Tutorial NX MCD

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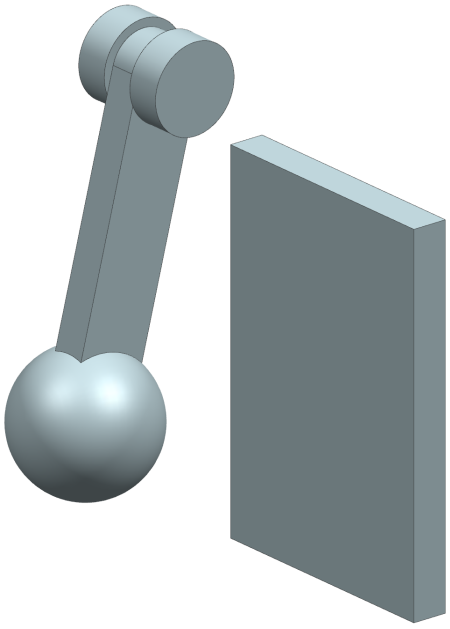


1 Introduction

In this tutorial you will understand how NX Motion can help you obtain physical data corresponding to mechanical operations. The example that is given is a simple pendulum hitting a fixed wall.

2 General principles of NX Motion

Different type of components have to be defined in NX Motion:

1. Motion bodies
2. Joints
3. Loads
4. Contacts
5. Markers

2.1 Creating a motion body

The different parts of the model have to be defined as **motion bodies**. The steps to create a motion body are shown in figure 1.

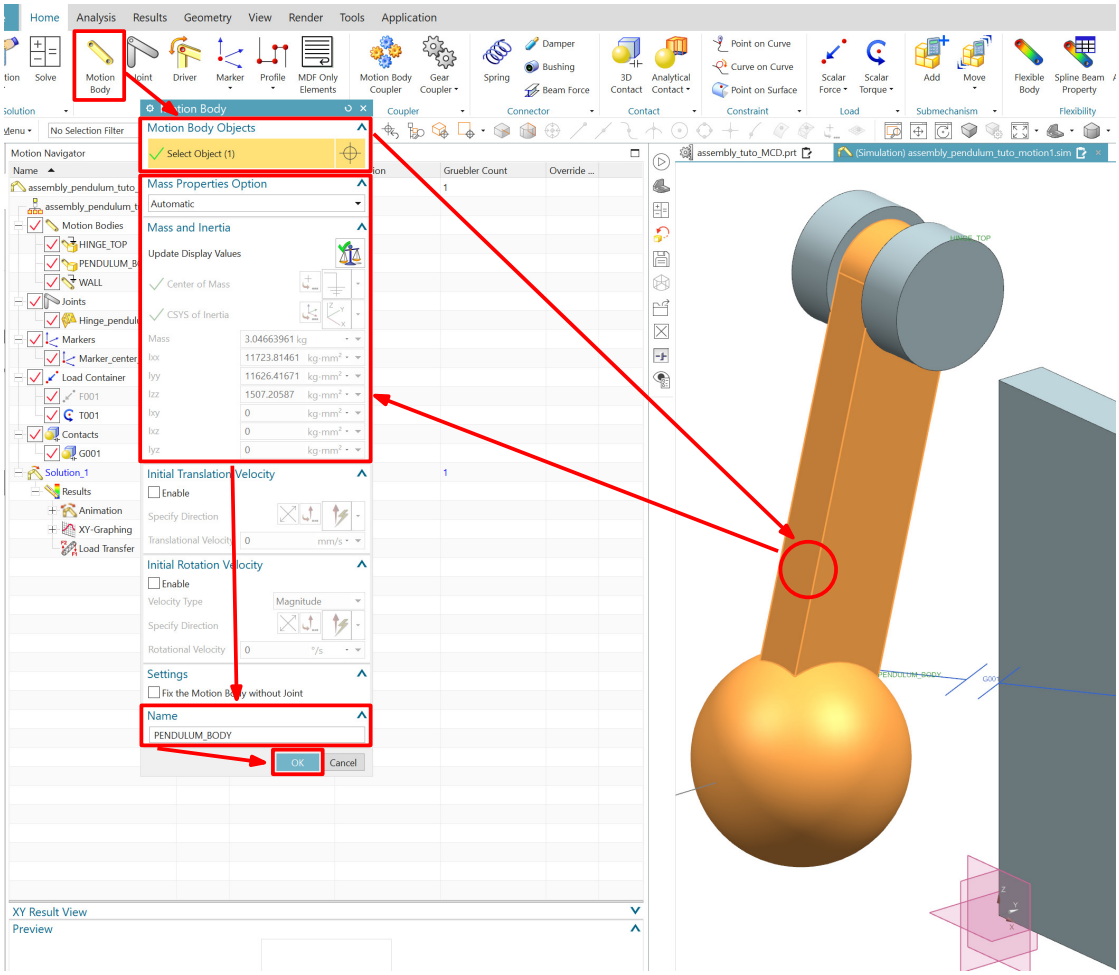


Figure 1: Creating a motion body

The 3 motion bodies are the **Pendulum**, **Hinge** and **Wall**. Don't forget to give clear names to each of your motion bodies.

2.2 Creating a joint

A joint defines how two parts are moving relative to each other. Different type of joints exist, here we will create a **revolute joint** between the pendulum and the hinge (figure 2).

- Click on joint
- Choose "Revolute"
- Choose the pendulum as "Action" with the center of the top circular part as the "Origin" and the vector along the x-axis
- Choose the hinge as the "Base" with the same origin and vector
- Give a clear name to the joint

- Click on OK

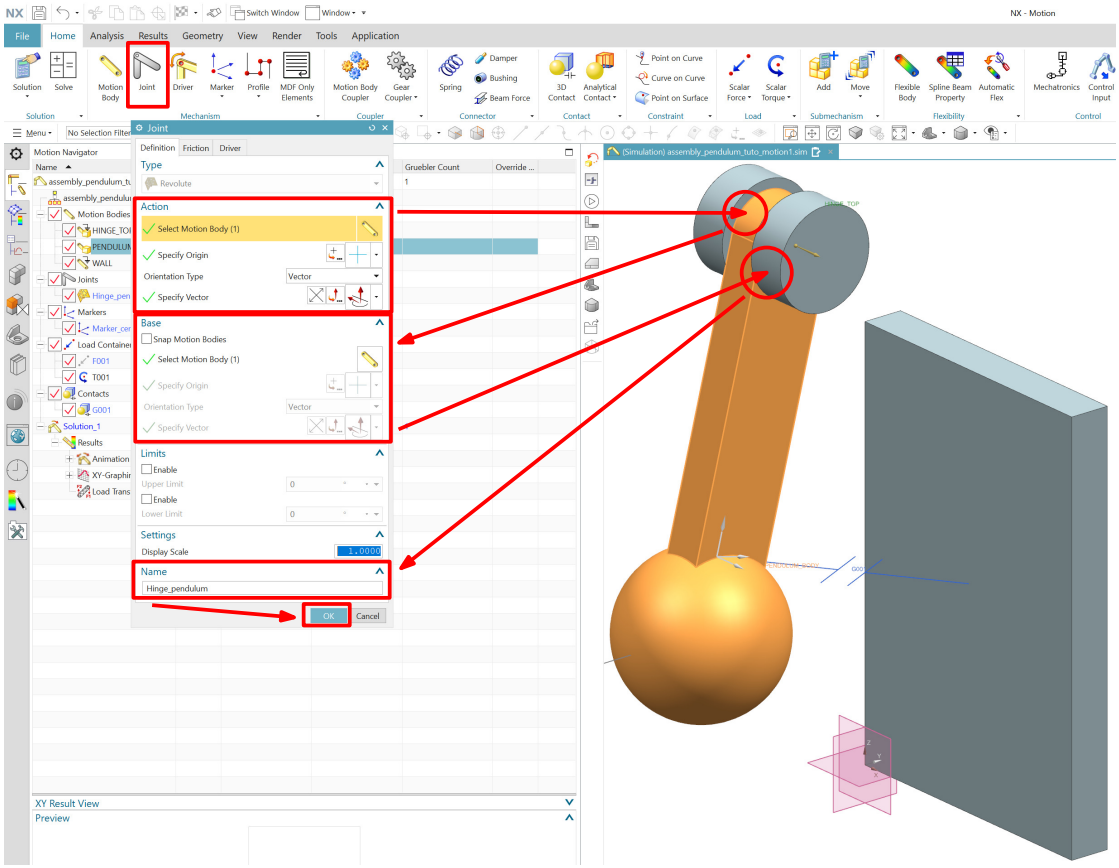


Figure 2: Creating a joint

We also need to create a **fixed joint** for the hinge and the wall, this is done simply by right clicking on the motion body and choosing "Fix the motion body without joint" (figure 3).

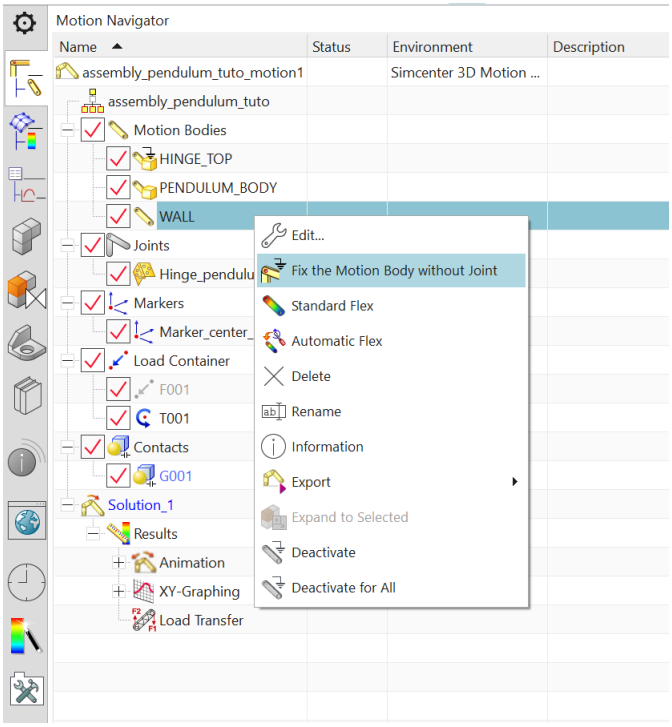


Figure 3: Fixing a body without joint

2.3 Loads

In this tutorial, the pendulum is either swung towards the wall by an imposed torque or pushed by a scalar force.
To create a scalar torque, follow the following steps (figure 4):

- Click on Scalar Torque
- Select the joint of the hinge
- Choose the value of the torque (500Nmm for example)
- Choose a clear name
- Click on OK

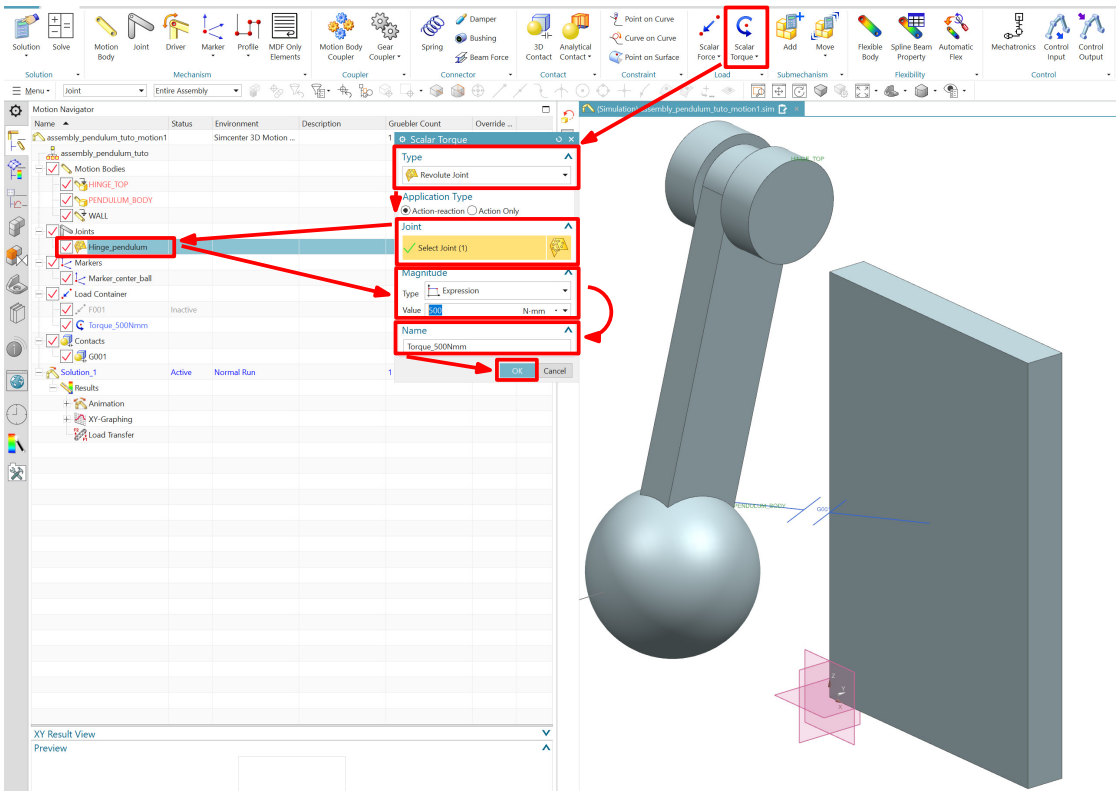


Figure 4: Creating a scalar torque

This scalar torque is applied constantly, sometime a force or torque is applied only for a small amount of time, it is possible to give an expression for a loading. An easy way to do this is through an excel table. The steps to impose a scalar force coming from an excel table are shown in figures 5 and 6.

- Click on Scalar Force
- Choose the direction of the force (here choose Y)
- Choose the body (here choose the ball of the pendulum)
- Under "Magnitude", choose "Function" and launch the function manager
- Choose "Table in AFU" and click on "New"

- In the ID creation steps, indicate a clear name for your table
- Go to the ID creation step
- Choose the spreadsheet option
- In the excel spreadsheet you can enter your values, here we defined a force that is active only for 0.01s (put the same values as on the figure 6
- Go to "complements" and click on "Update Table function" then close the spreadsheet
- You can click on **OK** on the function editor window
- In the function manager window, select the table you just created
- Click on **OK** on all the remaining windows

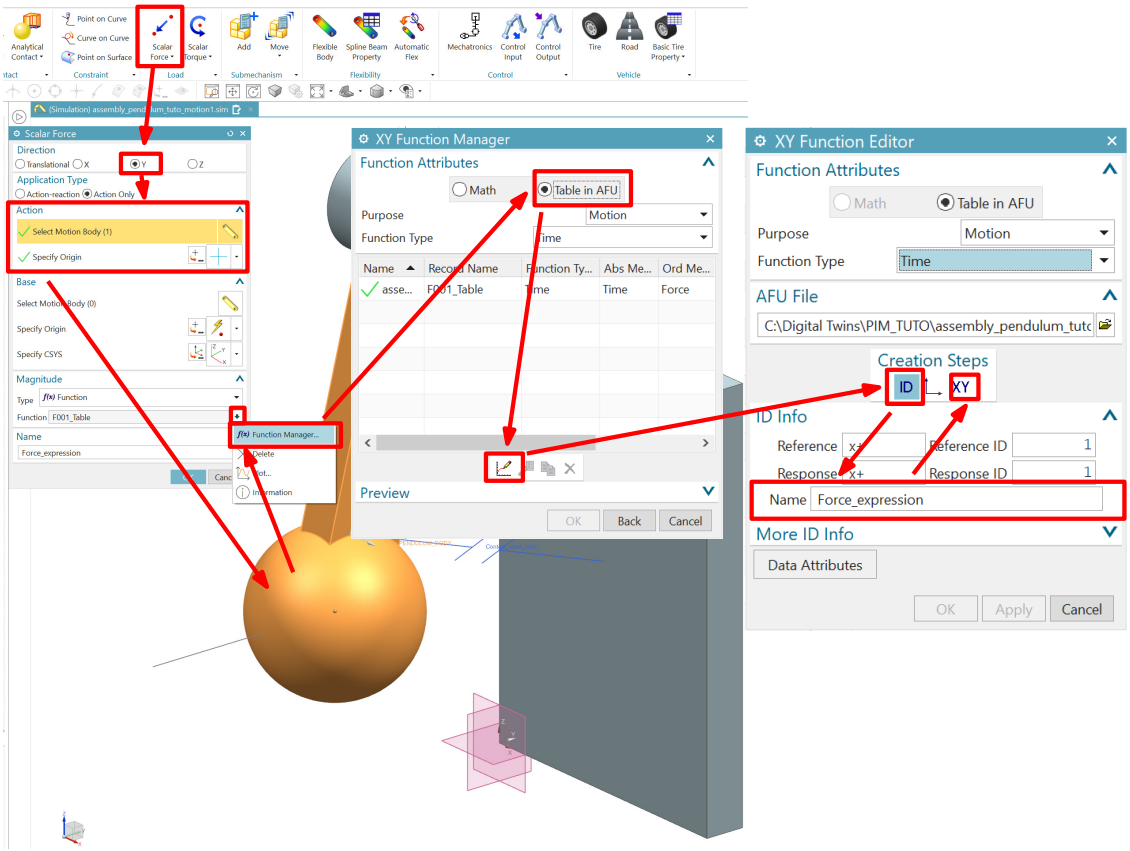


Figure 5: Creating a scalar force from an excel table - part 1

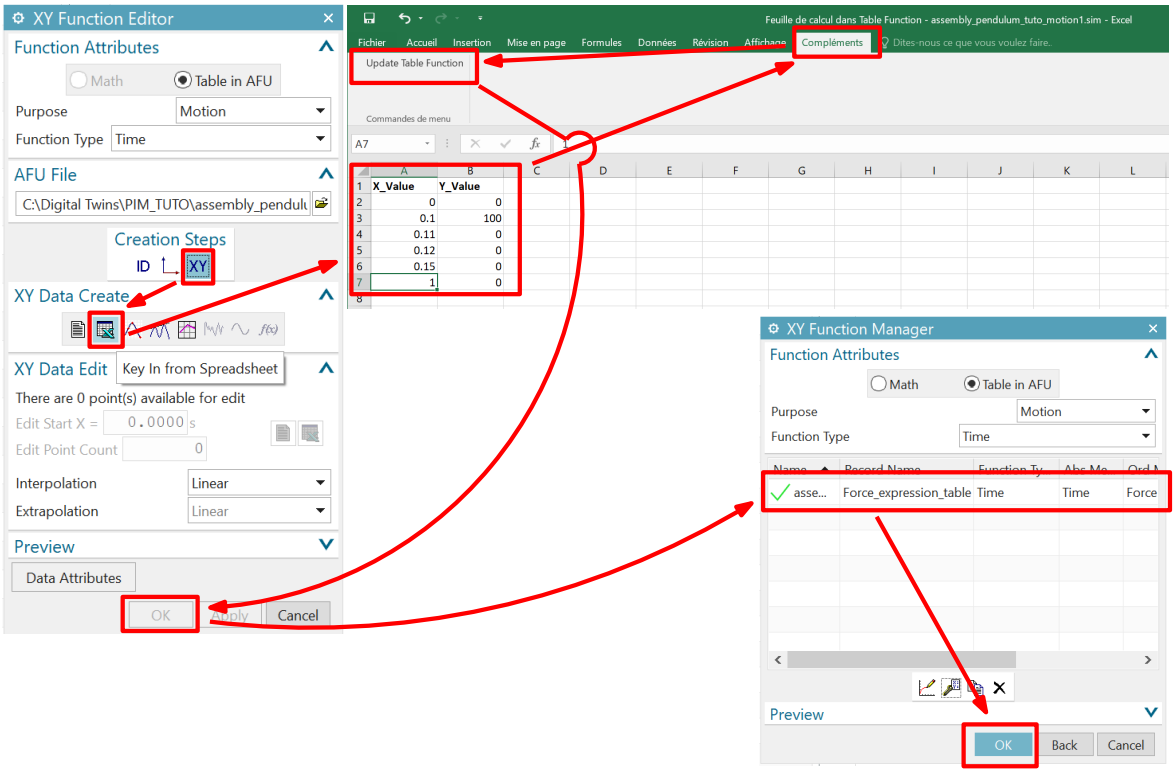


Figure 6: Creating a scalar force from an excel table - part 2

2.4 3D Contact

One of the big interest in NX Motion is to implement a contact between two parts. This allows NX to compute the impact force, which can then be used to perform a finite elements analysis.

The steps to implement a contact are shown in figure 7.

- Click on 3D contact
- Select the first body (here: the pendulum)
- Select the second body (here: the wall)
- Select the correct parameters for the contact (the contact parameters are a difficult part of implementing contact, Siemens provides some hints for good combination of parameters on that website: `http://www2.me.rochester.edu/courses/ME204/nx_help/index.html#uid:id562936`
- Give a clear name to the contact
- Click on OK

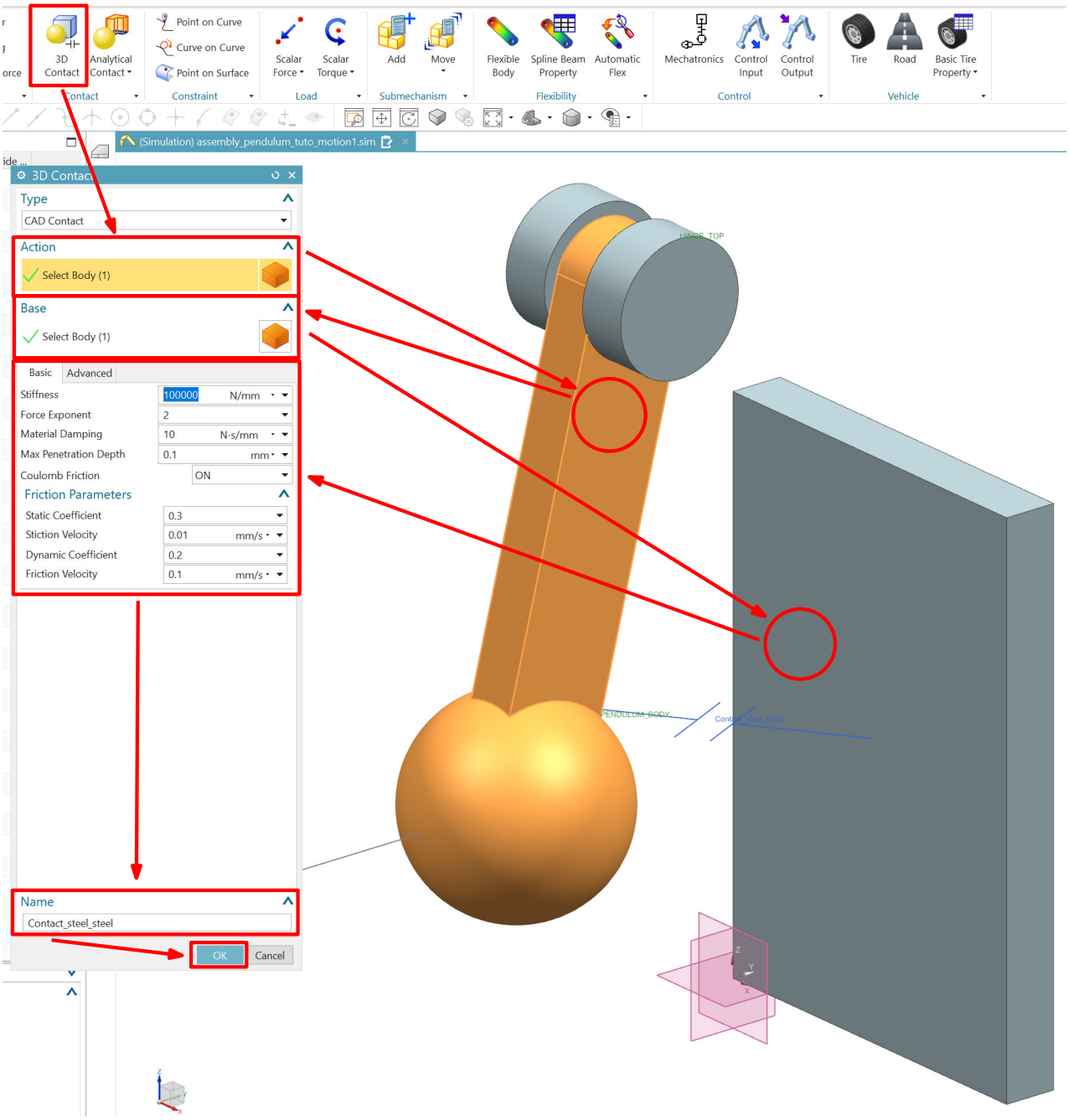


Figure 7: Creating a 3D contact

3 Launching a simulation

Once all the part and elements have been set, the simulation is launched by first creating a new solution and then clicking on **Solve**. The steps are shown in figure 9.

- Click on Solution
- Choose a new solution
- Choose the time of the simulation, here choose 5s
- Choose how many time steps you want in your simulation (the more time steps, the more accurate the simulation will be but the more computation time it will take), here choose 5000

- Choose a clear name for the solution (if you plan to compare the influence of numerical parameters it is a good idea to create different solutions instead of changing the values each time for the same solution)
- Click on OK

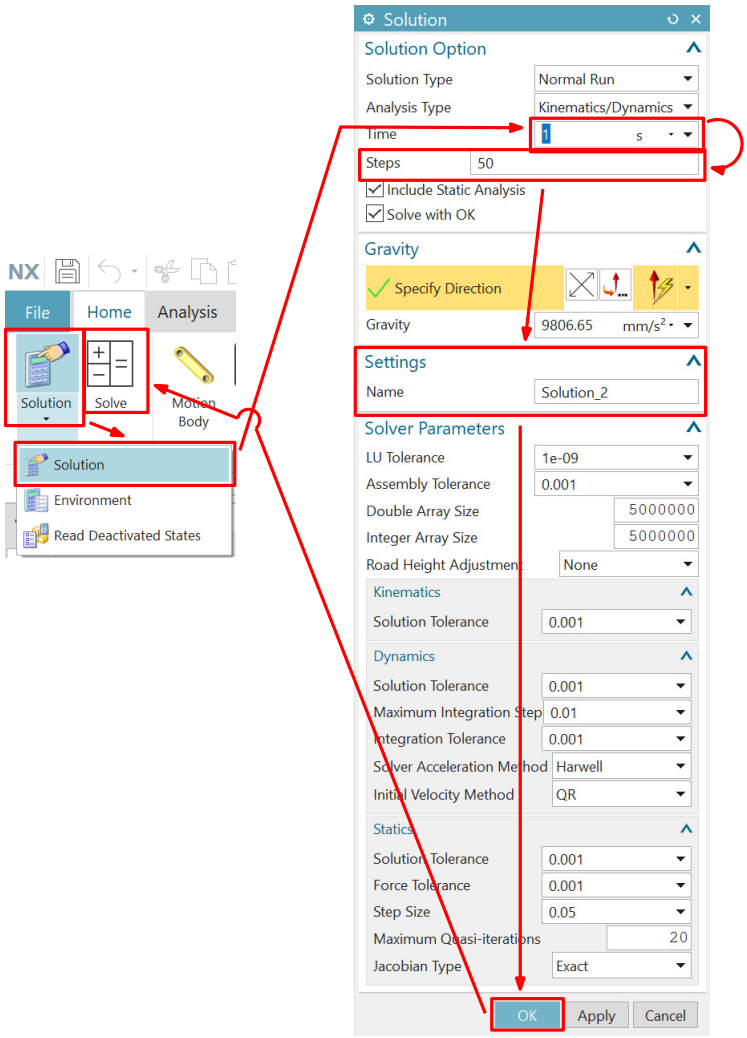


Figure 8: Creating a solution

4 Extracting data from NX Motion

For a number of element, NX Motion gives information about their displacement, velocity, acceleration or force. They are available in the **XY Result View** window (figure 9). You can then plot those data along time.

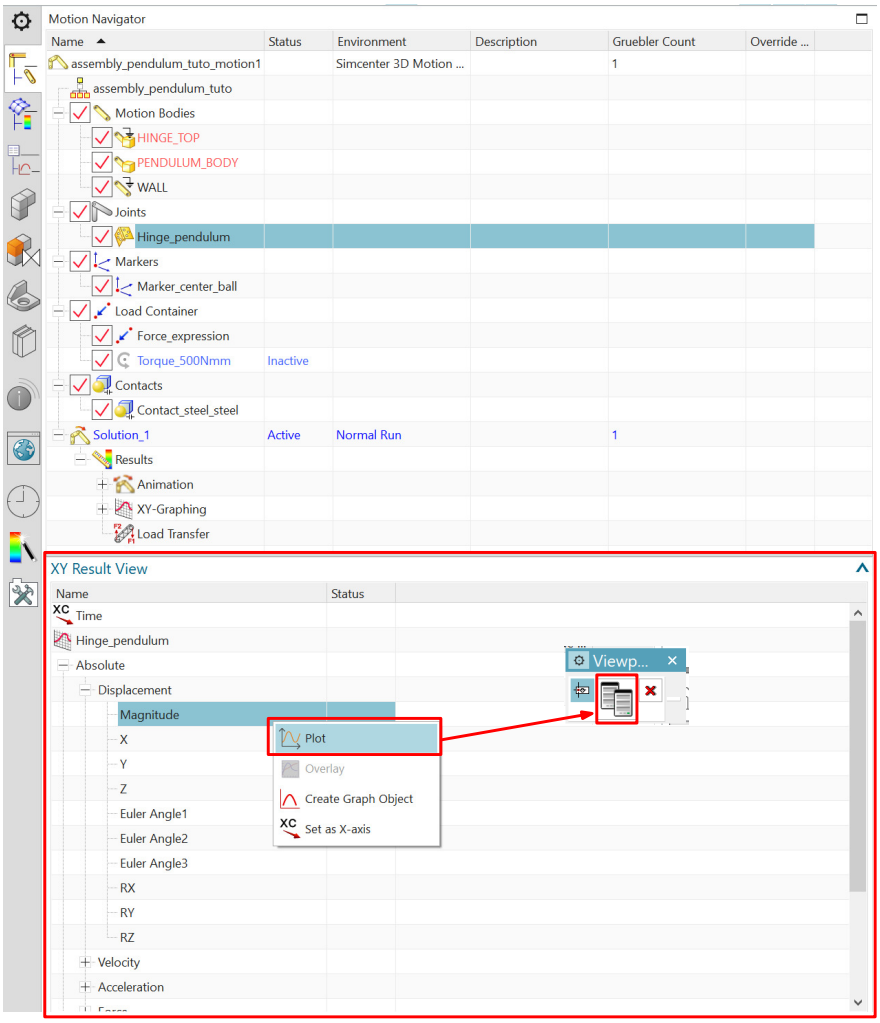


Figure 9: XY Result View

The typical elements that provide data are:

- Motion bodies
- Joints
- Loads
- Contacts (useful to get the force of an impact)

You might want to have the displacement,velocity or acceleration of a specific point, this is possible by creating a **marker**. The steps to create a marker are shown in figure 10.

- Click on Marker
- Select the body, here choose the pendulum
- Choose the point where yo uwant the marker to be (here choose the center of the ball)
- Give a clear name to the marker
- Click on OK

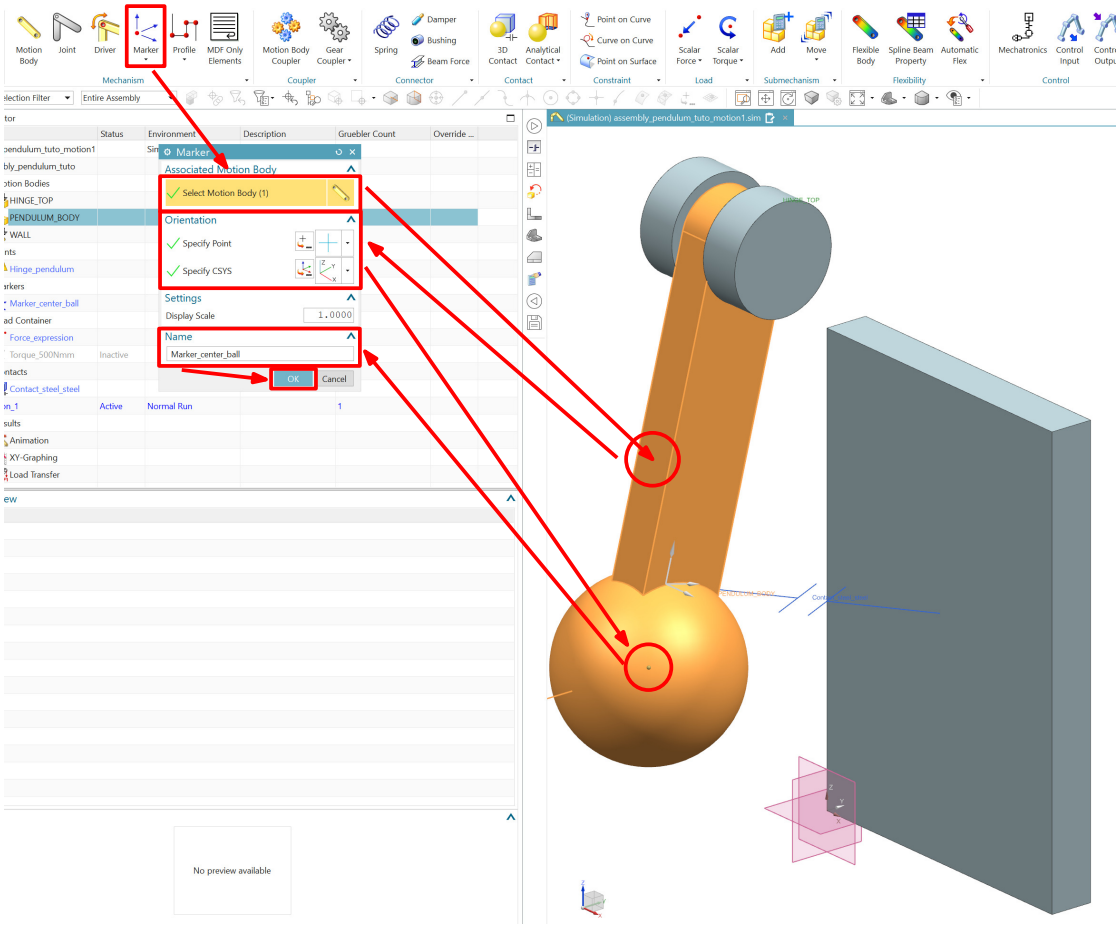


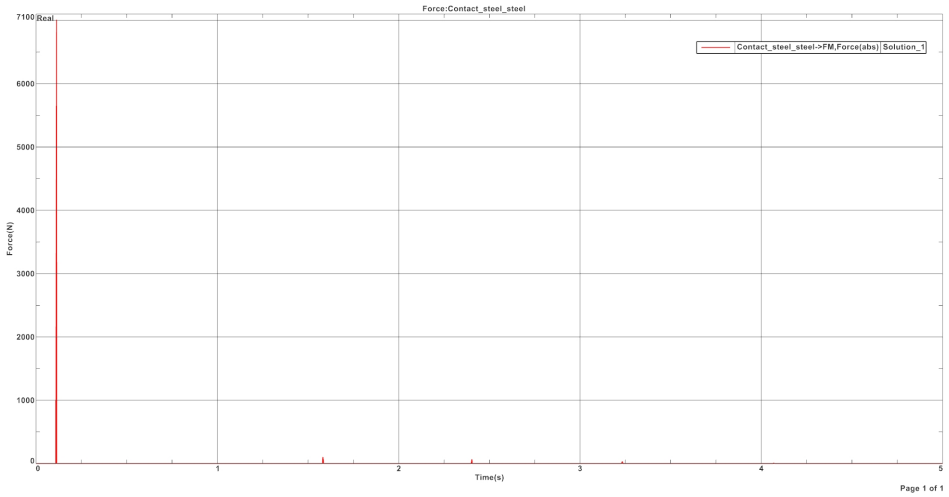
Figure 10: Creation of a marker

It is then possible to access the data you want by looking at the **XY Result view** corresponding to the marker.

5 Impact force of the pendulum on the wall

Using what we learned before, the impact force of the pendulum on the wall is obtained by going in the **XY Result View** of the contact and looking at the force magnitude.

The obtained graph should be the following:



As you can see, saving a graph from NX doesn't give a very clear image, it is however possible to extract the data used for this graph into a .csv file you can then use in excel or Matlab for example. The steps for this operation are shown in figure 11.

- Click on "Toolbar"
- Click on "Save graph"
- Choose "Comma Separated Value File"
- Click on the record name you want to save
- Click on "Add"
- Choose the location and name of the file
- Click on OK

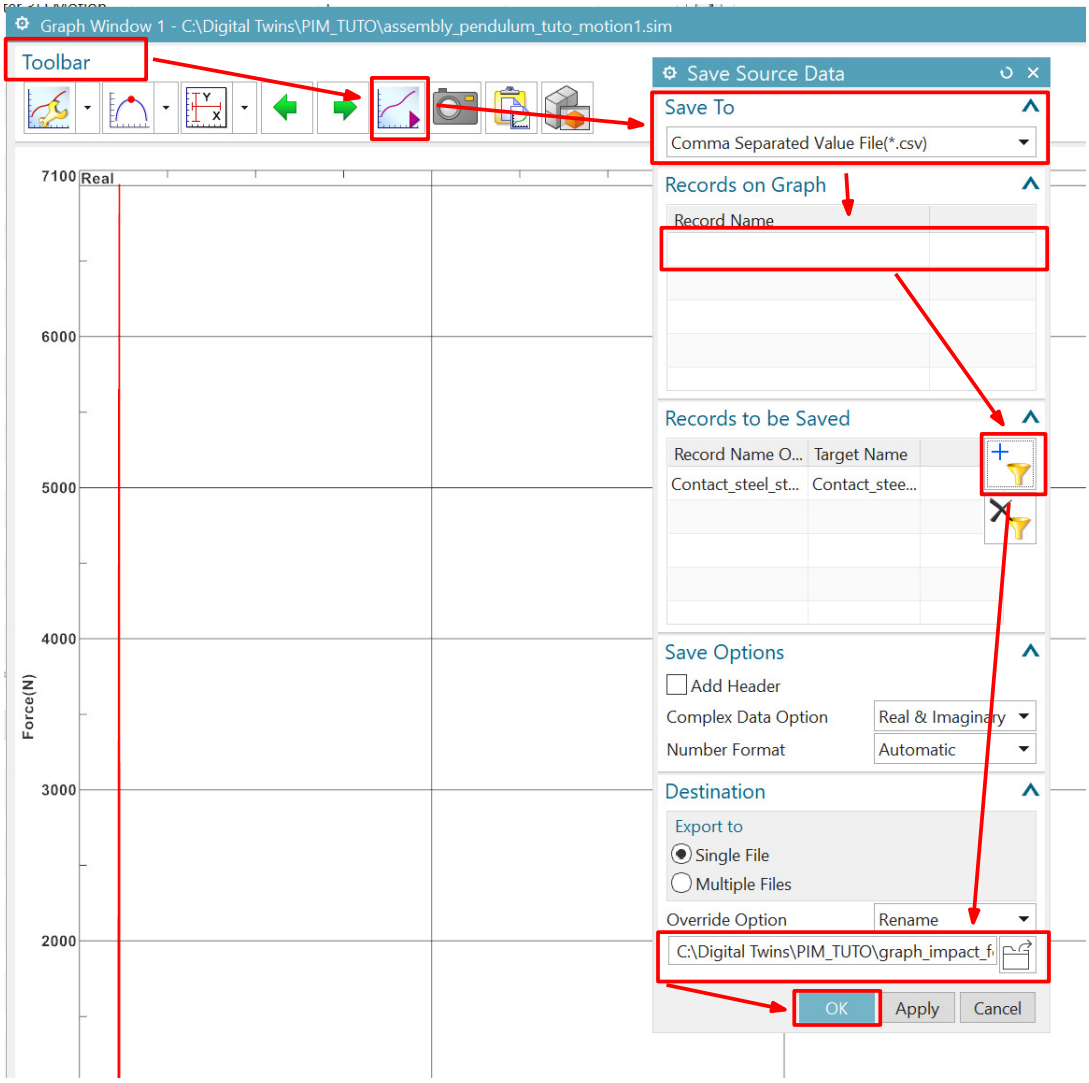


Figure 11: Importing a graph as a .csv file

6 Conclusion

With this tutorial, you should be able to use NX Motion as a way to verify some movements and to check values for physical parameters and compare them with reality of analytical computations.

You can also use that model to input real data from experiments. You will then obtain a model really close to reality and you will be able to test modifications easily without having to create a physical prototype. Using such type of models is one of the first step to create what is called a **Digital twin**.