New Features of PC Crash 10.0

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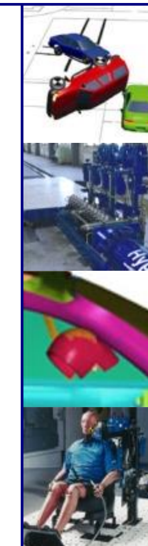
PC-Crash 10.0

- 3D Window
  - Additional increments for slow motion mode (3D onscreen and animation)
- General
  - Mouse wheel zoom retains position in 2D window (Google Maps Mode)
- Crash3 Calculation
  - Direct import of deformation line from vehicle DXF drawing
- Database
  - Updated databases
  - Import of drive mode from DSD database
- Diagrams
  - Filter selection (CFC filters) for smoothing curves for time dependent graphs



PC-Crash 10.0

- Extended drawing module:
  - Import and processing of blocks
  - Support for complex DXF formats (blocks, paperspace, etc.)
  - Default line types can be exported and imported
  - Traffic light object
    - 3D visualization
    - New definition of the light sequence (1 global sequence table for all traffic lights)
    - Pedestrian traffic light
    - Variable number of signals
    - Overlay of turn arrows and pedestrian symbols
    - Extended snap functions
    - Triangulation measurement grid

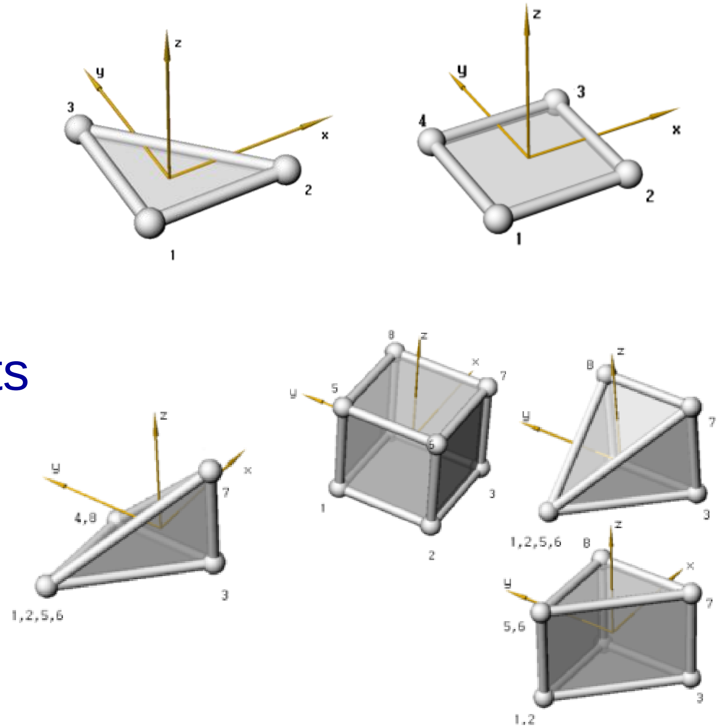
PC-Crash 10.0

- FE calculation module
  - Calculation of Shells, Solids, Rods with constraints and boundary conditions and different load conditions, contact handling and usage of different materials (elastic, elastoplastic, thermoelastoplastic)
  - Import of Gmsh meshes
  - Multiprocessor support
  - Batch processing is possible
  - Color coded visualization of displacements, stresses and strains
  - Support of color coded parts for grouping elements
- 2D animation
  - Values window overlay
  - Selection of different compression options

PC-Crash 10.0

- Laser scan data
  - 3D laser scanner data can be loaded and displayed in xyz or xyzrgb (colored) format
- Multibody simulation
  - Double sided contact can be set for all bodies
  - Multibody systems can be loaded as vehicle surface
  - Additional joint types (ball, hinge, slider, universal, piston, etc.) with joint limits
- ReconData
  - Access to vehicle images with scale via the Internet

FE Calculation



- Elements:
  - Shells:
    - Shell_C0_3, Shell_BT_4
    - Integrated contact elements
  - Solids:
    - Solid_Iso_6, Solid_Iso_4
  - Rods:
    - Rod_2
    - Integrated contact elements
  - Spring/Dampers:
    - Beam_Spring_2: translational and rotational

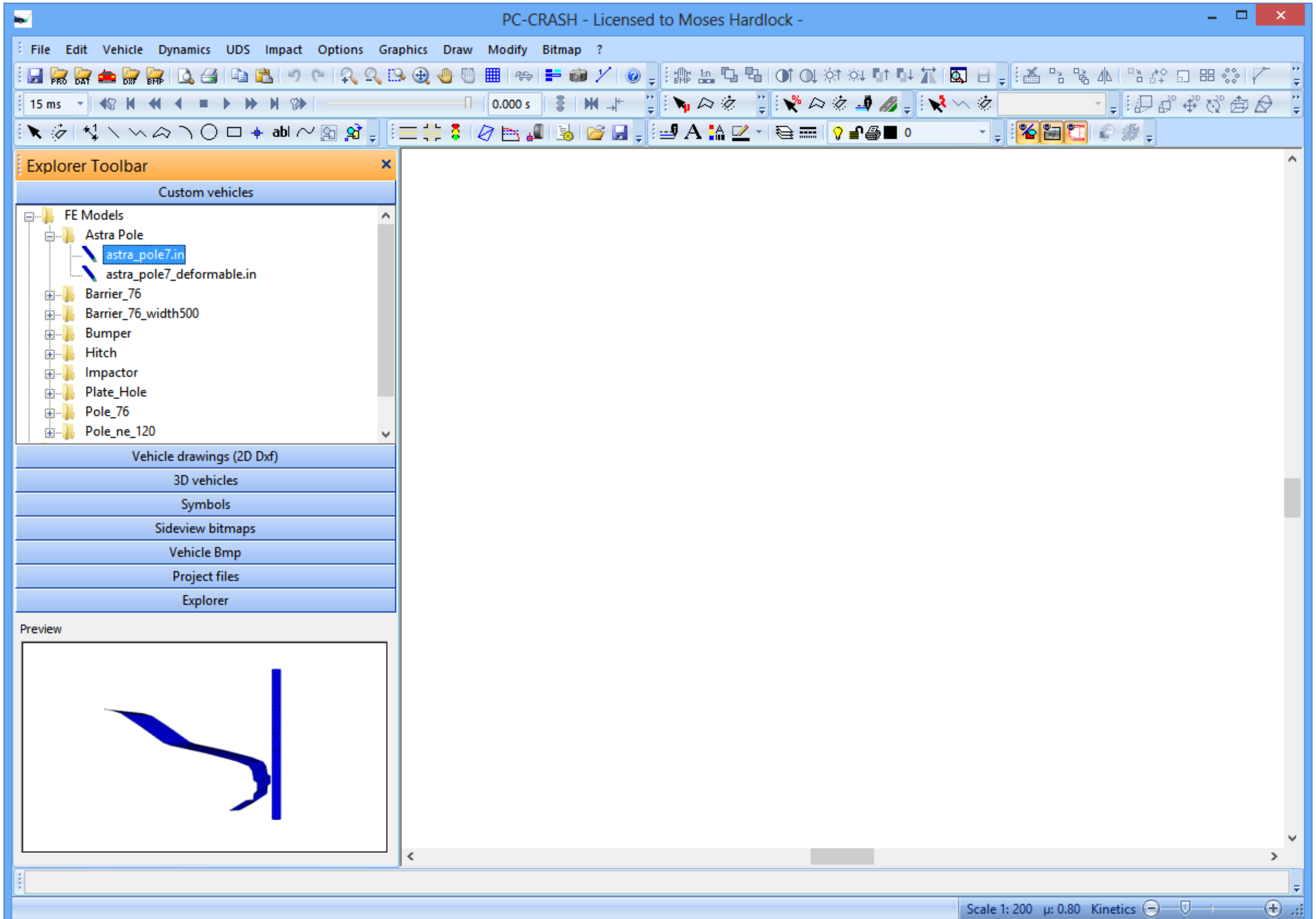
FE Calculation

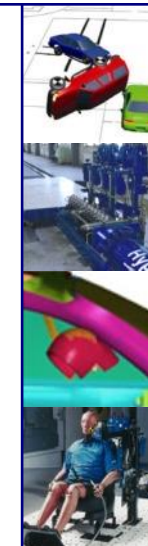
- Nodes:
  - Define geometry
  - Mass, moment of inertia
  - Constraints
  - Loads
- Constraints)
  - Boundary Condition:
  - RigidBody Constraint:
- Loads:
  - Force, moment, acceleration, angular acceleration, pressure

FE Calculation

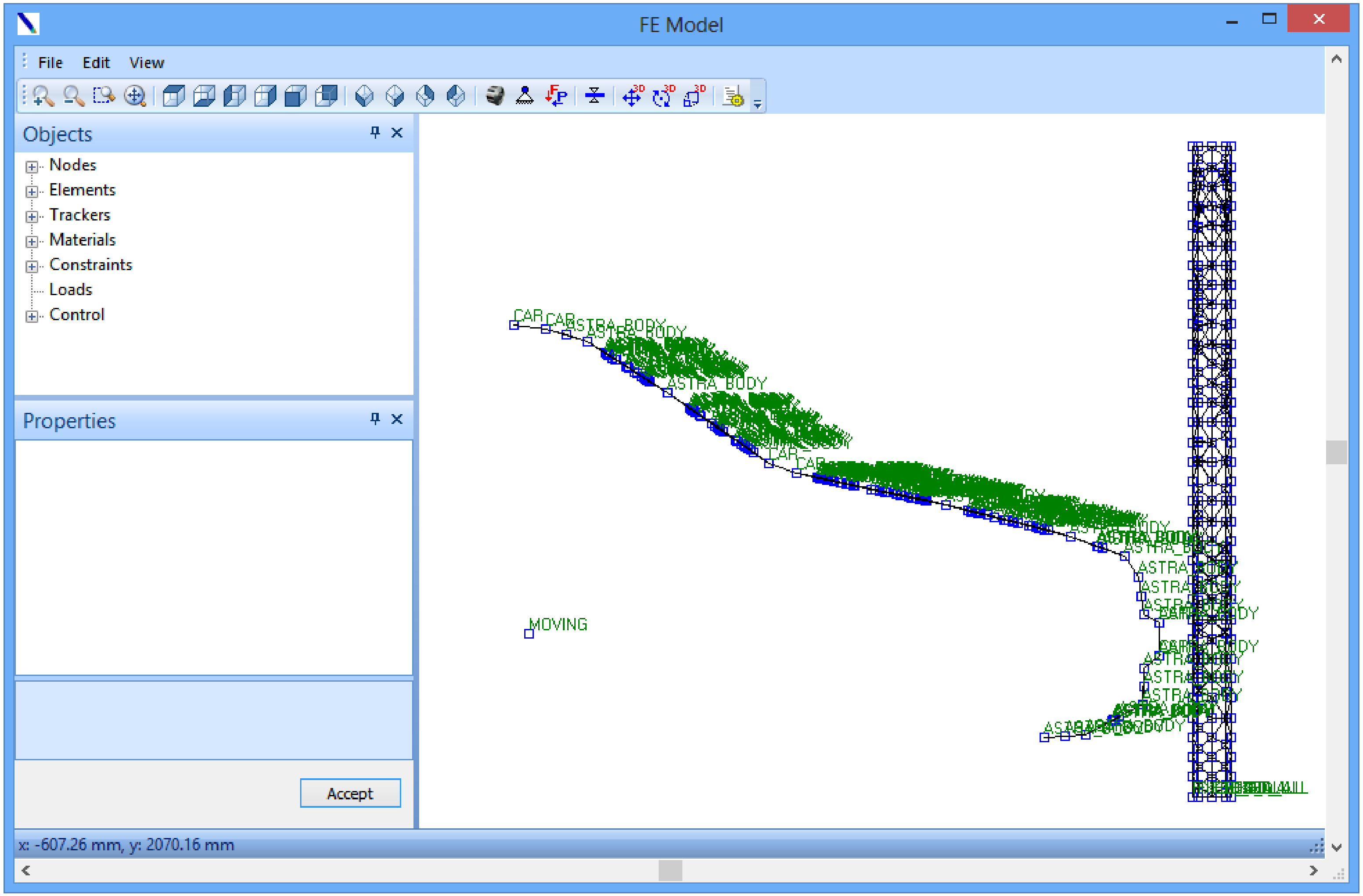
- Material models (Isotropic):
  - Elastic:
    - E: Young‘s modulus
    - ρ: density
    - ν: Poisson ratio
    - Failure_stress, Failure_strain
  - Elastoplastic:
    - Yield stress, strain hardening
    - Stress/strain curve
    - Strain rate
  - Thermoelastoplastic
    - α, T

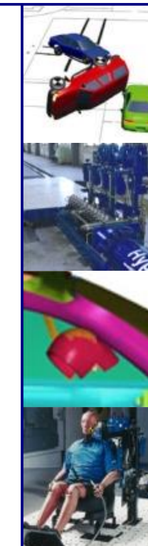
FE Calculation

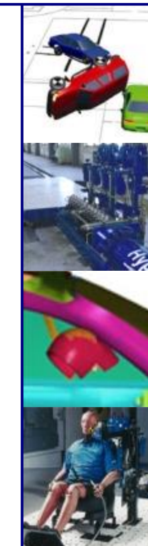




FE Calculation







FE Calculation

Add FE Objects

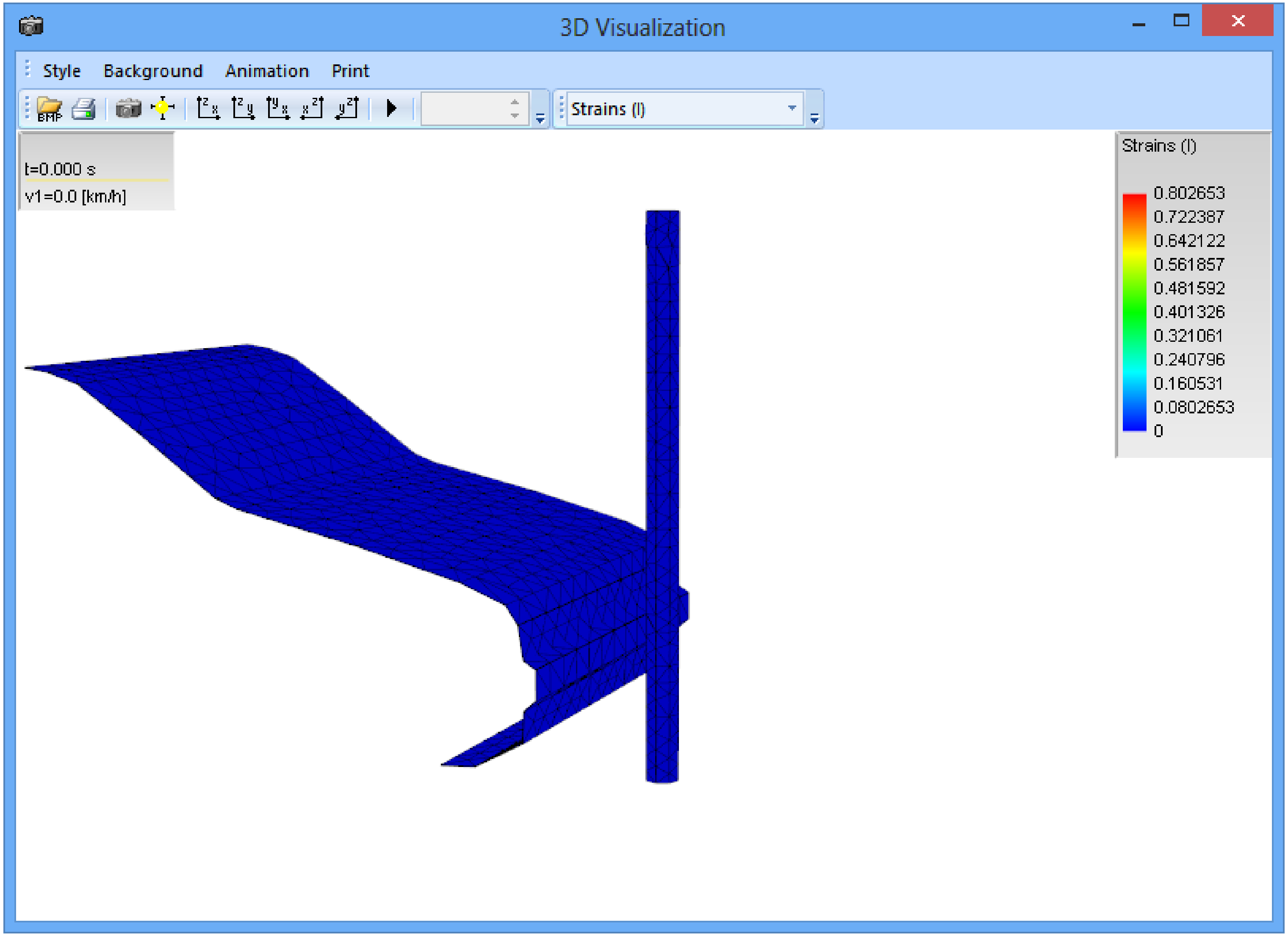
Name	Type	Details
A263	ELASTOPLASTIC	A263 E = 224 RHO = 8.36E-009 NU = 0.3 failure_stress = 1.004 YIELD_STRESS = 0.585 EP = 0.9365
ALUMINUM2024T3	ELASTOPLASTIC	ALUMINUM2024T3 E = 73.0807 RHO = 2.77E-006 NU = 0.33 failure_stress = 0.482609 YIELD_STRESS = 0.34472 EP = 0.1
BERYLIUM	ELASTOPLASTIC	BERYLIUM E = 289.565 RHO = 1.85E-006 NU = 0.027 failure_stress = 0.289565 YIELD_STRESS = 0.224068 EP = 0.1
BIRD	ELASTOPLASTIC	BIRD E = 100 RHO = 9.143E-010 NU = 0.49 failure_stress = 0.01 YIELD_STRESS = 0.5 EP = 0
BONE	ELASTOPLASTIC	BONE E = 14 RHO = 1.3E-006 NU = 0.43 failure_stress = 0.13 YIELD_STRESS = 0.11 EP = 0.1
BRASS	ELASTOPLASTIC	BRASS E = 109.6 RHO = 8.47E-006 NU = 0.33551 failure_stress = 0.275 YIELD_STRESS = 0.1034 EP = 0.1
BRONZE	ELASTOPLASTIC	BRONZE E = 109.6 RHO = 8.874E-006 NU = 0.335 failure_stress = 0.275 YIELD_STRESS = 0.128 EP = 0.1
COPPERANNEALED	ELASTOPLASTIC	COPPERANNEALED E = 117.2 RHO = 8.9E-006 NU = 0.32 failure_stress = 0.185 YIELD_STRESS = 0.07 EP = 0.01
COPPERHARDDRAWN	ELASTOPLASTIC	COPPERHARDDRAWN E = 117.205 RHO = 8.9E-006 NU = 0.32 failure_stress = 0.295 YIELD_STRESS = 0.265 EP = 0.1
GLASS	ELASTOPLASTIC	GLASS E = 65 RHO = 2.6E-006 NU = 0.23 failure_stress = 0.001 YIELD_STRESS = 0.07 EP = 0.01
LEAD	ELASTOPLASTIC	LEAD E = 13.7888 RHO = 1.134E-005 NU = 0.425 failure_stress = 0.0179255 YIELD_STRESS = 0.00896273 EP = 0.001
MAGNESIUM	ELASTOPLASTIC	MAGNESIUM E = 44.8137 RHO = 1.77E-006 NU = 0.35 failure_stress = 0.255093 YIELD_STRESS = 0.151677 EP = 0.1
MOLYBDENUMWROUGHT	ELASTOPLASTIC	MOLYBDENUMWROUGHT E = 275.776 RHO = 1.03E-005 NU = 0.32 failure_stress = 1.10311 YIELD_STRESS = 0.551553 EP = 0.1
NICKEL	ELASTOPLASTIC	NICKEL E = 220.621 RHO = 8.9E-006 NU = 0.31 failure_stress = 0.499845 YIELD_STRESS = 0.365404 EP = 0.1
NICKEL	ELASTOPLASTIC	NICKEL E = 220.621 RHO = 8.9E-006 NU = 0.31 failure_stress = 0.499845 YIELD_STRESS = 0.365404 EP = 0.1
PLATINUM	ELASTOPLASTIC	PLATINUM E = 146.85 RHO = 2.145E-005 NU = 0.39 failure_stress = 1.51677 YIELD_STRESS = 0.025854 EP = 0.01
SILVER	ELASTOPLASTIC	SILVER E = 68.9441 RHO = 1.05E-005 NU = 0.37 failure_stress = 0.124099 YIELD_STRESS = 0.0551553 EP = 0.01
STEEL	ELASTIC	STEEL E = 200 RHO = 7.8E-006 NU = 0.3
STEELANSI304	ELASTOPLASTIC	STEELANSI304 E = 193.043 RHO = 8.03E-006 NU = 0.29 failure_stress = 0.599814 YIELD_STRESS = 0.268882 EP = 0.1
STEELANSIC1020	ELASTOPLASTIC	STEELANSIC1020 E = 199.928 RHO = 7.85E-006 NU = 0.29 failure_stress = 0.448137 YIELD_STRESS = 0.330932 EP = 0.1
STEEL_EP	ELASTOPLASTIC	STEEL_EP E = 210 RHO = 7.8E-006 NU = 0.3 YIELD_STRESS = 0.18 EP = 0.1
STEEL_THERMOEP	THERMOELASTOPLASTIC	STEEL_THERMOEP E = 210 RHO = 7.8E-006 NU = 0.3
TITANIUMB120VCA	ELASTOPLASTIC	TITANIUMB120VCA E = 102.037 RHO = 4.85E-006 NU = 0.3 failure_stress = 1.37888 YIELD_STRESS = 1.30994 EP = 0.1

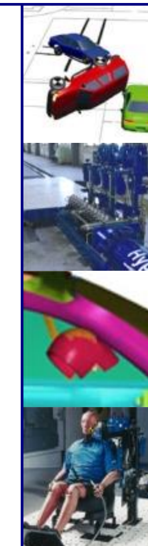
OK Cancel

Add FE Objects

Name	Type	Details
CAR	RIGID_BODY	CAR Master_node = 0
FIXED_ALL	BOUNDARY_CONDITION	FIXED_ALL ax = 0 ay = 0 az = 0 arx = 0 ary = 0 arz = 0 vx = 0 vy = 0 vz = 0 vrx = 0 vry = 0 vrz = 0
MOVING	BOUNDARY_CONDITION	MOVING vx = [0,5,0.01,off,100,off] vy = 0 vz = 0 vrx = 0 vry = 0 vrz = 0

FE Calculation





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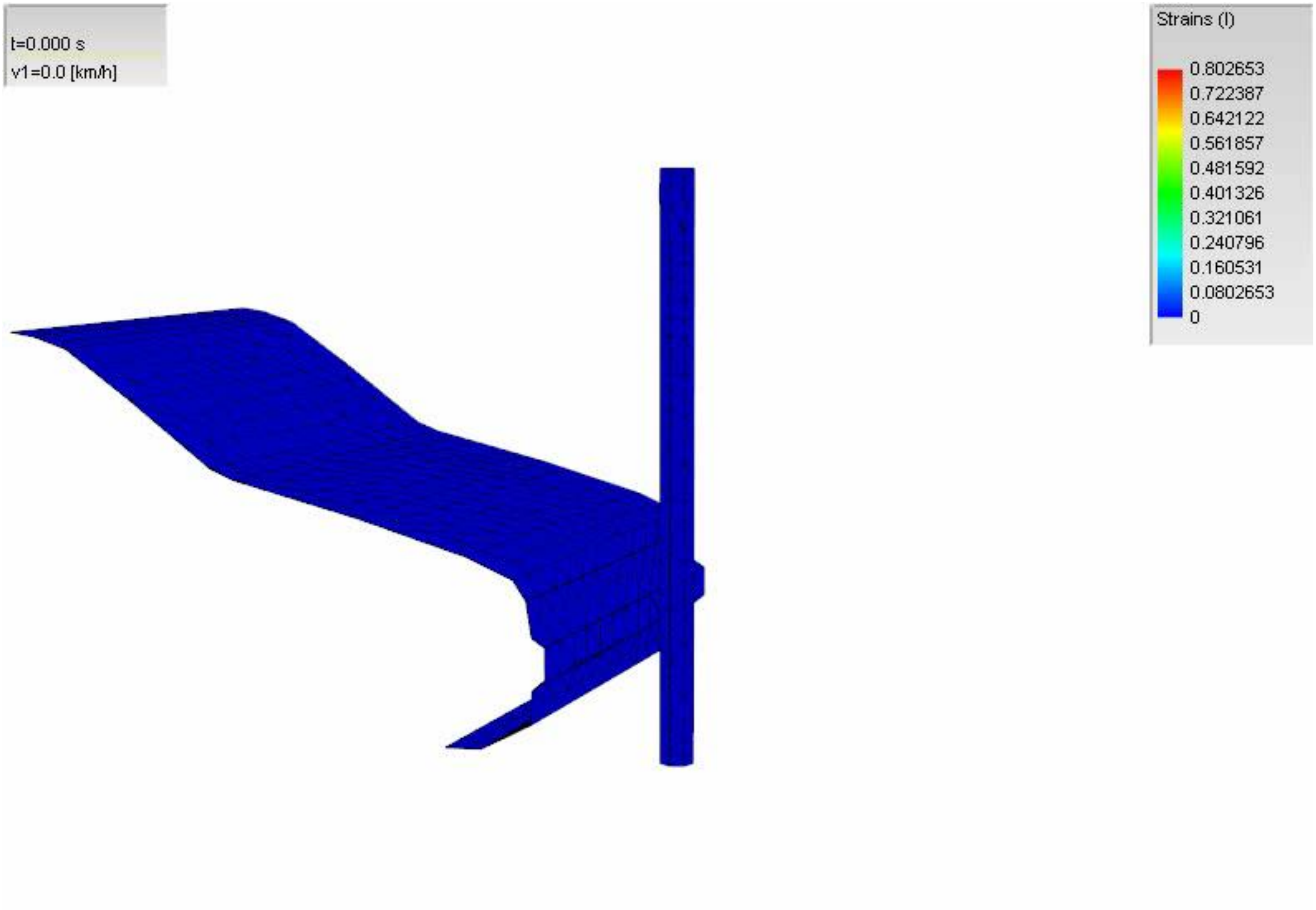

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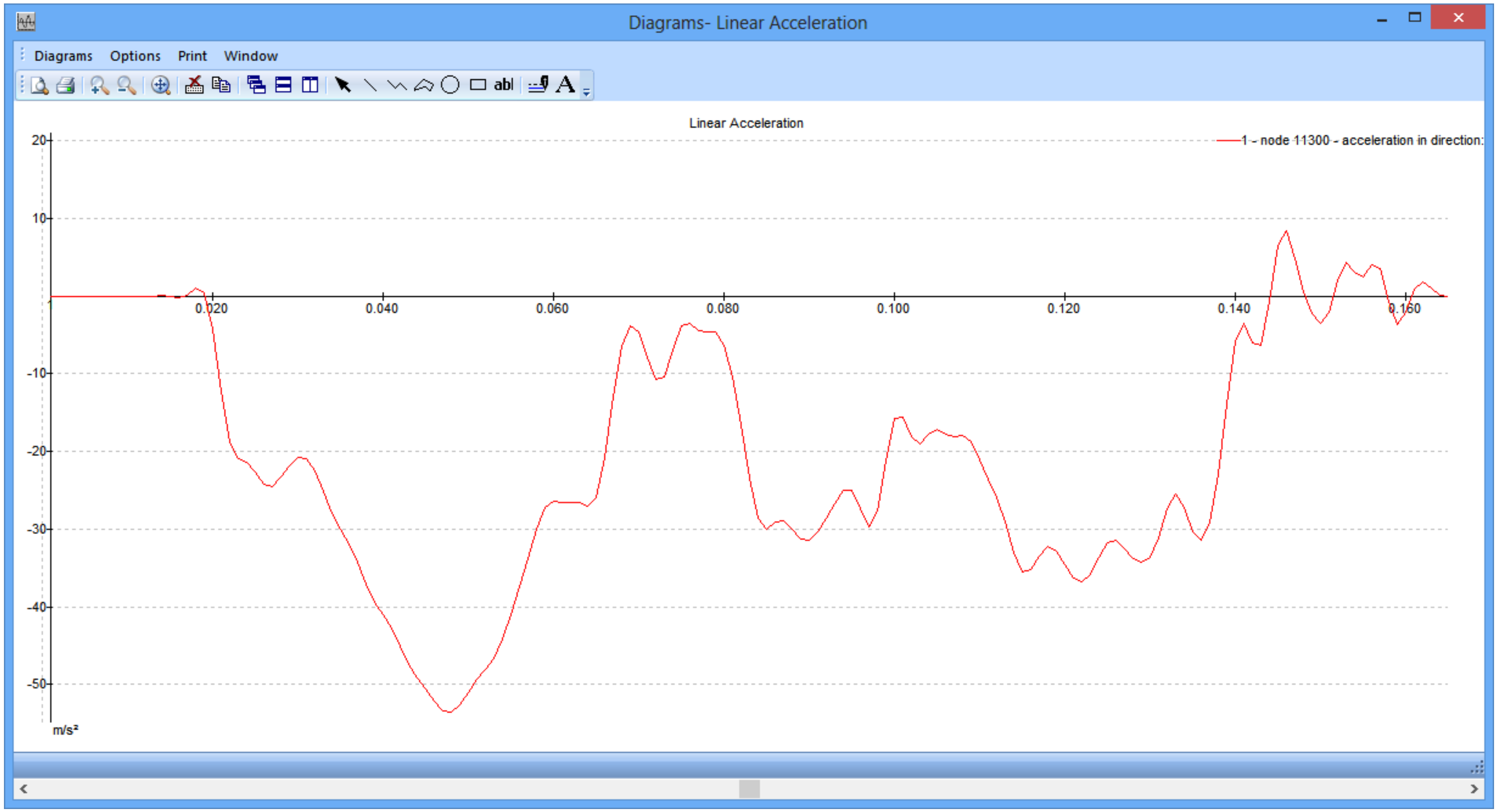

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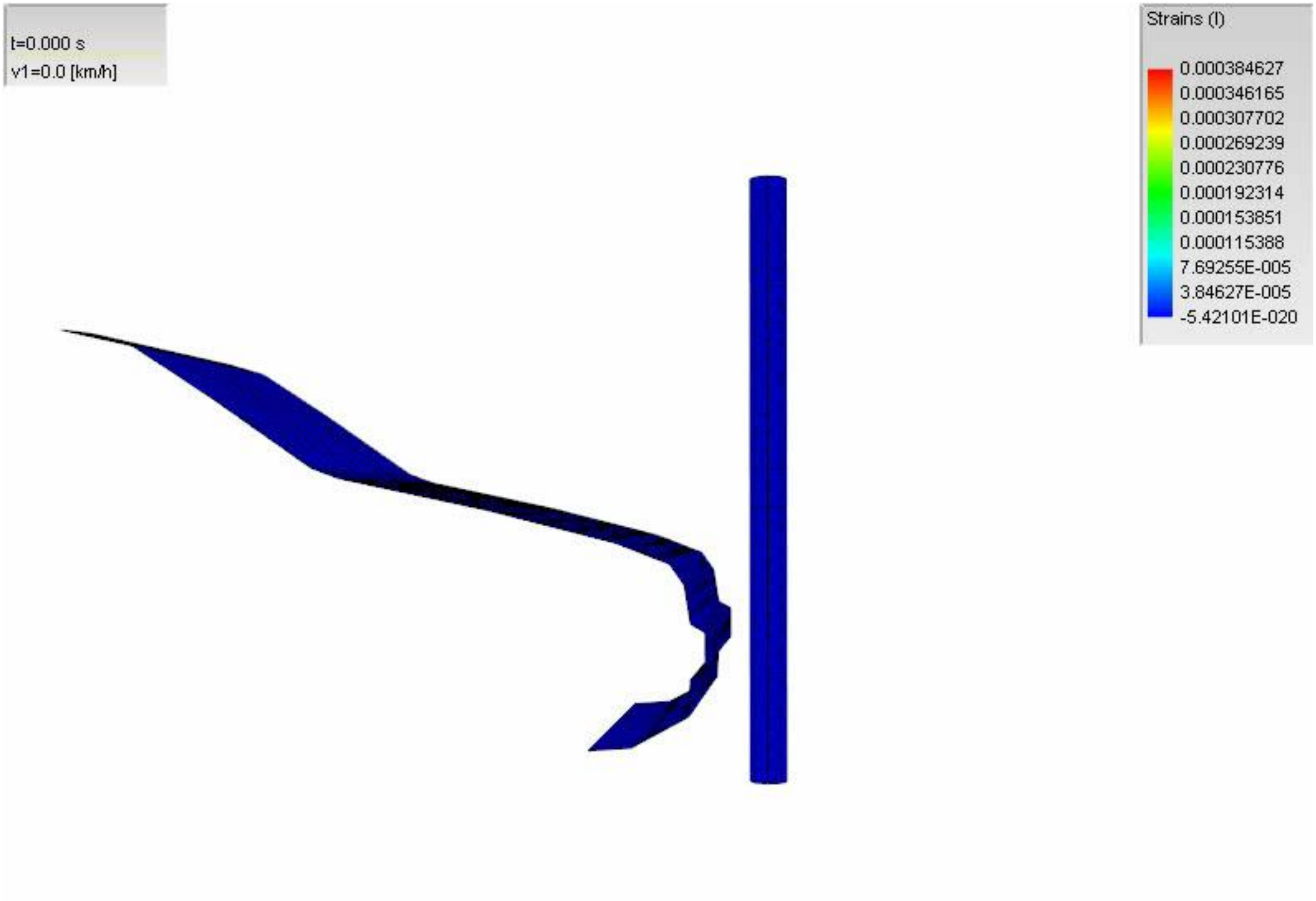

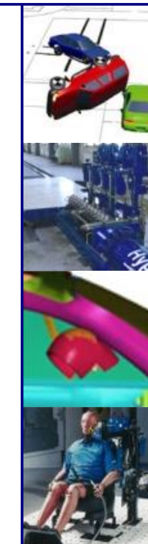

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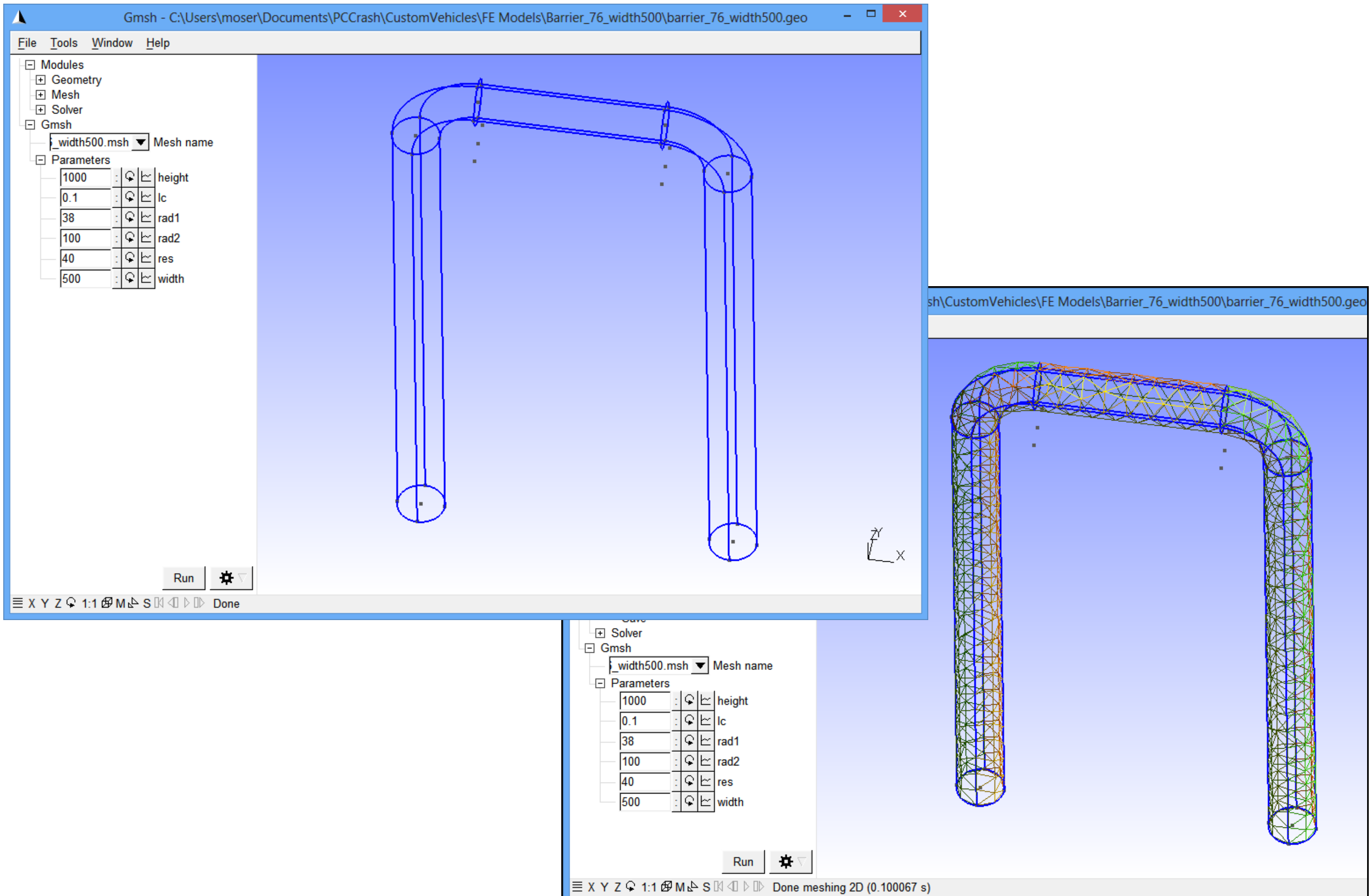

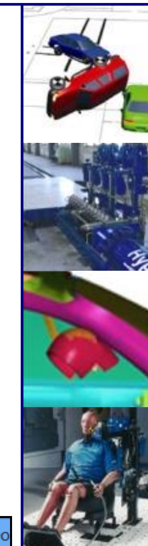

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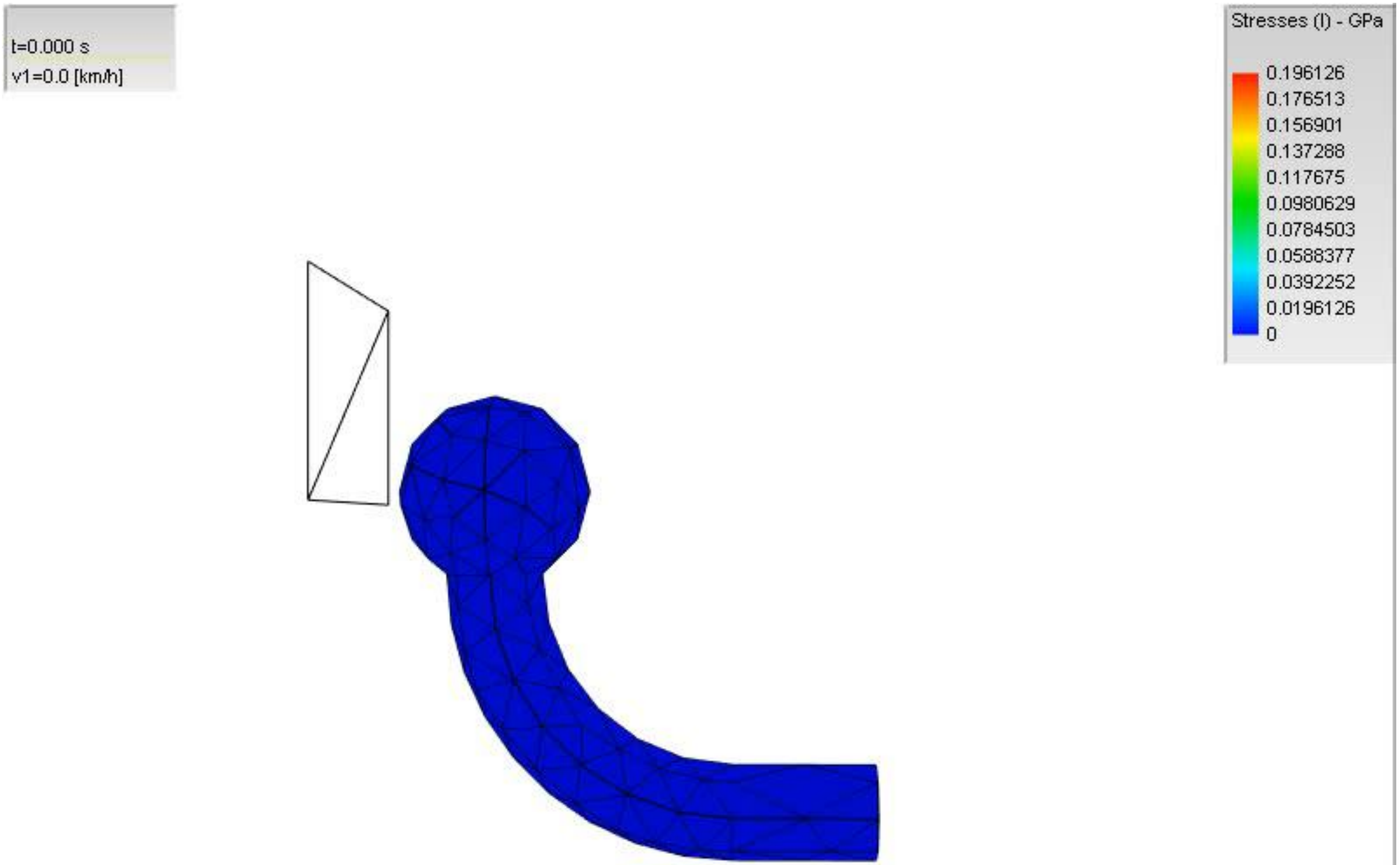
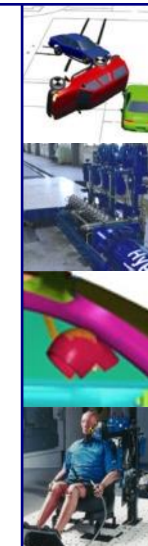
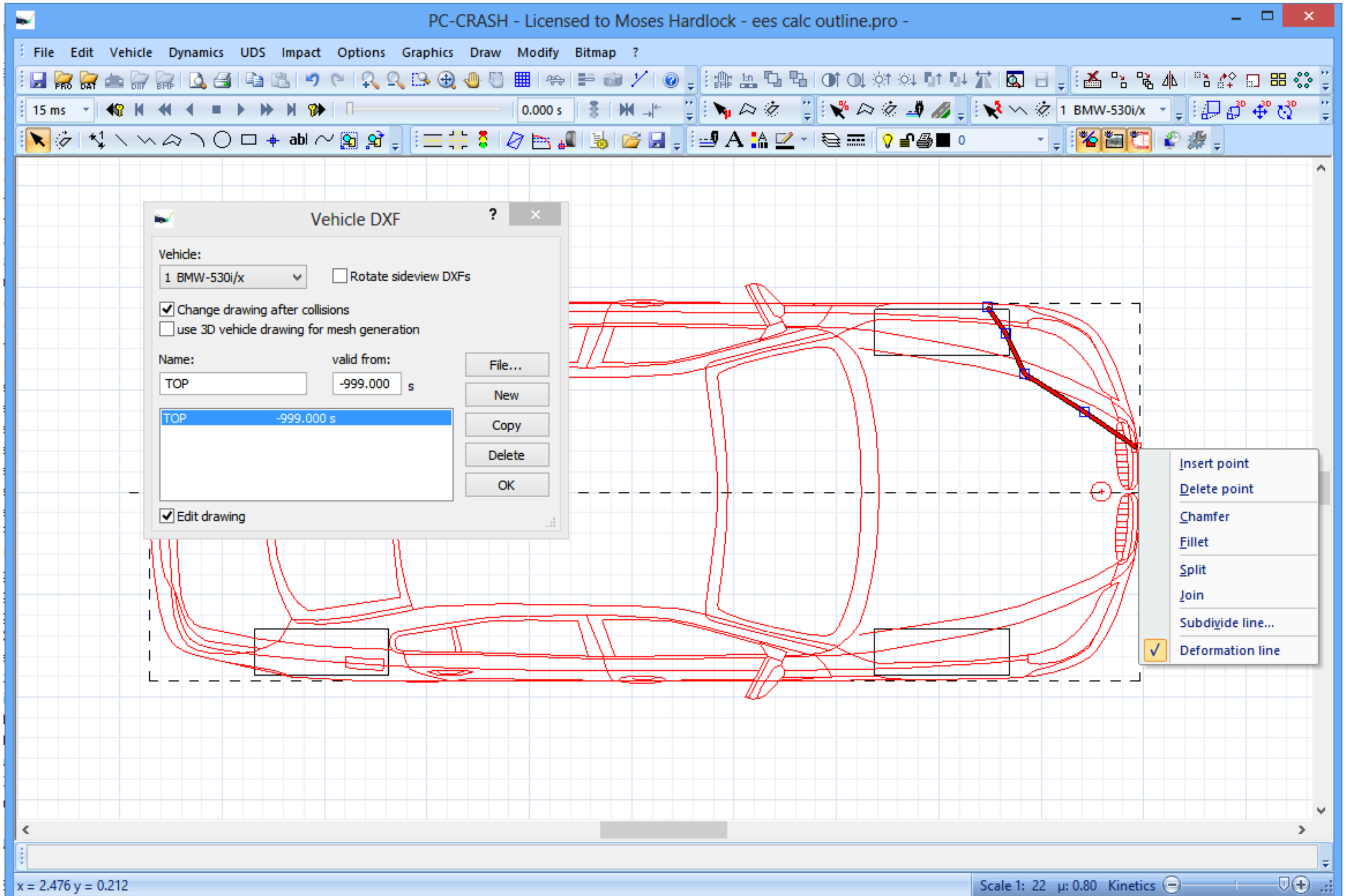
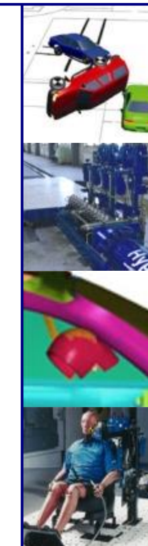




EES Calculation





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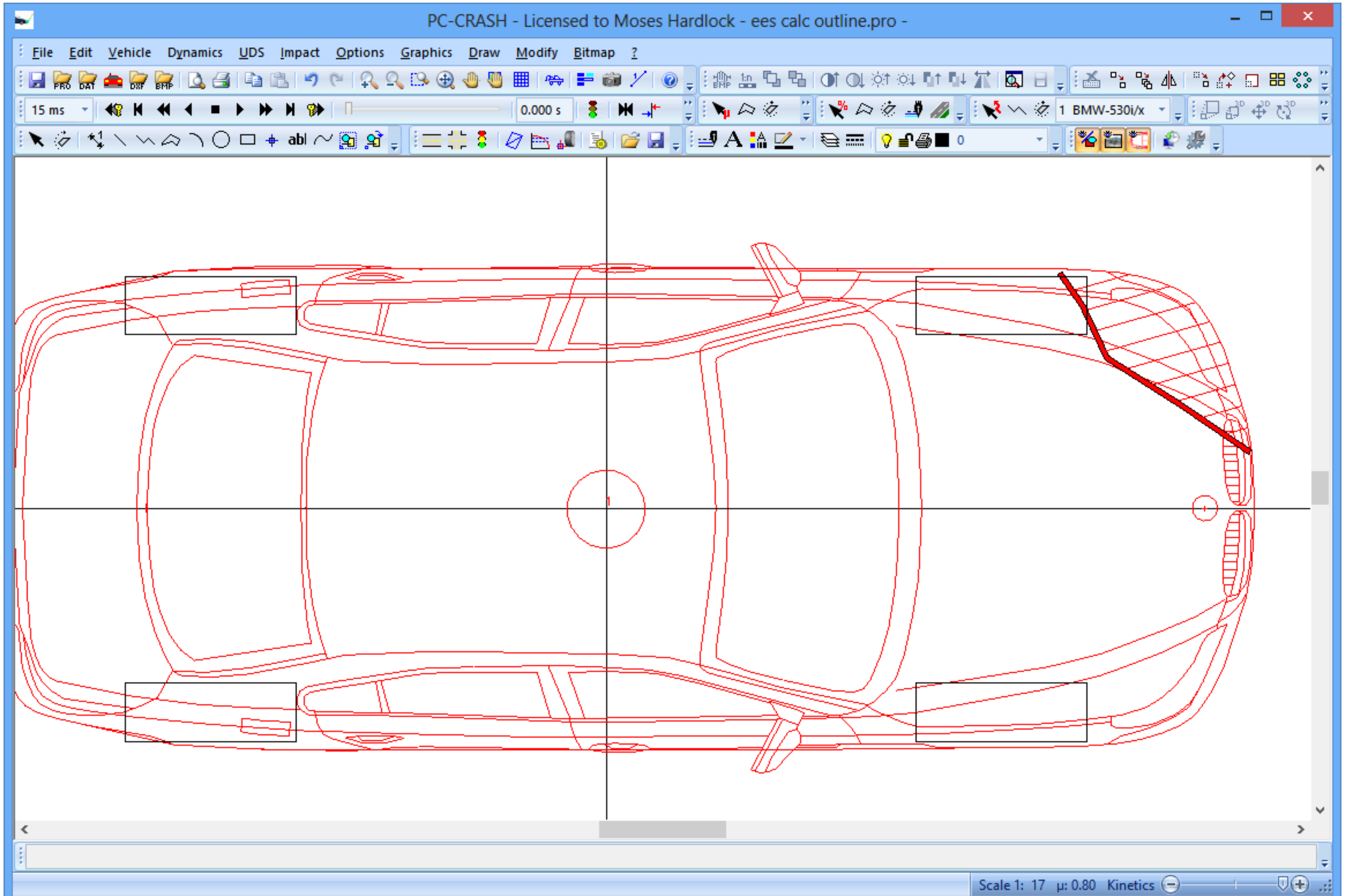

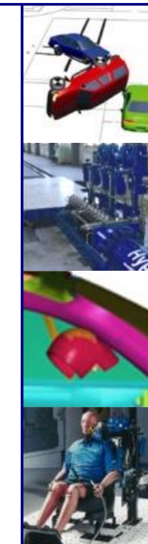

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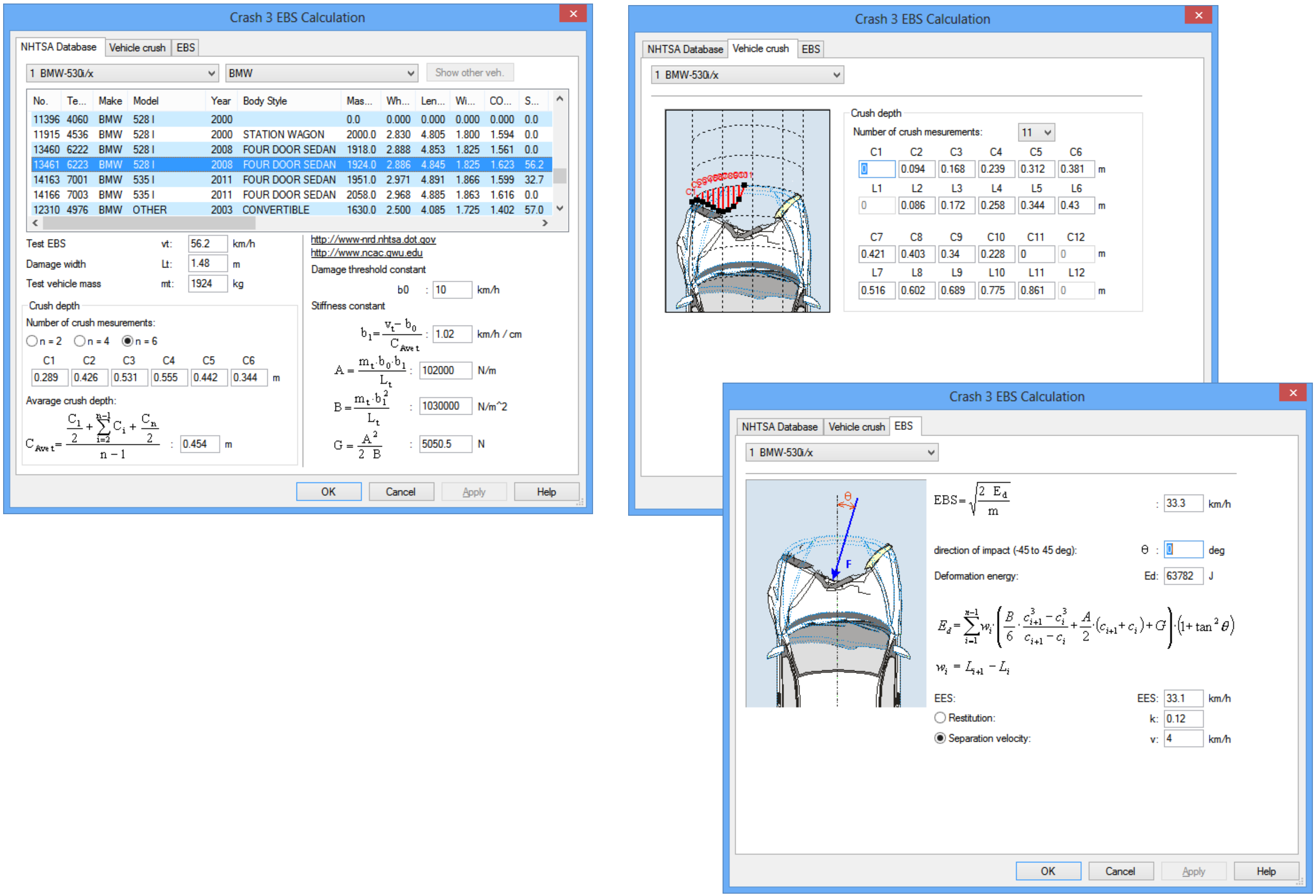


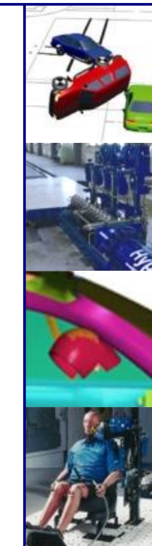
$$b_1 = \frac{v_t - b_0}{C_{Ave\,t}} \qquad A = \frac{m_t \cdot b_0 \cdot b_1}{L_t} \qquad B = \frac{m_t \cdot b_1^2}{L_t} \qquad G = \frac{A^2}{2\,B}$$

$$C_{Ave\,t} = \frac{\frac{C_1}{2} + \sum_{i=2}^{n-1} C_i + \frac{C_n}{2}}{n-1}$$

$$EBS = \sqrt{\frac{2\,E_d}{m}}$$

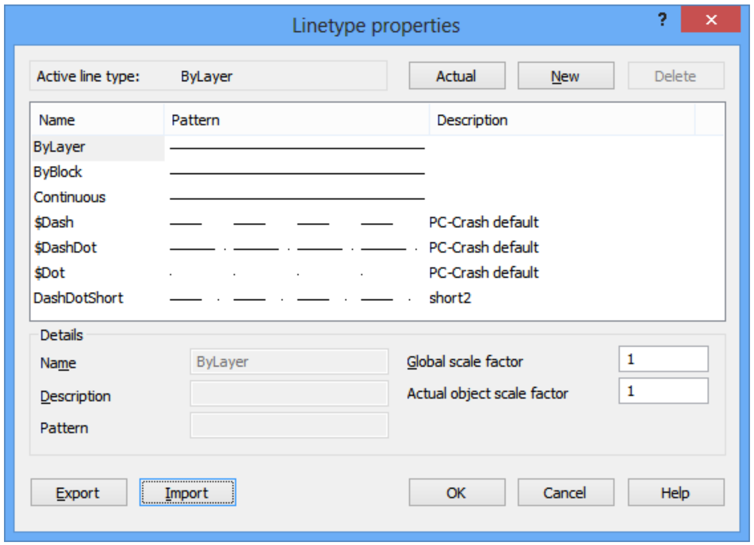
$$E_d = \sum_{i=1}^{n-1} w_i \left(\frac{B}{6} \cdot \frac{c_{i+1}^3 - c_i^3}{c_{i+1} - c_i} + \frac{A}{2} \cdot (c_{i+1} + c_i) + G \right) \cdot (1 + \tan^2 \theta)$$

$$w_i = L_{i+1} - L_i$$

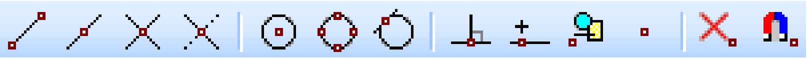


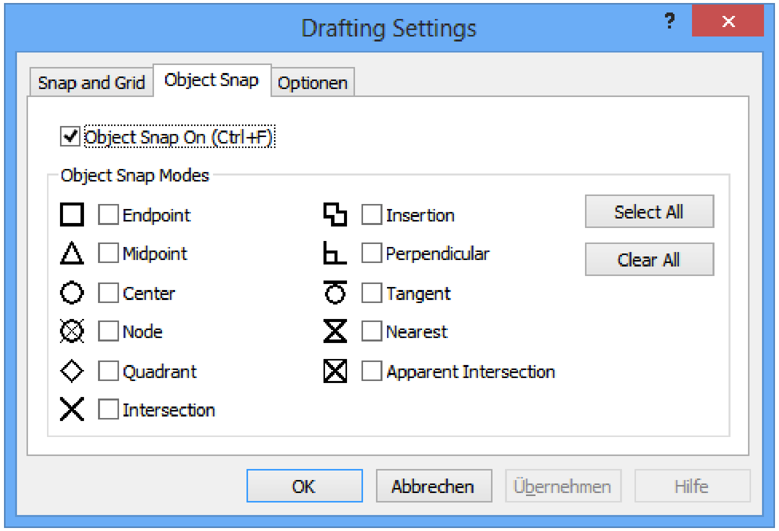
Drawing Program

User defined linetypes

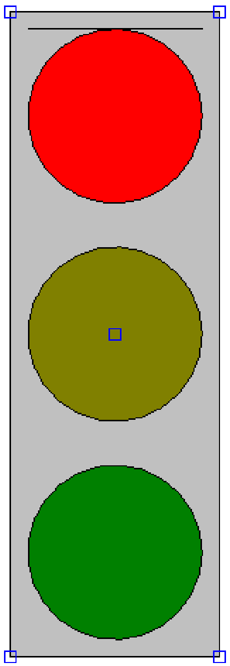


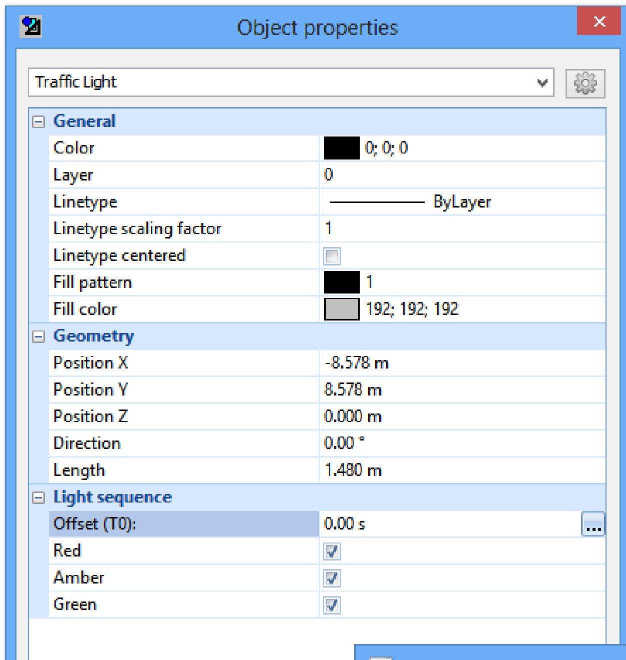
Snap functions

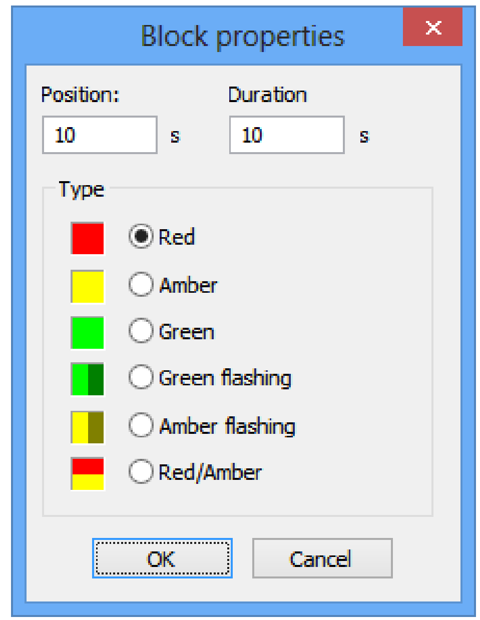


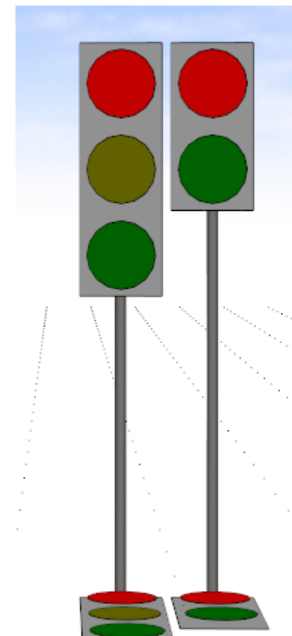


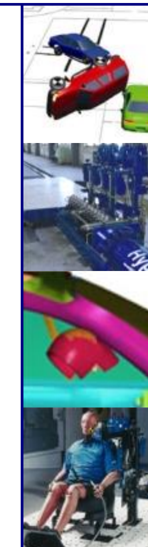
Traffic lights

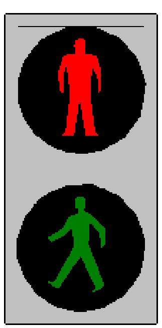


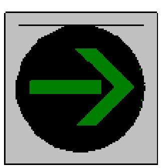


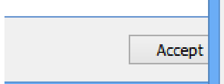


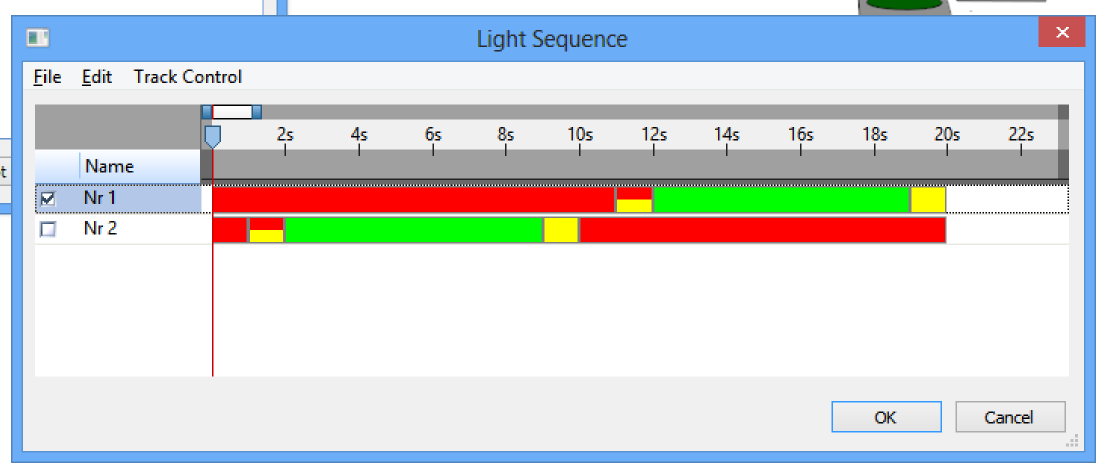




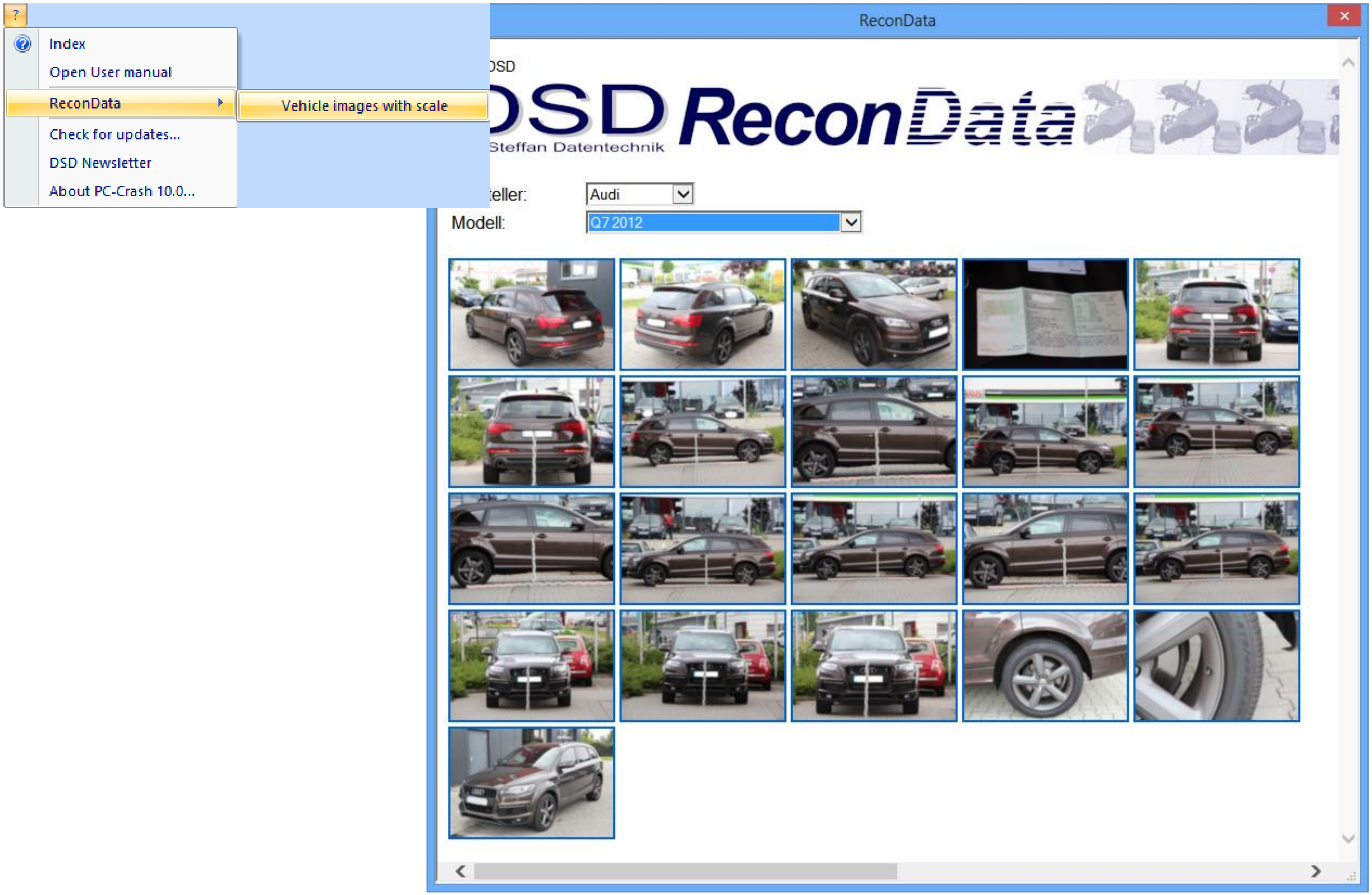








ReconData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Open User manual
ReconData
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About PC-Crash 10.0...
ReconData
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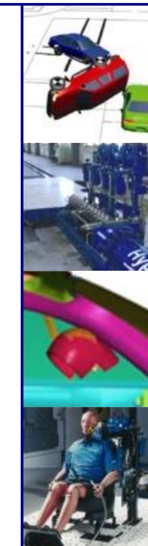
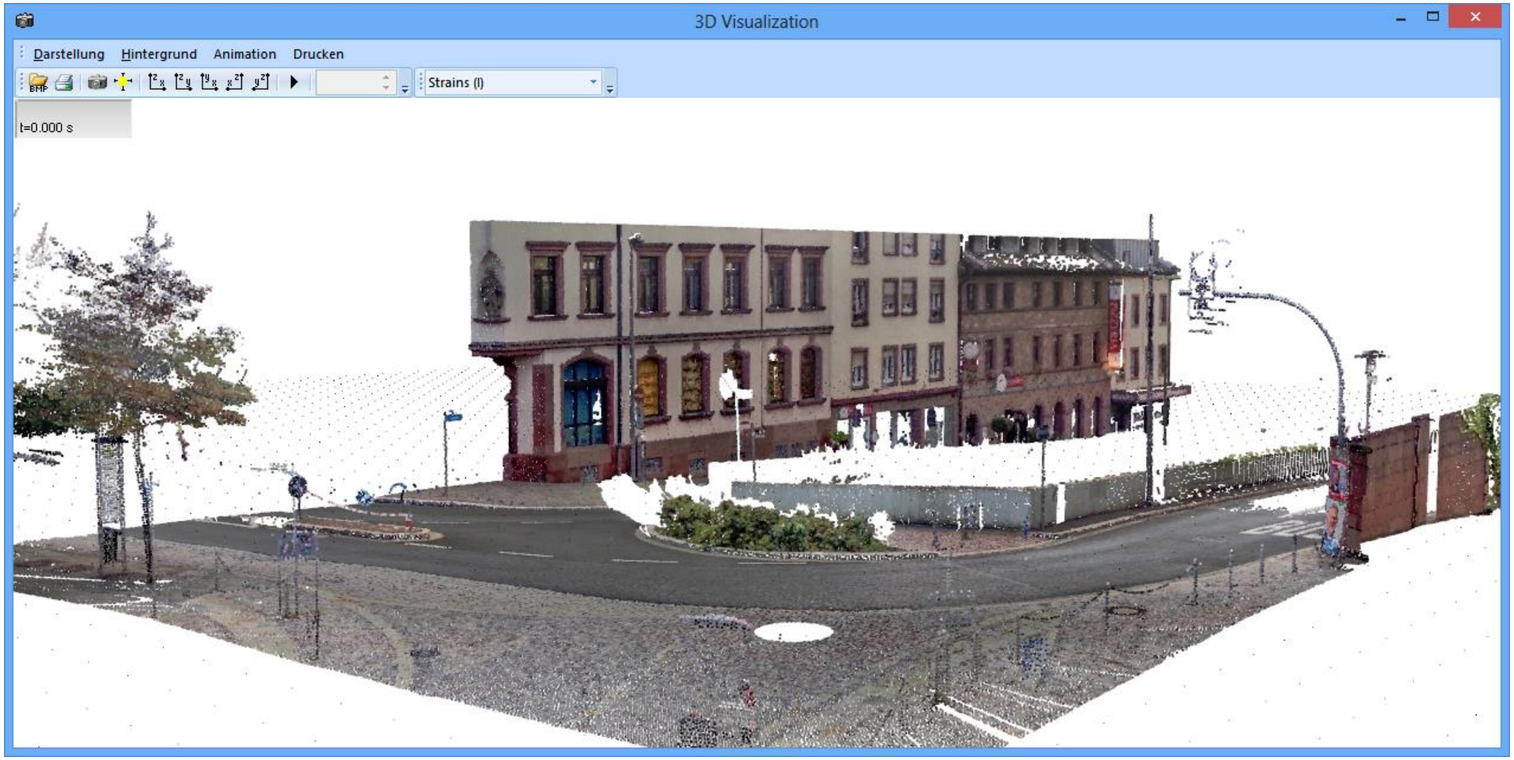
teller:
Audi
Modell:
Q7 2012

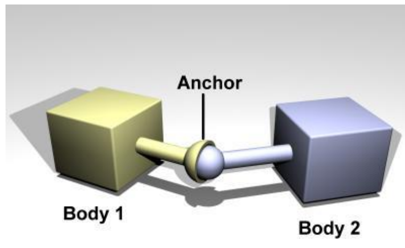


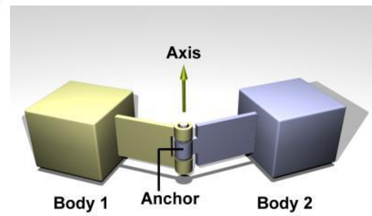
Laser scan data

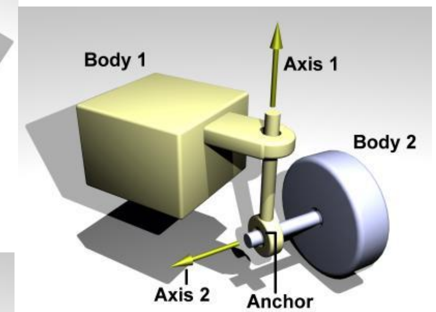


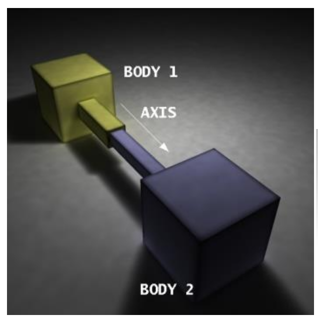
Multibody new joint types

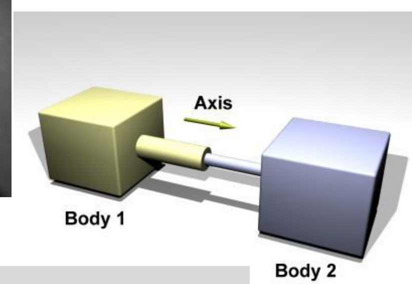
- Ball
- Hinge
- Hinge2
- Slider
- Piston
- Universal
- PUJoint
- PRJoint

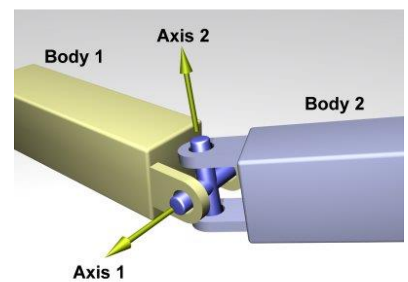


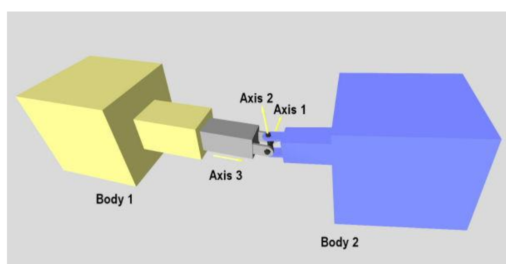


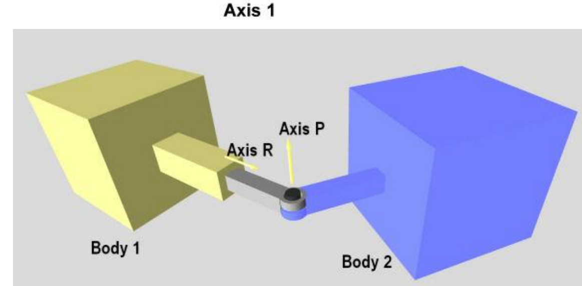


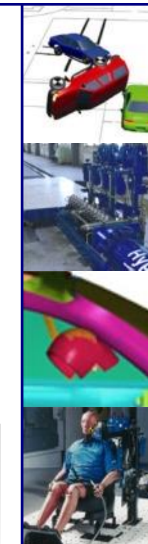




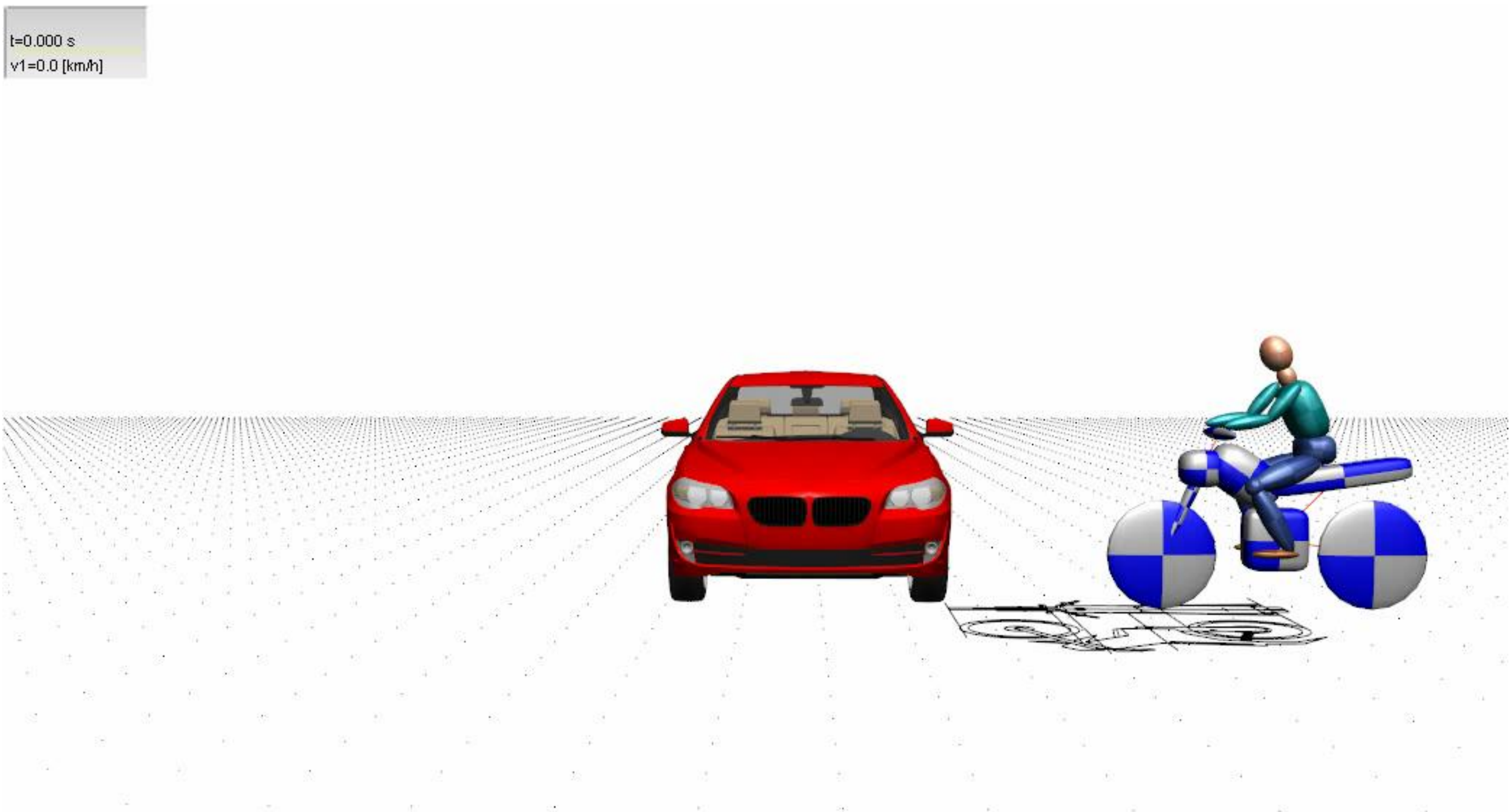






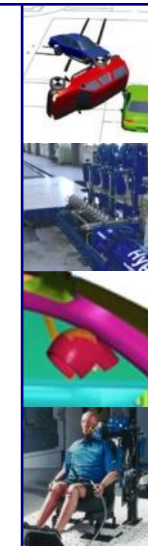


Multibody new joint types



PC-Rect 4.2

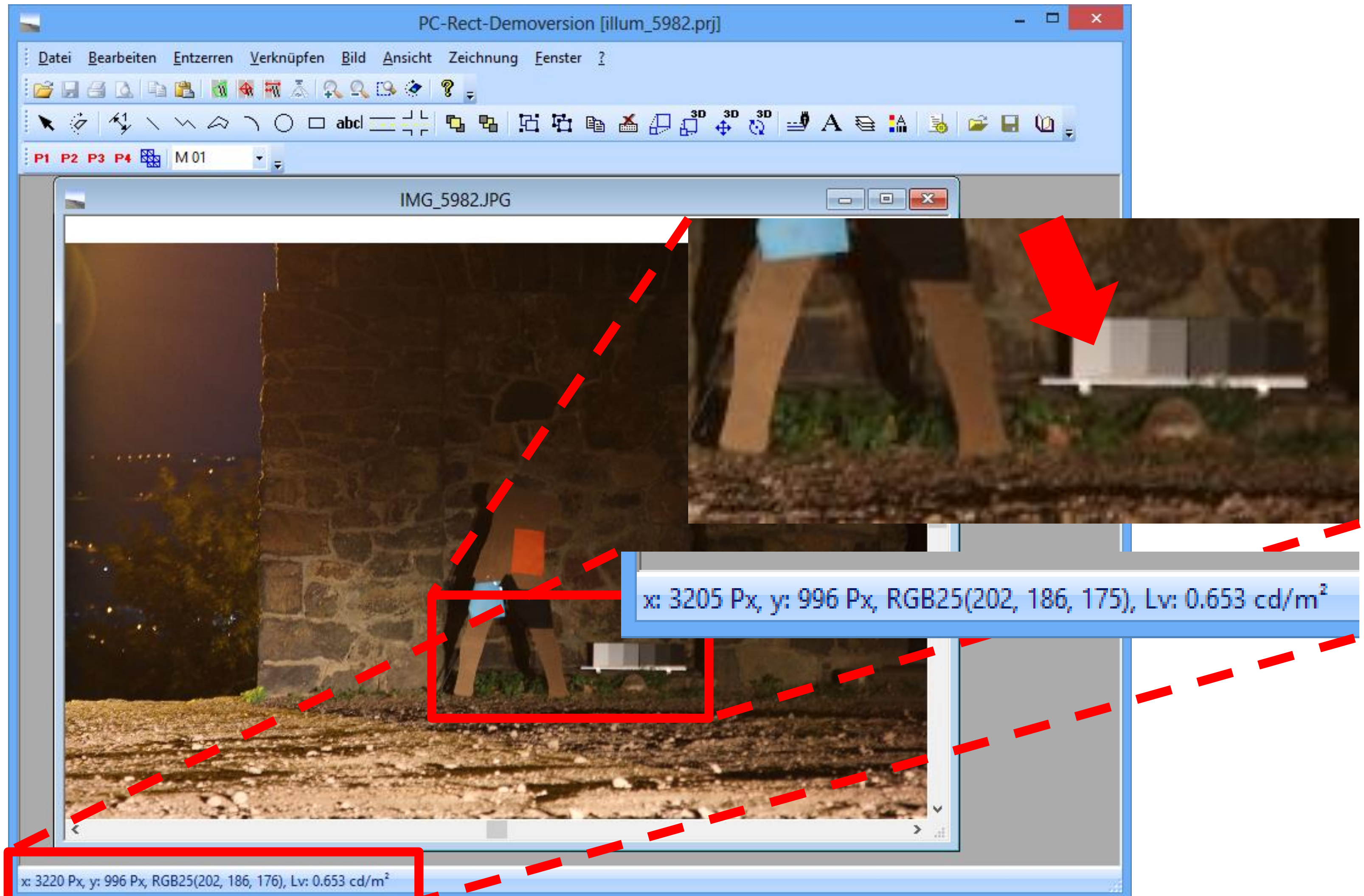
- Luminance calculation
- Improved functionality in the measurement grid window/method
- Panorama generation
- Snap function for grid points using pattern recognition

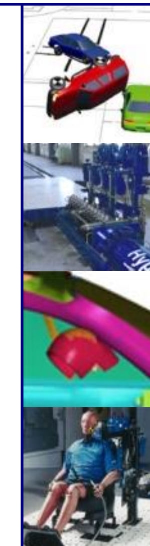


Luminance calculation

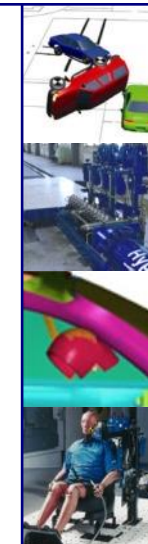
- Usage of the camera calibration file (Image Engineering)
- Conversion of image data to luminance
  - Exif information is used automatically
- Definition of the area of interest
- Calculation of visibility
  - Luminance difference thresholds according to Adrian
  - SBU diagram
  - Diagram according to DIN 5037

Luminance calculation





Luminance image



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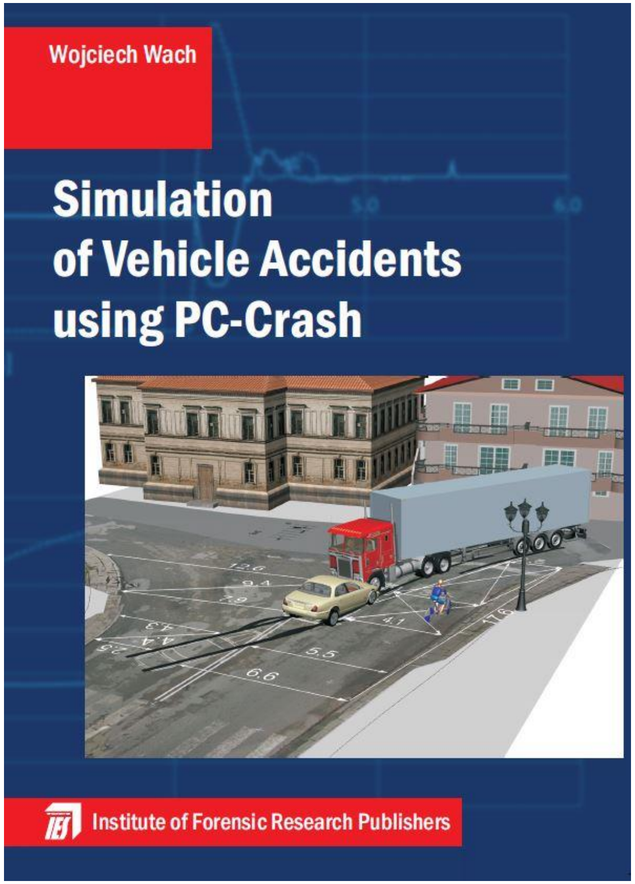

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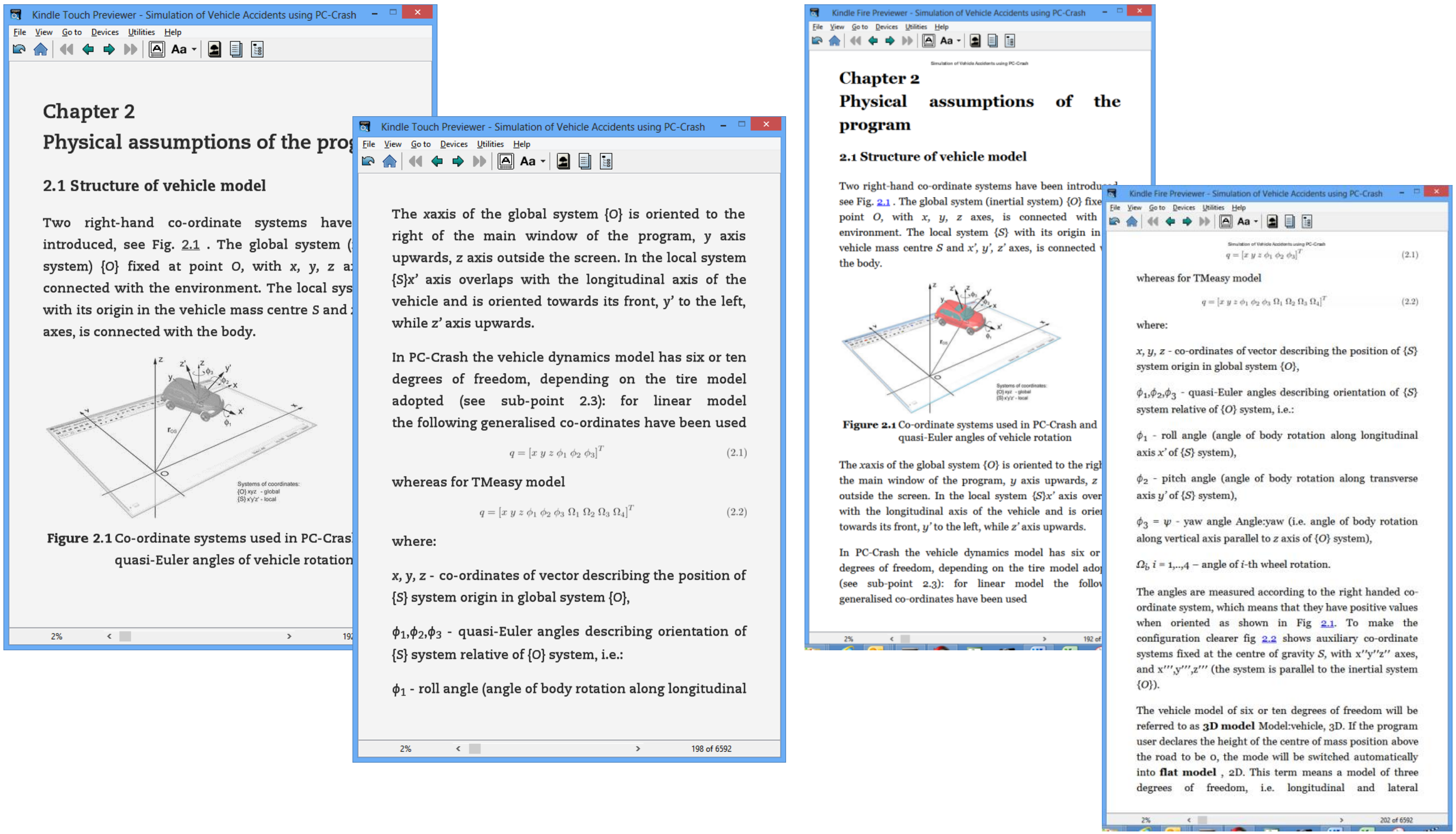

Kindle Touch Previewer - Simulation of Vehicle Accidents using PC-Crash

Chapter 2
Physical assumptions of the prog

2.1 Structure of vehicle model

Two right-hand co-ordinate systems have introduced, see Fig. 2.1 . The global system (system) {O} fixed at point O, with x, y, z a connected with the environment. The local sys with its origin in the vehicle mass centre S and axes, is connected with the body.

Figure 2.1 Co-ordinate systems used in PC-Cras quasi-Euler angles of vehicle rotation

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The xaxis of the global system {O} is oriented to the right of the main window of the program, y axis upwards, z axis outside the screen. In the local system {S}x' axis overlaps with the longitudinal axis of the vehicle and is oriented towards its front, y' to the left, while z' axis upwards.

In PC-Crash the vehicle dynamics model has six or ten degrees of freedom, depending on the tire model adopted (see sub-point 2.3): for linear model the following generalised co-ordinates have been used

$$q = [x\ y\ z\ \phi_1\ \phi_2\ \phi_3]^T \quad (2.1)$$

whereas for TMeasy model

$$q = [x\ y\ z\ \phi_1\ \phi_2\ \phi_3\ \Omega_1\ \Omega_2\ \Omega_3\ \Omega_4]^T \quad (2.2)$$

where:

x, y, z - co-ordinates of vector describing the position of {S} system origin in global system {O},

ϕ_1,ϕ_2,ϕ_3 - quasi-Euler angles describing orientation of {S} system relative of {O} system, i.e.:

ϕ_1 - roll angle (angle of body rotation along longitudinal

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Chapter 2
Physical assumptions of the program

2.1 Structure of vehicle model

Two right-hand co-ordinate systems have been introdu see Fig. 2.1 . The global system (inertial system) {O} fixe point O, with x, y, z axes, is connected with environment. The local system {S} with its origin in vehicle mass centre S and x', y', z' axes, is connected the body.

Figure 2.1 Co-ordinate systems used in PC-Crash and quasi-Euler angles of vehicle rotation

The xaxis of the global system {O} is oriented to the righ the main window of the program, y axis upwards, z outside the screen. In the local system {S}x' axis over with the longitudinal axis of the vehicle and is orie towards its front, y' to the left, while z' axis upwards.

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$$q = [x\ y\ z\ \phi_1\ \phi_2\ \phi_3]^T \quad (2.1)$$

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$$q = [x\ y\ z\ \phi_1\ \phi_2\ \phi_3\ \Omega_1\ \Omega_2\ \Omega_3\ \Omega_4]^T \quad (2.2)$$

where:

x, y, z - co-ordinates of vector describing the position of {S} system origin in global system {O},

ϕ_1,ϕ_2,ϕ_3 - quasi-Euler angles describing orientation of {S} system relative of {O} system, i.e.:

ϕ_1 - roll angle (angle of body rotation along longitudinal axis x' of {S} system),

ϕ_2 - pitch angle (angle of body rotation along transverse axis y' of {S} system),

$\phi_3 = \psi$ - yaw angle Angle:yaw (i.e. angle of body rotation along vertical axis parallel to z axis of {O} system),

Ω_i, $i = 1,..,4$ – angle of i-th wheel rotation.

The angles are measured according to the right handed co-ordinate system, which means that they have positive values when oriented as shown in Fig 2.1. To make the configuration clearer fig 2.2 shows auxiliary co-ordinate systems fixed at the centre of gravity S, with x''y''z'' axes, and x'''y'''z''' (the system is parallel to the inertial system {O}).

The vehicle model of six or ten degrees of freedom will be referred to as **3D model** Model:vehicle, 3D. If the program user declares the height of the centre of mass position above the road to be 0, the mode will be switched automatically into **flat model** , 2D. This term means a model of three degrees of freedom, i.e. longitudinal and lateral

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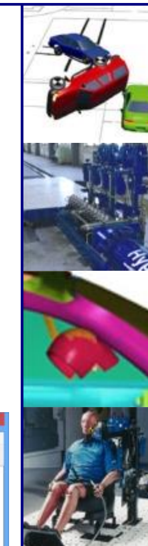

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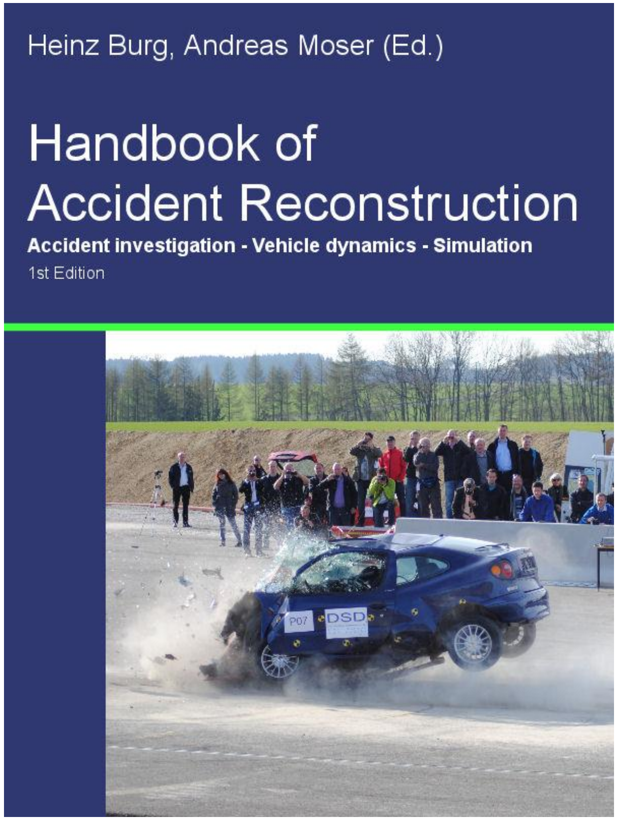

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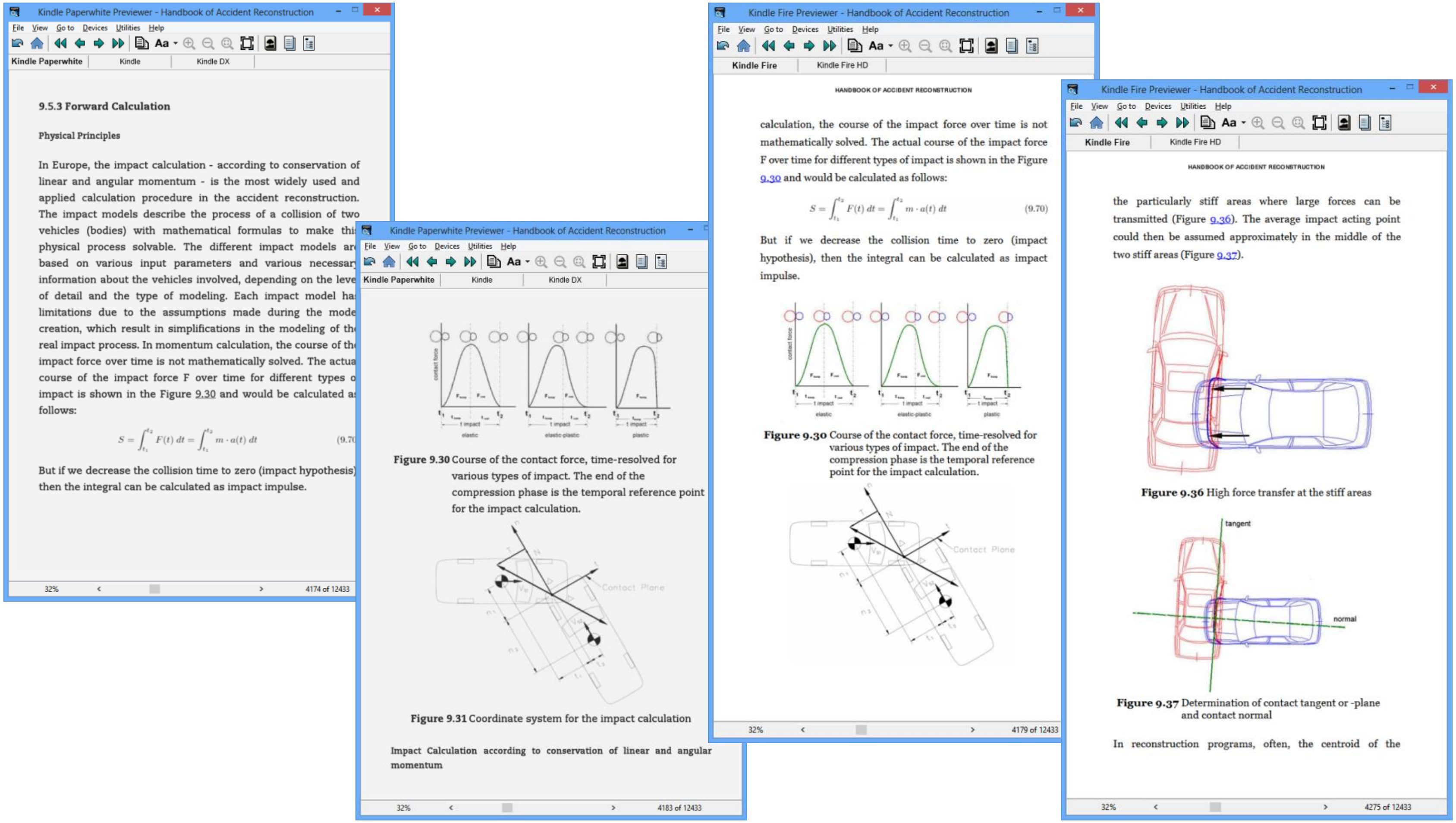
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9.5.3 Forward Calculation

Physical Principles

In Europe, the impact calculation - according to conservation of linear and angular momentum - is the most widely used and applied calculation procedure in the accident reconstruction. The impact models describe the process of a collision of two vehicles (bodies) with mathematical formulas to make thi[s] physical process solvable. The different impact models ar[e] based on various input parameters and various necessar[y] information about the vehicles involved, depending on the leve[l] of detail and the type of modeling. Each impact model ha[s] limitations due to the assumptions made during the creation, which result in simplifications in the modeling of th[e] real impact process. In momentum calculation, the course of th[e] impact force over time is not mathematically solved. The actua[l] course of the impact force F over time for different types o[f] impact is shown in the Figure 9.30 and would be calculated a[s] follows:

$$S = \int_{t_1}^{t_2} F(t)\,dt = \int_{t_1}^{t_2} m \cdot a(t)\,dt$$

But if we decrease the collision time to zero (impact hypothesis) then the integral can be calculated as impact impulse.

Figure 9.30 Course of the contact force, time-resolved for various types of impact. The end of the compression phase is the temporal reference point for the impact calculation.

Figure 9.31 Coordinate system for the impact calculation

Impact Calculation according to conservation of linear and angular momentum

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calculation, the course of the impact force over time is not mathematically solved. The actual course of the impact force F over time for different types of impact is shown in the Figure 9.30 and would be calculated as follows:

$$S = \int_{t_1}^{t_2} F(t)\,dt = \int_{t_1}^{t_2} m \cdot a(t)\,dt \quad (9.70)$$

But if we decrease the collision time to zero (impact hypothesis), then the integral can be calculated as impact impulse.

Figure 9.30 Course of the contact force, time-resolved for various types of impact. The end of the compression phase is the temporal reference point for the impact calculation.

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the particularly stiff areas where large forces can be transmitted (Figure 9.36). The average impact acting point could then be assumed approximately in the middle of the two stiff areas (Figure 9.37).

Figure 9.36 High force transfer at the stiff areas

Figure 9.37 Determination of contact tangent or -plane and contact normal

In reconstruction programs, often, the centroid of the

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Thank you very much for your attention!