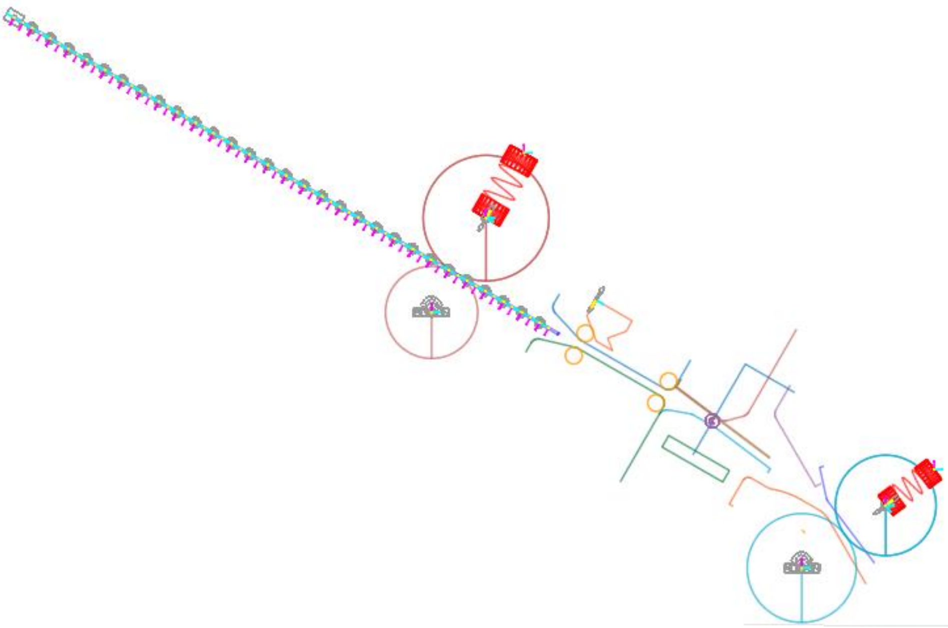
Media Transport System with IGES Import Tutorial (MTT2D)



FunctionBay

Edition Note

This document describes the release information of **RecurDyn V9R4**.

Table of Contents

Chapter
1

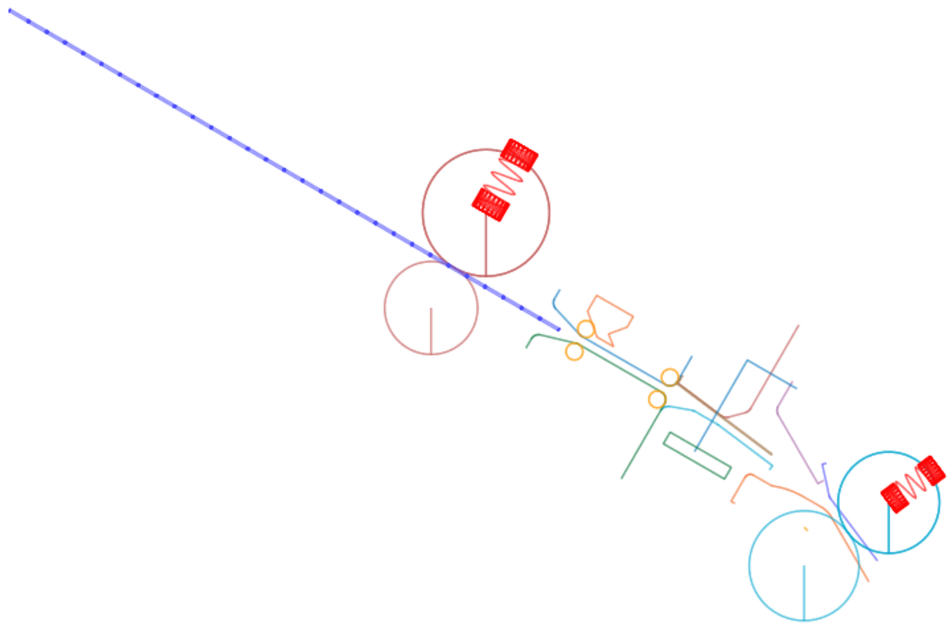
Getting Started

Objective

The purpose of this tutorial is to acquaint you with the 2D Media Transport Toolkit (MTT2D) and how to simulate the behavior of paper traveling through rollers and guides. You will learn how to import an IGES file and use the imported geometry to define an MTT2D model. It is not unusual for one engineer to design the paper path and for another engineer to do the simulation. The initial paper path design is often considered from the side view as a 2D configuration and it can be represented as 2D lines and arcs in an IGES file. This is the case for this tutorial; the paper path is provided for you in an IGES file and your responsibility is to perform the simulation.

As part of the simulation you will define guides on a body and control roller motion using an event sensor. An event sensor corresponds to a photoelectric cell (or the functional equivalent) that can be used to detect the entrance of the leading edge of the paper into the paper path or the departure of the trailing edge from the paper path.

You will create the media transport model shown below. Note that while this example considers the simulation of paper, the media sheet could correspond to a film or any other flexible media.



Audience

This tutorial is intended for experienced users of RecurDyn.

Prerequisites

Users should first work through the 3D Crank-Slider Tutorial and the Engine with Propeller Tutorial, or the equivalent to under the basics of working with RecurDyn.

Procedures

The tutorial is comprised of the following procedures. The estimated time to complete each procedure is shown in the table.

Procedures	**Time (minutes)**
Simulation environment setup	5
Geometry creation	25
Logic creation	15
Analysis and plotting	10
Total	**55**

Estimated Time to Complete

55 minutes

Chapter
2

Setting Up Your Simulation Environment

Task Objective

Learn how to set up the simulation environment, including units, materials, gravity, and the working plane. Find out how to create a media transport subsystem (2-D).

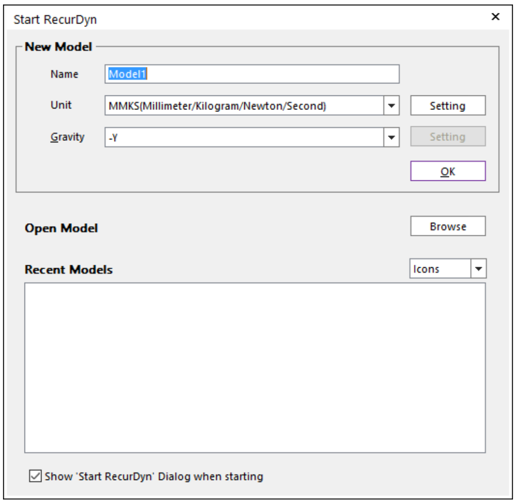
Estimated Time to Complete

5 minutes

Starting RecurDyn

To start RecurDyn and create a new model:

1. On your Desktop, click the **RecurDyn** tool.
2. **RecurDyn** starts and the **Star RecurDyn** dialog window appears.
3. Accept the default values.
4. Click **OK**.

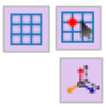


Setting Up the RecurDyn User Environment

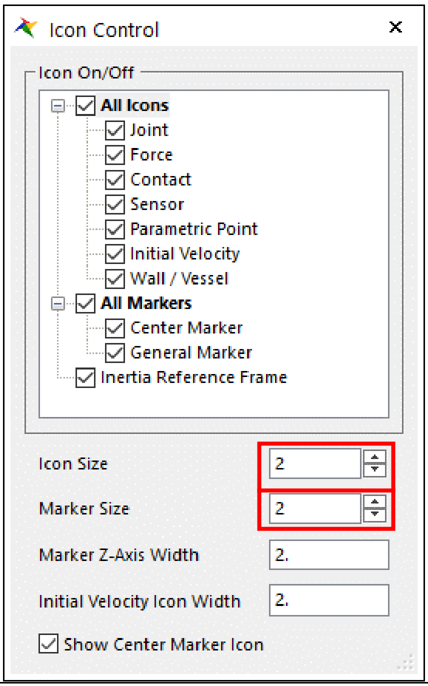
In this section, you will create an **MTT2D** subsystem and turn off the grid and snap-to-grid because you want to snap to the imported IGES geometry and not the grid.

To set up the environment:

1. Click the **MTT2D** icon of the **Subsystem Toolkit** group in the **Toolkit** tab.
2. The **MTT2D** subsystem appears in the database window, and a new toolkit, **MTT2D**, appears on the ribbon menu.



3. Turn off **Grid** and **Snap to Grid**.
4. Set the **Icon** and **Marker** size to **2**.

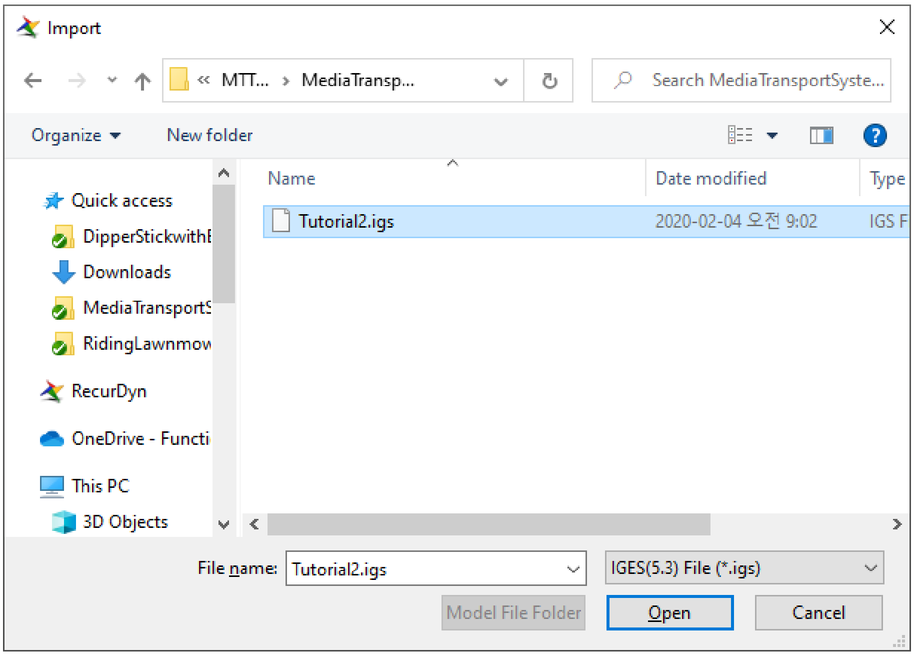


Importing the IGES Geometry

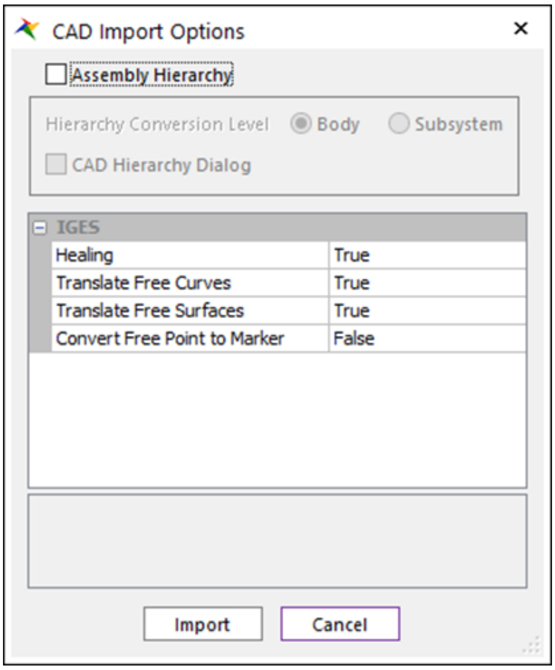
To import the IGES geometry:

1. From the **File** menu, click **Import**.

2. Set **Files of type** to **IGES** and browse to the directory indicated by the instructor.



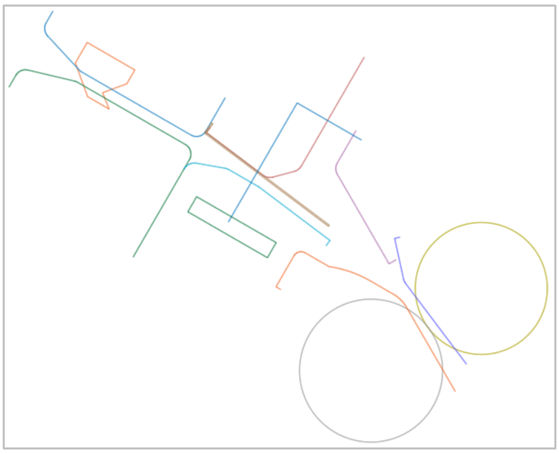
3. Click **Open**. The **CAD Import Options** window appears. Clear the **Assembly Hierarchy** checkbox and click the **Import** button.



A set of IGES geometry appears in the model window as shown in the graphics to the right. Note that each piece of IGES geometry is an independent body with no mass properties. Before running a simulation, you must make sure that each body is either:

- Fixed to ground
- Given mass properties
- Deleted.

Upcoming steps in the tutorial will address the management of the geometry.



4. This would be a good time to **save** your model as **MTT2D_IGES.rdyn**.

Chapter
3

Creating Geometry

You will create new geometry and manage the IGES geometry you imported to create an MTT2D model.

Task Objective

Learn to create:

- Roller pairs that move the paper
- Linear and arc guides that guide the paper
- A backstop body to register the paper.

Estimated Time to Complete

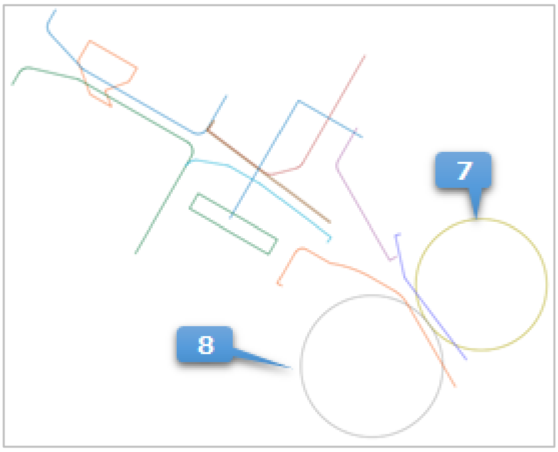
25 minutes

Creating Roller Pairs

You will create two roller pairs: an upper and a lower. You will use existing IGES geometry to create the lower pair and create new geometry for the upper pair.

To create lower roller pair:

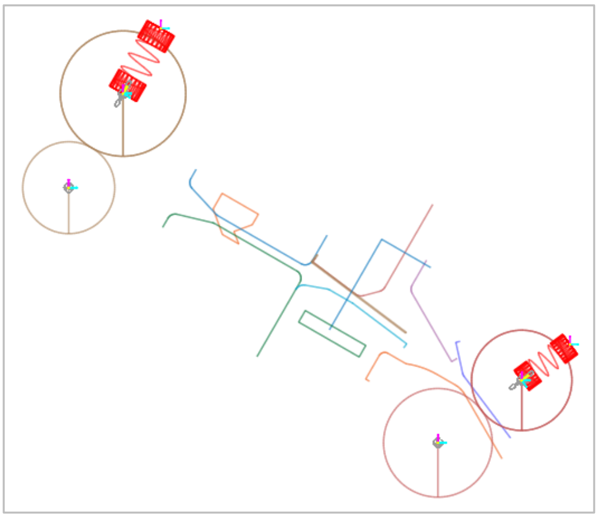
1. In the **MTT2D** tab, click the **Pair Roller** icon Using the **Point, Radius, Direction, Radius** creation method:



   - **Center Point**: Pointing toward to the center of the IGES Geometry labeled **8** in the figure to the right. The crosshair jumps to the center. Click the left mouse button.
   - **Radius**: In the command input field, enter **13**.
   - **Direction**: Pointing toward to the center of the IGES Geometry labeled **7**. The crosshair jumps to the center. Click the left mouse button.
   - **Radius**: In the command input field, enter **12**.
2. Delete the IGES bodies **_CCURVE7** and **_CCURVE8** by selecting the body names in the database window and pressing the **Delete** button on your keyboard.

To create the upper roller pair:

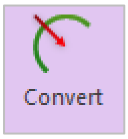
There is no IGES geometry available for use in creating the upper roller pair, so use the data below with the creation method of **Point, Radius, Direction, Radius**. The graphical result should be similar to the figure on the right.



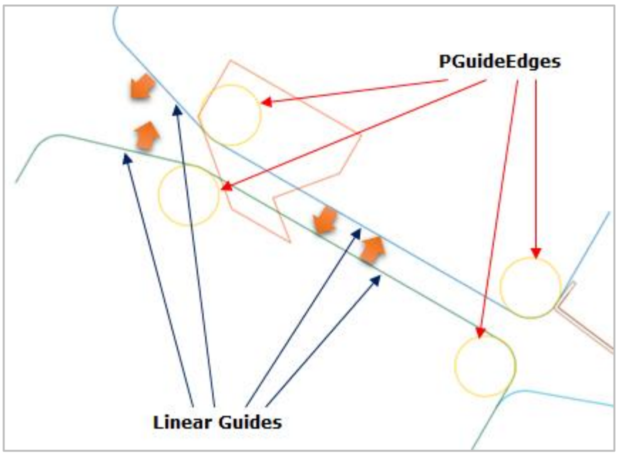
- **Center Point: -279.1, 143.5, 0**
- **Radius Point: In the command input field, enter 11.**
- **Direction Point: In the command input field, enter a directional vector of 0.5, 0.866, 0 (30-degree angle).**
- **Radius Point: In the command input field, enter a radius value of 15.**

Creating Sheet Guides at the Upper Passage

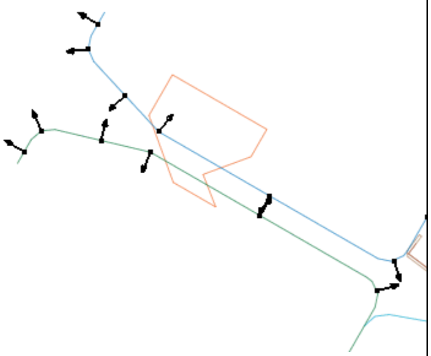
To create guides entities at the upper section

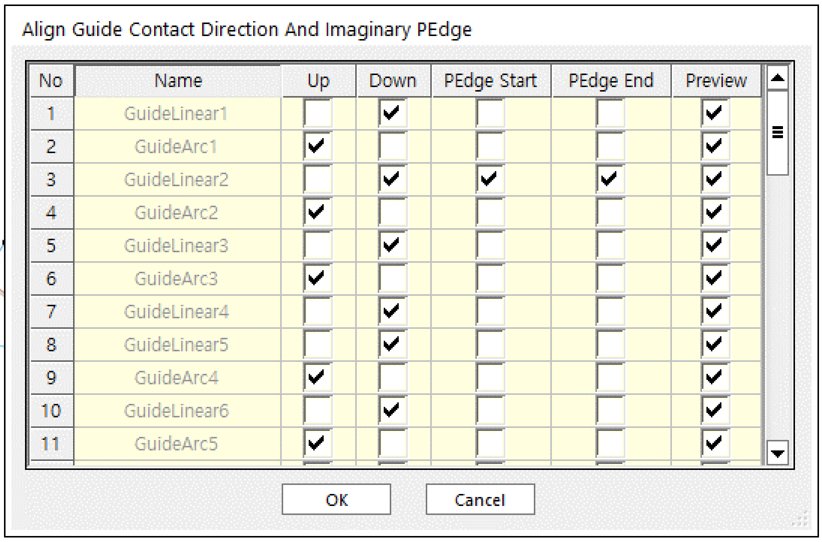


1. Using the **Guide Convert** tool in the **MTT2D** tab, create **Linear Guides** and **Arc Guides**. (see the figure on the right) by selecting the curves. The guides have a contact direction (refer to arrows in the figure) and you want to make sure the guides contact the sheet such that the sheet stays in the passage.



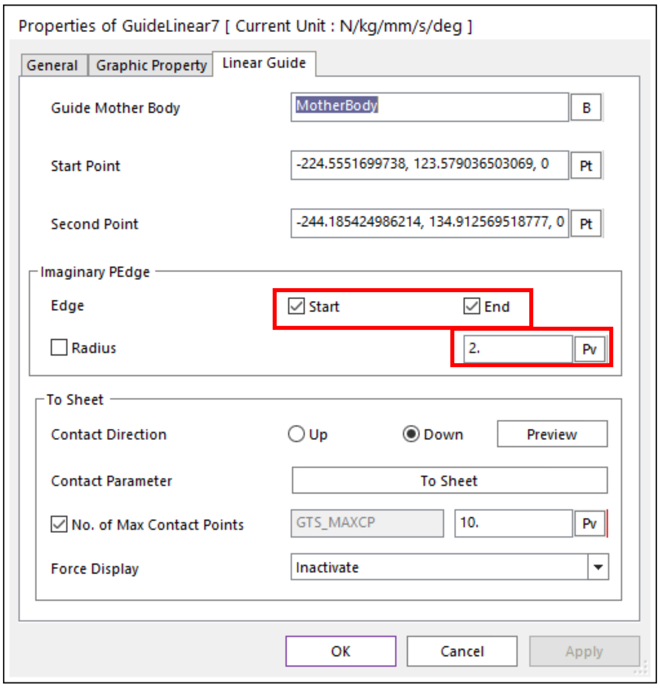
2. Change the contact direction by using in the **MTT2D** tab.





No	Name	Up	Down	PEdge Start	PEdge End	Preview
1	GuideLinear1	☐	☑	☐	☐	☑
2	GuideArc1	☑	☐	☐	☐	☑
3	GuideLinear2	☐	☑	☑	☑	☑
4	GuideArc2	☑	☐	☐	☐	☑
5	GuideLinear3	☐	☑	☐	☐	☑
6	GuideArc3	☑	☐	☐	☐	☑
7	GuideLinear4	☐	☑	☐	☐	☑
8	GuideLinear5	☐	☑	☐	☐	☑
9	GuideArc4	☑	☐	☐	☐	☑
10	GuideLinear6	☐	☑	☐	☐	☑
11	GuideArc5	☑	☐	☐	☐	☑

3. Add imaginary **PEdge** on start and end point of linear guides in **Properties** dialog box of **Linear Guide**. The radius is 2.



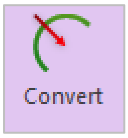
To change the color:

Change the color of the guide entities to **yellow**.

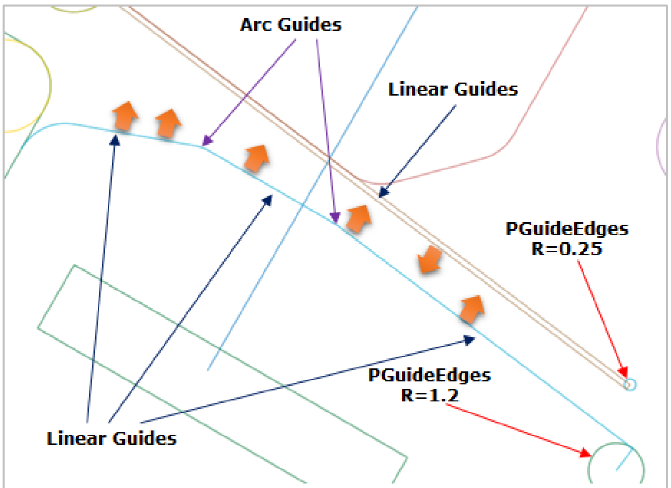
Tip: Note that you can select all of the guide entities by selecting the first guide name in the Database Window (named GuideLinear1) and then selecting the last guide entity name while holding down on the shift key. Then click on the right mouse button and select Properties. You can then go to the Graphic Property tab, change the color to yellow, and click OK. The color of all guide entities will be changed.

Creating Sheets Guides at the Middle Passage

To create guides entities at the middle passage:



1. Using the **Guide Convert** tool in the **MTT2D** tab, create **Linear Guides** and **Arc Guides**. (see the figure on the right) by selecting the curves. The guides have a contact direction (refer to arrows in the figure) and you want to make sure the guides contact the sheet such that the sheet stays in the passage. You can change the contact direction by using **Align Guide Contact Direction** tool in the **MTT2D** tab.

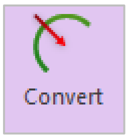


Guides along middle path in yellow

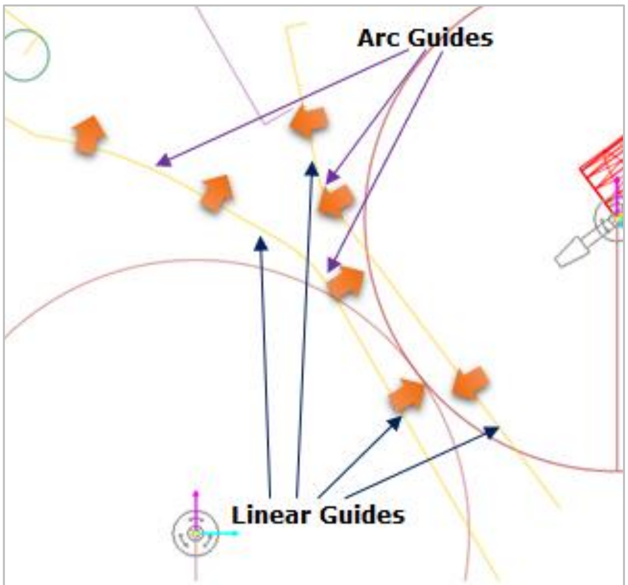
2. Add imaginary **PEdge** on start or end point of linear guides in **Properties** dialog box of **Linear Guide**. The radiuses and positions refer to the above figure.
3. As before, change the color of the guide entities to **yellow**.

Creating Sheet Guides at the Lower Section

To create guides entities at lower section:



1. Using the **Guide Convert** tool in the **MTT2D** tab, create **Linear Guides** and **Arc Guides**. (see the figure on the right) by selecting the curves. The guides have a contact direction (refer to arrows in the figure) and you want to make sure the guides contact the sheet such that the sheet stays in the passage. You can change the contact direction by using **Align Guide Contact Direction** tool in the **MTT2D** tab.



Guides along lower path in yellow

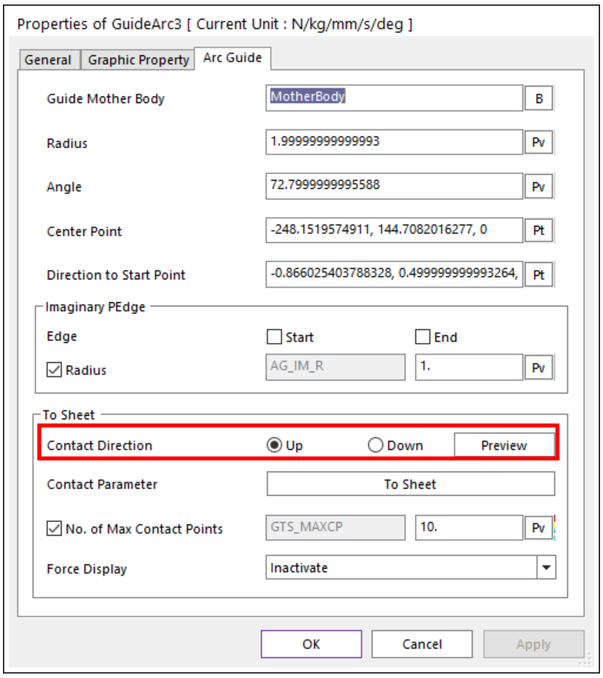
2. As before, change the color of the guide entities to **yellow**.

To check the directionality of the linear and arc guides:

Each guide has a contact direction. Some of the tips above explain how to define the guides such that the contact direction is defined correctly. However, mistakes can happen, and it may be useful to check the contact directionality of each guide.

1. Enter the **Properties** dialog box and select the **Linear Guide** or **Arc Guide** tab. There will be a Contact Direction line as shown inside the red rectangle in the figure to the right.
2. Click on the **Preview** button to see the contact directionality of the guide entity. The dialog box will disappear, and an arrow will appear that point in the direction that the guide contact will act.
3. Press the **Escape** key and the guide dialog box will reappear.
4. Modify the **Contact Direction** to Up or Down as needed.
5. Click **OK**.

Now would be a good time to save your model.



Defining and Moving the Backstop Body

The Backstop body is labeled **_CCURVE** in the database window.

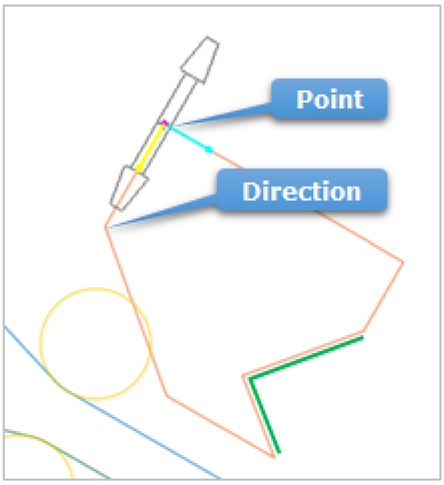
To define and move the backstop body:

1. Delete other ramming curves (_CCURVE4, _CCURVE5, _CURVE11, _CURVE12).
2. Display the **Properties** dialog box for the **_CCURVE** body and rename it to **Backstop** (use the **Name** text box in the **General** tab of the Properties dialog box).
3. Move the **Backstop** body **2.5 mm** in the +X direction and **4.33 mm** in the +Y direction.

Refining the Backstop Body

To refine the backstop body:

1. Click the **Translational** joint icon to define a translational joint, using the **Point, Direction** creation method. Use the two points from the Backstop's IGES geometry as shown in the figure to the right.



2. Add linear guides to the **Backstop** body as shown with the green lines in the figure on the right.
3. Display the Properties dialog box for each of the linear guides and make the following changes.
   - Make sure that the Mother Body is the **Backstop** body.
   - Click the **Contact Parameter to Sheet** and from the Contact parameter dialog box that appears, clear the selection of the **Stiffness (K)**.
   - Change the stiffness value from **1.2** to **12** so that the paper does not pass through the Backstop body.

Tip: In the **Contact Parameter** window, clear the **Stiffness (K)** check box.

Chapter

4

Adding Logic

In this chapter, you will add a sensor and the controlling logic to the mechanism so that the paper reverses direction once the trailing edge has passed the scan line.

Task Objective

Learn how to use an event sensor and control logic to define the motion of a roller pair.

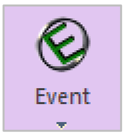
Estimated Time to Complete

15 minutes

Adding Logic to Reverse the Paper

In this section, you will use an event sensor to define the motion of the fixed rollers and the expression.

To create an event sensor:



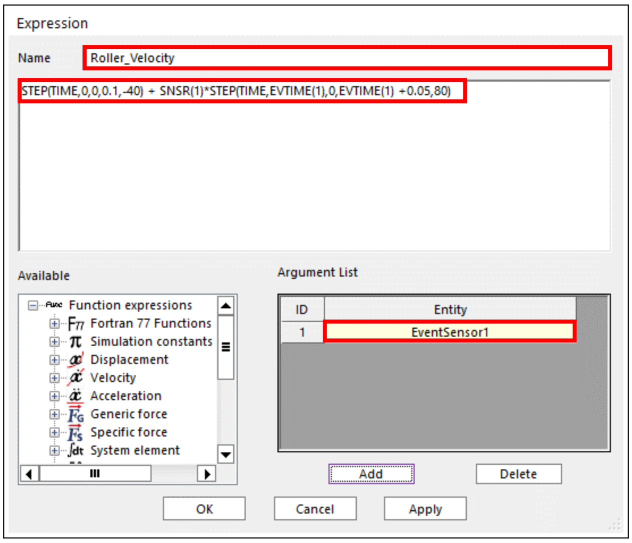
1. Click the **Event Sensor** icon, and use the **Point, Distance** creation method. In the Command Input window enter:
   - **-212.1, 117.6, 0** as the location.
   - **1.7** as the distance value.

Create an expression and assign it to RevJoint1:

1. Display the property dialog box for **RevJoint1**. (Tip: Make sure to right-click the RevJoint1 entry in the Database Window without having first selected it using a left-click. This will allow you to edit the revolute joint instead of the entire FixedRollerGroup.)
2. Select **Include Motion**.
3. Click **Motion**.
4. Change the second pull-down menu from **Displacement (time) to Velocity (time)**.
5. Click **EL (Expression List)**.
6. Click **Create**.
7. Type in the expression as provided above.
   - **STEP(TIME,0,0,0.1,-40) + SNSR(1)*STEP(TIME,EVTIME(1),0,EVTIME(1) +0.05,80)**

The roller velocity smoothly transitions from 0 to -40 radians per seconds. Between 0.00 and 0.05 seconds after the sensor is tripped the roller velocity smoothly transitions from -40 to 40 radians per second.

8. Change the name to **Roller_Velocity**.
9. Click **Add** to add a text box to the **Argument List**.
10. Drag the Event Sensor name (**EventSensor1**) from the database window into the text box in the Argument List.
11. Click **OK** to close the Expression window.
12. Click **OK** to close the Expression List window.

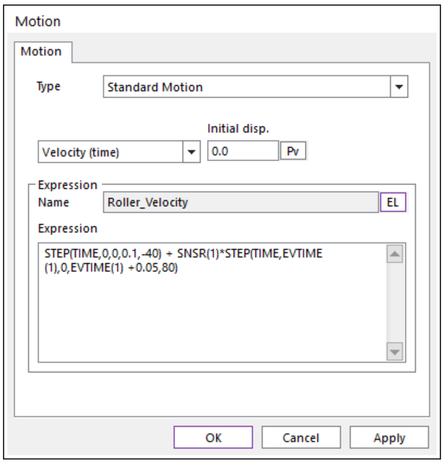


The Motion window should appear as shown in the figure to the right.

13. Click **OK** to close the Motion window.

14. Click **OK** to close the Joint window.

Note that when you specify the motion for the other roller you can reuse the same Motion Expression from the Expression List.



To assign an expression to RevJoint3:

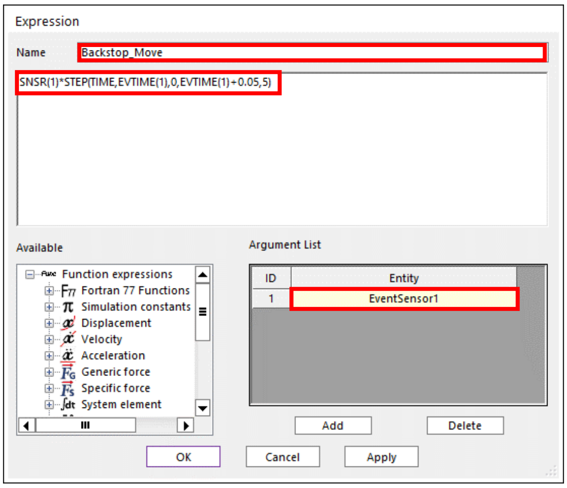
1. Follow the instructions for **RevJoint1** for **RevJoint3** but reuse the same **Motion Expression** from the **Expression List** instead of creating it again.
2. This would be a good time to save the model again.

Adding Logic to Move the Backstop Body

Use the event sensor to define the motion of the **Backstop** body in the same way as outlined for creating an expression for **TraJoint3**. The instructions are summarized below.

Add logic to move the Backstop body:

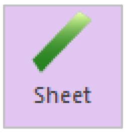
1. Open the properties dialog box of the translational joint and activate the motion.
2. Click **EL (Expression List)** and create a new expression.
3. Name the motion **Backstop_Move**.
4. Define the motion expression as shown below.
   - **SNSR(1)*STEP(TIME,EVTIME(1),0,EVTIME(1)+0.05,5)**
5. Click **Add** to add a text box to the **Argument List**.
6. Drag the **Event Sensor** name (**EventSensor1**) from the database window into the text box in the **Argument List**.



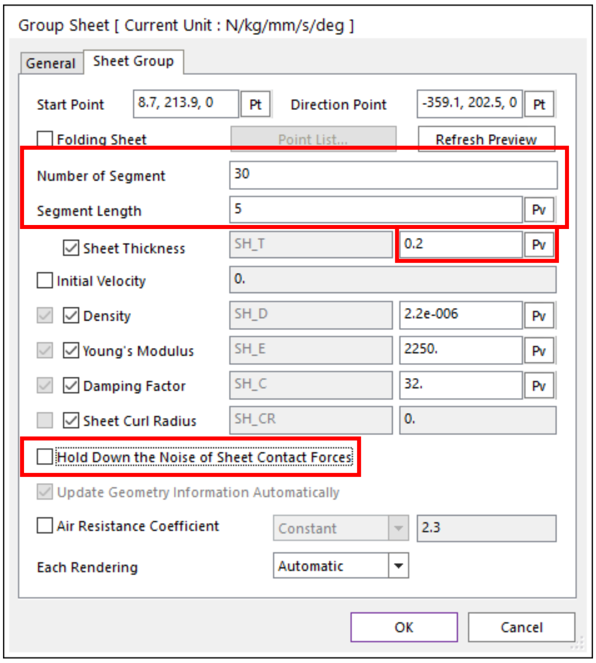
The Backstop body smoothly moves 5 mm into the paper path between 0.00 and 0.05 seconds after the sensor is tripped. Note that this is a **displacement (not velocity) motion**.

Creating the Sheet

To create the sheet:



1. In the **MTT2D** tab, click the **Sheet**.
2. Select the creation method **Point, Point, WithDialog**.
3. Click the two points shown below.
   - **Sheet Start Point: -378.7, 213.9, 0**
   - **Sheet End Point: -359.1, 202.5, 0**
4. Modify the Sheet Properties dialog box as needed to match the figure on the right, and then click **OK**.



Chapter

5

Running Simulation and Plotting Results

Task Objective

Learn how to run a simulation of the media transport model and plot the contact forces of several of the arc and linear guides.

Estimated Time to Complete

10 minutes

Running a Dynamic Simulation

To run a dynamic simulation:

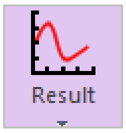
1. Click the **Dynamic/Kinematic** icon of the **Simulation Type** group in the **Analysis** tab.
2. Set:
   - **End time** to **0.55**.
   - **Number of steps** to **220**.
   - **Plot Multiplier Step Factor** to **5**.
3. Select **Hide RecurDyn during Simulation**.
4. Click **Simulate**.
5. Check the status of the simulation by placing the cursor over the **RecurDyn** icon in the task bar at the bottom of the screen. As you point at the icon it will report the percent completion of the simulation.

   The **RecurDyn** icon turns green as the simulation progresses and the RecurDyn window reappears when the simulation is complete. The simulation completes in less than a minute on a 2.4GHz or faster computer.

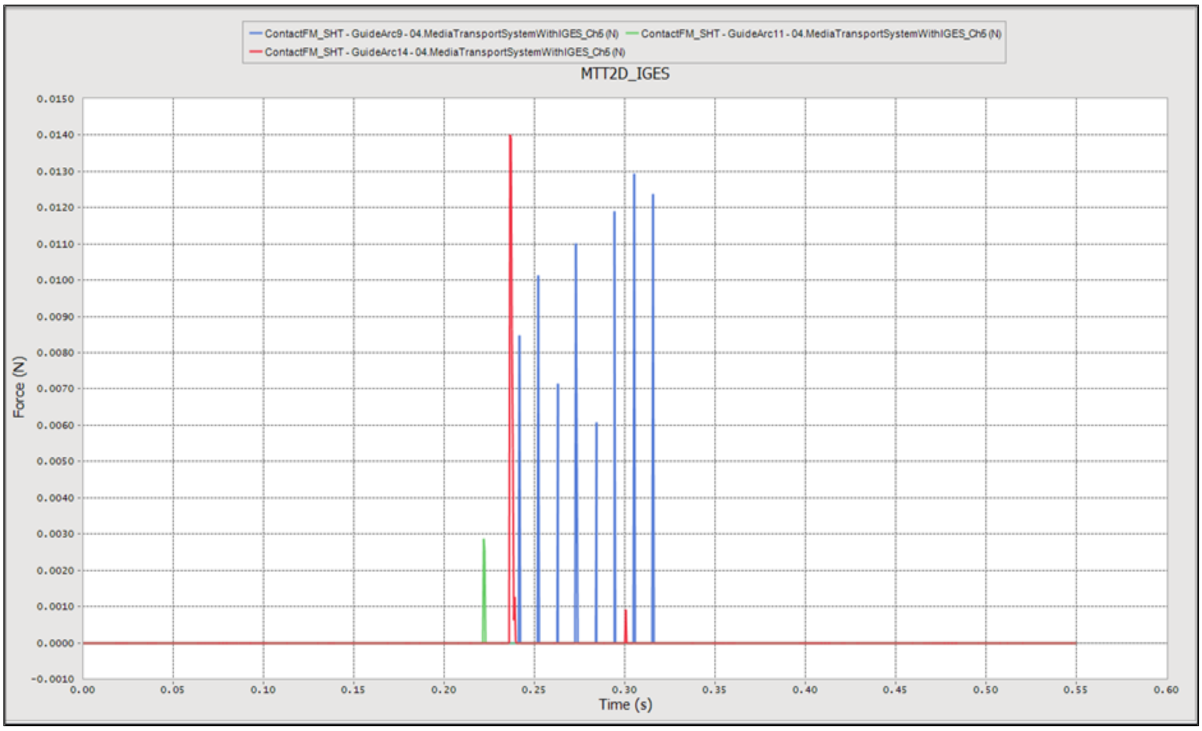
6. Animate the model using the **Play** button of the Animation Control in the Analysis tab. Note how the sheet reverses after the trailing edge passes the scan line. The backstop body moves into place and the roller pair drives the paper into the backstop body. The paper forms an arc as it hits the guides on the Backstop body, resulting in the pressure needed to register the paper. The paper might buckle or wrinkle if the roller pair tried to move the paper much further.

Plotting Results

To plot the output data:



1. Click the **Plot Result** icon of the **Plot** group in the **Analysis** tab.
2. In the database window on the right, expand the **Arc Guide** item.
3. Expand the **GuideArc9, GuideArc11**, and **GuideArc14** items.
4. In each section, double-click **ContactFM_SHT**.
5. Adjust the labels and axes so the plot looks like the one next.



Optional Analysis

1. (Optional) Studies of the performance of the MTT2D indicate that the most realistic results occur when the friction type for the sheet to roller contact is set as follows.

Component	Friction Type		
Driving Roller	Step	Linear	Linear
Driven (Passive) Roller	Step	Step	Linear
Results	(Default)	Better	Worse

   Display the Properties dialog box for each of the two fixed roller groups, click **To Sheet** and change the friction type to Linear. Rerun the simulation. Are the results improved?

2. (Optional) Display the Properties dialog box for the Sheet. Click **Hold Down the Noise of Sheet Contact Forces** and run the simulation again. Are the results improved?

You're done! Congratulations. By participating in this tutorial, you better understand the basics of working with the 2D Media Transport Toolkit (MTT2D).

Thanks for participating in this tutorial!