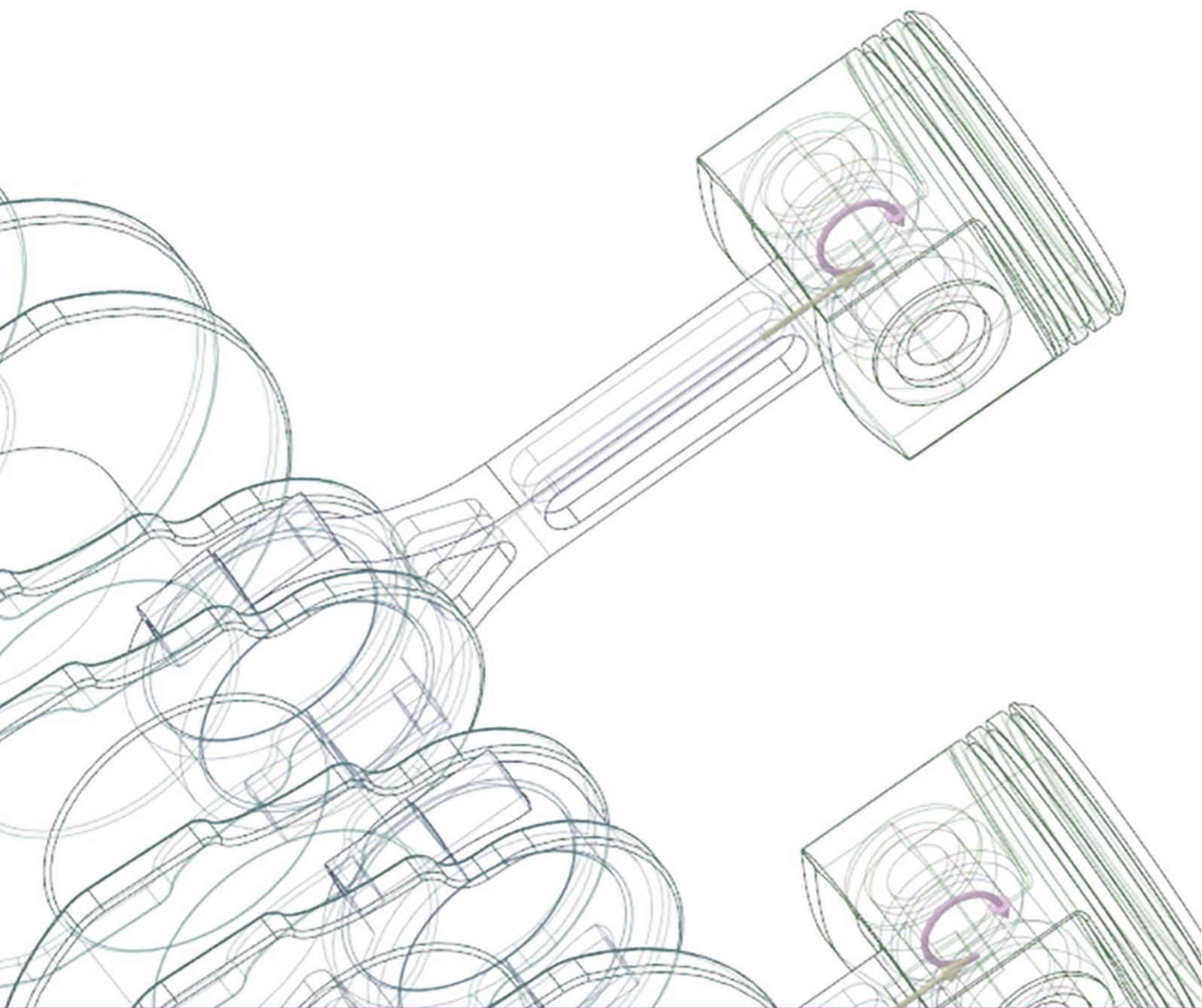


Algorix[®]

MOMENTUM



User's guide

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Date	Version	Comment
2013-01-15	Alpha1	First release (alpha)
2013-02-05	Alpha2	Second release (alpha)
2013-02-25	Alpha3	Third release (alpha)
2013-06-03	Beta1	First release of Beta.
2013-07-01	Beta2	Second release of Beta
2013-09-17	Beta3	Third release of Beta
2013-10-14	Beta4	Fourth release of Beta
2013-12-10	1.2.1	Official release
2013-12-12	1.2.2	Updated support links.
2014-02-10	1.3.0	1.3 release
2014-11-18	1.4.0	1.4 release
2016-12-20	1.6.0	1.6.0 release and rename to Momentum

1 Introduction

Algoryx Momentum is a fully integrated add-in that extends the functionality of Ansys SpaceClaim with motion dynamics for multi-body systems with *joints*, *frictional contacts* and *analysis*, driven by the physics engine *Algoryx Dynamics*. If Luxion KeyShot is present, *Algoryx Momentum* can feed KeyShot with simulation data for the production of photo-realistic physics-based images and videos. With its low learning threshold and seamless integration to SpaceClaim, *Algoryx Momentum* will revolutionize the use of CAD in future product development.

Algoryx Momentum is an add-in to SpaceClaim and not a separate program. Once *Algoryx Momentum* has been installed successfully, you will find it as an extra tab within SpaceClaim.

1.1 User's Guide

This user's guide begins with a brief introduction to the add-in and its main components. *Algoryx Momentum* is a powerful tool that specializes in bringing motion dynamics to CAD models. Components, edges and axes are key concepts when working with the add-in. If you want a component to move around or along an axis simply select one of the joint tools and click on that axis. If you want that joint to be a motor or to have some special attributes, it's only a few clicks away.

Algoryx Momentum is a valuable tool to have when for instance, simulating rapid prototype models, evolving new designs and generating sales material.

The models referred to in this document can be found in DemoModels.zip that can be downloaded from <http://www.algoryx.se/products/momentum/#tab-2>

1.2 Dynamics for SpaceClaim Online Help and Support

If you need further help to concepts introduced in this document or other features of *Algoryx Momentum*, feel free to use the *Algoryx Momentum Online Help and Support*. It can be found by opening SpaceClaim, clicking on the "Momentum"-tab, and clicking on the **help**-button in the ribbon-menu.

2 Tutorials

This section will explain how to use the example files in a step-by-step fashion. Working through these tutorials will quickly help you grasp the new concepts this add-in introduces. Two versions of each file are included together with this document, one with only the model and another with the simulation data included. The ones with the simulation data included are thought to act as reference models and not to be used with the tutorials.

Note: the files used in the following tutorials can be found at <https://www.algoryx.se/mainpage/wp-content/uploads/2014/02/DemoMaterial-140812.zip>

2.1 Intro

In this tutorial, you will:

- Learn about the basic components of the add-in.
- Create your first joints.

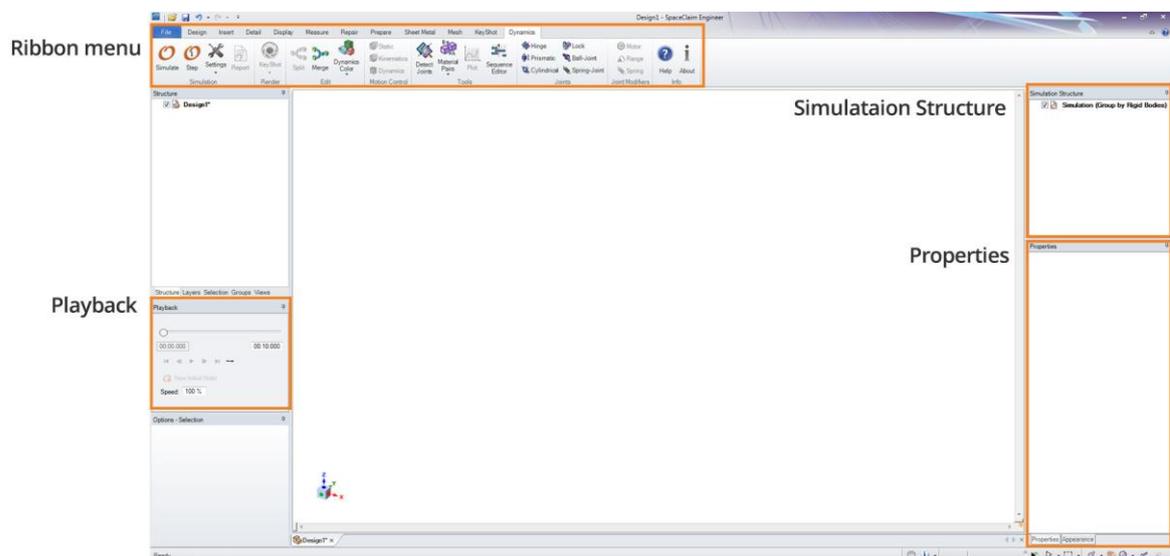


Figure 1: Main components of the add-in. *The precise layout may vary depending on local settings.*

This tutorial illustrates basic usage and explains the main components of the add-in.

The Ribbon menu - This is where you first activate the add-in as well as the place where all the tools and joints reside.

The Properties tab – Here you can change the properties for the selected joint.

The Playback tab – Play back your recorded simulations and step through them frame by frame.

The Simulation Structure – This is where you organize your model to be suited for simulation. It also provides some different sorting options.

Intro tutorial: Step 1 – Open the document and activate the add-in

- Open SpaceClaim.
- Open the model **Intro.scdoc**

- Start the add-in by clicking on the **Activate Momentum**  button under the **Momentum tab** in the ribbon menu or the Simulation Structure tab.

Intro tutorial: Step 2 – Create your first joints

- Right click on the Rigid Body named **Design2**  in the **Simulation Structure** and press **Split**, this splits all the components into Rigid Bodies. (*Important: For a solid to appear in the Simulation Structure, it needs to reside within a component, otherwise it will not show up and can not be simulated*)
- A second way of splitting up the model into separate rigid bodies is to select an *edge, face or solid* and click on the split button in the ribbon menu

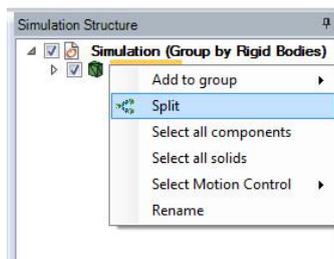


Figure 2: Splitting a body.

- Choose the **Hinge joint**  in the ribbon menu.
- Left click on an edge of the box named “**Hinge box**”. This will create a hinge between the box and the world.
- Press the **Simulate** button  in the ribbon menu to simulate the scene. Wait until the simulation has finished, or interrupt it by pressing **Stop**.
- Left click on the solid named “**Pole**” and select **Motion Control > Static** in the ribbon menu. This option can also be chosen if you right click on the rigid body in the **Simulation Structure**. (*This locks the object to the world and prevents it from falling down.*)
- Choose the **Prismatic joint**  located below the hinge joint in the ribbon menu.
- Ctrl-left click on the box named “**Prismatic box**” and then left click on an edge of the pole. (*Ctrl-clicking selects the entire component and moves it along/around the axis you select next.*)
- Press the **Simulate** button  in the ribbon menu to simulate the scene. Wait until the simulation has finished, or interrupt it by pressing **Stop**.
- If you want to remove joints, simply select them in the SpaceClaim structure and press the **Delete** button. Alternatively you can select them by clicking directly on the joint in the design view with the selection tool and then press the **Delete** button.
- Try the **Cylindrical joint** in the same way and see what that does too.
- The **Lock joint**  locks the object to the world, or if you ctrl-click, to another object. Try locking one of the boxes to the world by deleting the hinge joint and then, with the lock joint selected, clicking on one of its edges. Decreasing the **Elasticity in Translation X, Y and Z** in the lock's properties-tab will “loosen” the lock in the selected axis.

2.2 Domino

In this tutorial, you will:

- Learn about the different motion controls.
- Simulate using only contacts.

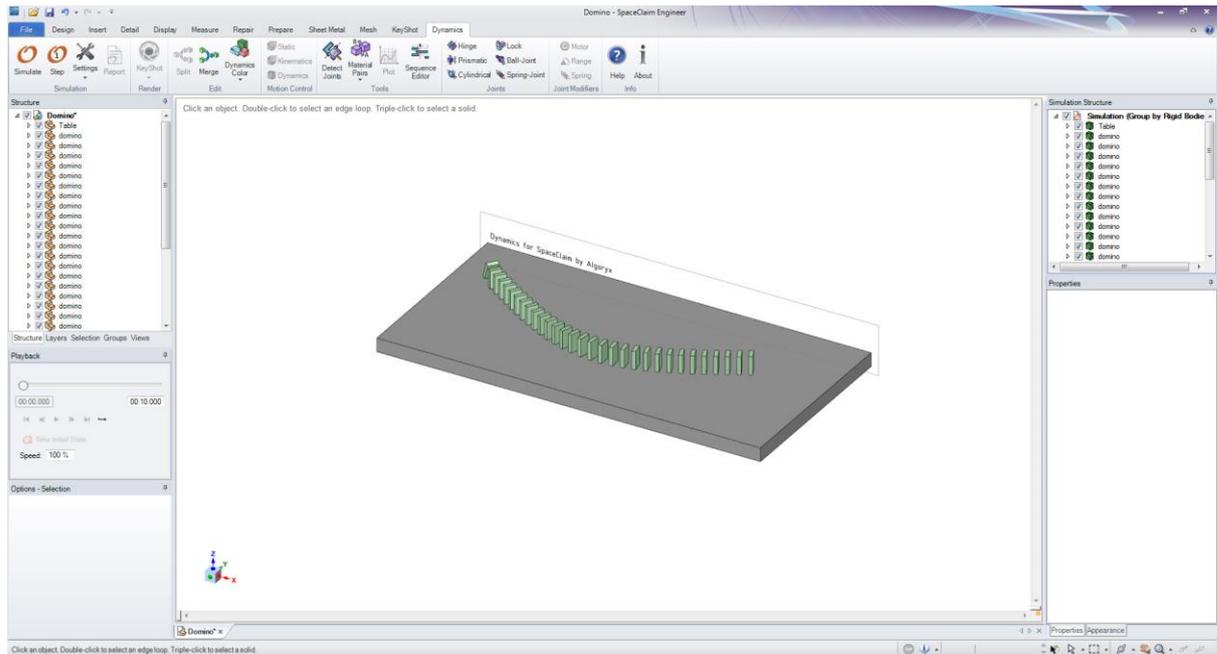


Figure 3: Domino scene

This tutorial illustrates how the add-in handles automatically generated contacts.

The **Motion Control** tool is used to specify the control of a simulated rigid body.

1. **Static:** The rigid body will have zero velocity, will not be affected by any forces and have infinite mass. Suitable for stationary objects such as a ground.
2. **Kinematics**
The rigid body will have an infinite mass and will not be affected by any forces, however it can have a velocity.
3. **Dynamics**
The rigid body will be affected by forces/gravity (default).

Domino tutorial: Step 1 – Motion controls

- Open the model **Domino.scdoc**
- Start the add-in by clicking on the **Activate Momentum**  button under the **Momentum** tab in the ribbon menu or the Simulation Structure tab.
- Right click on the **Rigid Body**  in the **Simulation Structure** and press **Split**.
 - Left click somewhere on the table and select **Motion Control > Static** in the ribbon menu. This option is also available if you right click on the rigid body named **"Table"** in the **Simulation Structure** and select **Select Motion Control > Static**.

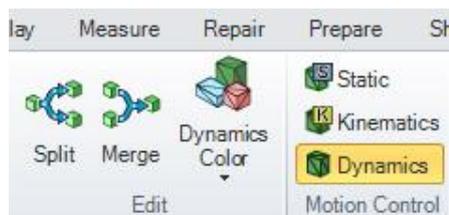
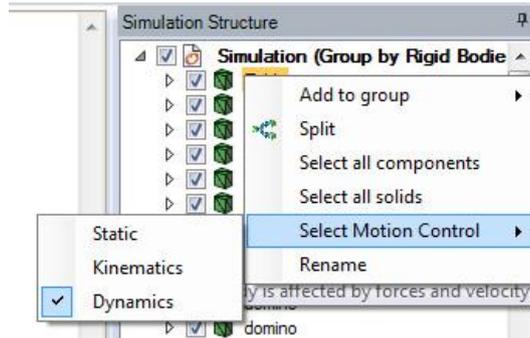


Figure 4: Motion Control in the Ribbon Menu



Select Motion Control in the Simulation Structure

- Open the **Material Pairs**-menu in the ribbon menu. For the given material pair (Default material, default material), set the **Friction** value to 0.5.
- Press the **Simulate** button  in the ribbon menu to simulate the scene. Wait until the simulation has finished, or interrupt it by pressing **Stop**.
- [Optional] Copy the falling domino to the end of the dominos and let it fall from that direction, too, to create a totally new simulation.
- [Optional] In the Ribbon menu, press the Simulation Options  button and choose if you want to **Render Contacts** or not.

2.3 Sign

In this tutorial, you will:

- Learn to create multiple linked joints.

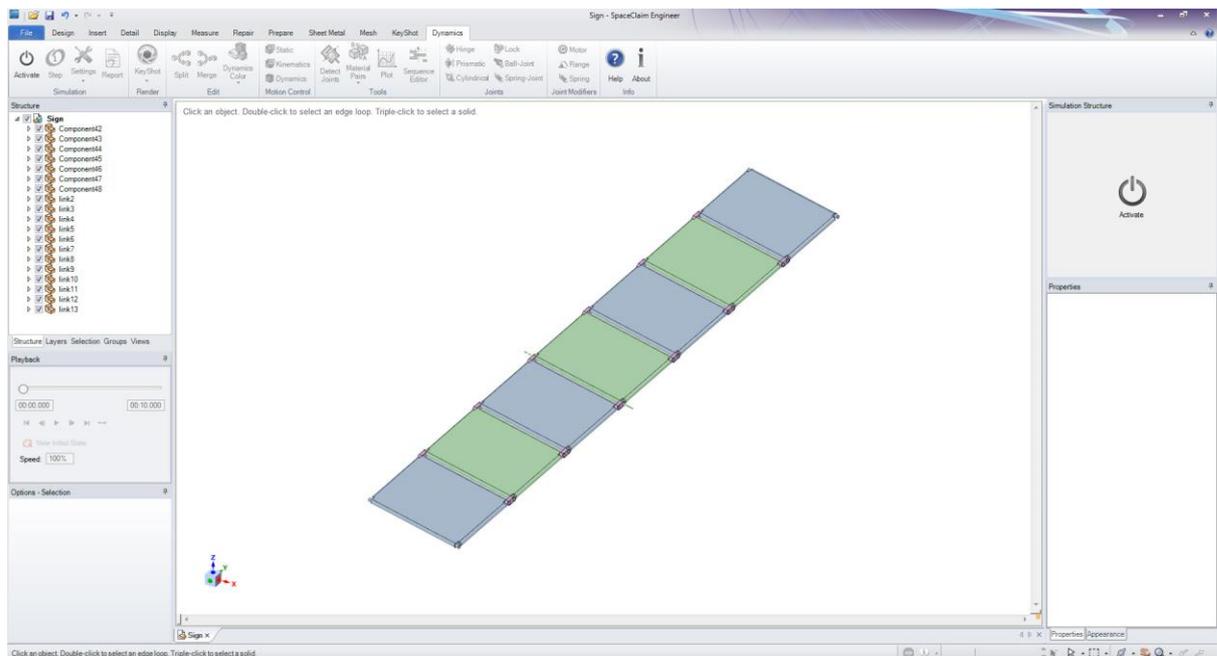


Figure 5: Welcome sign scene.

This tutorial illustrates some of the possibilities one single kind of joint can offer.

Welcome Sign tutorial: Step 1 – Multiple Joints

- Open the model **Sign.scdoc**
- Start the add-in by clicking on the **Activate Momentum**  button under the **Momentum tab** in the ribbon menu or the Simulation Structure tab.
- Right click on the Rigid Body  named **Design2** in the **Simulation Structure** and press **Split**.
- Select the **Hinge** joint from the ribbon menu.
- Left click on the right most axis to lock the sign to the world around that axis.

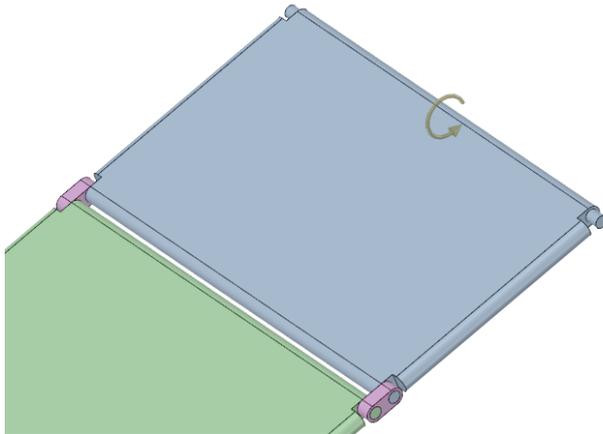


Figure 6: Sign model attached to the world with a hinge.

- Ctrl-left click somewhere on the same part and then on the axis of the links connecting to the part (or the inside of the cylindrical hole in the links). (Tip: *Use the scroll wheel while hovering the cylindrical hole to select the underlying components*).
- Ctrl-left click on the green part and left click on the other side of the same links and continue like so until all the pieces are connected with the links joining them together. Make sure that the hinges connecting the single parts are purple (indicating that two bodies were connected to each other) rather than green (one rigid body connected to the world).

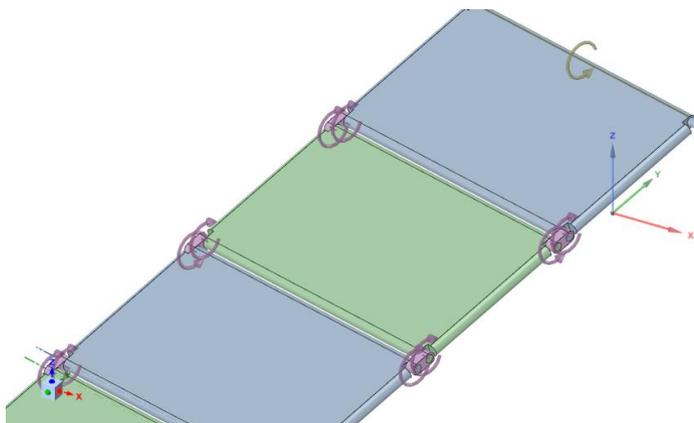


Figure 7: Sign model – parts attached to each other.

- Press the **Simulate** button  in the ribbon menu to simulate the scene. Wait until the simulation has finished, or interrupt it by pressing **Stop**.

2.4 Sign using Detect Joints

In this tutorial, you will:

- Learn how to use the “Detect Joints” tool

Detect Joints is a feature which will, given overlapping radial geometries (aka. pin in a hole), try to automatically detect the joint geometry. The user will get a list of potential joints, and get to choose for each or all which joint that should be created.

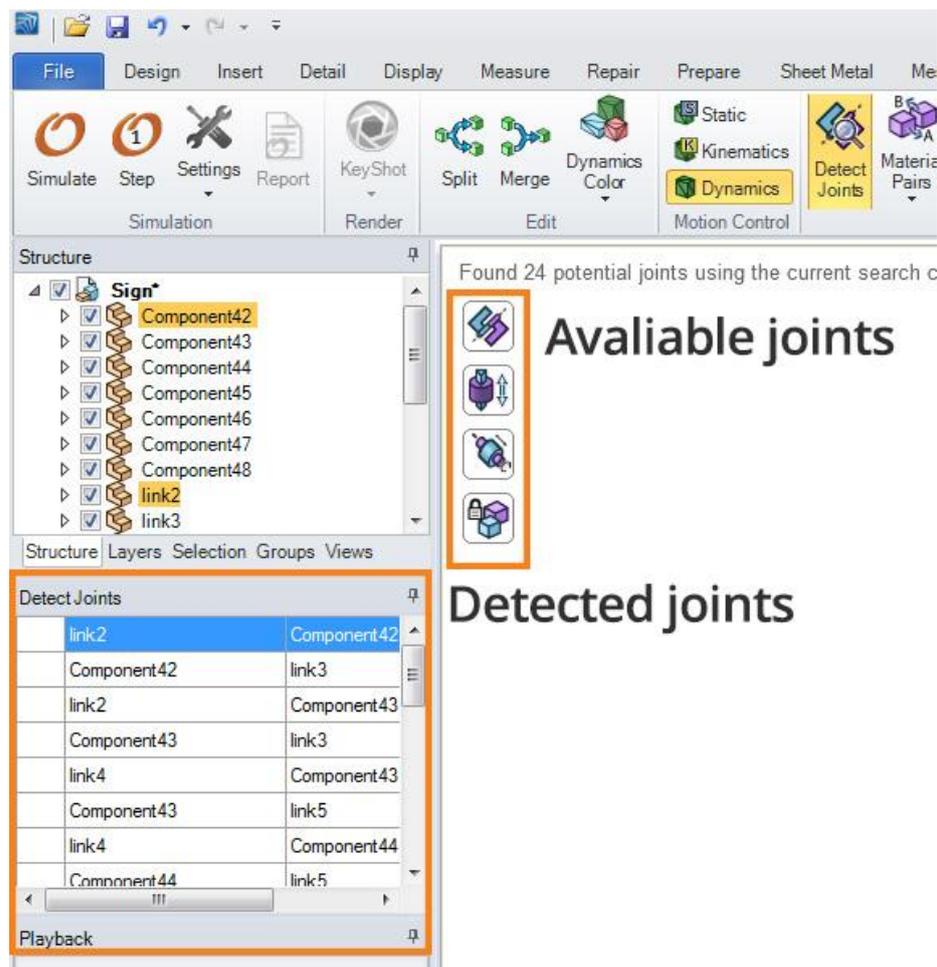
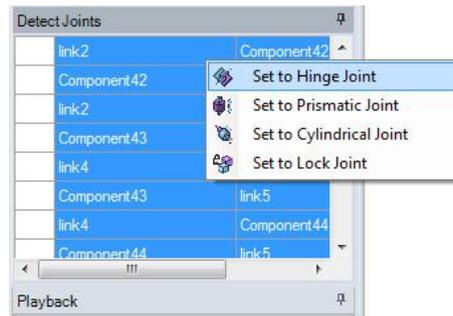


Figure 8: Detect joints UI.

- Open the model **Sign.scdoc**
- Start the add-in by clicking on the **Activate Momentum**  button under the **Momentum** tab in the ribbon menu or the Simulation Structure tab.
- Right click on the Rigid Body  named **Design2** in the **Simulation Structure** and press **Split**.
*Now instead of manually adding each individual hinge, we will use the **Detect Joints** feature.*
- Click **Detect Joints** in the ribbon menu
 - In the list of detected joints, mark all (Ctrl+A).
 - Either right mouse click in the list of joints to get a menu of available joint types:



- Or click one of the joint types in the Construction window.
- Finally we need to connect the right most component to the world.
 - Select the Hinge tool and left click on the right most axis to lock the component to the world around that axis.

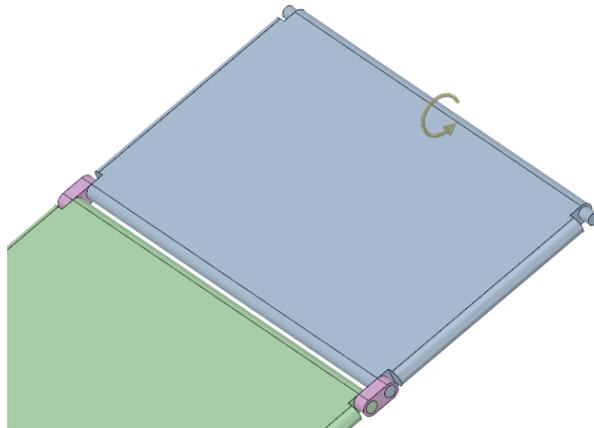


Figure 9: Sign model attached to the world with a hinge.

- Press the **Simulate** button  in the ribbon menu to simulate the scene. Wait until the simulation has finished, or interrupt it by pressing **Stop**.

2.5 Drill Machine

In this tutorial, you will:

- Learn to group the model into rigid bodies.
- See what joints and contacts working together can accomplish.

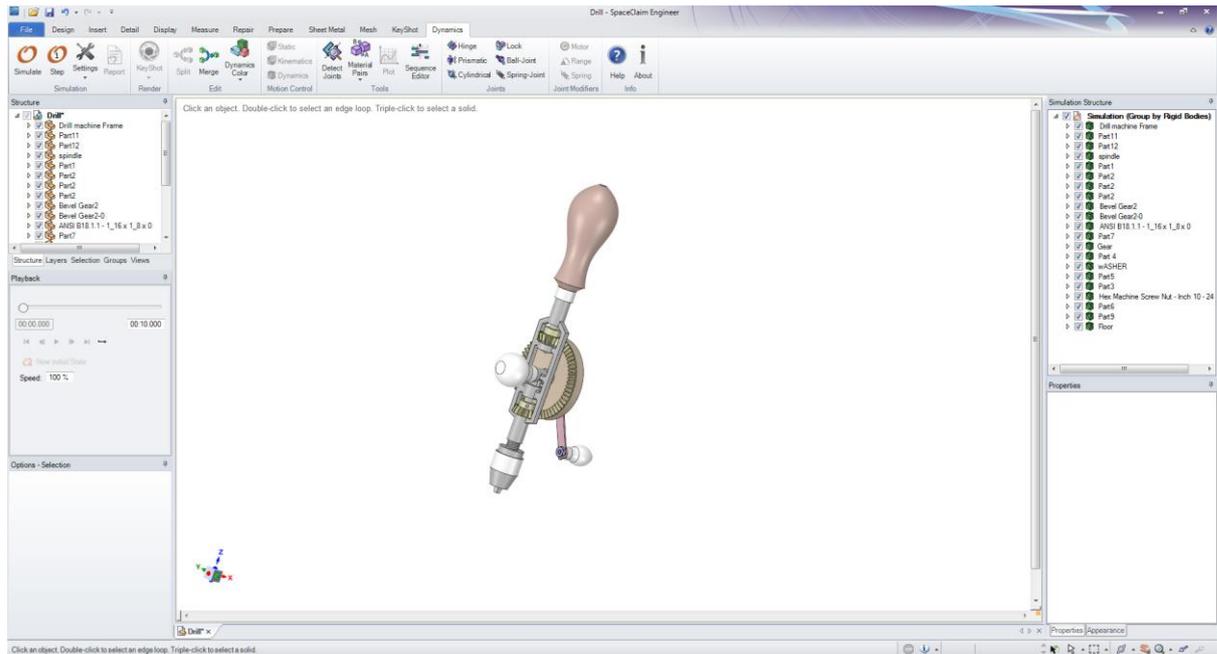
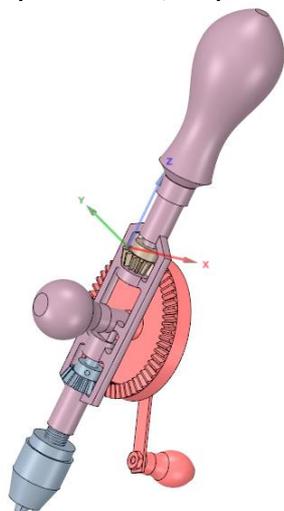


Figure 10: Drill Machine scene.

This tutorial illustrates how easy it is to create interesting dynamic movement with joints and automated contacts. It will also teach you how to think regarding rigid bodies when preparing a model for simulation.

Drill Machine tutorial: Step 1 - Merge components into Rigid Bodies

- Open the model **Drill Machine.scdoc**
- Start the add-in by clicking on the **Activate Momentum**  button under the **Momentum tab** in the ribbon menu or the Simulation Structure tab.
- Right click on the only Rigid Body present in the **Simulation Structure** and select "split" to split the drill into individual parts.
- Select the **Merge tool** in the ribbon menu.
 - Click somewhere on the head of the drill and then another part of the head to merge the parts together (Ctrl click to merge multiple parts together).
- Continue grouping the model into rigid bodies like this or by using the **Split tool**
- *By now you should have all the parts of the drill grouped and ready for simulation. If you select the different rigid bodies in the **Simulation Structure** you can see what parts each rigid body consists of. In the picture below, the parts belonging to a common rigid body have the same color.*



Drill Machine tutorial: Step 2 – Connecting the model with joints

- Select the  **Hinge** joint in the ribbon menu and **Ctrl-left click** on the head of the drill and then select the axis of the frame to rotate around.
- Repeat this for the upper small cogwheel also.
- **Ctrl-left click** the big cogwheel and select an axis on the frame to rotate around.

Drill Machine tutorial: Step 3 – Motors and properties

The joint on the big cogwheel should be a motorized hinge. This can be accomplished in a couple of different ways.

Either:

- Select the **Hinge** you wish to make a motor with the **selection tool**.
- In the **Properties** tab, select **Motor > true** and enter the desired speed.
- Select the Hinge and click the **Motor button** in the ribbon menu

Or: prior to adding the hinge you want to be a motor. This way is more useful if you wish to add multiple joints with the same properties:

- Select the  **Hinge** joint in the ribbon menu
- In the **options panel**, select **Enable motor** and enter desired speed.

Drill Machine tutorial: Step 4 – Adjusting parameters

- If you do not wish for the floor to fall down in space you should right click on them in the **Simulation Structure** and select **Select Motion Control > Static**. Or click on the floor in the design view and select **Motion Control > Static** in the ribbon menu
- Press the **Simulate** button  in the ribbon menu to simulate the scene. Wait until the simulation has finished, or interrupt it by pressing **Stop**.
- [Optional] In the Ribbon menu, press the **Settings**  button and choose if you want to **render contacts/joints** or not.
- Step through your recorded simulation in the **playback tab** and see if you should modify the design or if it is good as is.

2.6 Boxer Engine

In this tutorial, you will:

- Learn to combine different joints.
- Import the simulation into KeyShot and render a movie.

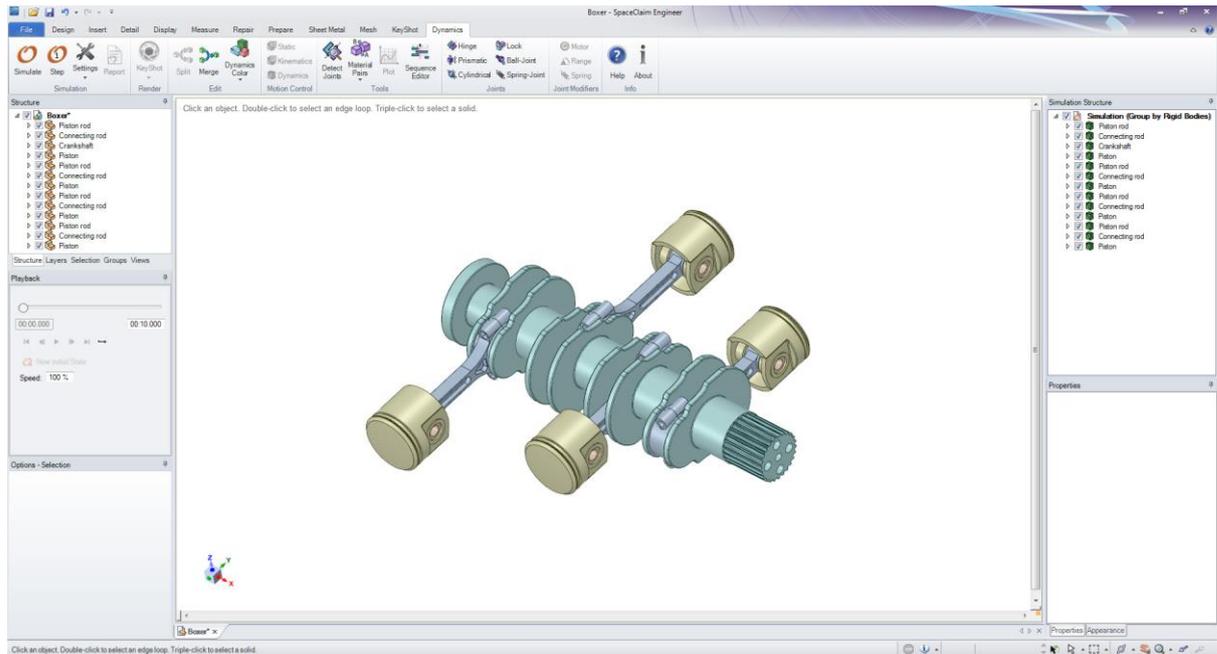


Figure 11: Boxer Engine scene

This tutorial illustrates the complete pipeline from importing a model (originally downloaded from www.GrabCad.com), adding joints and motors and finally exporting it into KeyShot for rendering.

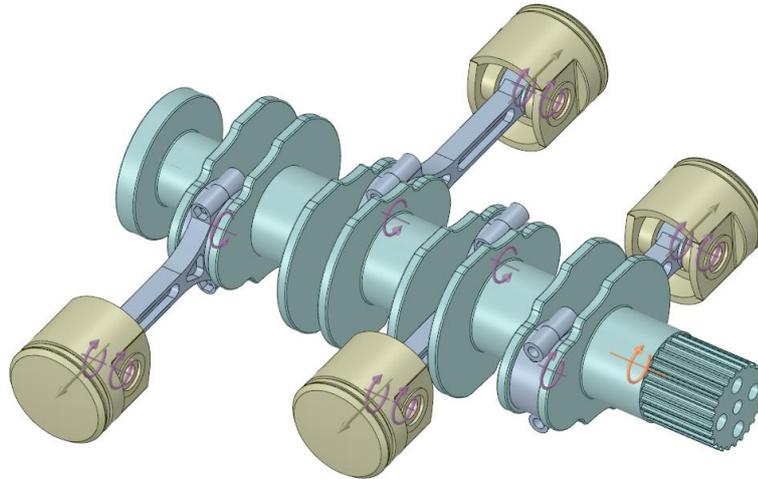
Boxer Engine tutorial: Step 1 - Split components into Rigid Bodies

- Open the model **Boxer.scdoc**
- Start the add-in by clicking on the **Activate Momentum**  button under the **Momentum tab** in the ribbon menu or the Simulation Structure tab.
- Right click on the **Rigid Body**  in the Simulation Structure and select **Split** to split all the components into separate rigid bodies.

Boxer Engine tutorial: Step 2 - Connecting the model with joints

- Select the  **Hinge** joint from the ribbon menu.
- Ctrl-left click on one of the connecting rods and left click on the axis on the crankshaft that the rod is going to rotate around.
- Do the same for the purple cylinder connecting the connecting rod with the piston.
- Repeat for all the rods.
- With the  **Hinge** tool selected, left click on the center axis of the crankshaft to lock the hinge it to the world.
- Select the crankshaft hinge and set **Enable motor** to true in the properties tab as well as a desired speed, e.g., 360deg/s.
- Select the **Prismatic** joint from the ribbon menu
- Left click on the center axis of each of the pistons.

- After having placed a **Prismatic** on each piston, your model should look like this:



- Press the **Simulate** button  in the ribbon menu to simulate the scene. Wait until the simulation has finished, or interrupt it by pressing **Stop**.
- [Optional] Adjust the parameters of the joints to your liking.

Boxer Engine tutorial: Step 3 – Exporting to KeyShot

- Click the KeyShot button in the ribbon menu
 - Keyshot is opened
- Add materials and environments to your liking
- Press Render

2.7 Sequence Editor

In this tutorial, you will:

- Learn to add joints and events to the sequence editor

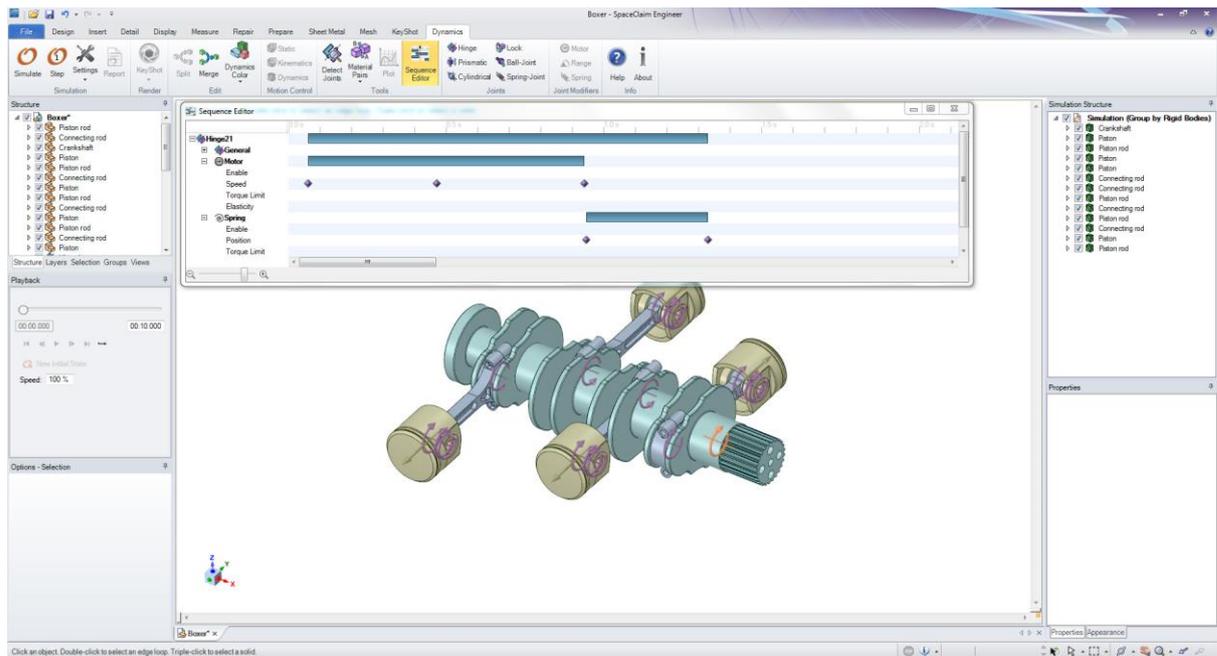


Figure 12: Sequence Editor

This tutorial will give you a basic understanding of how and why to use the sequence editor.

Sequence Editor tutorial: Step 1 – Adding joints

Continuing from the boxer tutorial

- Right click on the motorized hinge joint either in the SC Structure or directly in the construction window and select **Use in Sequence Editor**. This will add the joint to the Sequence Editor allowing for further control of its behavior.

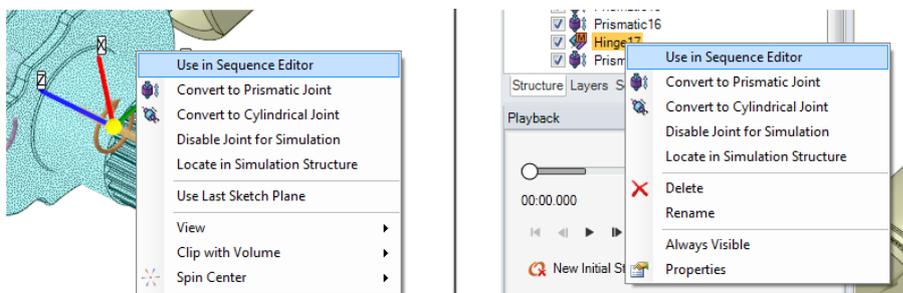
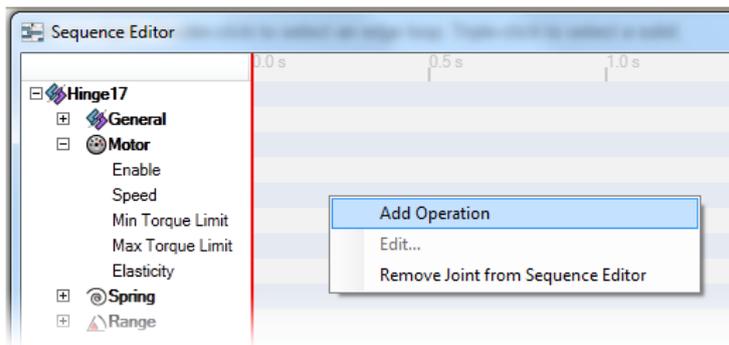


Figure 13: Different ways of adding joints to the Sequence Editor.

Sequence Editor tutorial: Step 1 – Adding events

- Right click in the **Sequence Editor** on the corresponding line you want to control, e.g. speed, and enter a value in the pop up box.
- You can either enter an exact time you want the change to occur or simply drag-and-drop the event in the **Sequence Editor**.
- Enter $-180^\circ/s$ and press Ok. Try to drag the event to have it occur later in the simulation. (note: events will snap to one another if multiple events are present)
 - Entering a function as a value is currently not supported.

- *Tip: You can preview an events value by hovering over it and change it by double clicking on it.*



If there are events in the Sequence Editor these values will override the joints properties

Figure 14: Adding events to the Sequence Editor

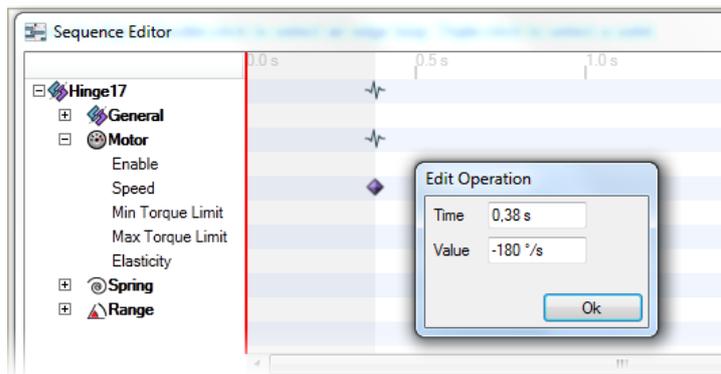


Figure 15: Edit operation

3 Troubleshooting

If you experience problems in starting *Algoryx Momentum*, make sure that you installed the correct version of Ansys SpaceClaim and Algoryx Momentum. *Algoryx Momentum* should appear as a separate tab within Ansys SpaceClaim. If problems persist, contact please support@spaceclaim.com.

If you can start Algoryx Momentum from within Ansys SpaceClaim, but have problems in using it, please use the reference *Algoryx Momentum Online Help and Support*. It can be found by opening Ansys SpaceClaim, clicking on the “Momentum”-tab, and clicking on the **help**-button in the ribbon-menu.