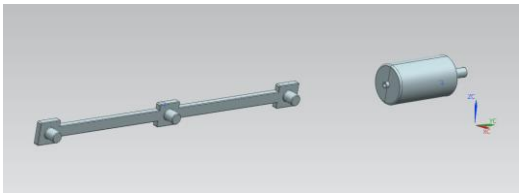
Using Siemens NX 11 Software

Assembly example – Steam Train Mechanism

1 – Introduction.

Copy/paste the folder *C:\Commun\NX\steam_train* into your local folder and open the file *train_assembly.prt*.

- Two parts are already loaded: an *axle* and a *cylinder*.



2 – Adding a wheel.

- Click the *Add* button in the *Assemblies* toolbar 

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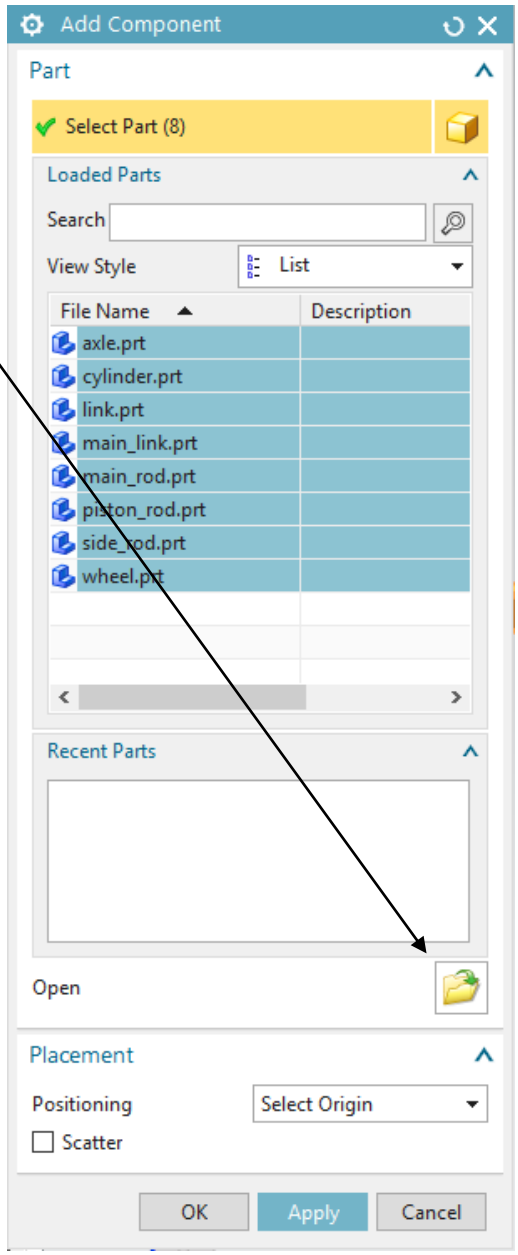
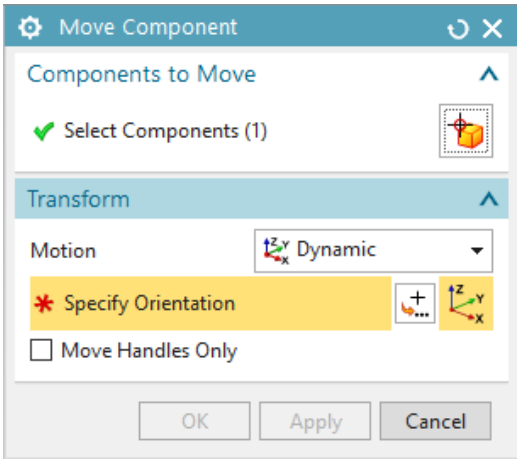
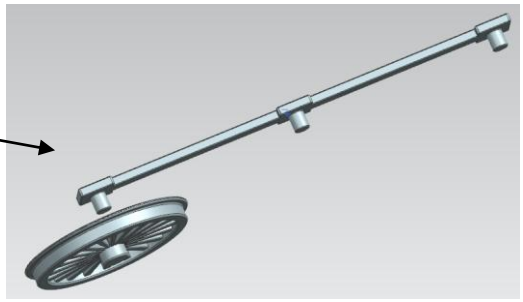
- In the *Add Component* dialog box, click the *Open* button and select the part files located in the *steam_train* folder. Click *OK* to validate your selection.
- The selected files should appear in the *Loaded Parts* field.
- Inside this list, select the *wheel.prt* part and click *OK* to load it into the assembly.
- When the *Point* dialog box opens, just keep the default values and click *OK*. The wheel should appear in the visualization window.



3 – Moving a wheel manually.

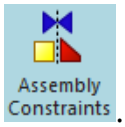
- Using the *Move Component* button, select the wheel you just loaded.
- In the *Move Component* dialog box, select *Dynamic* as *Motion* in the *Transform* field.
- Click on *Specify Orientation*. A reference frame should appear on the wheel. Click and drag the axes and the angles in order to move the wheel.
- Once the wheel approximately positioned as shown, click *OK* to validate its new position.





4 – Constraining the wheel.

Assembly constraints between the wheel and the axle will be added.

- Click on the *Assembly Constraints* button 

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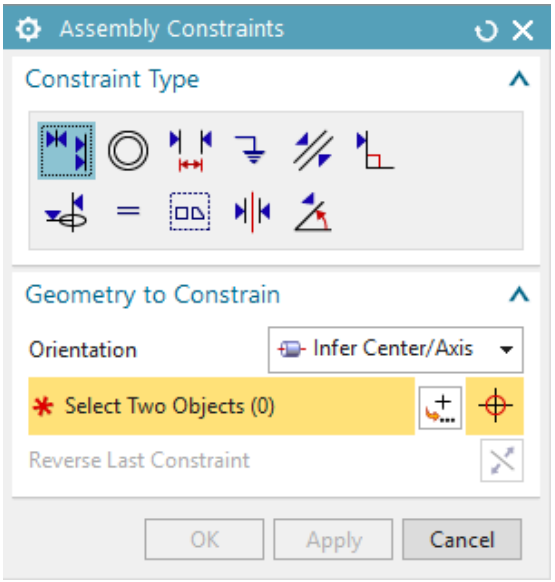
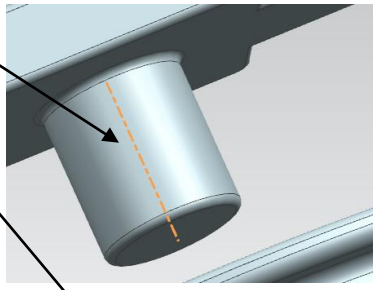
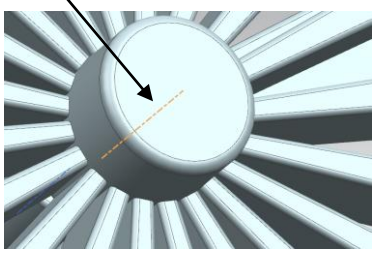
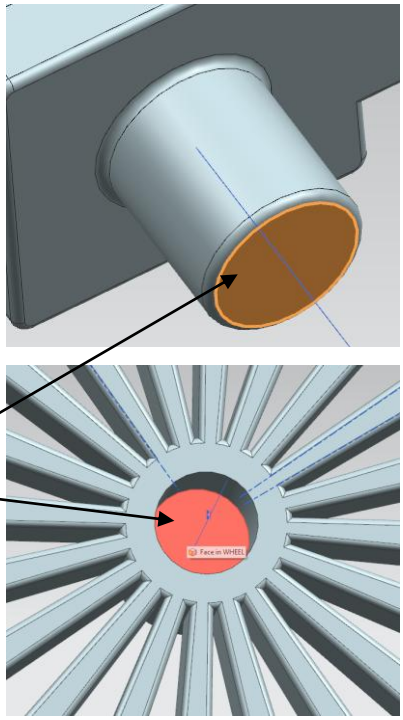
- In the *Assembly Constraints* dialog box, select *Touch/Align* as *Constraint Type*.
- Then, select the *Infer Center/Axis* in the *Orientation* option of the *Geometry to Constraint* field.
- Select as objects the third axis centre of the axle and the axis centre of the wheel.





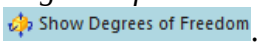


- Click *Apply* to validate the constraint. A new constraint should appear in the visualization window.
- **Note**: if you set a wrong constraint, you can delete it by selecting it in the visualization window and click *delete*. You can also visualize the list of constraints in the *Constraint Navigator*.
- Add a second constraint of type *Touch/Align* with the option *Orientation* set to *Touch*. Apply this constraint to the top face of the third axis of the axle, and the interior bottom of the wheel axis.
- Click *OK* to validate.



5 – Visualizing the degrees of freedom.

With these two constraints the wheel should only be able to rotate around its axis.

- You can check it by clicking on the *Show Degrees of Freedom* button 

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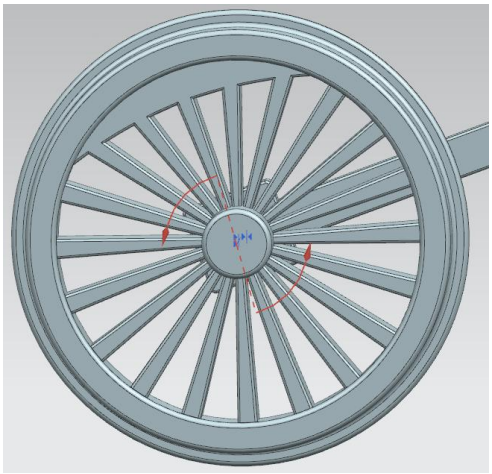
- Then select the wheel. Arrows shows the possible motions of the wheel. They should look as shown.
- To undo the display of these arrows, just refresh the window by clicking on *F5*.

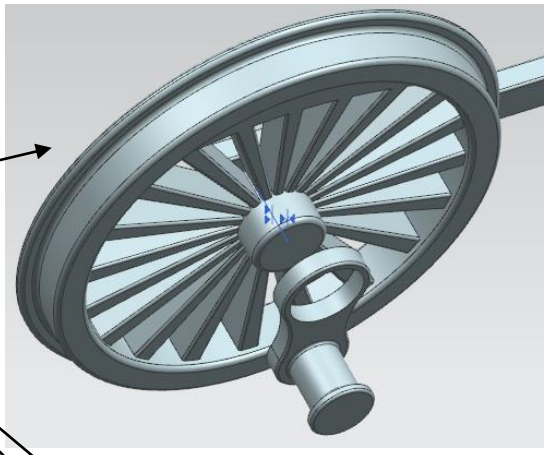


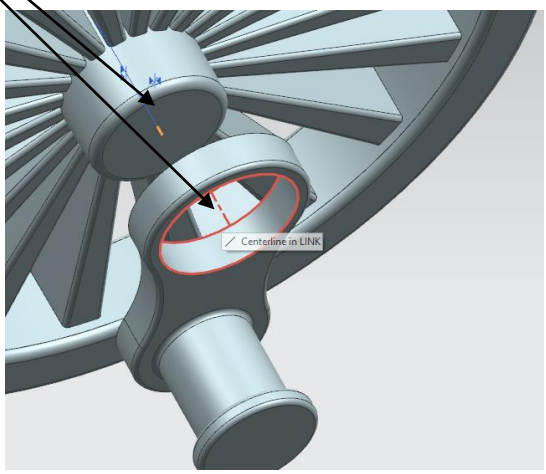
6 – Adding two more wheels.

- Add two more wheels with the same constraints on the two remaining axes of the axle.

7 – Adding the links.

- In the *Add Component* dialog box, add the part file *link.prt* and position it near the left wheel similarly as shown.
- Add an *Align/Lock* constraint  between the centre axis of the wheel and the centre axis of the hollow part of the link. This constraint will force the link to rotate with the wheel.
- Then, add a *Touch* constraint  between the upper edge of the hole of the link and the upper edge of the centre axis of the wheel.





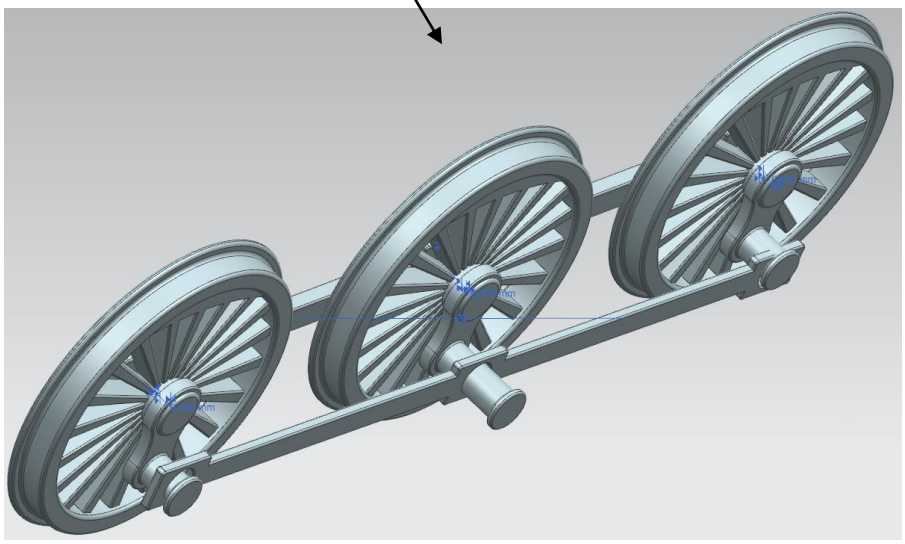
7 – Adding more links.

- Add one more *link.prt* part to the right wheel, with the same constraint.
- Add the *main_link.prt* to the centre wheel, with the same constraints.

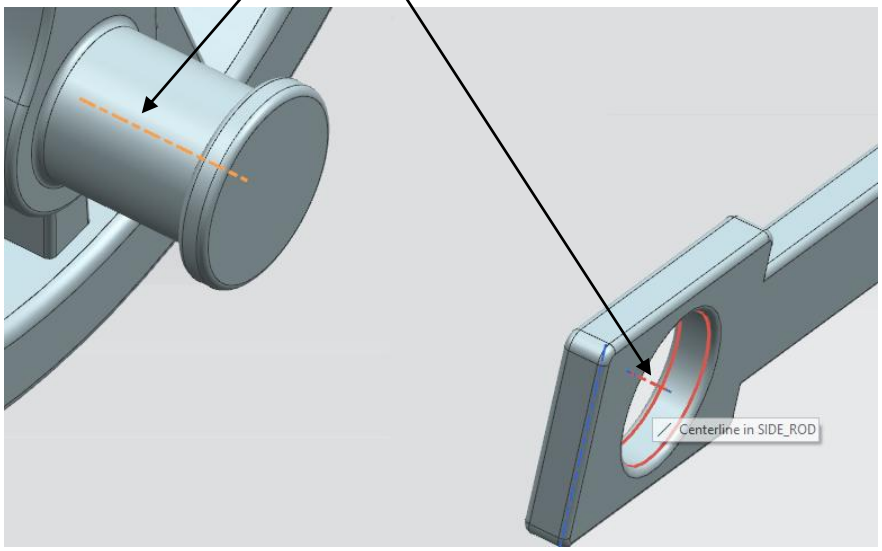
Warning: the *main link* is slightly different from the two other links.

8 – Adding the side rod.

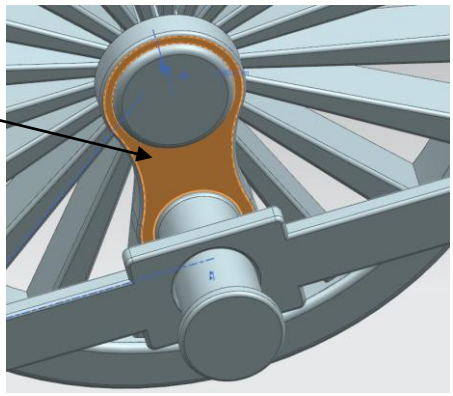
- Add the *side_rod.prt* part to the assembly and position it roughly as shown.

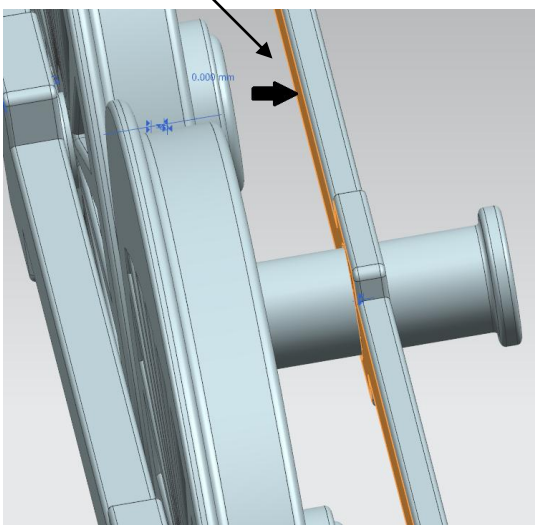


- Add a *Parallel* constraint  between the side rod and the axle.
- Align each of the three holes of the side rod with the knob of each corresponding link. For this, use the *Align* constraint  type with the *Infer Center/Axis* orientation option.
- **Warning**: make sure to select the axis of each knob and then the axis of each corresponding hole.



- Finally, add a distance constraint  of **25 mm** between the upper face of the main link and the lower face of the side rod.



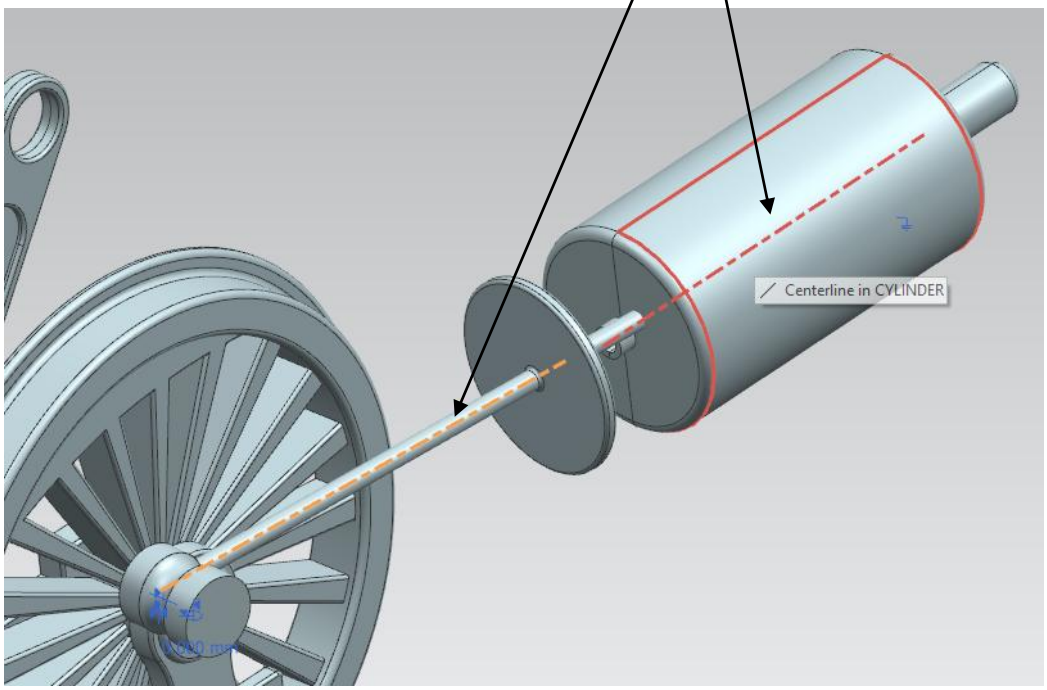


9 – Adding the main rod.

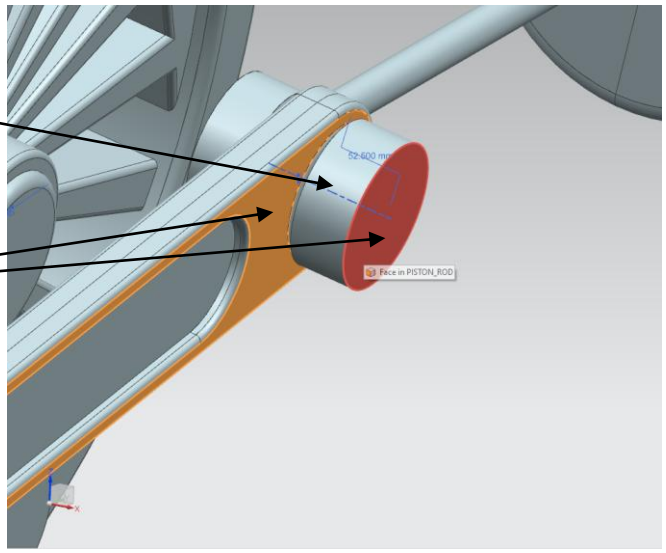
- Add the *main_rod.prt* part to the assembly.
- Add an *Align* constraint  of one of the axis of its holes with the axis of the knob of the main link.

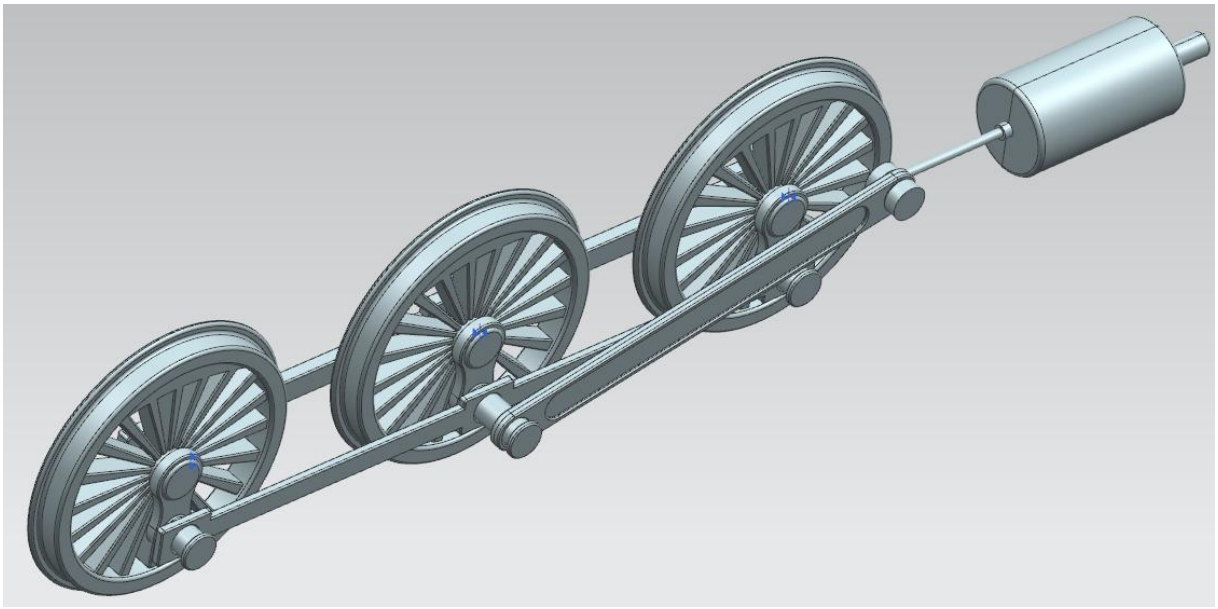
10 – Adding the piston.

- Add the file *piston_rod.prt* to the assembly.
- Add and *Align* constraint  between the axes of the piston and the cylinder.



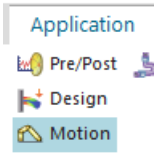
- Add and *Align* constraint  of the other hole's axis of the main rod with the axis of the knob of the piston.
- Add a distance constraint  of **52.5 mm** between the main rod and the head of the piston as shown in figure.
- The final assembly should look like as shown.



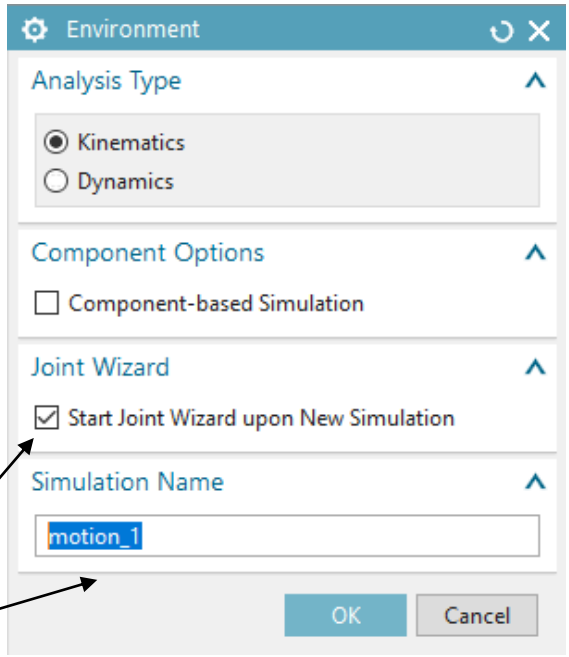


11 – Simulation of the assembly.

The following will explain how to get a simulation from the previous assembly.



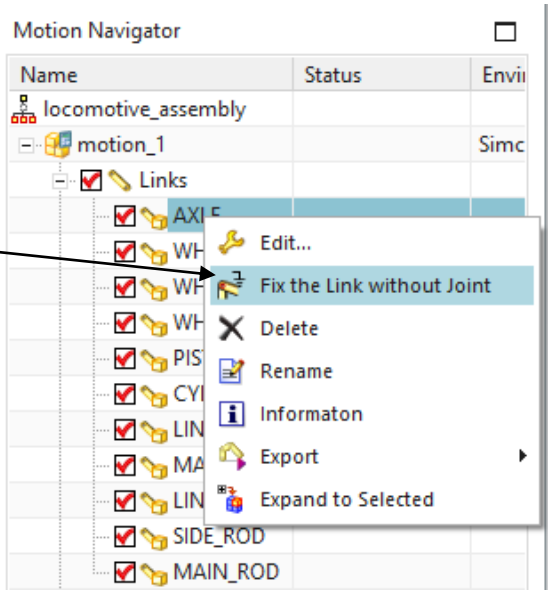
- Click on the *Motion* button of the *Application* toolbar.
- In the *Motion Navigator* dialog box, right-click on the *train_assembly* and choose *New Simulation*.
- The *Environment* dialog box will open. Inside it, choose *Kinematics* as *Analysis Type* and check the *Start Joint Wizard upon New Simulation* option.
- Click *OK* to validate.
- When the *Motion Joint Wizard* opens, just click *OK* to validate. This wizard will convert the assembly constraints into kinematics constraints.
- If an information window opens and is asking you to attach a fix joint to some part, answer *No*.



- The *Motion Navigator* will now have two kinds of object: *Links* and *Joints*.
  - *Links* are the parts subject to kinematic constraints.
  - *Joints* set what kind of kinematic constraints exist between two *links/parts*.

Two constraints may though be missing for the simulation.

- Right-click on the *axle* link and activate the *Fix the link without joint* option. This option specifies that the axle will have to stay fixed in space and should not move.
- Do the same for the *cylinder* link.

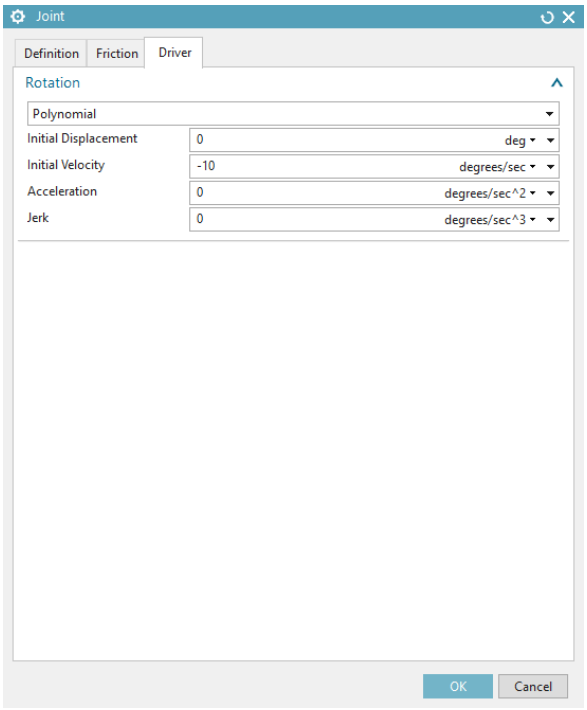


11.a – Setting the Driver.

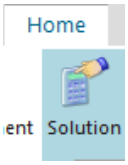
The *Driver* is the joint on which a force is applied. Here, we will choose as driver the joint between the central wheel and the axle.

- Locate the adequate *Revolute Joint* in the *Motion Navigator* tree and double-click on it (if you followed this tutorial carefully, the right joint should be *J002*).
- In the *Driver* tab of the *Joint* dialog box, select the *Polynomial* option of the drop-down menu of the *Rotation* field.
- Set the *Initial Velocity* option to **-10 degree/sec** and let the other fields to zero.
- Click *OK* to validate.

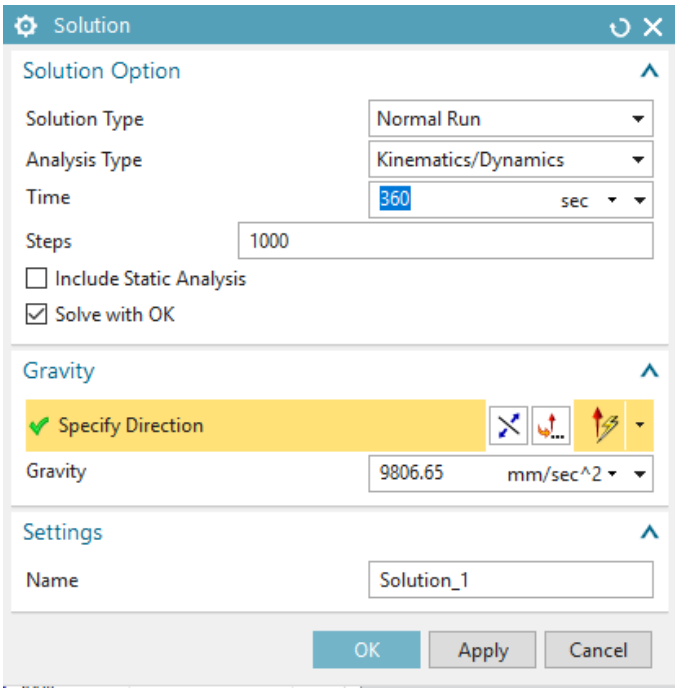
Now, all the physical parameters (links, joints and driver) of the simulation are set. We now will launch the computation of the simulation itself.



11.b – Computing the animation.



- Click on the *Solution* button of the *Home* toolbar.
- In the *Solution* dialog box, set the different field values as shown in figure.
- Once *OK* clicked, the computation will take some time (about ~20 s). You can check the current status of the computation in the status bar (located at the bottom of the visualization window).
- Whence the computation done, close the *Information* window.



12 – Animation.

- Finally, click on the *Animation* button 

in order to open the *Animation* dialog box.
- Within that dialog box, click *Play* for visualizing the animation.
- You can control the animation speed using the *Animation Delay* slide bar.