



Maximizing the Effectiveness of Bulk Materials Handling Equipment

A white paper from DEM Solutions



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SUMMARY

Put yourself in the place of the operator who first turns on the conveyors at a new mine. Are you confident about the ability of the transfer points to operate as specified, or do you start slowly and ramp up your throughput – unsure of whether the equipment will perform properly? What if the transfer point blocks on the first day you run the equipment? What if a chute or conveyor belt wears out within a few days or weeks? Your plant is already down because a critical component of the materials handling system has not been designed properly.

What happened? Did those engineering the transfer points and chutes verify that the equipment wouldn't plug when handling the actual ore or coal from your mine? Were they able to confirm for you, before the equipment was commissioned, that the delivery to receiving belts was properly aligned, or that the wear protection was located correctly?

Such questions and more can be answered using DEM simulation properly deployed to meet the challenges of designing materials handling systems that meet demands for maximizing the productivity of mine assets.

In this paper, DEM Solutions describes how its EDEM bulk materials handling simulation solutions give mining companies more reliable and robust materials handling equipment.



Figure 1

Bulk materials handling equipment failure.

THE COST OF POOR DESIGN

The current approach to designing bulk materials handling equipment is grounded in empirical design methods. In mine operations, materials handling equipment typically goes through its first test when it is put into operation in the field. EPCMs and equipment suppliers that use this approach have no means of predicting how well their design will perform under the range of material type and operating conditions expected during the life of the mine. They similarly have no quantitative way to decide on the location and extent of wear protection. As a result, mining companies are not able to gauge the sensitivity of equipment performance to operating conditions, resulting in vague estimates of limits on throughput and uncertainty over capacity to cope with changes in material characteristics.

Failure of a transfer point due to poor design usually entails substantial loss of production that, if it occurs at mine start up, can have major financial consequences in delays in delivery of product and in cost of redesign and replacement. Hedging against the impact of unplanned stoppage during the life of a mine requires maintenance of levels of buffer stocks to ensure continuous feed to process plant and to meet contracted loading and shipping schedules. Very often multiple conveying lines are installed to guarantee continuous production. Large stocks of expensive spare parts are often maintained in order to respond quickly to unscheduled downtime.

These are all additional costs that mining companies must endure because of the limitations of the traditional design methods.

SIMULATION

Delivering Better Designed Equipment

Simulation offers designers of bulk materials handling equipment the means to identify and eliminate problems with a design before it is commissioned. It provides mining companies with the assurance that the equipment will not only perform as required at start-up, but also that it will be able to handle any differences in flow behavior arising from changes in the properties of the material being mined over the lifetime of the mine. Simulation also enables information on equipment wear and responses to changes in throughput to be evaluated computationally, before the equipment is ever fabricated.

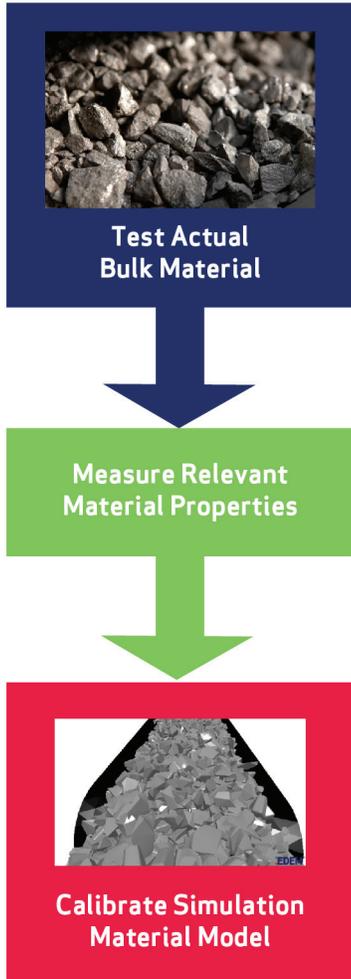


Figure 2

Proper material model calibration process for DEM simulation of bulk materials handling in mine operations.

This ability to evaluate equipment performance early in development cycles provides mining companies with a lower risk alternative to the traditional design methods. It allows mining companies to ask those engineering the equipment – before equipment is manufactured and installed – questions such as:

- What will happen if we increase the throughput by 20%?
- What happens if our material is wetter, drier, or a different grade?
- Is the wear protection sized and positioned to account for changes in operating conditions?

In order to use simulation to answer these questions, there must be confidence that the simulated material behavior will reflect the real material behavior.

To make this connection between the real bulk material and the model material in the simulation, the properties used to define the computational model representing the real material – the “material model” – must be determined from measurements of the bulk flow behavior of the actual material. Figure 2 shows the process of calibrating the material model using flow characteristics measured directly from the actual material to be handled by the equipment.

Correct calibration is key to ensuring that the DEM simulation will provide information of engineering quality. If calibration is not carried out correctly or, worse, is not carried out at all, then it is not possible to have confidence that such simulations will adequately represent the real material flow behavior. The contrast between the predicted flow behavior from a DEM simulation using a non-calibrated material model and a properly calibrated model is illustrated in Figure 3.

DEM Solutions provides a robust set of material testing, material model calibration, and simulation solution deployment services that are specifically designed for simulation of bulk materials handling equipment in mine operations. The simulation solution employs EDEM®, DEM Solutions’ bulk materials simulation software, to provide mining companies and companies engineering the equipment with a complete engineering solution that is systematically calibrated to deliver results that can be used with confidence in the equipment design process.

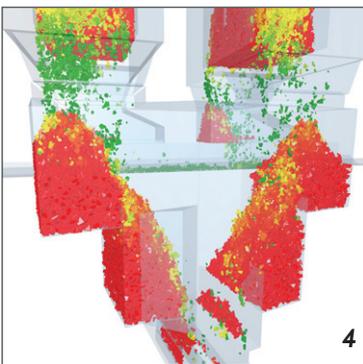
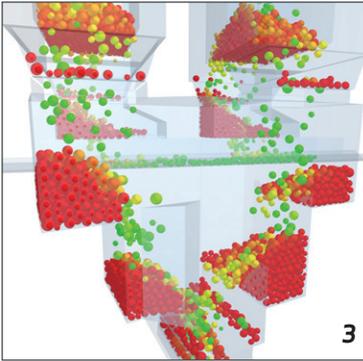


Figure 3-4

The simulation of bulk material flow through a transfer tower using a non-calibrated DEM material model (top image) indicates that the material will be transported through the tower without a problem. In this case the actual material is a copper ore at a high moisture content and is, in reality, quite cohesive. When the same simulation was performed using a material model that had been properly calibrated the simulation (bottom image) showed that in fact, a blockage would occur soon after the conveyor was put in to operation. Using the calibrated simulation, the equipment designers were able to identify that the design needed to be modified in order to prevent blockage occurring.

EDEM SOFTWARE AND SERVICES

A Complete Engineering Solution

The challenge for mine project managers and engineering design teams in deploying bulk materials simulation and integrating it into existing engineering workflows varies from project to project. The need may be to answer a specific question: will a particular transfer chute handle the target throughput for which it's been designed? Or it may be desirable to simulate all transfer points in a conveying line to ensure there no “surprises”.

Sensitivity analysis of the ability of each transfer point to cope with the range of material flow characteristics that are anticipated to be experienced during the life of the mine provides a means of reducing risk of malfunction in the future. Equipment designers employing EDEM simulation benefit from a much more robust design methodology when compared to reliance solely on traditional methods, ensuring a quality engineering delivery to their clients.

If simulation has not previously been used in design of your bulk materials handling equipment it may be challenging to integrate bulk materials simulation software and calibration services in to the equipment design process across your projects or your organization. Mining companies may or may not have their own engineers involved in equipment design. Engineering companies may or may not have their own in-house bulk materials experts available to work on particular projects at locations around the globe.

DEM Solutions is able to meet these differing needs by working closely with mining companies and their suppliers to understand their individual needs and find the right mix of software and services for their projects and engineering workflows. Sometimes this solution may be a DEM Solutions consulting project to help a company wishing to explore ‘what if’ scenarios without investing in the complete EDEM simulation solution; sometimes it may be provision of material model calibration services to existing EDEM users; or sometimes an engineering team may want to integrate the calibrated bulk materials simulation solution into their engineering design workflow for a particular team or project to leverage the benefits of deploying the solution throughout their company.

The full range of DEM Solutions services and software that is depicted by Figure 5 and that may be blended to meet individual needs includes:

EDEM SOFTWARE AND SERVICES:

A Complete Solution for Simulating Your Mine's Bulk Materials Handling Equipment

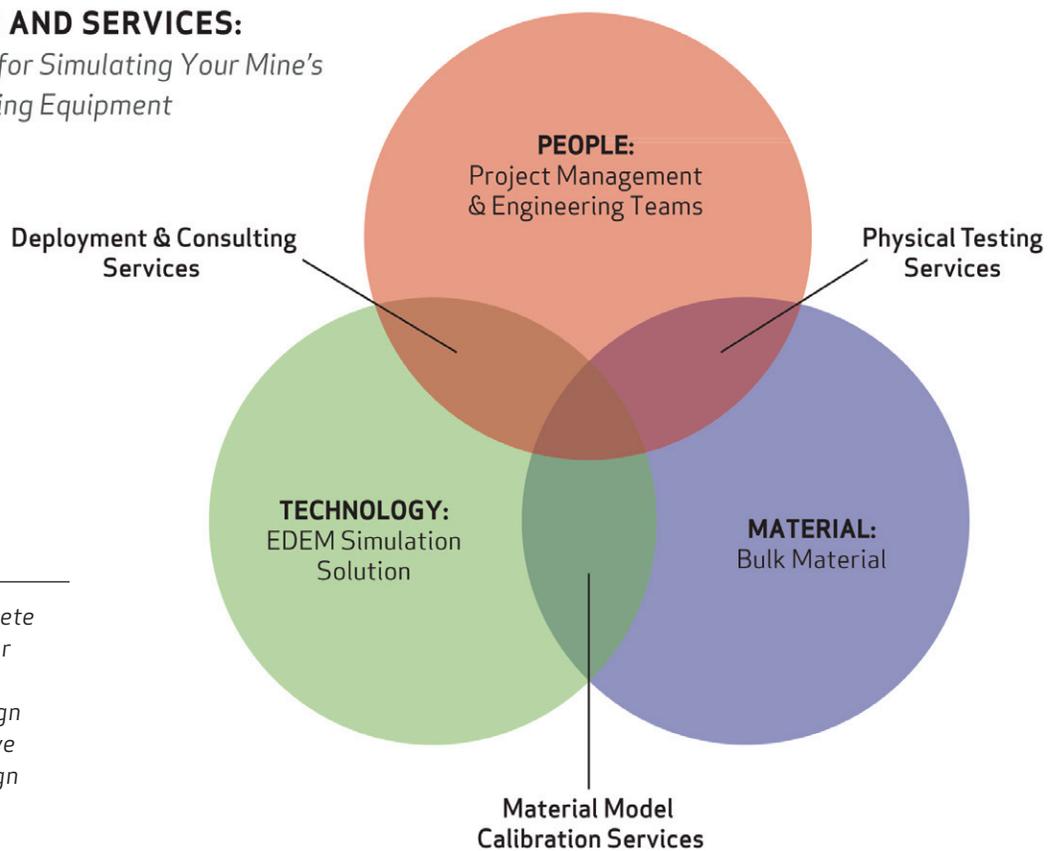


Figure 5

DEM Solutions' offers a complete engineering design solution for the mining industry, providing engineering services and design software together to help solve bulk handling equipment design challenges.

Physical Material Testing Services Material testing provides the basis for calibrating the material models used in EDEM simulations. These tests measure how actual mine site samples behave in dynamic flow conditions, to ensure that equipment designers have properly calibrated material models for use in EDEM simulations. These tests differ from the standard confined compression tests often carried out to provide design data for engineering of silos and hoppers and sometimes also used in the empirical and semi-empirical methods traditionally employed in the design of bulk material handling equipment. Such tests provide only static and quasi-static material data, and poorly represent the inherently dynamic nature of material flow through bulk materials handling equipment.

DEM Solutions works with mine owners to obtain samples of the material that the equipment is intended to handle, and manages the logistics of getting the tests carried out by partners who are experts in dynamic flow testing of ores and run-of-mine coals.

Material Model Calibration Services Fundamental to any bulk materials handling simulation is the need to describe the physical material in the form of a mathematical model. Through its Material Model Calibration Services, DEM Solutions uses sophisticated mathematical optimization techniques to define and calibrate the best EDEM Material Model for the particular material so that it accurately represents the behaviors observed in dynamic flow testing. This calibrated material model is then used to represent the real material in an EDEM simulation, containing all the material behavior parameters calibrated so that simulations can be executed with confidence. Customers can build a library of their materials, as calibrated EDEM material models, for use whenever a simulation is required.

Consulting Services Combining extensive bulk materials simulation know-how and experience helping clients with mining applications, DEM Solutions provides guidance on how to use calibrated material models with EDEM simulation software. We also provide training on use of the software for teams interested in integrating EDEM into their workflow. For projects that require full outsourcing, DEM Solutions can also provide full project execution and engineering support for the entire process, physical testing through simulation. If equipment design is required we also partner with bulk materials engineering specialists to provide engineering design advice based on simulation outcomes.

Solution Deployment Services DEM Solutions can help determine what mix of these services is right for the design challenges at hand. We assist with individual engineering team or enterprise-wide deployments of various combinations of these software and services offerings.

EDEM EDEM simulation software gives its users the power to evaluate equipment performance virtually. It has been optimized to simulate a variety of individual types of mined bulk materials – dry or wet, high and low cohesion materials – as those materials pass through bulk materials handling equipment. When combined with properly calibrated material models, the software allows equipment designers to virtually test the performance of a design.

They can identify and modify areas of equipment that are at risk of plugging, identify where flow is dispersed and change the design in order to concentrate flows and minimize dust production, check that material flow on to receiving conveyors is correctly aligned and delivered at the correct velocity relative to belt, or adjust the flow from conveyors feeding crushers and other comminution plant to ensure balanced

loading. The software also calculates the location and magnitude of loading on equipment surfaces. This provides the designer with the information needed when choosing the optimum location and type of wear protection required.

CONCLUSIONS

Using simulation in the design and evaluation of bulk materials handling equipment results in a more reliable and robust materials handling system. This has significant strategic benefit to mine owners by reducing the risk of unscheduled downtime and the associated costs of lost production and of holding valuable buffer stocks. Simulation also gives mining companies better understanding of equipment throughput limits, estimates of lifetime and likely performance under different operating conditions before making final purchase decisions.

When those tasked with the engineering of materials handling systems in mine operation, whether they are mining companies, EPCMs or OEMs, deploy DEM Solutions' bulk materials simulation software and services based on a systematic material model calibration approach, they can be confident that they are using a complete simulation solution developed specifically to meet their needs and to provide increased confidence that simulation-designed equipment will meet its performance requirements. In short, mine operators can make equipment and operational choices with confidence.



ABOUT DEM SOLUTIONS

DEM Solutions leads the market in DEM simulation, providing software, deployment and consulting services. Headquartered in Edinburgh, Scotland, our international sales and engineering staff support worldwide clients who use our simulation solutions to increase productivity, reduce operational costs, shorten product development cycles and drive product innovation. We uniquely offer DEM simulation technology supported by expert advice on deployment, in addition to full material model calibration and engineering simulation services. DEM Solutions has the product, the know-how and the vision to deliver the world's leading simulation solutions for bulk materials handling and processing.

For More Information

For more information, please visit www.dem-solutions.com/industries/mining.php

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