

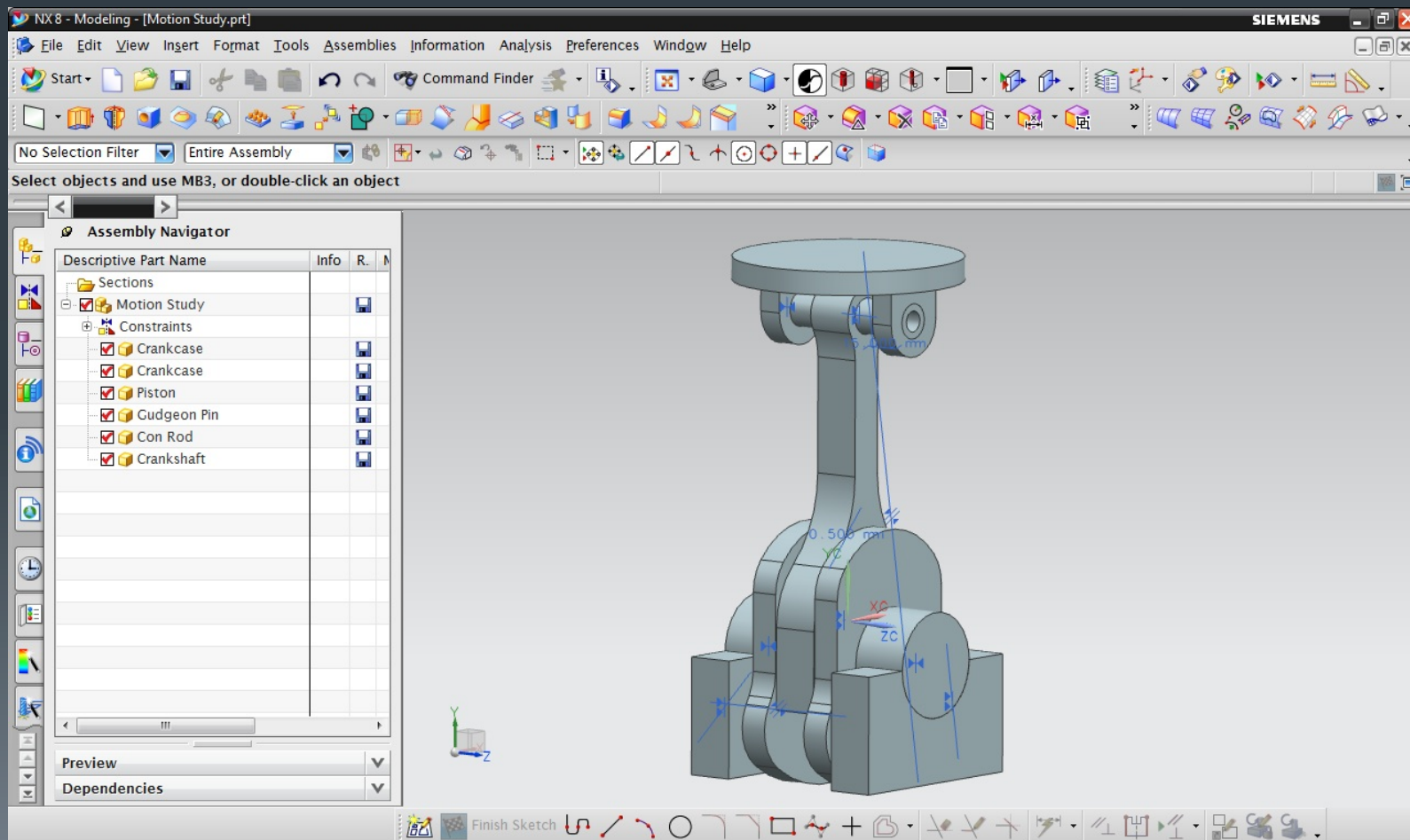


Computational Methods

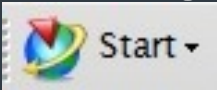
Motion Simulation

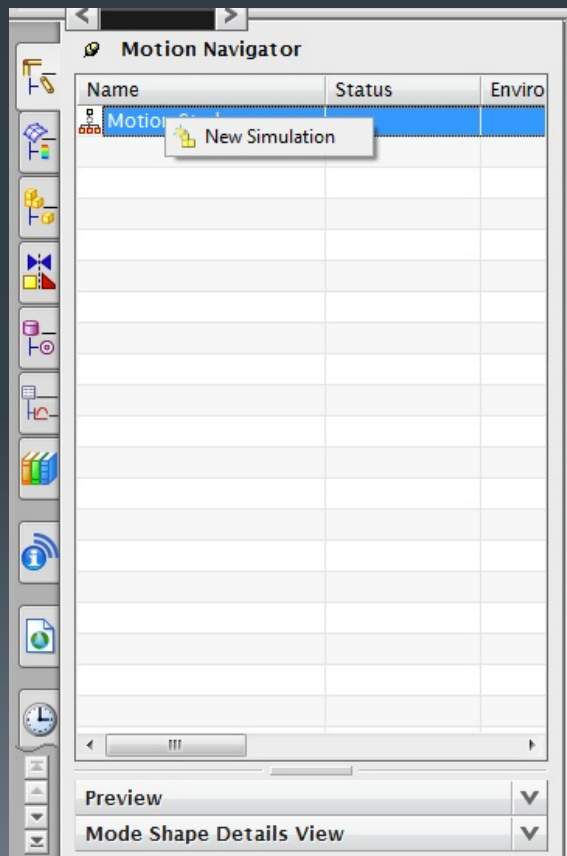
Introduction

Note – This tutorial assumes that you have got to the assembly stage of the model with the components off Moodle, shown below.



Setting up Motion Simulation

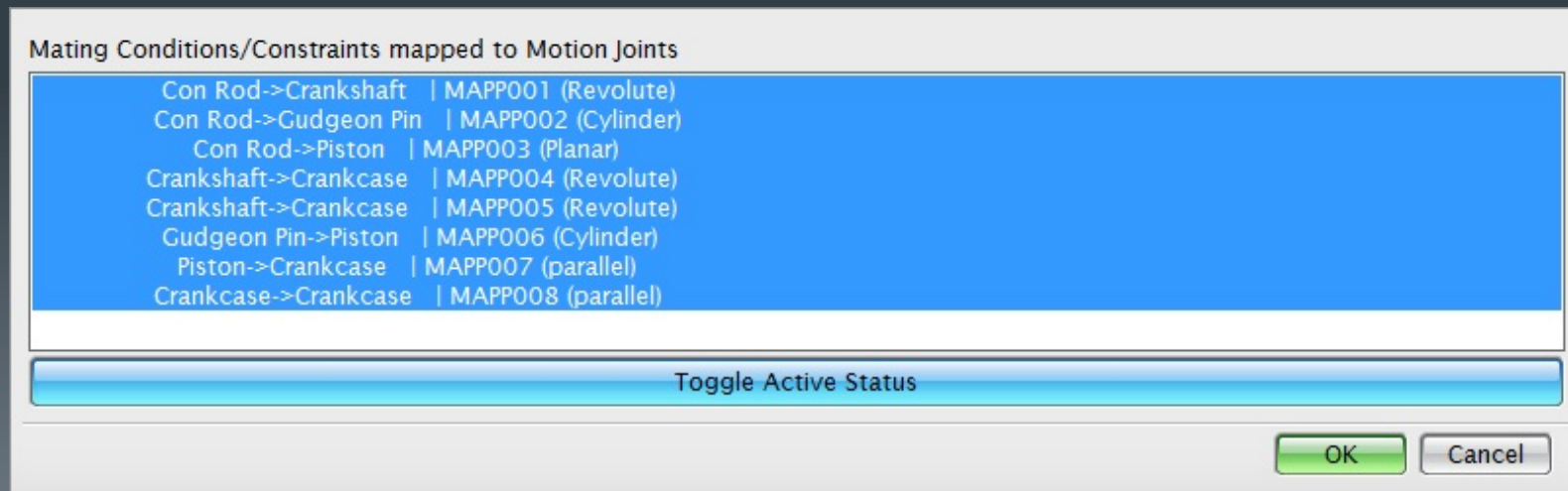
To start with, we need to navigate to the Motion Simulation area. Click  and navigate to Motion Simulation.



Right click on the assembly in the Motion Navigator and select 'New Simulation'. Accept the defaults, ensuring that a 'Dynamic' simulation is selected.

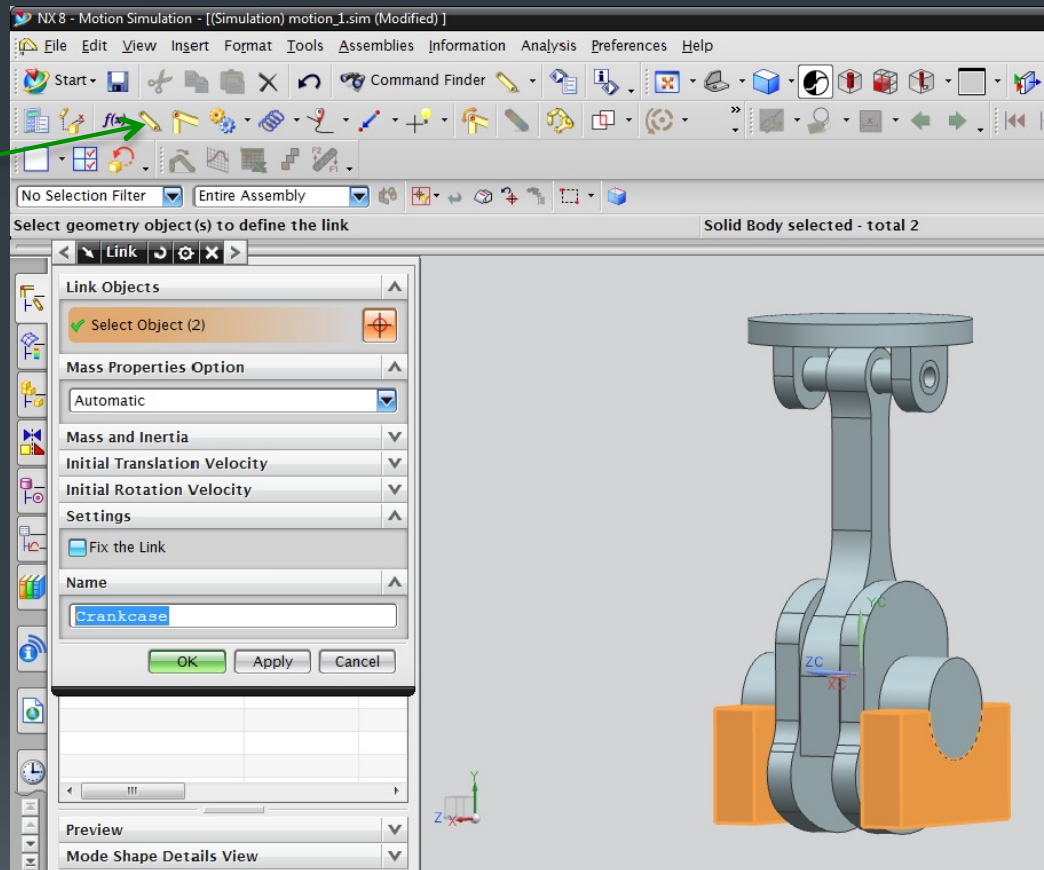
Setting up Motion Simulation

When the 'Link Wizard' appears, highlight all of the items and 'Toggle Off'. This wizard defines links and joints automatically and it determines these from your assembly model constraints. If these constraints have been done correctly then the wizard will most probably give you what you need, but to be sure we are going to define the Links/Joints ourselves.



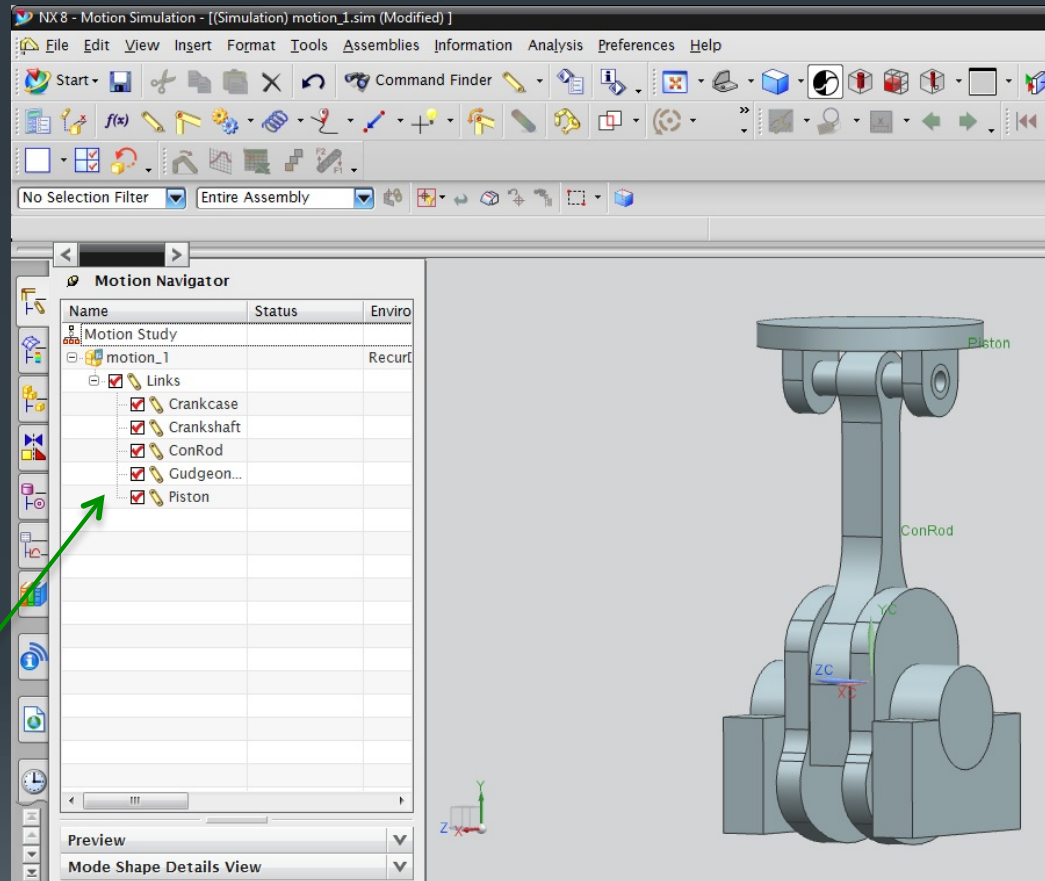
Setting up the Links

To start off we need to select the 'Link' command. Then we will select both of the Crankcase parts. This will define them as one rigid body for the purpose of the simulation.



Setting up the Links

Now select the rest of the individual parts and define each of them as separate links for the simulation. When finished you should have these.



Gruebler Count

Now we are ready to set the 'Joints'. When creating links a 'Gruebler Count' (a Degree Of Freedom count) is also created. Each link has 6 Degrees Of Freedom and by creating joints you take away these DOF's. On the right is a list of joints and their DOF constraints.

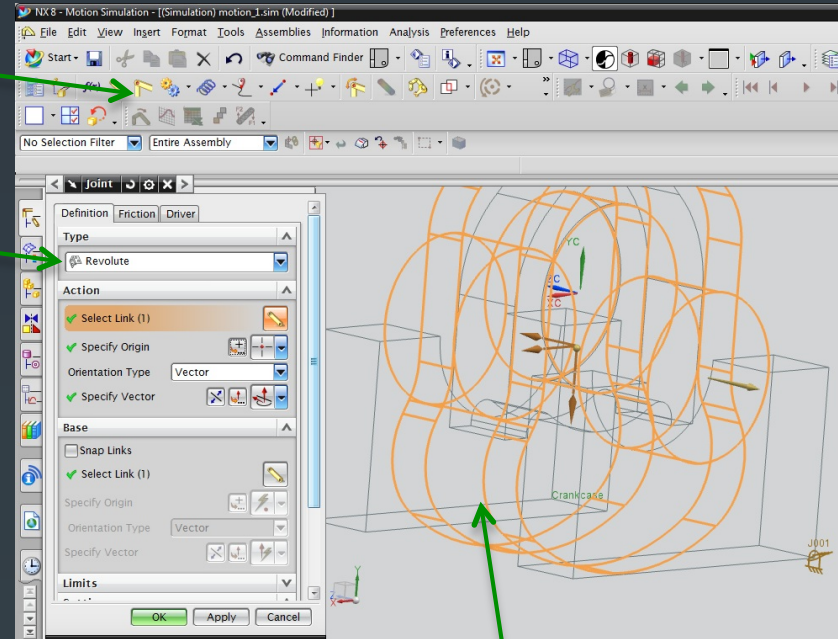
Joint type	DOF constrained		Total
	Translational	Rotational	
Revolute	3	2	5
Slider	2	3	5
Cylindrical	2	2	4
Screw	-	-	5 if using the RecurDyn solver, 1 if using Adams/Solver; must be combined with a cylindrical joint.
Universal	3	1	4
Spherical	3	0	3
Planar	1	2	3
Fixed	3	3	6
Constant Vel	3	1	4
At Point	3	0	3
In Line	2	0	2
In Plane	1	0	1
Orientation	0	3	3
Parallel	0	2	2
Perpendicular	0	1	1

Setting up Joints

Select the 'Joint' icon.

Under 'type' select 'Revolute'. This will be the first joint we apply.

Next we need to select the 'Action' link, in this case it will be the crank as this is the link that will be moving and we will need to apply a 'Driver' to it also.

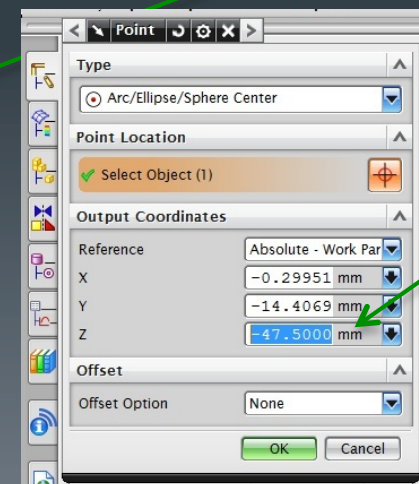
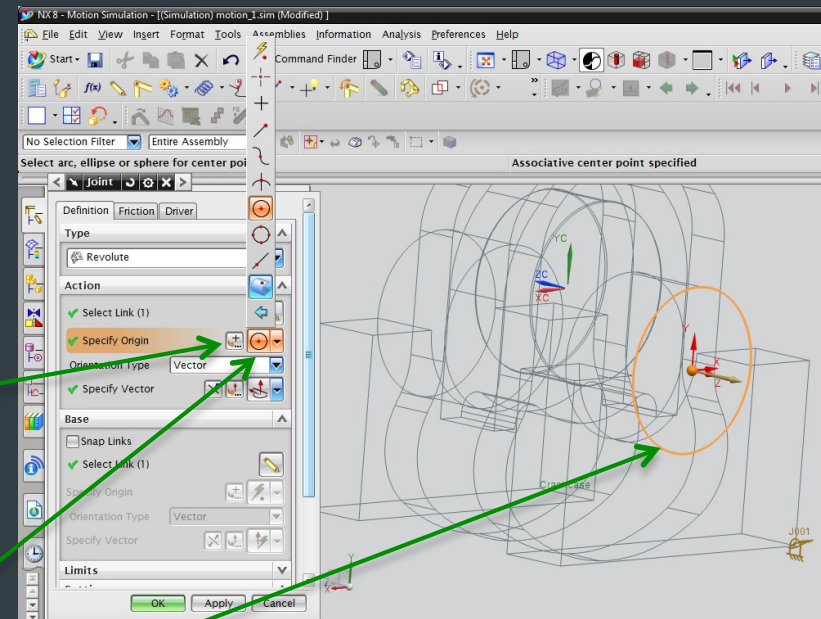


Select the crank, the point at which you select will initially be used as the 'Origin', but we can change this in the next step.

Setting up Joints

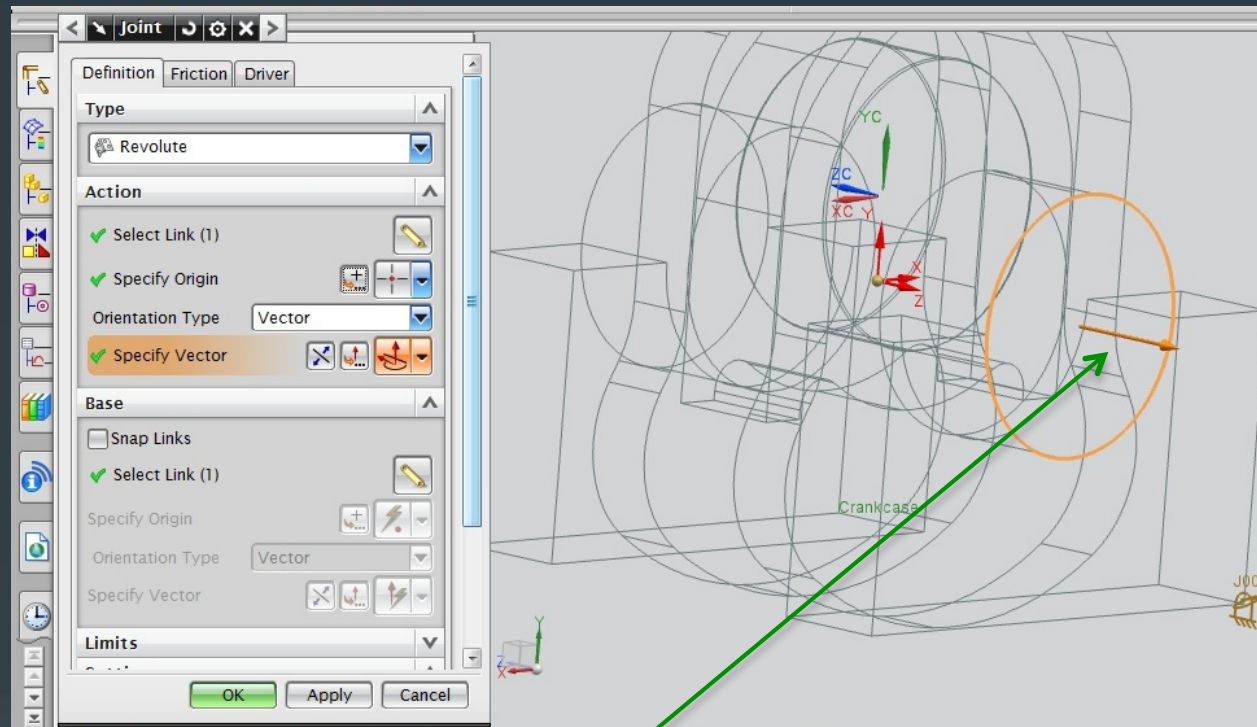
At this point your origin is probably in a different position, it is important to get the origin in the centre of the part. We can do this by Co-Ordinates.

First select the centre point method and then select the edge of the crank shaft. This will then pick up the centre point.



Next select the Co-Ordinates icon and change the Z to 0mm.

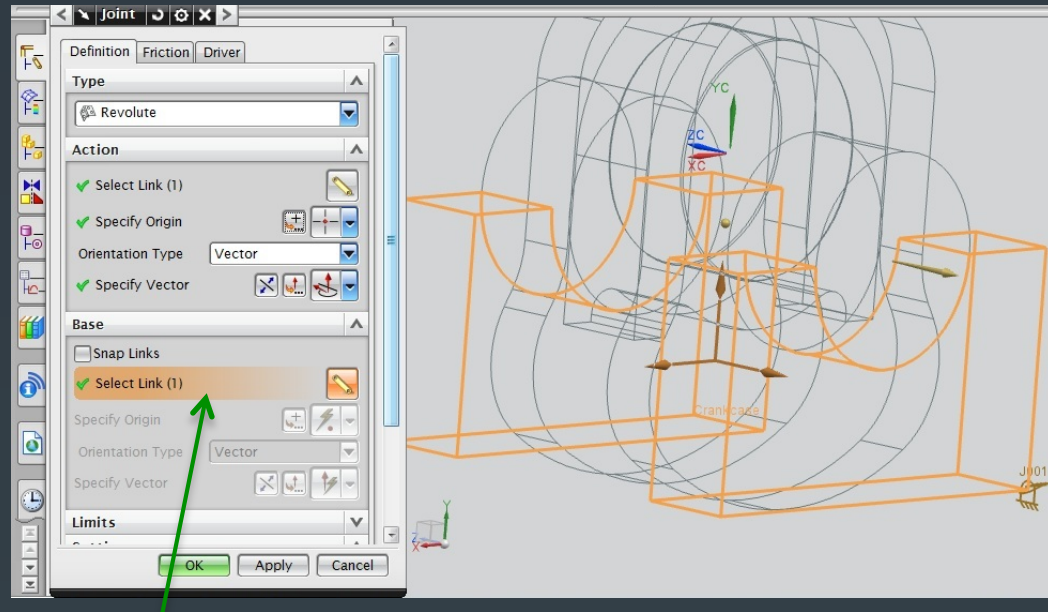
Setting up Joints



The vector may already be selected depending on where you selected the crank, but make sure it is in the correct orientation.

This vector is the vector the crank will rotate around.

Setting up Joints

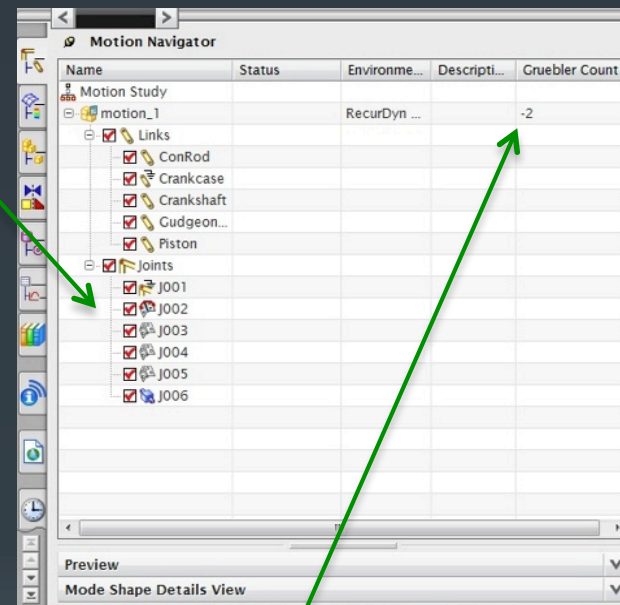


Select the 'Base' link as the crankcase, this will effectively connect the crank to the crankcase and allow it to rotate within it.

The crankcase will also need to be 'Fixed' so do this by applying another joint after, this will be you fixed item in space.

Setting up Joints

Now go through and apply the rest of the joints you think you will need, on the right is the amount and type of joints you will need to help you. Do not worry if your order is slightly different, as long as the amount and type is the same. On J002 you will notice a red arrow, this shows this is the 'Driver' joint.



Notice that by using these joints the 'Gruebler Count' is -2, this is not a problem for this first simulation but if we wanted reaction forces we would need to address this.

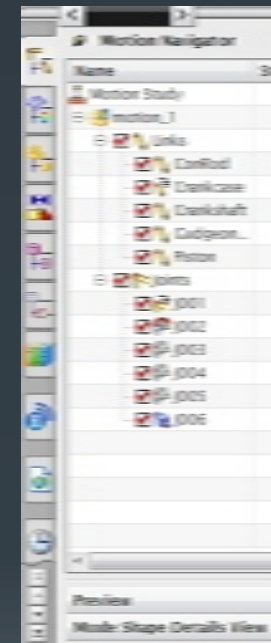
Setting up Joints

Now I will explain the joints on the right –

J001 – This is a Fixed joint for the Crankshaft, we need at least one fixed joint to fix the model in space.

J002 – This is a Revolute joint, the action link is the Crankshaft and the base link is the Crankcase. The vector is the vector the Crank will rotate around.

J003 – This is a Revolute joint, the Con Rod is the action link and the Crank is the base link. The vector is the vector the Con Rod will rotate around.

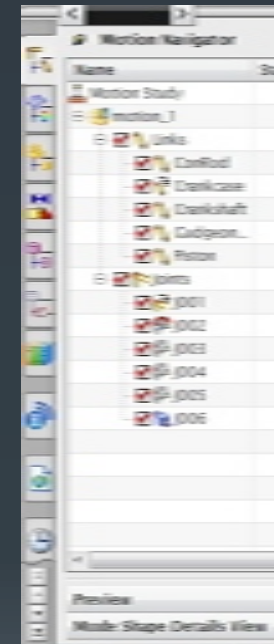


Setting up Joints

J004 – This is a Revolute joint, the Gudgeon Pin is the action link and the Con Rod is the base link. The vector is the vector the Gudgeon Pin will rotate around.

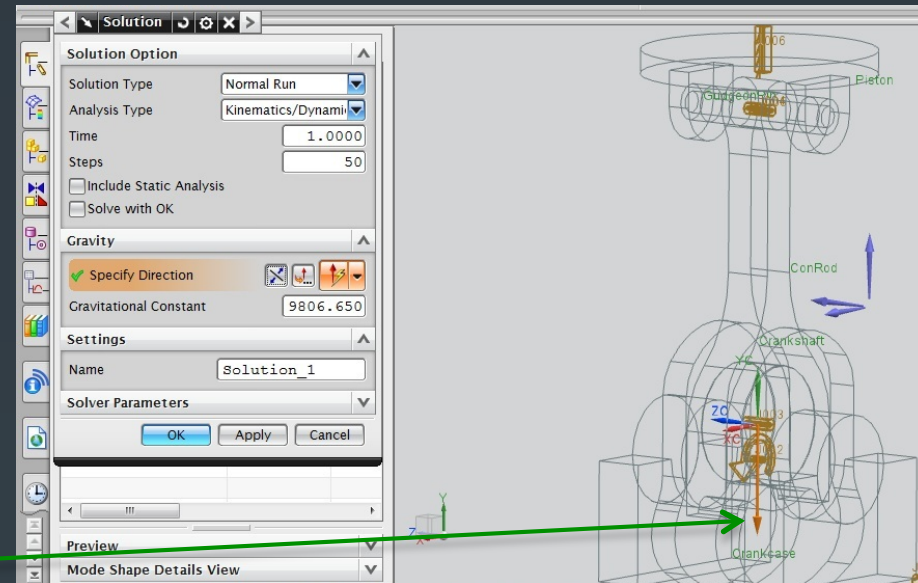
J005 - This is a Revolute joint, the action link is the Piston and the base link is the Gudgeon Pin. The vector is the vector the Piston will rotate around.

J006 – This is a Slider joint, the action link is the Piston, the base link is the Crankcase. The vector should be the direction (vertically up and down) that the piston moves.



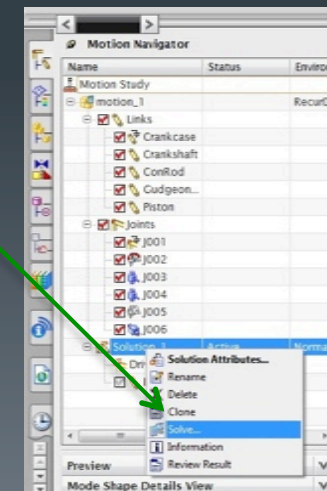
Setting up a Solution

For the first solve, keep the standard solve time & steps. Make sure that Gravity is acting in the correct vector & direction which is shown by the orange arrow.



Once the solution has been set, right click on solution 1 and select solve.

When the solve has finished, use the animation buttons in the top toolbar to play the animation.



Potential problems

Many of the errors that you *might* see during the animation can be easily solved by rechecking your model. The most common is not having a fixed joint, then your model will simply disappear off the screen in the direction gravity is acting on it. Alternatively you may see one of your parts, the piston for instance, start to move but only this part disappears, this is due to it not having a 'Base Link' to the Gudgeon Pin.

If the parts all move together but not necessarily in the correct orientation of each other then you will need to check your origins and vectors of the problem joint.

For a final exercise, see if you can change the joints on the model and get the Gruebler Count to 0.