

Altair MotionView 2019 Tutorials

MV-8100: Tire Modeling

altairhyperworks.com

MV-8100: Tire Modeling

Introduction

The tire models describe the interface between the wheel and the road. For this tire interface, the tire parameters and properties are set by a Tire Property File with the extension (.tir) while the road interface is described by a Road Property File with the extension (.rdf). One Body, one Point, and two Marker connections are needed to define the tire interface. In addition, physical properties of the tire such as the unloaded radius, aspect ratio, width, mass, and moment of inertia's that need to be specified. The purpose of this tutorial is to show the process of how to build a tire model in the MotionView interface and to interpret the results. In this tutorial, you will learn how to:

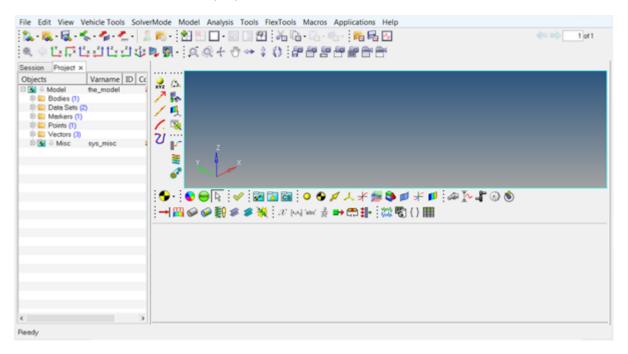
- Launch MotionView and load the MBD-Vehicle Dynamics Tools preference file
- Build a Tire model
- Run the model in MotionSolve
- View the simulated results

Step 1: Launching MotionView.

To build an AutoTire entity, you must first load the **MBD-Vehicle Dynamics Tools** preference file in MotionView. Once loaded, HyperWorks remembers and automatically loads the **MBD-Vehicle Dynamics Tools** preference file each time you start HyperWorks. To load the **MBD-Vehicle Dynamics Tools** preference file follow the steps below.

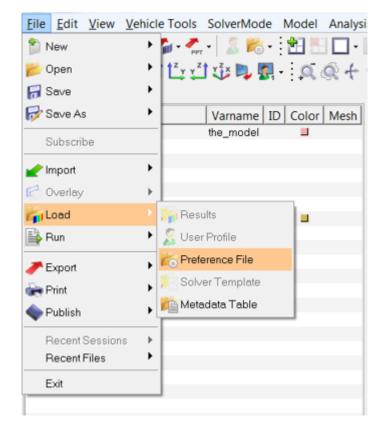
1. Start a new MotionView session.

The MotionView window is displayed.



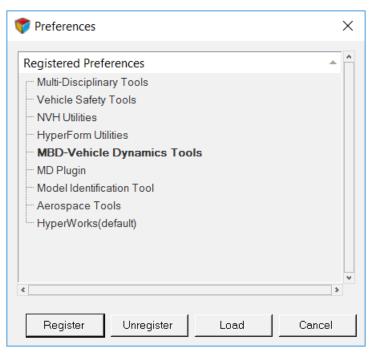






The **Preferences** dialog is displayed.

3. From the **Preferences** dialog, select *MBD-Vehicle Dynamics Tools* and click *Load*.



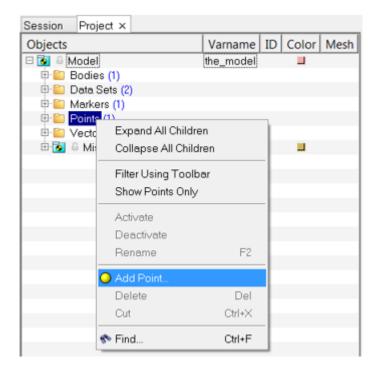


Step 2: Building a Tire Model.

Follow the steps below to create a tire model in the MotionView interface.

Adding a Point to the Model

1. Create a point for the model by right-clicking the **Points** folder in the **Project** browser. Click on the **Add Point** option from the context menu.



The Add Point or PointPair dialog is displayed.



2. Enter Wheel CM as the Label and p_wheel_cm as the Variable and click OK.

🛆 Add P	Point or PointPair	x
	System Model Wheel CM p_wheel_cm	
Type:	le	
Comment	(Optional):	
	OK Apply Car	ncel

The Wheel CM point is added in the Project browser.

Objects	Varname	ID	Color	Mesh
🗆 😼 🖨 Model*	the_model			
🕂 😜 Bodies (1)				
🕀 🚞 Data Sets (2)				
🕀 😜 Markers (1)				
🖻 📂 Points (2)				
Global Origin	P_Global_Origin	0		
	p_wheel_cm	0		
🕂 🚞 Vectors (3)				
🗄 🔂 🖨 Misc	sys_misc			

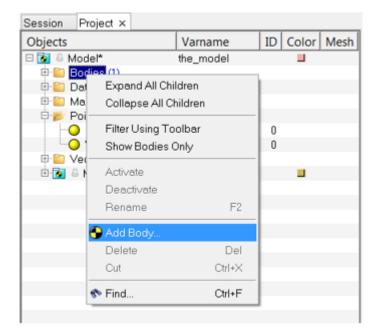
3. Enter the value of 313 for **Z** coordinate in the **Properties** tab as shown in the image below.

+ -	p_wheel_cm	X V Ja			
Properties Measure	Coordinates: × 0.0000 Y: 0.0000 Z: 313.0000	Get coordinates from node:	Node X: Y: Z:	Unresolved	Data Summary



Adding a Body to the Model

4. Create a Hub body by right-clicking the **Bodies** folder in the **Project** browser. Click on the **Add Body** option from the context menu.



The Add Body or BodyPair dialog is displayed.

5. Enter Hub as the Label and b_hub as the Variable and click OK.

🛆 Add Body or BodyPair							
Parent System Model Label: Hub Variable: b_hub							
Type: Single Body Pair Comment (Optional):	•						
QK Apply Q	ancel						



6. The **Hub** body is added in the **Project** browser.

Session	Project ×					
Objects			Varname	ID	Color	Mesh
🗆 💽 🔒 M	fodel*		the_model			
🖹 🖗 📂 E	Bodies (2)					
	Ground B	ody	B_Ground	0		1
	Hub		b_hub	0		÷.
🕀 📔 Data Sets (2)						
🖻 🔛 N	Aarkers (1)					
📄 🕀 📂 F	Points (2)					
- (Global Or	igin	P_Global_Origin	0		
	Wheel CN	1	p_wheel_cm	0		
😐 🗎 🔪	/ectors (3)					
😐 💽 (Misc		sys_misc			

7. Click on the **CM Coordinates** tab of the **Hub** body to use the wheel center as the center of this body. Select the **Use center of mass coordinate system** check box.

-		b_hub X V fm
9.	Properties	Vse center of mass coordinate system
	CM Coordinates	I Ose center of histor containate system
	Inertia Coordsys	
	Body Coordsys	
	Initial Conditions	Orient two axes
		Origin: Z Axis
		Point Unresolved DxDyDz 0.000, 0.000, 1.000

8. Double click the *Point* collector button in the panel area.

Properties	✓ Use center of mass coordinate system	m
CM Coordinates	i ose center or mass coordinate system	
Inertia Coordsys		
Body Coordsys		
Initial Conditions		Orient two axes
	Oriain:	Z Axis
\rightarrow	Point Unresolved	DxDyDz 0.000, 0.000, 1.00

The **Select a Point** window opens. Select the **Wheel CM** point and click **OK**.

🛆 Select a Point	X
p_wheel_cm ✓ Only show entities within valid scope ● Filename Data ● Pilename Data ● Option Data ● Points ● Bodies ● Markers ● Data Sets ● Misc	Global Origin Wheel CM
	OK Cancel

The wheel center is used as the center of the hub body.

Properties	✓ Use center of mass coordinate system	n	
CM Coordinates	i ose center or mass coordinate system		
Inertia Coordsys			
Body Coordsys			
Initial Conditions		Orient two axe	s 🗾
	Origin:		Z Axis
	Point Wheel CM	▼ DxDyDz	0.000, 0.000, 1



Updating Mass and Inertia Properties of the Hub Body

9. From the **Properties** tab enter the following data as shown in the image below to set the mass and inertia of the hub body.

•	b_hub X	J f≈		
Properties	Flex Body (CMS)	C Get Prop	erties from associated Graphic(s)	
CM Coordinates	I Hex Body (civilo)	i detriop		
Inertia Coordsys				
Body Coordsys		Inertia prop	erties:	
Initial Conditions		boc	1.0000e+14 by:	0.0000
		lyy:	2.0000e+14 bz:	0.0000
	Mass: 380	.0000 lzz:	1.0000e+14 lyz:	0.0000

Setting Initial Conditions to the Hub Body

10. Enter the following data in the **Initial Conditions** tab as shown in the below image to set the initial conditions.

Properties CM Coordinates Inertia Coordsys Body Coordsys Initial Conditions	b_hub X √ Translational velocity Image: Comparison of the compa	_Fx Rotational velocity ₩ Wx 0.0000 ₩ Wy: 65.0000 ₩ Wz: 0.0000	Use VM <u>Market</u> Unresolved Use VM <u>Market</u> Unresolved	

Note These initial conditions applied at the Hub body represent a tire+rim with an initial forward velocity **Vx** of *20000mm/s* and rotating at *65rad/s*.

Adding a Marker to the Model

11. Right-click on the *Markers* folder in the **Project** browser and click on the *Add Marker* option from the context menu.

Session Project	×				
Objects		Varname	ID	Color	Mesh
🗆 💽 🕒 Model*		the_model			
🕀 📔 Bodies (
🕀 📔 Data Set					
B-⊯ Markers , Gl	Expand All Chi	Idren	b		
Points	Collapse All Cl		ľ		
B Vecto	Collapse All C	lindren	-1-		
🕀 💽 🖨 Mis	Filter Using To	olbar			
	Show Markers	Only			
	Activate				
	Deactivate				
	Rename	F2	Ŀ		
	Add Marker				
	Delete	Del			
	Cut	Ctrl+X			
8	Find	Ctrl+F			

The Add Marker or MarkerPair dialog is displayed.



12. Enter Tire Reference Marker as the Label and m_tire_ref as the Variable and click *OK*.

🛆 Add	Marker or MarkerPair
Parent	System Model
Label:	Tire Reference Marker
Variable:	m_tire_ref
Type: G Sing C Pair	
Commen	t (Optional):
	OK Apply Cancel

13. The **Tire Reference Marker** is added in the **Project** browser.

Session Project ×				
Objects	Varname	ID	Color	Mes
🗆 🚺 🔓 Model*	the_model			
🕀 😜 Bodies (2)				
🕀 📔 Data Sets (2)				
🖻 📂 Markers (2)				
	Global_Frame	0		
	m_tire_ref	0		
🕀 😜 Points (2)				
🕀 🚞 Vectors (3)				
🗄 🔂 🖨 Misc	sys_misc			

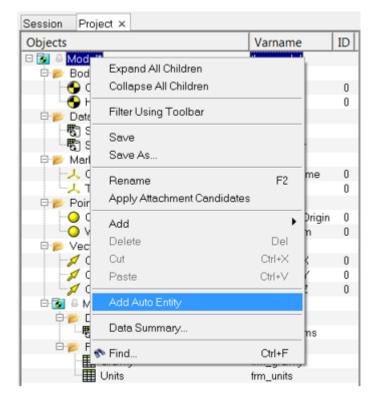
14. Use the **Body** and **Point** collector buttons in the **Properties** tab in the panel area to define the attachments for the marker by selecting the *Hub* as the body and *Wheel CM* as the origin.

Properties	Floating marker	Parent: Body Hub	
			Orient two axes
		Origin: Point Wheel CM	Z Axis DxDyDz 0.000, 0.



Adding an AutoTire Entity to the Model

15. Right-click on the *Model* in the **Project** browser and select *Add Auto Entity* from the context menu.



16. The Add Entity window opens.

🛆 Add Entity	-				**
	ystem Model				
Variable: ts_0					
Type:	AutoSpring	•			
Note (Literal):					
₹.					•
			0K	Apply	Cancel



17. Select the *AutoTire* entity from the drop-down menu and click *OK*.

🛆 Add Entity	10,000	-			x
Parent: Sy Label: AutoTir Variable: ts_0	stem Model				
Type: Single Pair Note (Literal):	AutoTire AutoReboundStop AutoCTITire AutoCDTire AutoMFTire AutoTire	•			* *
		0	K	Apply	Cancel

18. The **AutoTire** panel is displayed in the panel area and the added auto entity is created in the **Project** browser.

Session	Project ×					
Objects			Varname	ID	Color	Mes
🗆 💽 🔒 M	odel*		the_model			
	utoTires (1)					
-0	AutoTire (D	ts_0			
🖹 🕀 📂 B	lodies <mark>(2)</mark>					
-6	Ground B	ody	B_Ground	0		
	Hub 🖌		b_hub	0		
🕀 📔 🖸)ata Sets <mark>(2</mark>)					
🖻 📂 M	farkers <mark>(2)</mark>					
	Global Fra	ame	Global_Frame	0		
L	🗸 Tire Refe	rence Marker	m_tire_ref	0		
🕀 🔛 P	oints (2)					
🖻 🗎 V	ectors (3)					
😟 - 🔂 🖇	Misc		sys_misc			
1						



19. From the **Connectivity** tab select the **Hub Body** as **Hub**, **Wheel Center** point as **Wheel CM**, **Tire Marker** as **Tire Reference Marker**, and **Road Marker** as **Global Frame** to define the tire interface as shown in the image below.

(-)	ts_0 × √ fn	
Property Files	Hub Body Hub	
	Wheel Center Wheel CM	
	Tire Marker Tire Reference Marker	
	Road Marker Global Frame	Help

- Note The AutoTire is defined by a **Hub Body**, **Wheel Center**, **Tire Marker**, and **Road Marker** where:
 - Hub Body: The wheel body on which the tire forces act.
 - Wheel Center: Point where the tire will be attached, usually the wheel center.
 - **Tire Marker**: Reference marker which determines the direction in which the tire forces act.
 - **Road Marker**: Reference marker of the road, it is the marker with respect to which the road is positioned and oriented for the simulation.
- 20. The Tire model is displayed in the MotionView graphics area.





p.12

21. From the **Property Files** tab, review the tire properties.

4-		b_0	X J fa								
	Connectivity Property Files	Tire Property File:	C: VProgram Files VAI	tair\2017.0.0.21	\\w/md\autoentities/gro	operties/Tires/MF	SWIFT\TND_0	Edit File	Road Property	File: 🧭 C.VProgram Files/Witair\2017.0.0.21	www.dvautoentities/groperties/Time Edit File
		Unloaded Radius:	313.5000	Wheel Mass:	36.0000	Hub Offset:		0.0000			
		Tire Widh:	205.0000	Wheel DQC	1.7500e+06	Wheel CM offse	e 🗌	0.0000	Method	20	Generate Road Graphics
		Aspect Ratio:	0.6000	Wheel M1:	3.0000e+06	Tire Role:	front		Road Type: Function Name	FLAT	Help
		Tire Side:	leit 💌	Wheel IZZ:	1.7500e+06	VARSUB Switch	t Off	Ψ	1 0100011100		

The AutoTire entity allows you to modify the tire properties as desired by editing the **Tire Property File**.

The graphic tire representation can be modifying by editing the properties field, such as **Unloaded Radius**, **Tire Width**, **Aspect Ratio**, and **Hub Offset**. Once the tire property file is loaded, some of the fields will automatically get filled.

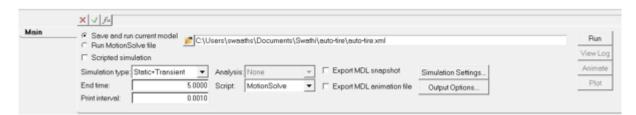
Note Changing the value in entry field will not change the values in tire properties file. These entry fields are meant to create tire graphic.

If you want to make changes to the file using the **Edit File** button, it is recommended that you save it with a different name and reload the file so that the graphic attributes get automatically filled in the graphical user interface.

Step 3: Running the Model in MotionSolve.

Once the tire model is created, it is now ready to run.

- 1. Save your model as Auto-Tire.mdl.
- 2. Click on the **Run Solver** toolbar icon ¹⁰⁰, and rename the MotionSolve input to Auto-Tire.xml.
- 3. Select the **Static + Transient** option from the **Simulation** type drop-down menu and enter 0.001 in the **Print interval** field.



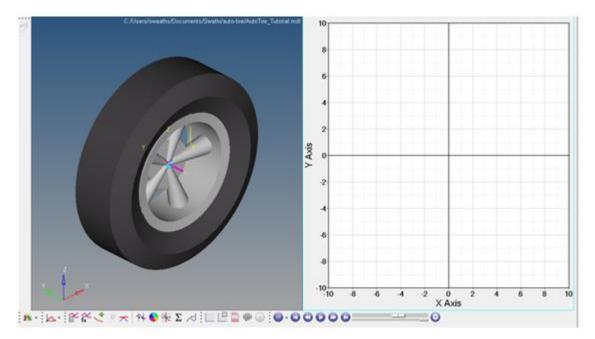
- 4. Click the *Run* button.
- 5. After the MotionSolve is complete, the **View Log**, **Animate**, and **Plot** buttons are enabled. These buttons allow you to plot results, look at an animation, or examine tabular results.



Step 4: Viewing the Simulated Results.

1. Click the **Plot** button to view the simulation results.

The plot is displayed in the second window (on the right).



2. Click anywhere in the plot window and click on the *Expand/Reduce* button from the toolbar.



3. The plot window is expanded.



4. The AutoTire entity automatically creates tire outputs based on the simulation, which can be accessed from .plt file as shown below.

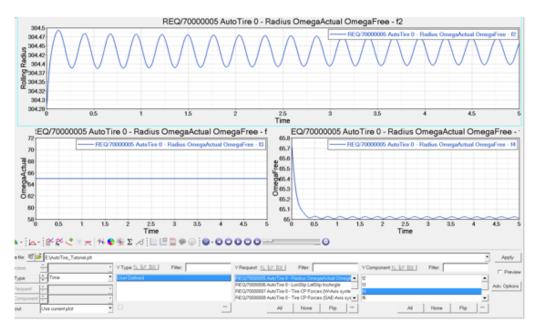
Detatile: 10	E (AutoTine_Tutorial.pit							-	Apply
Subcese:	÷	 YType: <u>1. UP [1]</u> 	Filec	YRequest 11. [17 [1]]	Filec	Y Component 11, 117 [11]	Filter:		P Preview
ХТуря:	Time	User Defined			Radius OmegaActual Omega	• 2		-	
XRequest.	+	0		REQ/20000006 AutoTire 0 -	Tire CP Forces (W-Axis syste	N 10			Adv. Options
× Component	÷	•		REQ/7000008 AutoTire 0 -	Tire CP Forces (SAE-Axis sys)	• 6		*	
Leyout	Use current plot	-		Al	None Flip **	AI	None Flip		

Output Plots:

Different output plots based on the simulation are explained briefly below.

• REQ/70000005 Auto Tire0 – Radius OmegaActual OmegaFree

- $_{\odot}$ f2 Radius Rolling radius of the tire.
- \circ f3 OmegaActual Angular velocity of the tire.
- $\circ\,$ f4 OmegaFree Angular velocity at which the tire will be having a zero slip ratio.



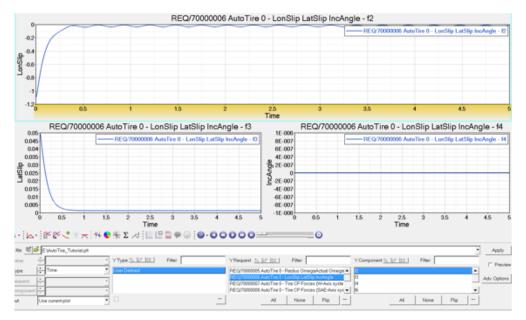




• REQ/70000006 Auto Tire0 – lonSlip latSlip IncAngle

The following outputs are available in both ISO and SAE co-ordinate systems. The one shown in plots are in ISO.

- $_{\odot}$ f2 LonSlip Slip Ratio or Longitudinal slip in percentage. In this case the tire is rolling freely therefore the slip ratio is approximately 0.
- $_{\odot}$ f3 LatSlip Lateral slip starts from 0.05 as lateral slip is the ratio of Vy and Vx. In our case Vy/Vx = 1000/20000 = 0.05
- $_{\circ}$ f4 IncAngle Inclination Angle of the tire from XZ plane.



• REQ/70000007 Auto Tire0 – Tire CP Forces (W-Axis system)

The Tire contact patch forces are available in both W and SAE axis system. The one shown in plots are in W-axis System.

