CASE STUDY

ARABLE FARMING DESIGN INNOVATION

ALTAIR DEM AND CFD TECHNOLOGY OPTIMIZES AMAZONE'S PNEUMATIC SEEDING TECHNOLOGY

About the Customer

Founded in 1883 and headquartered in Osnabrück, Germany, Amazone is a global leader in agricultural machinery. Amazone offers an array of advanced, cost-effective systems for arable farming, spanning seed drills, soil tillage, fertilization, crop protection, and more. To deliver on its commitment to continuous innovation, Amazone leverages Altair's cutting-edge technology when designing and developing its machinery to help its customers maximize their harvests.

Their Challenge

Organizations in the agriculture equipment industry face immense pressure to meet the sector's growing demands. Alongside the quality of seeds and soil, precise and efficient agricultural machinery is vital in achieving high-yield harvests. In arable farming, utilizing precision seed drills can enhance crop yields. To improve their customers' harvests, Amazone sought to improve seed placement in pneumatic seeding machines.

Precise seed distribution ensures each plant has space to grow, maximizes yields, and minimizes the use of expensive seeds and fertilizer. However, it requires a deep understanding of seeds' dynamic behavior within the pneumatic conveying system. Examining the seed transport process is difficult due to the complexity of dynamic interactions, the cost and difficulty of scaling experimental investigations for large machinery, and limited insights from conventional testing. In a previous project, Amazone's use of Altair® EDEM™ in the development of fertilizer machines helped them better understand the system and slashed development time. For this project, the first step was to develop a predictive model that couples the discrete element method (DEM) and computational fluid dynamics (CFD) simulations to represent the seed transport process. The goal was to achieve an ideal distribution of seeds to increase yields while reducing material usage.

> By leveraging Altair's DEM-CFD simulation solution – combining the power of EDEM and AcuSolve – we achieved precise seed placement, optimized harvest output, reduced seed waste, accelerated development, and empowered farmers with more efficient, more sustainable farming solutions.
>
> Jan Bruns, calculation engineer, Amazone

REDUCED DEVELOPMENT TIME BY UP TO

40% ▼

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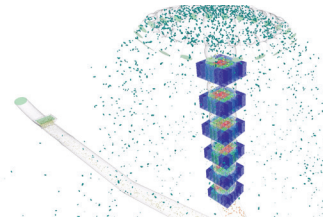
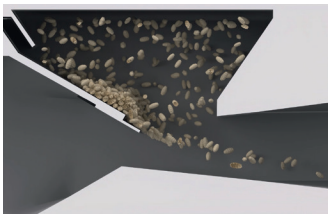
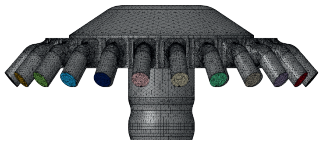
Our Solution

The project focused on modeling a critical subsystem of the pneumatic seeding machine. This consisted of the particle tank, dosing unit, pneumatic conveying line, riser tube, and distributor head. The team reduced the system to its most relevant parts to develop a bidirectionally coupled DEM-CFD simulation. This approach helped the team capture the intricate interactions between seed particles and the surrounding air flow, helping Amazone's engineers better understand the seed drills' behavior and optimize their design.



First, the study utilized coupled DEM and CFD modeling to analyze particle-fluid interactions in a pneumatic system handling wheat grains. EDEM modeled wheat shapes as non-spherical (ellipsoidal) particles to represent the seeds' geometry, incorporating accurate physics for standard friction, drag, and lift forces. Next, calibration tests – including static angle of repose and inclined plane tests – ensured realistic particle behavior. For CFD, Altair® AcuSolve® simulations used the Spalart-Allmaras (SA) turbulence model to represent air flow, integrating non-spherical drag and lift models to account for the particles' aspect ratio. Lastly, the team defined the pneumatic system's air intake velocity (20 m/s) and particle feed rate (0.18 kg/s). The simulation modeled momentum exchange between the solid (seeds) and fluid (air) phases to capture their mutual influence. Throughout, EDEM determined particle behavior while AcuSolve updated the fluid field, communicating drag and lift forces back to EDEM.





TOP: The mass flow analysis along the riser indicated optimal centering of seeds before entering the distribution head, ensuring consistent sowing patterns. **MIDDLE:** Coupling DEM and CFD simulation enabled Amazone to accurately represent the seed transport process. **BOTTOM:** The development of a predictive simulation model to visualize the particle-fluid multiphase flow required the modeling of the distributor head of the pneumatic seeding machine.

Results

The deployment of DEM-CFD simulation delivered conclusive results:

Reduced Development Time: By leveraging virtual design tools, Amazone minimized their reliance on expensive physical prototypes and shortened their development cycle by roughly 40%.

Improved System Understanding: The simulation provided unprecedented insights into the conveying line's internal dynamics, empowering engineers to optimize seed transport processes that were nearly impossible to observe using physical testing alone.

Optimized Seed Distribution: Simulation results showed a strong correlation with experimental test data, evaluated based on the measured Coefficient of Variance for particle mass across outlets. The experiments allowed the team to examine the behavior of the mass distribution along the riser, ensuring consistent sowing patterns and optimizing seed distribution.

Sustainable Resource Use: Precise seed placement reduced material usage, conserving expensive seeds while maximizing yields. This helped Amazone deliver on its commitment to sustainable, efficient farming practices.

Enhanced Profitability: By improving the efficiency of seed usage and maximizing yields, farmers can boost profitability and reduce input costs.

The collaboration between Amazone and Altair demonstrated how coupled DEM-CFD simulations can transform seeding technology. By accurately modeling dynamic particle-fluid interactions, the project advanced state-of-the-art intelligent crop production. This breakthrough not only enhances crop yields but also supports sustainable farming practices, paving the way for future innovations in precision agriculture.

This project's success establishes a foundation for scaling **simulation-driven design** across other agricultural machinery. Upcoming efforts between Amazone and Altair will focus on the virtual design of entire machines, incorporating AI based reduced-order models and GPU acceleration to further enhance simulation capabilities and improve the global agricultural sector.

To learn more, please visit **altair.com/edem**