Marcus Schittenhelm, Roland Zander
INTEC GmbH

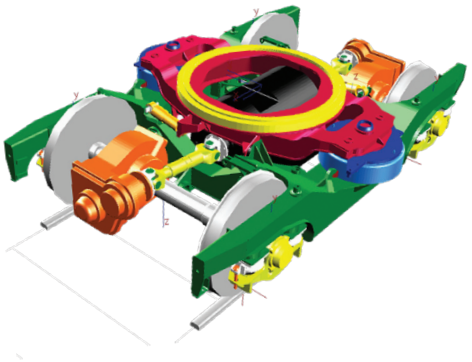


Fig. 1: Typical 3D cardan joint/shaft application example (driven railway bogie [Metro de Madrid/CITEF])

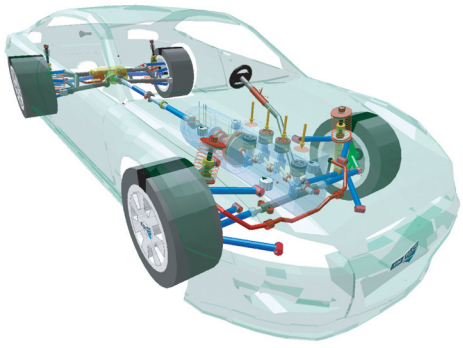
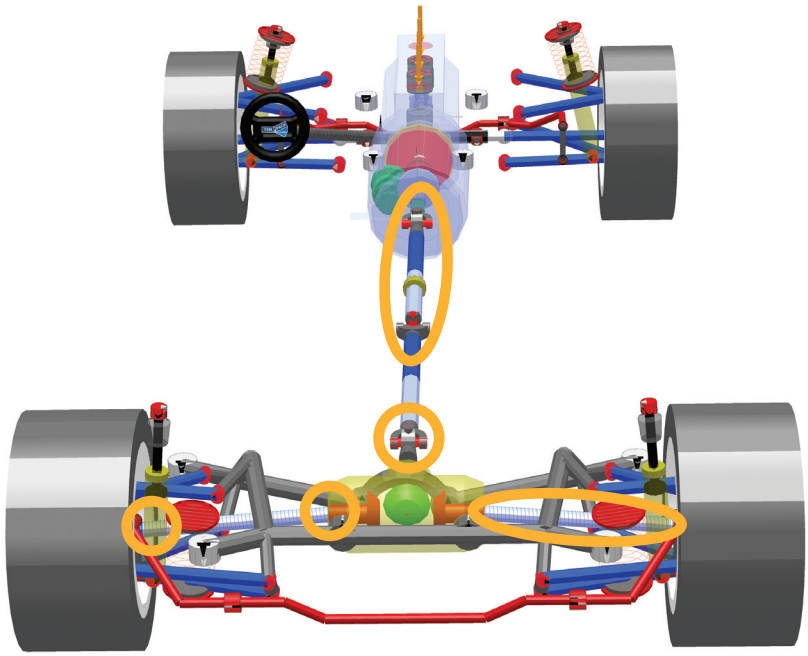


Fig. 2: Typical 3D constant velocity joint/shaft application example



New Driveline Force Elements

SIMPACK Version 8.902 introduces six new SIMPACK Driveline Force Elements:
Cardan Joint force element 53 (FE 053), Constant Velocity Joint (FE 054), Cardan Shaft (FE 058) and Constant Velocity Shaft (FE 059). All of these elements have been added in order to optimise calculation speed and result accuracy in detailed 3D coupled drive shaft simulation scenarios and are described here.
Two other new force elements, the differential gearbox (FE 056) and the planetary gear (FE 057), will also be available with version 8.902.
Until recently, drive shaft models with 3D coupling effects usually had to be built up using SIMPACK kinematic cardan or constant velocity joints/constraints in combination with SIMPACK standard rotational/translational force elements. Depending on the chosen topology, this type of modelling resulted in constantly changing joint state values when using 3D rotating drive shafts. Apart from many joint states, this modelling might cause poor integration performance due the required number of Jacobian evaluations and limitations in the maximally suitable integration step size.
The following new Driveline elements have been developed to avoid these effects and to increase the available level of modelling detail:

CARDAN JOINT (FE 053):
3D elastic single point coupling between two shafts. Cardan joint kinematic effects including torsional and translational stiffness of the cardan joint are considered.
→ Combination of necessary cardan joint kinematics and elasticity within one single element.

CARDAN SHAFT (FE 058):
3D elastic spatial coupling between two shafts. Kinematic effects of two cardan joints including torsional nonlinear stiffness and friction effects during length compensation are considered.
→ Equivalent massless modelling of a whole cardan shaft assembly.

CONSTANT VELOCITY JOINT (FE 054):
3D elastic single point coupling between two shafts. Constant velocity joint kinematic effects including torsional and translational stiffness of the constant velocity joint are considered.
→ Combination of necessary constant velocity joint kinematics and nonlinear elasticity within one single element.

CONSTANT VELOCITY SHAFT (FE 059):
3D elastic spatial coupling between two shafts. Kinematic effects of two constant velocity joints including torsional nonlinear stiffness and friction effects during length compensation.
→ Equivalent massless modelling of a whole constant velocity shaft assembly.