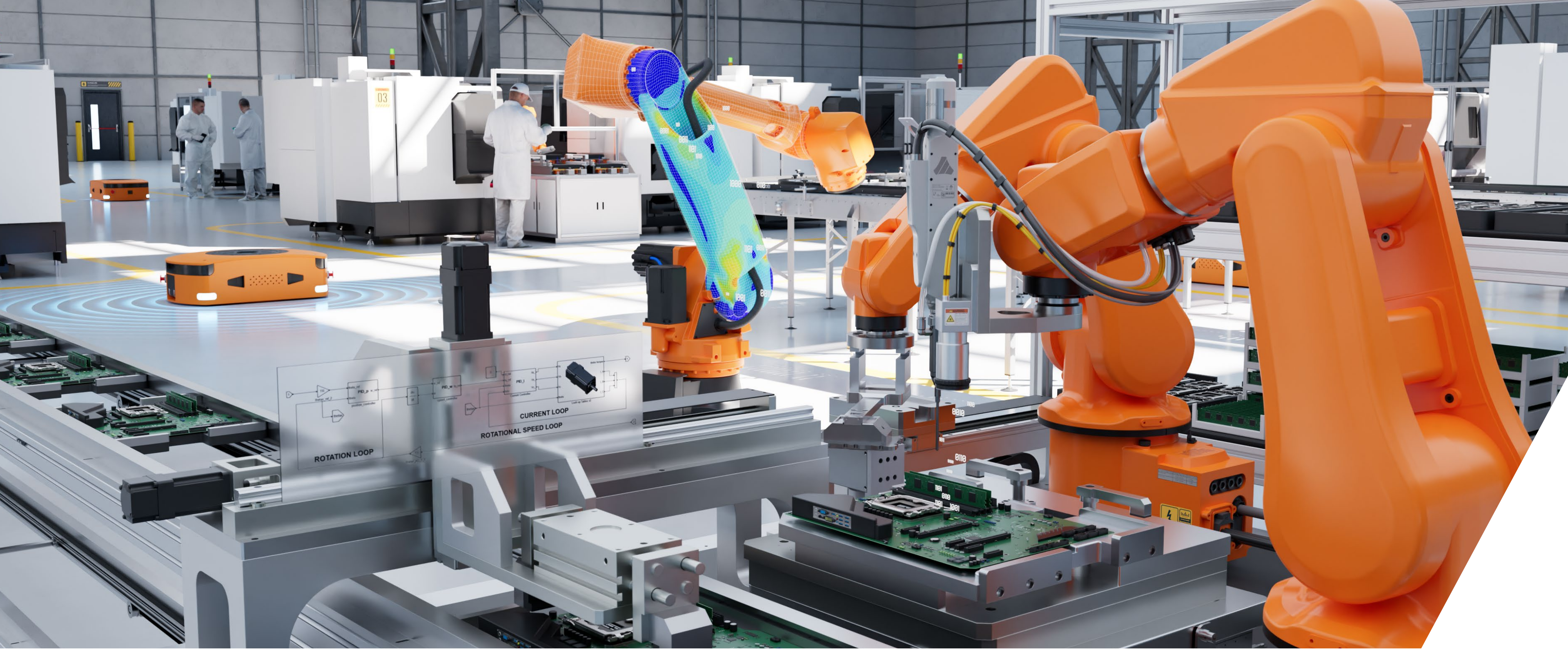

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MULTIBODY SOLUTIONS 2025

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HIGHLIGHTS

Motion Solutions

1 Inspire Motion

시스템 평가 및 개선을 위한 DOE 및 최적화 기능 지원
유연체, 접촉, FMU 관련 기능 강화

2 Motion View / MotionSolve

FRA, 케이블 모델링, 실시간 해석 등 다물체 동역학 해석 기능 강화

3 Motion Vertical

Jupyter 기반 리포트 및 그래프 시각화를 통한 결과 분석 지원
타이어 모델 기능 강화 및 신규 Output 추가

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INSPIRE MOTION

2024.1

Design Exploration

WHY?

- Optimize components and moving systems for best overall performance

HOW?

- **Variables** – various motion entities such as motor speed, actuator velocity, or spring-damping rates. Part shape parametrics are best controlled through sketches
- **Responses** - monitor outputs coming from specific entities
- **Objectives** and **Constraints** - optimize for the ideal Response conditions, or understand behavior within Response boundaries

1. Define Variables

Name	Active	Type	Value	Min	Max	Mode	Preview
Hole_Dist	✔	Length	80.0 mm	30.0 mm	120.0 mm	Continuous Variable	
Spring_K	✔	Stiffness	2.5 N/mm	2.0 N/mm	3.0 N/mm	Continuous Variable	

2. Define Responses

Name	Active	Response Type	Component	Request Type	Set Type
T_MAX	☑	Motion	Torque	Maximum	Motor

3. Define Objectives and Constraints

Active	Type	Response	Expression	Bound Value
☑	Objective	T_MAX	Minimize	N/A
☑	Constraint	T_MAX	>=	500.0 N*mm
☑	Constraint	T_MAX	<=	575.0 N*mm

4. Solve and View Results

Results Explorer

Exploration Name: Optimization_2 Type: Optimization

Summary | Evaluation | Iteration | Scatter Plot

	K1	D1	Joint_ANG_DISP	ANG_VEL	Objective_1	Objective_2	Constraint_1	Constraint_2	Constraint_3	Constraint_4	Co
Run 42	28.613 N/mm	35.93 N*s/…	-75.976 deg	1.331 rad/s	-75.976 deg	1.331 rad/s	-75.976 deg	1.331 rad/s	1.331 rad/s	-75.976 deg	Feasi
Run 43	29.22 N/mm	35.605 N*s/…	-76.88 deg	1.372 rad/s	-76.88 deg	1.372 rad/s	-76.88 deg	1.372 rad/s	1.372 rad/s	-76.88 deg	Feasi
Run 44	28.09 N/mm	35.938 N*s/…	-75.2 deg	1.299 rad/s	-75.2 deg	1.299 rad/s	-75.2 deg	1.299 rad/s	1.299 rad/s	-75.2 deg	Feasi
Run 45	35.159 N/mm	24.054 N*s/…	-84.335 deg	2.148 rad/s	-84.335 deg	2.148 rad/s	-84.335 deg	2.148 rad…	2.148 rad/s	-84.335 deg	Violat
Run 46	40.31 N/mm	33.02 N*s/mm	-88.779 deg	2.078 rad/s	-88.779 deg	2.078 rad/s	-88.779 d…	2.078 rad…	2.078 rad/s	-88.779 deg	Violat
Run 47	29.784 N/mm	35.929 N*s/…	-77.628 deg	1.397 rad/s	-77.628 deg	1.397 rad/s	-77.628 deg	1.397 rad/s	1.397 rad/s	-77.628 deg	Feasi
Run 48	30.043 N/mm	35.886 N*s/…	-77.983 deg	1.414 rad/s	-77.983 deg	1.414 rad/s	-77.983 deg	1.414 rad/s	1.414 rad/s	-77.983 deg	Feasi
Run 49	27.329 N/mm	35.665 N*s/…	-74.058 deg	1.262 rad/s	-74.058 deg	1.262 rad/s	-74.058 deg	1.262 rad/s	1.262 rad/s	-74.058 deg	Feasi
Run 50	28.093 N/mm	35.842 N*s/…	-75.215 deg	1.301 rad/s	-75.215 deg	1.301 rad/s	-75.215 deg	1.301 rad/s	1.301 rad/s	-75.215 deg	Feasi

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Design Exploration

Latch Mechanism – spring sensitivity DOE

Objectives:

- Minimize motor actuation torque

Constraints:

- Angle of grey part must exceed 3 deg of rotation

Responses:

- Rotation of grey part

Variables:

- Spring Stiffness

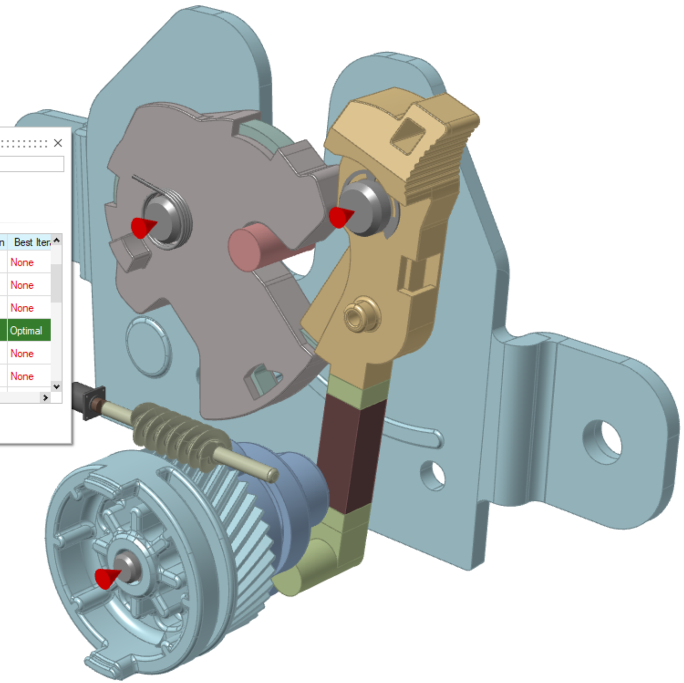
Results Explorer

Exploration Name: Optimization_1 Type: Optimization

Summary | Evaluation | Iteration | Scatter Plot

	R1	ANGLE	SPRING_TORQUE	Objective_1	Constraint_1	Constraint_2	Condition	Best Iter
Run 19	2.548 N*mm/rad	168.702 deg	7.644 N*mm	7.644 N*mm	168.702 ...	168.702 deg	Violated	None
Run 3	3.051 N*mm/rad	132.53 deg	9.152 N*mm	9.152 N*mm	132.53 d...	132.53 deg	Violated	None
Run 14	3.501 N*mm/rad	45.687 deg	10.504 N*mm	10.504 N*mm	45.687 d...	45.687 deg	Violated	None
Run 20	3.834 N*mm/rad	0.315 deg	11.503 N*mm	11.503 N*mm	0.315 deg	0.315 deg	Feasible	Optimal
Run 18	3.854 N*mm/rad	0.286 deg	11.562 N*mm	11.562 N*mm	0.286 deg	0.286 deg	Violated	None
Run 16	3.936 N*mm/rad	0.249 deg	11.809 N*mm	11.809 N*mm	0.249 deg	0.249 deg	Violated	None

Compare



~ 25 min for 20 iterations

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2024.1

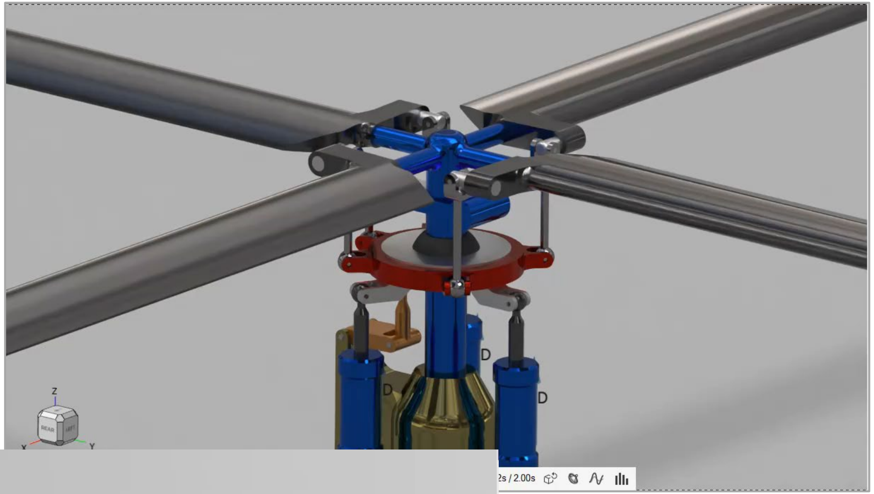
Animation playback using Quality rendering

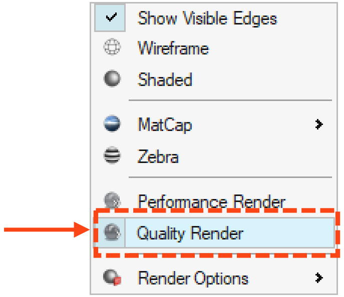
WHY?

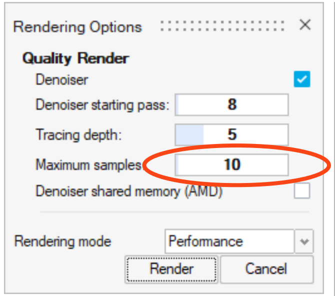
- Generate professional-looking animations

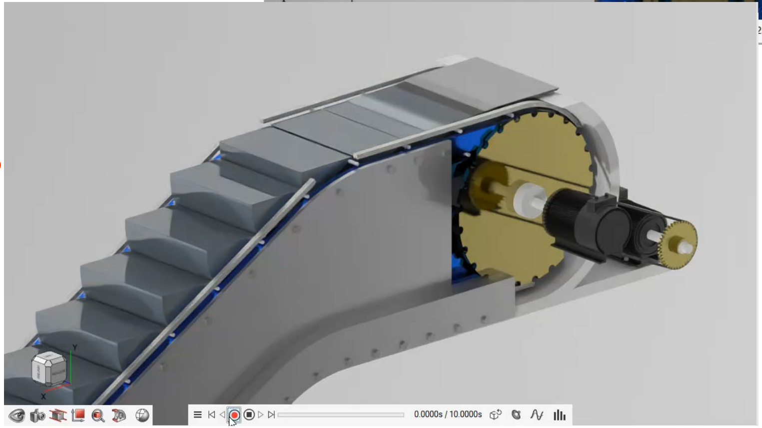
HOW?

- After solving a motion analysis, set the render mode to Quality Render
- Use the record button on the motion animation play bar to record a rendered video
- Maximum Samples can be adjusted for finer resolution









Results stored in: Documents/Altair/captures

2024.1

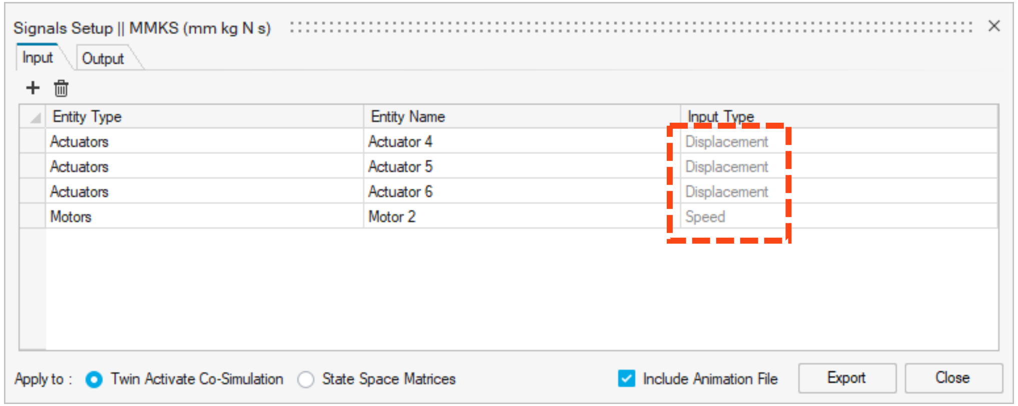
Additional input signals support for Twin Activate

WHY?

- Expands use case potential by giving users more freedom in controlling multibody plant model inputs

HOW?

- Twin Activate now supports all motor and actuator input types, such as Angle, Speed and Velocity (previously force and torque only)



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2024.1

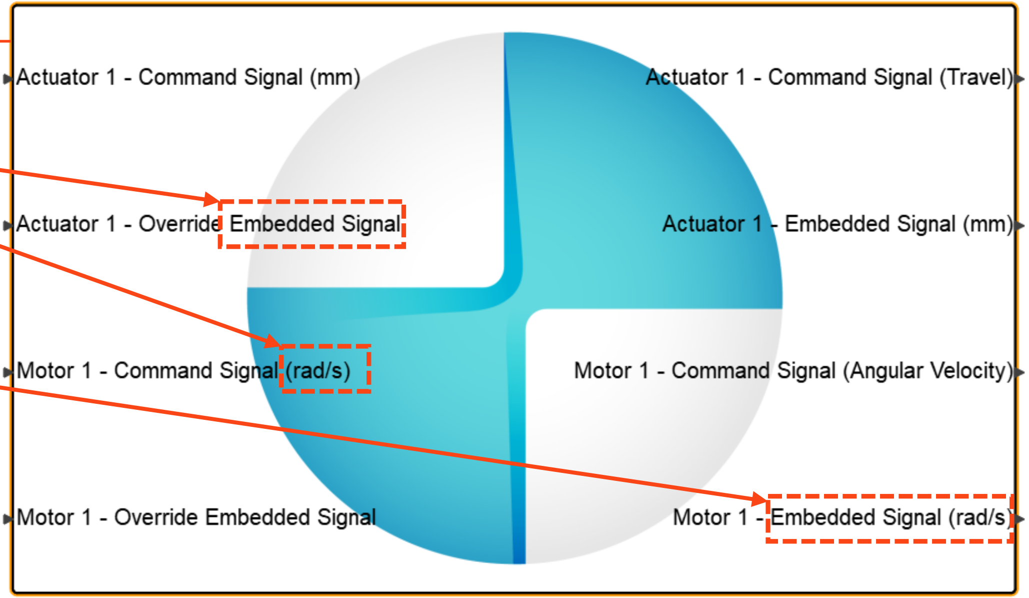
Improved multibody plant representation in Twin Activate

WHY?

- Improved visual representation for easier understanding

HOW?

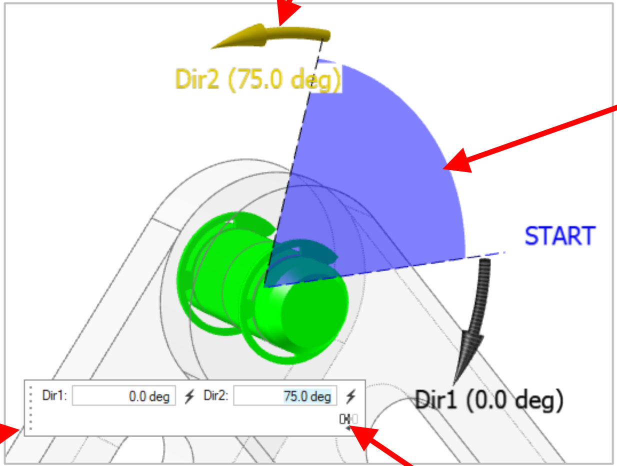
- Signals embedded within the plant versus the command signals supplied by the user are better distinguished
- Unit labels next to inputs and outputs
- Outputs for Embedded signals automatically generated when output for main input signal is created

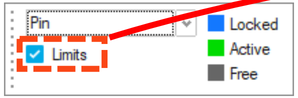


2025

Joint Limits

WHY?	• Define limiting boundaries to how far a joint is allowed to translate or rotate, without the need for geometry and motion contact
WHAT?	• Stiffness and damping impact properties defined through Property Editor • Plot resulting Limit force or Torque
HOW?	• Defined through the joint micro dialog • Select the manipulator arrows to activate micro dialog for turning limits on/off and setting values • Manipulator size based on joint graphic size.





Currently, all Inspire Motion joint types supported except Ball & Socket

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2025

Flex Bodies of Rigid Groups

WHY?

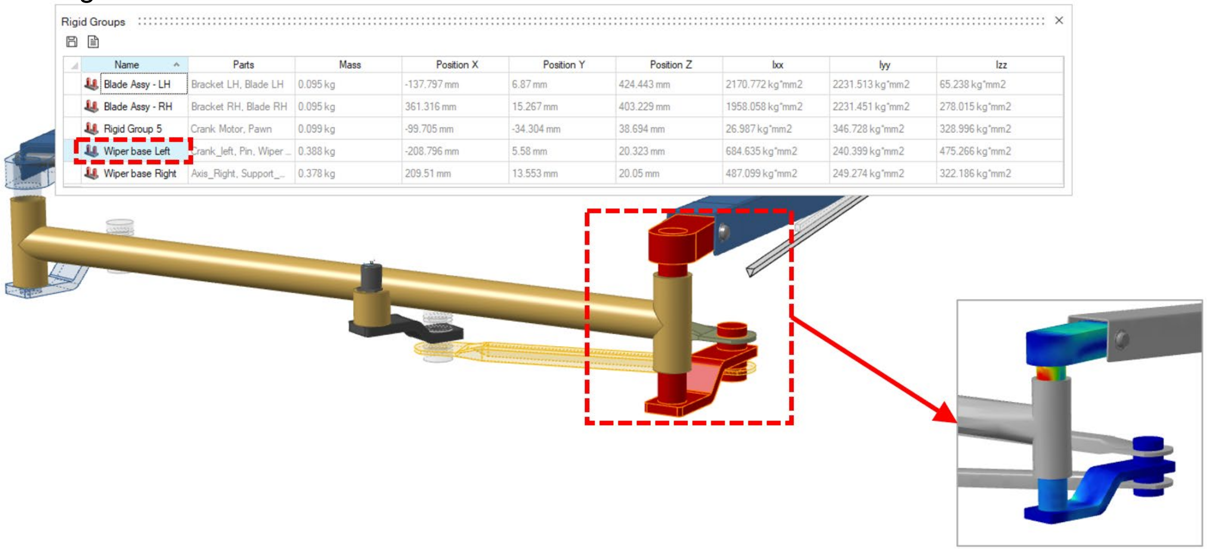
- Quickly and easily flexify Rigid Groups

WHAT?

- Each part can have its own material properties
- Message pre-warns to check for gaps and/or interferences between rigid group parts

HOW?

- Individual parts of the Rigid Group are rigidly bonded together



Name	Parts	Mass	Position X	Position Y	Position Z	Ixx	Iyy	Izz
Blade Assy - LH	Bracket LH, Blade LH	0.095 kg	-137.797 mm	6.87 mm	424.443 mm	2170.772 kg*mm2	2231.513 kg*mm2	65.238 kg*mm2
Blade Assy - RH	Bracket RH, Blade RH	0.095 kg	361.316 mm	15.267 mm	403.229 mm	1958.058 kg*mm2	2231.451 kg*mm2	278.015 kg*mm2
Rigid Group 5	Crank Motor, Pawn	0.099 kg	-99.705 mm	-34.304 mm	38.694 mm	26.987 kg*mm2	346.728 kg*mm2	328.996 kg*mm2
Wiper base Left	Crank_left, Pin, Wiper ...	0.388 kg	-208.796 mm	5.58 mm	20.323 mm	684.635 kg*mm2	240.399 kg*mm2	475.266 kg*mm2
Wiper base Right	Axis_Right, Support_...	0.378 kg	209.51 mm	13.553 mm	20.05 mm	487.099 kg*mm2	249.274 kg*mm2	322.186 kg*mm2

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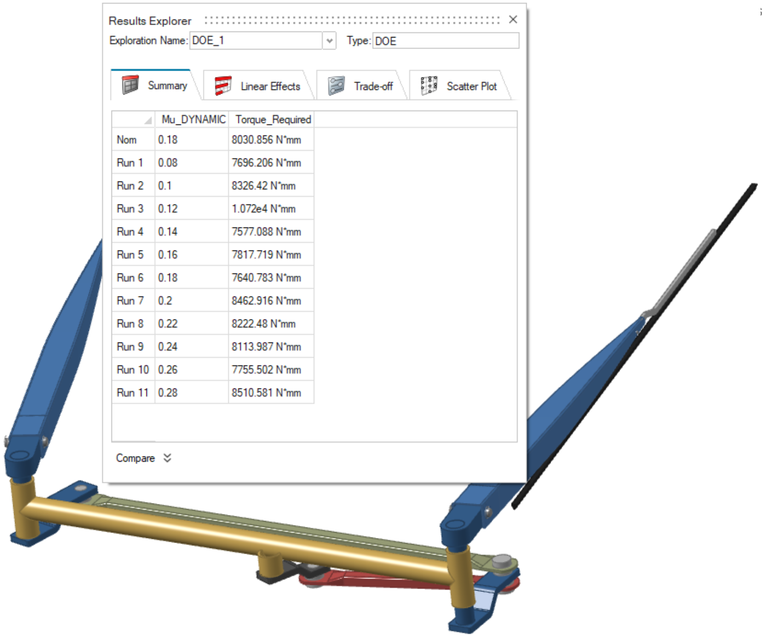
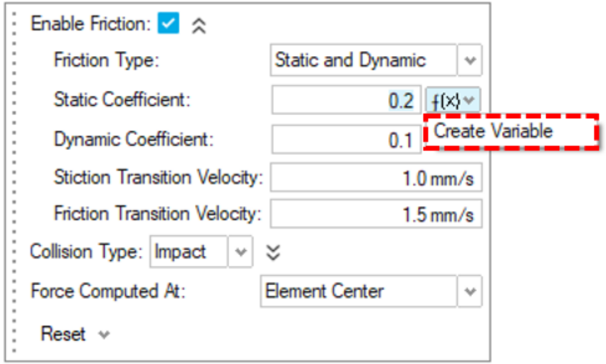
2025

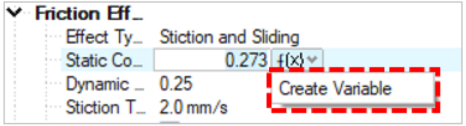
New Design Variables

WHY?	• Quickly check sensitivity of model performance to changes in friction properties
WHAT?	• Static and Dynamic Contact friction coefficients • Static and Dynamic joint friction coefficients
HOW?	• Contact friction defined through Contact properties micro dialog • Joint friction defined through Property Editor





Contact Friction Coefficients



Joint Friction Coefficients

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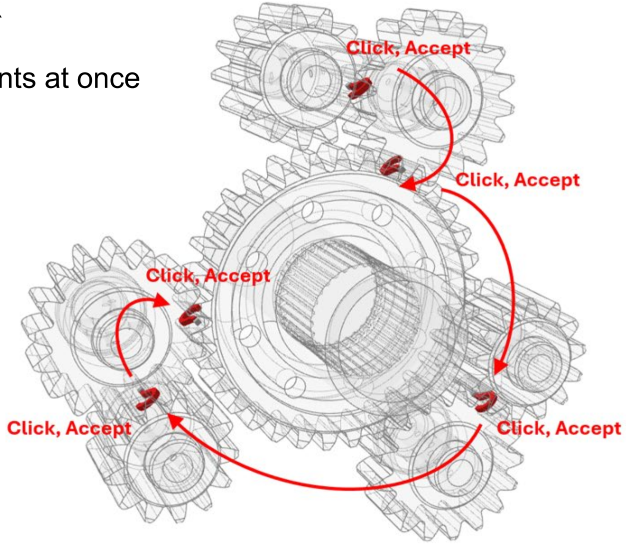
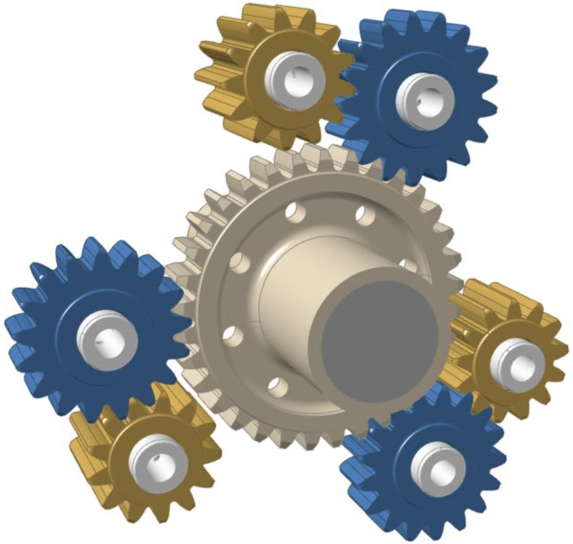
2025

Define Motion Contacts at Free Joints

WHY?	• Quickly add multiple contact joints based on pre-detected Free Joints
HOW?	• Set Contacts find filter, click on free joint, click accept, repeat… OR • Box-select all free joints at once





2025

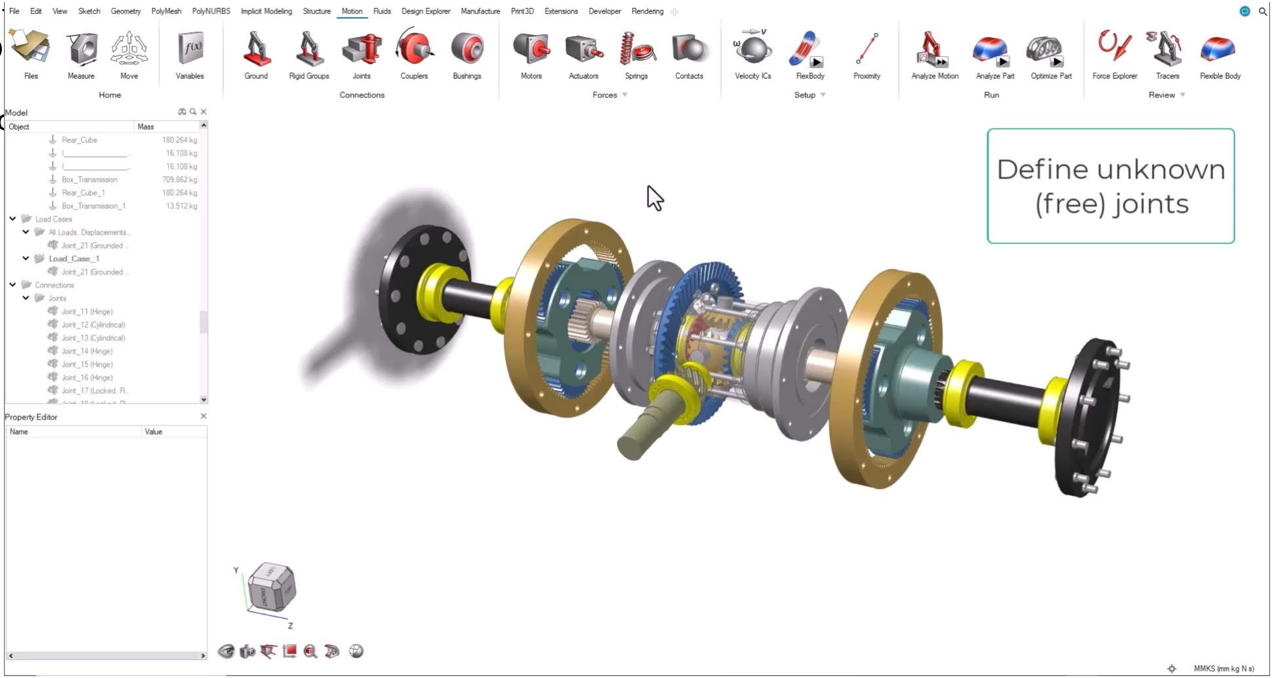
Define Motion Contacts at Free Joints

WHY?

- Quickly add multiple contact joints based on pre-detected Free Joints

HOW?

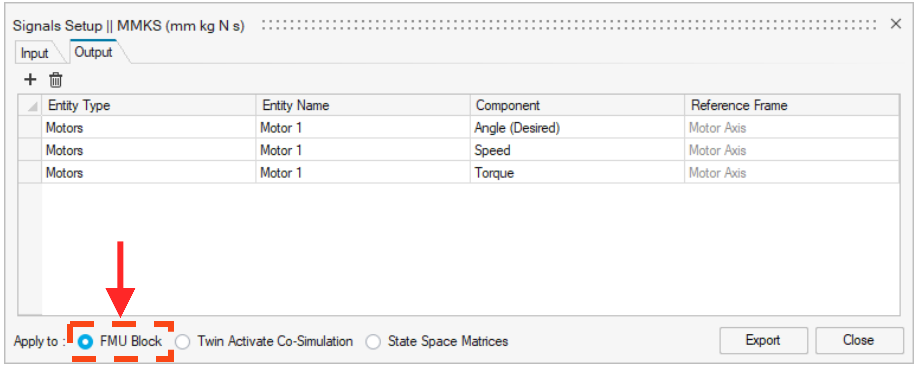
- Set Contacts find fil accept, repeat… O
- Box-select all free jo

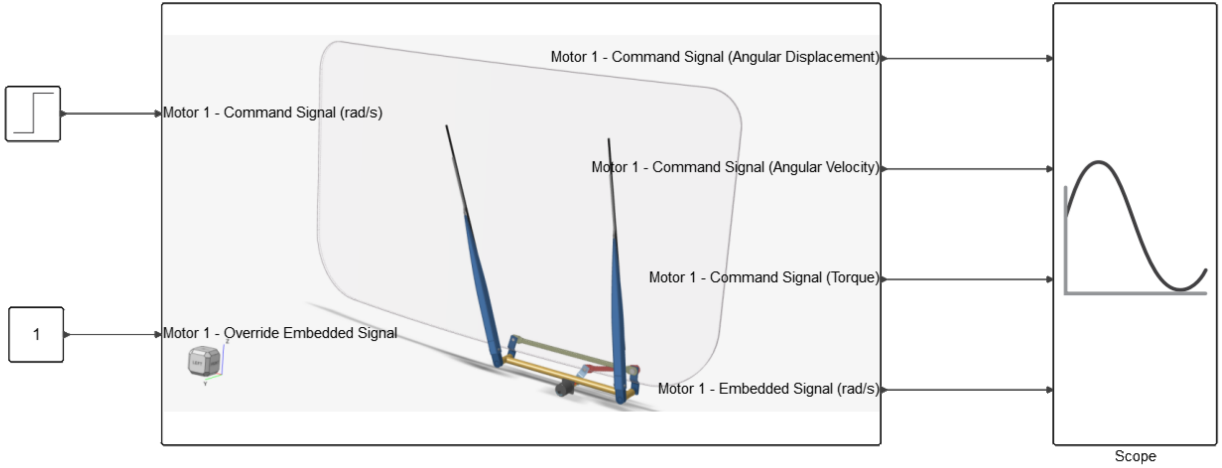


2025

FMU Export

WHY?	• More freedom in representing multibody systems inside Twin Activate
HOW?	• Under Run Settings, Export, use the Input/Output Signals table to define the FMU inputs and outputs, and export an .fmu block





2025

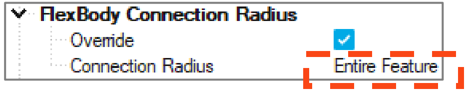
Display Joints as Detected Features

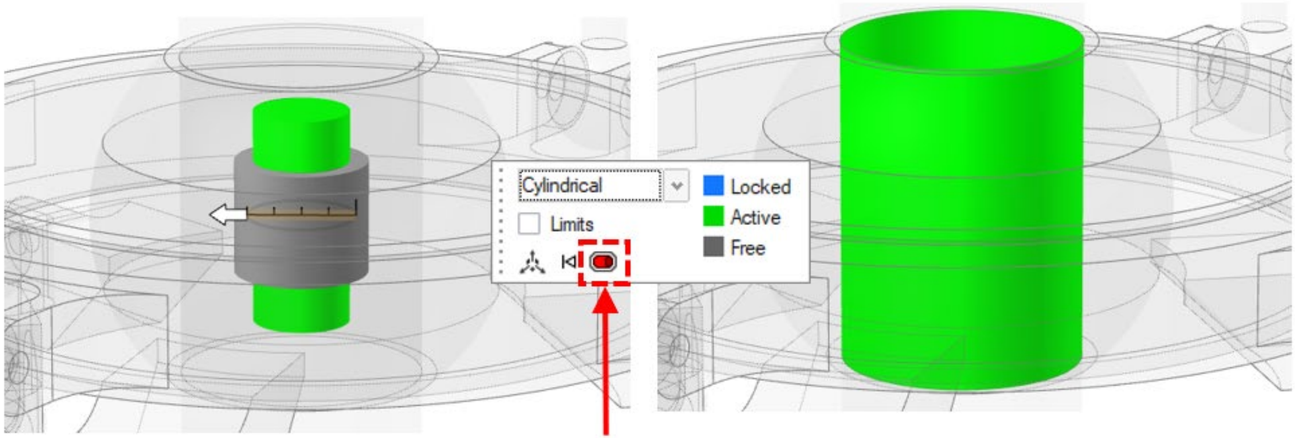
WHY?

- Easily and quickly visualize the features of the joint that bear the loads for use in Analyze Part or Flex Body Connection Radius

HOW?

- While editing a joint, click on the Show Detected Features to toggle the view of the joint between the kinematic representation and the associated geometric feature





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MOTIONVIEW / MOTIONSOLVE

Improvements for cable modeling

WHY?

- Consider cables, wires, and hoses early on in your design.
- Detect interference, kinks, and estimate range of motion

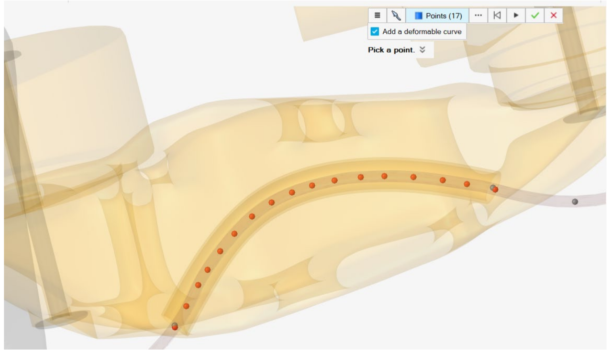
WHAT?

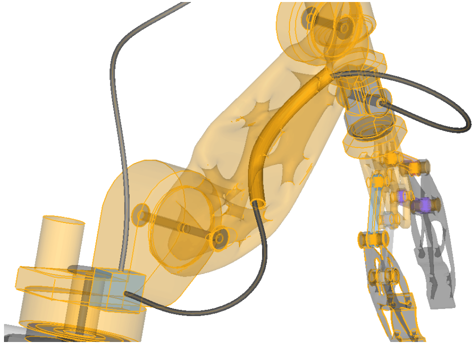
- Users can model highly flexible slender elements in contact with their surroundings
- Define Deformable curves on Polybeam
- Deformable Curve contact

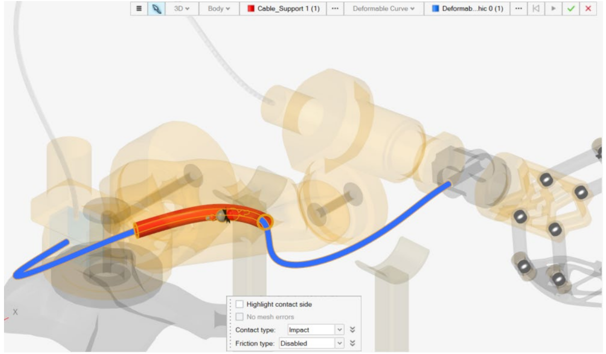
HOW?

During polybeam creation:

- Add deformable curves
- Define radii along the curve
- Define contact between curve and rigid/flex bodies







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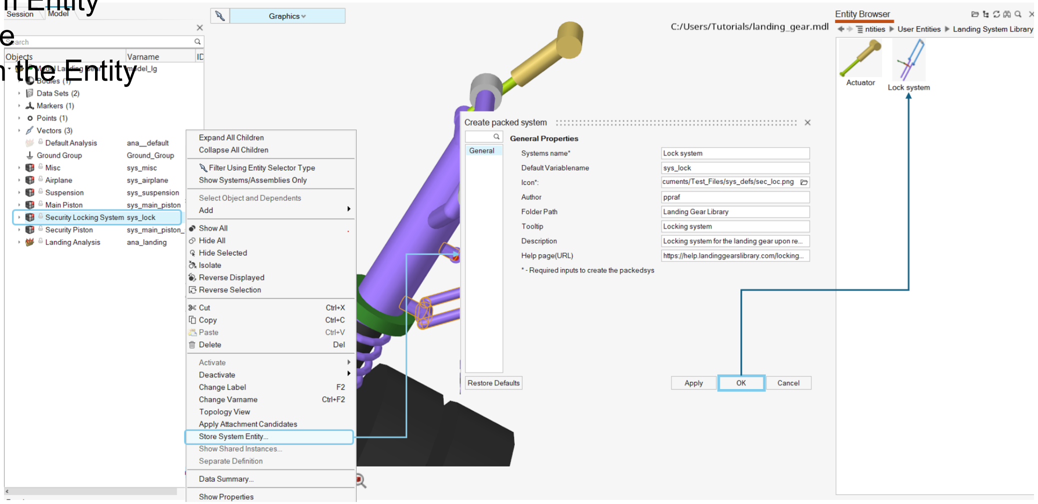
System definitions in Entity Browser

WHY?	• Enhance the workflow for *System* definitions • Easy to store and access definitions • Support for customer libraries
WHAT?	• Save *Systems* into the *Entity Browser* • Access them easily to instantiate in any model
HOW?	• Build a model with *Systems* • Use right click option to “Store System Entity” • Fill in details along with an icon image • To restore, double click on the icon in the Entity Browser



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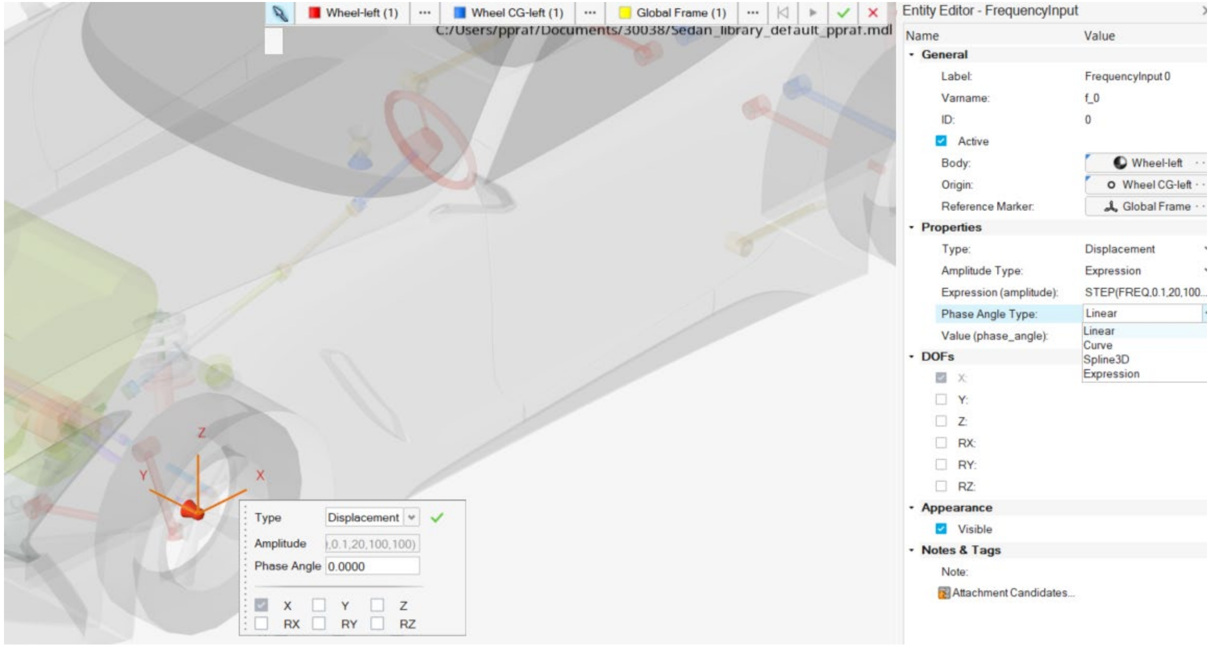
Enhancements

FrequencyResponse

- FrequencyInput capability has been extended to provide non-linear inputs such as a Curve or an Expression



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MotionSolve – RealTime for Vehicle

WHY?	• Speed up simulation time without sacrificing accuracy
WHAT?	• Solve small car/ truck model in realtime
HOW?	• Speed up simulation using Proprietary Method • 1-click automatic real-time simulation • Run large DOEs, Optimization

MotionView

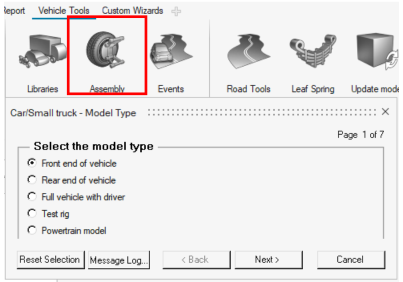
MotionSolve

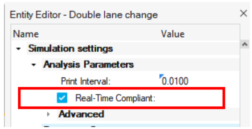
MotionSolve native RealTime Engine

RT → fmi

1-click automatic real-time analysis

Steps to Run MotionSolve-RealTime from MotionView



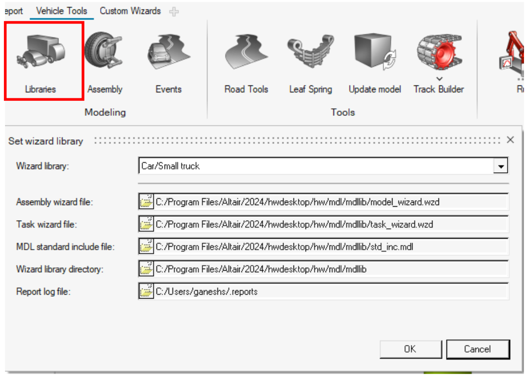


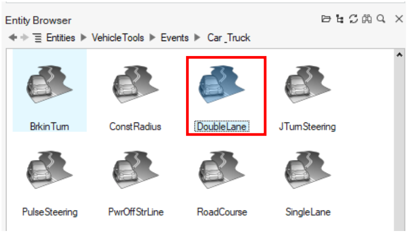
Select Car/Small truck Library

Build assembly

Add dynamic event

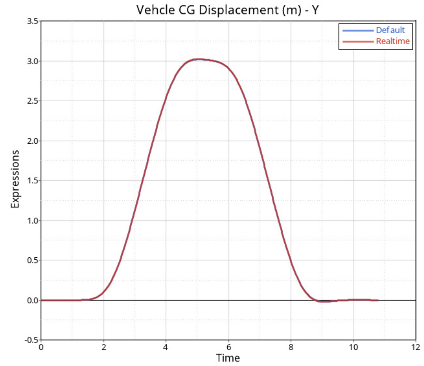
Run MotionSolve in RealTime



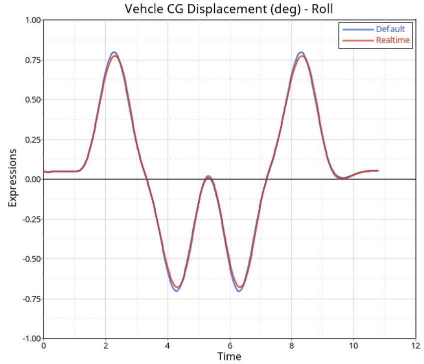


Example

- A two-Door Sedan model is built from car/small truck wizard
- The model comprises 383 kinematic degrees of freedom and 19 additional states



RMS Error – 0.08%



RMS Error – 1.21%

Simulation wall time – 40.1 sec

Simulation wall time – 7.7 sec

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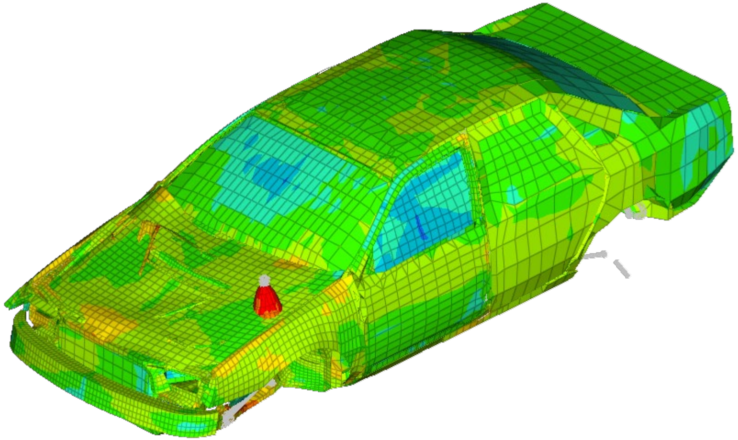
Frequency response analysis enhancement

WHY?	• Understand how a system reacts to excitations of different frequencies and amplitudes • Important for NVH analysis to identify potential issues like resonance or instabilities.
WHAT?	• Frequency Dependent Force/Torque • Modal participation factor • Kinetic energy, dissipative energy, and strain energy distribution. • Transfer path analysis
HOW?	• Add Force_FreqDependent with FFOSUB • Add write_mode_factor in Param_FreqResponse • Add flag write_energy_dist in Param_FreqResponse • Add pfpath_flexbody_id in Param_FreqResponse



Taurus model, flexbody vehicle

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mkb matrices from Linear

WHY?	• To represent the non-linear mechanical system at the operating point in a continuous time-invariant linear mkb format for stability analysis, control design and FE modeling.
WHAT?	• MotionSolve calculates the Mass (.mas), Stiffness (.stf), and Damping matrices (.dmp) written file in oml and matlab formats similar to state space matrices.
HOW?	• To enable mkb matrices from a linear state space analysis use write_mkb = “true” in Param_Linear statement • These matrices are used for further processing in Compose/Matlab or as inputs to FE model.

```
% Mass Matrix = 2 x 2
Mas=[
  5.0000000000000010E-04   0.0000000000000000E+00;
  0.0000000000000000E+00   1.0000000000000002E-03];

% Stiffness Matrix = 2 x 2
Stf=[
  1.8000000000462350E+01  -7.9999999996070166E+00;
 -7.9999999996077271E+00   7.9999999996070166E+00];

% Damping Matrix = 2 x 2
Dmp=[
  1.7999993749999998E+00  -7.9999937499999980E-01;
 -7.9999937499999980E-01   7.9999937499999980E-01];
```


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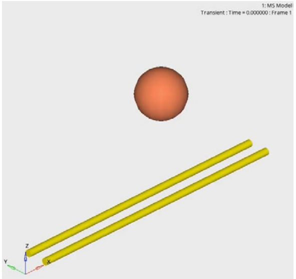
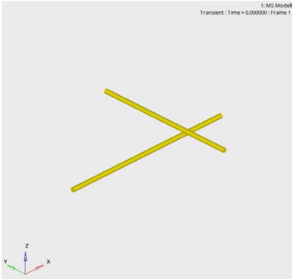
Higher Pair Force Contact - Deformable Curves, Deformable Surfaces

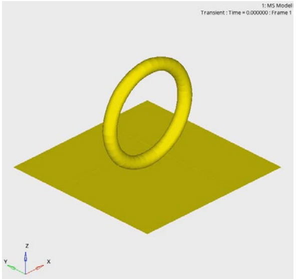
WHY?	• Provide computational more efficient contact definitions compared to the more generic Force_Contact
WHAT?	• higher pair force to define contact between deformable curves, deformable surfaces and graphics
HOW?	• Using Force_PTdCV, Force_DCVCV, Force_DCVSF, Force_GRADCV, Force_GRADSF



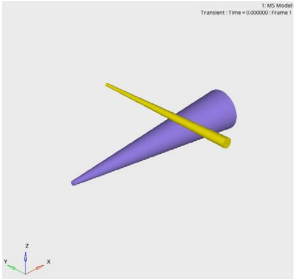
Force_PTdCV



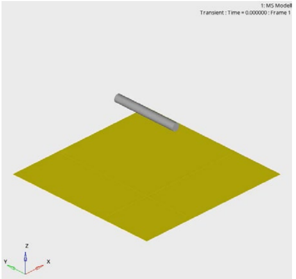
Force_DCVCV



Force_GRADCV



Force_GRADSF

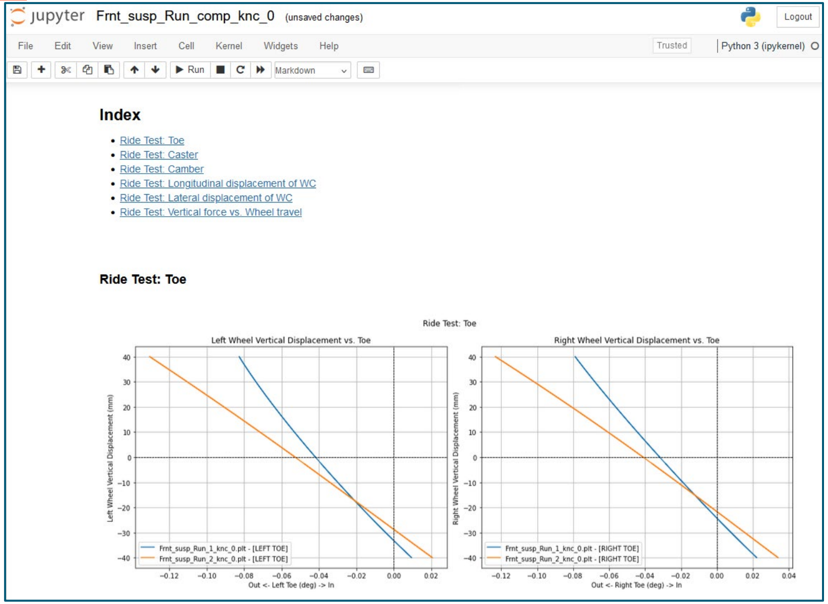


Force_DCVSF

MOTION VERTICAL

Jupyter Notebook for plotting results

WHY?	• Provide an alternative to traditional reporting tools. • Lightweight, customizable and programmable.
WHAT?	• Vehicle simulation reports in Jupyter Notebook.
HOW?	• Auto-generated using result files. • Invoke the report from MotionView.



ALTAIR

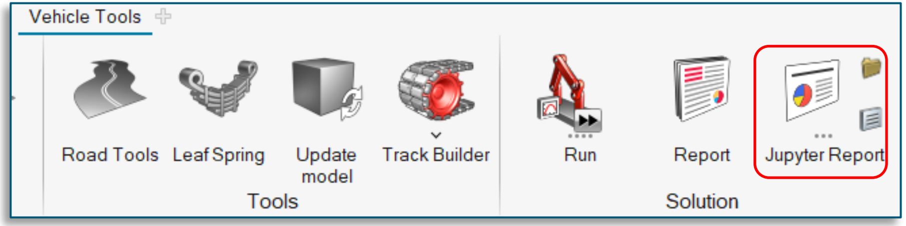
Jupyter Notebook for plotting results

What is Jupyter Notebook?

An open-source web application that allows you to create and share documents containing live code, equations, visualizations, and narrative text.

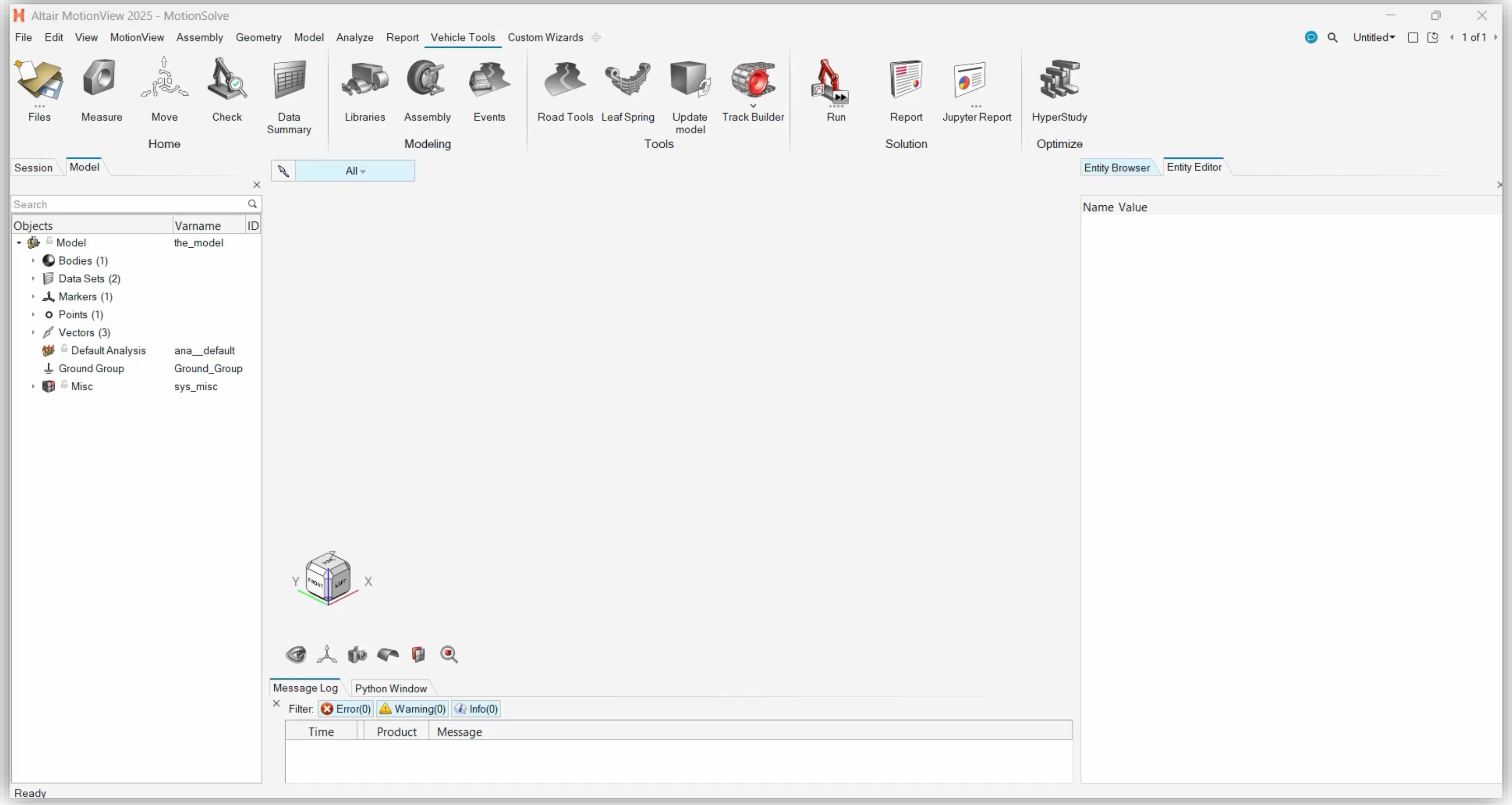
Jupyter Notebook reports are available for:

- Full Vehicle Events with Altair Driver.
- Suspension KnC analysis (with SDF).



Jupyter Reports are add-on. These do not replace HV/HG reports.

Jupyter Notebook - Plot



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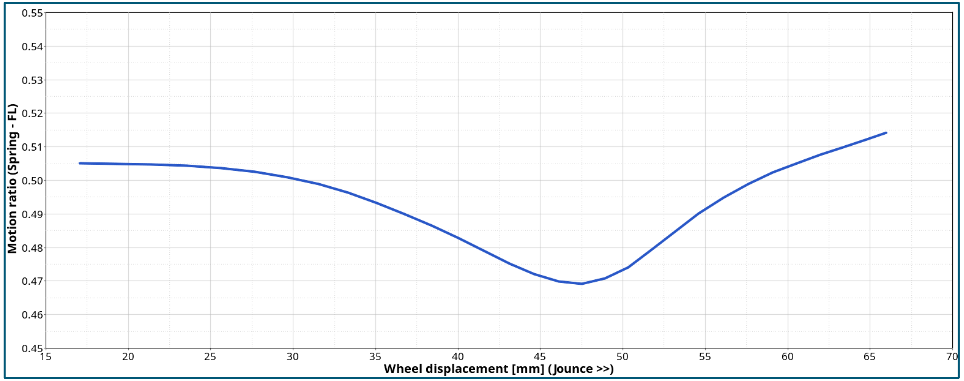
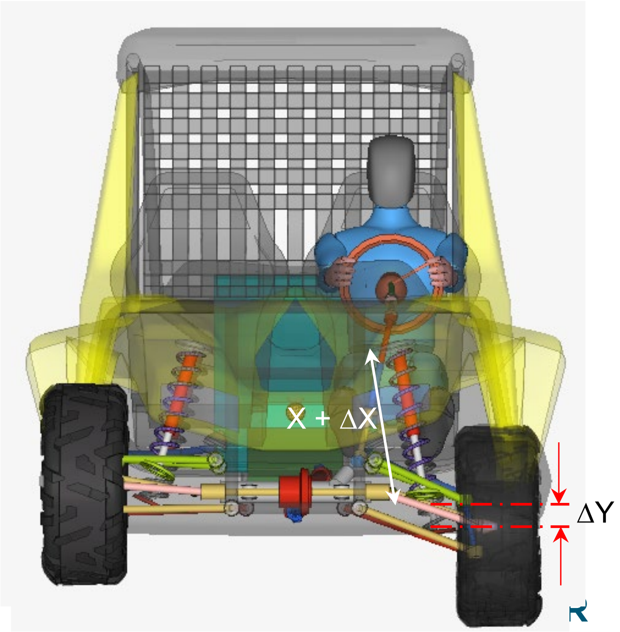
Motion ratios (Spring)

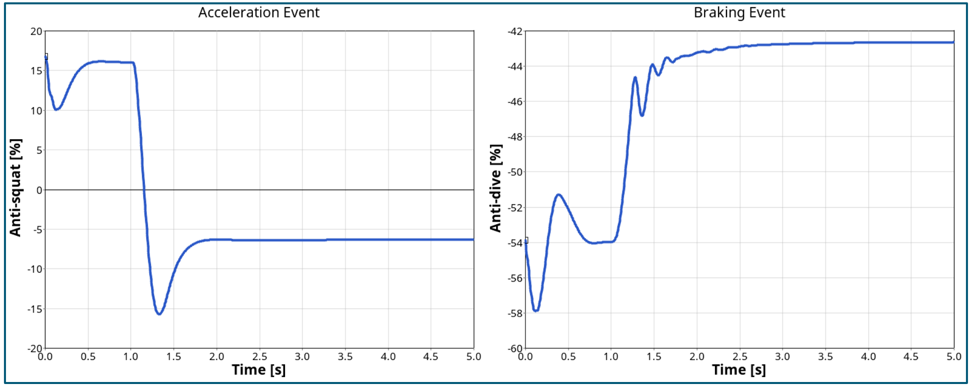
WHY?	• Important metric in vehicle and suspension design.
WHAT?	• User-sub based output requests.
HOW?	• Integrated into the vehicle assembly wizard.

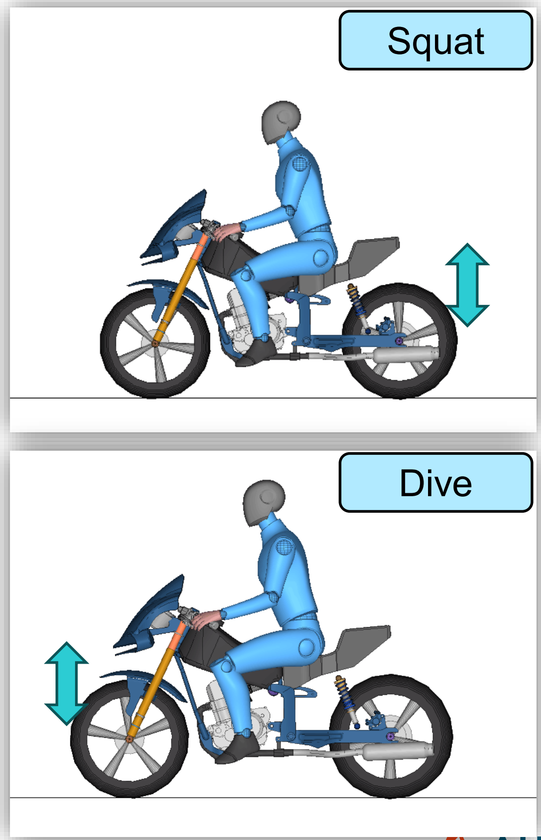




Anti-squat/dive outputs (2W)

WHY?	• Important metric in vehicle and suspension design.
WHAT?	• User-sub based output requests.
HOW?	• Integrated into the Two-wheeler vehicle assembly wizard.





*Available for 2W models built using the assembly wizard.

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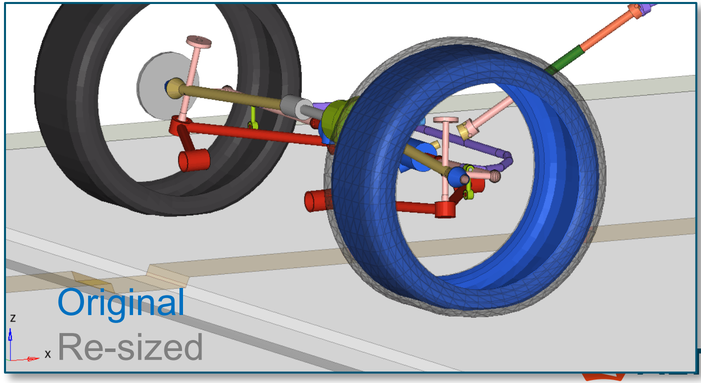
CD-Tire updates: re-sizing, MF++, licensing

WHY?	• Features supported by Fraunhofer CD-Tire. • Useful design tools for quick performance estimation.
WHAT?	• Official support and documentation for re-sizing feature. • Official support for CD-Tire MF++. • Updates to the license checkout logic.
HOW?	• Re-sizing feature: Include re-sizing block in the tire property file (or in the control file). • Magic Formula tire: Browse the CD-Tire MF++ tire property file in the vehicle model.

```
[TIRE_AND_RIM_RESIZING]
TIRE_REF   = 245/40R18   #Reference tire specification
RIM_REF    = 18x8.5      #Reference rim specification
TIRE_NEW   = 265/40R18   #Target tire specification
RIM_NEW    = 18x9        #Target rim specification
```



THANK YOU

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#ONLYFORWARD

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