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Tire Envelope Swept Volume
Using
CATIA V5 DMU Kinematics

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- To create the correct tire clearance envelope, there needs to be an understanding of basic suspension geometry.
- This example will touch upon areas such as Ackermann Steering, Front/Rear Steer, Jounce/Rebound, Clearance Zones and Turning Radius.
- The result will be a swept volume using CATIA DMU Kinematics.

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- Certain parameters were set in this particular design.
  - Track: Front/Rear = 1490/1510mm
  - Wheelbase = 2489.2mm
  - Tire Size: (http://www.csgnetwork.com/tireinfo4calc.html)
    - Front = P245/45ZR-17
      (Tire Radius = 326.15mm)
    - Rear = P275/40ZR-18
      (Tire Radius = 338.60mm)
  - Wheel Size:
    - Front = 17 x 8.5 in, Offset = 56mm
    - Rear = 18 x 9.5 in, Offset = 63mm

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- Parameters (cont'd).
  - Scrub Radius = +10mm
  - Steering Axis Inclination = 8.8°
  - Caster Angle = 6.5°
  - SLA Ratio = 1.43:1
  - Brake Rotor Offset (Hub face to Rear Rotor face) = 38mm
  - Ackermann Steering = 82.5%
  - Shock Extension/Compression = 48.7/48.7mm
- All of these parameters affect Tire Clearance Envelope.

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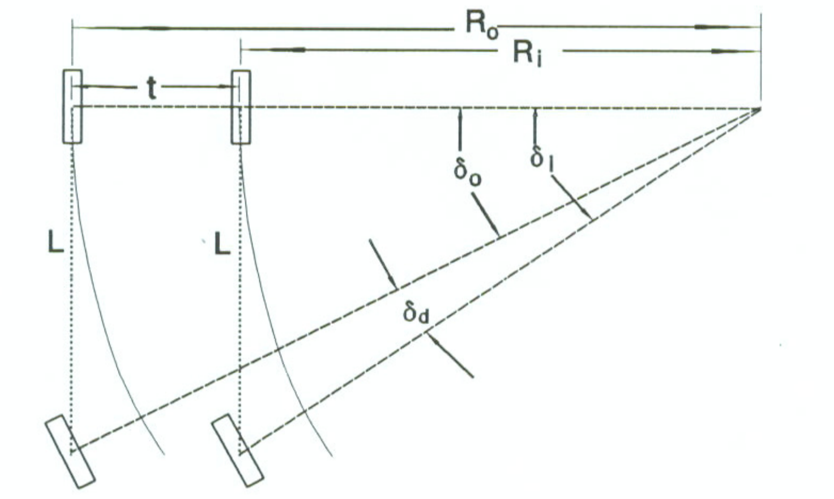
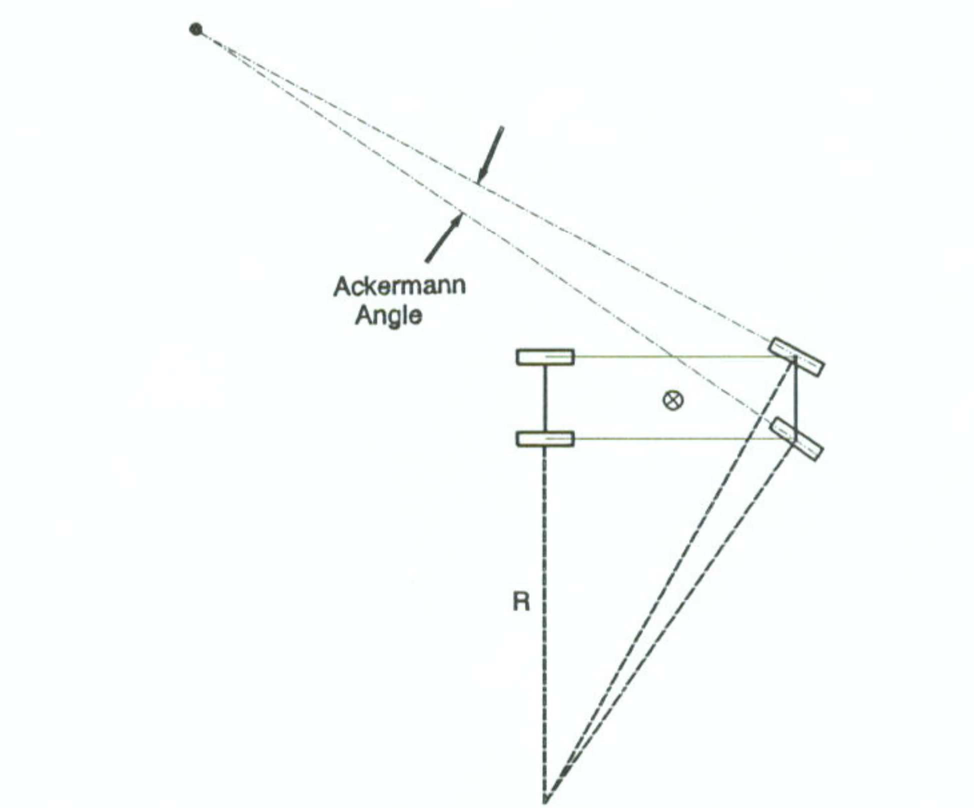
- Ackermann Steering Principle.



Ackermann Steer Angles



Ackermann Steering System

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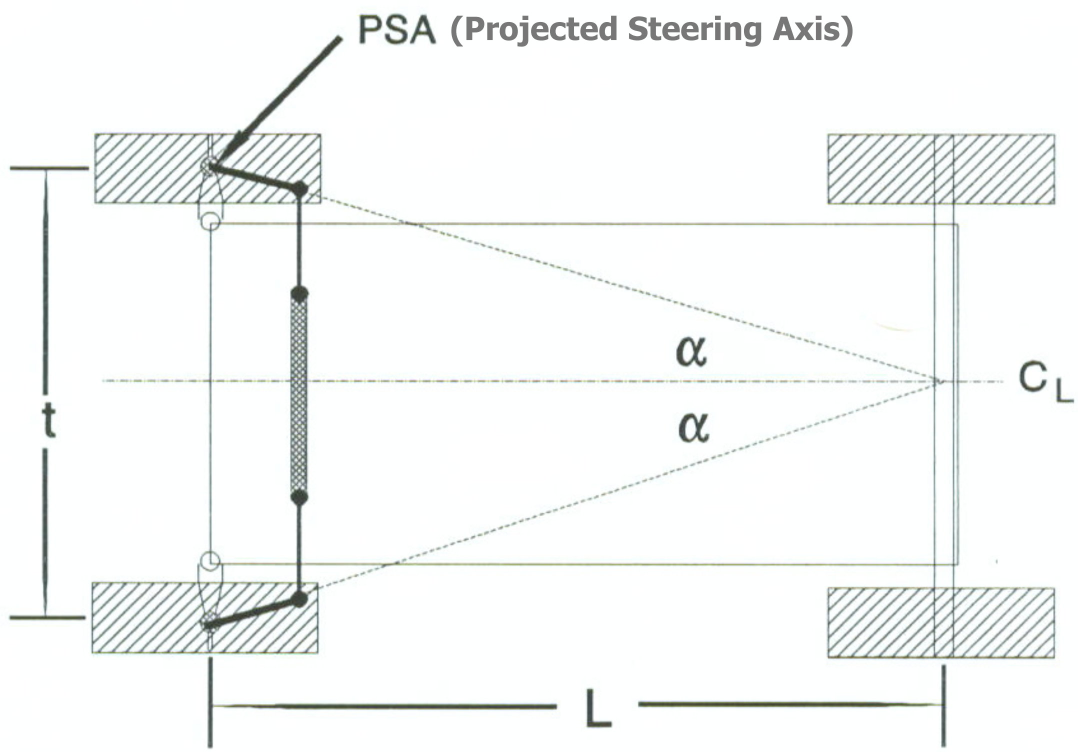
- Rear Steer is used with Recirculating Ball Steering Gear.



Rear Steer Suspension

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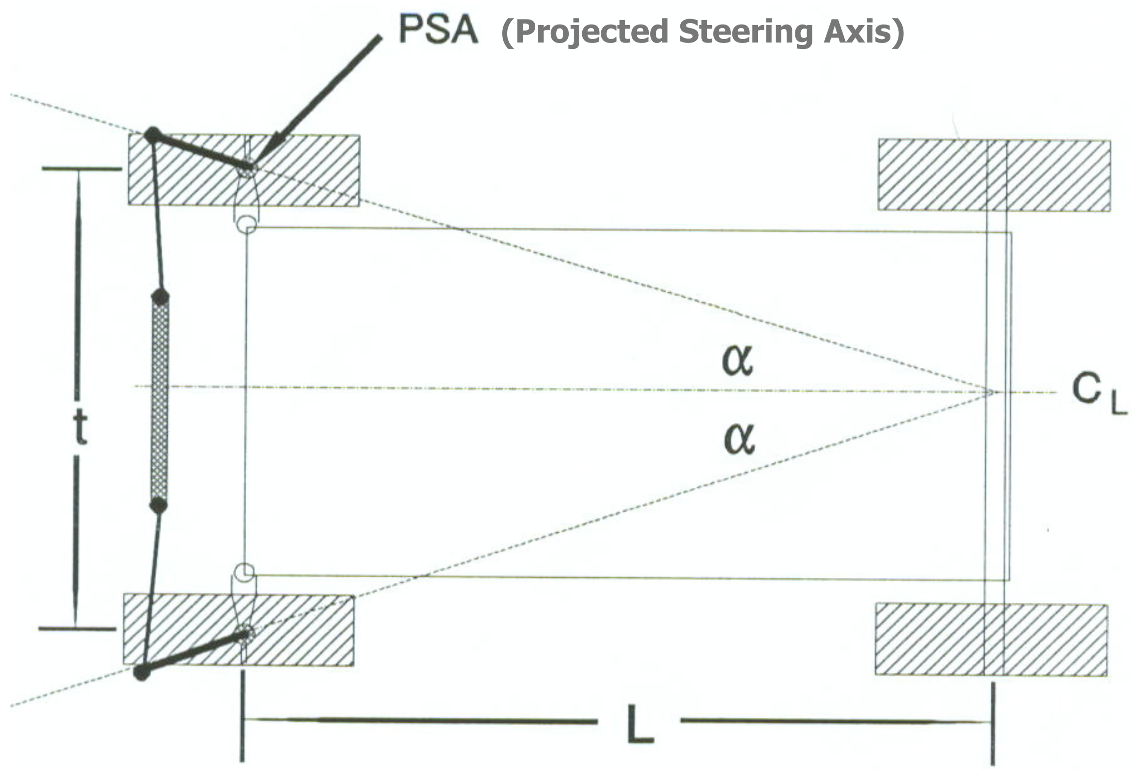
- Front Steer is used with Rack & Pinion Steering Gear.



Front Steer Suspension

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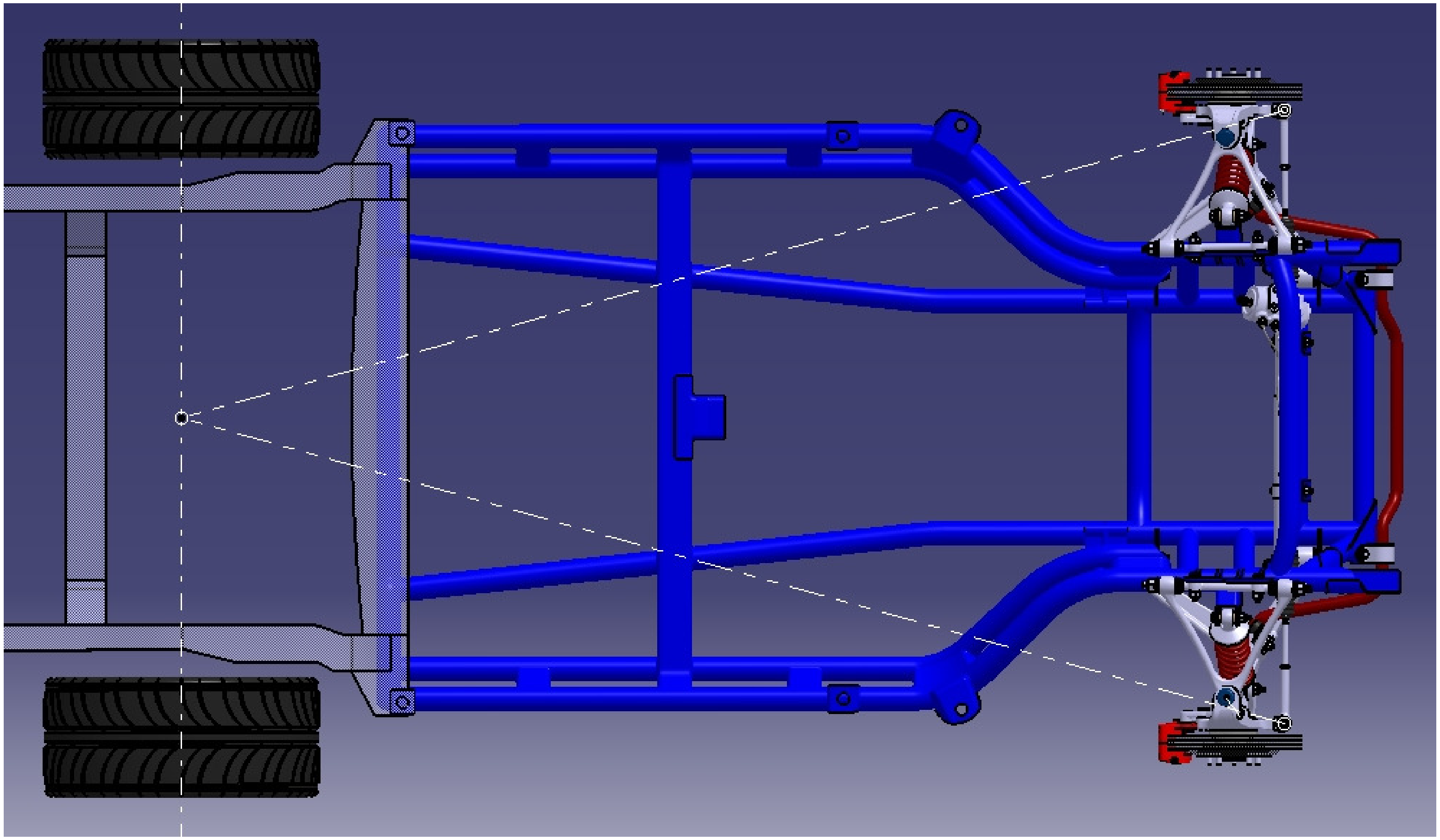
- Ackermann angles set up the Tie Rod Ends.



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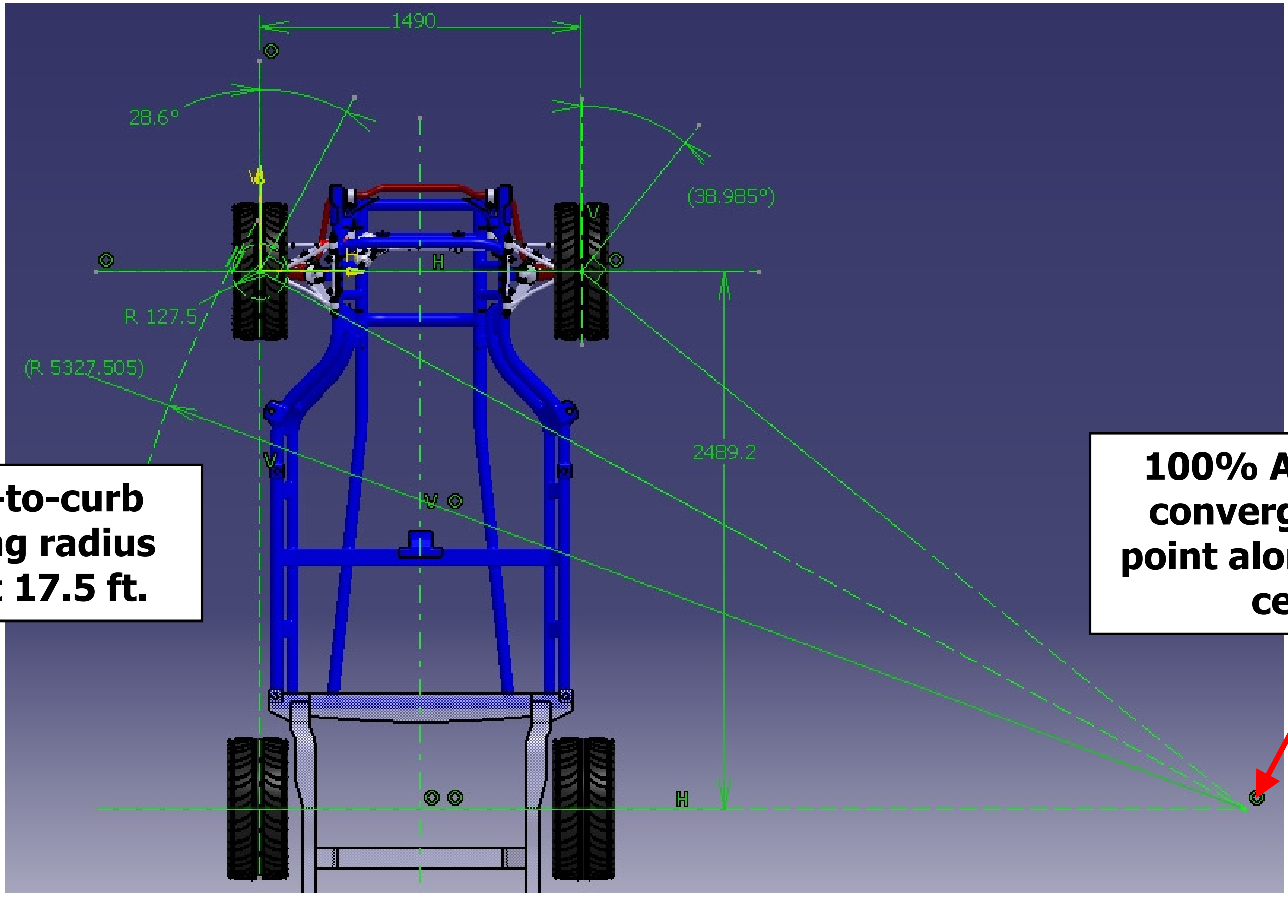
- 100% Ackermann angles and the resultant Turning Angles.



Curb-to-curb turning radius set at 17.5 ft.

100% Ackermann will converge at the same point along the rear axle centerline.

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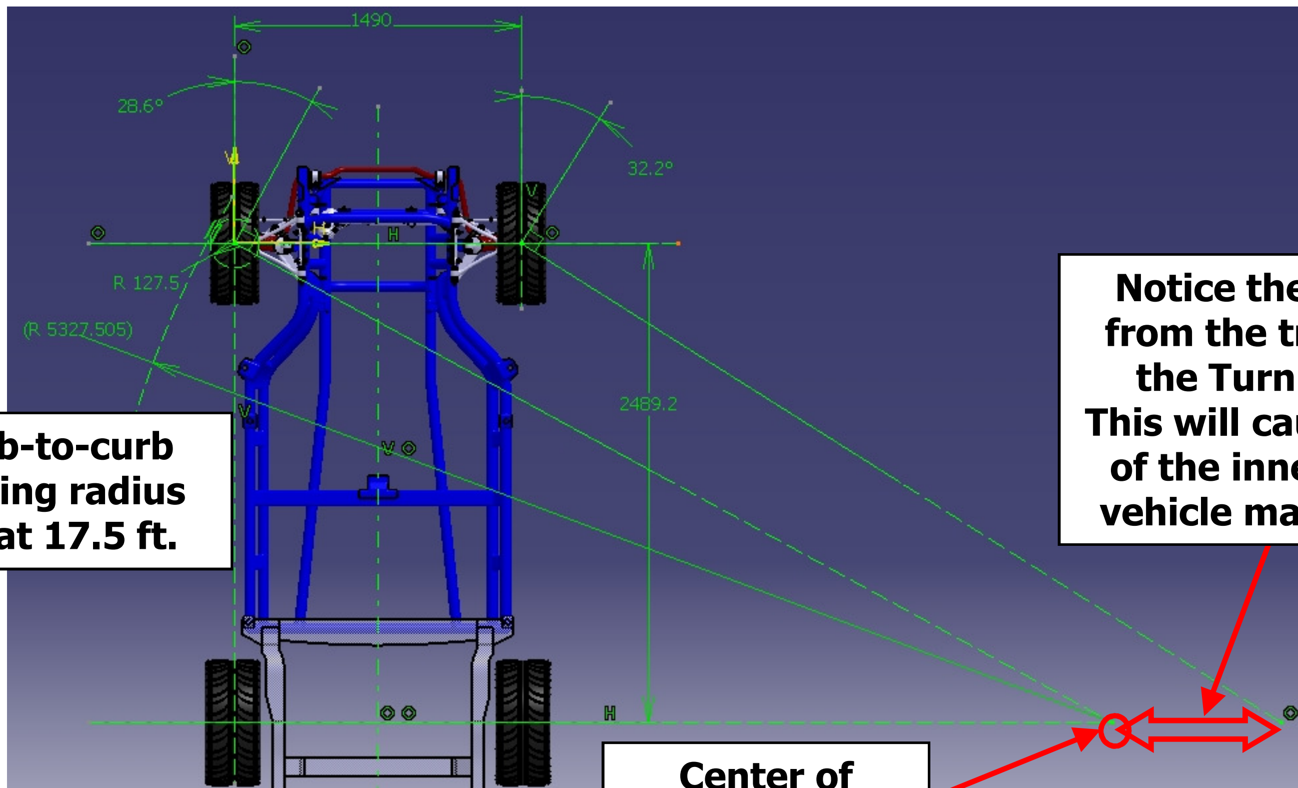
- 82.5% Ackermann angles and the resultant Turning Angles.



Curb-to-curb turning radius set at 17.5 ft.

Notice the divergence from the true center of the Turning Radius. This will cause scrubbing of the inner tire as the vehicle makes the turn.

Center of turning radius

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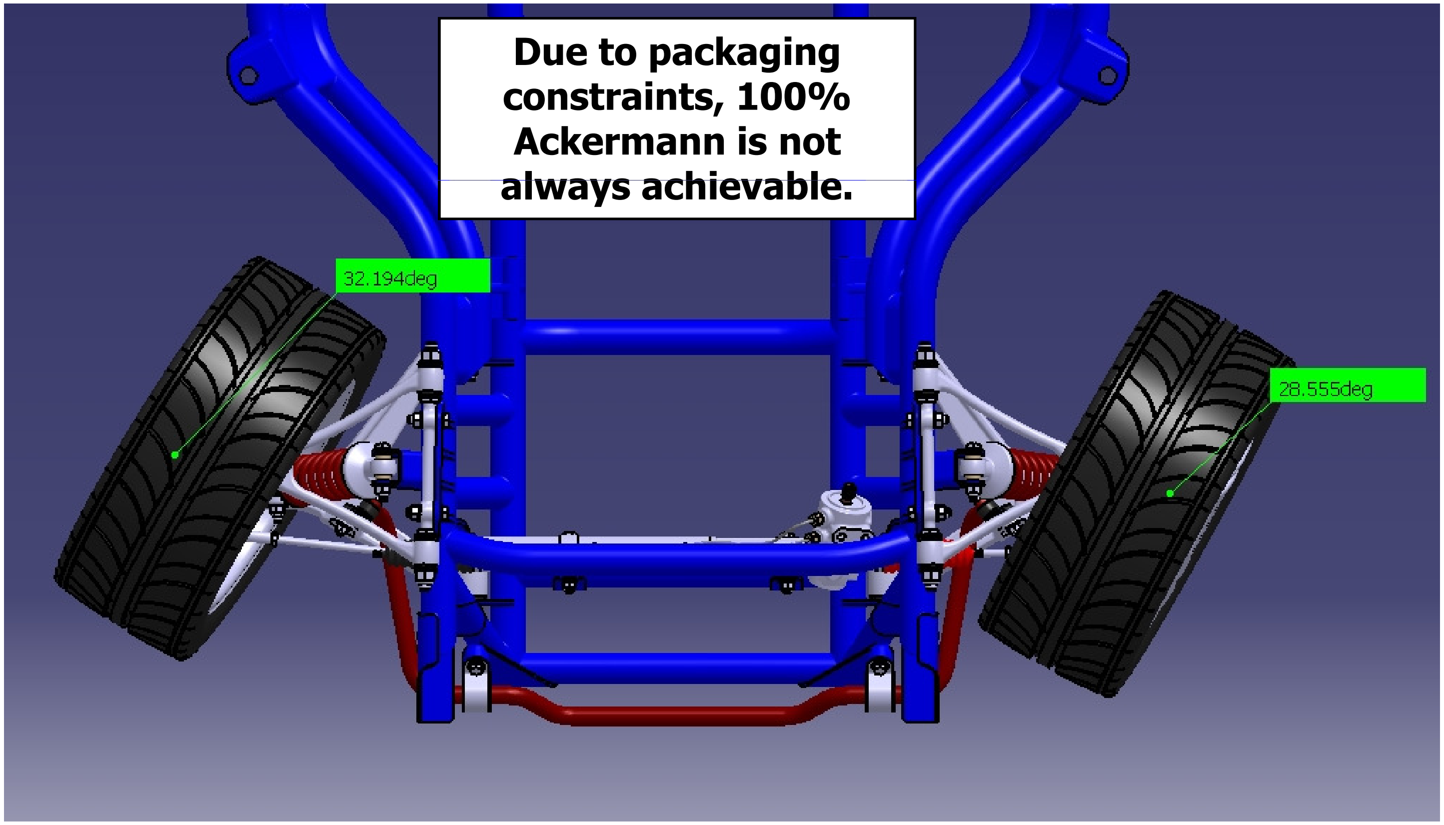
- Less than 100% Ackermann is a normal compromise in today's passenger vehicles.



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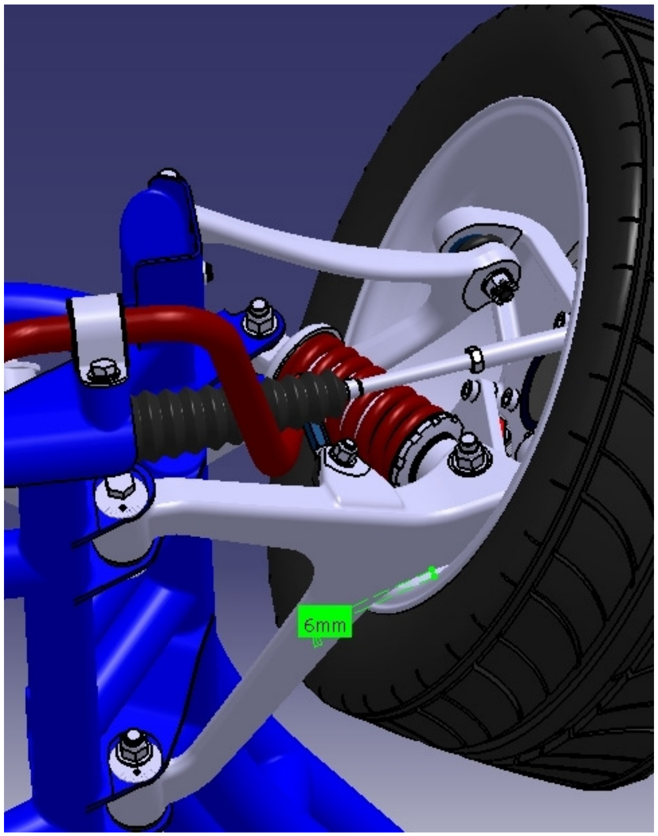
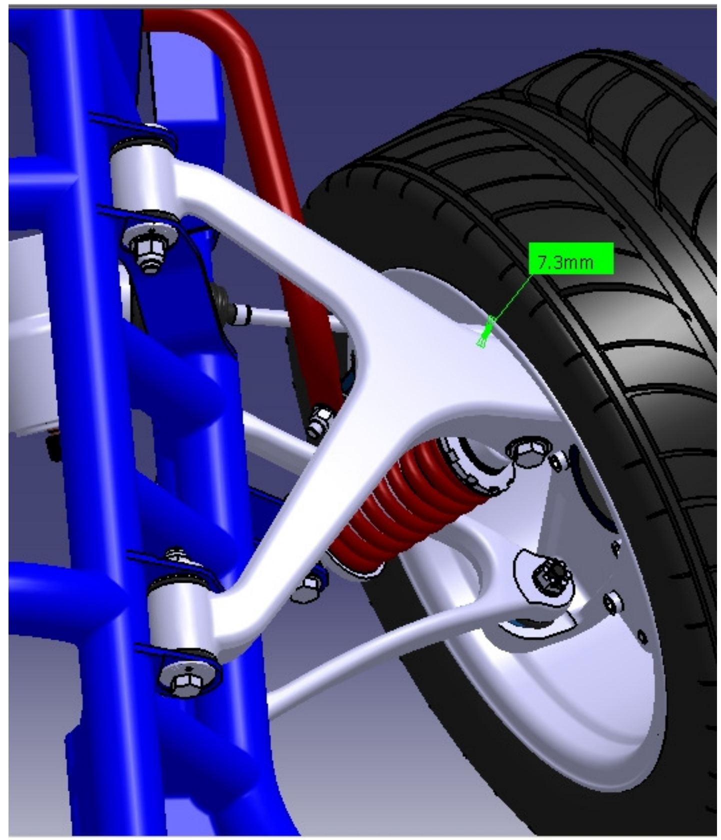
- The worst condition is at full jounce and full turning angles.





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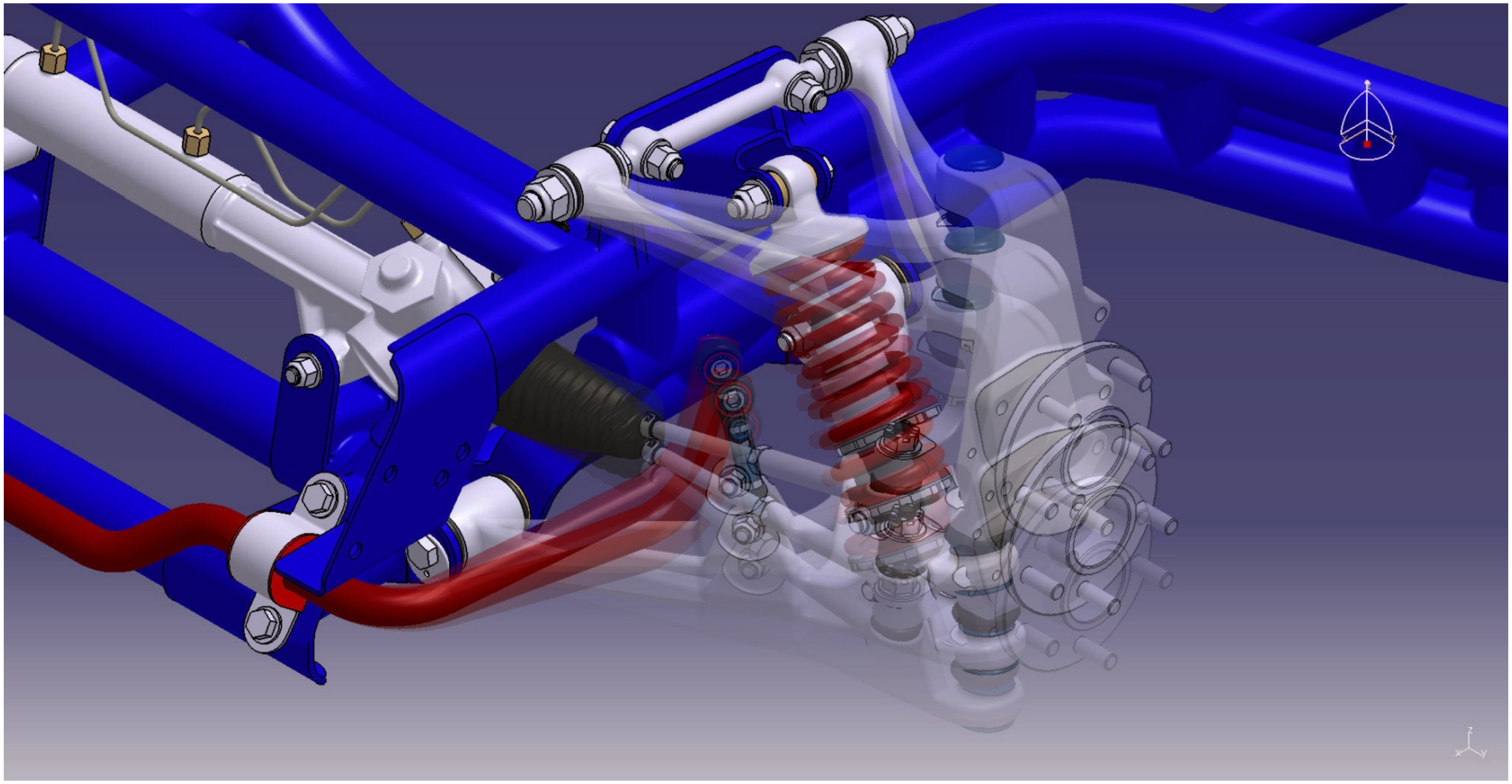
- The jounce (full up) and rebound (full down) must be determined.



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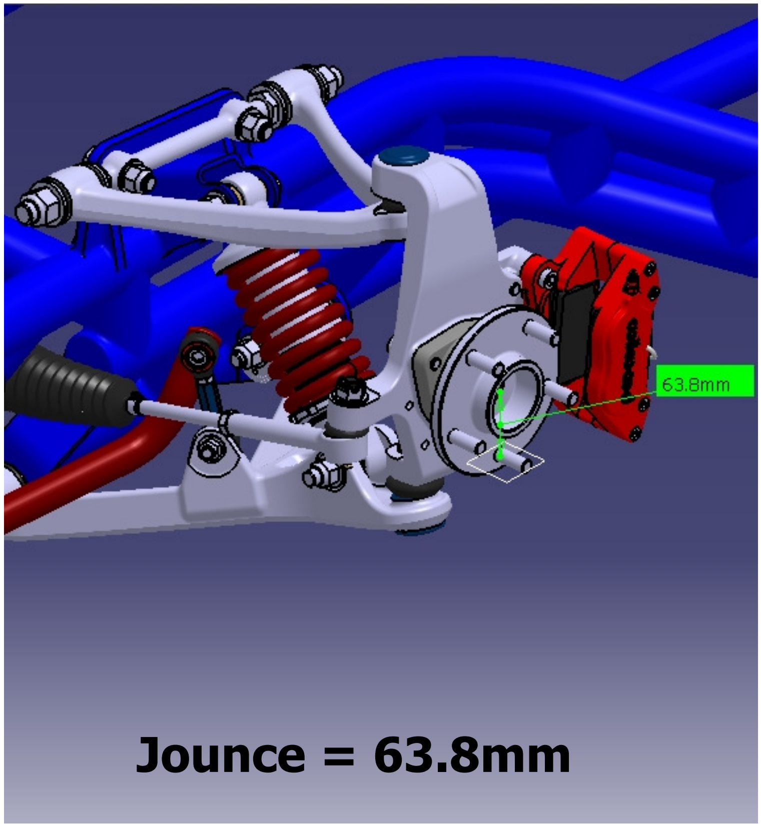
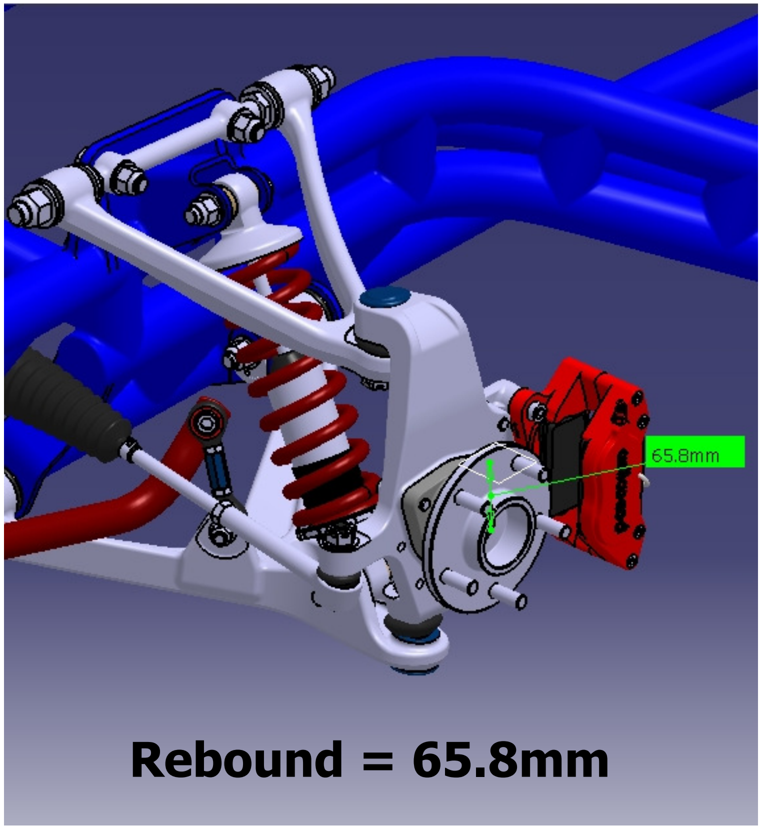
- Measure the jounce (full up) and rebound (full down).





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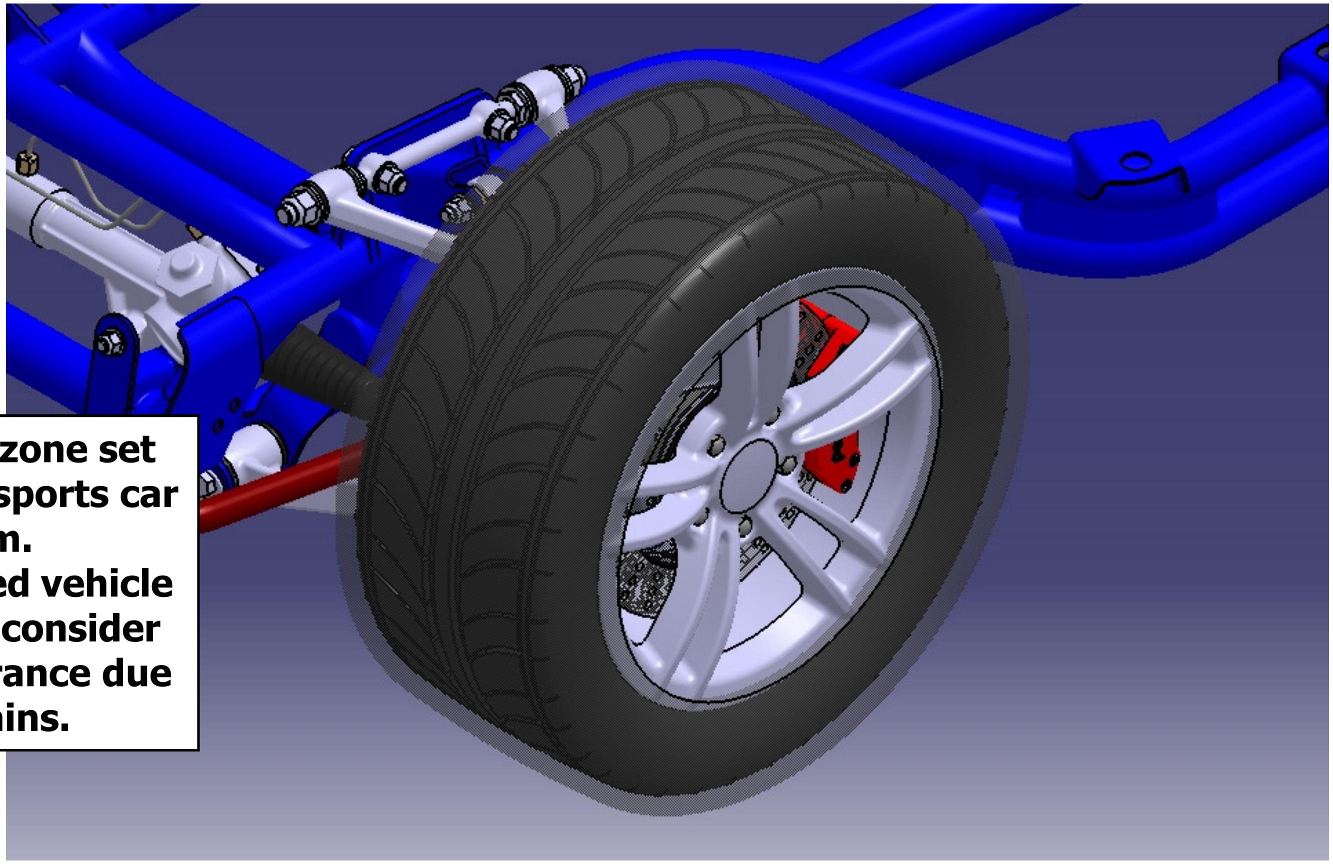
- Another parameter is the clearance zone required around the tire.



**The clearance zone set on this one-off sports car is 19 mm.
A mass produced vehicle would need to consider additional clearance due to tire chains.**

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Now there is enough information to get an accurate Swept Volume representing the Tire Clearance Envelope.

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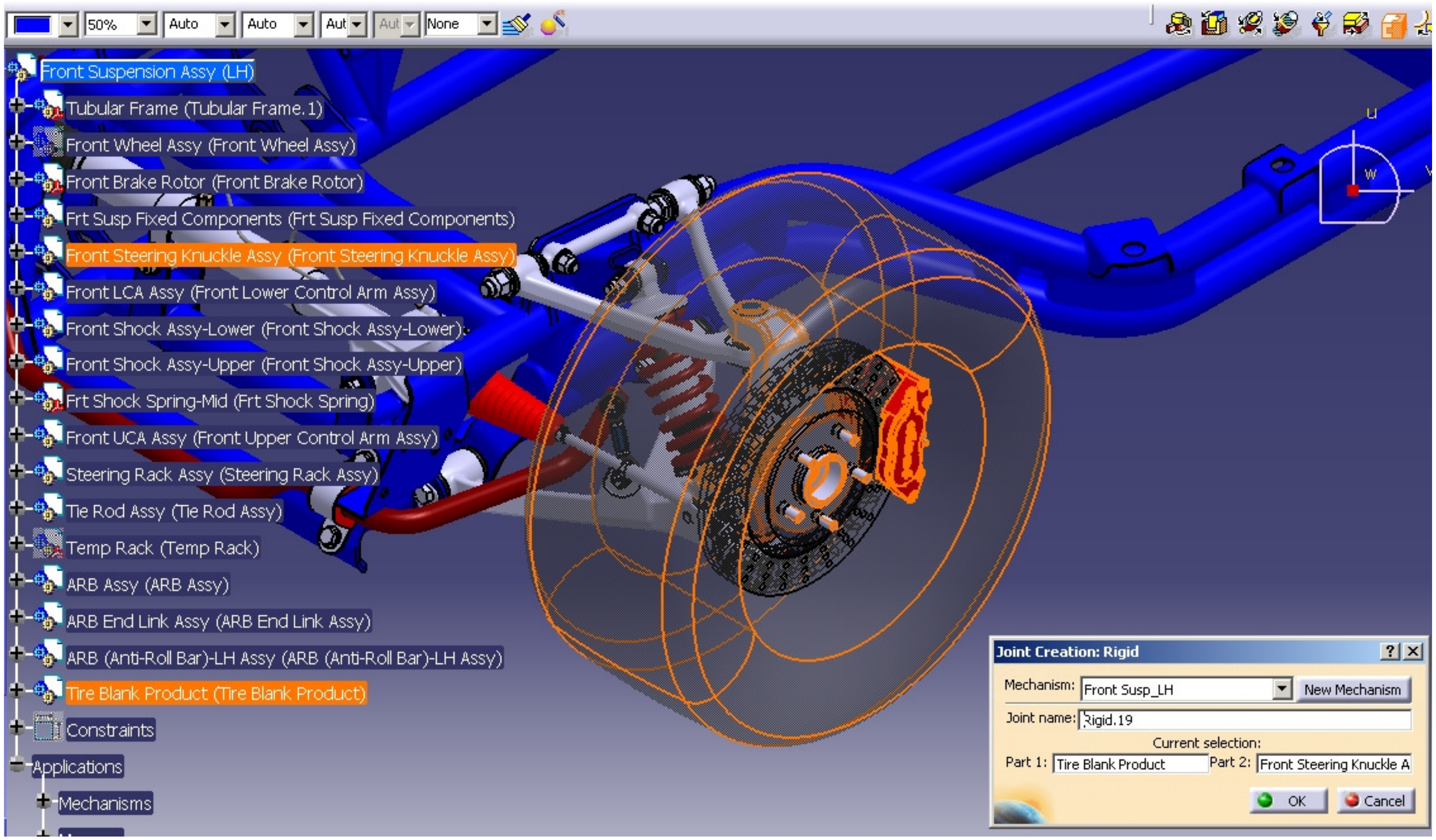
- Step 1: Create a Rigid Joint for the Tire Clearance Zone in the current Kinematic Mechanism.



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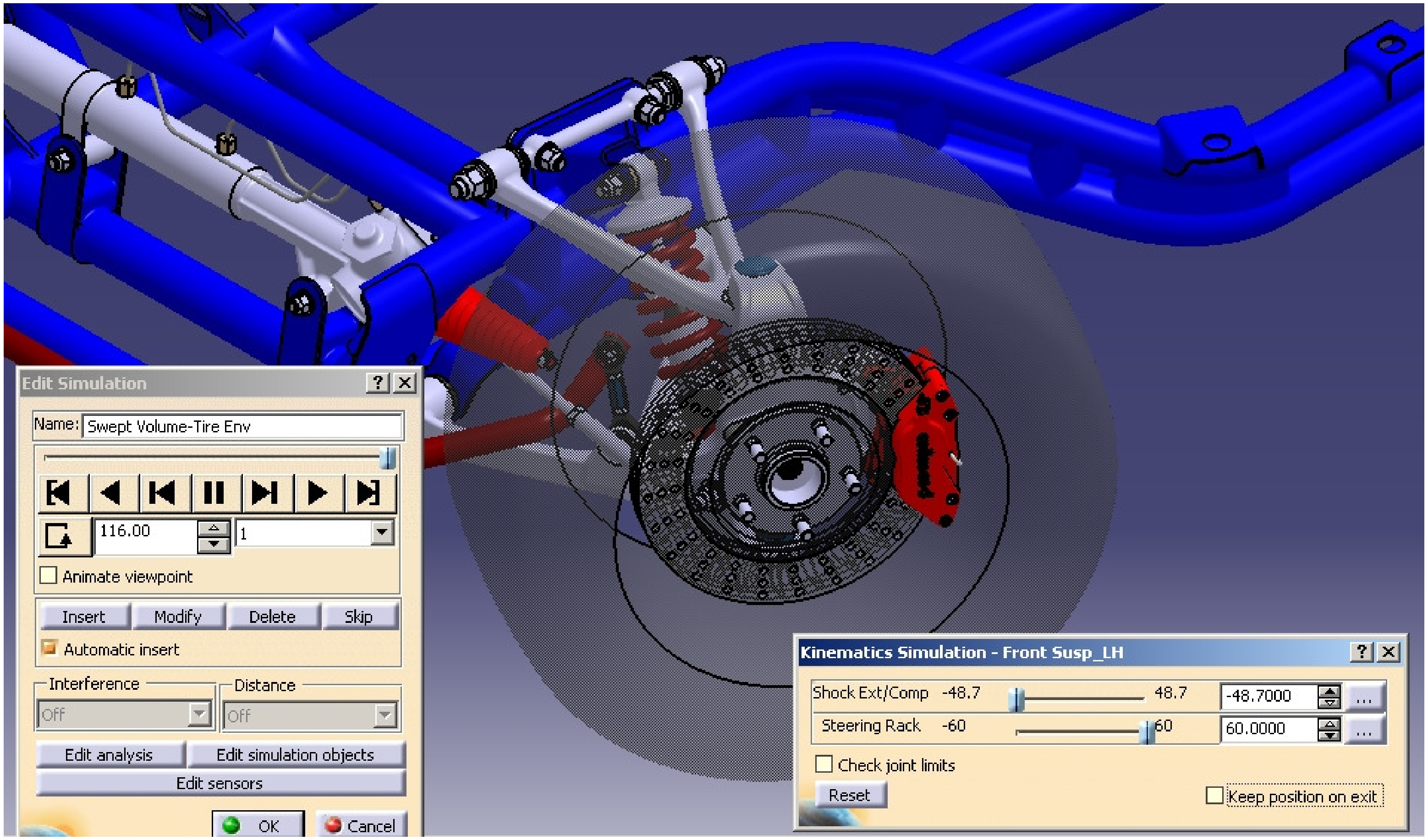
- Step 2: Create a Simulation in DMU Kinematics.



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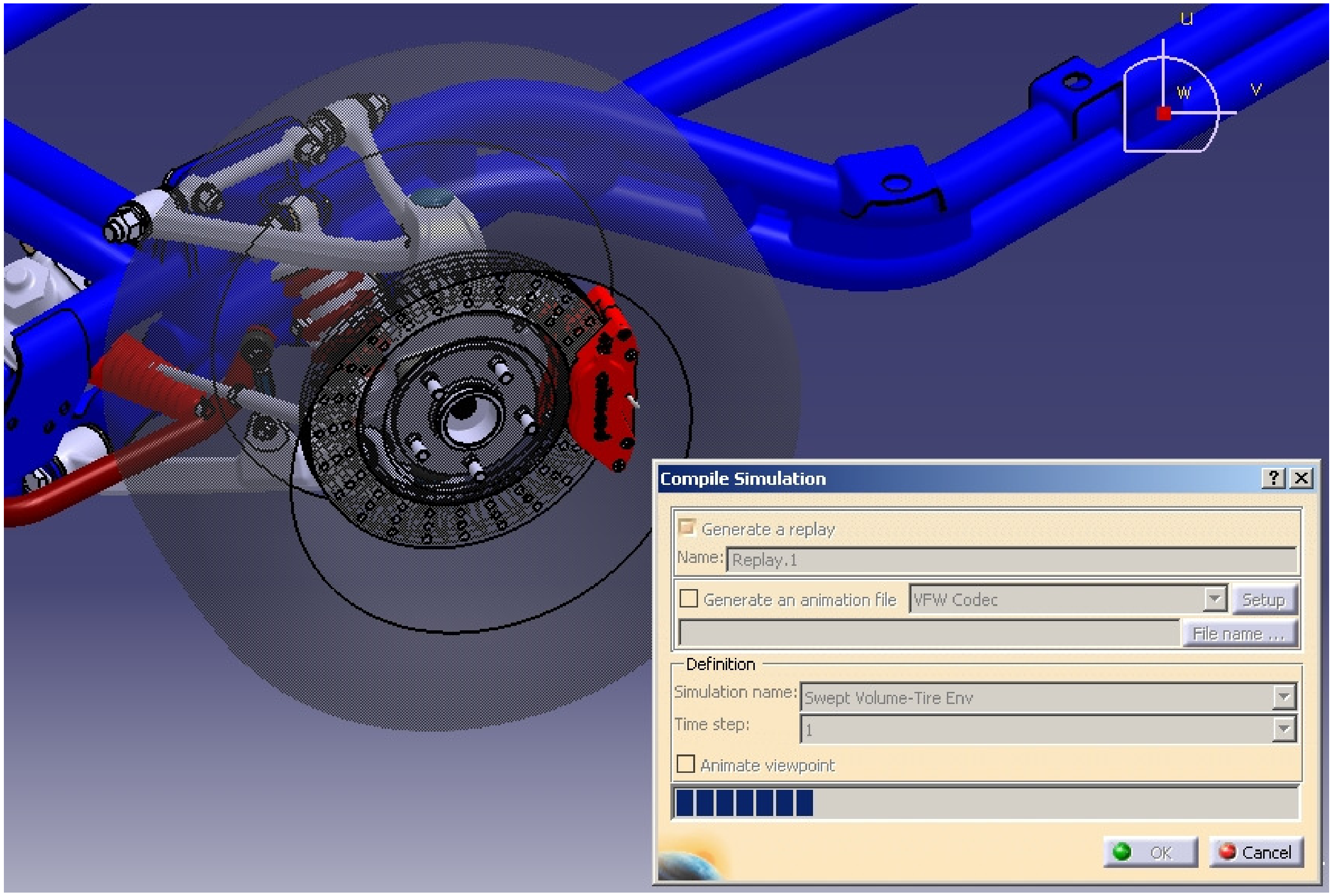
- Step 3: Compile the Simulation in DMU Kinematics.



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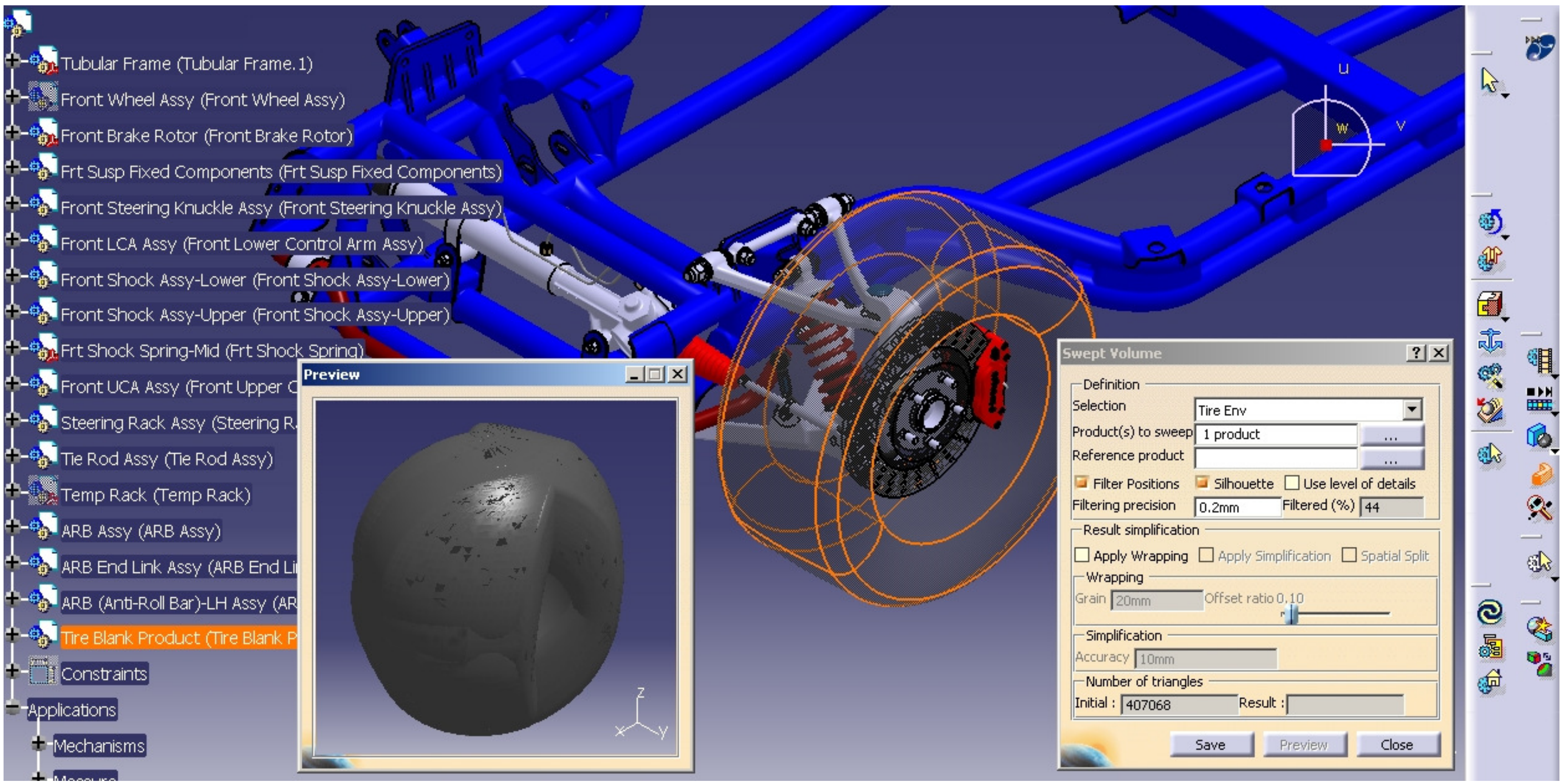
- Step 4: Generate the Swept Volume in DMU Kinematics.



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- Step 5: Add the Swept Volume into the Product.