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Theory 301: Multibody Model

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Multibody model

- Elastically-deformable “rigid” bodies
- Kinematically-constrained joints or spring/dampers connect bodies
- Linear deformation-based contact forces with friction

Multibody model

$$\left(\frac{x}{a}\right)^n + \left(\frac{y}{b}\right)^n + \left(\frac{z}{c}\right)^n = 1$$

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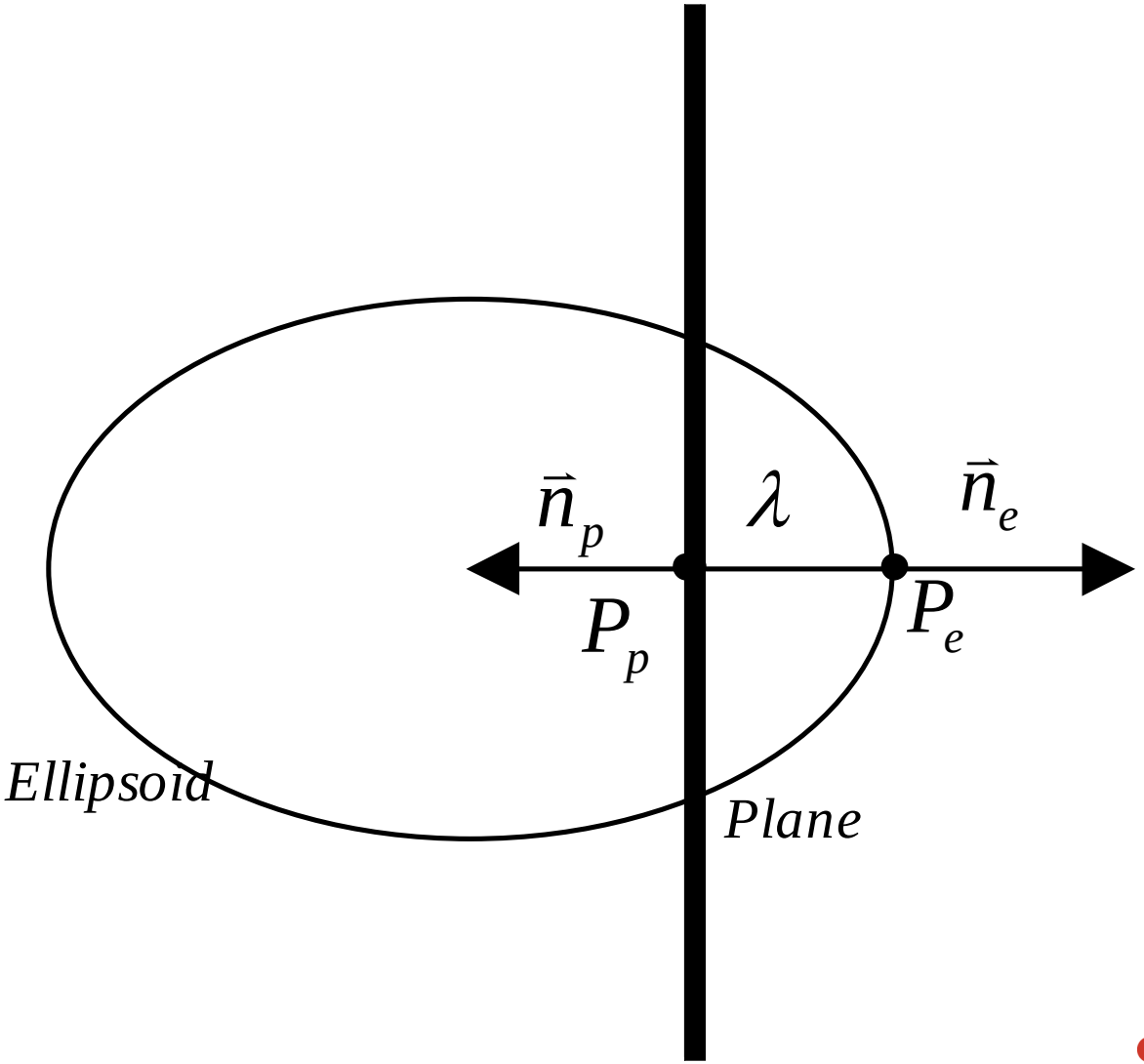
Ellipsoid contact model

- Based on a linear stiffness function
- A coefficient of restitution is specified to define the amount of elasticity during the contact
- Once the contact normal force is calculated friction forces are calculated, using the specified contact friction between two bodies or a body and the ground surface

Ellipsoid-ground plane contact



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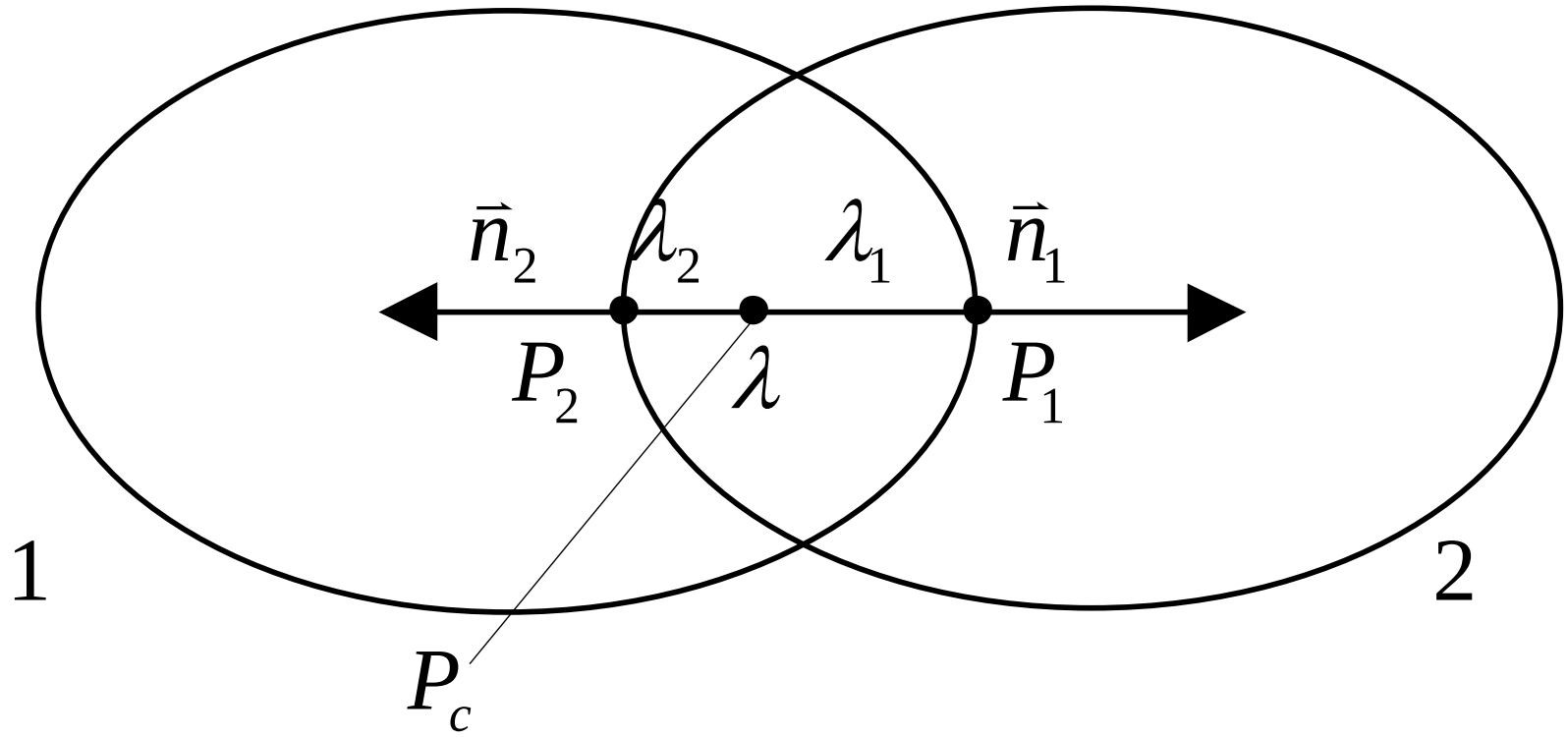
Ellipsoid-ellipsoid contact model



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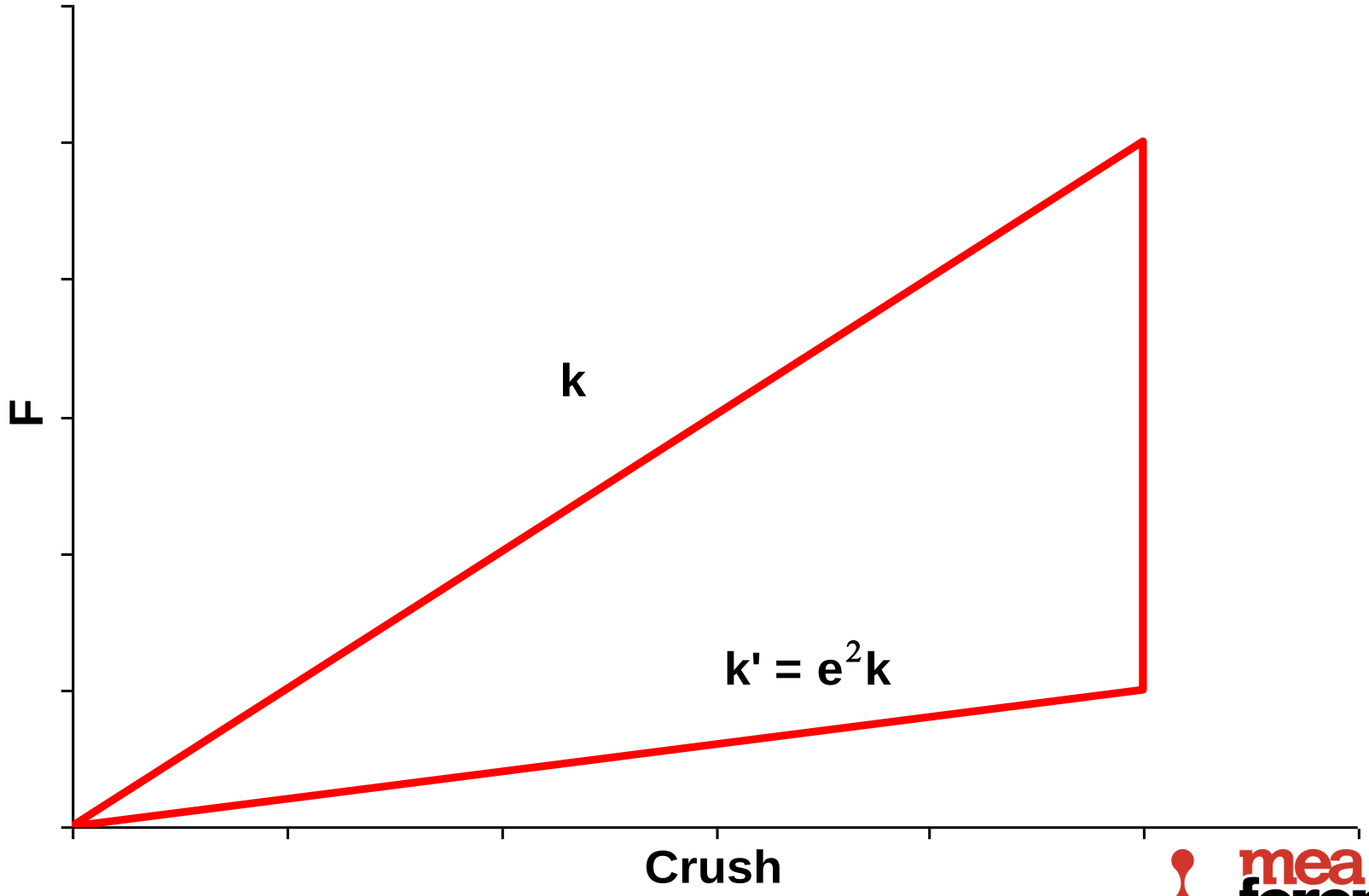
Force-deflection / restitution model



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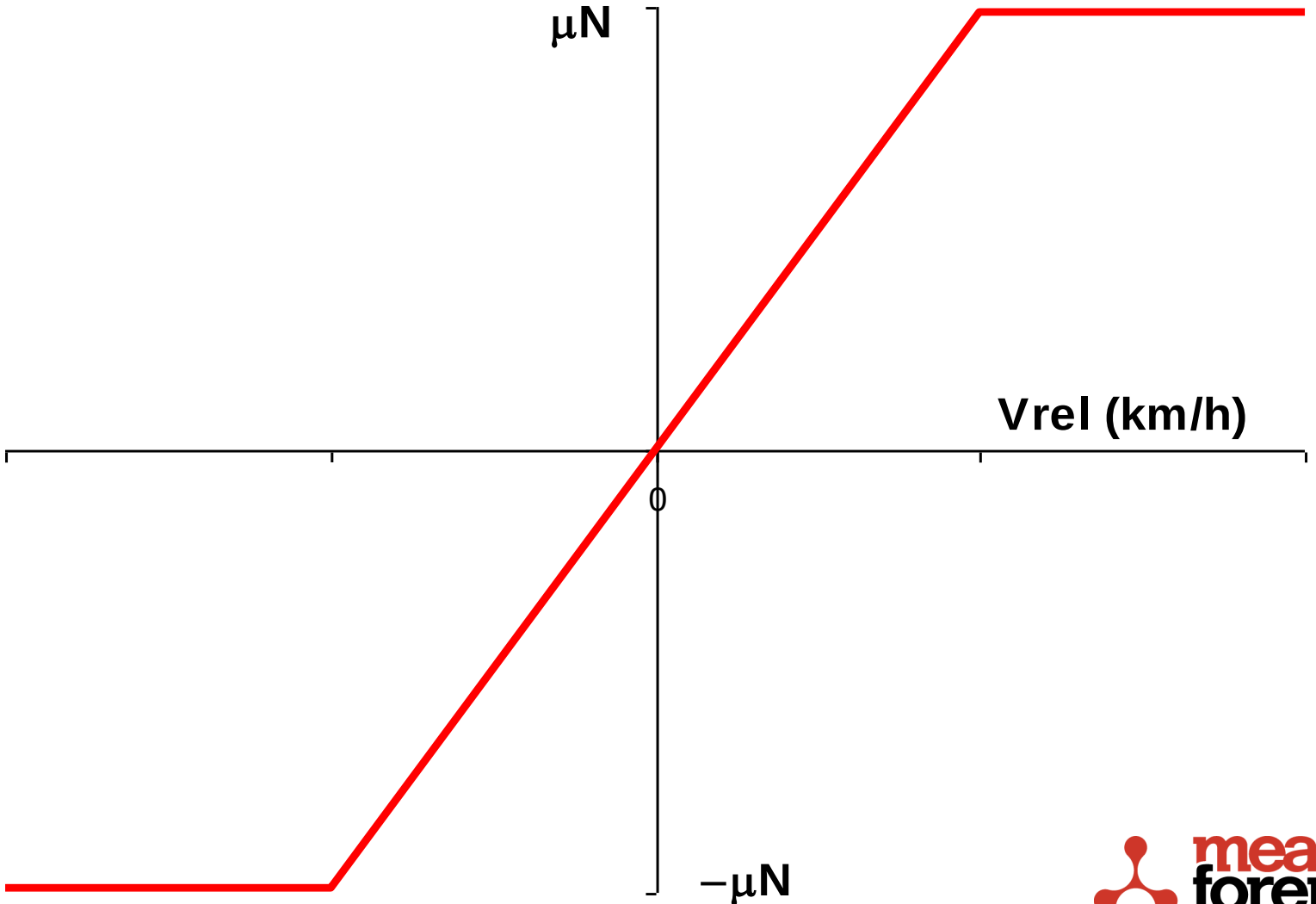
Ellipsoid friction model



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Typical Vehicular Uses

- Rollovers (on flat and 3D ground profiles)
  - Roof stiffness set to 25% of lower body stiffness
  - Wheel stiffness set to 50% of lower body stiffness
  - Wheel to ground friction the minimum of 0.80 or as specified for the scene
- Low speed impacts
- Sustained contact impacts

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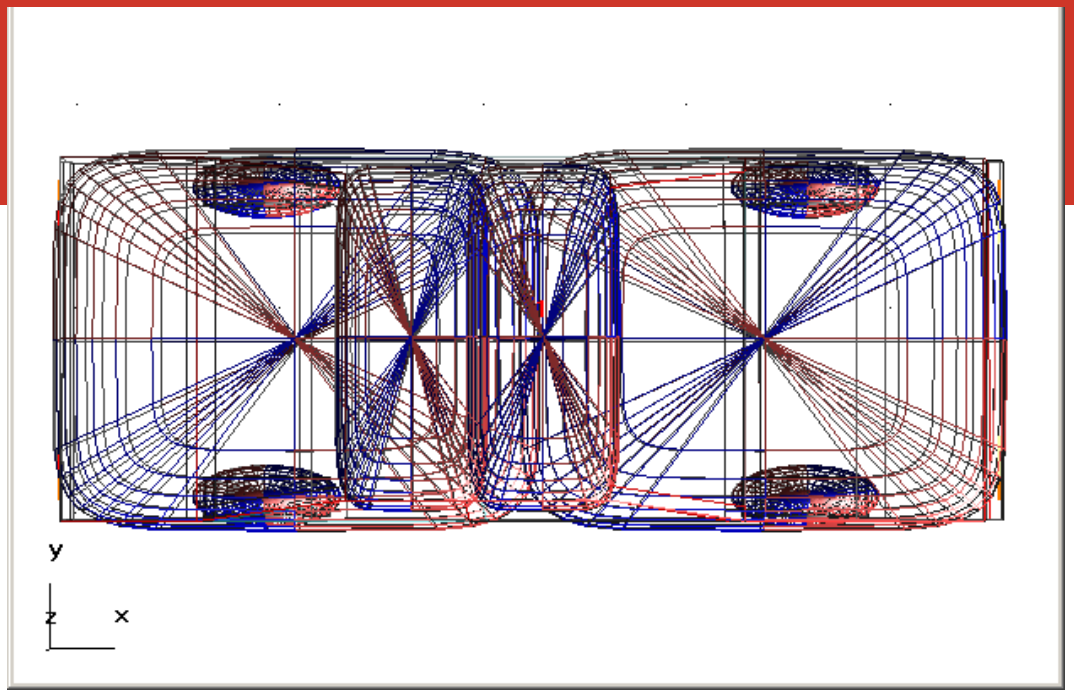
Typical Ellipsoidal Vehicle Model

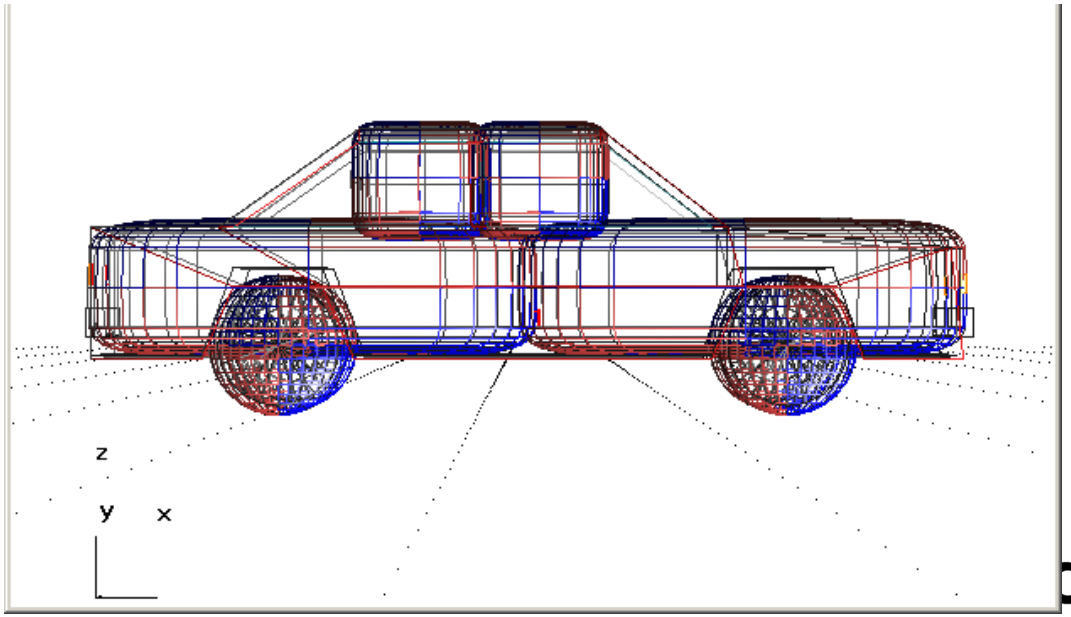
Top view



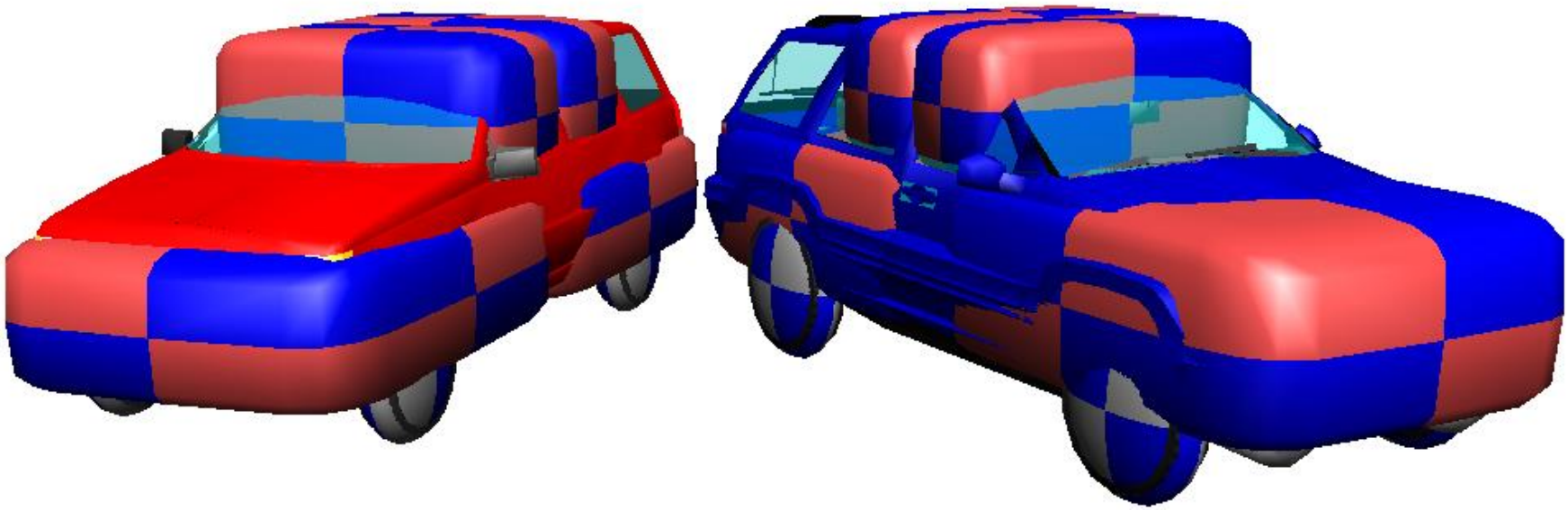
Present car model has 8 ellipsoids:

- 4 for body
- 4 for wheels

Side view



Ellipsoid model



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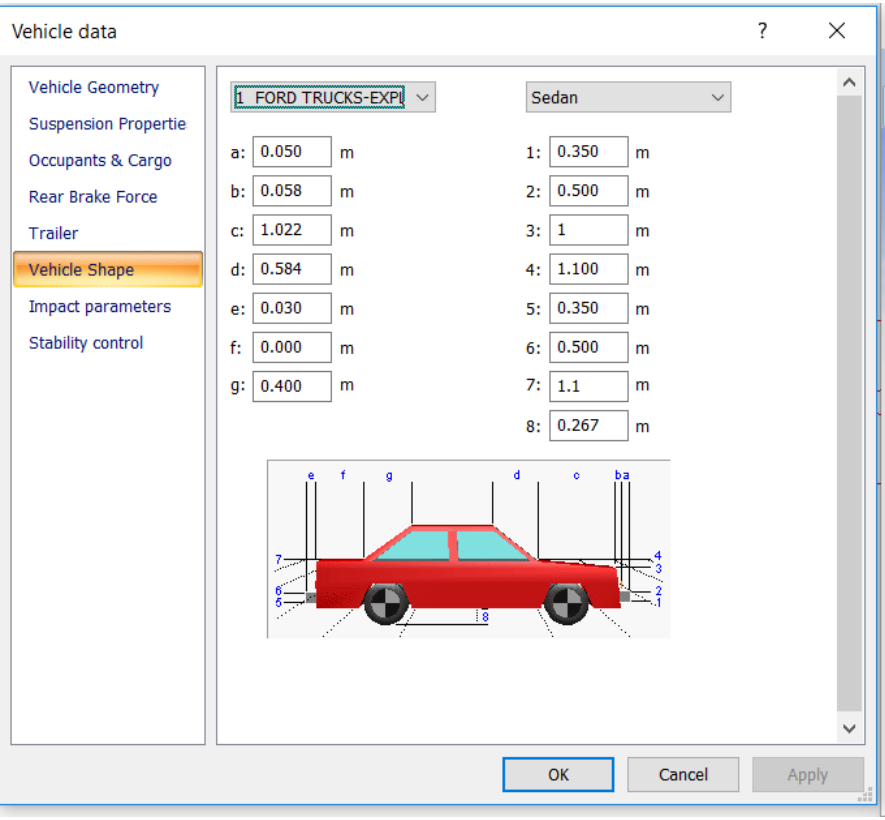
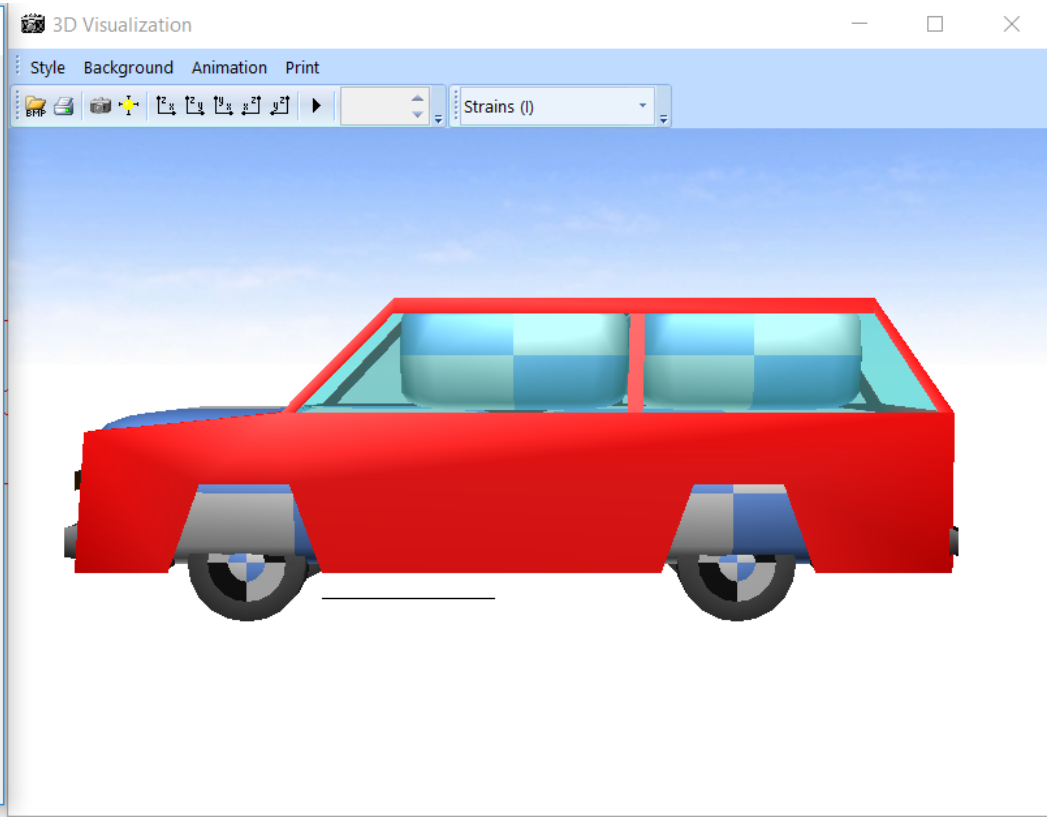
Vehicle Shape editor





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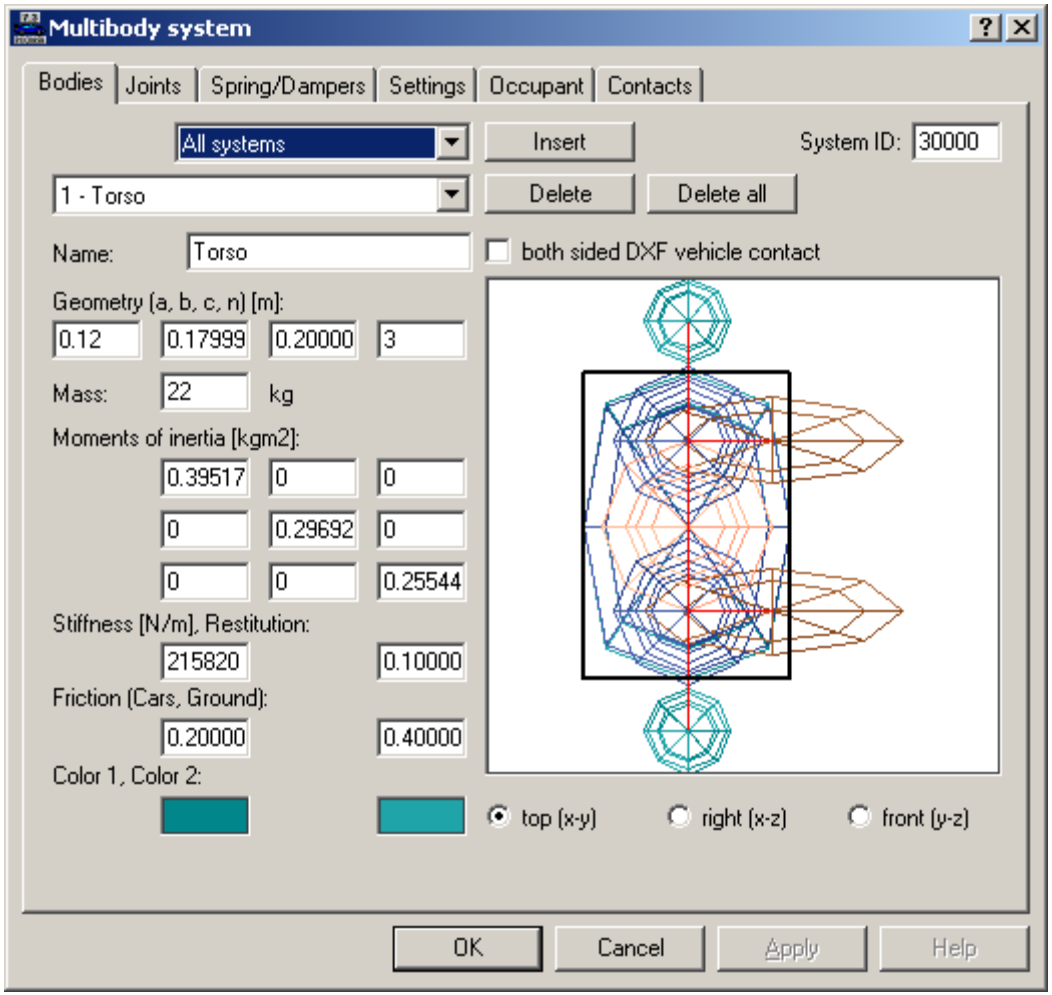
Multibody Editor



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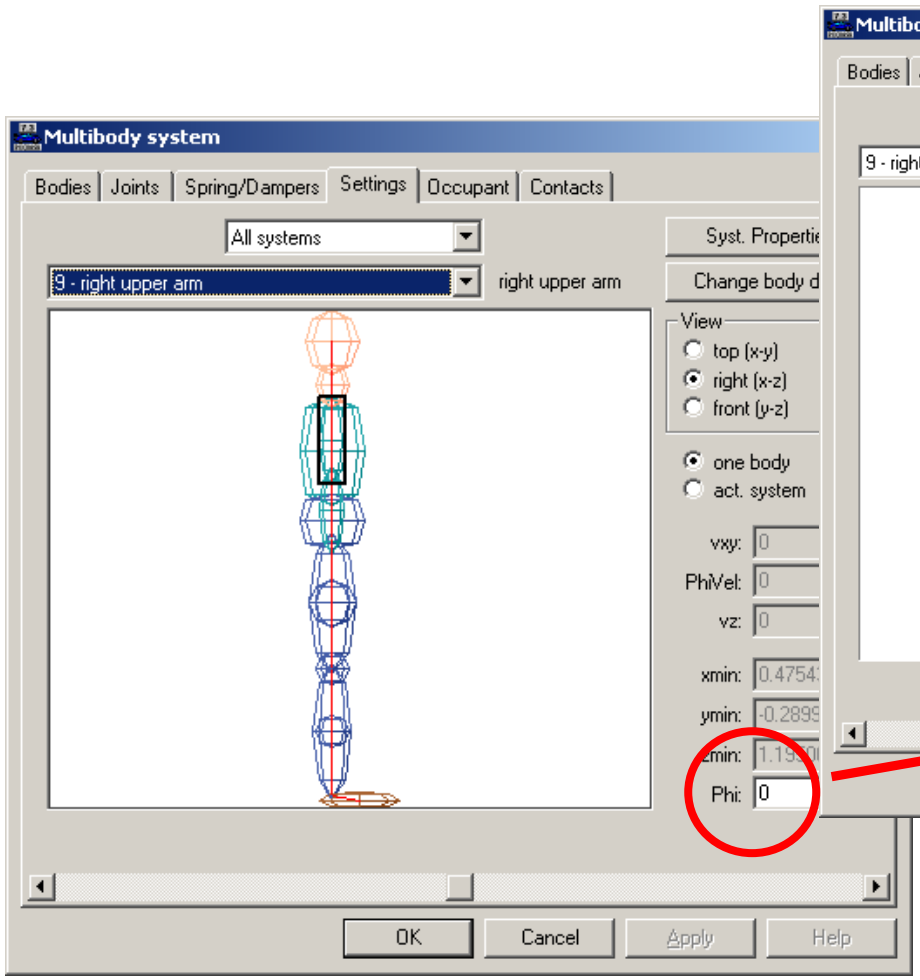
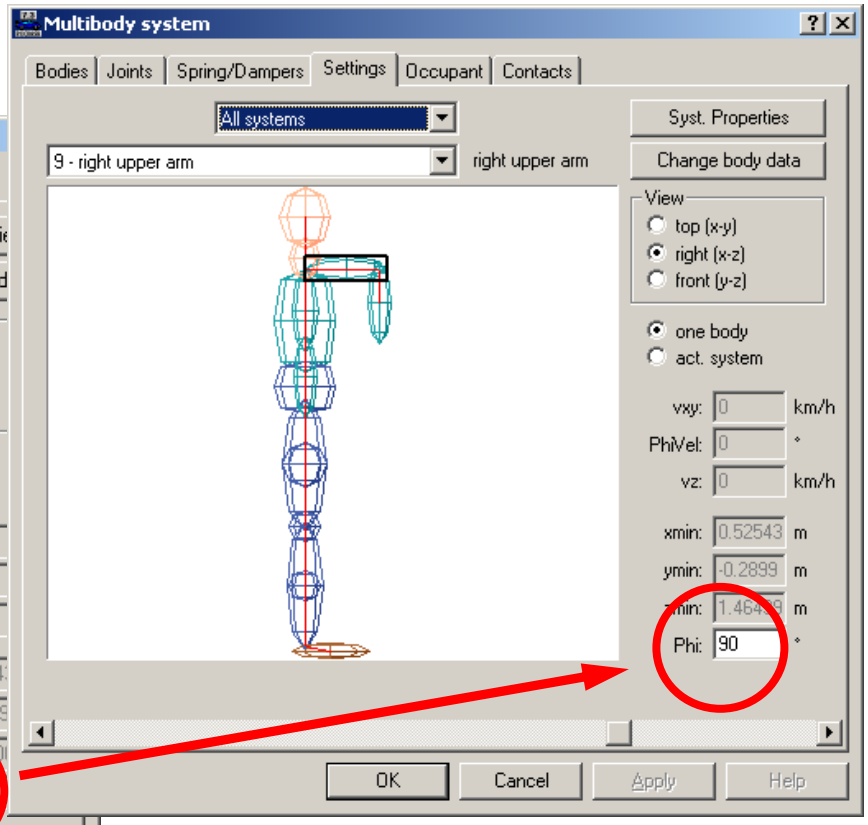
Multibody editor - Posing





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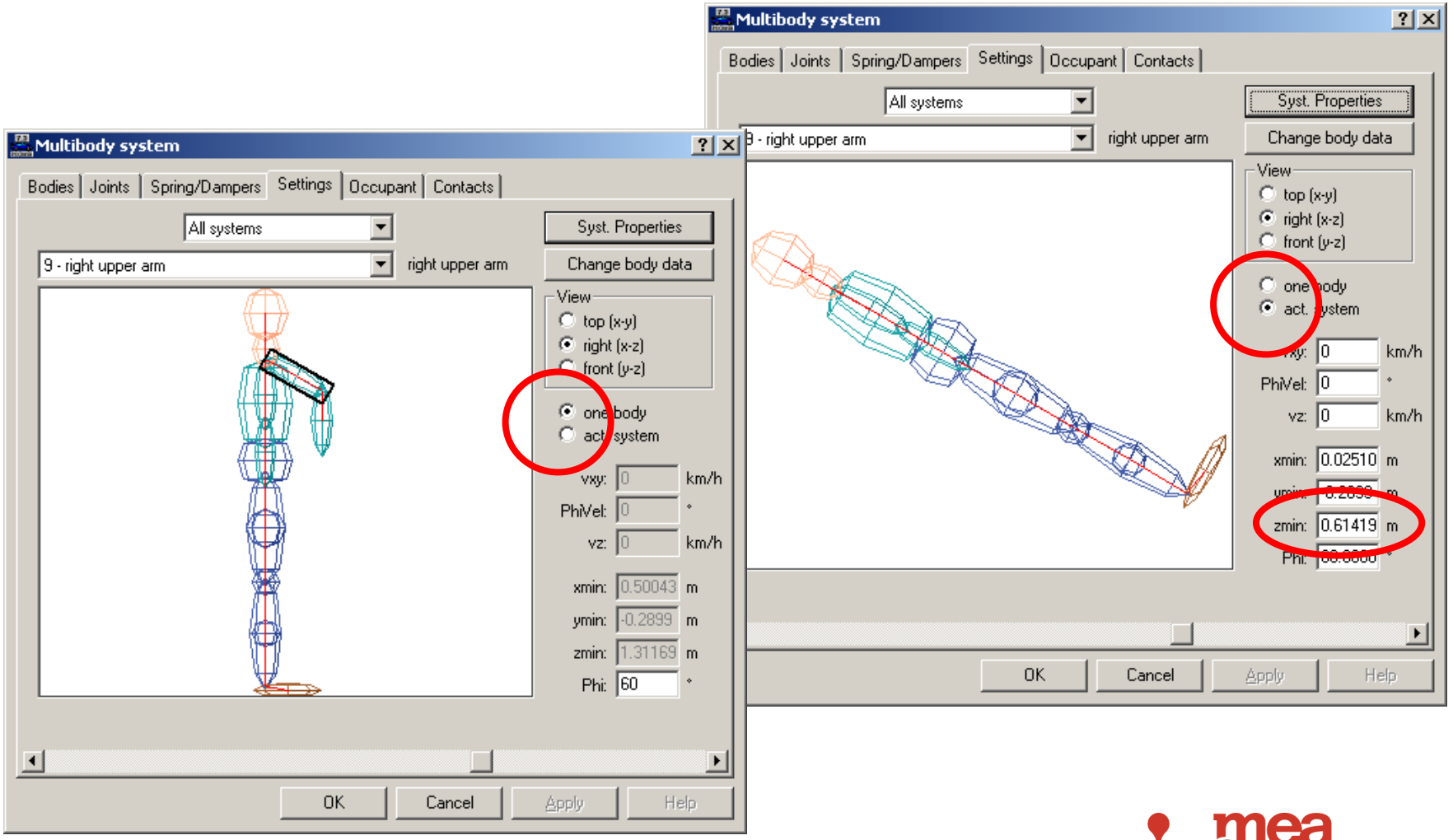
Multibody editor - Posing



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Multibody editor

- Numbers displayed in aEb notation
- Angles applied in order Roll-Pitch-Yaw (X-Y-Z) in global frame
- Editor display snaps to first body with respect to Yaw
- Act. System adjusts properties for all bodies as a unit

Multibody editor – Adding bodies

- Click Insert on Bodies tab
  - Adjust geometry and inertia
- Click Insert on Joint tab
  - Select bodies to link
  - Edit joint locations relative to each body
- Click Settings tab
  - Adjust body orientation