with the machine in order to optimize the design and process
- **Predict** the interactions among fibrous agricultural materials and machine parts







Swather raking grass

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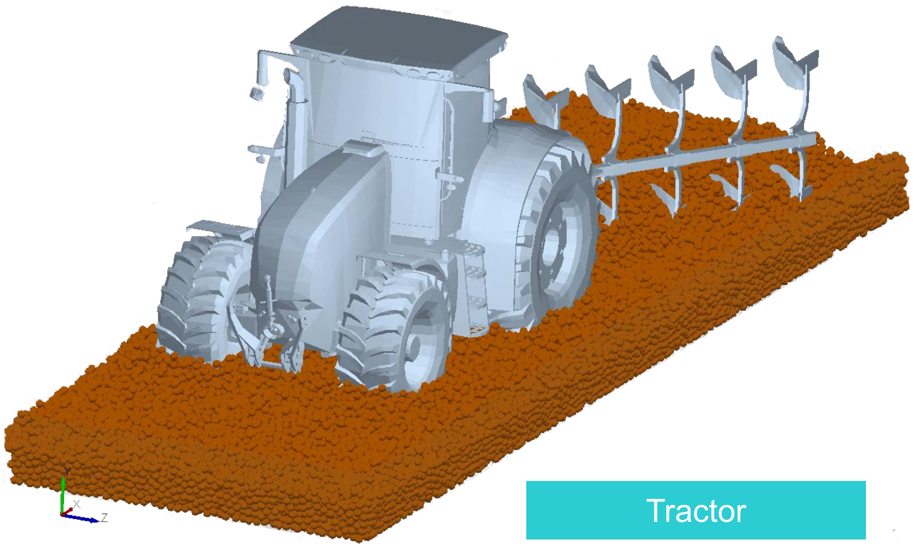
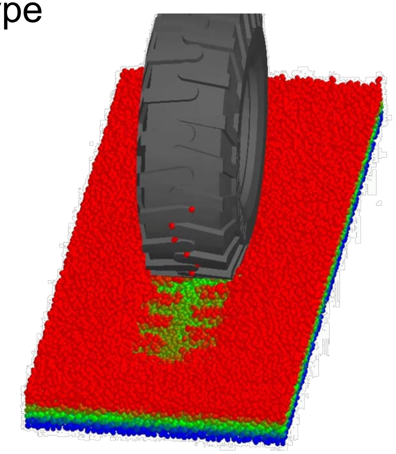
Machine – Soil Interaction

- **Model** machine – soil interaction
- **Get** accurate forces exerted on machine
- **Include** dynamic response of equipment
- **Test** new designs with a range of materials without the need for physical prototype
- **Virtually test** all equipment manoeuvres through a simple setup process





Tractor

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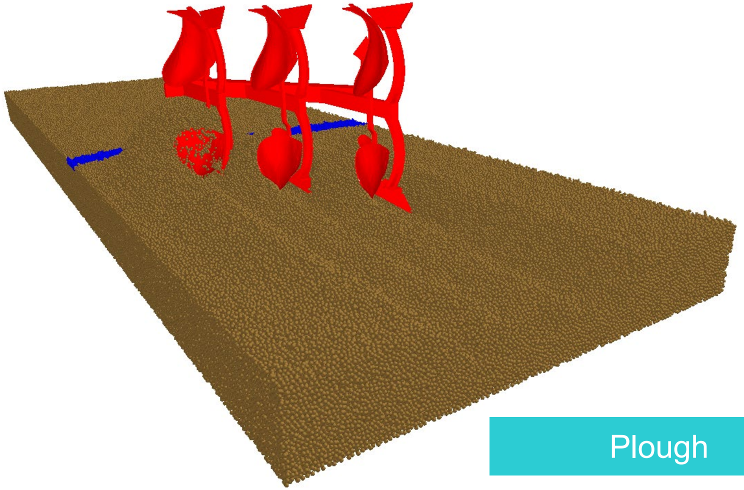
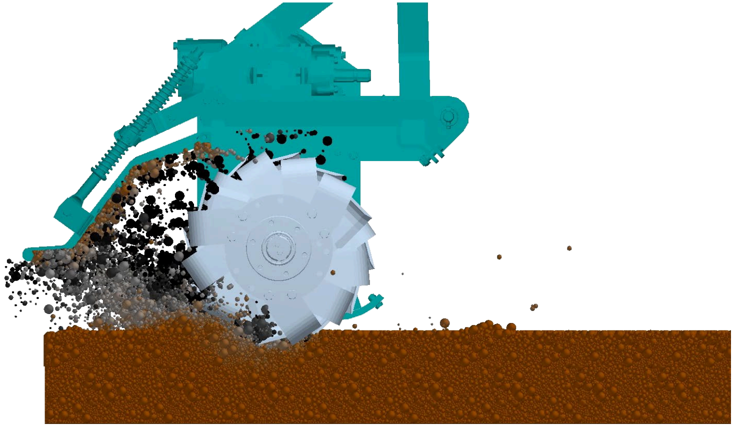
Machine – Soil Interaction

- **Model** tillage operation and the interaction between soil and plough
- **Understand** soil movement and plough depth
- **Optimize** the tool geometry
- **Optimize** plough performance



Plough



Rotovator

- **Analyze** soil pulverization quality
- **Assess** power required for rotovator to operate at desired depth of cut
- **Perform** analysis for different configurations and different blade designs to optimize design

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Employing EDEM software at CNH has allowed for an accelerated pace of machinery development to more fully understand crop-machine and soil-machine interactions.

The unprecedented level of model customization that can be achieved through the EDEM API allows us to obtain the results we need to drive product innovation at CNH.

Dr. Martin Roberge
Manager Soil Crop Flow Modeling
CNH Industrial

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FOR MORE INFORMATION VISIT

www.altair.com/edem

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