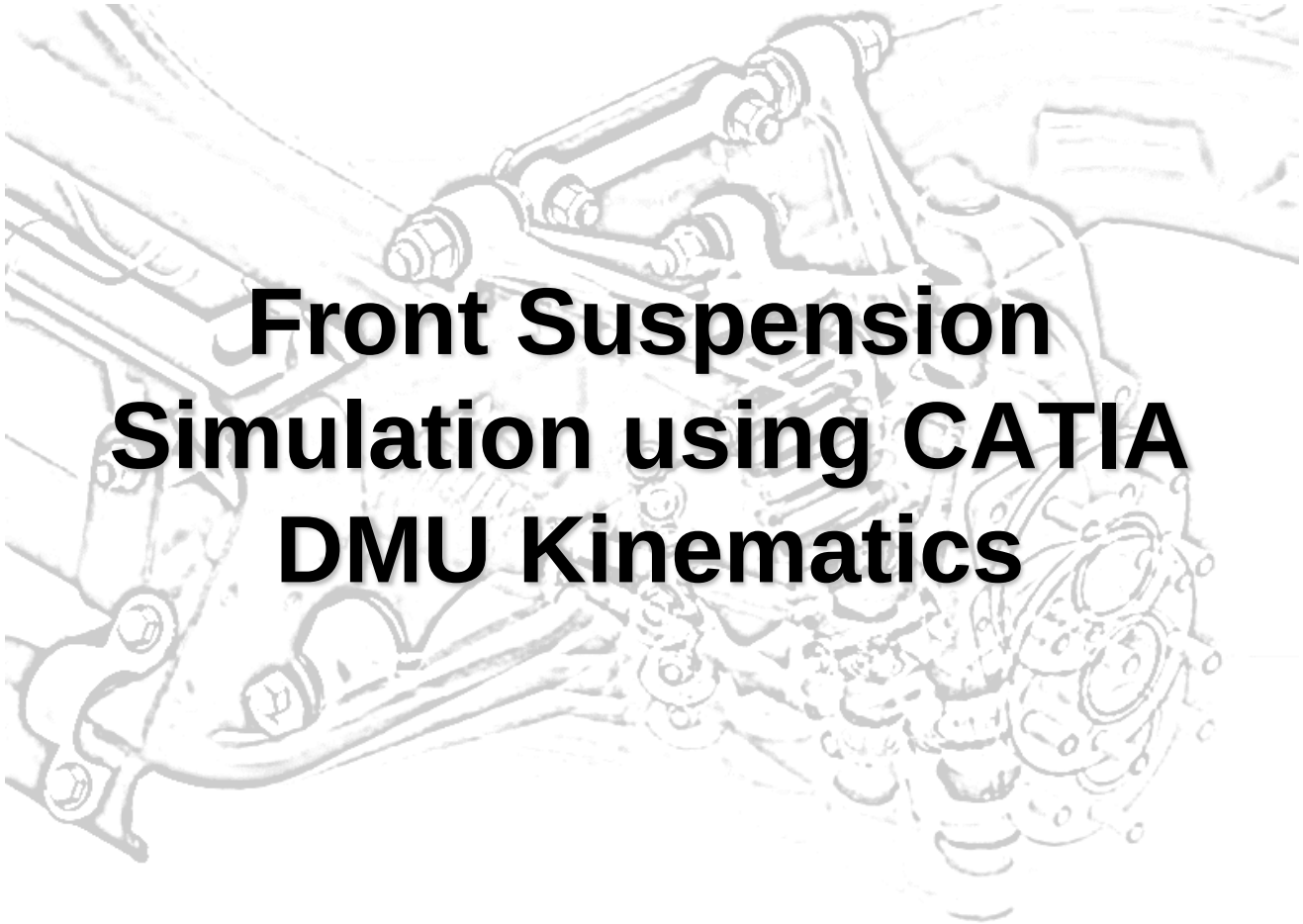


Front Suspension Simulation using CATIA DMU Kinematics

BND TechSource

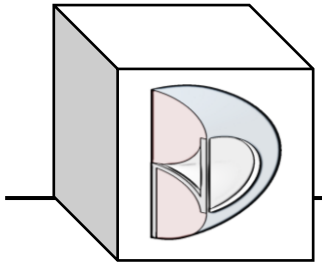
- The following licenses are required to create this DMU Kinematic simulation:
  - Digital Mockup Kinematics
  - Mechanical Part Design
  - Generative Shape Design
  - Assembly Design

BND TechSource

- To create this DMU Kinematic simulation, we must begin with several known parameters.
- Known:
  - All suspension “hard points”.
    - Pivot points and lines
    - Angles of axes and planes
  - Min/Max Command values
    - Shock down/up (-50mm, 48mm)
    - Steering left/right (-55mm, 55mm)

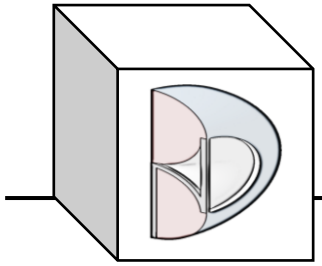
BND TechSource

Vehicle Suspension Hardpoints					
Front Suspension					
Configuration:	GM C5 Corvette Independent Front Suspension				
Scrub (Pivot) Radius =				10.0 mm	
Steering (Kingpin) Inclination Angle (SAI) =				8.8 deg	
Caster Angle =	6.5 deg	+0.4 deg		+/- 0.5 deg	
Mechanical (or caster) trail =				35.5 mm	
Toe Angle =		+0.04 deg		+/- 0.10 deg	
Camber Angle =		-0.2 deg		+/- 0.5 deg	
Ball Joint Pivot Points relative to Suspension Analysis Axis					
Upper (Double wishbone, Multi-link, Trailing Arm, etc.) = (x, y, z)					
Upper Ball Joint =	X	Y	Z		mm
	-17.51	663.90	468.99		
Lower (Double wishbone, Multi-link, Trailing Arm, etc.) = (x, y, z)					
Lower Ball Joint =	X	Y	Z		mm
	16.11	709.94	171.58		
Lower only (MacPherson strut) = (x, y, z)				n/a	
Upper Strut Attachment/Pivot Point (MacPherson strut) = (x, y, z)				n/a	



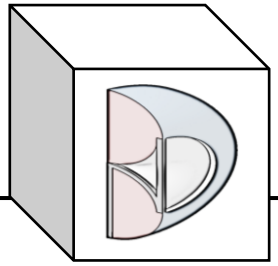
BND TechSource

Control Arm Chassis Attachment Points relative to Suspension Analysis Axis					
Forward Upper (Double wishbone, Multi-link, Trailing Arm, etc.) = (x, y, z)					
UCA Fwd Mnt =	X	Y	Z	mm	
	125.23	408.97	490.14		
Rearward Upper (Double wishbone, Multi-link, Trailing Arm, etc.) = (x, y, z)					
UCA Rwd Mnt =	X	Y	Z	mm	
	-158.38	394.43	431.36		
Forward Lower (Double wishbone, Multi-link, Trailing Arm, etc.) = (x, y, z)					
LCA Fwd Mnt =	X	Y	Z	mm	
	161.41	330.47	171.45		
Rearward Lower (Double wishbone, Multi-link, Trailing Arm, etc.) = (x, y, z)					
LCA Rwd Mnt =	X	Y	Z	mm	
	-223.59	330.47	171.79		
Fwd Lower only (MacPherson strut) = (x, y, z)			n/a		
Rwd Lower only (MacPherson strut) = (x, y, z)			n/a		



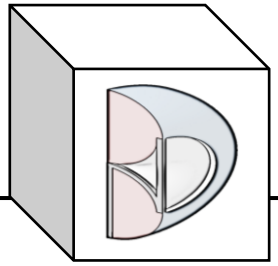
BND TechSource

Knuckle/Brakes/Steering					
Hub Dimensions:	(i.e. hub dia/thickness, pilot dia, hub face to knuckle, stud size/circle dia, etc.)				
	See CAD Data				
Brake Rotor Dimensions:					
Rotor Thickness =			32.0	mm	
Rotor Diameter =			325.0	mm	
Inner Face of Hub to Inner Rotor Surface =			38.0	mm	
Inner Hub Diameter =			190.0	mm	
Outer Hub Diameter =			217.0	mm	
Center Hole Diameter =			70.0	mm	
Brake Caliper to Wheel (min clearance) =			6.5	mm	
Steering Rack Centerline relative to Susp Analysis Axis = (x, y, z)					
Steering Rack Centerline =	X	Y	Z	mm	
	124.11	n/a	273.78		
Tie Rod Pivot Point (inboard) relative to Susp Analysis Axis = (x, y, z)					
Tie Rod Pivot Pt (inboard) =	X	Y	Z	mm	
	124.11	370.00	273.78		
Tie Rod Pivot Point (outboard) relative to Susp Analysis Axis = (x, y, z)					
Tie Rod Pivot Pt (outboard) =	X	Y	Z	mm	
	120.10	724.65	284.52		



BND TechSource

Springs/Shock Absorbers					
Spring Dimensions:	(i.e. Wire dia., OD, Active coils, Inactive coils, Free length, Ground ends, etc.)				
	See CAD Data				
Spring Rate =				87.5	N/mm
Shock Absorber Adjustable Damping (see chart)					
Shock Absorber Type:	Strange - Double Adjustable Coil-over - S5004				
Extension Length =				351.50	mm
Compressed Length =				254.00	mm
Stroke Length (without bump stop) =				98.04	mm
Bump Stop (length) =				14.30	mm
Shock Mounting Pivot Points relative to Susp Analysis Axis = (x, y, z)					
Shock Upper Pivot Point =	X	Y	Z		mm
	-16.98	495.07	464.33		
Shock Lower Pivot Point =	X	Y	Z		mm
	12.43	646.20	204.22		
Spring and Shock Installation Angle =				65.1	deg
Spring and Shock Absorber Motion Ratio @ Ride Ht =				0.759	unit/unit



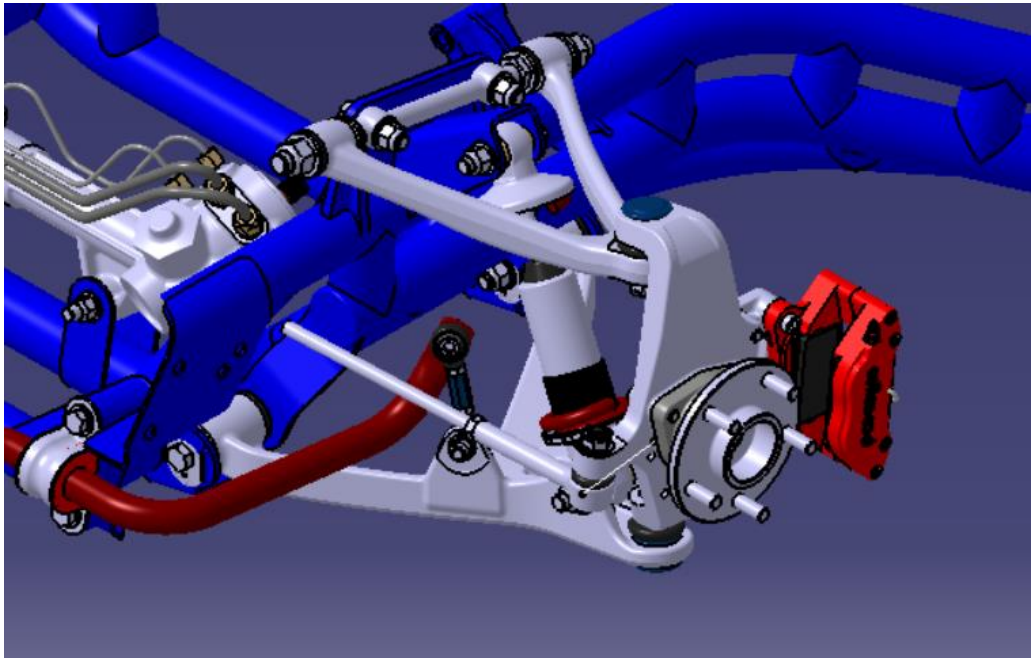
BND TechSource

ARB (anti-roll bar)										
ARB (anti-roll bar) Dimensions:										
Virtual torque arm (A):	226.1 mm									
Length of center (B):	812.8 mm									
Physical torque arm (C):	274.3 mm									
OD in millimeters: (D)	30.0 mm									
ID in millimeters: (if hollow)	21.0 mm									
ARB (anti-roll bar) Spring Rate =	95.2 N/mm									
ARB (anti-roll bar) Motion Ratio @ Ride Ht =	0.639 unit/unit									
ARB Bushing Rates (per deflection at loads)										
Design Results										
Tire Envelope =	See CAD Data									
Tool Clearance =	See CAD Data									
Routing Clearance (i.e. hoses, brake lines, fuel lines, electrical, etc.) =	See CAD Data									
Roll Center Height relative to Susp Analysis Axis =	13.28 mm									
Anti-dive Instant Center relative to Susp Analysis Axis = (x, y, z)										
Anti-dive Instant Center =	X	Y	Z	mm						
	-1405.9	n/a	172.84							
Bushing Rates (charted from Suspension Analysis Software)										
Wheel Rate (including ARB) =	89.25 N/mm									
Ride Rate (including ARB) =	65.88 N/mm									

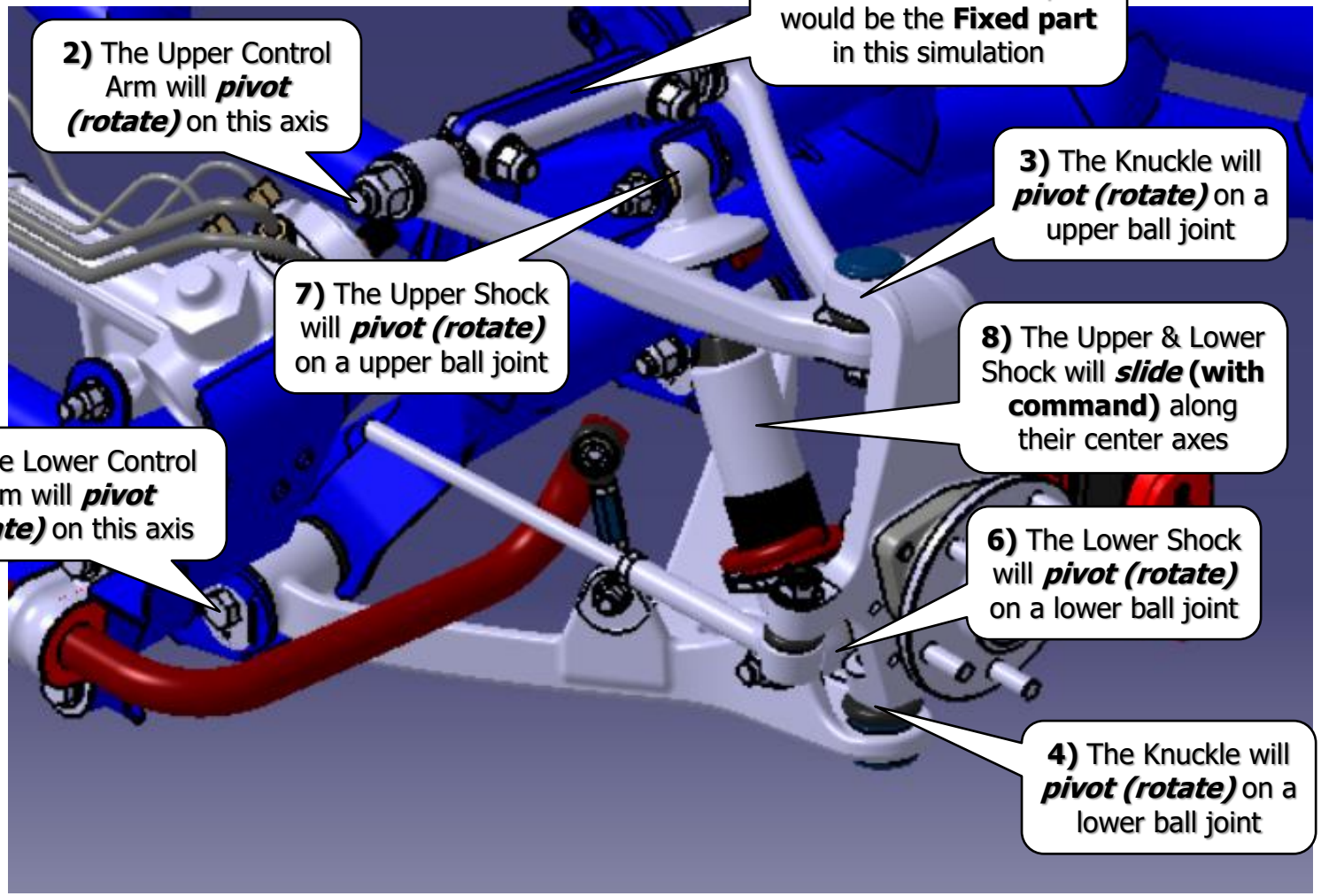
Step 1: Understand the suspension system

BND TechSource

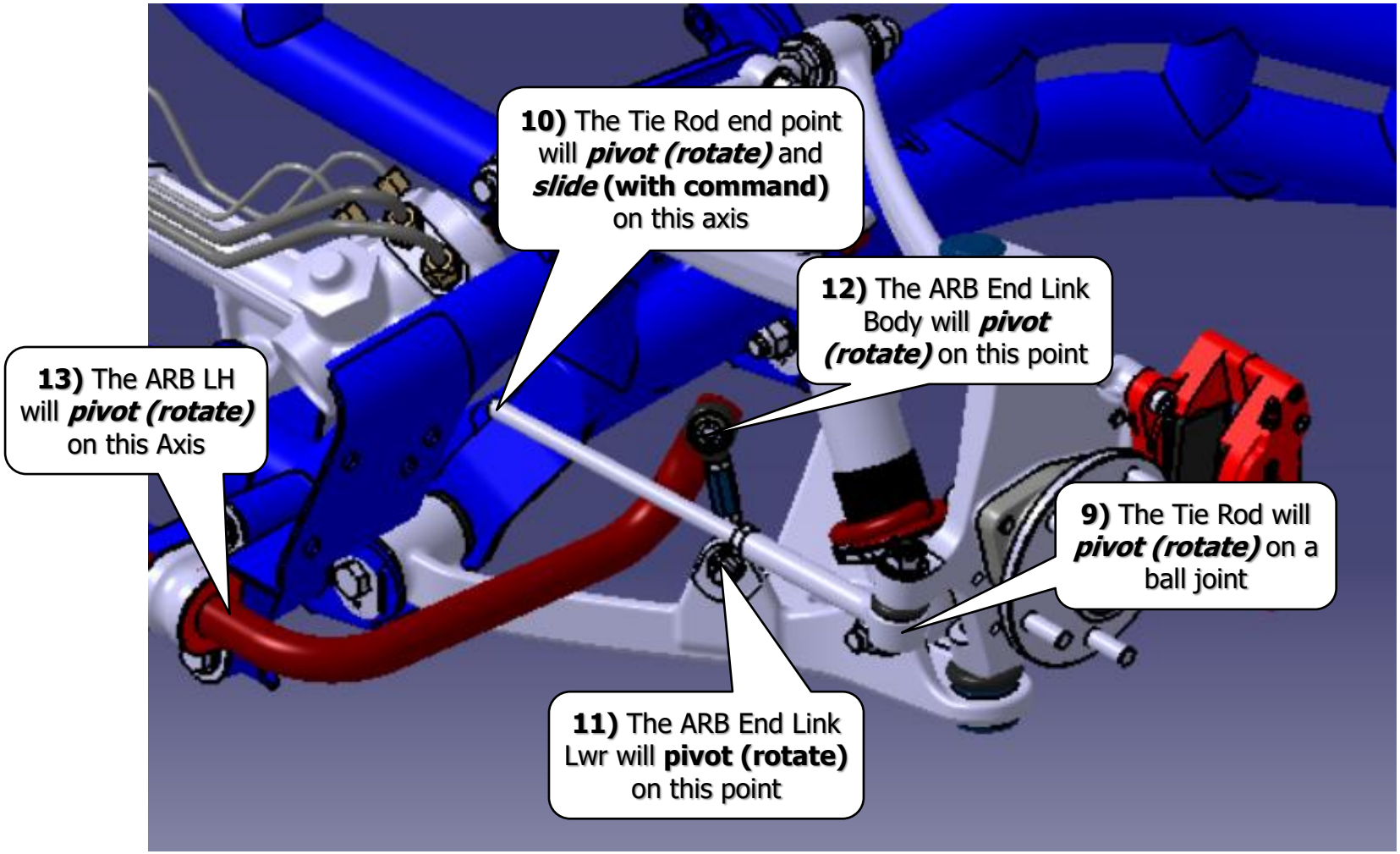
- Begin with the completed Front Suspension Assembly.
- This will help to understand all the pivot and links within the system.



BND TechSource

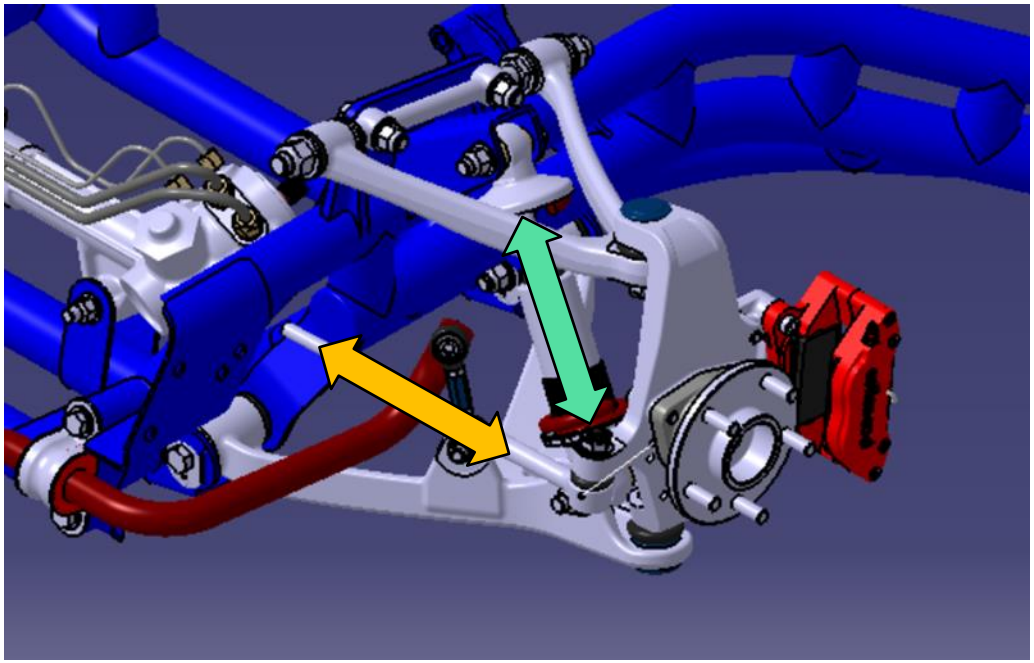


BND TechSource



BND TechSource

- Understand which joints need commands.
  - Min/Max Command values
    - Shock down/up (-50mm, 48mm)
    - Steering left/right (-55mm, 55mm)



Step 2: Create a kinematic skeleton structure

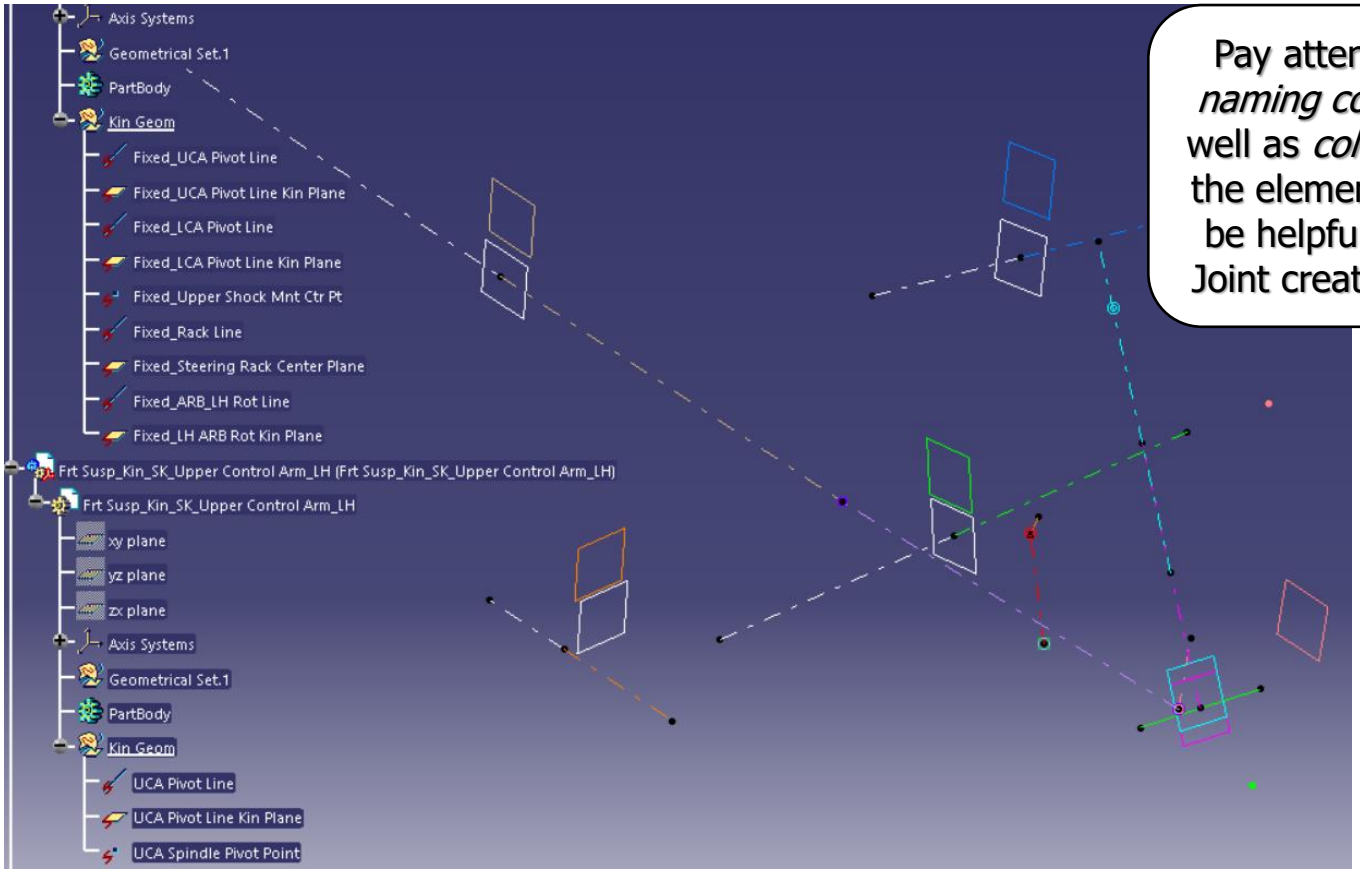
BND TechSource

- Create a skeleton product and all parts required for the kinematic simulation.

Pay attention to the *naming convention*, as it will be helpful during the Joint creation process.

BND TechSource

- Create all points, lines, & planes inside each part within the kinematic structure.

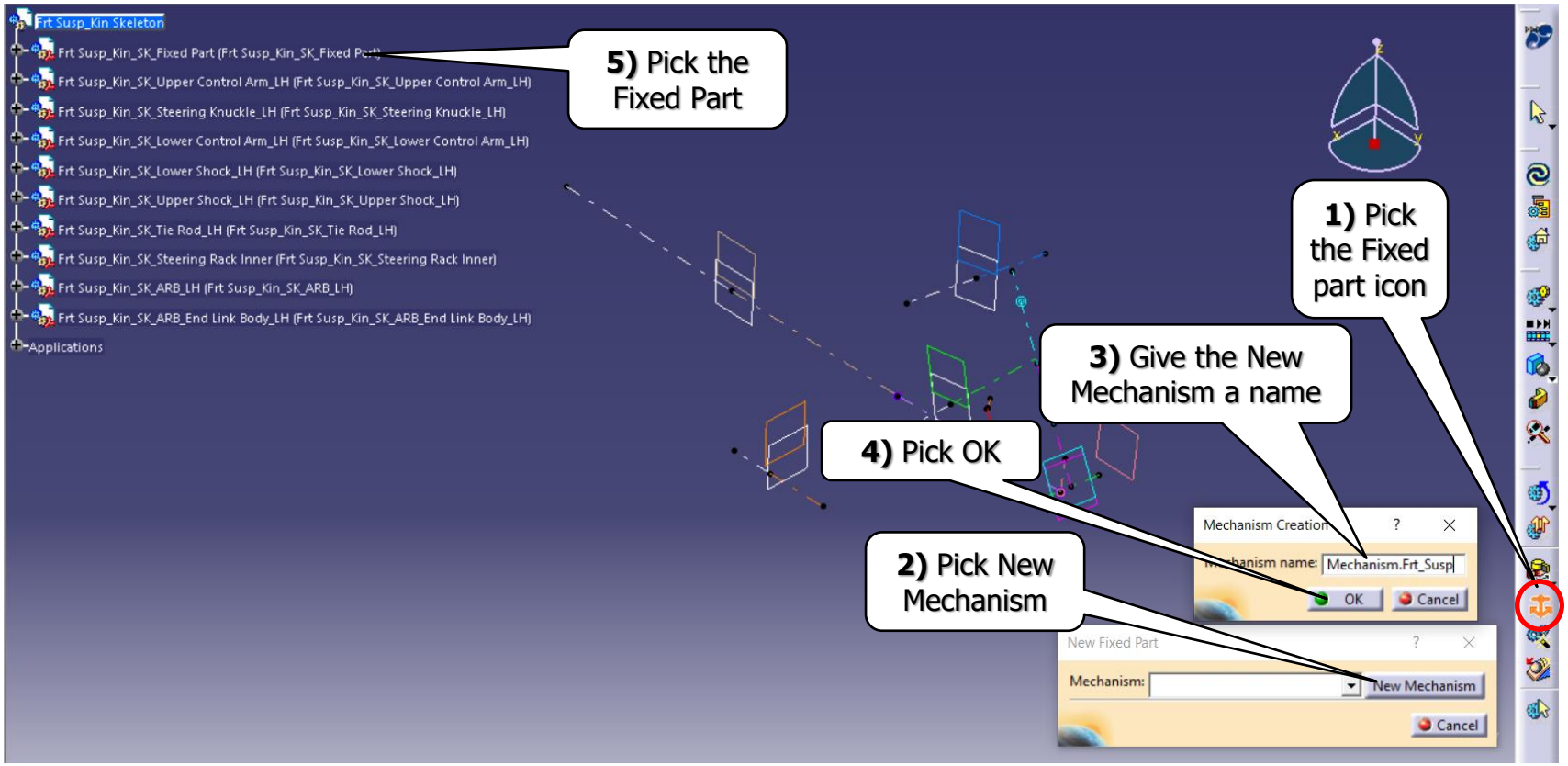


Pay attention to the *naming convention* as well as *color* applied to the elements, as it will be helpful during the Joint creation process.

Step 3: Create the kinematic Joints

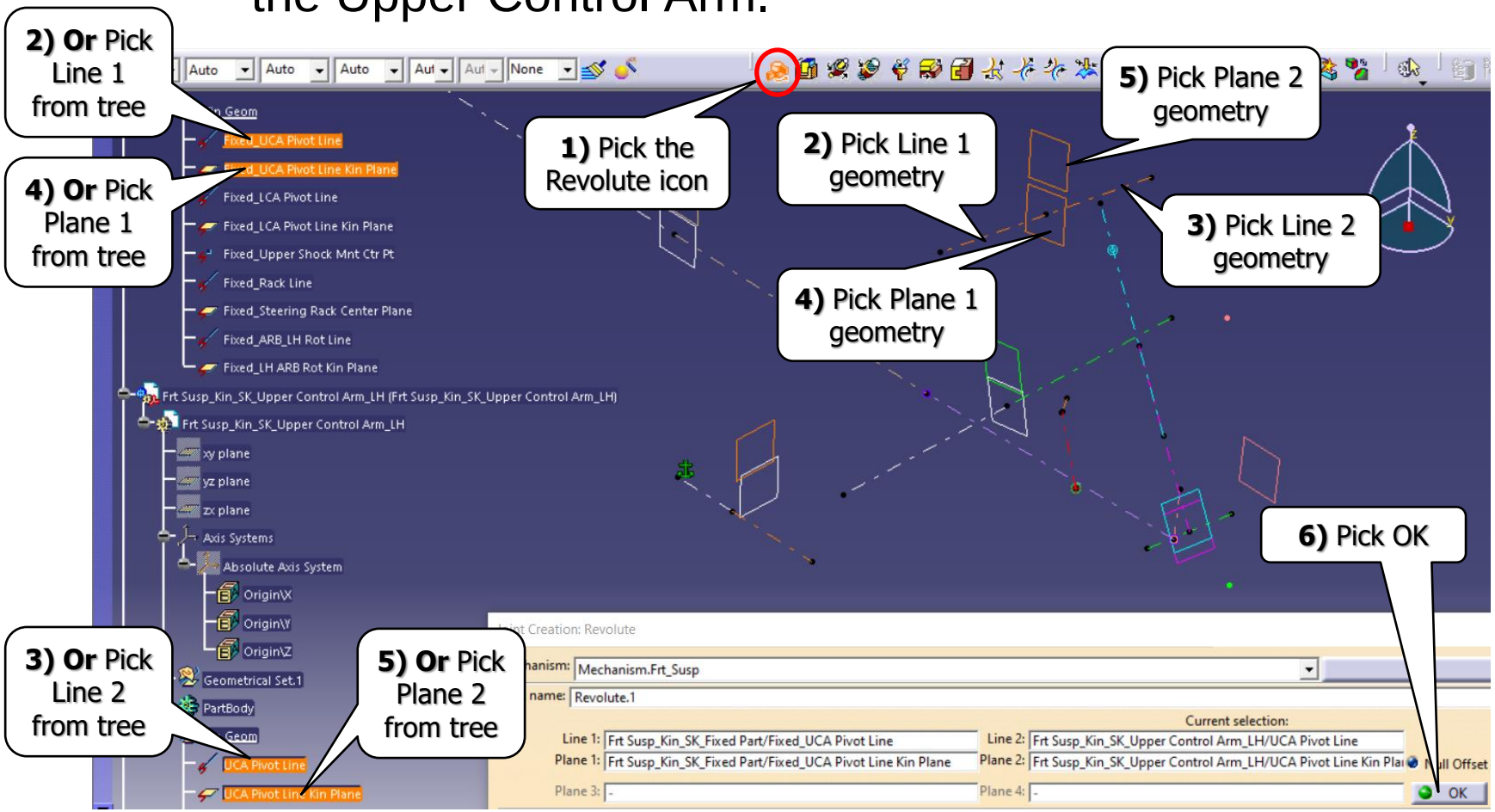
BND TechSource

- Create the Fixed Part and name the Mechanism.



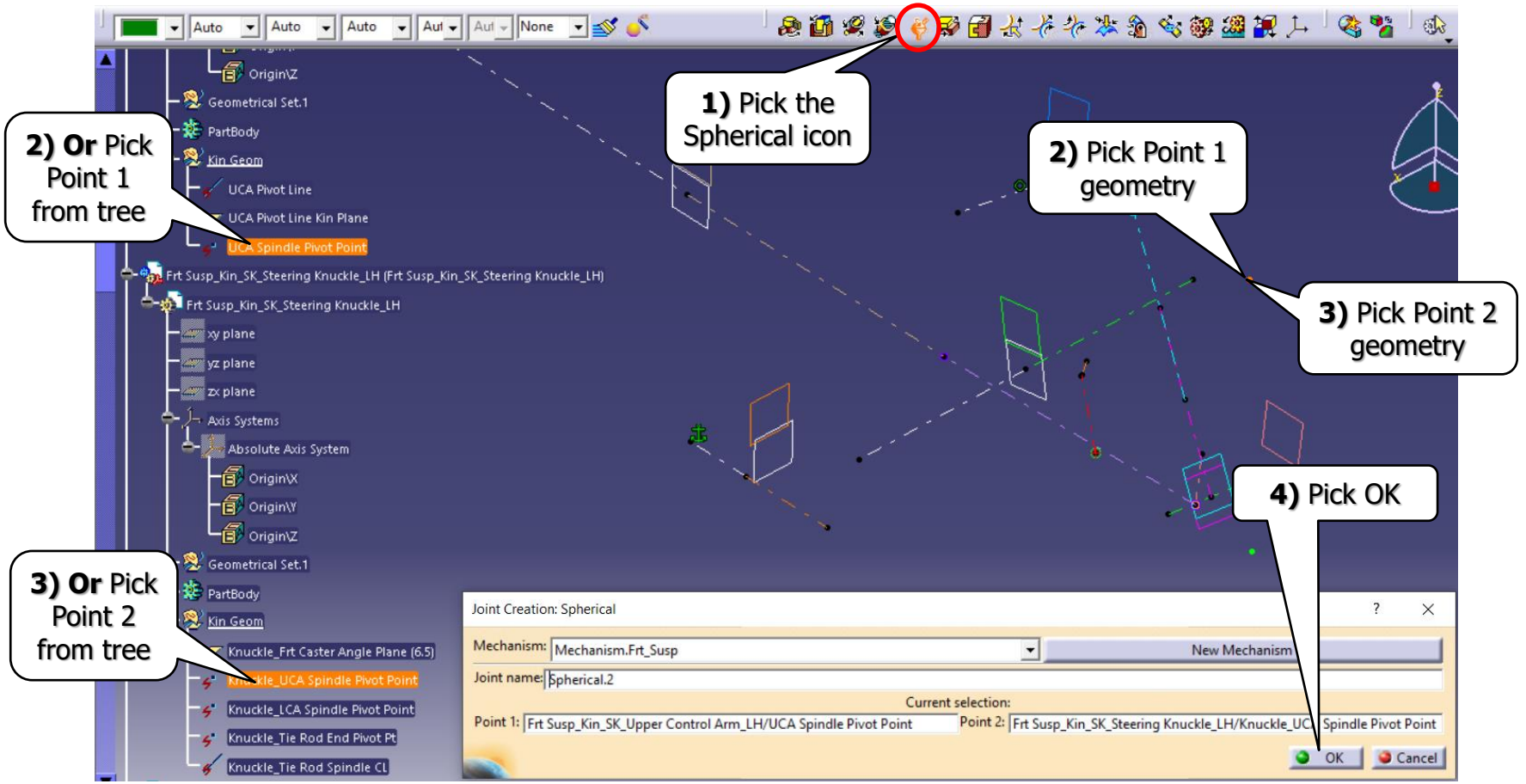
BND TechSource

- Create a Revolute Joint between the Fixed part and the Upper Control Arm.



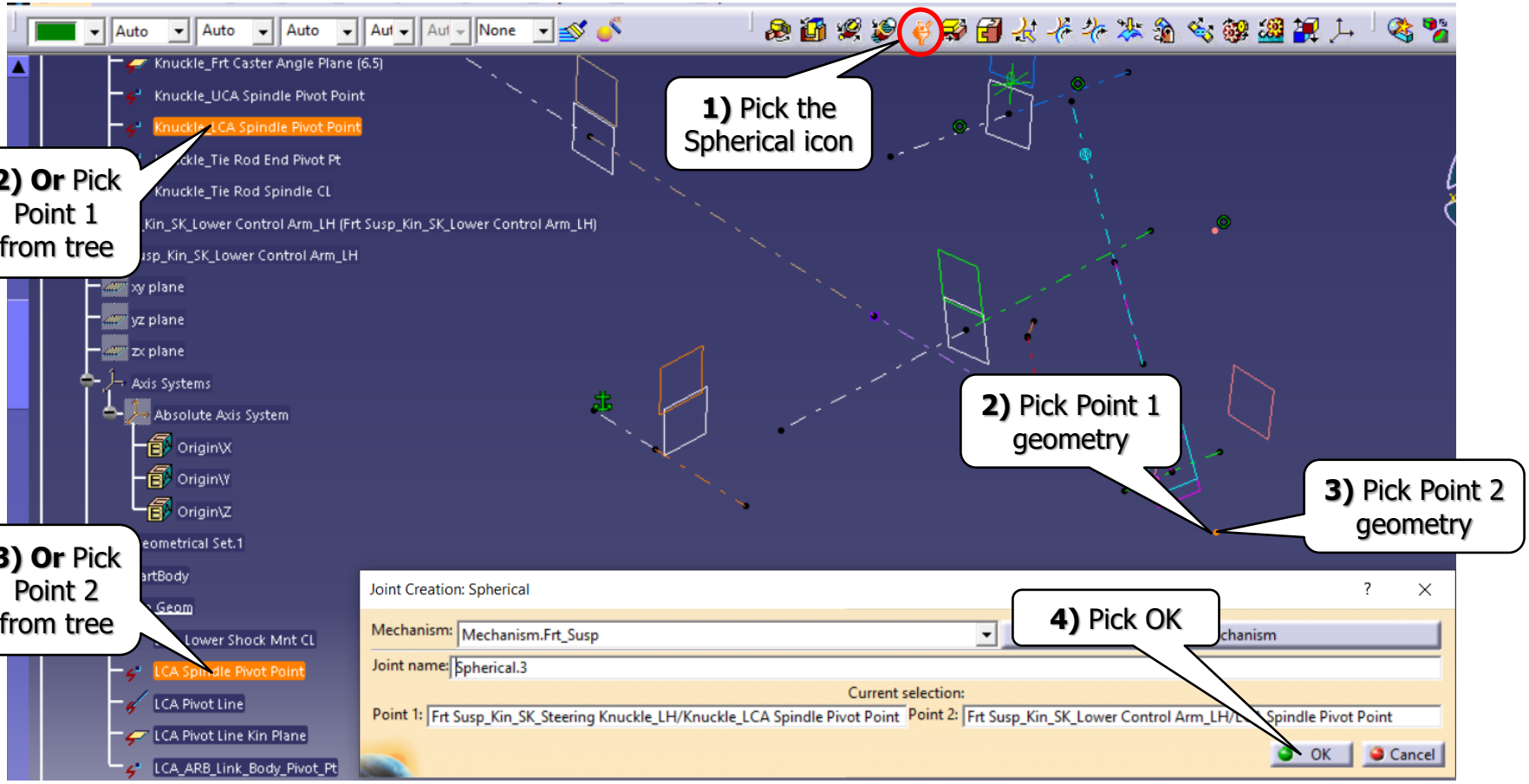
BND TechSource

- Create a Spherical Joint between the Upper Control Arm and the Knuckle.



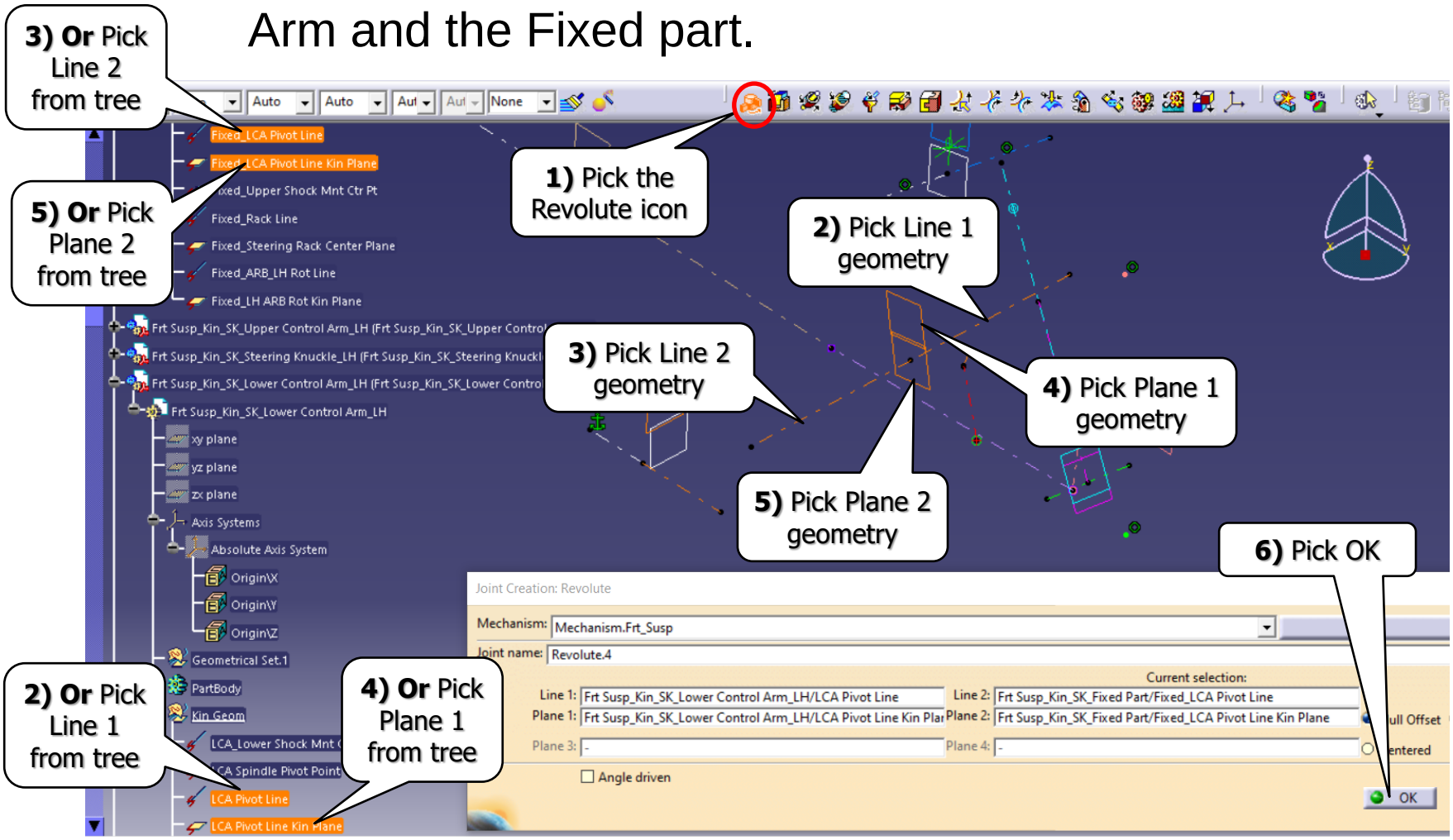
BND TechSource

- Create a Spherical Joint between the Knuckle and the Lower Control Arm.



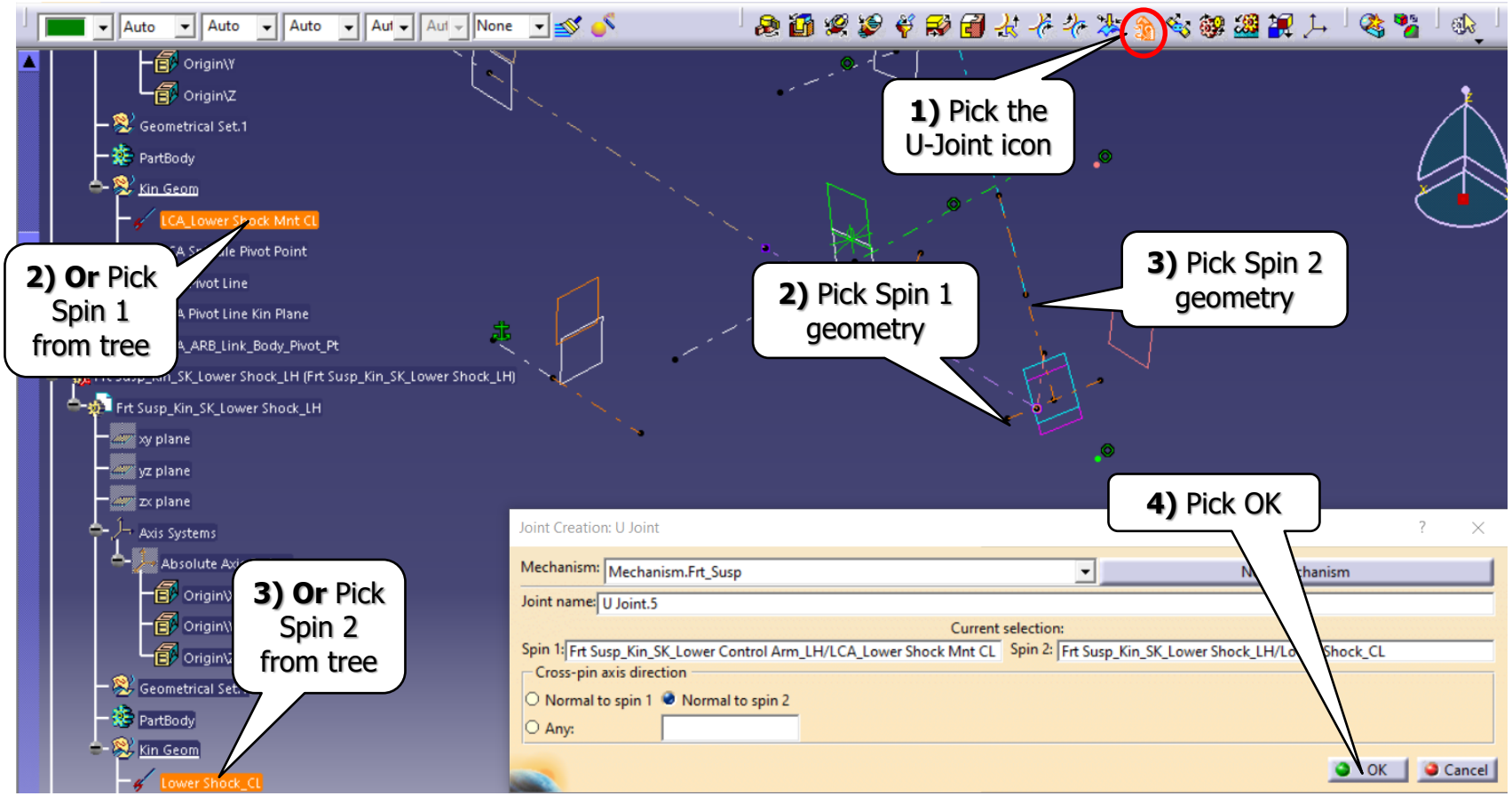
BND TechSource

- Create a Revolute Joint between the Lower Control Arm and the Fixed part.



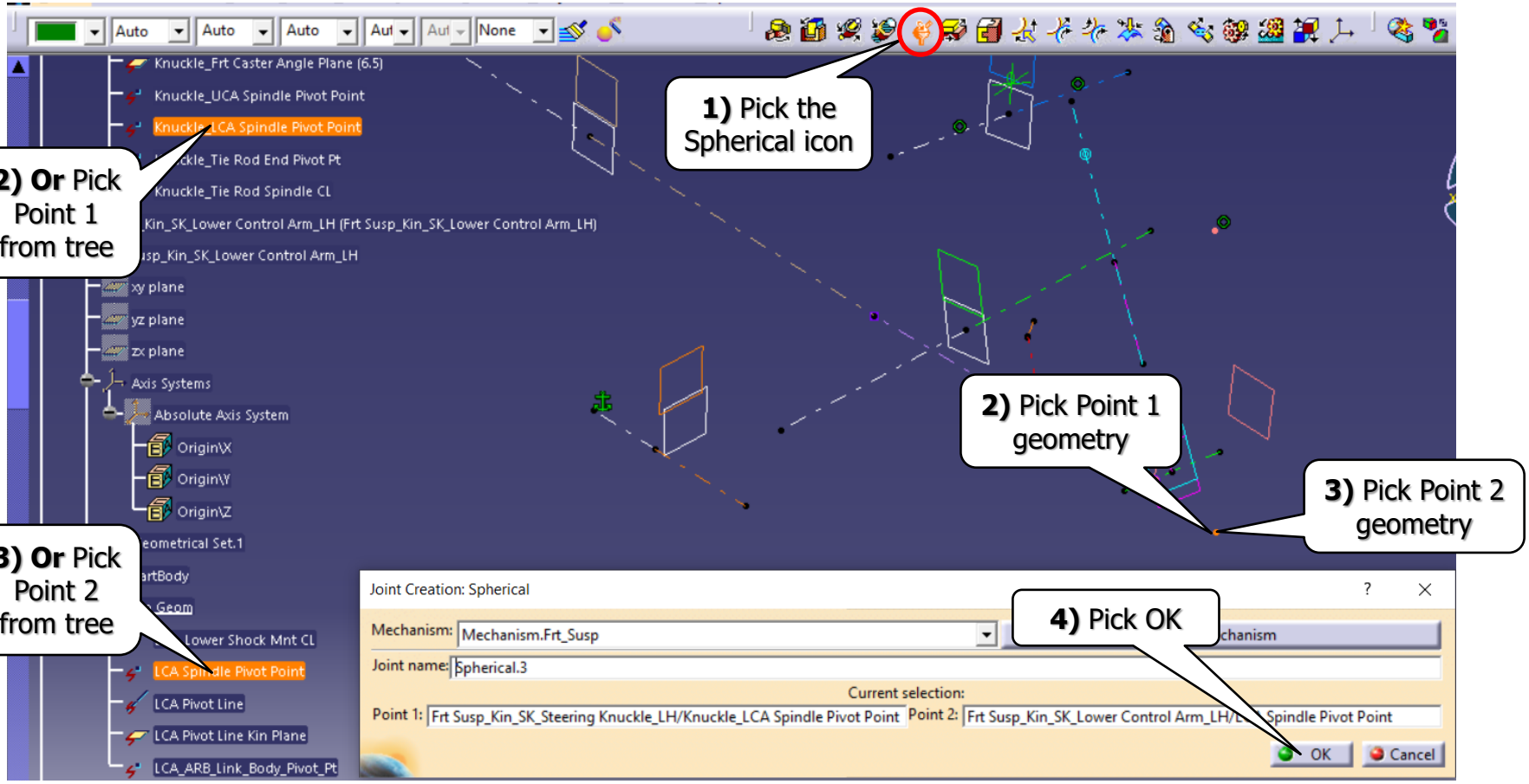
BND TechSource

- To avoid binding in the mechanism, we will create a Universal Joint between the LCA and the Shock Lower.



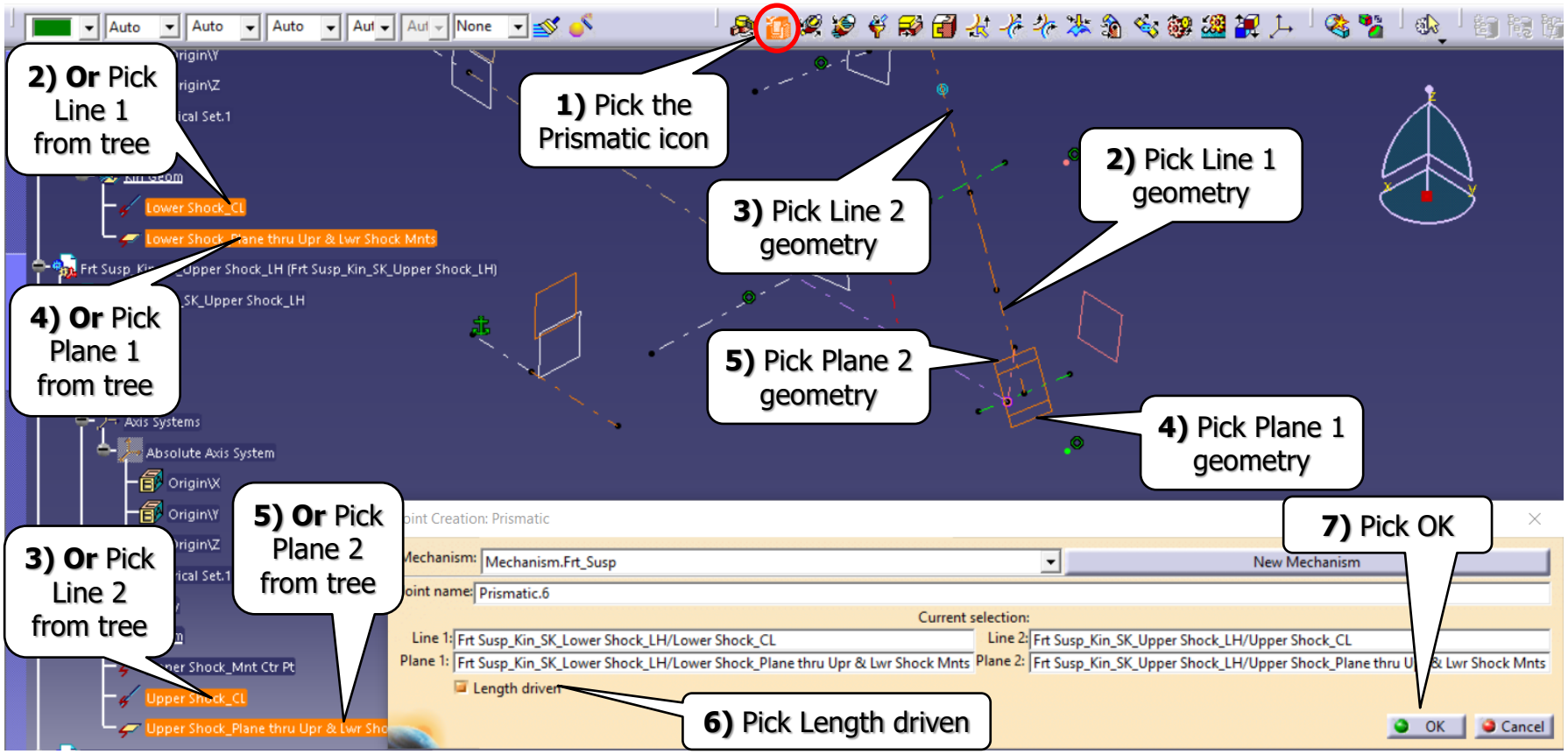
BND TechSource

- Create a Spherical Joint between the Knuckle and the Lower Control Arm.



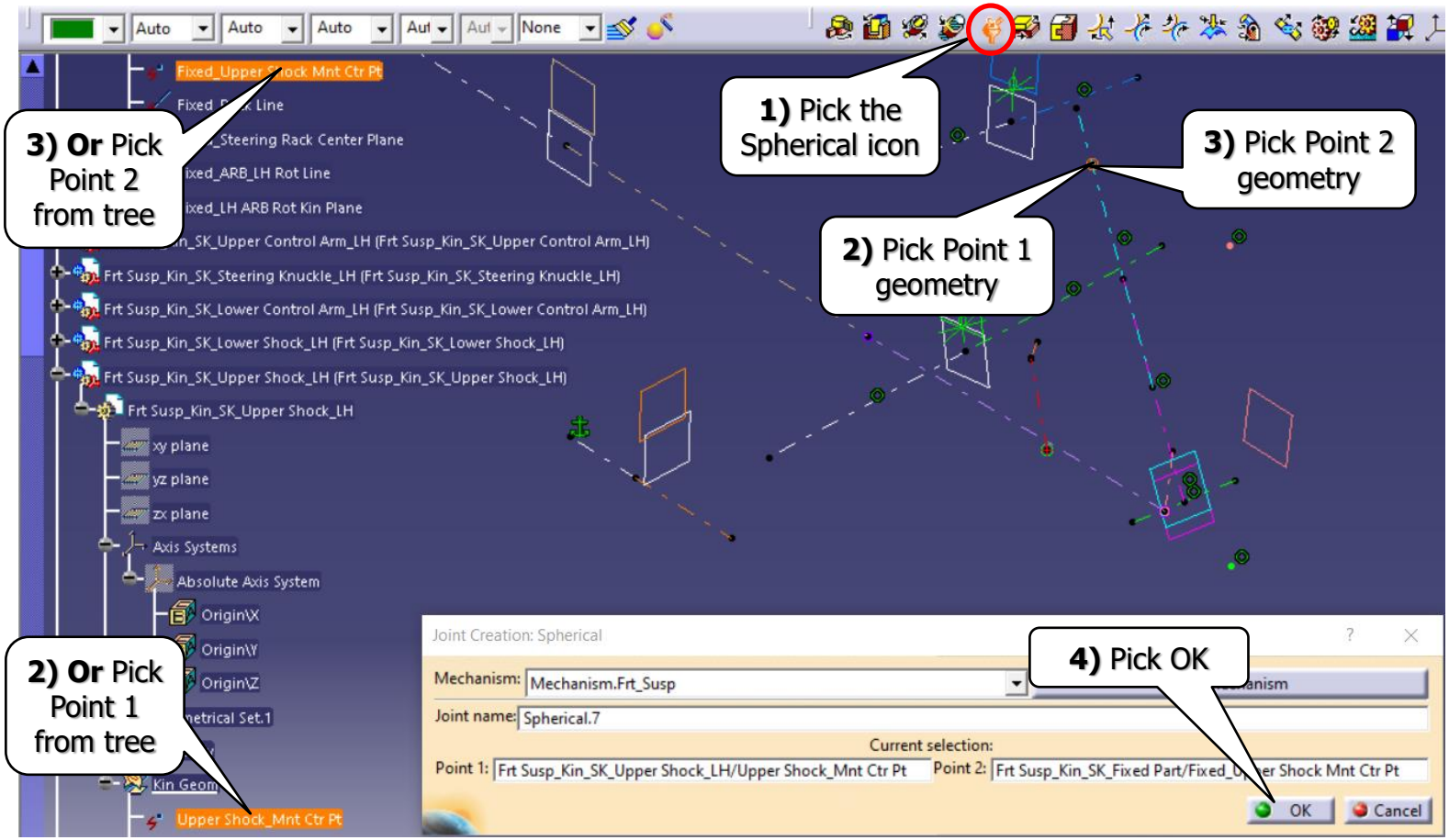
BND TechSource

- Create a Prismatic Joint between the Lower Shock CL and the Upper Shock CL and make it *Length driven*.



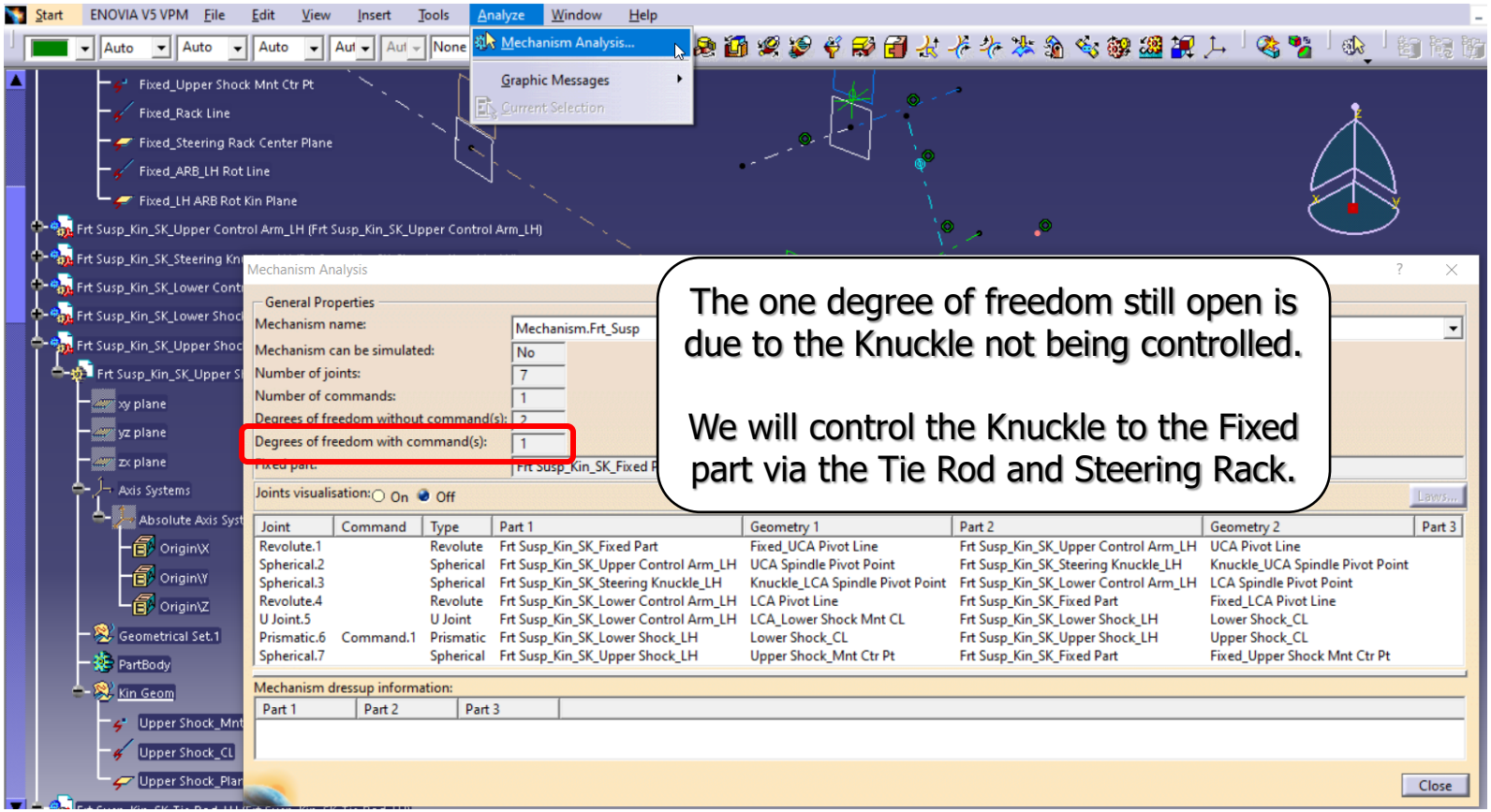
BND TechSource

- Create a Spherical Joint between the upper Shock mounting point and the Fixed part mounting point.



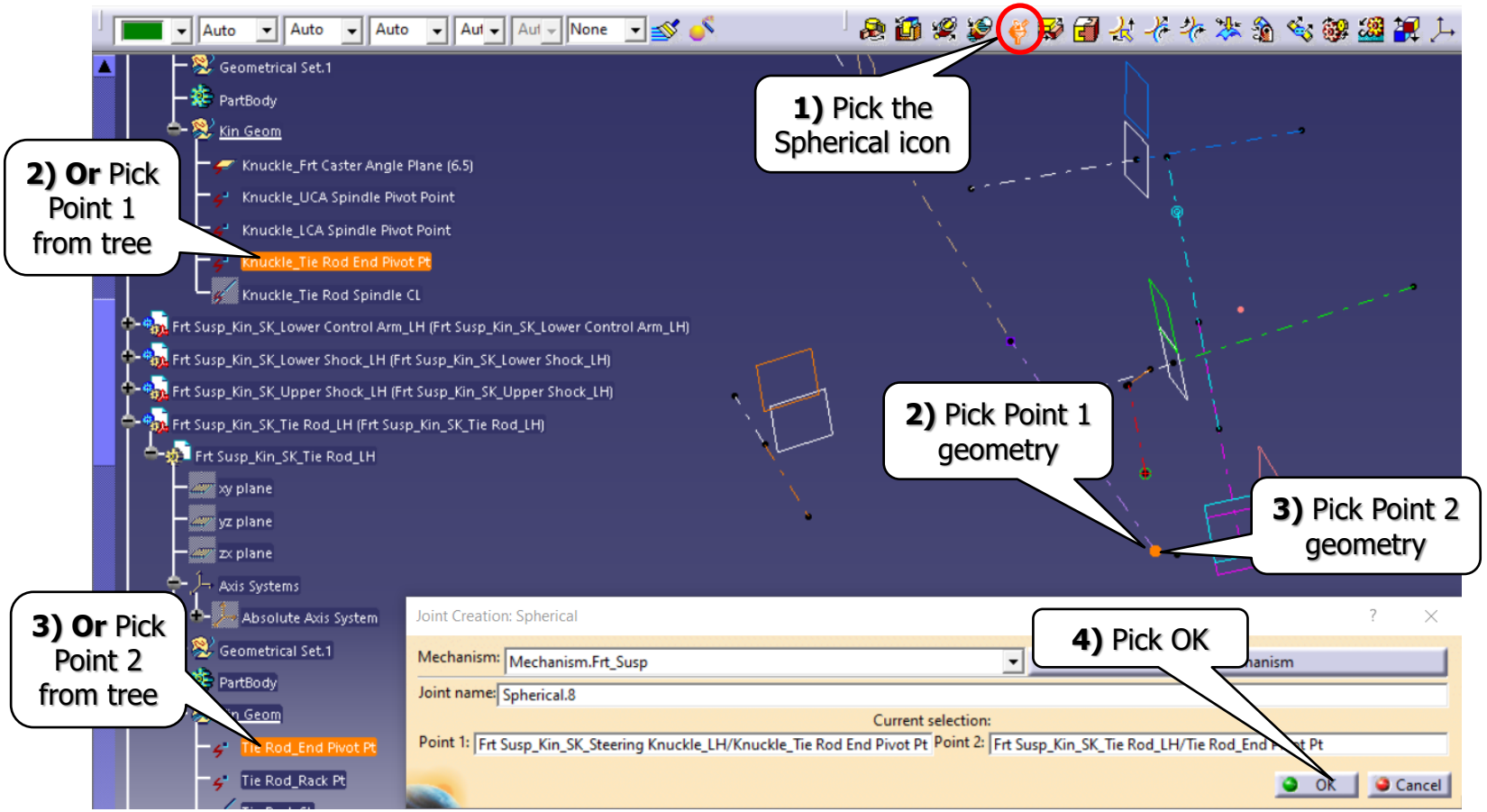
BND TechSource

- Use Analyze + Mechanism Analysis to understand there is still one degree of freedom open.



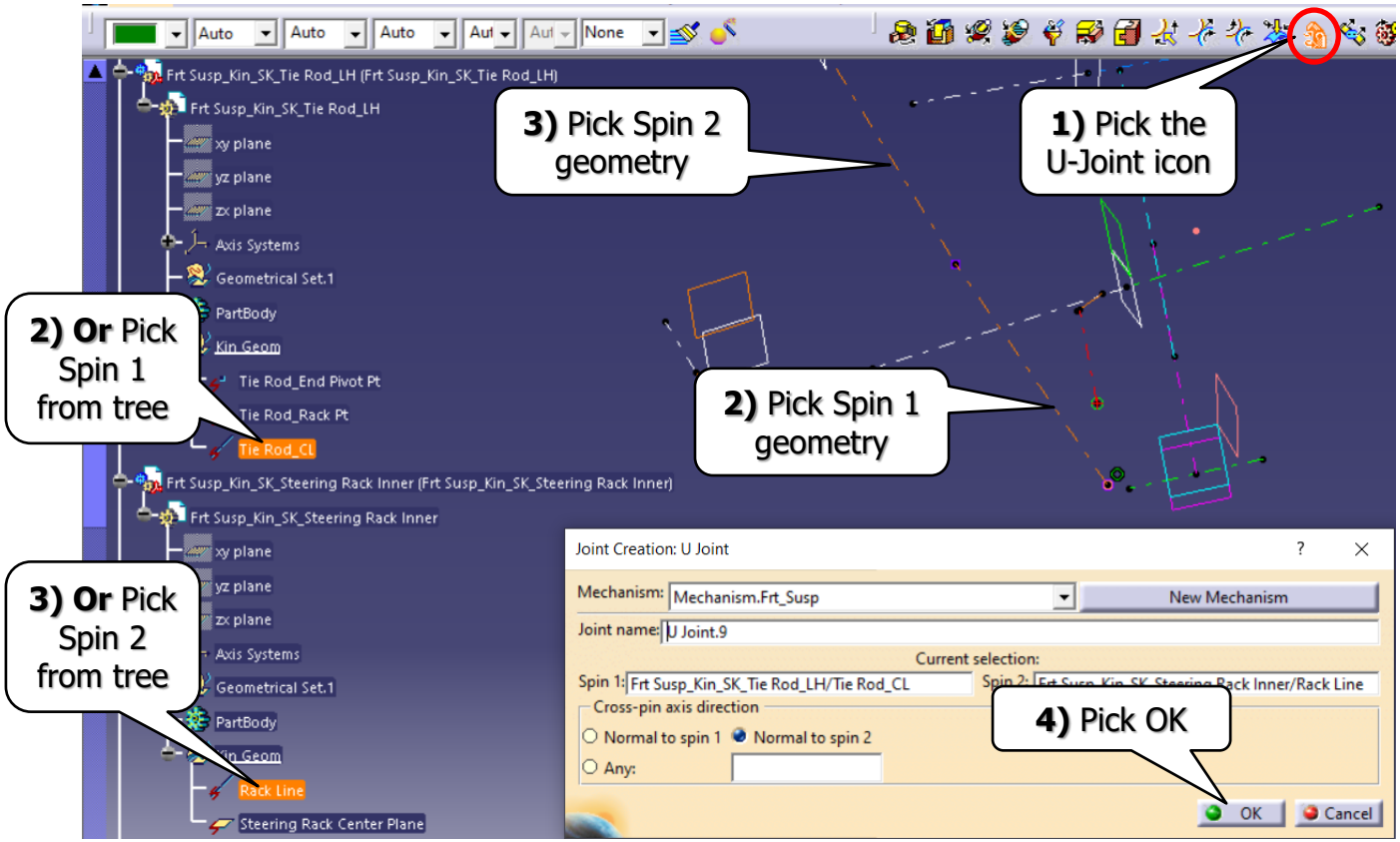
BND TechSource

- Create a Spherical Joint between the Knuckle spindle point and the Tie Rod spindle point.



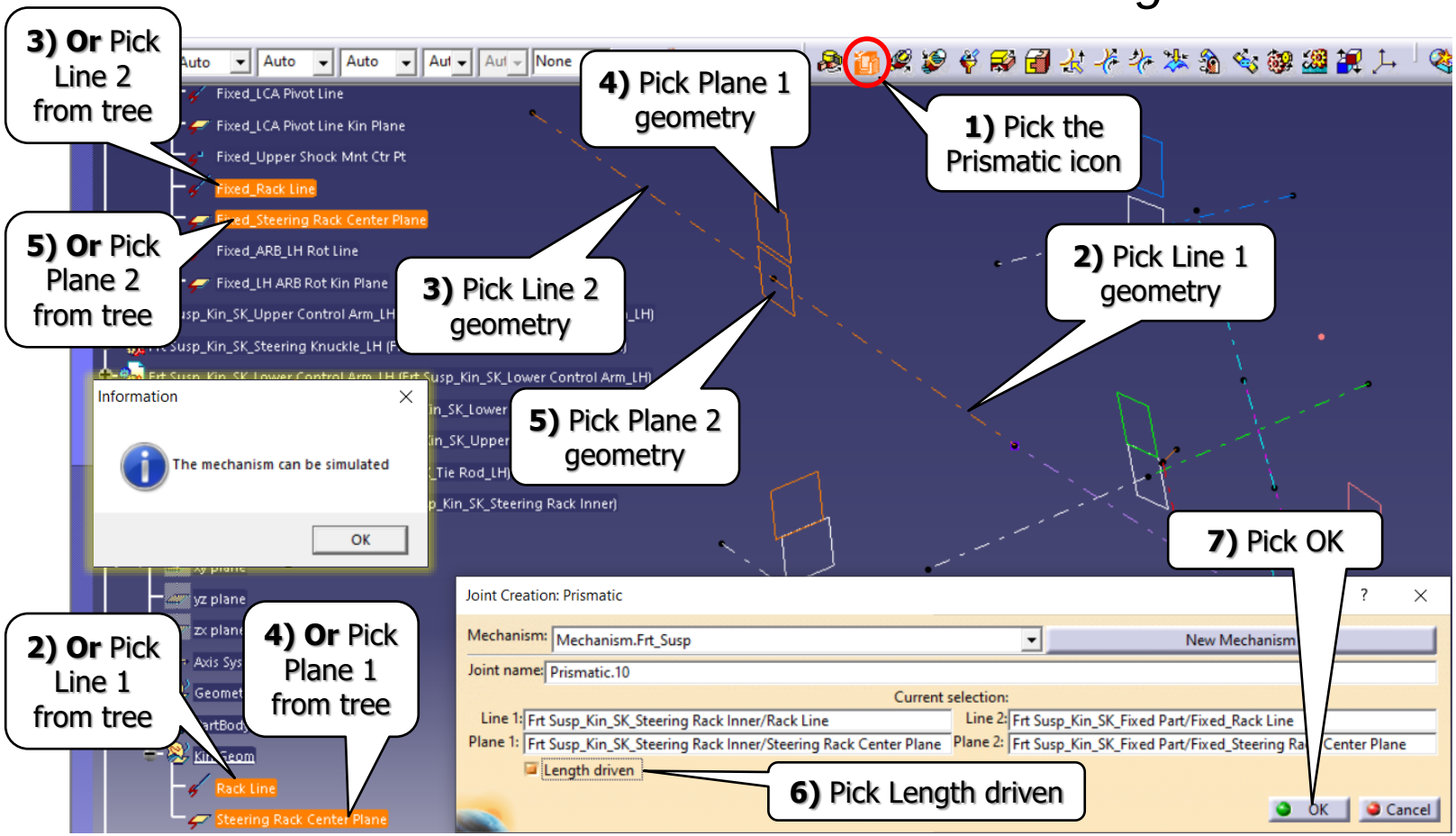
BND TechSource

- To avoid binding in the mechanism, we will create a Universal Joint between the Tie Rod and the Steering Rack Inner.



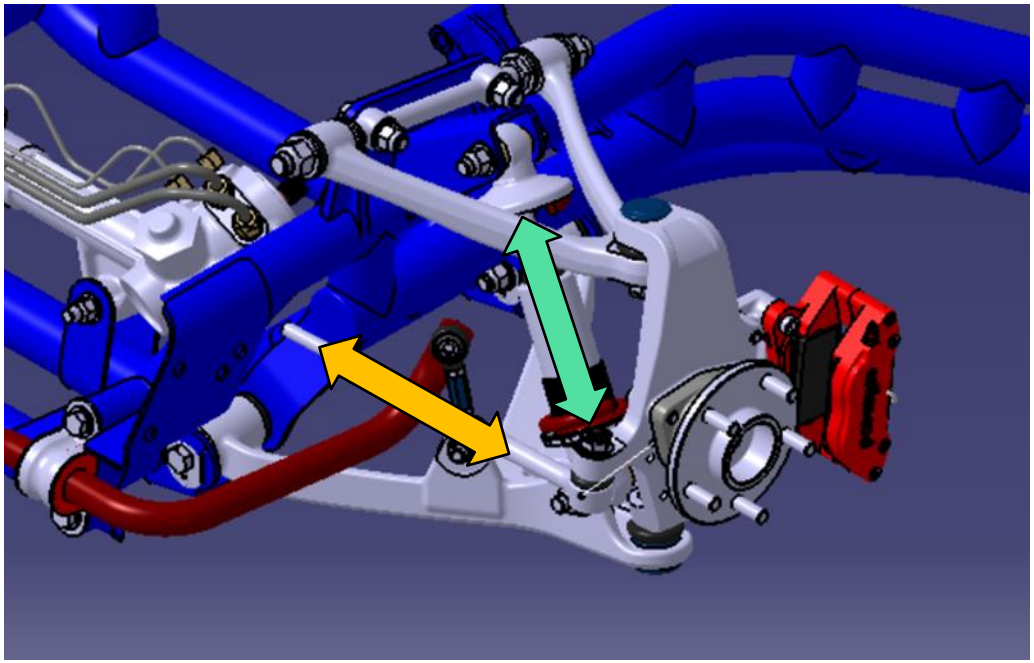
BND TechSource

- Create a Prismatic Joint between the Steering Rack Line and the Fixed Rack Line and make it *Length driven*.



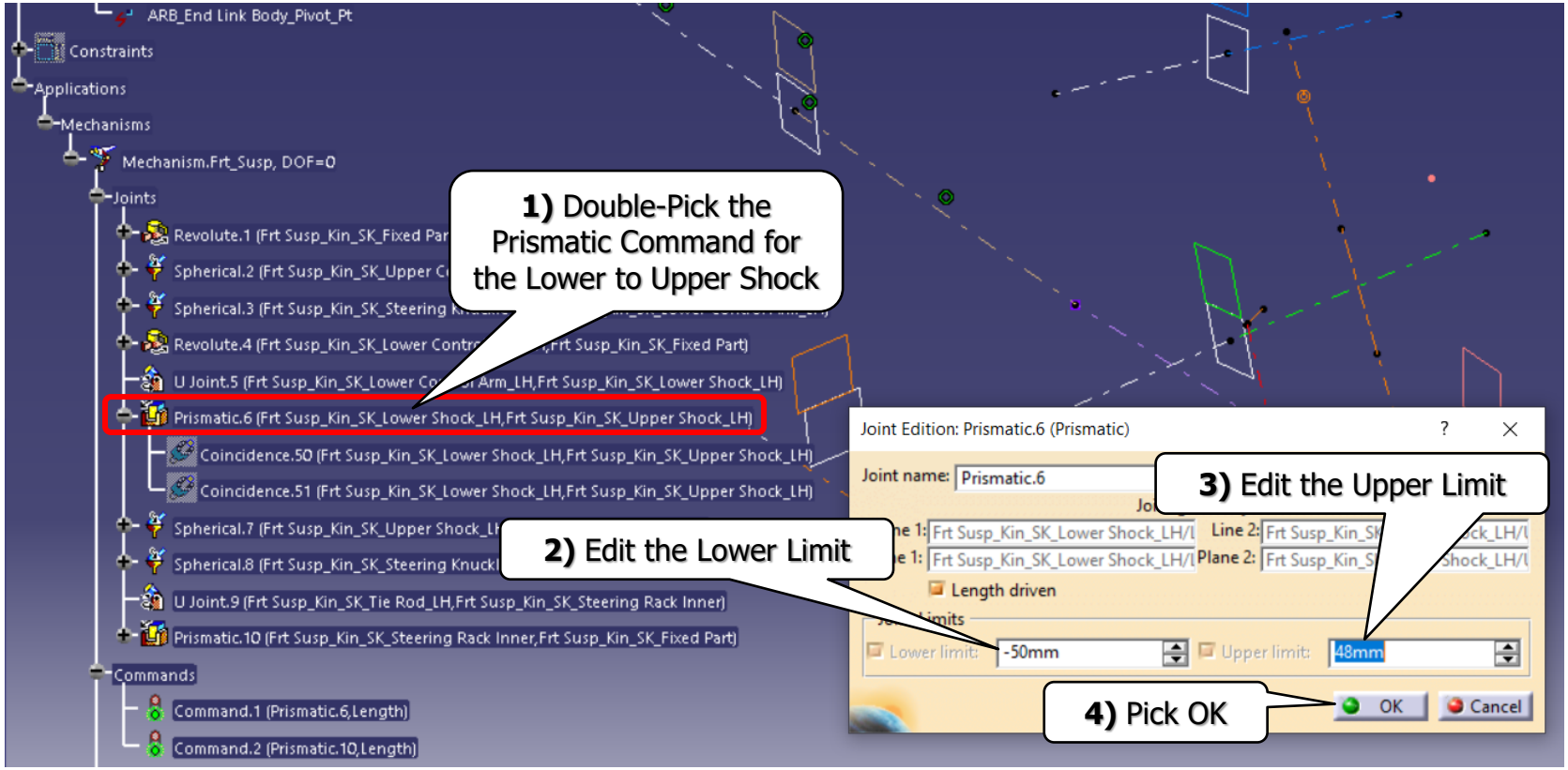
BND TechSource

- Edit the Command values for the driven commands.
  - Min/Max Command values
    - Shock down/up (-50mm, 48mm)
    - Steering left/right (-55mm, 55mm)



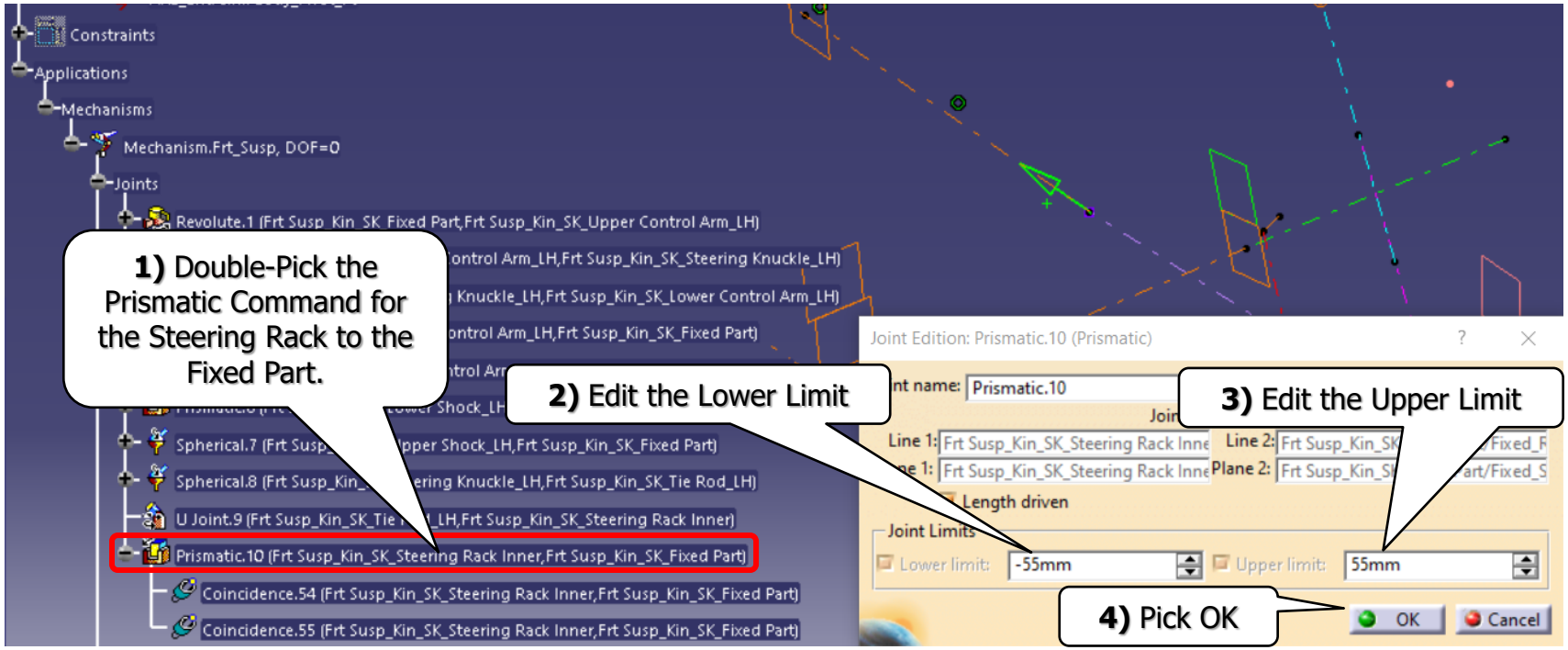
BND TechSource

- Edit the Command values for the driven commands.



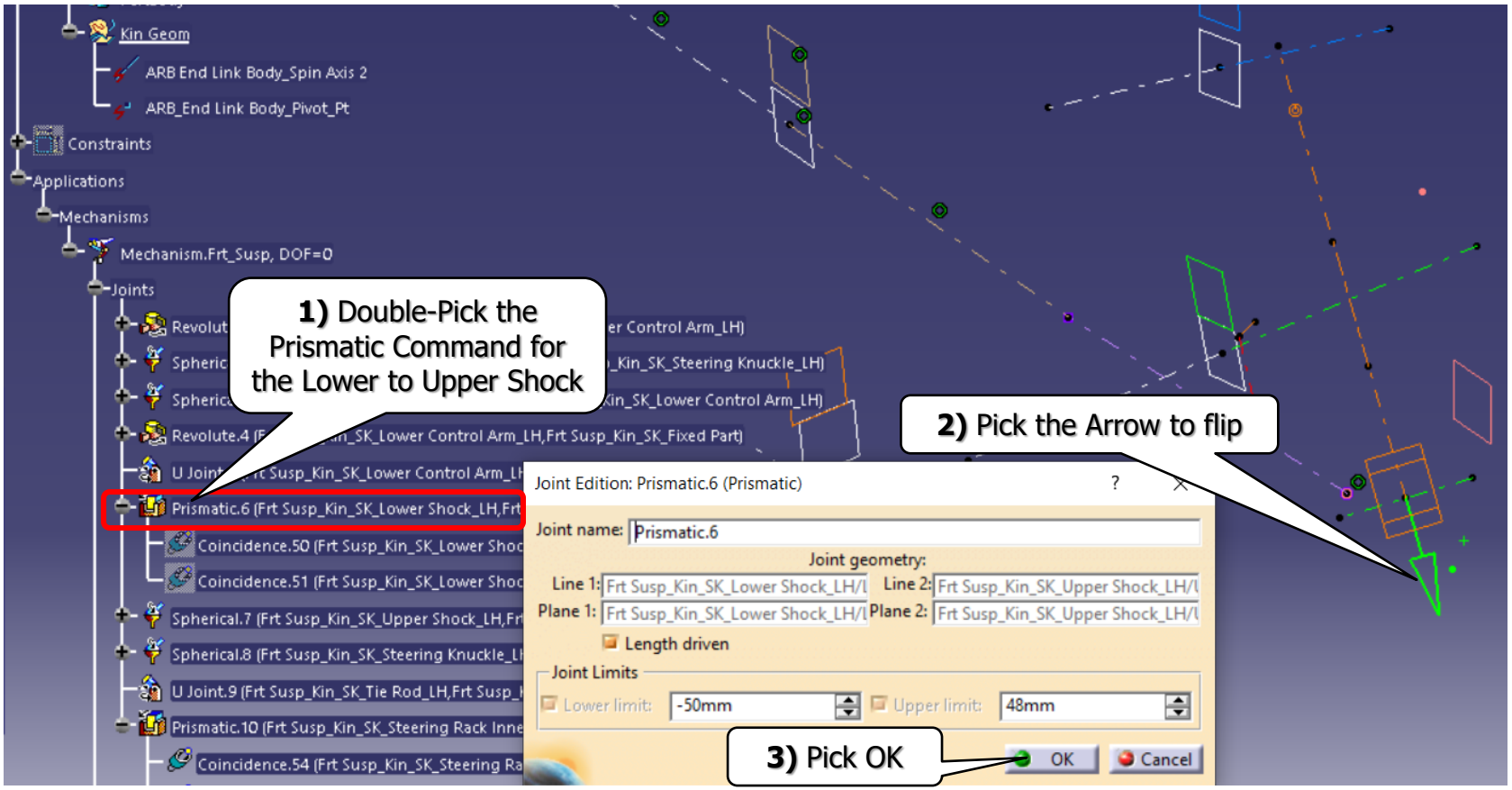
BND TechSource

- Edit the Command values for the driven commands.



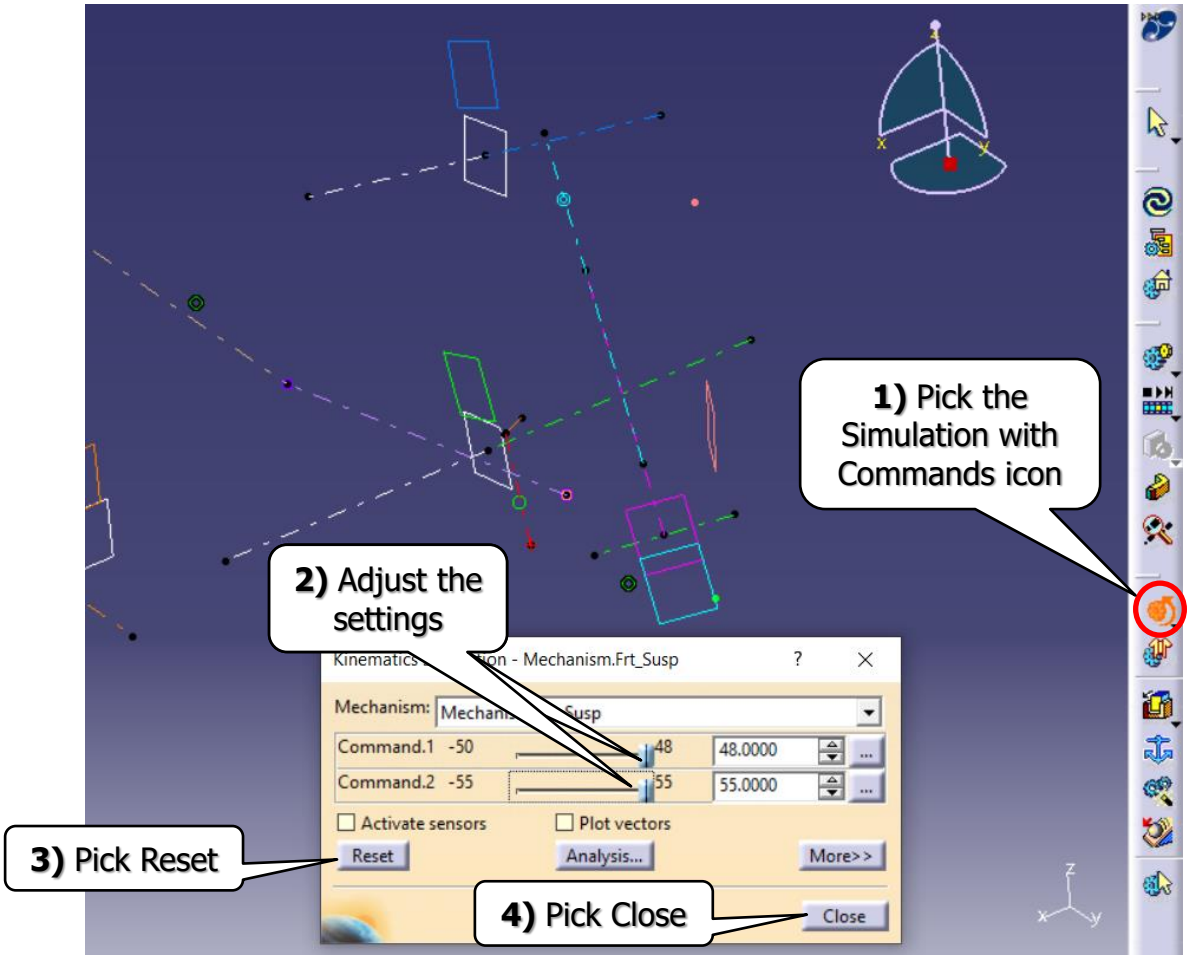
BND TechSource

- If 48mm is not upwards and -50mm not downwards:



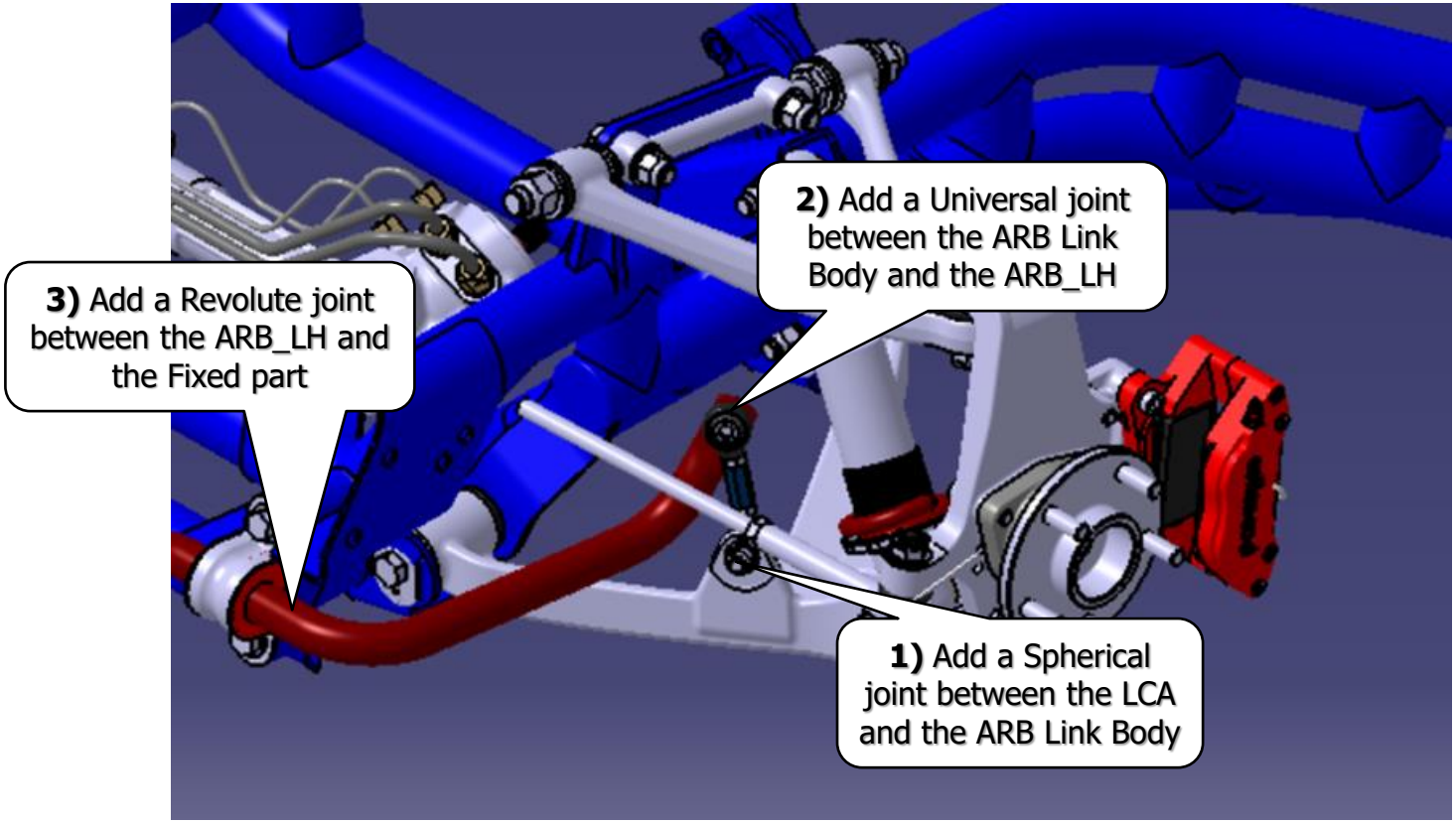
BND TechSource

- Run Simulation with Commands.



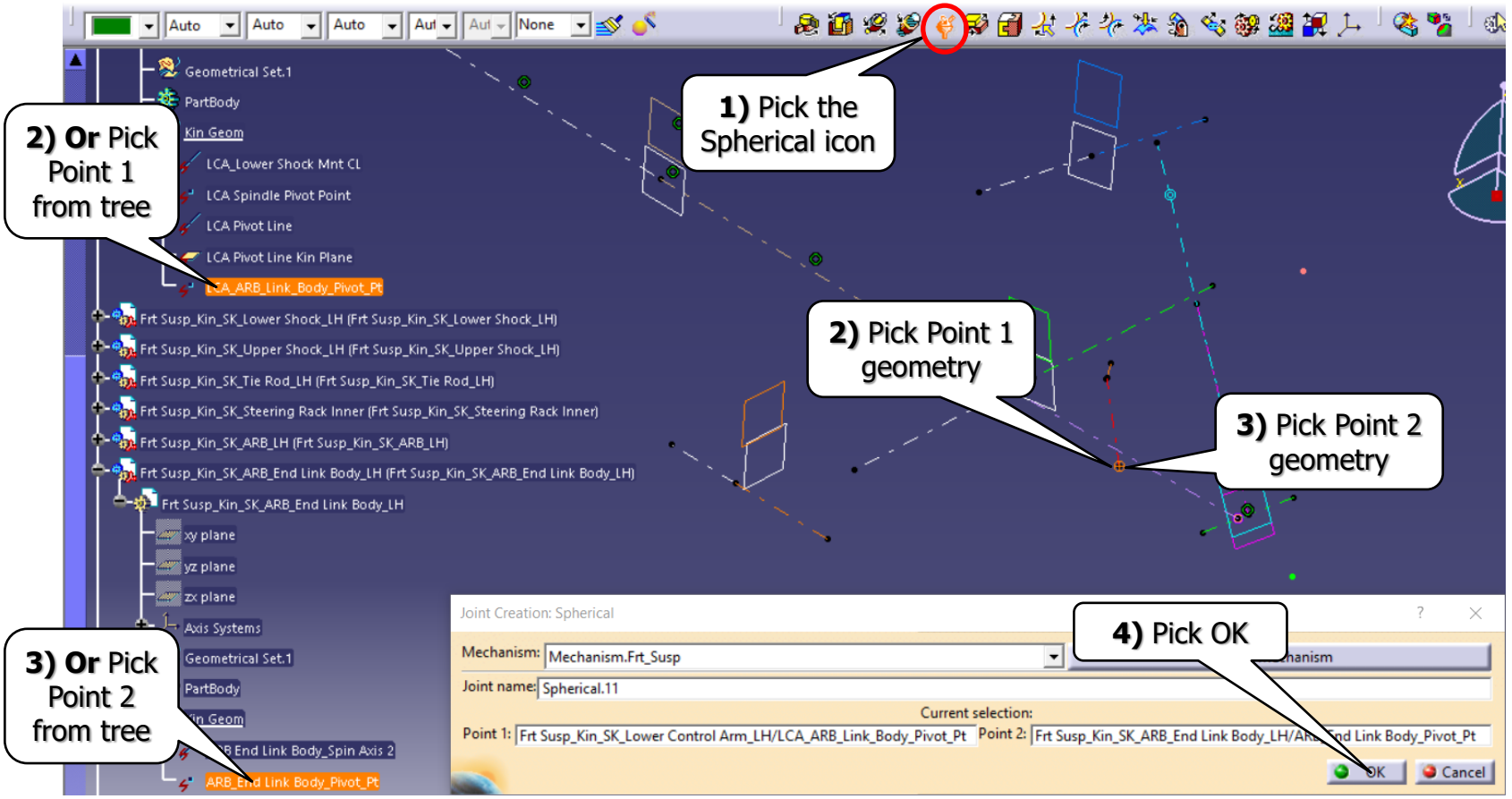
BND TechSource

- To finish the simulation, add the ARB into the mechanism.



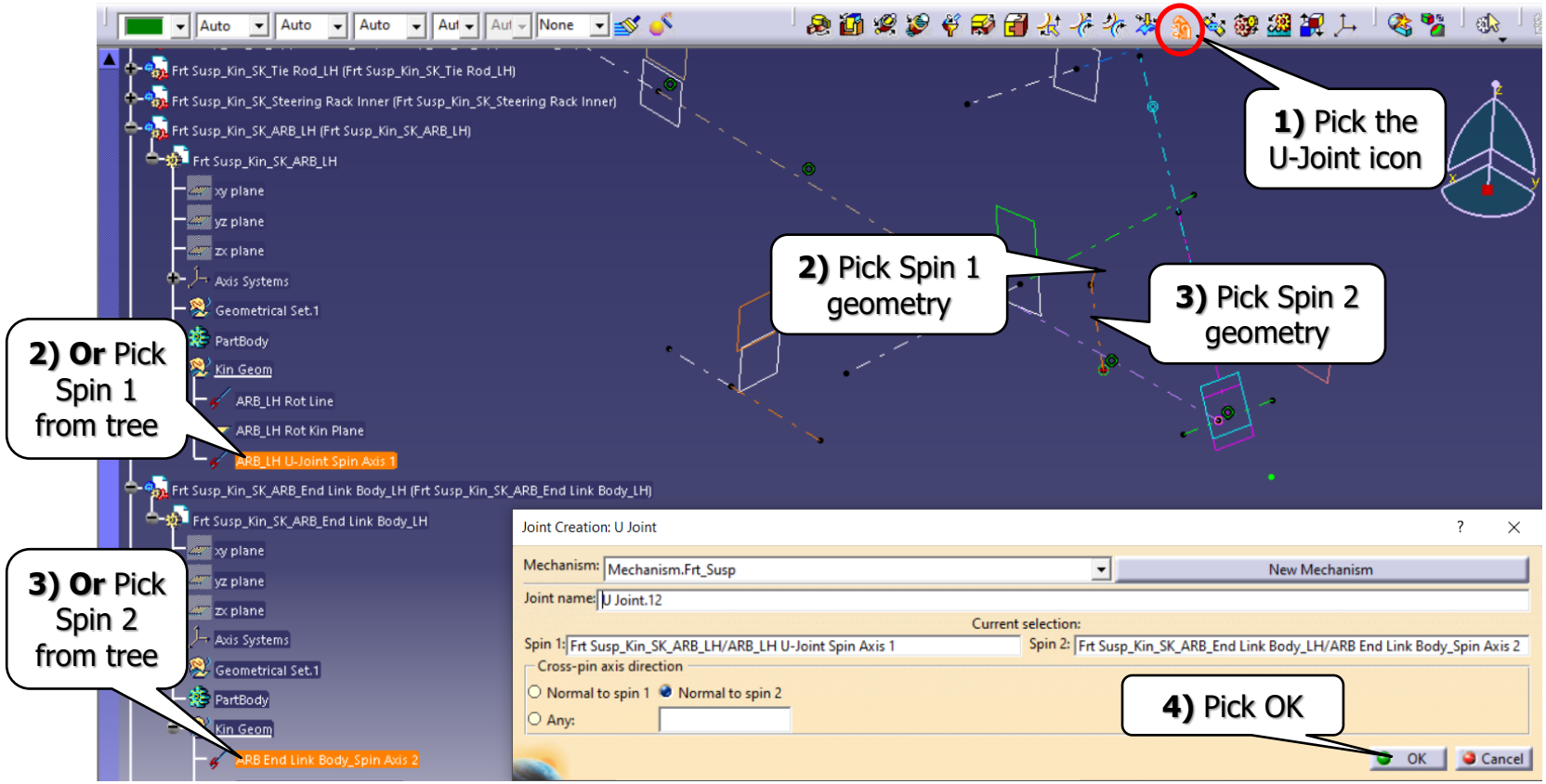
BND TechSource

- Create a Spherical Joint between the LCA ARB Link Body point and the ARB Link Body point.



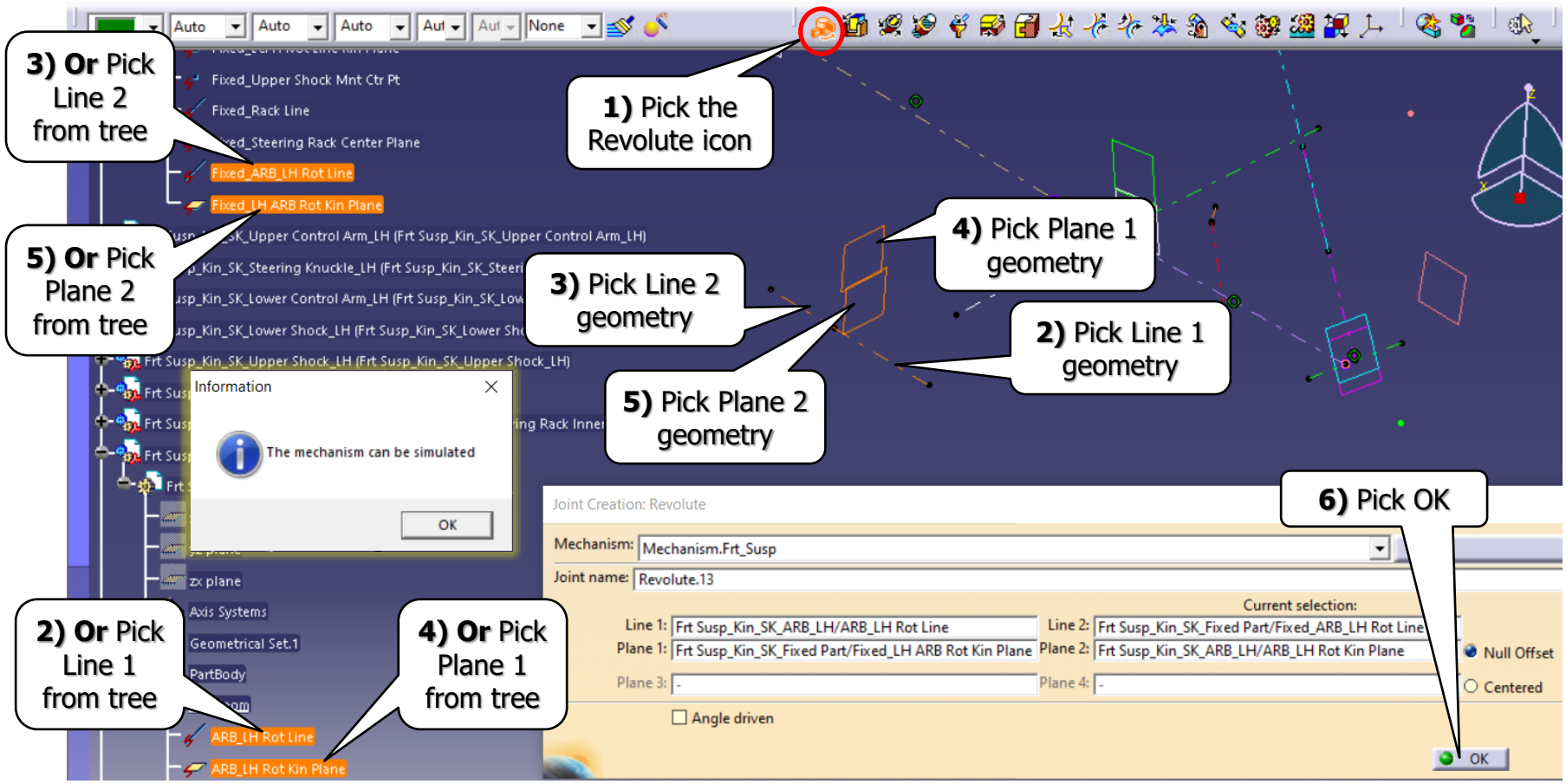
BND TechSource

- To avoid binding in the mechanism, we will create a Universal Joint between the ARB LH Spin Axis 1 and the ARB Link Spin Axis 2.



BND TechSource

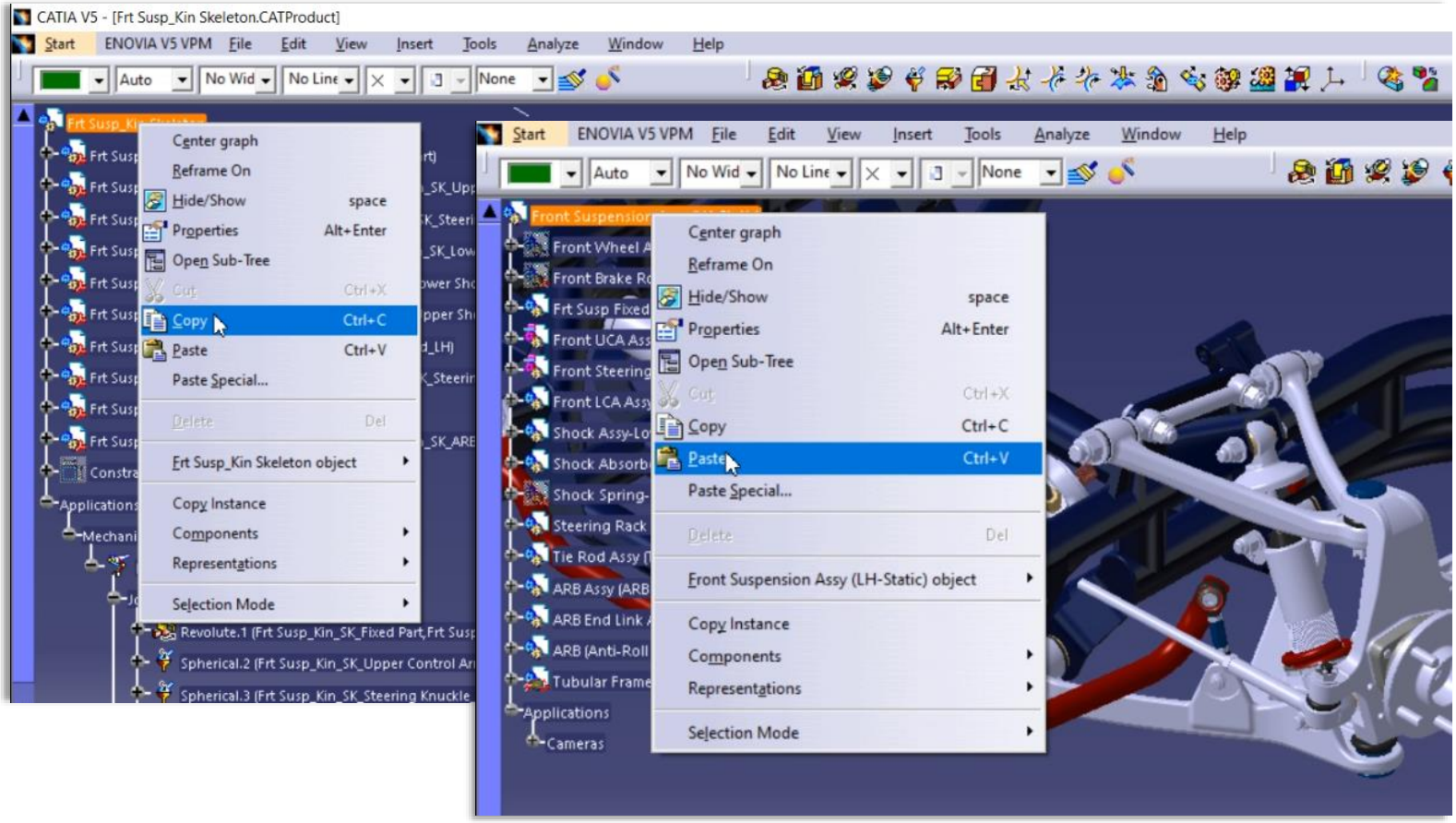
- Create a Revolute Joint between the ARB LH Rot line and the Fixed part Rot line.



Step 4: Link the Kinematic Skeleton to the Main parts assembly via Mechanism Dressup

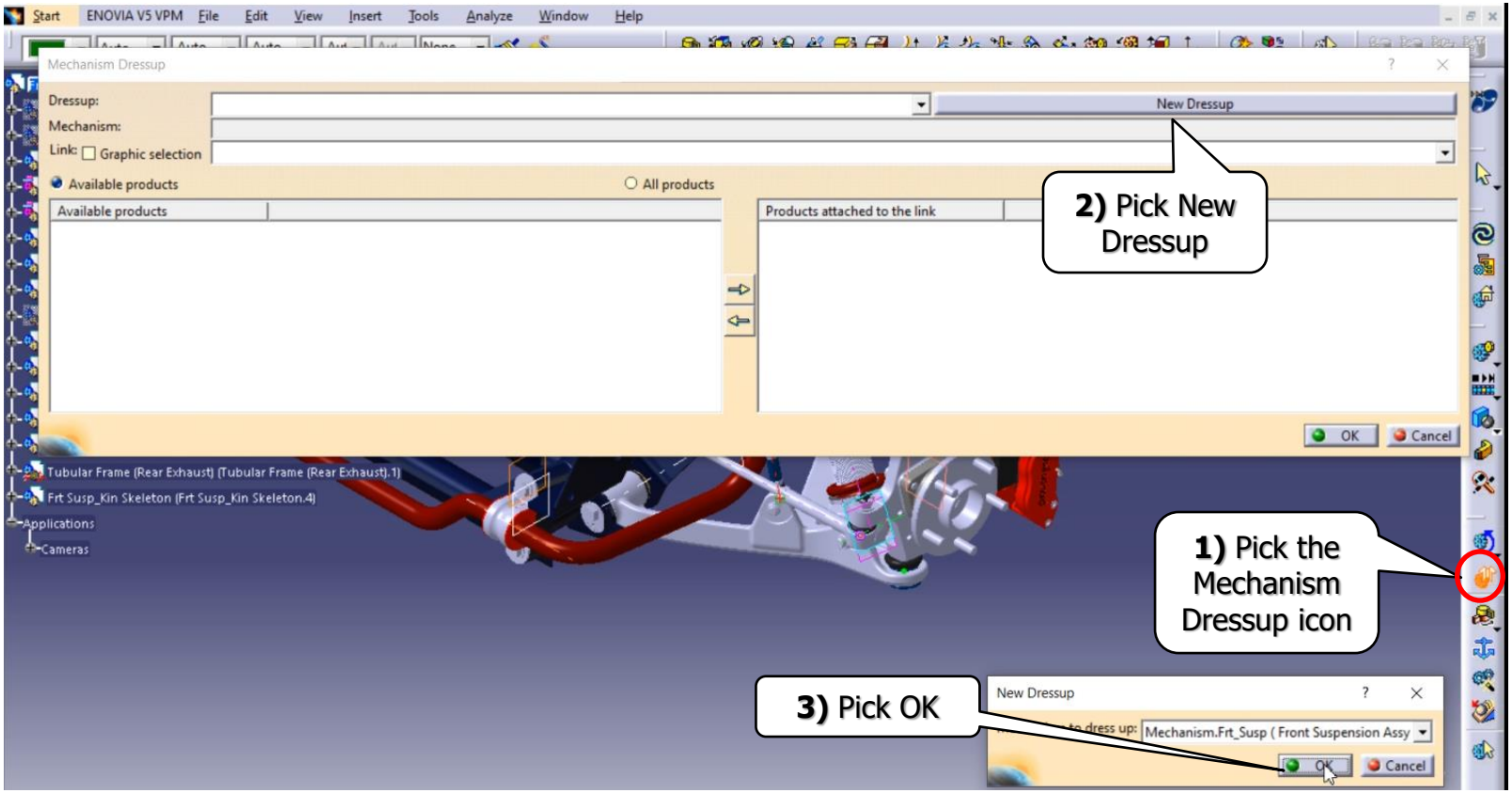
BND TechSource

- Copy the skeleton product and paste it into the suspension parts assembly.



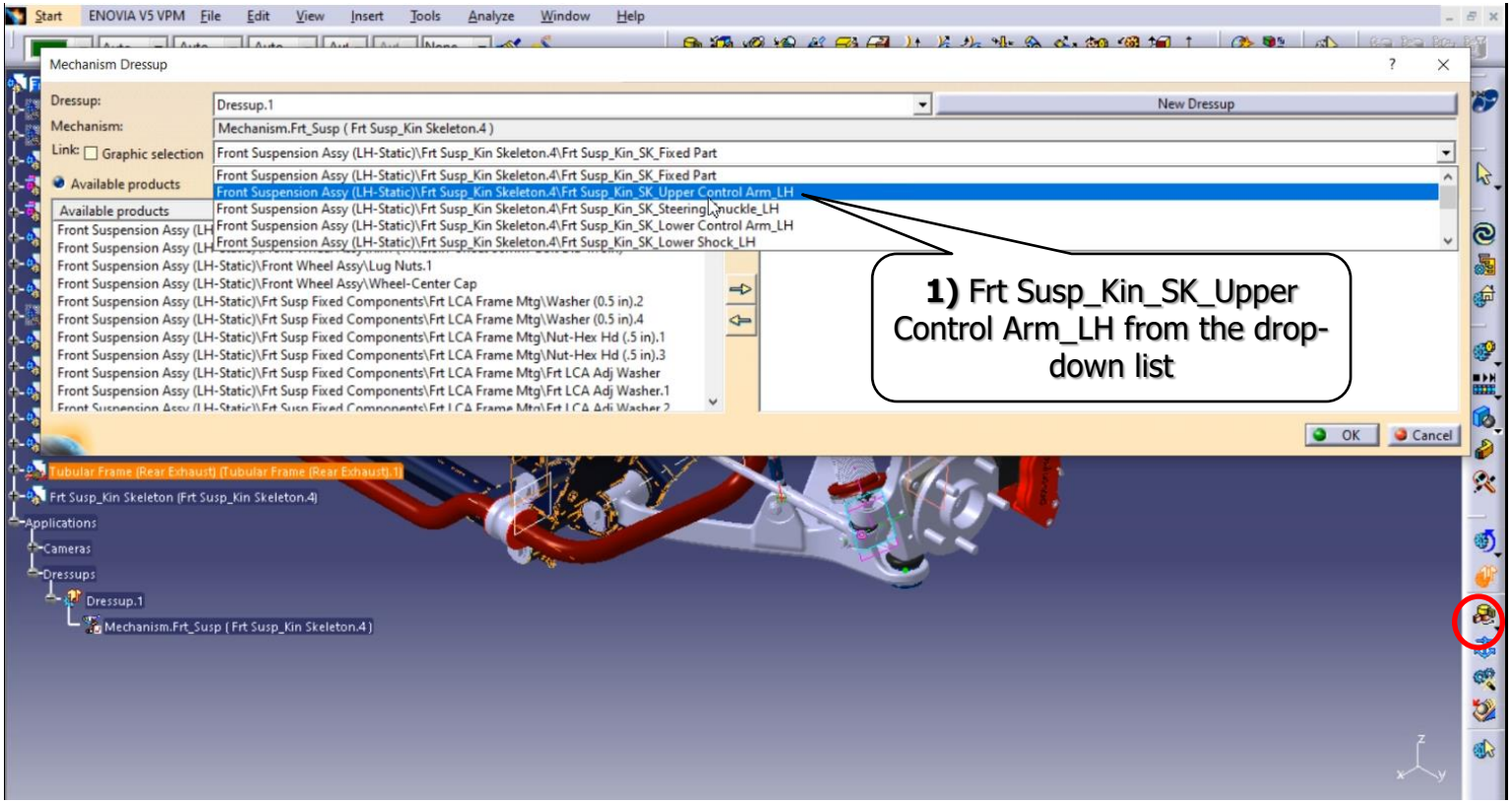
BND TechSource

- Link the parts to the kinematic skeleton using Mechanism Dressup.



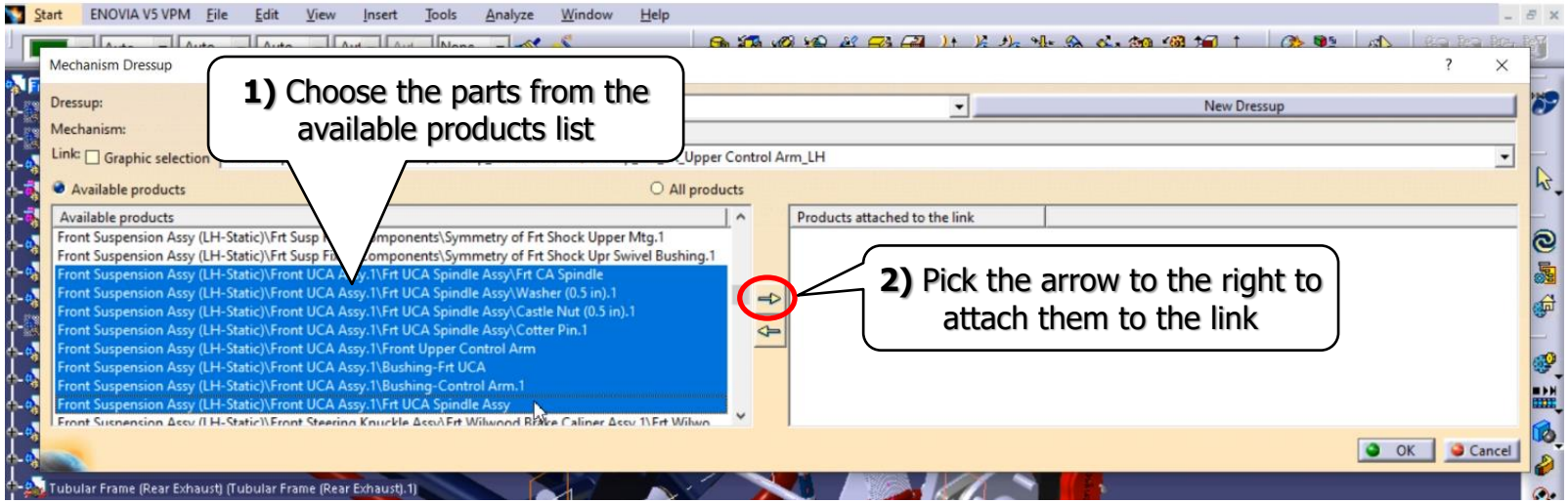
BND TechSource

- Step A: Choose Frt Susp_Kin_SK_Upper Control Arm_LH from the drop-down list.



BND TechSource

- Step B: Choose the parts from the available products list and pick the arrow to the right to attach them to the link.

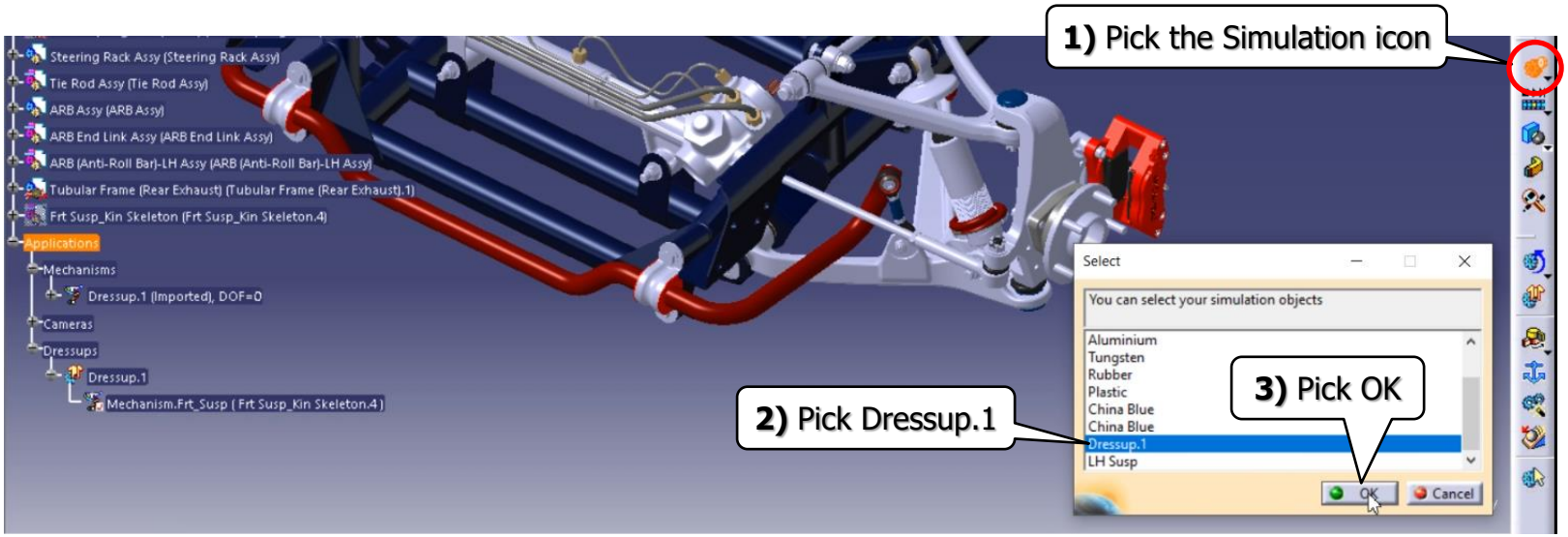


- Repeat Steps A & B until all the links on the drop-down list have been attached to the available products.

Step 5: Create and Save a Kinematic Simulation

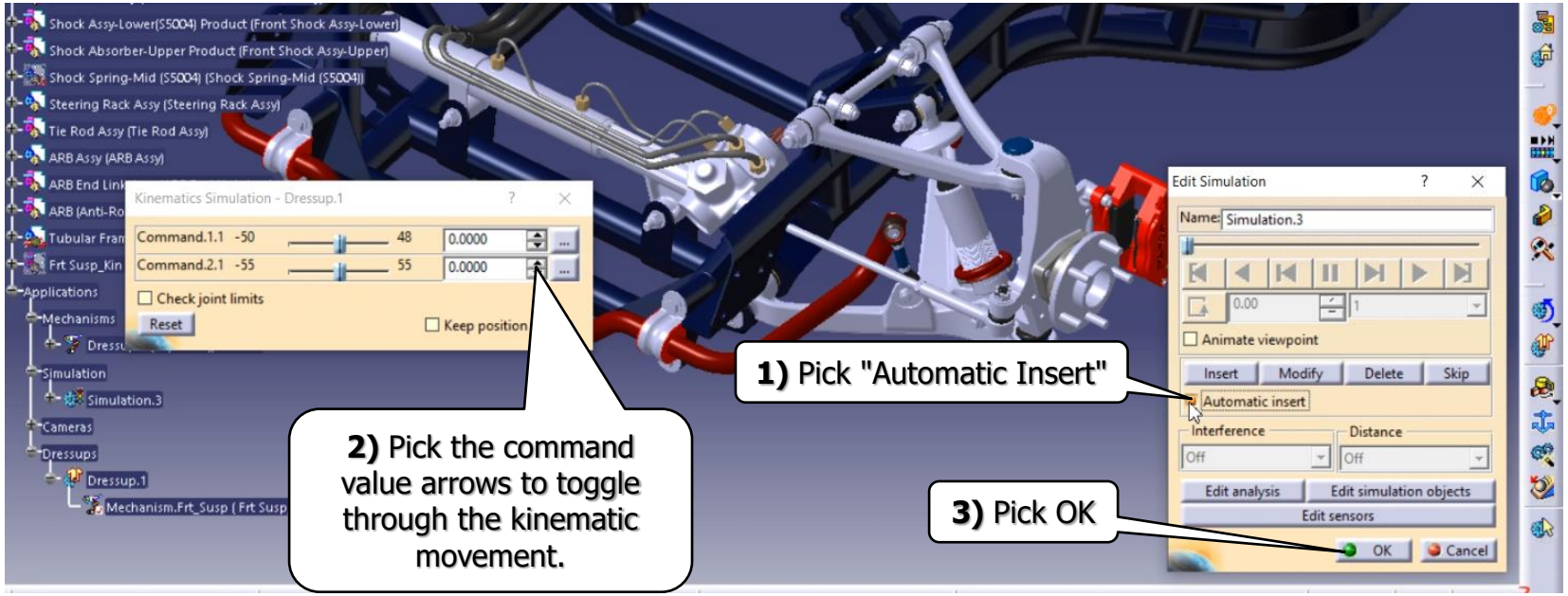
BND TechSource

- At this point we can run a simulation and see that all parts are now moving according to the kinematic mechanism.



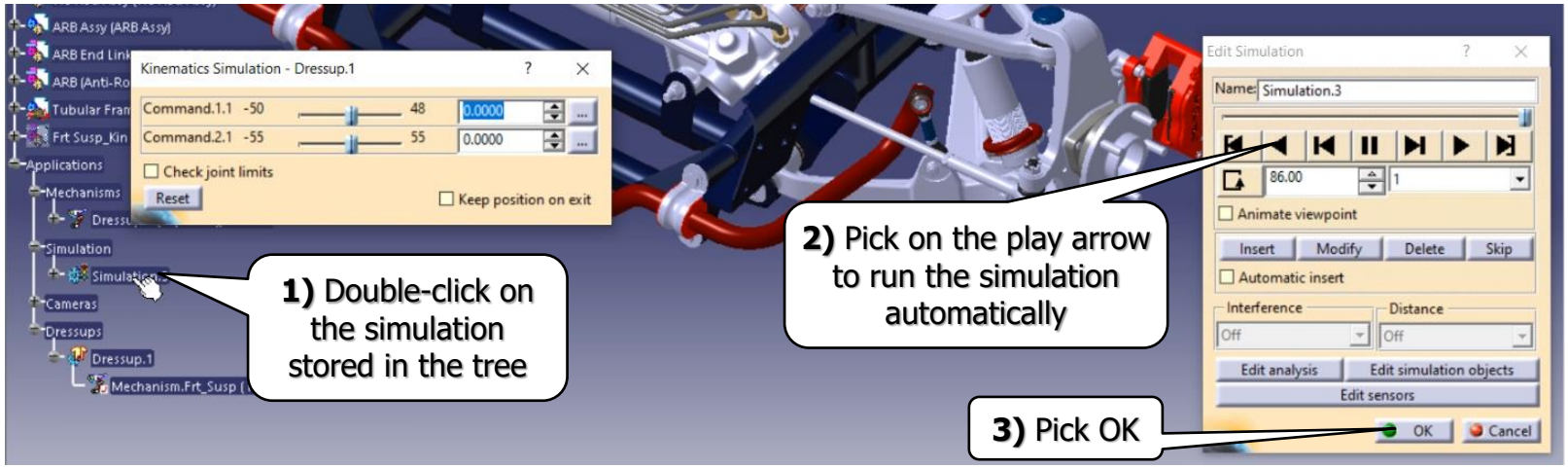
BND TechSource

- Create a simulation which can be stored and run automatically.



BND TechSource

- Run the Simulation.



BND TechSource

- Conclusion:

  This is an example of how to create a CATIA DMU Kinematic simulation for a front independent suspension.

  We hope this will help those who need this type of simulation.

  As always, we are open to any discussions this may bring.

  Please ***subscribe*** to our YouTube channel!