

# Media Transport System with IGES Import Tutorial (MTT2D)





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#### **Edition Note**

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

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# **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





# 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).



# **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**.

Start RecurDyn			×
New Model -			_
Name	Model1		
Unit	MMKS(Millimeter/Kilogram/Newton/Second)	Setting	
<u>G</u> ravity		Setting	
		<u>O</u> K	
Open Model		Browse	
Recent Mode	ls	Icons	•
Show 'Start	RecurDyn' Dialog when starting		

## 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.



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

Icon Control	×
Icon On/Off	
All Icons Joint Contact Contact Sensor Parametric Point Wall / Vessel All Markers Center Marker General Marker Inertia Reference Fr	ame
lcon Size	2
Marker Size	2
Marker Z-Axis Width	2.
Initial Velocity Icon Width	2.
Show Center Marker Ico	n .::

# **Importing the IGES Geometry**

#### To import the IGES geometry:

- **L**
- 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.

≷ CAD Import Options	×
Assembly Hierarchy	
Hierarchy Conversion Level	Body Subsystem
CAD Hierarchy Dialog	
IGES	
Healing	True
Translate Free Curves	True
Translate Free Surfaces	True
Convert Free Point to Marker	False
Import	Cancel

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**.



# **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

# **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



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







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

eneral Graphic Property Linear	Suide		
Guide Mother Body	MotherBod	У	В
Start Point	-224.555169	9738, 123.579036	503069, 0 Pt
Second Point	-244.185424	1986214, 134.9125	69518777, 0 Pt
Imaginary PEdge			
Edge	🗸 Start	$\checkmark$	End
Radius		2.	Pv
To Sheet			
Contact Direction	OUp	Own	Preview
Contact Parameter		To Sheet	
No. of Max Contact Points	GTS_MAXCF	10.	Pv
Force Display	Inactivate		

#### 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.



- 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.



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.

Properties of GuideArc3 [ Current L	Init : N/kg/mm/	's/deg ]	
General Graphic Property Arc Guide	:		
Guide Mother Body	MotherBody		В
Radius	1.99999999999999	993	Pv
Angle	72.7999999995	588	Pv
Center Point	-248.151957491	1, 144.70820162	277, 0 Pt
Direction to Start Point	-0.86602540378	8328, 0.4999999	999993264, Pt
Imaginary PEdge			
Edge	Start	🗌 End	
Radius	AG_IM_R	1.	Pv
To Sheet			
Contact Direction	© Up	O Down	Preview
Contact Parameter		To Sheet	
No. of Max Contact Points	GTS_MAXCP	10.	Pv
Force Display	Inactivate		•
L			
	ОК	Cancel	Apply

# **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:



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.



# **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.



# 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:

- Event
- 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**.
- 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.

<pre>ieP(IIME,0,0,0.1,-40) + SNSR(1)*SIEP(I</pre>	IME, EVTIME(1), 0, EV	TIME(1) +0.05,80)
	1110, E V 1111E(1), O, E V	(in E(i) - 0.05,00)
vailable	Argument Lic	
valiable	Argument Lis	it .
E		Entity
	ID 1	Entity EventSensor1
$ \begin{array}{c} \hline & \\ \hline \\ \hline$		Entity EventSensor1
$\begin{array}{c c} \hline & & \\ \hline \hline & & \\ \hline & & \\ \hline & & \\ \hline \hline \\ \hline \\$		Entity EventSensor1
→ Aver Function expressions ⊕ Fr 7 Fortran 77 Functions ⊕ T Simulation constants ⊕ D Siplacement ⊕ Z Velocity ⊕ Z Acceleration		Entity EventSensor1
Parable P		Entity EventSensor1
Pawe Function expressions ⊕ Fyr Fortran 77 Functions ⊕ Tyr Simulation constants ⊕ dy Violotly ⊕ dx Acceleration ⊕ Fx Generic force ⊕ Fx Specific force		Entity EventSensor1
→ Rwe Function expressions → Fry Fortran 77 Functions → T Simulation constants → D Displacement → D Siplacement → D Construction → Free Generic force → Free System element		Entity EventSensor1

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.

Tupe	Chandard Motion
type	Standard Motion
	Initial disp.
Velocity (	time) 🔻 0.0 Pv
Expression	n
Name	Roller Velocity EL
Expression	n
CTED/TIM	E 0 0 0 1 .40) + SNSP(1)*STEP/TIME EV/TIME
SILP(IIIVI	
(1),0,EVTI	ME(1) +0.05,80)
(1),0,EVTI	ME(1) +0.05,80)
(1),0,EVTI	WE(1) +0.05,80)
(1),0,EVTI	WE(1) +0.05,80
(1),0,EVTI	WE(1) +0.05,80

#### 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**.
- 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**.

SNSR(1)*STEP(TIME,EVTIME(1),0,EVT	AE(1)+0.05,5)
Available → Available → Try Fortran 77 Functions → TC Simulation constants → C Velocity → C Velocity → C Velocity → C Specific force → FG Specific	Argument List

# **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**.

Group Sheet [ Current Unit	: N/kg/mm/s/deg ]			
General Sheet Group				
Start Point 8.7, 213.9, 0	Pt Direction Point	-359.1, 202.5,	0 Pt	
Folding Sheet	Point List	Refresh Pre	view	
Number of Segment 30				
Segment Length	5		Pv	
Sheet Thickness	SH_T	0.2	Pv	
Initial Velocity	0.			
🗹 🗹 Density	SH_D	2.2e-006	Pv	
🗹 🗹 Young's Modulus	SH_E	2250.	Pv	
🔽 🗹 Damping Factor	SH_C	32.	Pv	
Sheet Curl Radius	SH_CR	0.		
Hold Down the Noise of	Sheet Contact Forces			
Update Geometry Information Automatically				
Air Resistance Coefficient Constant  2.3				
Each Rendering				
		ок	ancel	

# 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

# **Running a Dynamic Simulation**

#### To run a dynamic simulation:



Result

- 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!