

Application of Machine Learning Damper Models on Full Vehicle Simulation

Murilo Junqueira

Lead Engineer, Chassis Development / Dynamics

Suspension BU

Hitachi Astemo Americas, Inc

September 20th, 2023

Hitachi Automotive Systems

KEIHIN

SHOWA

NISSIN

are integrated to be

Hitachi Astemo

Powertrain Systems

Chassis Systems

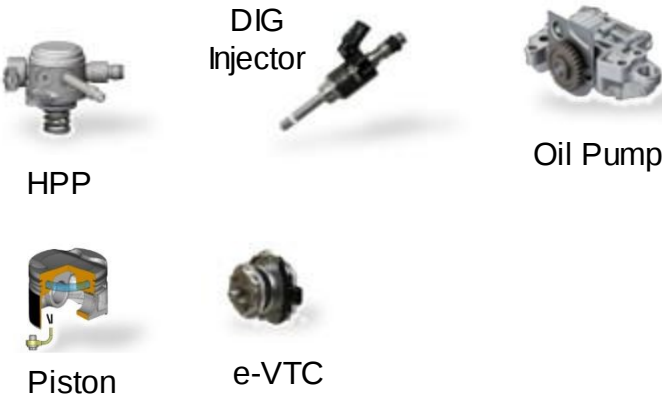
Motorcycle Systems

Autonomous Driving/Advanced Driver Assistance Systems

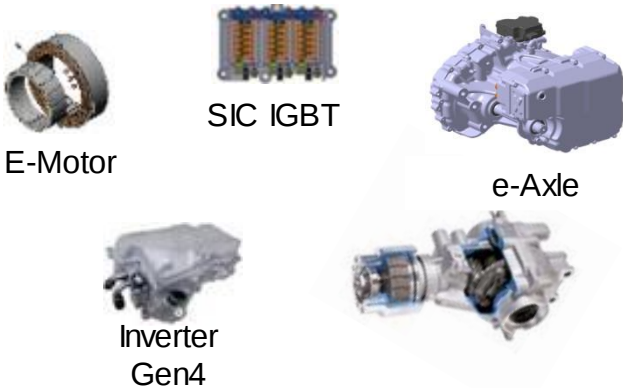
Astemo

Advanced
Sustainable
Technologies
for Mobility

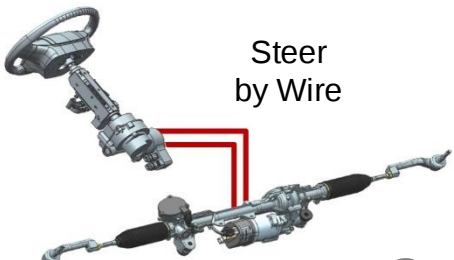
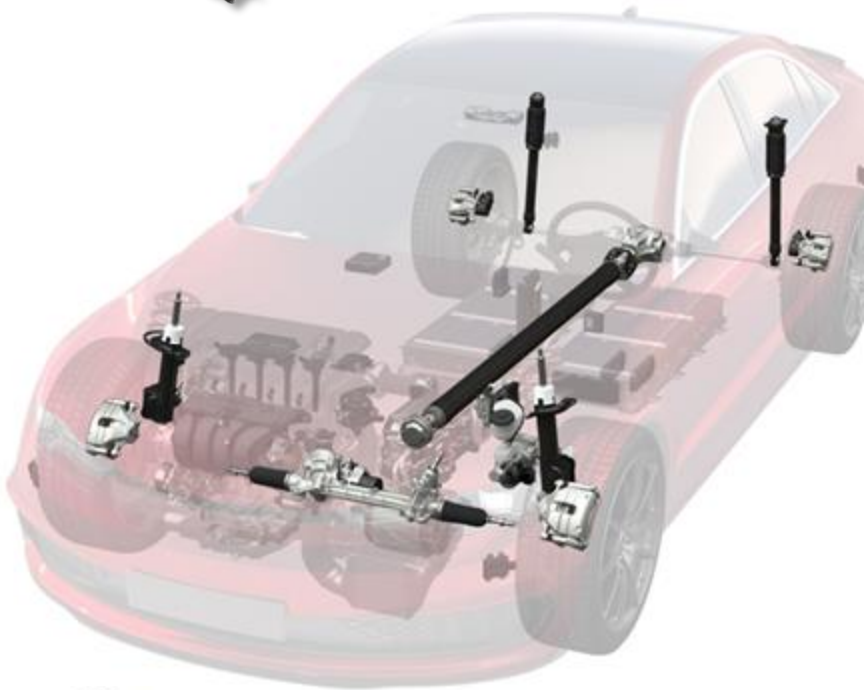
Internal Combustion Engine



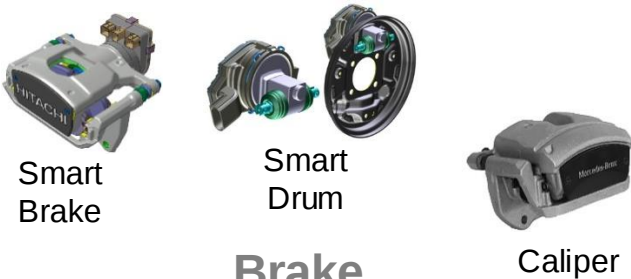
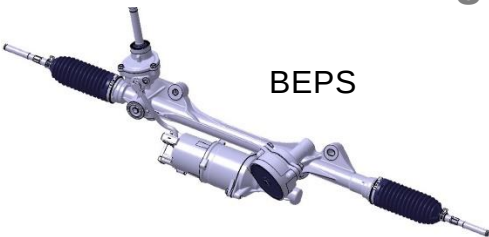
Electric Engine



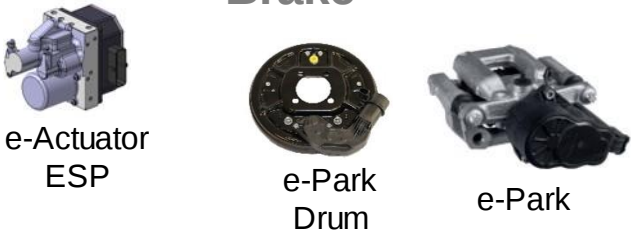
Suspension



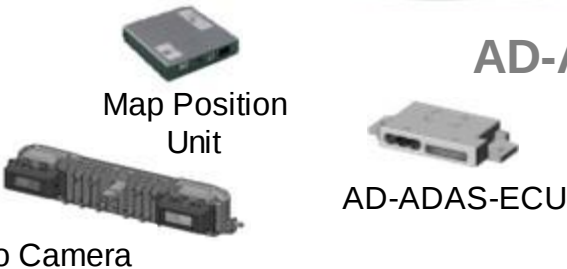
Steering



Brake

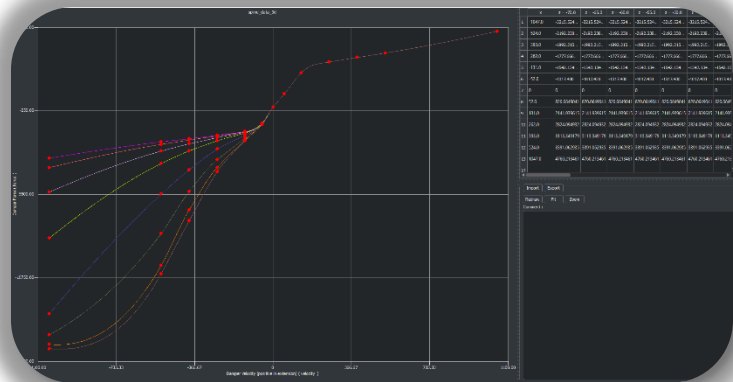


AD-ADAS

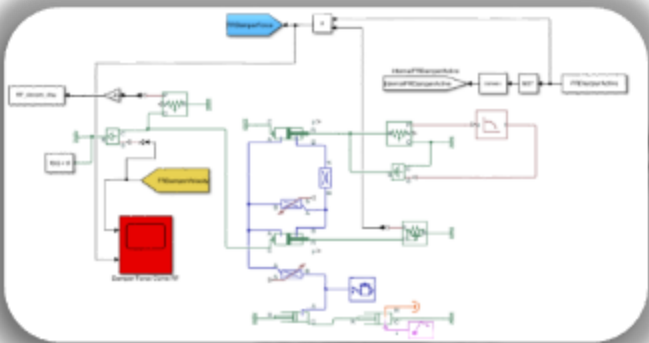


- Application of neural network damper models on full vehicle co-simulations;
- Comparison with 1D fluid models and tabular models;
- Path for Virtual Tuning

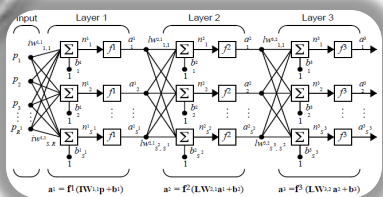
- With increasing usage of simulations and driving simulators, CAE teams are pursuing ways to improve representativeness of components.



Complex
Tabular data

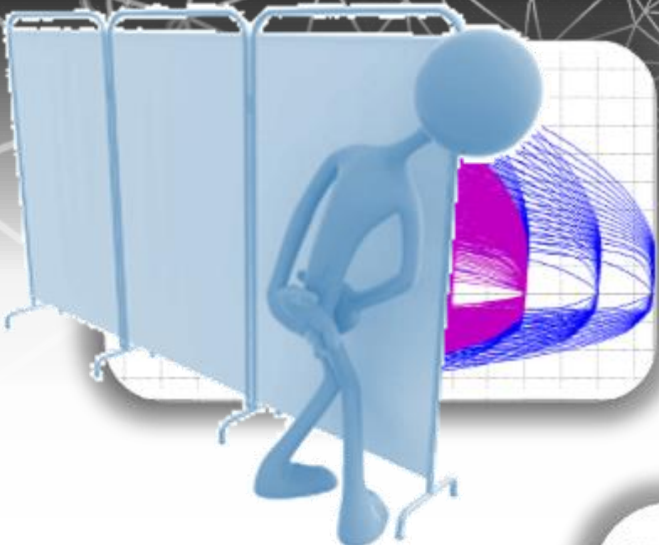


1D model

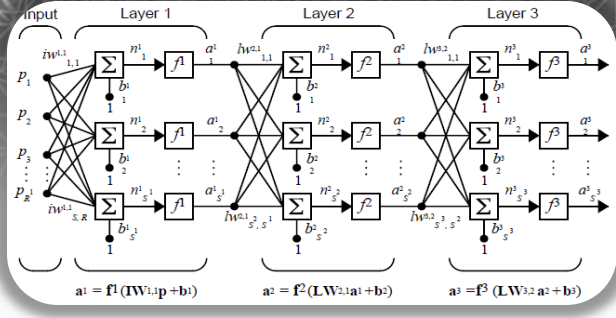


NN model

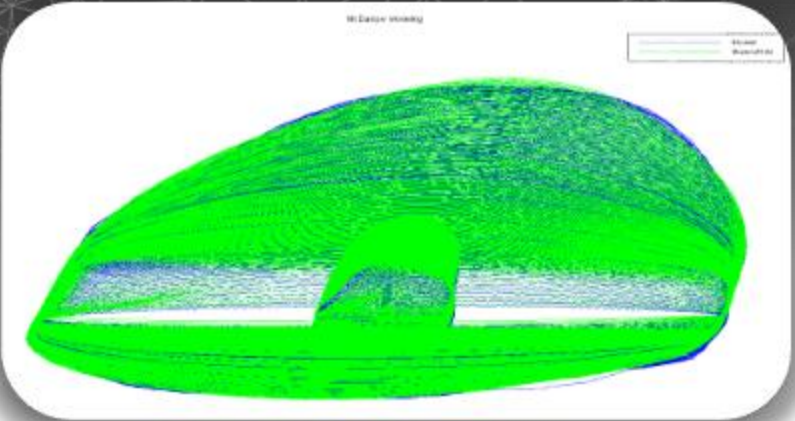
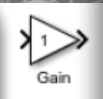




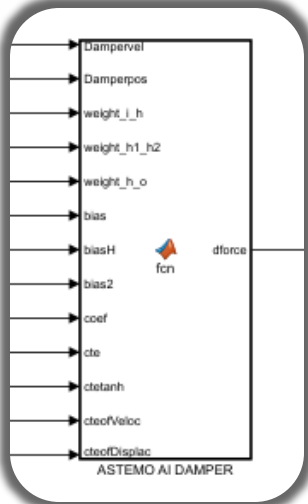
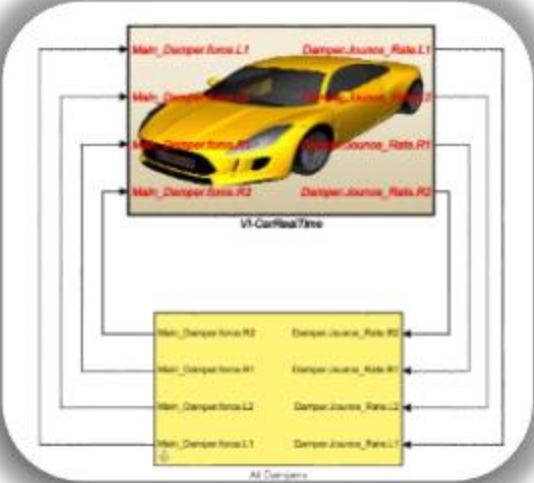
Test Data



Deep Learning Model

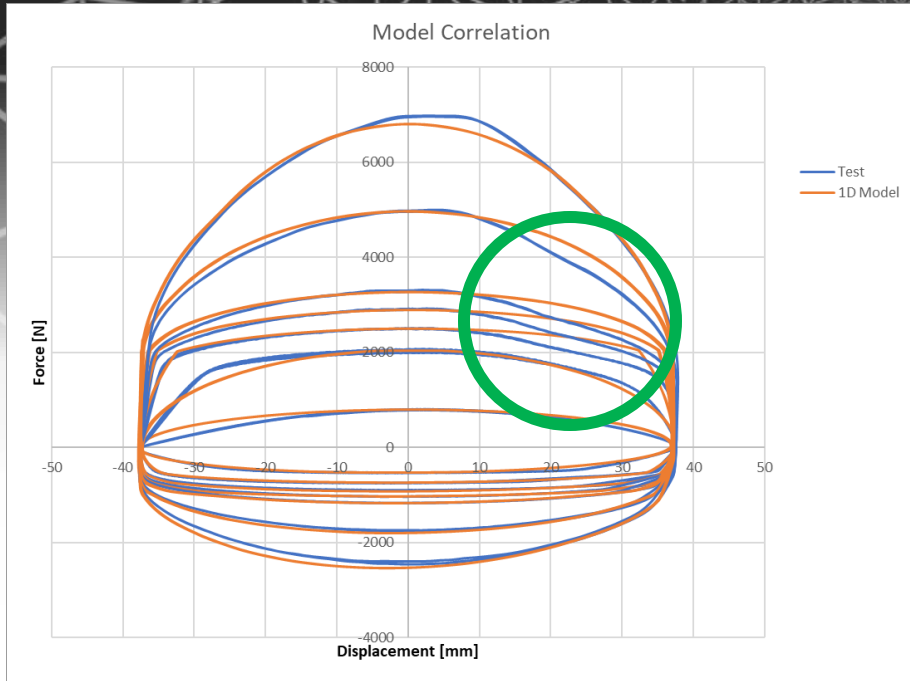


Damper Force Check

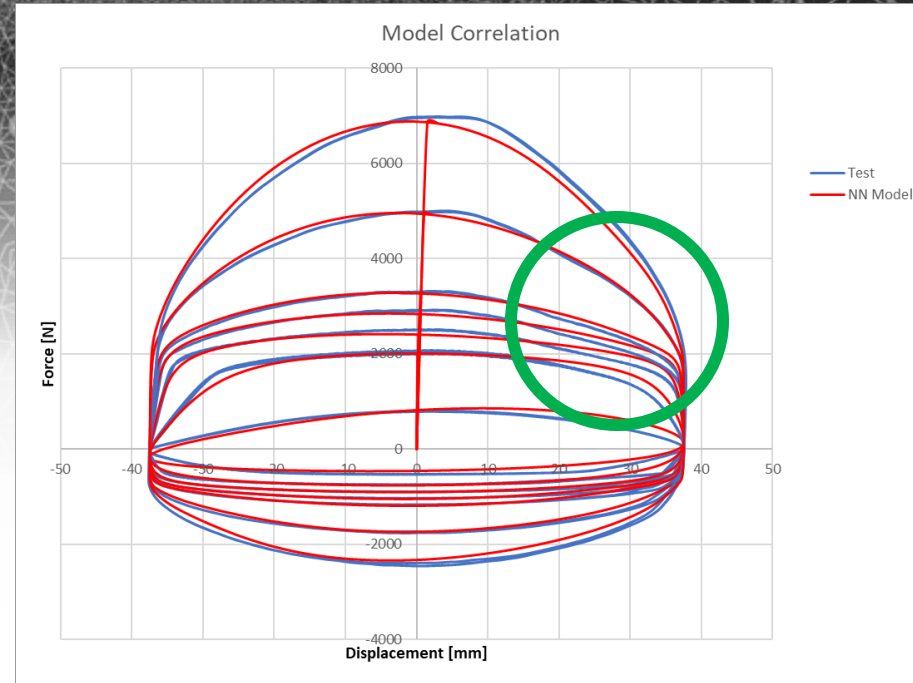


Damper Model

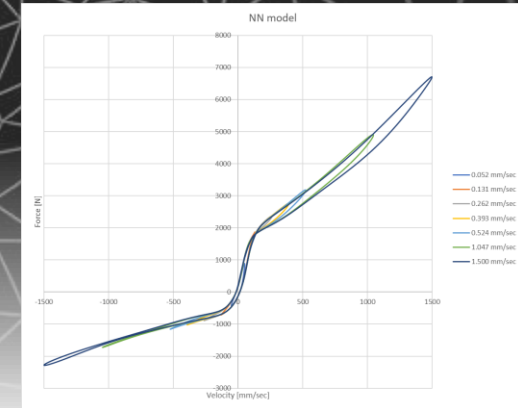
Model Correlation



1D model



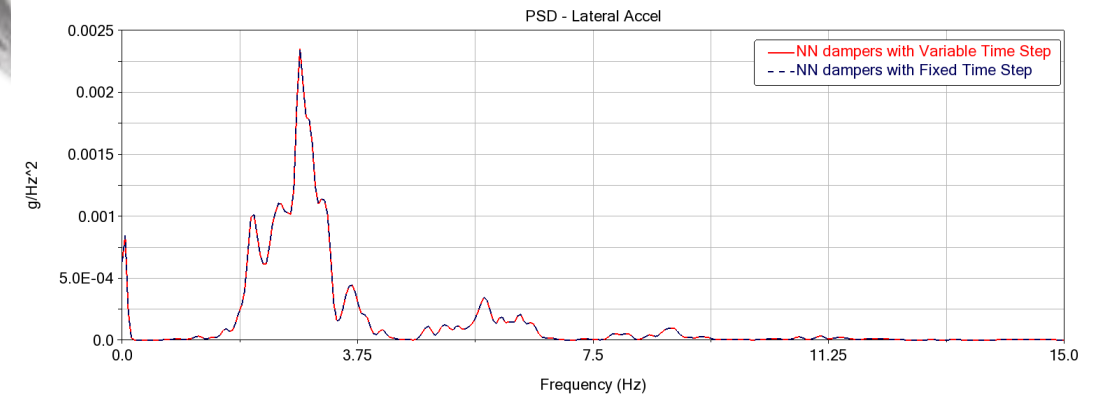
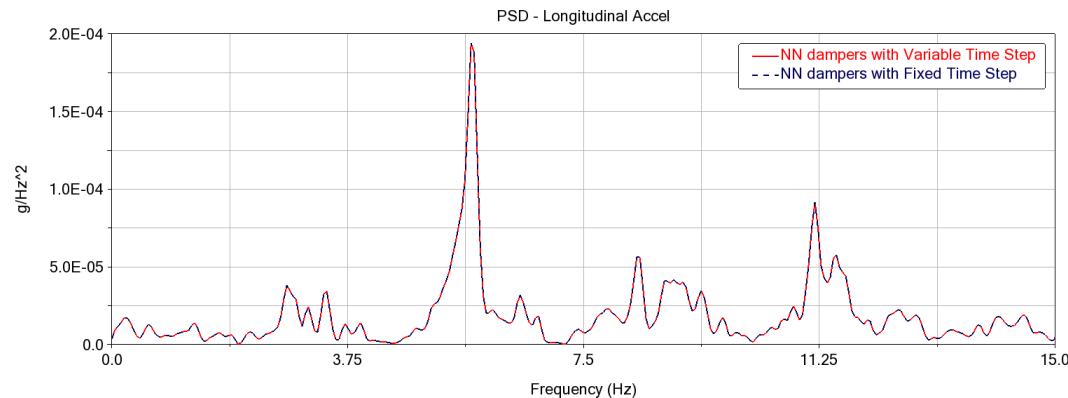
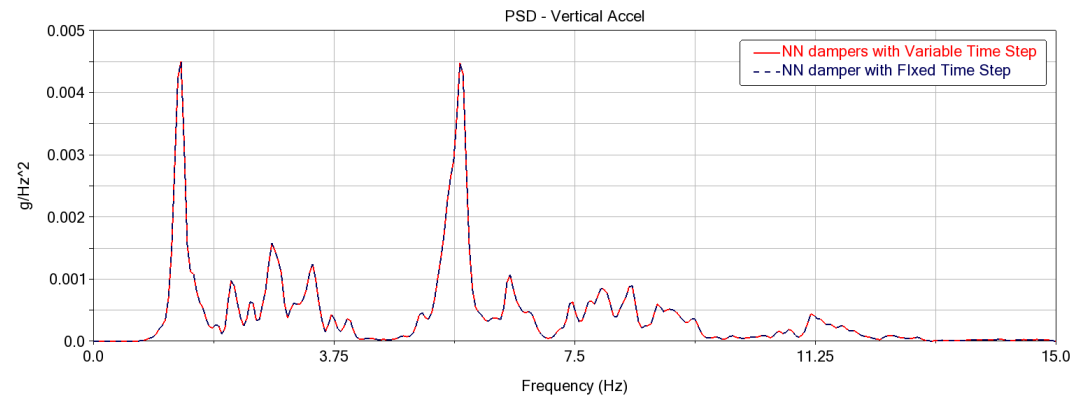
NN model



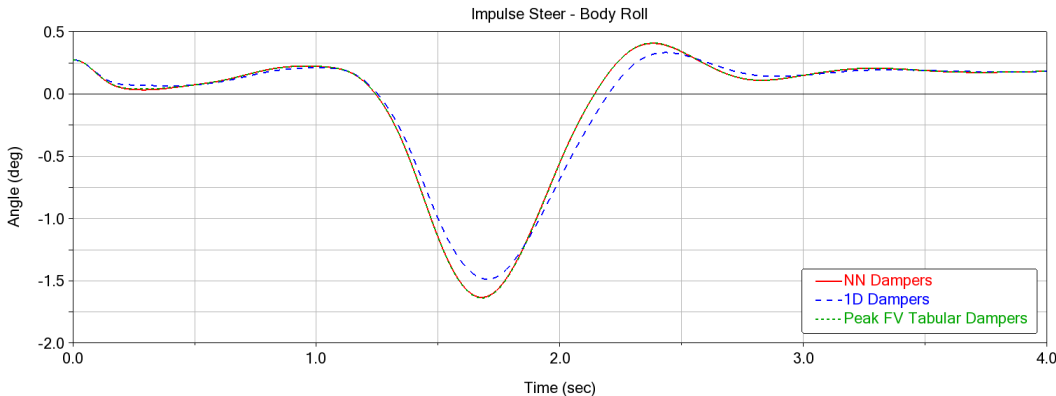
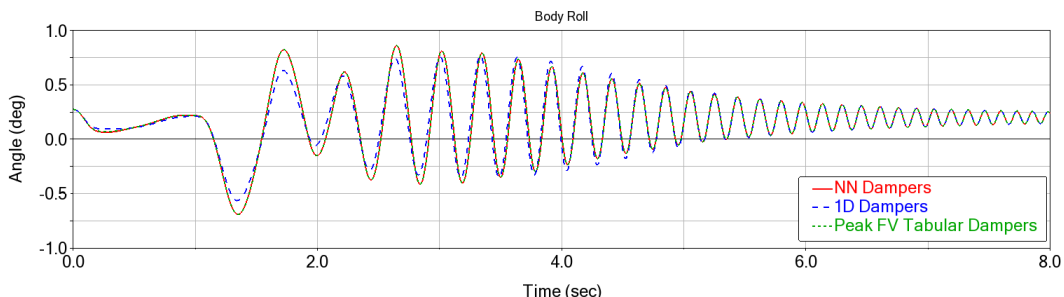
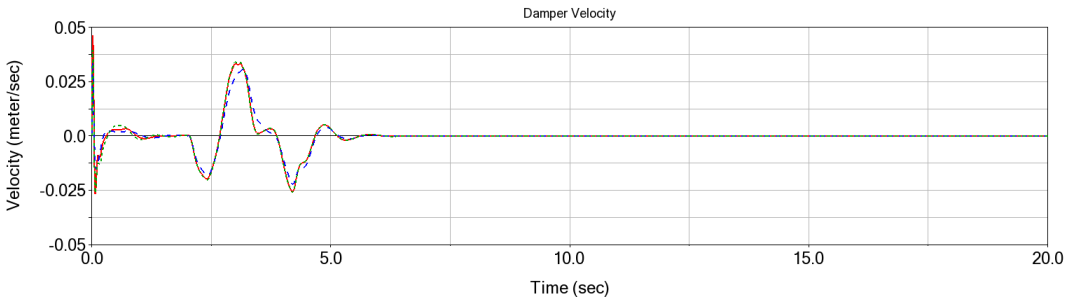
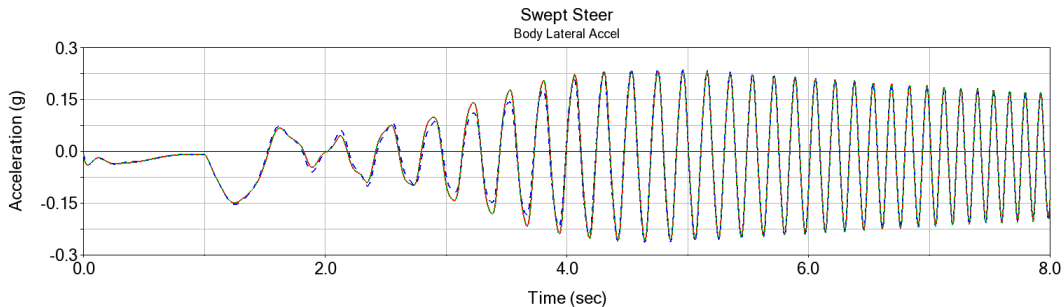
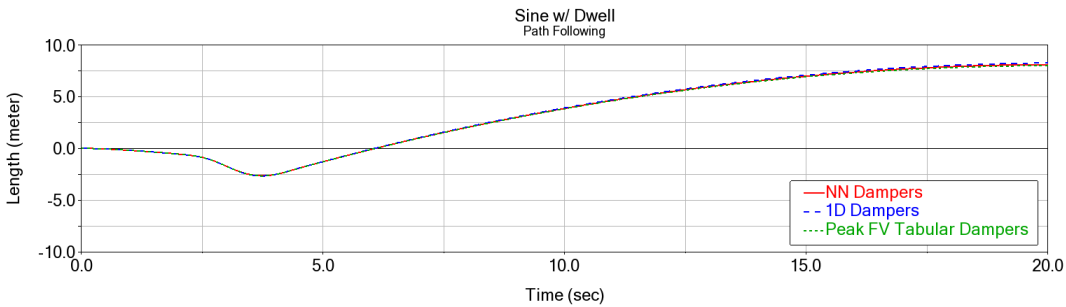
- The NN model can better capture the unusual behavior of a damper, including hysteresis.

Model Comparison – Time-step Check

- For better usage of simulators and to keep real-time experience, models must keep performance when running at fixed time-step:

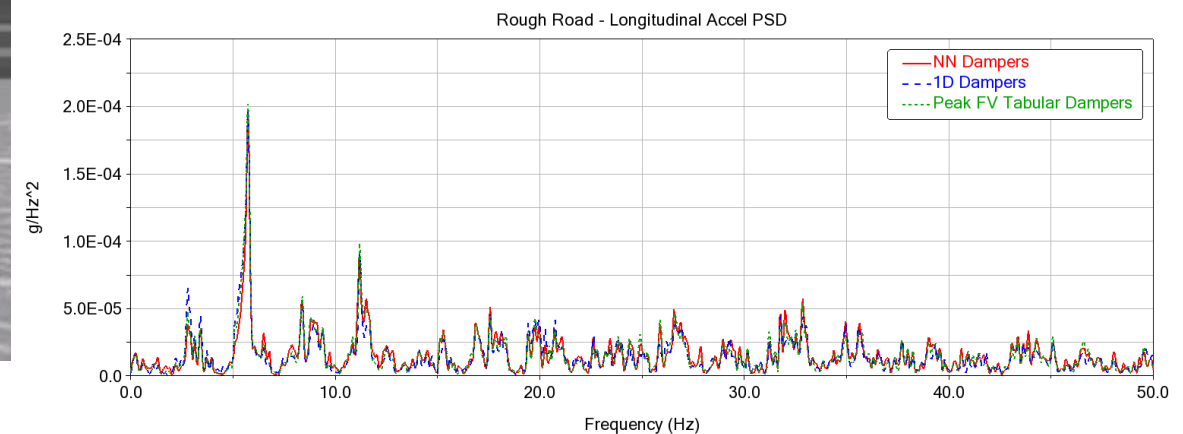
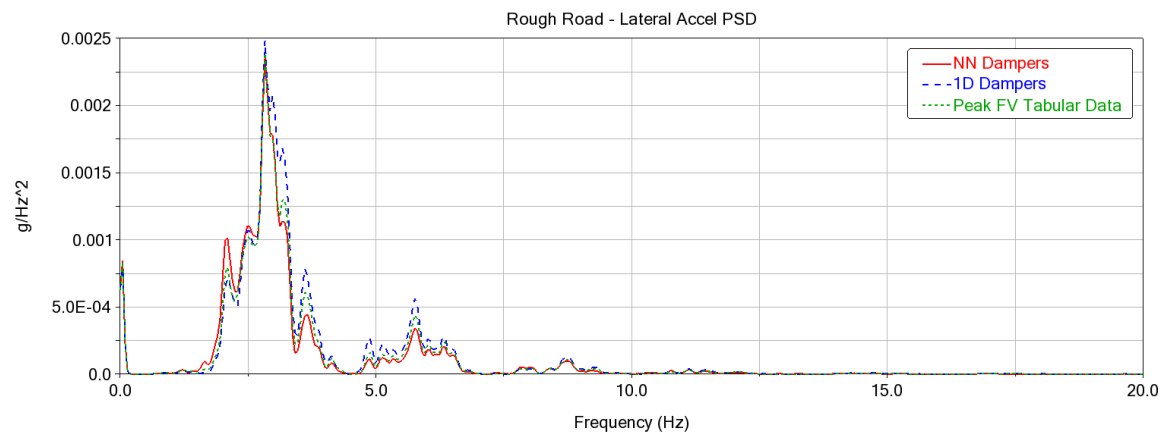
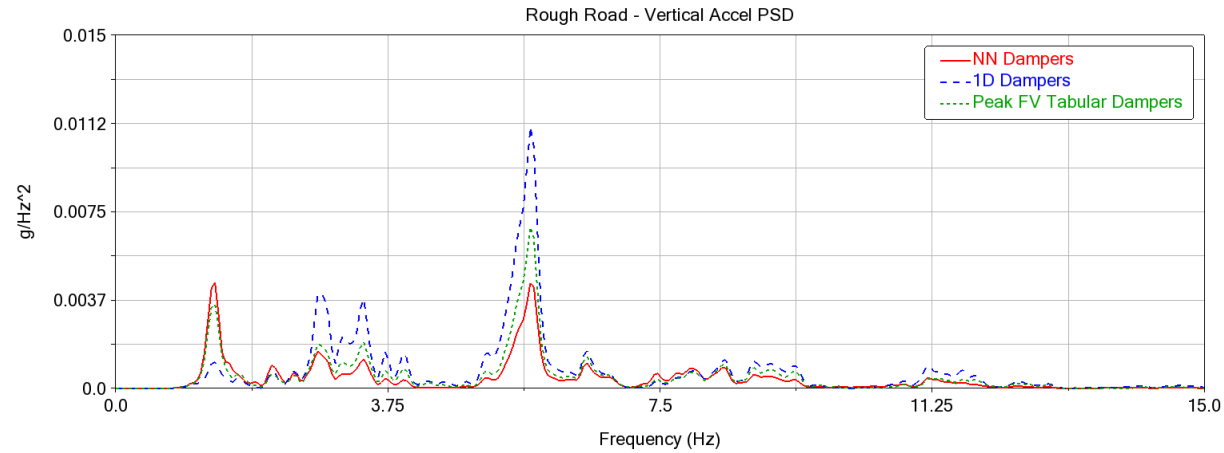


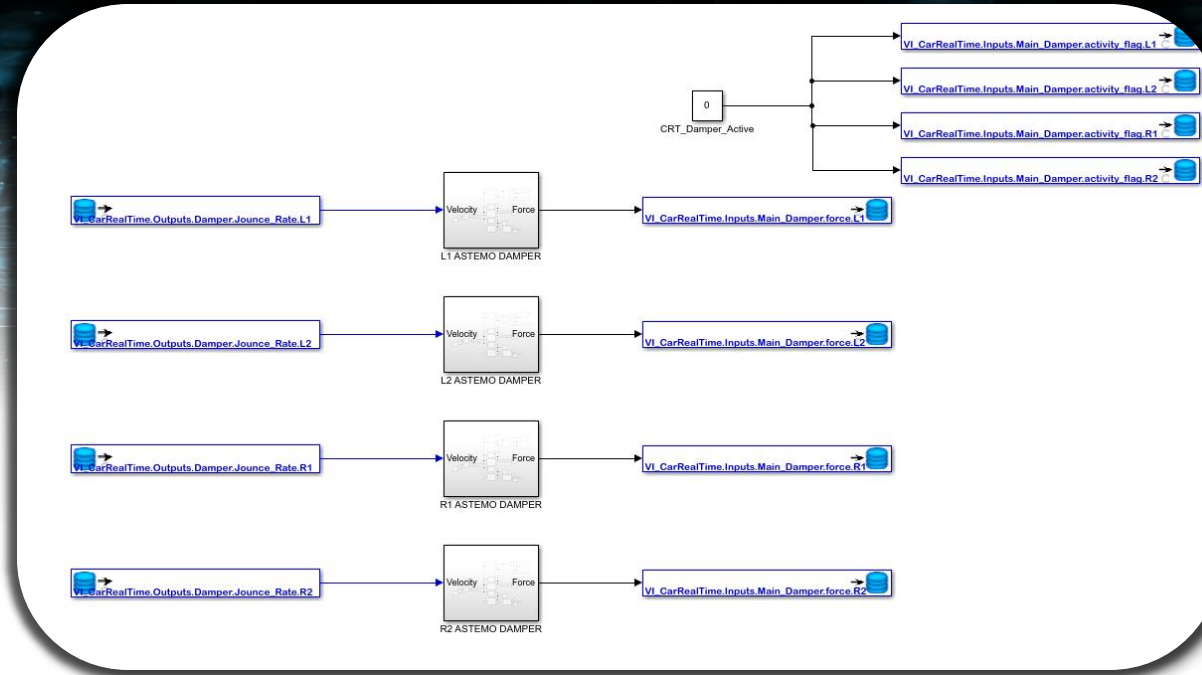
Model Comparison – Steering / Handling Events



Model Comparison – Ride Event

- The damper models showed significant differences





- Deep learning damper model shows benefits for real-time simulations;
- Hitachi Astemo is constantly looking for new technologies and opportunities to better align with the partners needs and with the virtual path.



- Enhanced Hybrid models – Combine with NN model to capture uncertainties
- Virtual Tuning Process – Add machine learning damper models to virtual tuning process improving the ride evaluations during early phases of new programs.

HITACHI
Inspire the Next 