COMBINING SYSTEM MODELING & DATA TO OPTIMIZE HEAVY EQUIPMENT PERFORMANCE

Information silos present a major challenge to Heavy Equipment OEMs. Poor integration of simulation models across the product life cycle, limited reuse of models between programs, and a variation of modeling maturity across various engineering disciplines result in lack of traceability and ultimately hampers development efficiency and product performance. Using system modeling and asset-centric data analytics solutions help develop and orchestrate coherent models to increase decision-making confidence and speed.

Overview

System modeling offers a common framework of communication, enabling manufacturers to connect accurate product-level simulation with functional requirements and data from asset-based digital twins. System dynamics models can be used to find trade-offs among conflicting requirements, determine optimal system specifications, and serve as the Authoritative Source of Truth for virtual product development activity.

Data analytics can work in concert with system models, facilitating the creation of real-time dashboards and lifecycle visualization to help understand and optimize the mechatronic performance of entire systems.

Challenges of the Traditional Product Development Processes

1. Poor model integration creates inefficiencies

Between departments in a manufacturing organization, models, be they developed by data scientists, mechanical engineers, hydraulics engineers, electrical engineers, etc. are generally limited in scope. They support a specific type of analysis or selected aspects of system design but are not designed with the intention to be shared with other groups along the product lifecycle. Most often, models need to be recreated by individual groups, creating inefficiencies and redundancies in engineering effort.

2. Information silos stifle collaboration

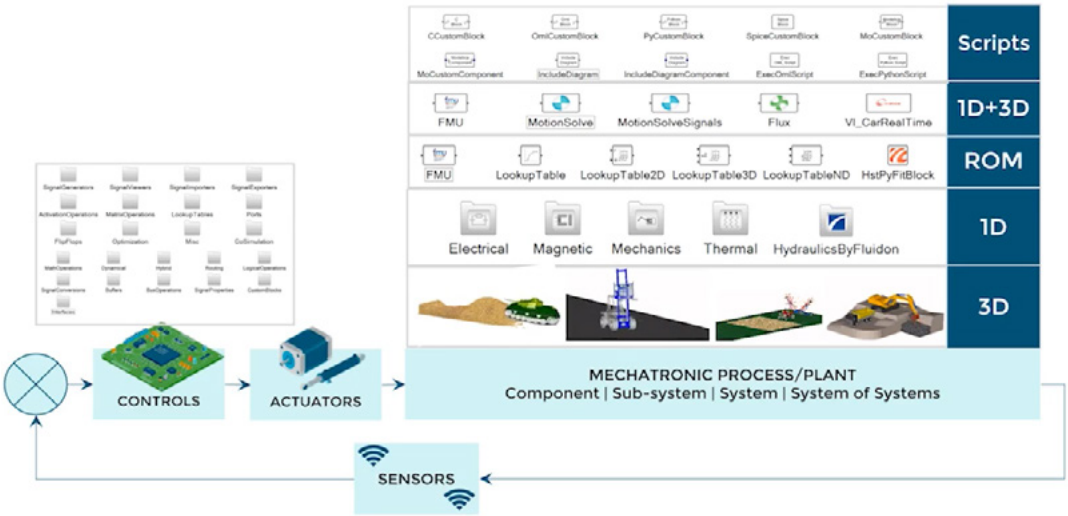
Information about these models and the simulation of their performance is typically shared in disparate presentations, spreadsheets, and informal communication, making the collection and synthesis of data for system-level understanding nearly impossible. Individual domain-specific models are created to support specific types of analysis or aspects of system design, but these models are not integrated into a coherent model of the overall system.

3. System integration comes to fruition only at the latter stages of development

Without system-level insights in the concept phase, designs are typically based on existing or competitive designs, often with an emphasis on physical over functional design. Unfortunately, this often results in technical issues being discovered in the latter stages of development. The cost for fixing design errors gets exponentially greater as you move out of the concept phase and into production, testing, and integration.

Bringing System-level Understanding to the Concept Design Stage

Altair has developed an open, flexible, purpose-driven solution to these development challenges. A common multidisciplinary engineering platform tightly coupled with real-time dashboarding and lifecycle visualization allows manufacturers to optimize both individual components, and critically, the overall system performance right from the concept design stage.



Multidisciplinary system simulation leveraging 0D, 1D, and 3D models in a unified environment

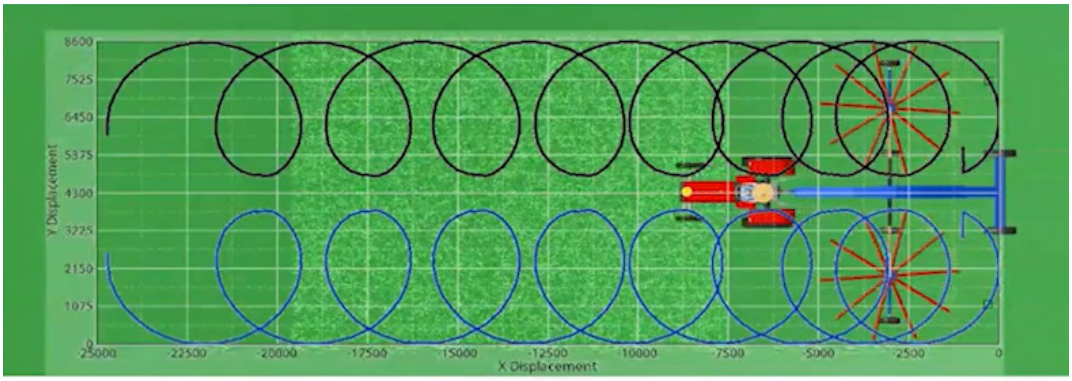
This system modeling platform allows companies to build multiple fidelity dynamic systems from scratch, incorporating equation-based models, block diagram-based models, 3D CAD, and 3D computer-aided engineering (CAE) models across multiple disciplines. If some of this information is already created, Altair can also bring in legacy data into this common framework. Within one common framework, the properties of mechanical, thermal, electrical, electromagnetic, hydraulic, and control systems can be modeled together to provide a holistic understanding of product behavior.

Increasing Consistency and Reliability

Multidisciplinary system modeling drives confidence that products will perform under a variety of real-world conditions. By considering multiple domains and their interactions with one another in an integrated environment, product designers can design products that will perform consistently and reliably over the typical long life cycles of heavy equipment.

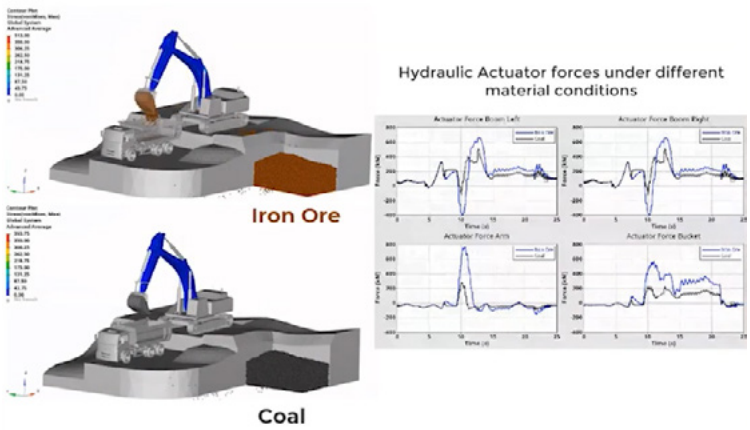
Optimize the entire product performance:

In this example, the gathering efficiency of a raking system can be assessed under various operating conditions, considering mechanical, electrical, electronics, and controls by combining how each these individual domains function as a whole.

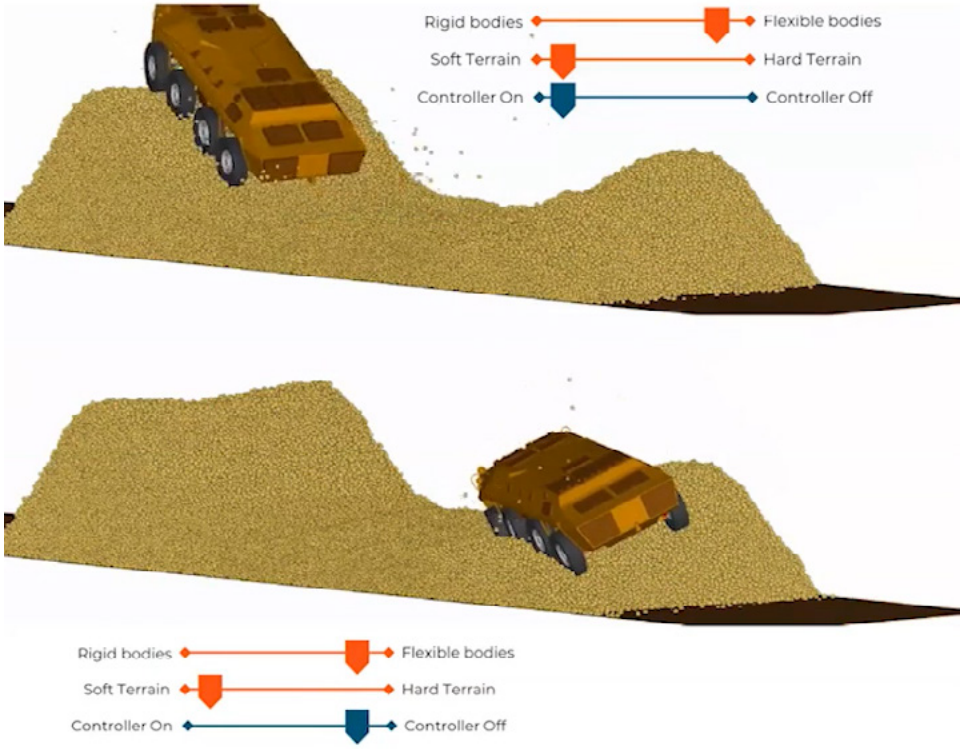


Accurate evaluate many different aspects of the equipment operation:
In this excavator simulation, performance for different maneuvers can be predicted for a variety of materials. The detailed hydraulic system model shows differences in actuator forces as it digs through iron ore vs. coal to show how the equipment might perform in these two scenarios. The hydraulic actuator output can then be used to quantify power requirements. Combining dynamics and discrete element modeling (DEM) can even be used to generate accurate loads for structural optimization and component durability assessment.

Accurate modeling of strength, durability, system motion, controls, and hydraulic performance combine to create more reliable equipment and drive design requirements.



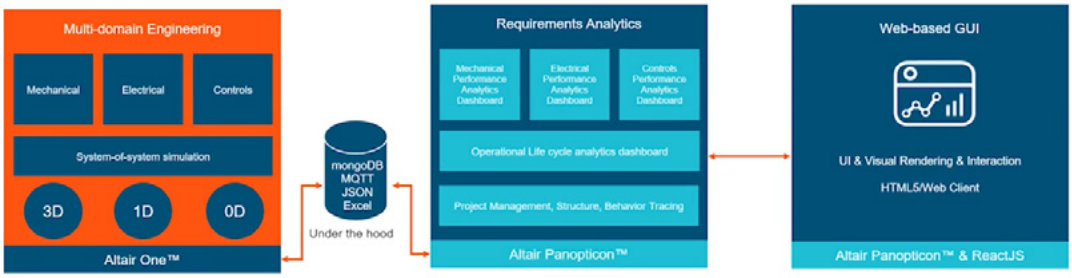
Understand bulk material behavior and its interactions with equipment:
The modeling of bulk materials is especially important to heavy equipment design and performance prediction. The dynamic stresses on equipment in motion can be dramatically affected by the material it is processing. The stability and mobility of vehicles can also be affected by the bulk material beneath it.



Creating a Collaborative Product Development Ecosystem

At various stages in the development process, engineers are faced with the fundamental questions of what they want to get out of a model, what fidelity is needed to accomplish this goal, and what criteria are used to measure success. Creating a digital thread using system modeling can help answer these questions through the development of 1D digital representations of product simulation, data analytics, and functional requirements.

Altair's open-architecture systems engineering tools help create this digital thread to connect product development processes from concept formulation through to product release. 1D digital representations can simultaneously support parts represented in multiple fidelities and be easily transferred, reviewed, modified, and optimized through collaboration with cross-functional teams, giving designers access to models at the fidelity needed for the particular analysis at every stage of the development process.



Connecting the dots between engineering, analytical verifiers, and visualization environment

A common engineering language can break down silos of information, helping to create seamless model interoperability and increase the speed of collaboration between groups to ultimately shorten time-to-market. Altair's data visualization tools use stream processing and visualization of real-time and time series data. This data can be used to create customized real-time dashboards to track KPIs and chart trends and anomalies. The data can also feed into Altair® Knowledge Studio®, which uses machine learning and artificial intelligence to enable data exploration and predicative analytics on the field data.

Ultimately companies don't just need better engineering data - they need ways to access the collective insights of the entire development process, synthesize mechatronic models, requirements analytics, and sensor data from the field, and use it all to drive business decision-making. Altair's integrated system modeling and data analytics solutions make it possible to increase organizational collaboration and get better performing equipment to market faster than ever before.

Want to learn more?
Watch the Webinar

Working with Altair

Large-scale projects require great precision and heavier loads in extreme environments. Altair's technology for simulation-driven design, data analytics, and HPC and Cloud computing support the development of reliable, innovative, and cost-effective products across all stages of the product lifecycle, from concept development to in-use operation. Simulation allows rapid investigation and analysis of product performance, factoring in fatigue and impact loads, and offering countermeasures for improvement. Data stream visualization and processing, along with asset-based digital twins allow heavy equipment manufacturers to gain visibility into the in-service life of a product, optimize its performance, perform predictive maintenance, and extend remaining useful life. Whether you're working on farmland, highways, or a construction site, we'll help you carry the load.

To learn more, visit altair.com/agriculture-construction