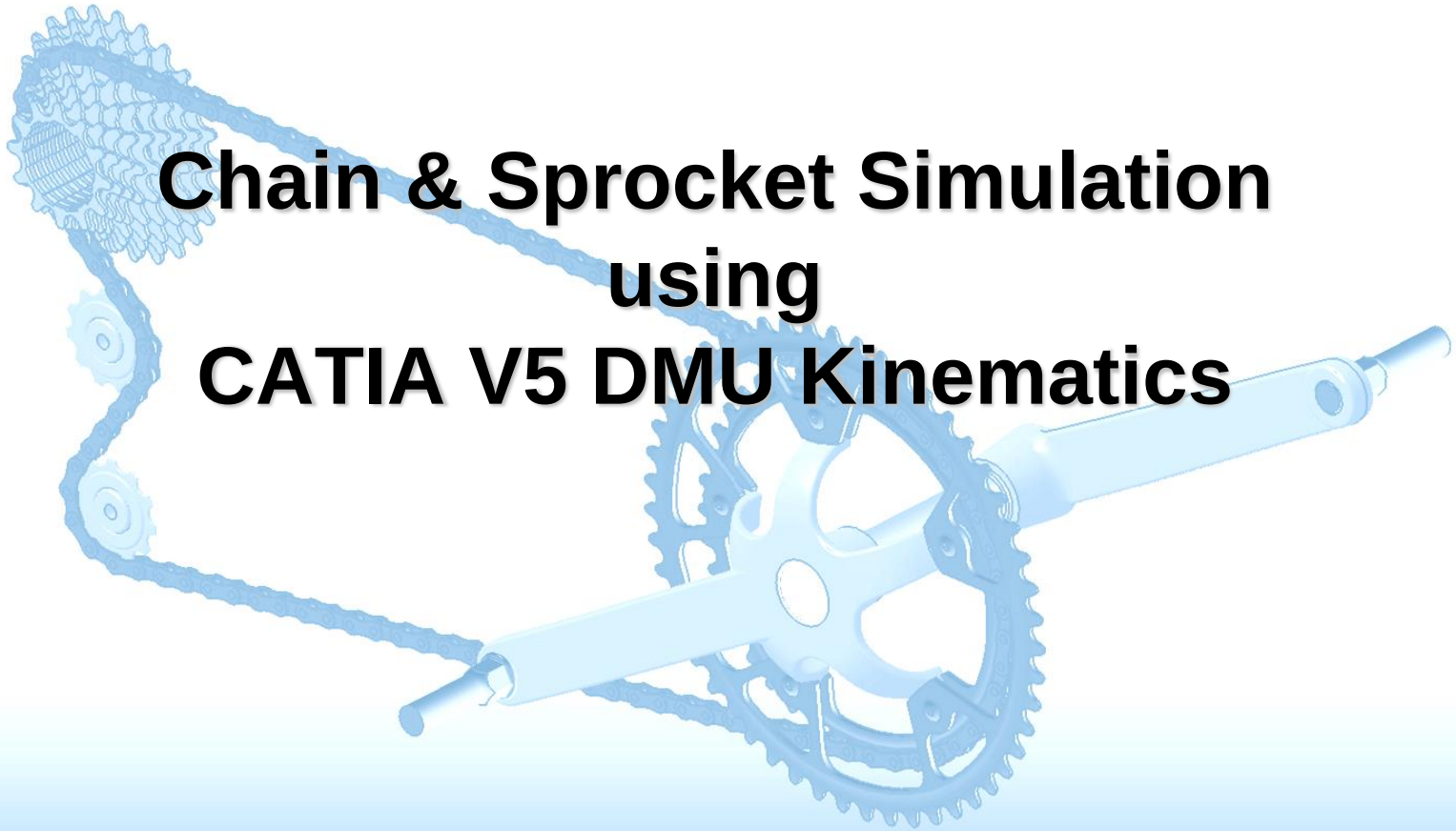
BND TechSource



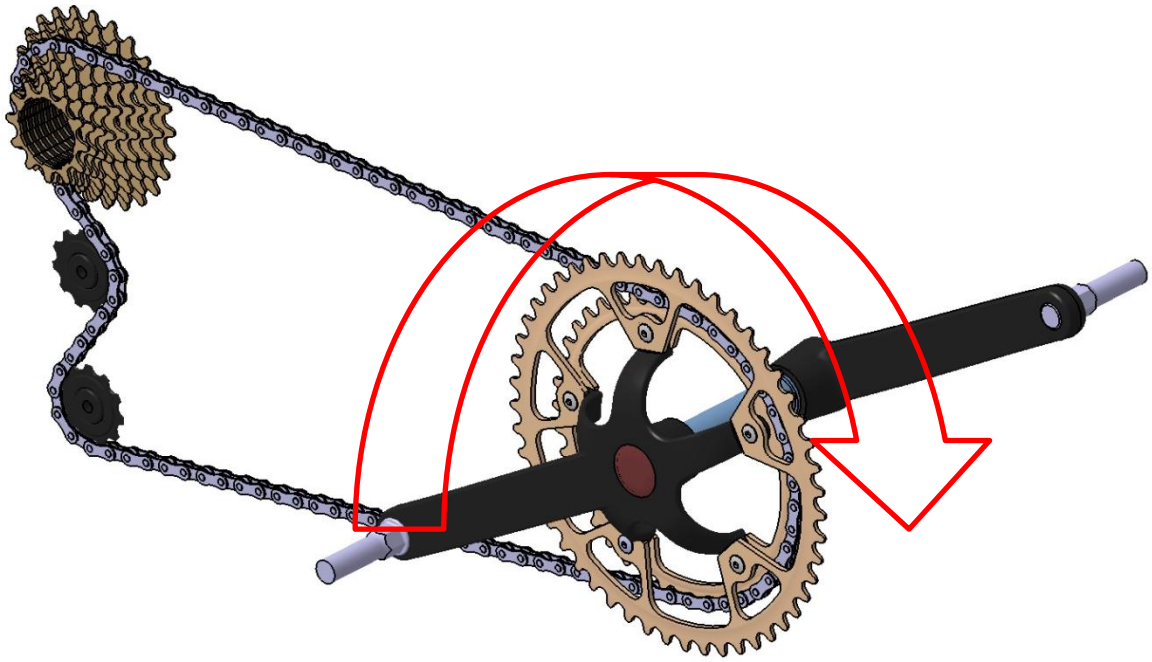
Chain & Sprocket Simulation using CATIA V5 DMU Kinematics

BND TechSource

- The following licenses are required to simulate Chain & Sprocket movement with CATIA V5 DMU Kinematics:
  - Digital Mockup + DMU Kinematics
  - Mechanical Design + Part Design
  - Mechanical Design + Assembly Design

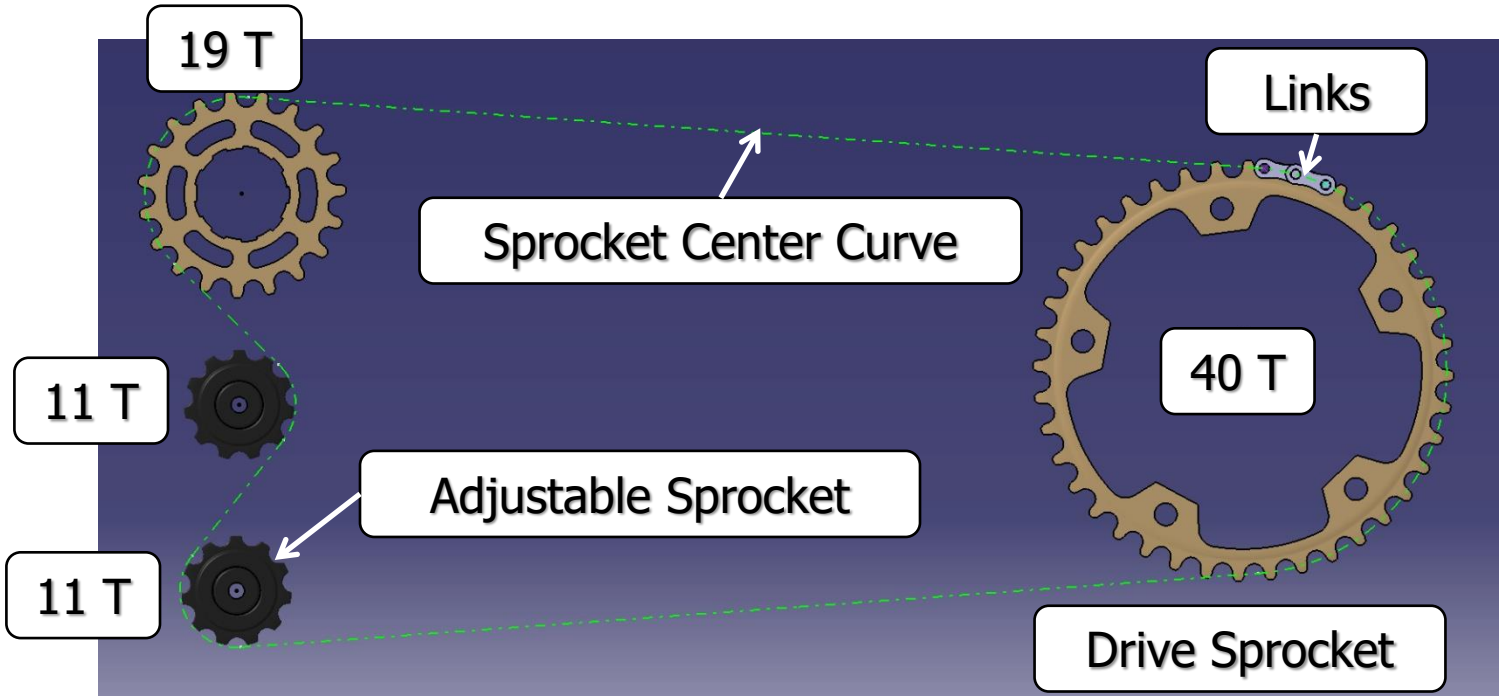
BND TechSource

- The end result we are trying to achieve is to simulate the movement of a bicycle chain around the sprockets.



BND TechSource

- There are certain known values when you begin your simulation.



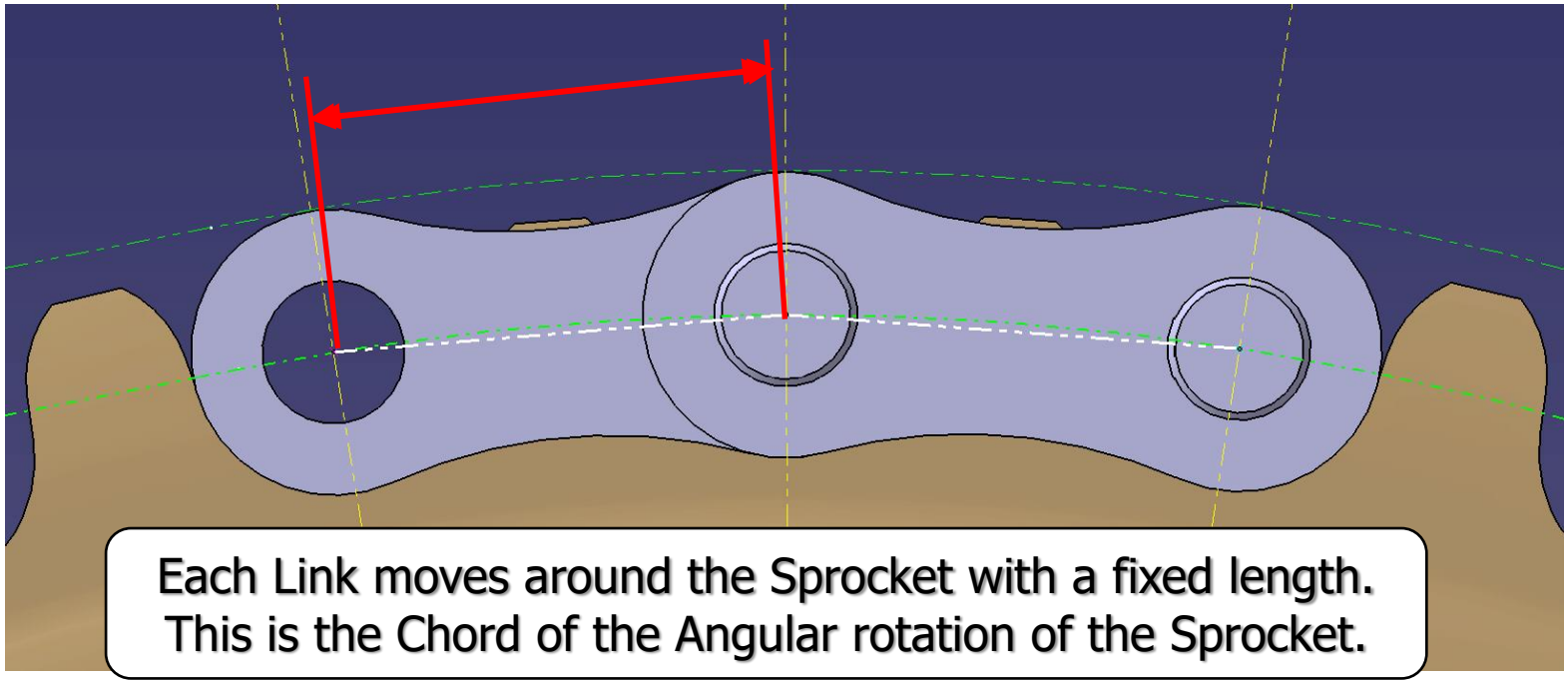
BND TechSource

- Known values:
  - Sprocket sizes (number of teeth)
  - Sprocket placement (center to center)
  - Sprocket adjustability (lower derailleur)
  - Link size (12.7mm)
  - Total Number of Links (106)

- These values will help set up the Sprocket Center Curve.

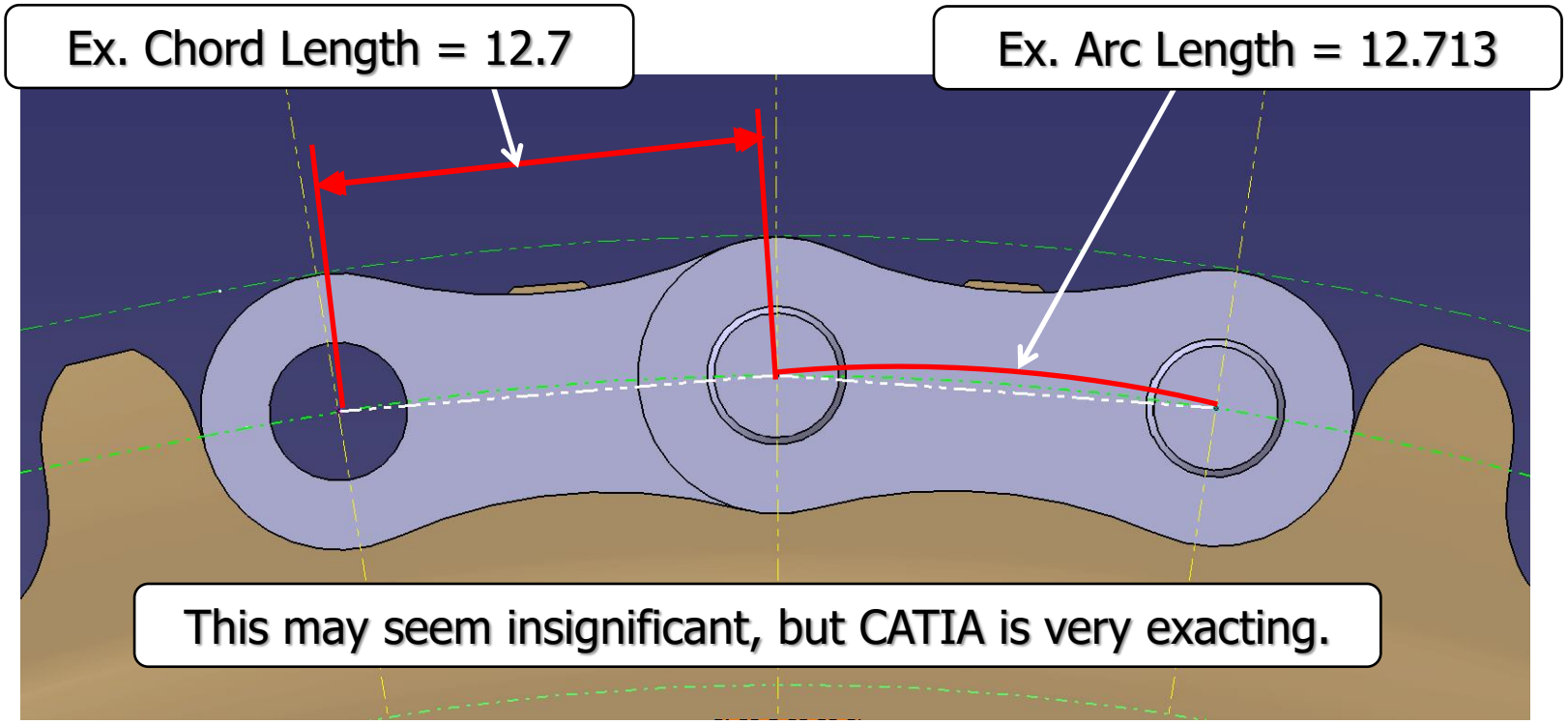
BND TechSource

- To accurately simulate the chain movement around the sprockets, you must first understand the chordal relationship of the Link to the Sprocket.



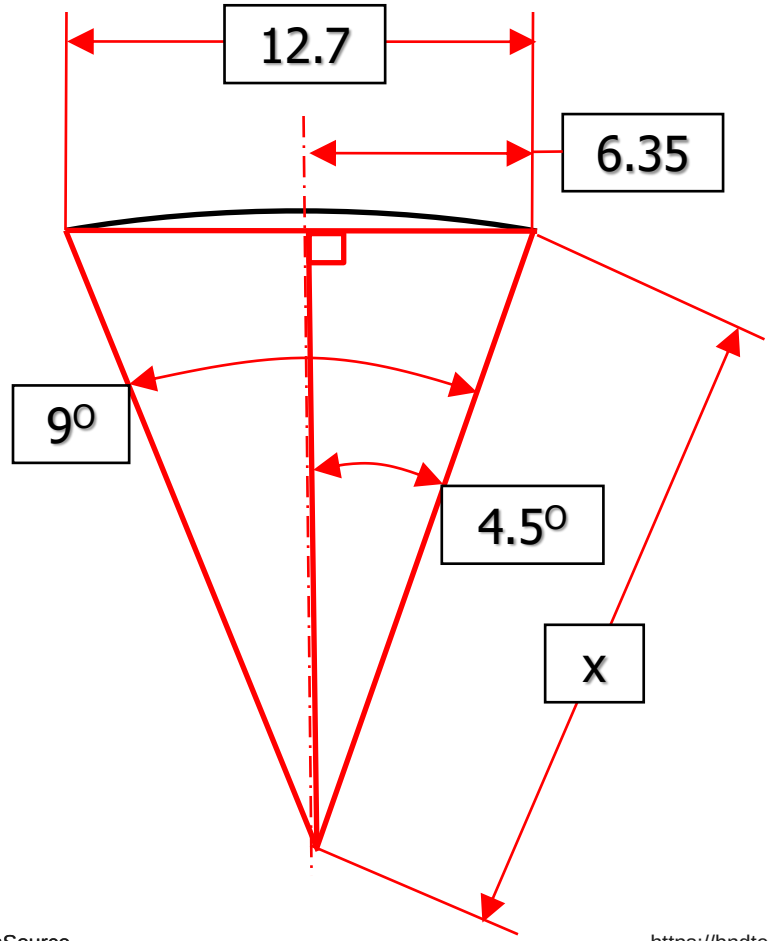
BND TechSource

- The Chord length is not the same as the Arc length.



BND TechSource

- Time for some trigonometry...

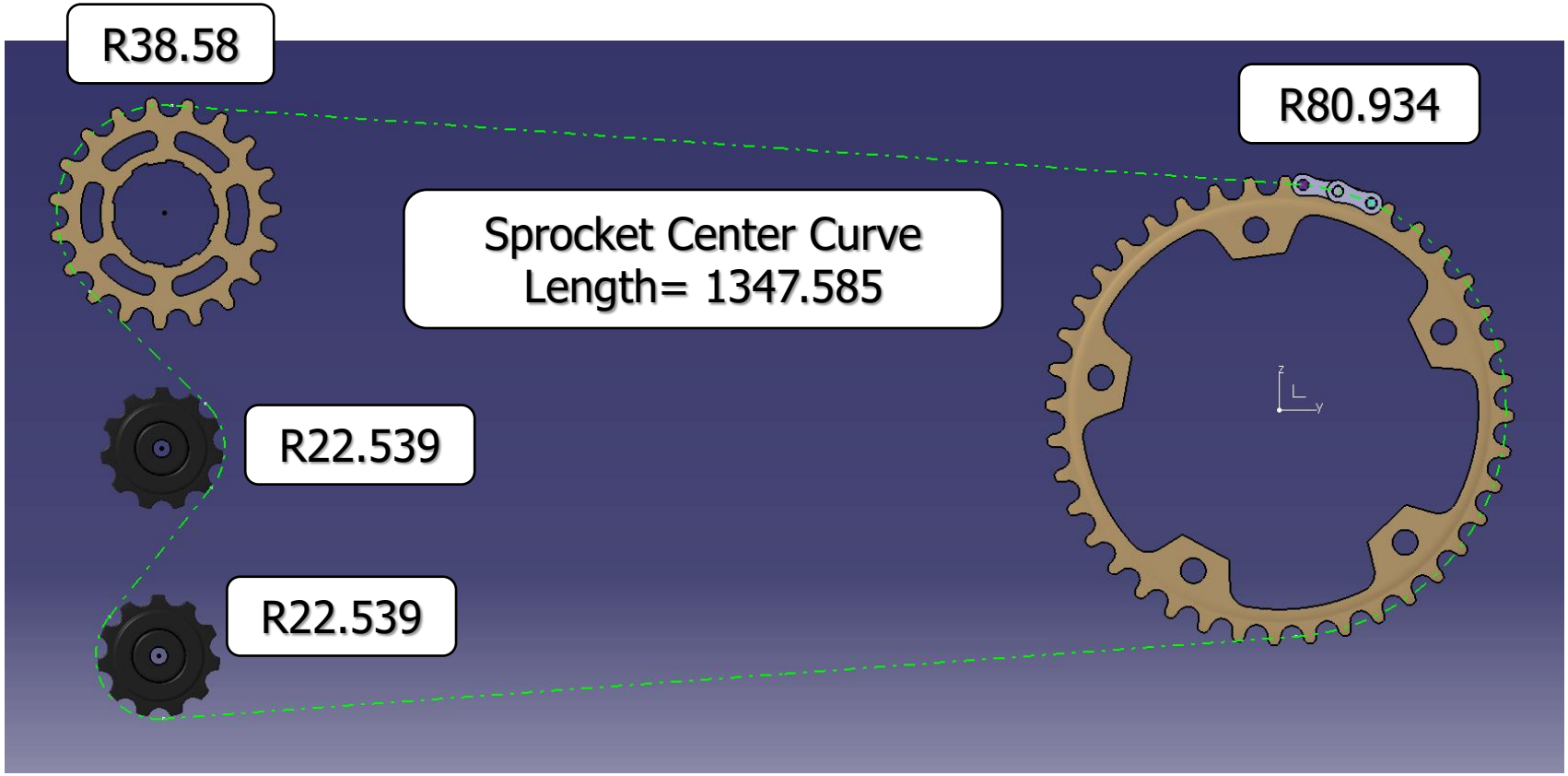


Ex. 40T Drive Sprocket:

$360^{o}/40 = 9^{o}$
Chord Length = 12.7
Radius = x
$\sin^{-1}(6.35/x) = 4.5^{o}$
$x = (6.35/\sin 4.5^{o})$
x = 80.934mm
Circumference = $2\pi R$ = 508.523mm
Arc Length =
508.523/40 = 12.713066
Sprocket Center Curve =
106*12.713066 = 1347.585mm

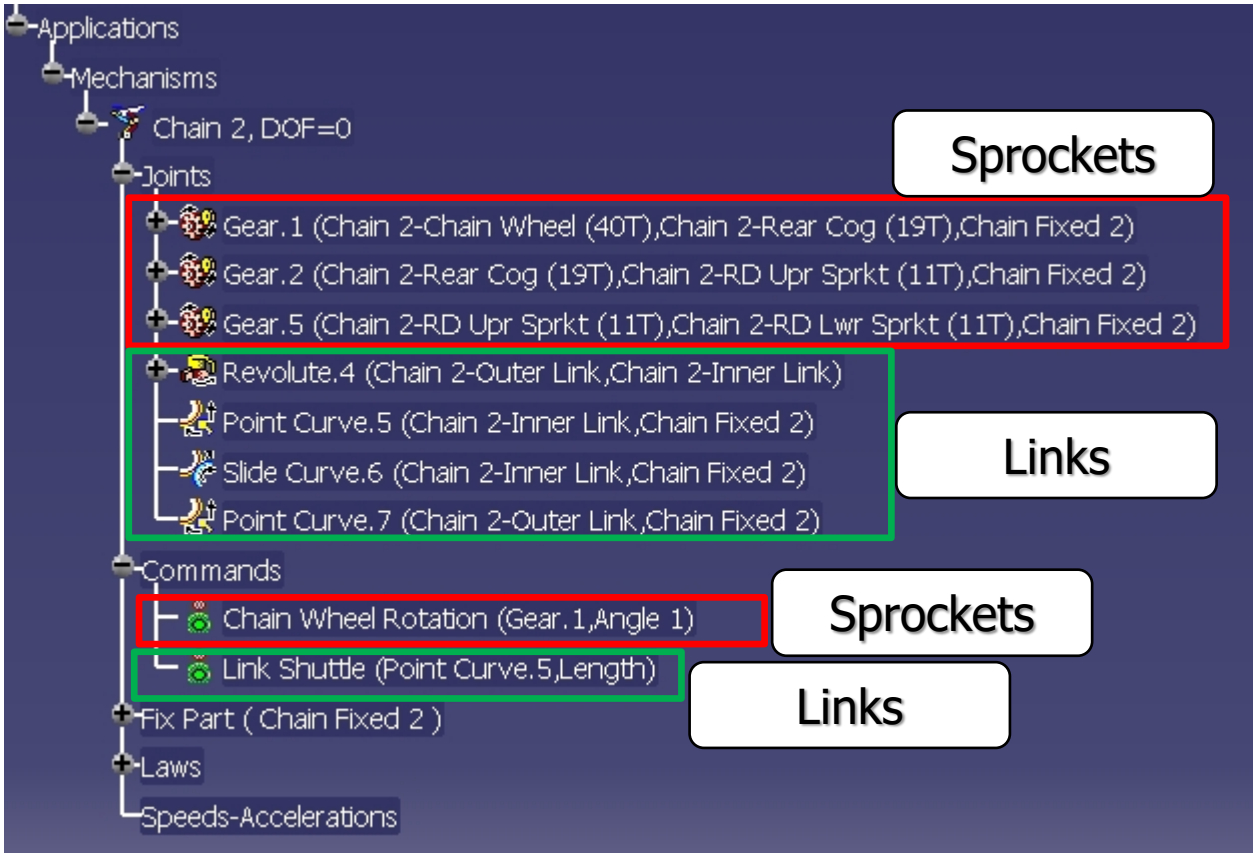
BND TechSource

- Now we have the information to proceed.



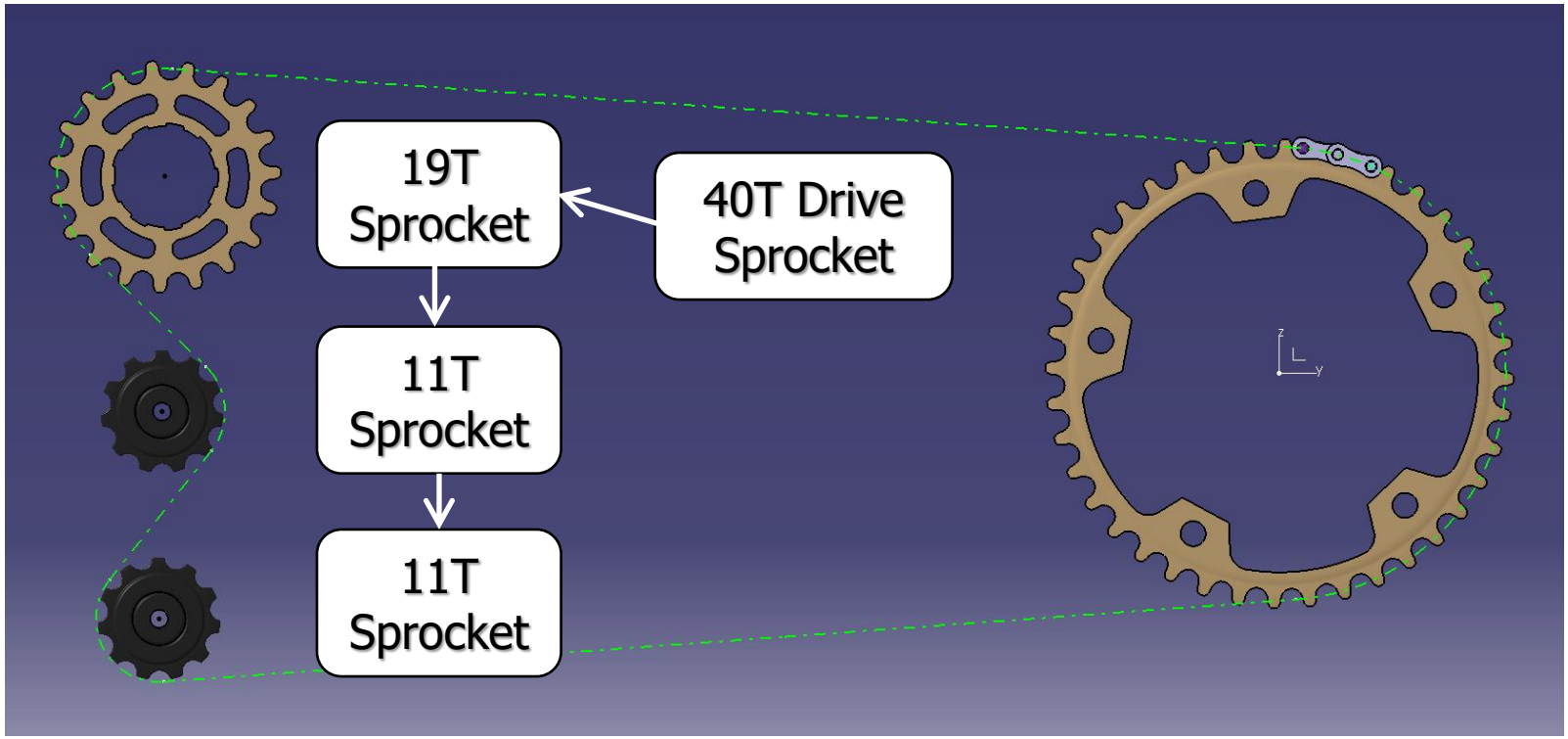
BND TechSource

- Here are the Joints and Commands to run the Simulation (Laws come later).



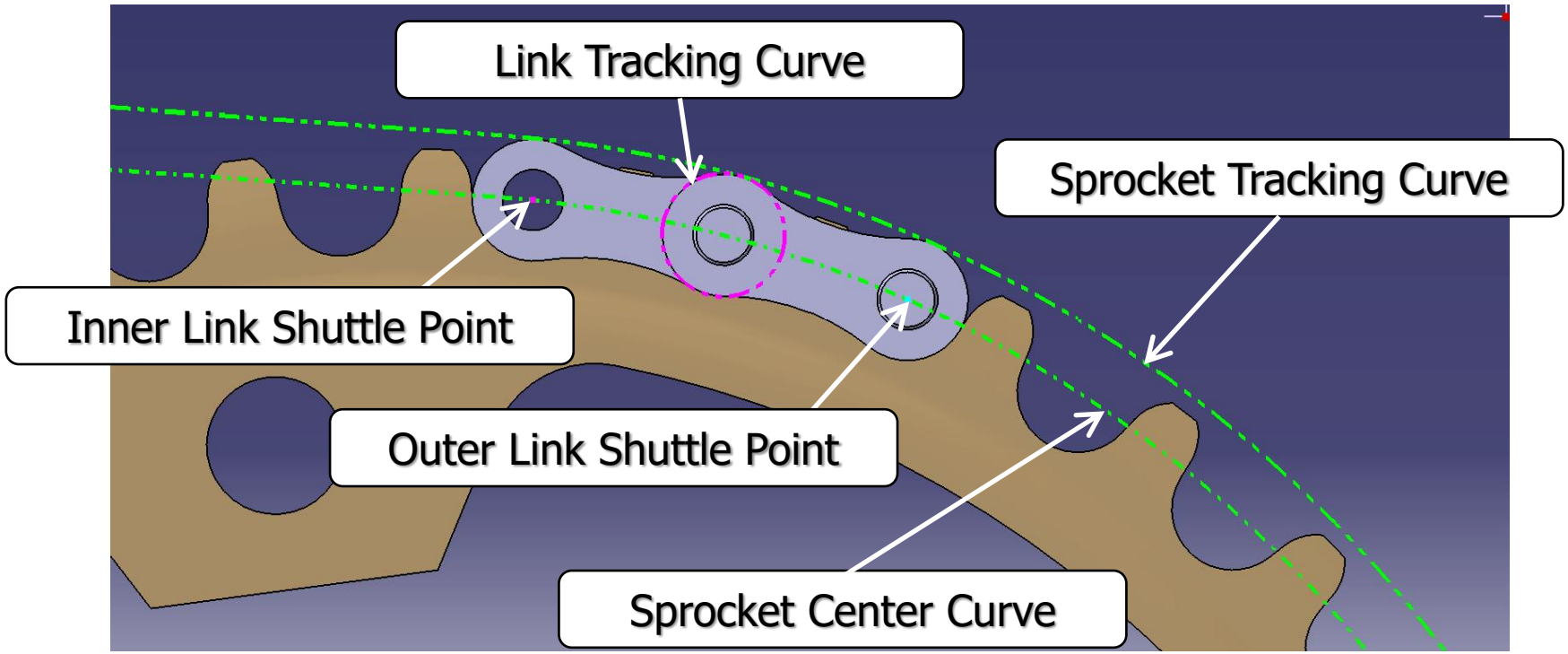
BND TechSource

- The Gear Joints for the Sprockets will begin with the normal ratio (ex. 40T/19T=2.105).



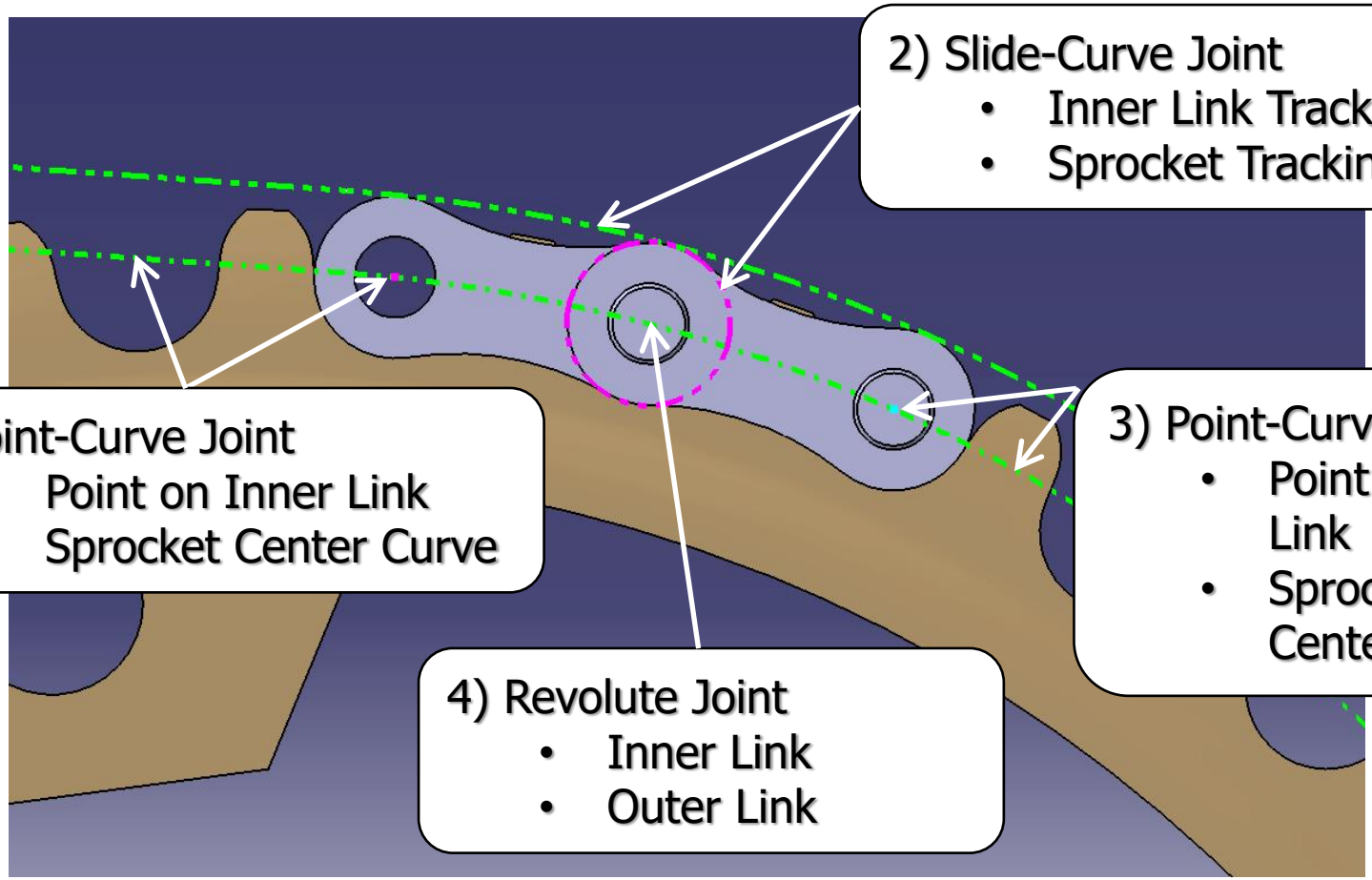
BND TechSource

- The Link Shuttle is created with two Links (Inner & Outer). These two links will run along the Sprocket Center Curve and the Sprocket Tracking Curve.



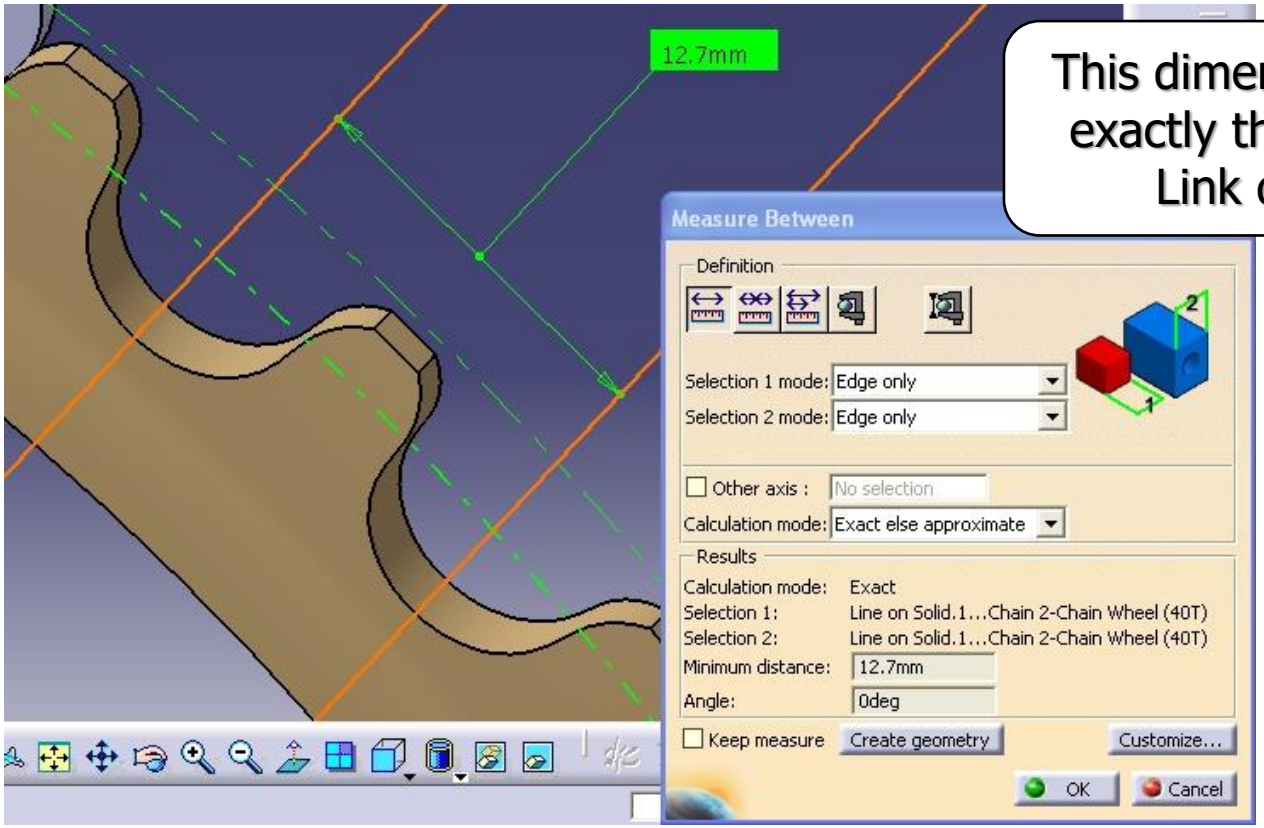
BND TechSource

- There will be four Joints in the Link Shuttle .



BND TechSource

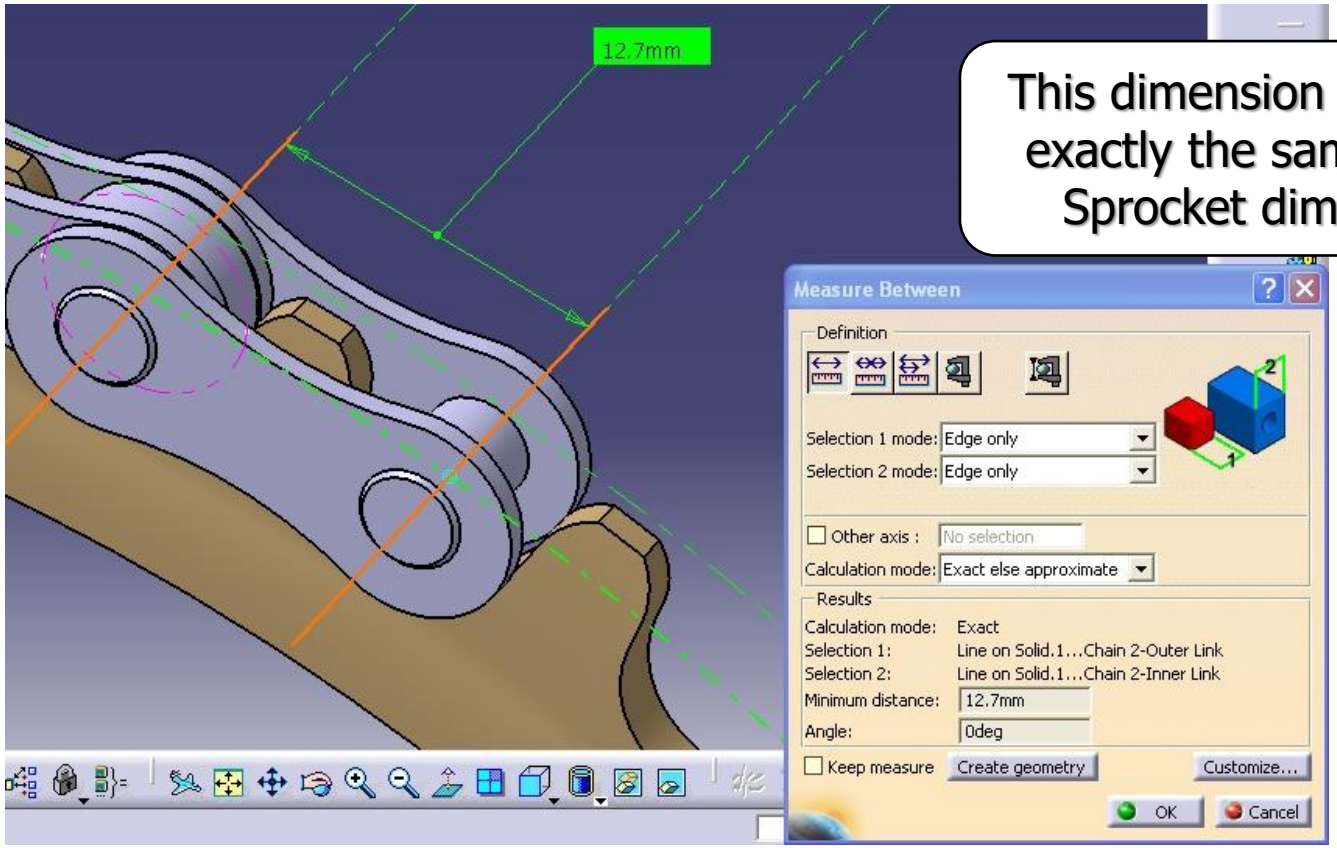
- Check Sprocket tooth-to-tooth centerline dimensions.



This dimension should be exactly the same as the Link dimension.

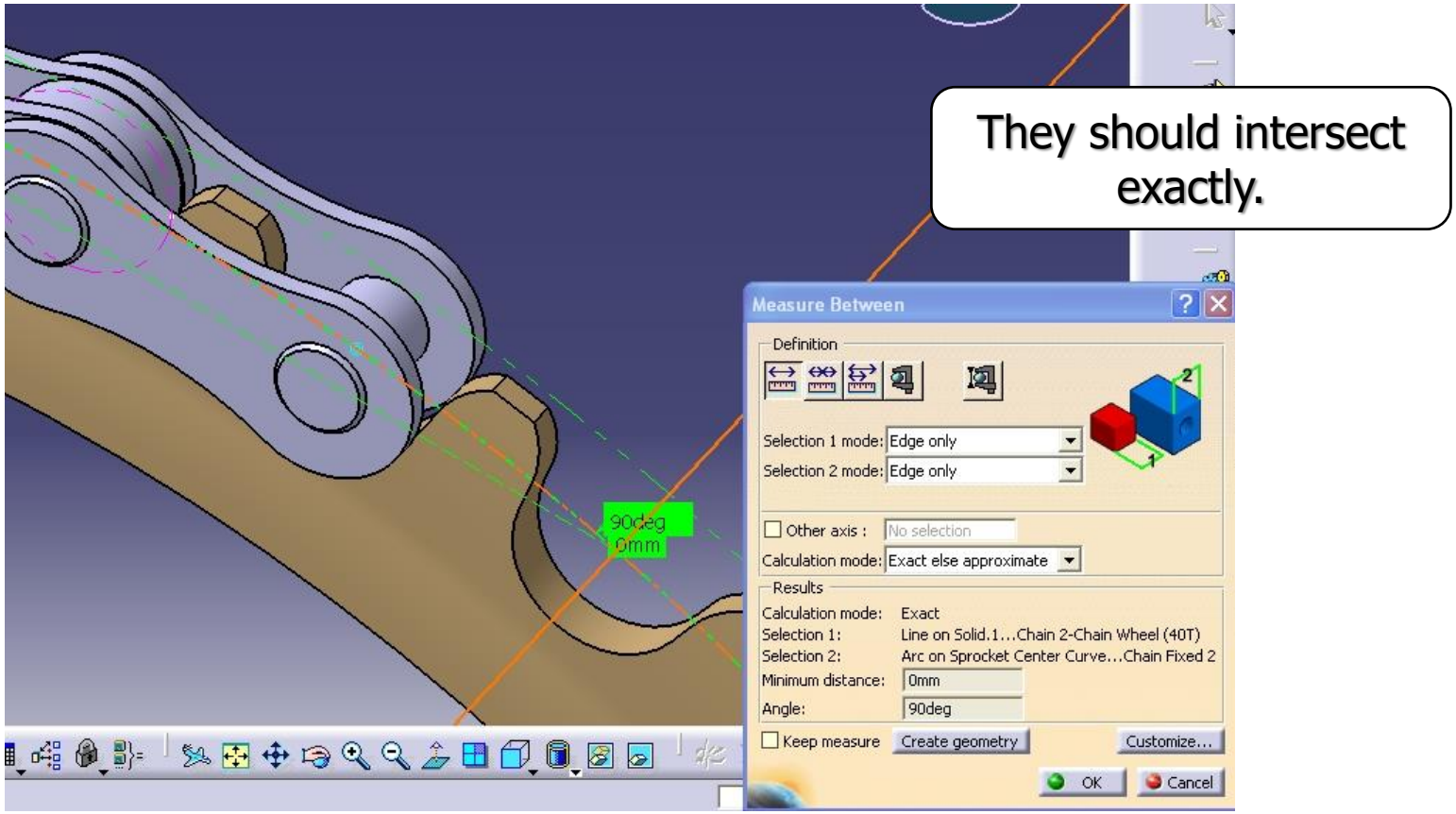
BND TechSource

- Check Link roller-to-roller centerline dimensions (for both Links).



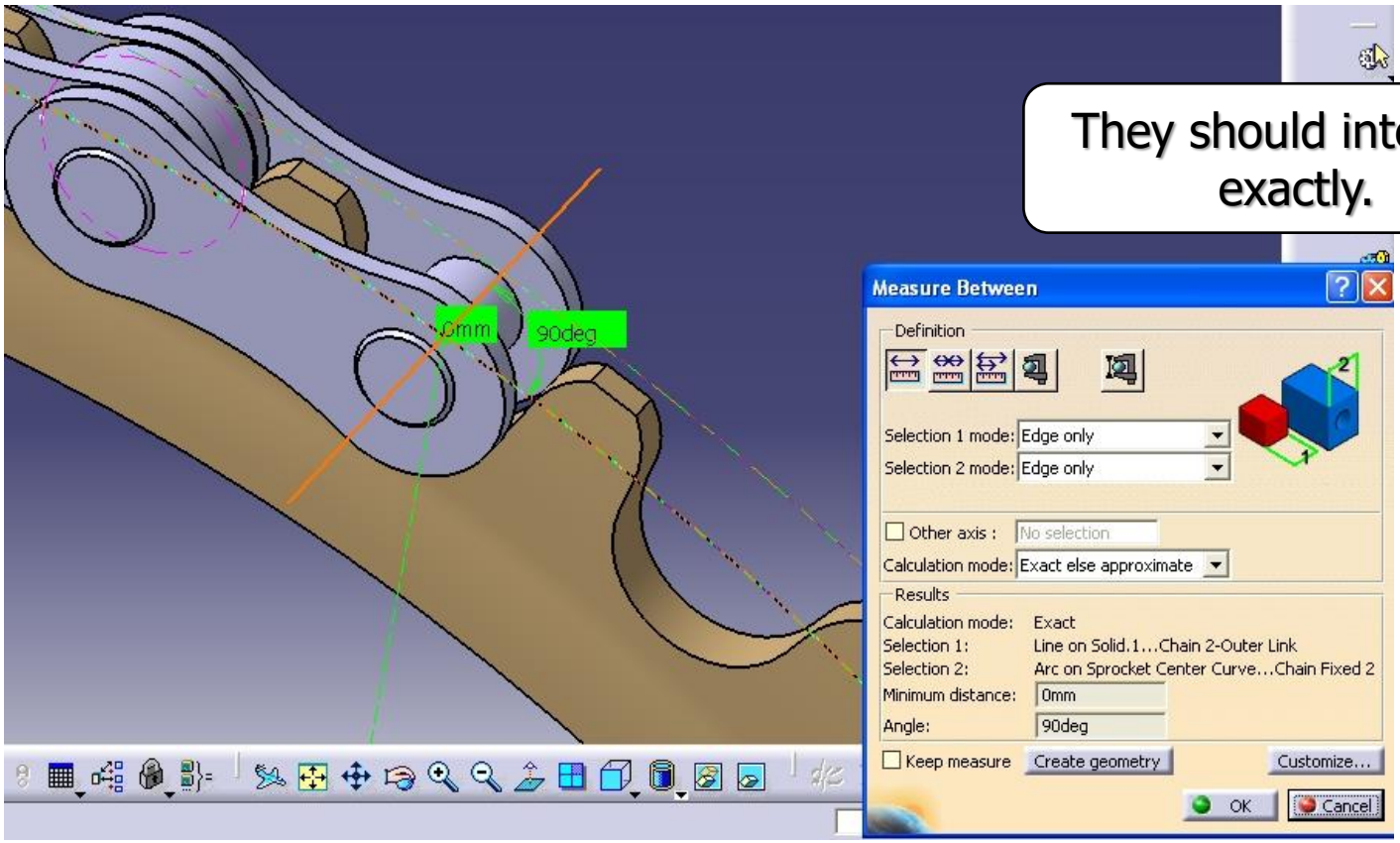
BND TechSource

- Check Drive Sprocket tooth centerline to the Sprocket Center Curve.



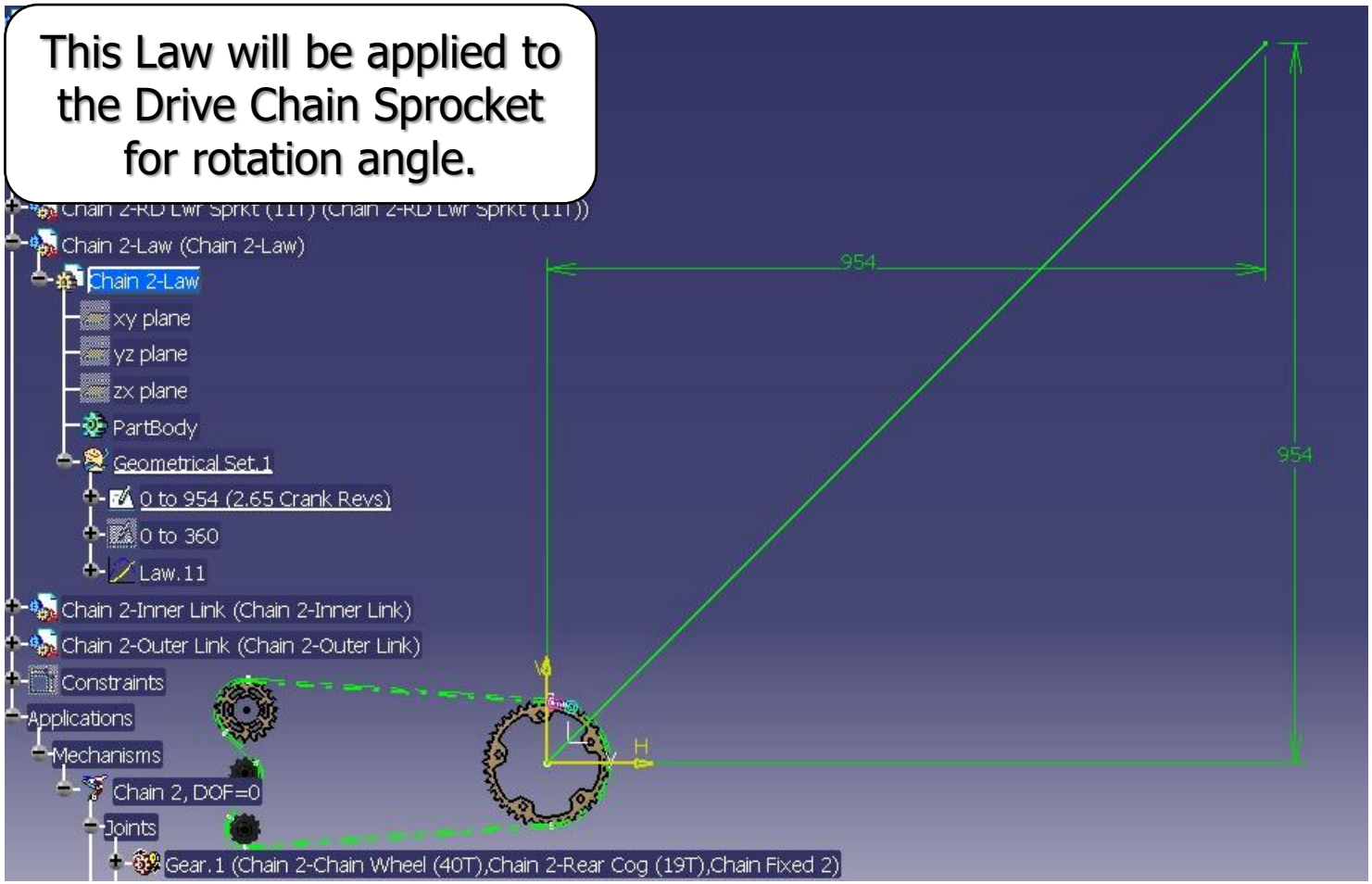
BND TechSource

- Check Link roller centerline to the Sprocket Center Curve.



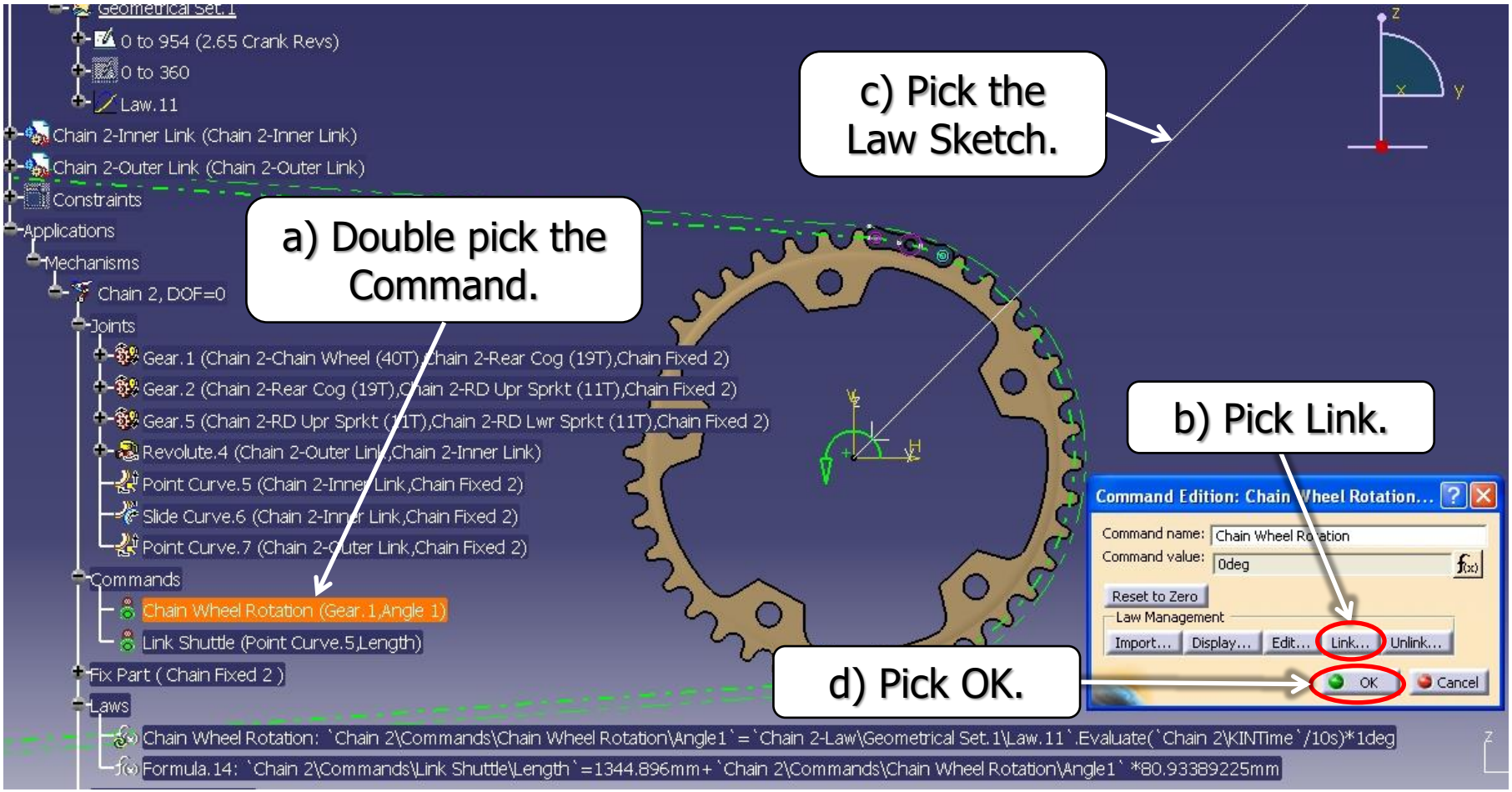
BND TechSource

- Create a Law Sketch 954 x 954 (106 x 9^{O}).



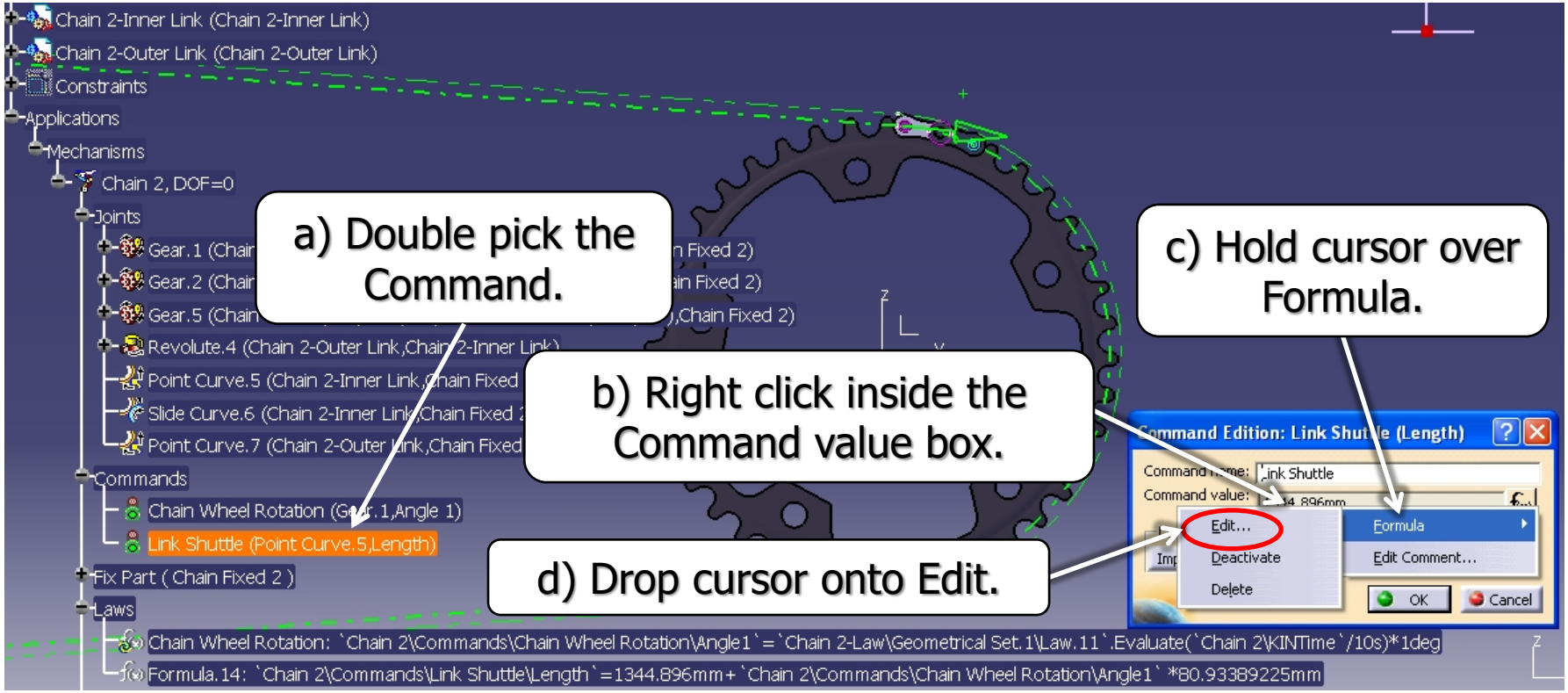
BND TechSource

- Apply the Law to the Gear Command.



BND TechSource

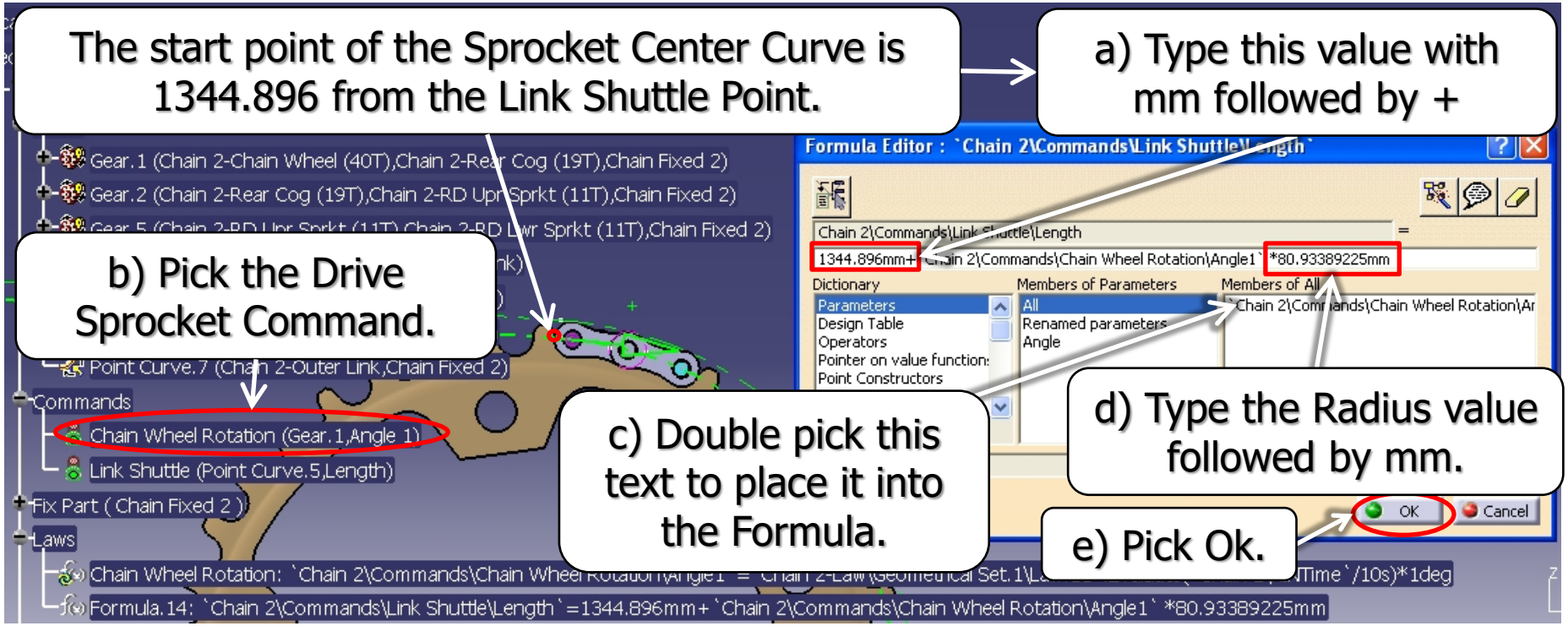
- Apply a Formula to the Shuttle Command.



BND TechSource

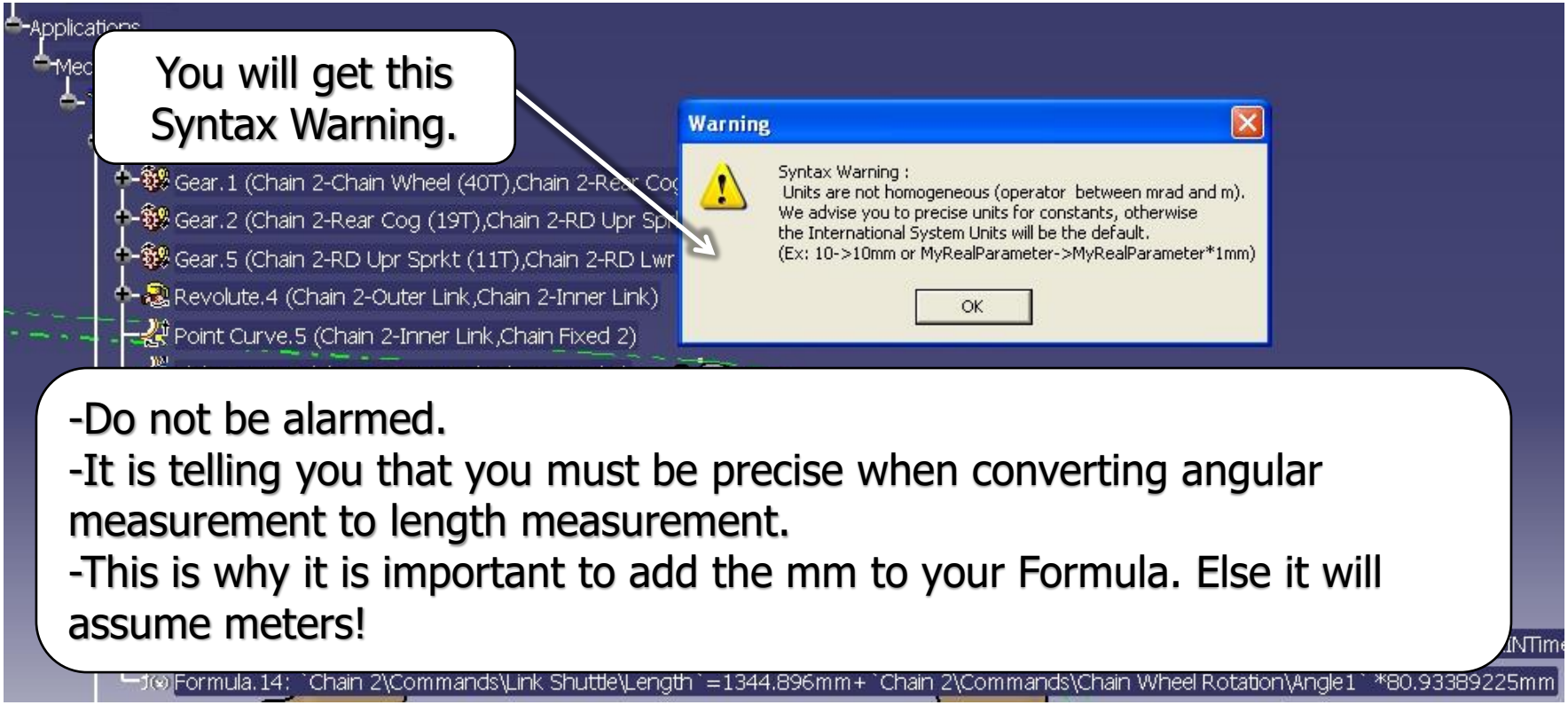
- Apply a Formula to the Shuttle Command (cont'd).

1344.896mm+'Chain 2\Commands\Chain Wheel Rotation\Angle1'*80.93389225mm



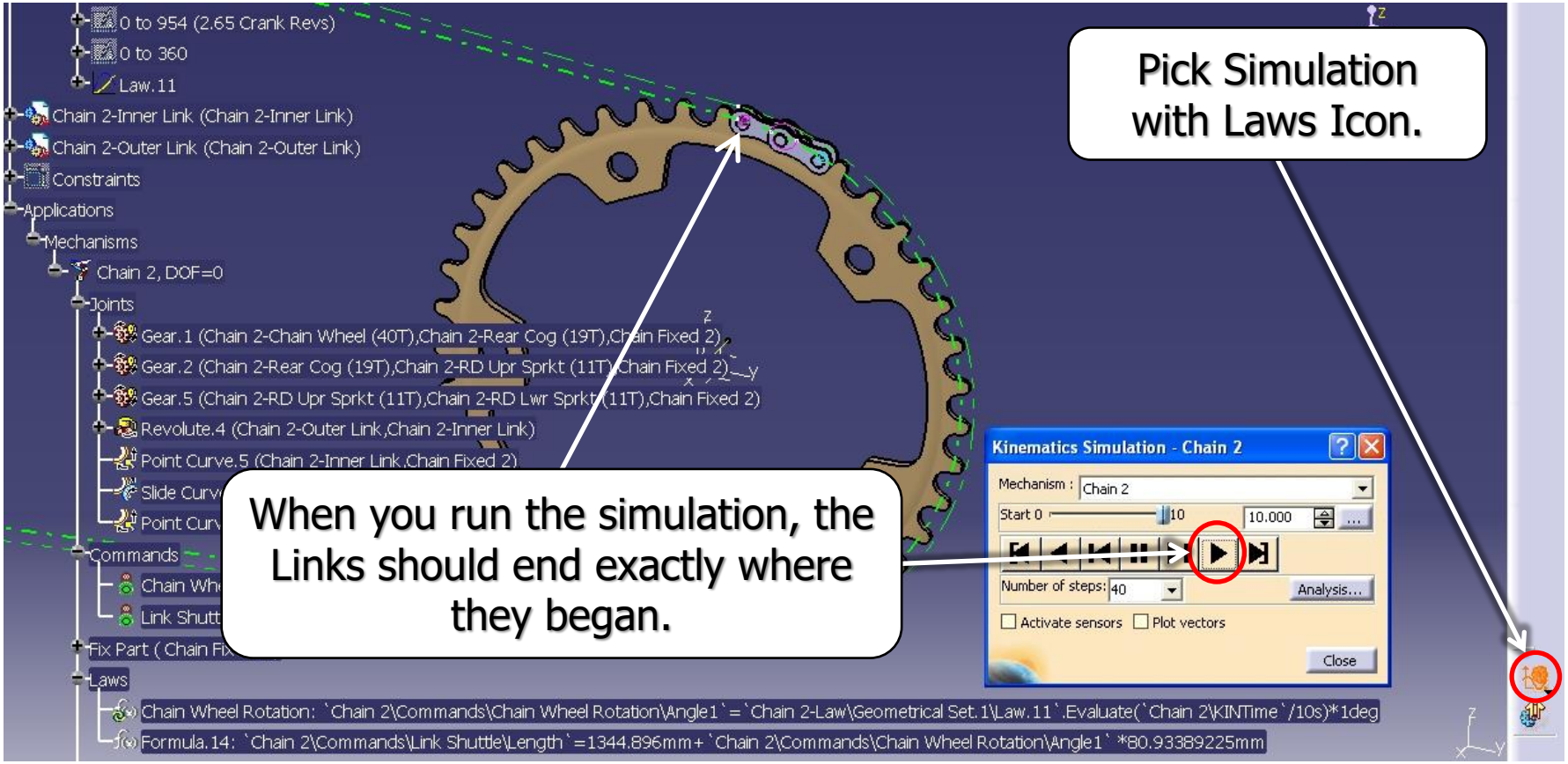
BND TechSource

- Apply a Formula to the Shuttle Command (cont'd).



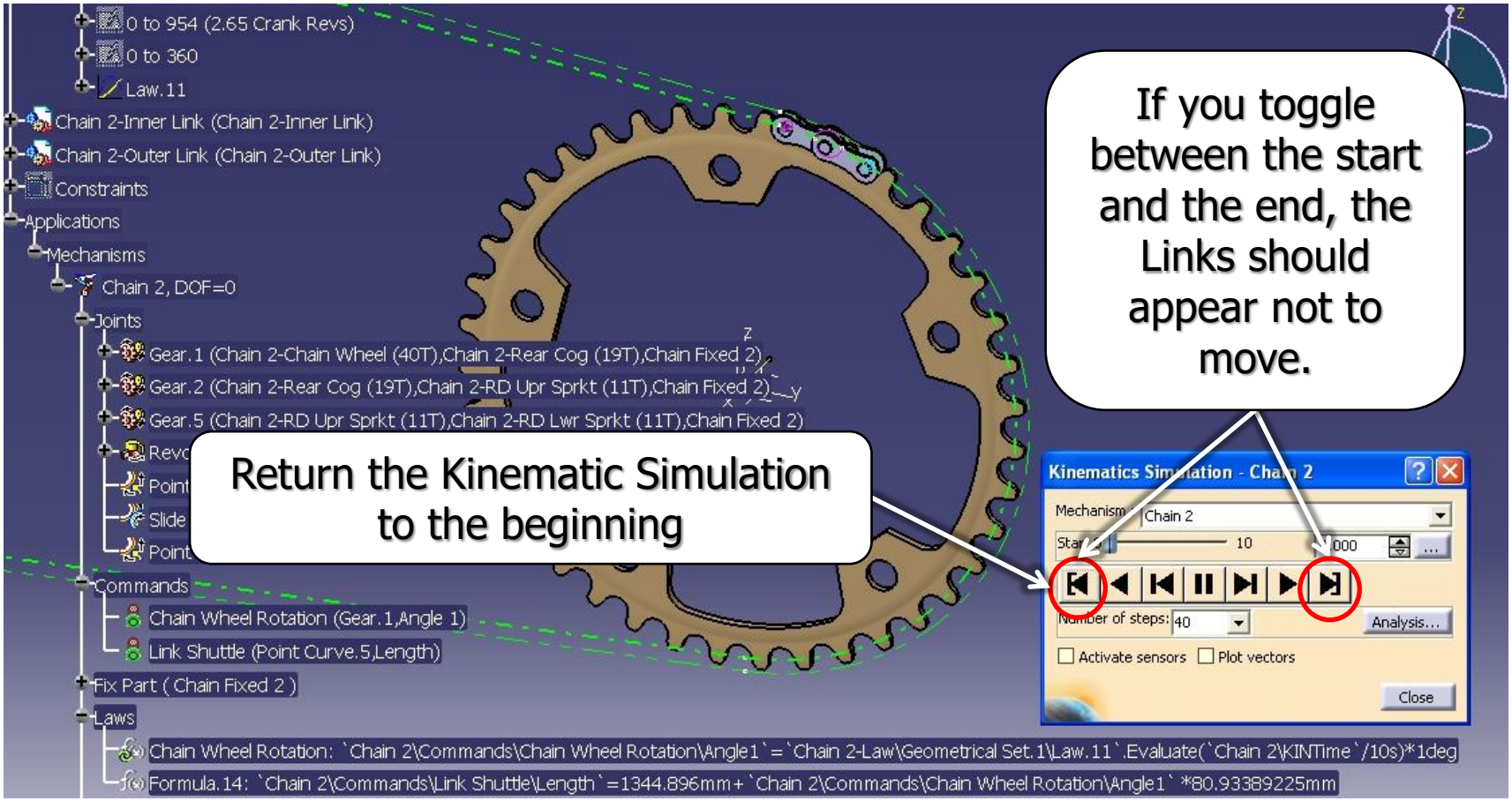
BND TechSource

- Run the Kinematic with Laws.



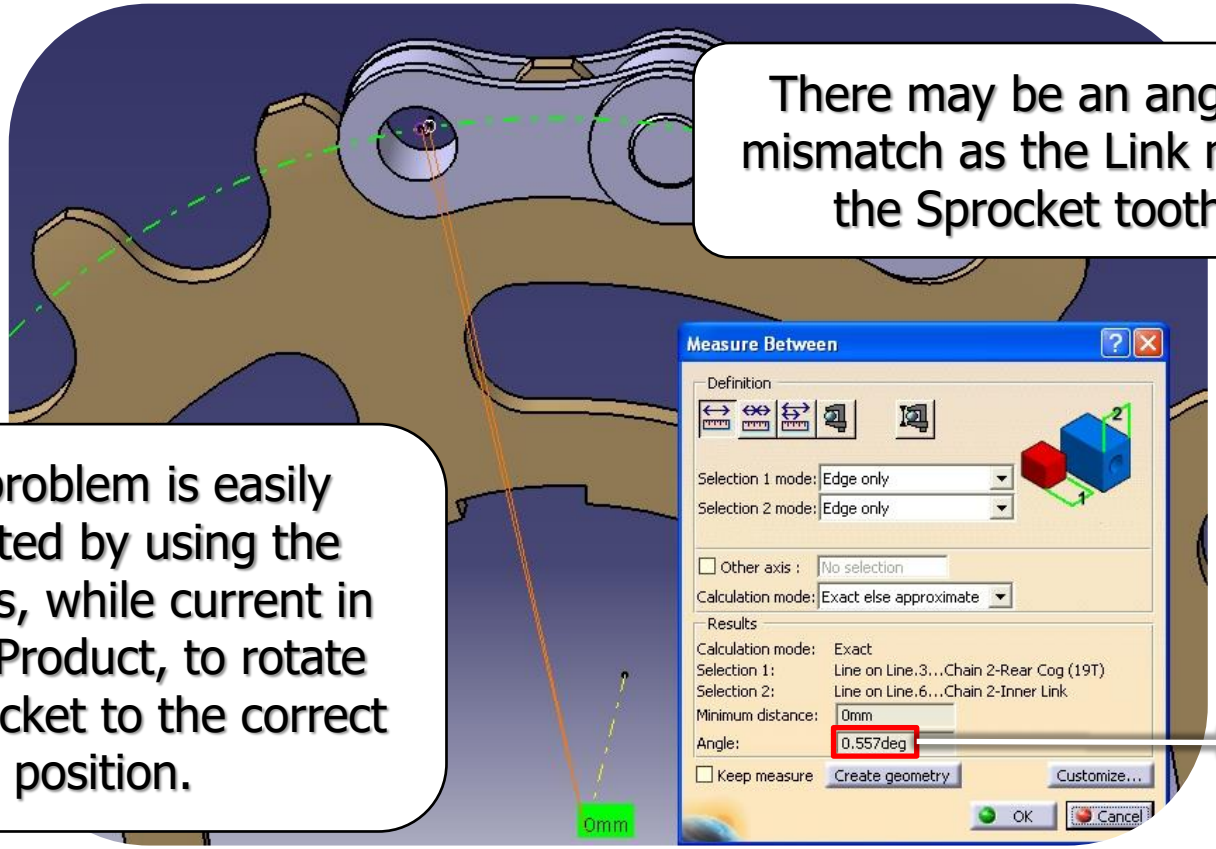
BND TechSource

- Return the Kinematic Simulation to the beginning.



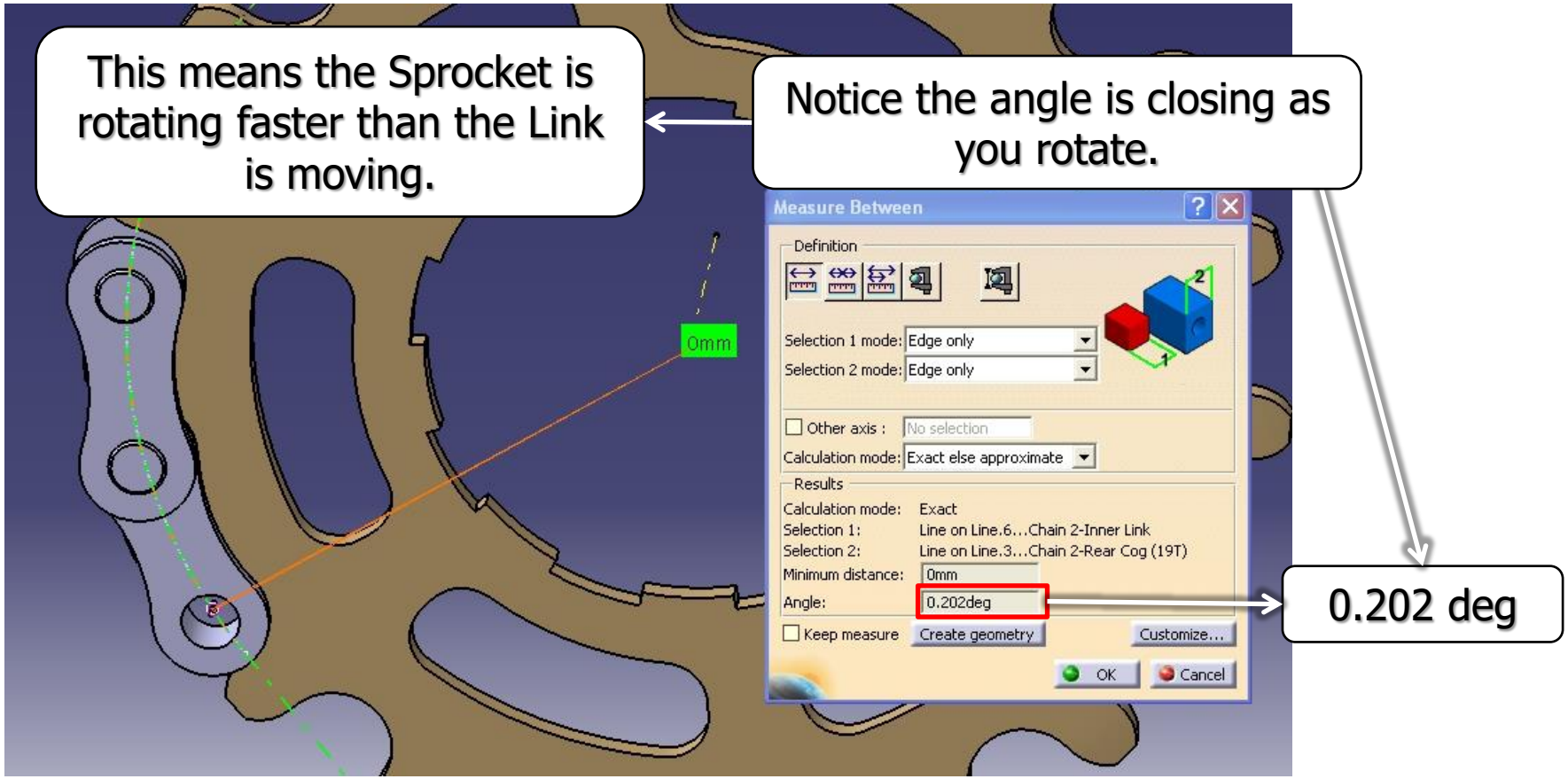
BND TechSource

- Check the Links as they travel across the other Sprockets. (19T Sprocket shown)



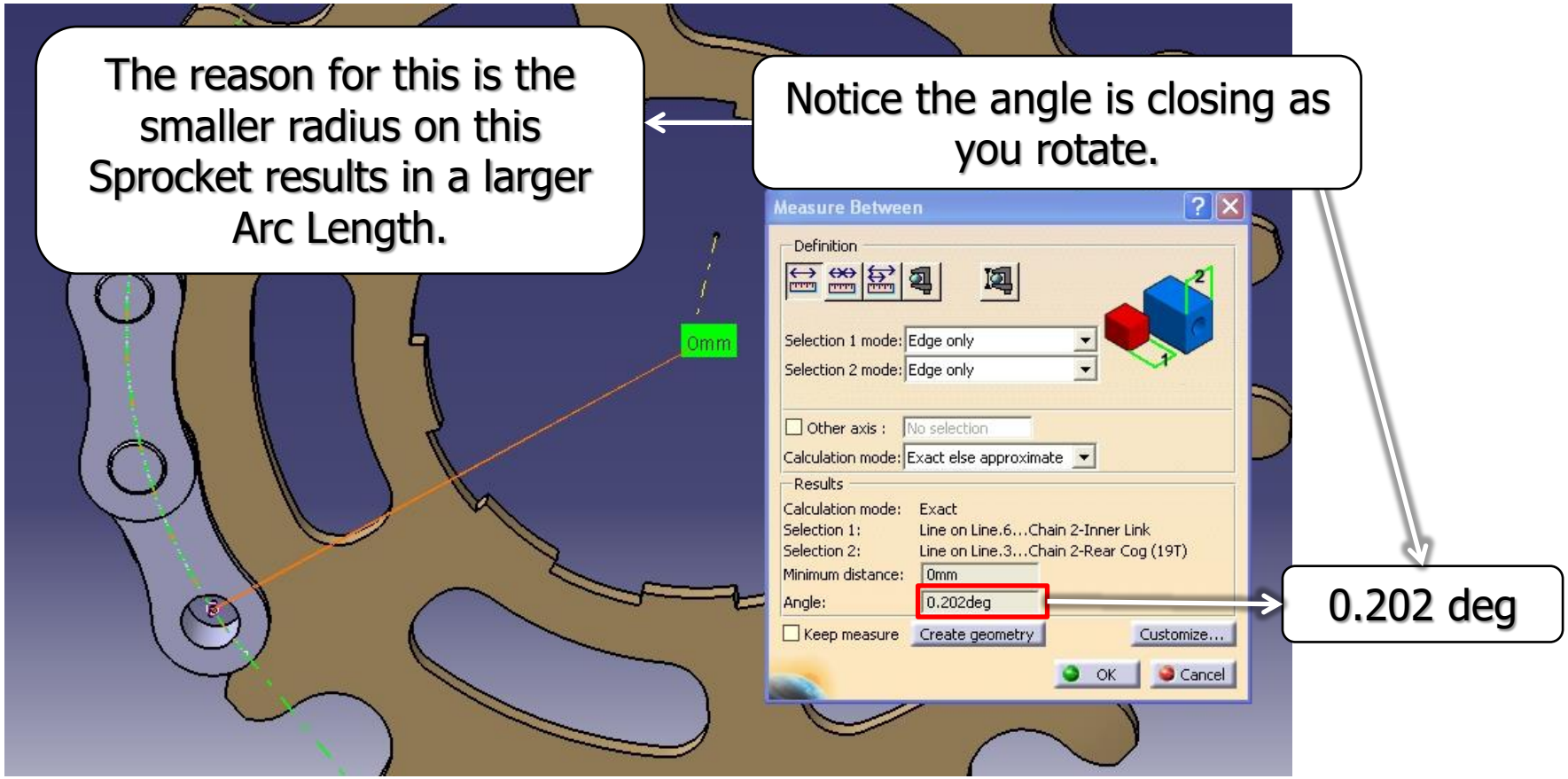
BND TechSource

- A different challenge arises as you rotate the Sprocket further around.



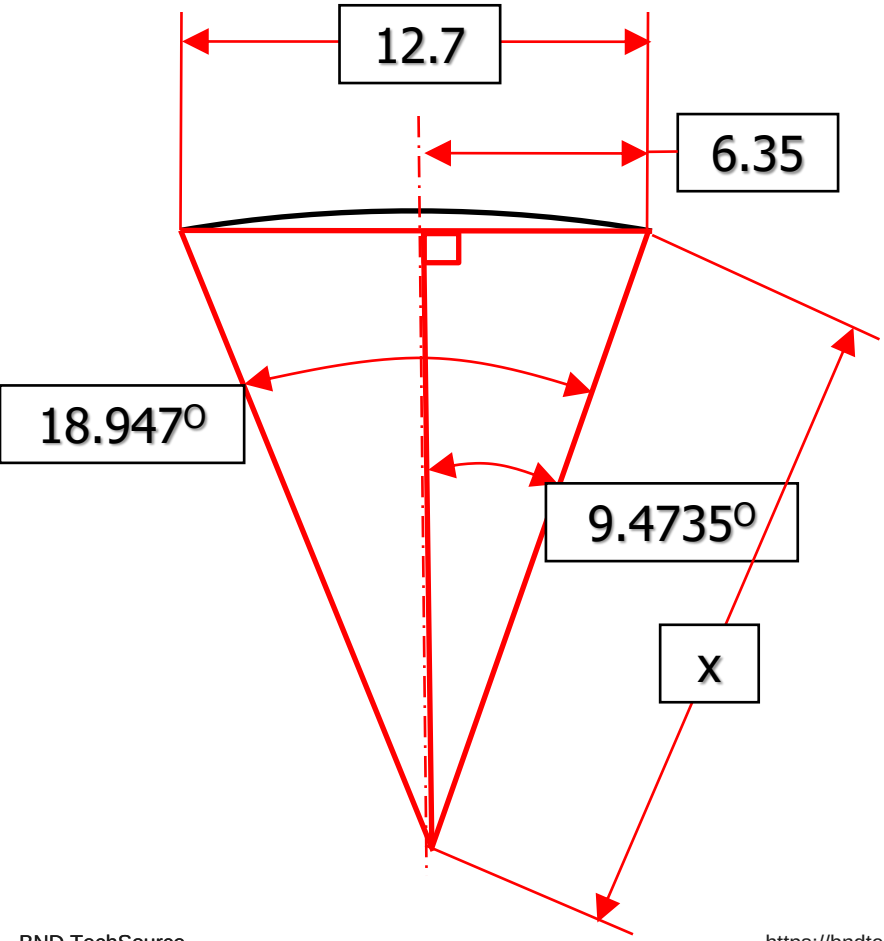
BND TechSource

- A different challenge arises as you rotate the Sprocket further around.



BND TechSource

- Time for some more trigonometry...



Ex. 19T Drive Sprocket:

$360^{o}/19 = 18.947^{o}$
Chord Length = 12.7
Radius = x
$\sin^{-1}(6.35/x) = 9.4735^{o}$
$x = (6.35/\sin 9.4735^{o})$
x = 38.58mm
$\text{Circumference} = 2\pi R = 242.403\text{mm}$
Arc Length =
242.403/19 = 12.75805

BND TechSource

- Adjust the Gear Ratio.

To correct the problem of different Arc Lengths, simply divide the Drive Sprocket Arc Length by the 19T Sprocket Arc length, then multiply the current Gear Ratio by that value.

12.713/12.758 = .996472801
Current Gear Ratio =
40/19 = 2.105263158
New Gear Ratio =
2.105263158* .996472801 = 2.097837476

The same technique can be applied to the 11T gears.

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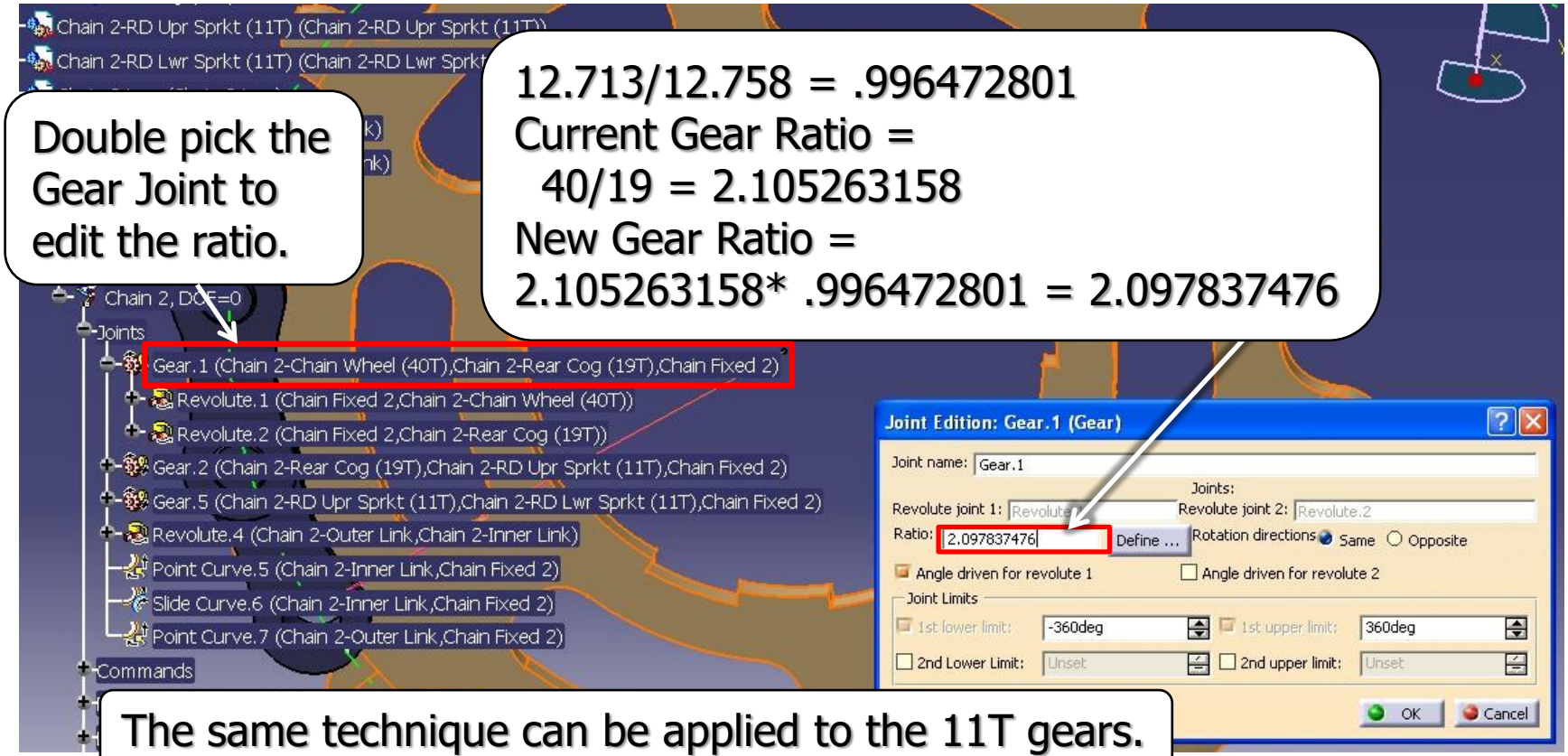
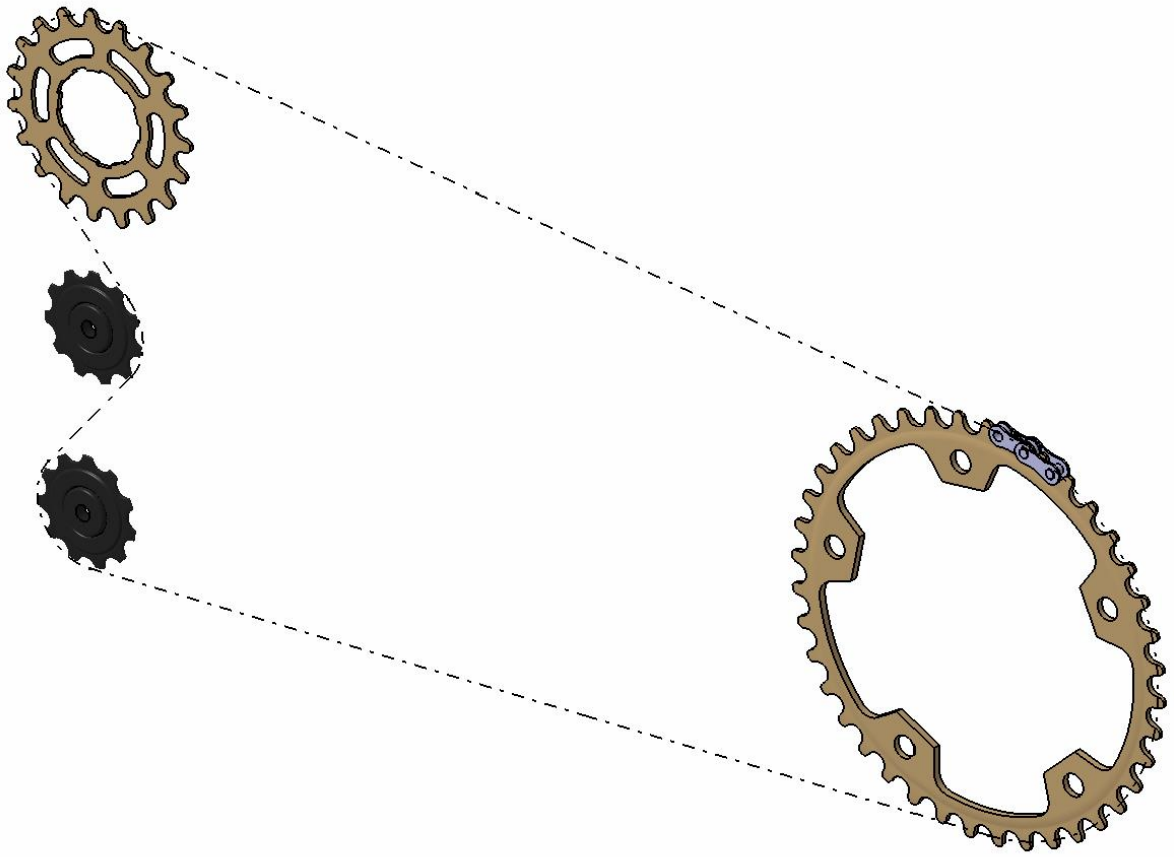
- Adjust the Gear Ratio.



BND TechSource

- Congratulations!! Now the real work begins...



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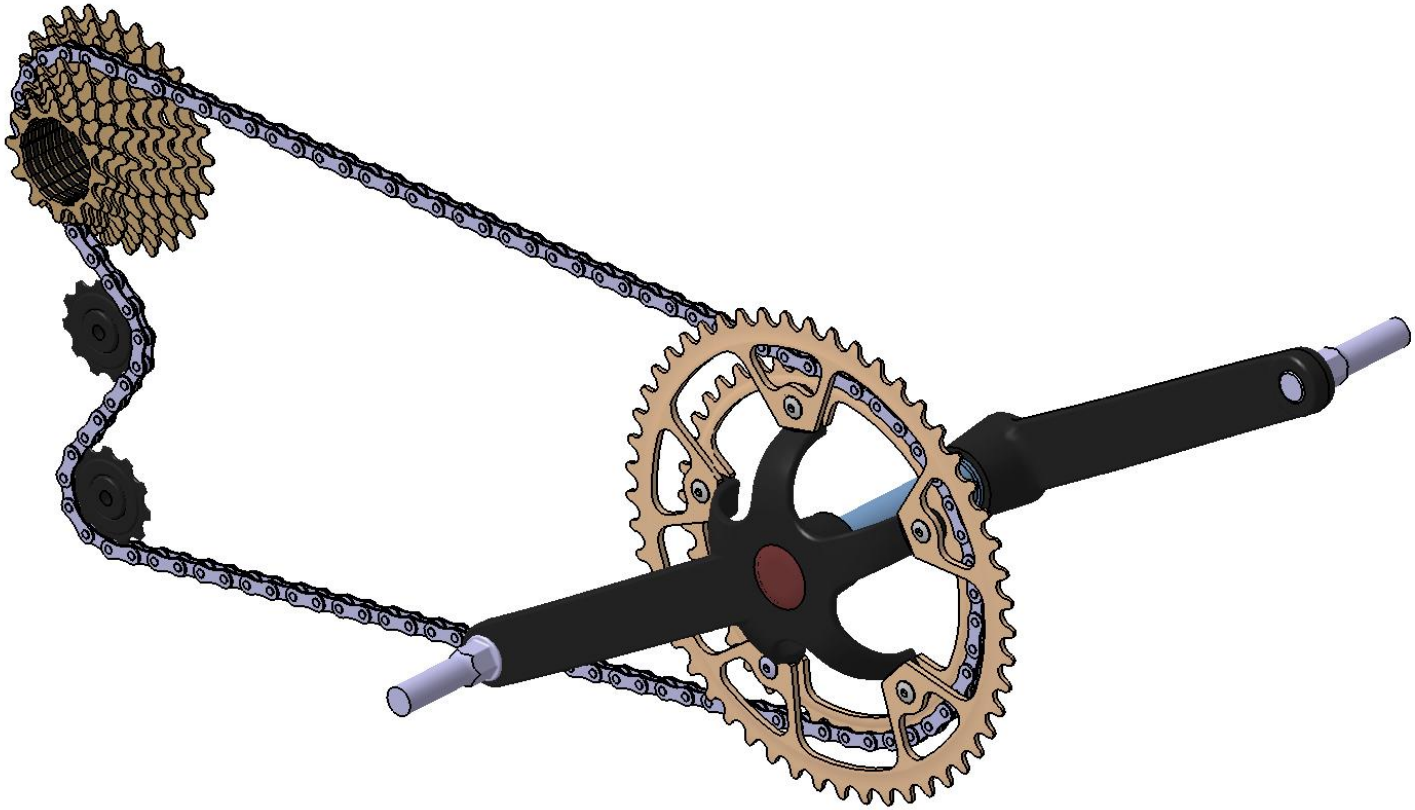
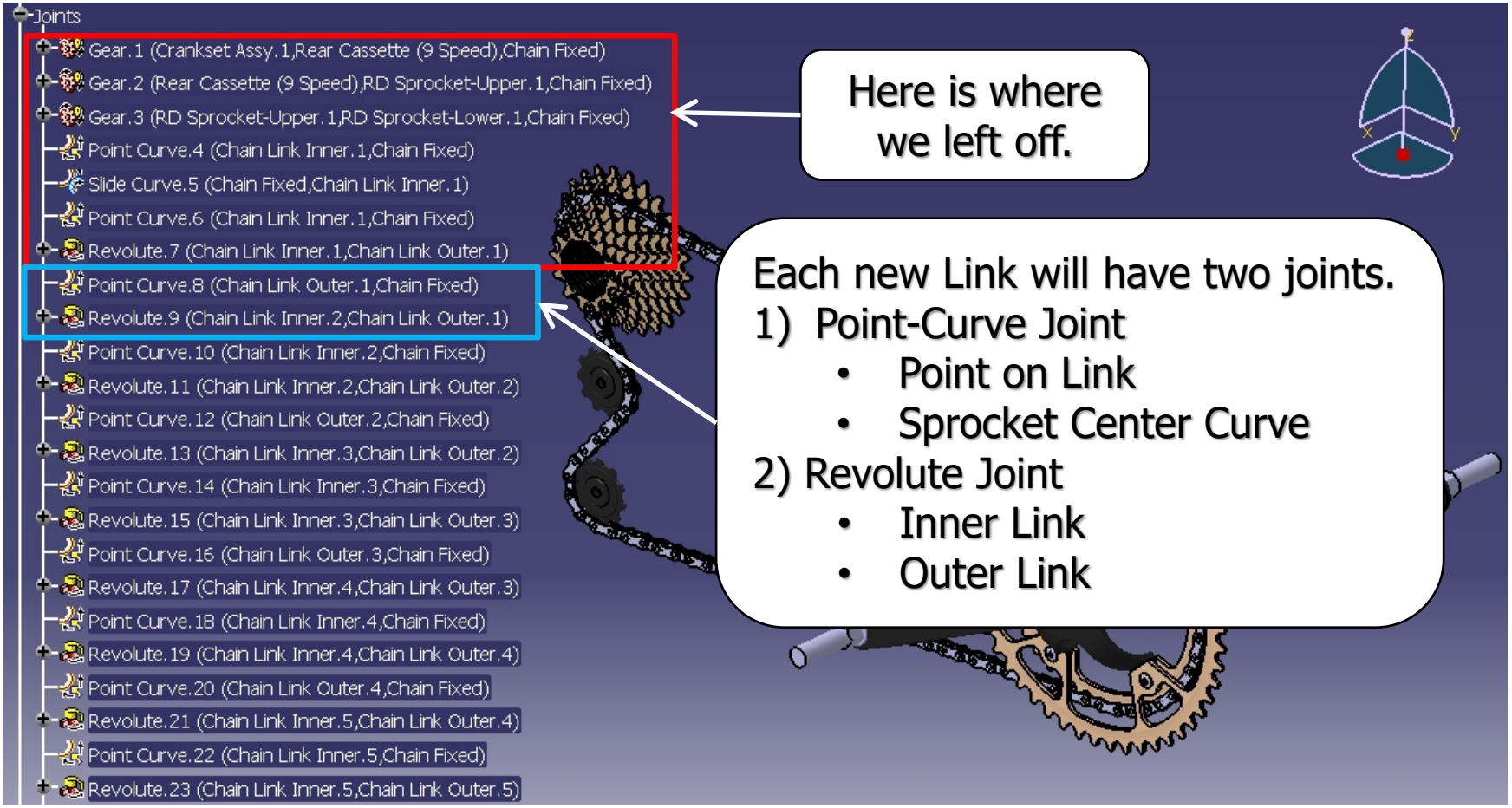
- Complete the chain with all 106 Links!



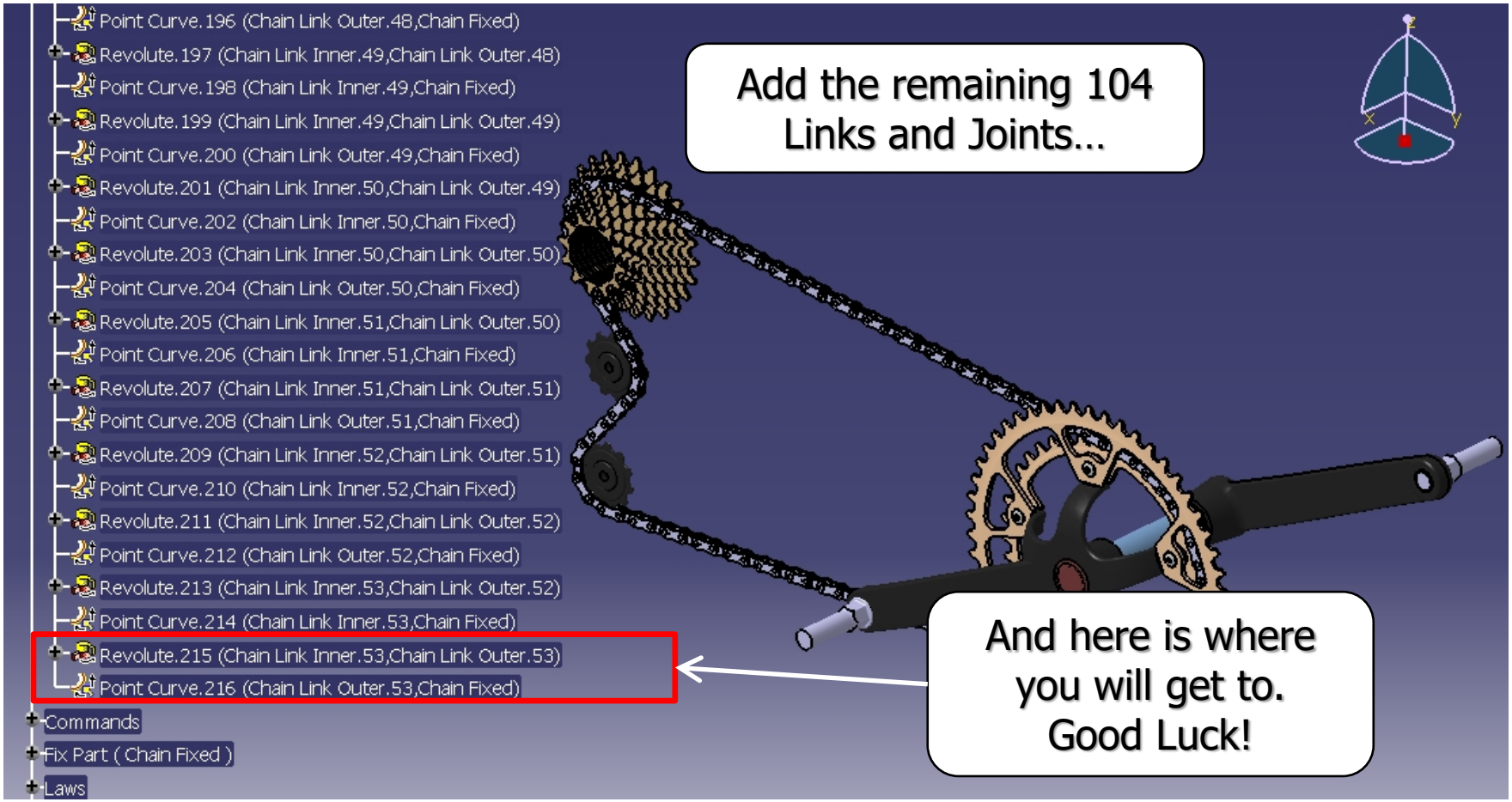
BND TechSource

- Complete the chain with all 106 Links!



BND TechSource

- Complete the chain with all 106 Links!



BND TechSource

- Conclusion:

  This tutorial of how we created our bicycle chain simulation put together at the request of our users.

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

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