

How environmental interaction expands system simulation for construction site vehicles

SimulationX is a tool for simulating multi-physics models¹. This modeling approach enables complex systems to be simulated and system behavior thus to be analyzed using a single model. With interfaces and export options, SimulationX models can be integrated into simulation couplings or real-time simulations. In the context of construction machinery, the following application areas exist: SimulationX models are used for verifying and testing automation functions as well as investigating operational comfort (vibration analysis) and safety (driving dynamics, tipping safety). SimulationX models have to interact with the environment in order to cover as many automation and operating scenarios as possible.

Solutions:

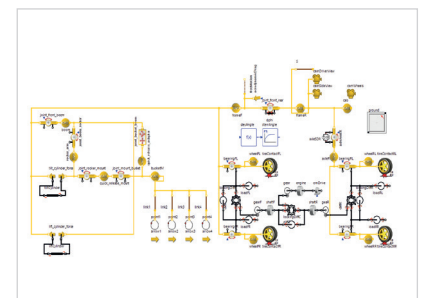
Bauen 4.0 makes the following simulation scenarios possible.

1. The user can now run construction machinery models directly in SimulationX on uneven ground and prepare the vehicle model's exposed points (bottom of the bucket, outriggers) so that they transfer forces and moments to the vehicle when they come into contact with the ground.
2. A new tire model for uneven ground is available in SimulationX, which enables real-time simulations. With the flexibly adjustable, parametric model, many applications can be covered, including stationary and dynamic behavior, turn slip, behavior at low speeds and parking maneuvers.
3. Using new and expanded interfaces (DDS², FMI³), SimulationX models can be coupled with 3D tools – specifically with the sensor simulation tool ESI PROSIVIC⁴ and the real-time development environment Unity⁵. These 3D tools enable the creation of realistic surfaces and detailed environments. Using DDS coupling, the necessary data for visualizing the vehicle motion can be transferred from SimulationX to the 3D tool. In addition, the contact between the construction machine and the ground can be detected in the 3D tool and processed in the SimulationX tire model. Signals that are generated in the 3D environment using virtual sensors can be transmitted unfiltered or processed to SimulationX. PROSIVIC provides virtual sensors such as LIDAR, radar or cameras for this purpose.

The project partner ESI ITI GmbH developed the prototypes for these new interaction modules. The coupling of SimulationX with the Unity software results from a cooperation with the TU Dresden, Endowed Chair of Construction Machinery.



Simulation of a wheel loader: Visualization of the forces on wheels and bucket in SimulationX



Structure view of the model in SimulationX



Visualization in the Unity environment

¹ <https://www.esi-group.com/products/system-simulation> · ² Data Distribution Service <https://www.omg.org/spec/DDS/>
³ Functional Mock-Up Interface <https://fmi-standard.org/> · ⁴ <https://www.esi-group.com/products/virtual-systems-controls>
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