



ALTAIR INSPIRE MOTION – AN OVERVIEW

Altair ATCx 2019 – Multibody & System Simulation

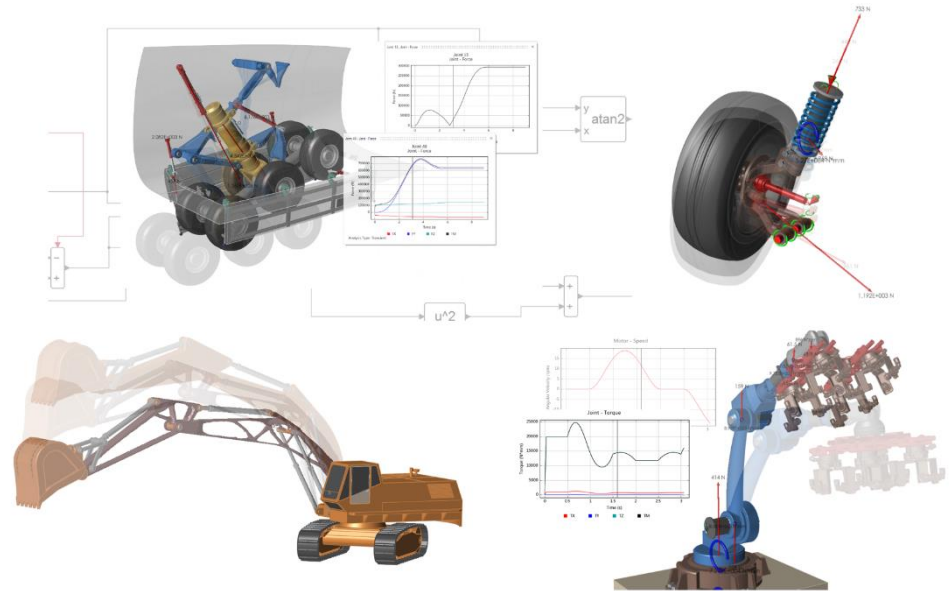
Scott Ziembra – Altair Engineering



Altair

AGENDA

- Altair Inspire Motion
- Highlights and Capabilities
- Example Applications
- Product Overview Demonstration (video)
- Using Motion Loads For:
 - Driving Design Topology for Light Weighting
 - Directional Insight into Structural Behavior
- Inspire Motion... or MotionView?
 - When, Why and Differences?
- Co-Simulation
- Customer Use Examples



ALTAIR INSPIRE MOTION



- A powerful, yet easy-to-use tool inside Altair Inspire for understanding the **dynamic motion** of moving systems
- A tool for providing **boundary loads** for an Inspire Structural Analysis or Topology Optimization
- A **fast-track approach** to MotionView models



PRODUCT HIGHLIGHTS

- **Used by Designers and Engineers** for understanding:
 - **Functional** behavior
 - **Directional** behavior
 - **Boundary loads** for stress analysis or topology optimization
 - A **Pre-build** to MV models
- **Easy to Use and Intuitive** interface
- **Multi-Environment Integration**
(*Geometry / Structures / Optimization*)
- **Automatic load transfer** to Inspire structural FEA or topology optimization
- **Coupled with solidThinking Activate** for 1D Model-Based system simulation
- Runs under ***MotionSolve*** engine,
Fully compatible with MotionView



CAPABILITIES

Modeling:

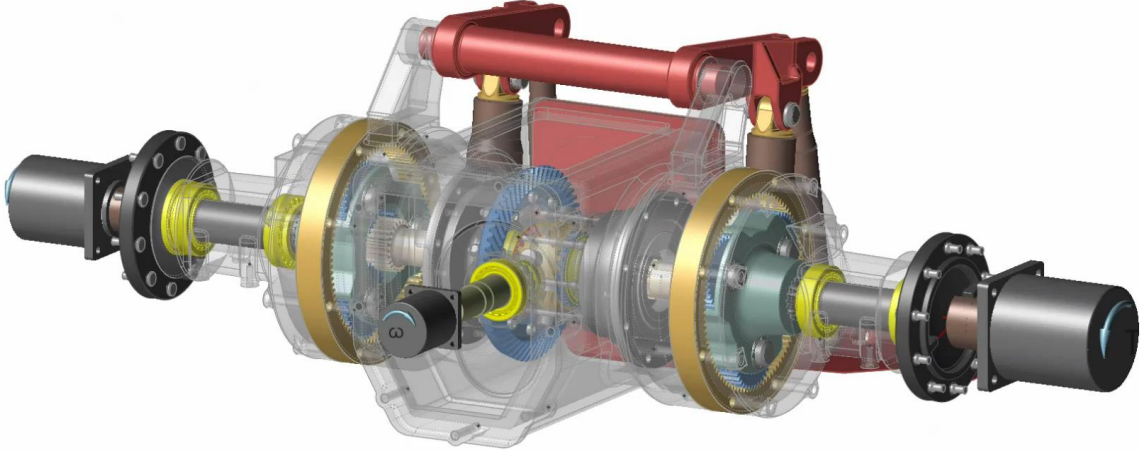
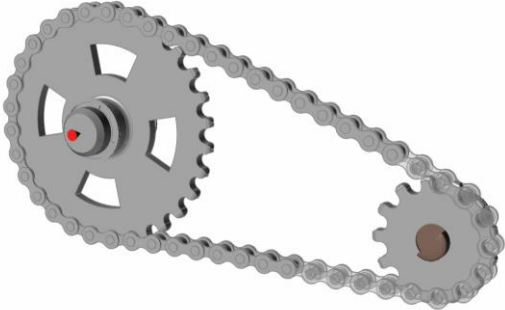
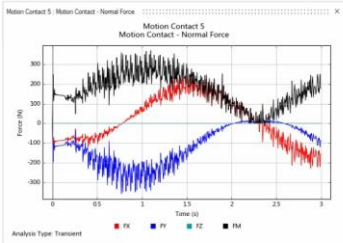
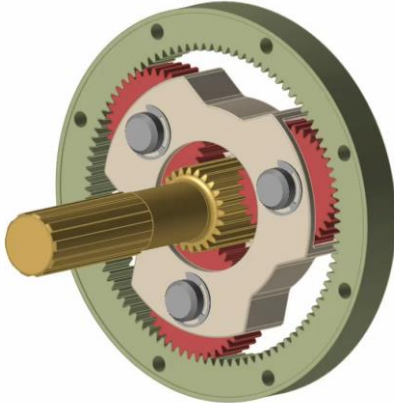
- **Rigid Groups**
- **Geometry-based Joint detection**
- **Motors & Actuators**
 - Torque
 - Displacement
 - Speed
 - Acceleration
- **Springs and Dampers**
- **Part/Part Contact**
- **Flexible joints**
- **Curve Profile Editor** (Import pre-defined data or customize input functions)

Post Processing / Visualization:

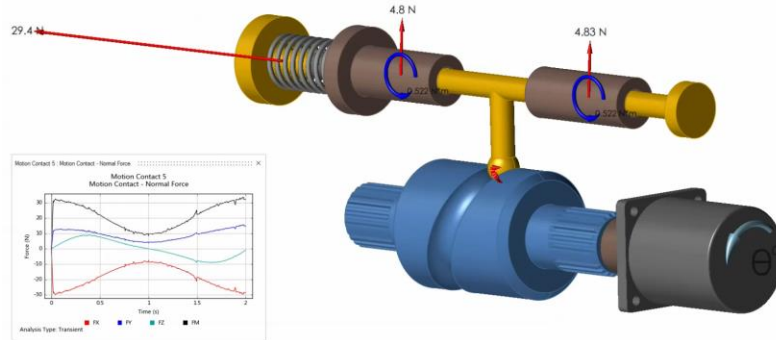
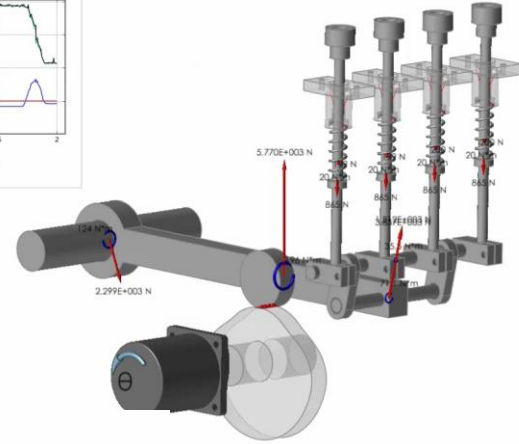
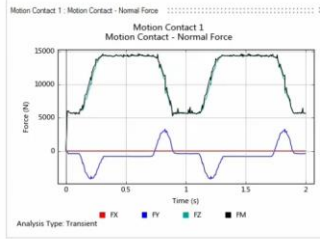
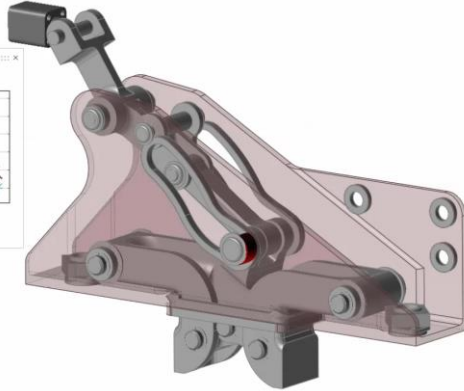
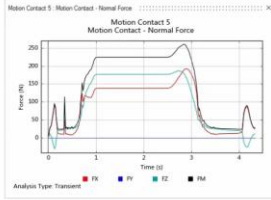
- **Easy click-to-plot**
- **Feature-specific result types**
 - Joint Disp / Vel / Accel
 - Spring Force / Extension
 - Actuator/Motor travel & input requirements
 - Contact Forces / Friction forces
- **Animated force vectors with numerical display**
- **Export plots to .csv file**
- **Tracers**
- **Use simulated position as new starting point for model**
- **Save video animation**



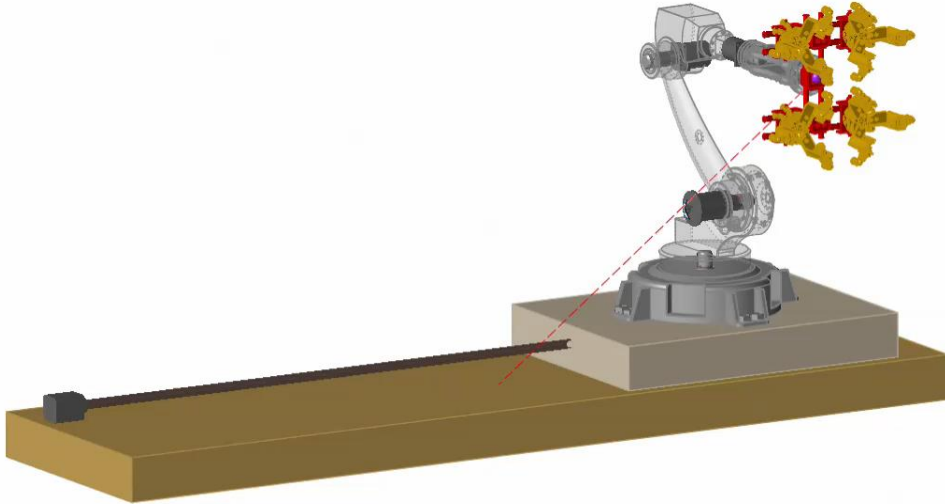
EXAMPLE APPLICATIONS



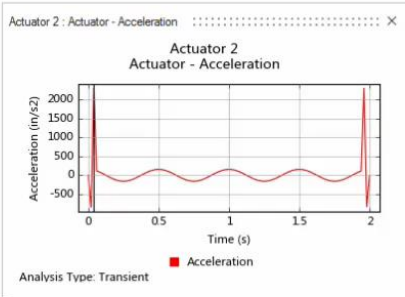
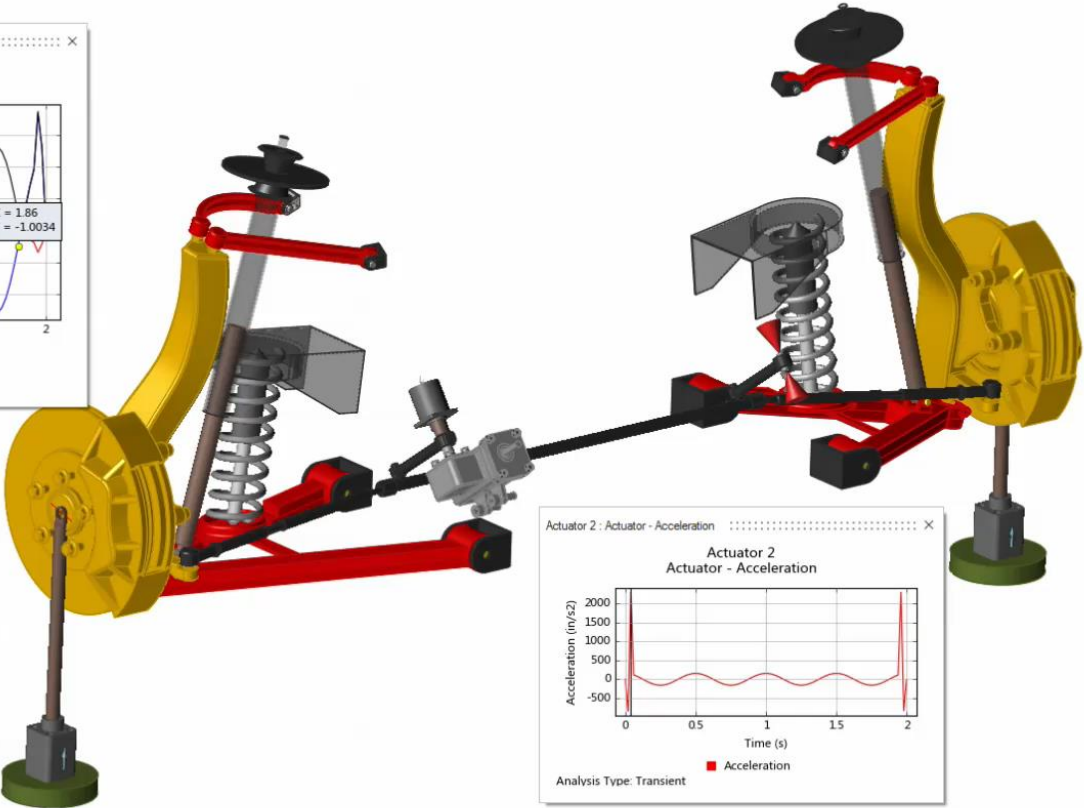
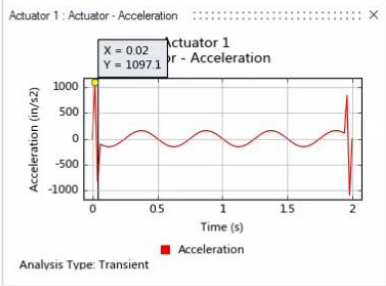
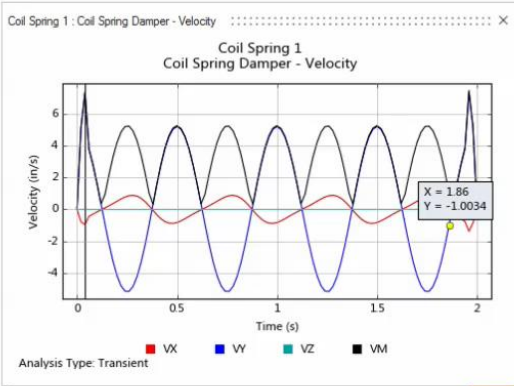
EXAMPLE APPLICATIONS



EXAMPLE APPLICATIONS



EXAMPLE APPLICATIONS



TOOL FOR QUICK TESTING

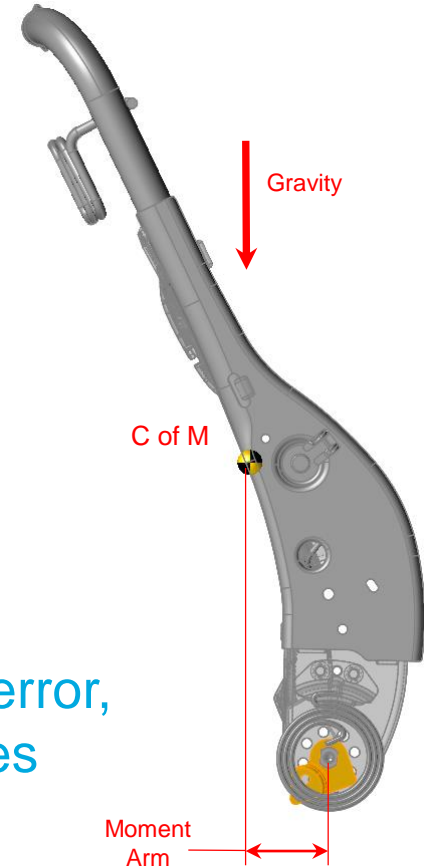
$$\text{Torque} = \text{Force} \times \text{Moment Arm}$$

$$\begin{aligned} \text{Force} &= \text{Seat Mass} \times \text{Gravitational Accel} \\ &= 5.9\text{Kg} \times 9.8 \text{ m/s}^2 \\ &= \mathbf{58.3 \text{ N}} \end{aligned}$$

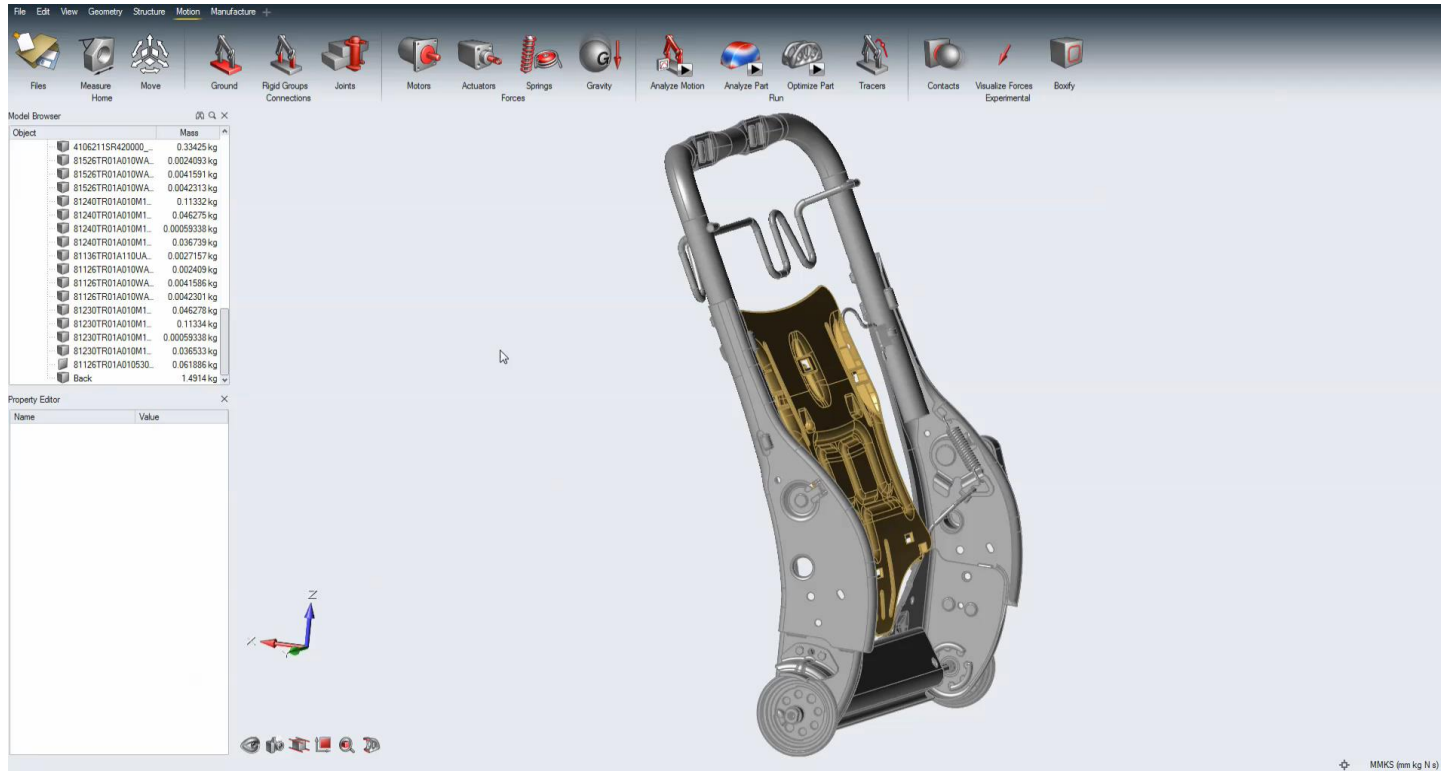
$$\text{Moment Arm} = 52.4\text{mm}$$

$$\text{Torque} = 58.3 \text{ N} \times 52.4 \text{ mm} = \mathbf{3053 \text{ N-mm}}$$

Manual calculations take time, are subject to human error, and are not able to adapt quickly to design changes



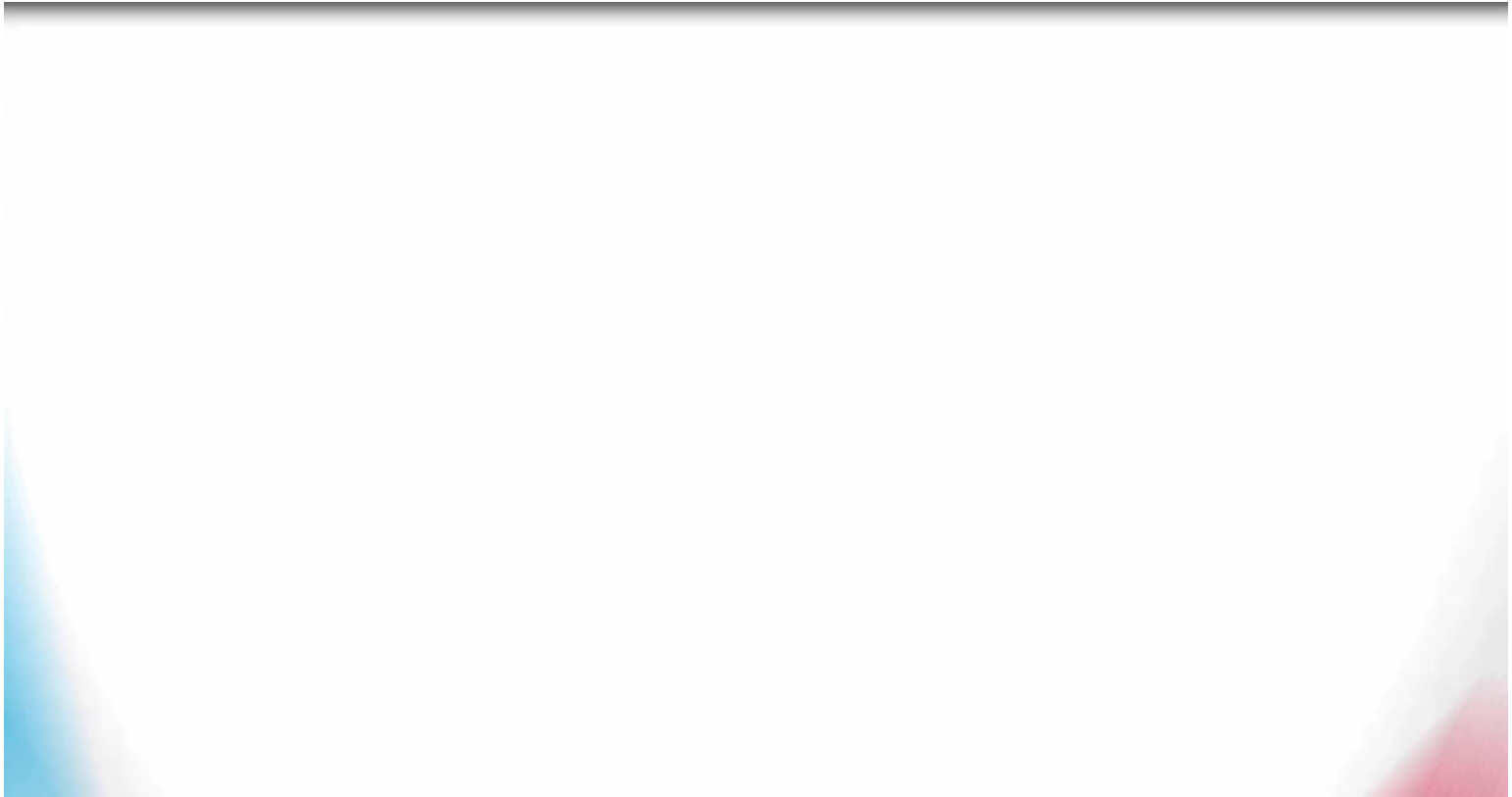
TOOL FOR QUICK TESTING – WORKFLOW EXAMPLE VIDEO



Reverse-determining
spring torque



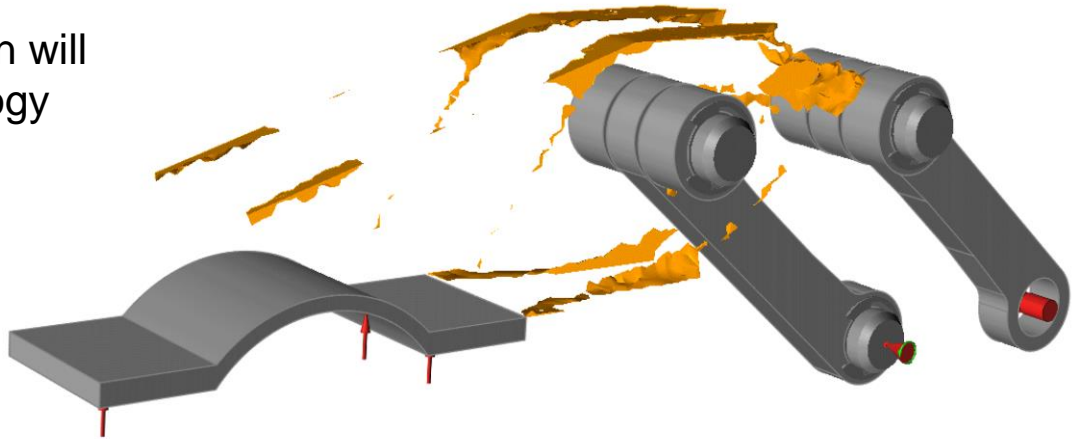
ALTAIR INSPIRE MOTION – PRODUCT OVERVIEW VIDEO



WHAT IS TOPOLOGY OPTIMIZATION?

- Given a **package space**, **manufacturing constraints**, and **loading conditions**, an ideal shape is generated that meets user-defined criteria, such as maximizing stiffness, minimizing mass, or targeting a natural frequency range

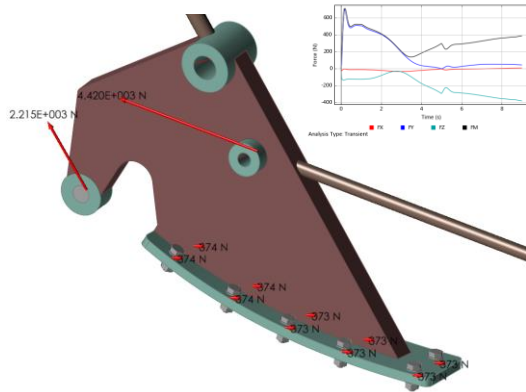
- Most simulations tell us if a design will meet performance criteria. Topology optimization creates designs that meet performance criteria.



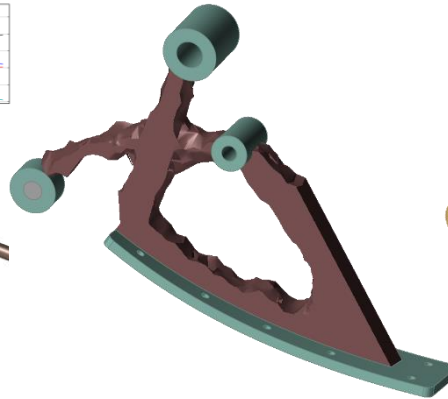
DRIVE DESIGN TOPOLOGY USING MOTION LOADS

- Given a package design space, quickly **mechanize**, **optimize** and **validate** your system for component light weighting

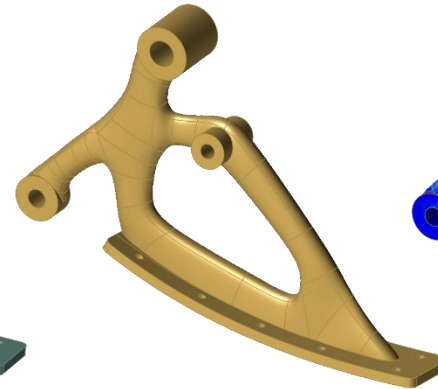
Dynamic Motion Loads Applied to Concept Design Space



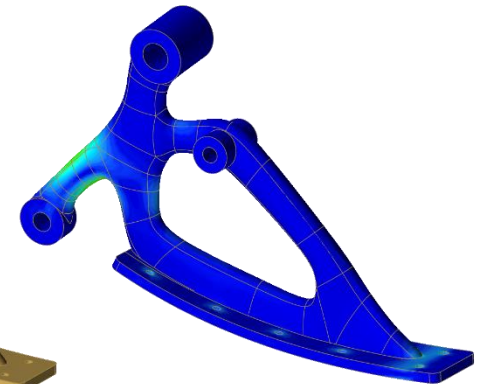
Optimized Structure



Improved Geometry



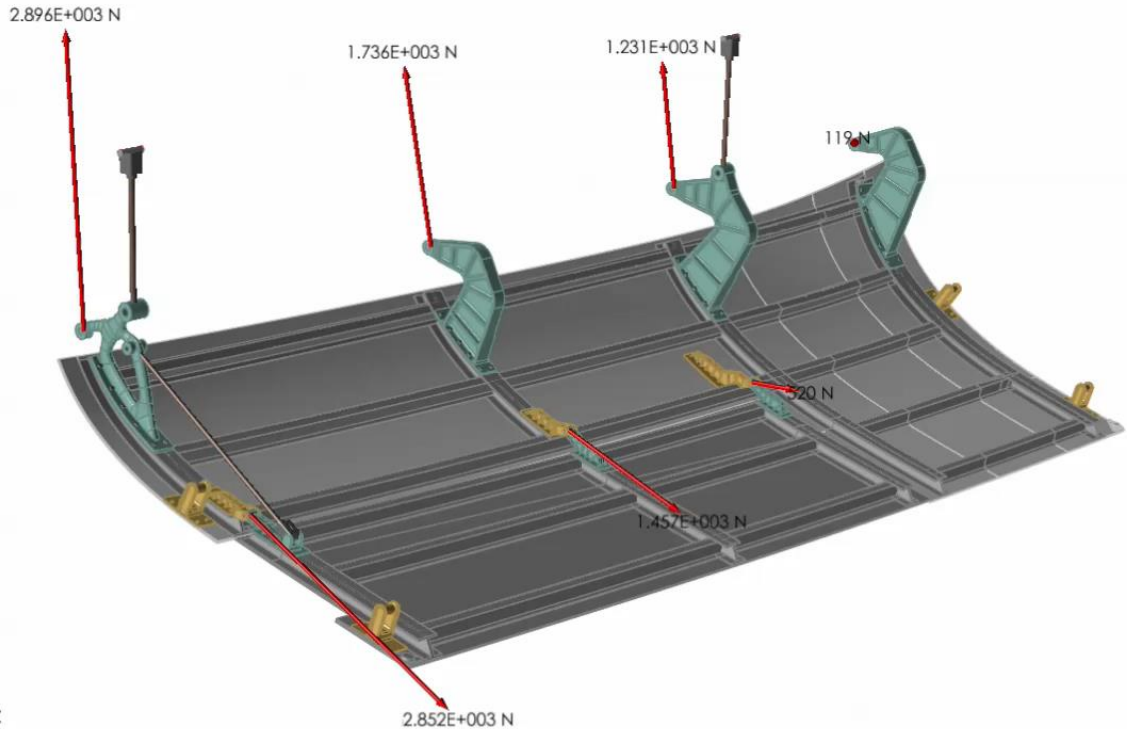
Validated Results



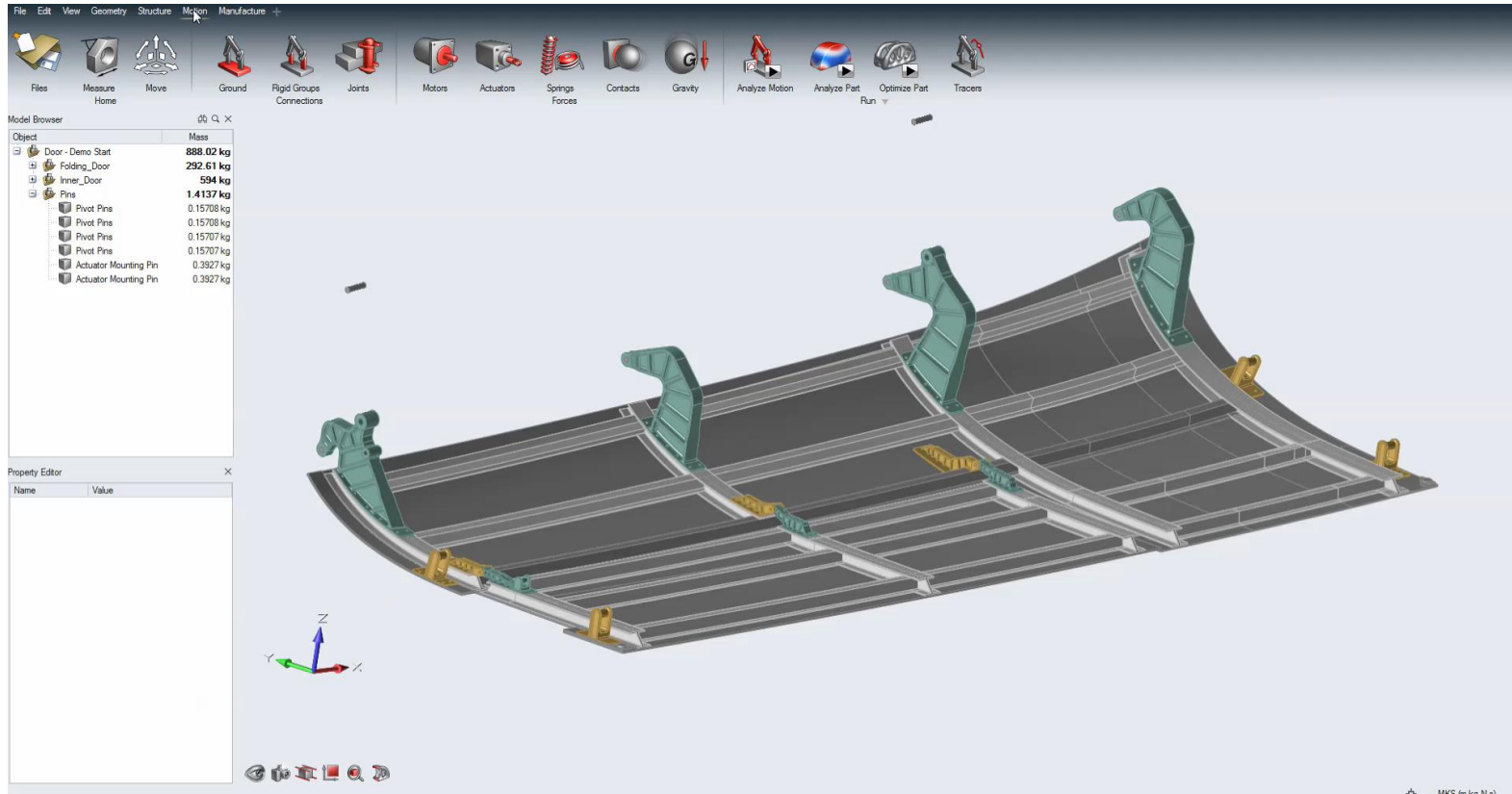
Concept to Optimized Design (58% mass reduction)



DRIVE DESIGN TOPOLOGY USING MOTION LOADS



MOTION LOADS FOR OPTIMIZATION - WORKFLOW EXAMPLE VIDEO



ALTAIR INSPIRE MOTION...OR MOTIONVIEW ?

Altair Inspire Motion

- CAD file support (native and neutral)
- Create / Modify / Repair Geometry
- Build dynamic/kinematic models
- Auto-generated Output Requests
- Basic Post Processing
- Integration with Inspire Structures
- Integration with Inspire Topology Optimization
- Pre-definition of models for MotionSolve/Activate Co-simulation

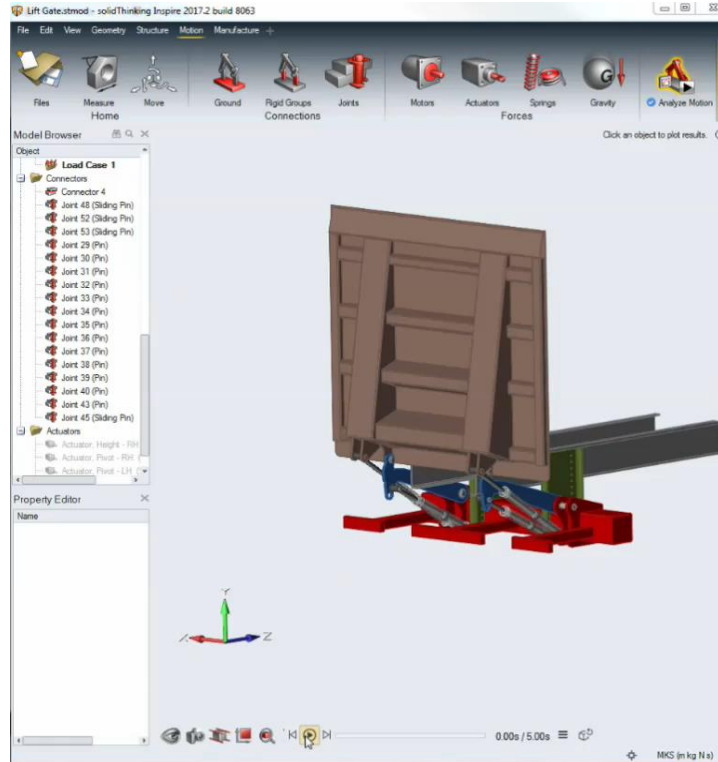
MotionView/MotionSolve

- Added fidelity
- Flexible body inclusion
- NLFE members
- Parameterization
- Customization
- Co-simulation with multidisciplinary tools
- Automotive Templates / Toolboxes
- Advanced Post Processing
- DOE / Optimization (via HyperStudy)

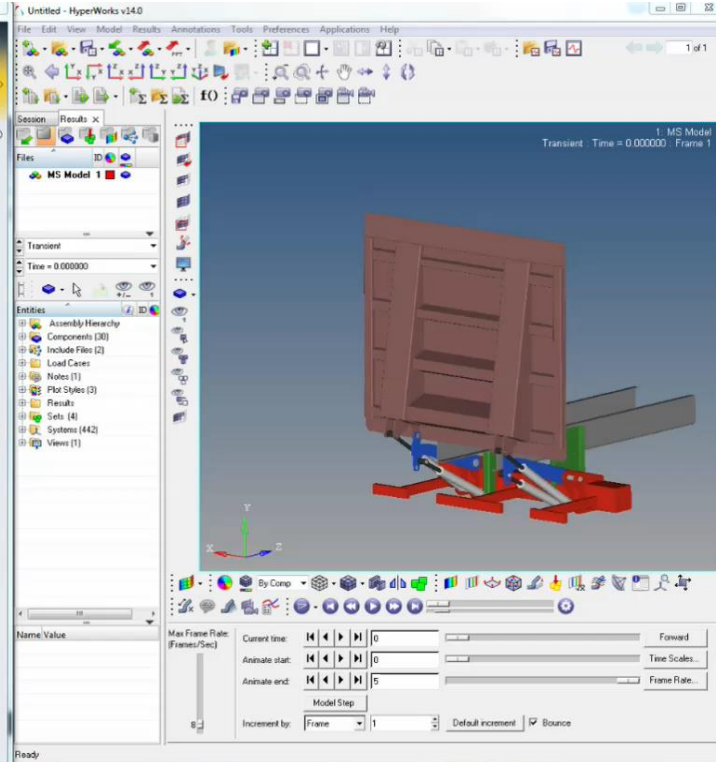


INSPIRE MOTION / MOTIONVIEW COMPATIBILITY

Altair Inspire Motion

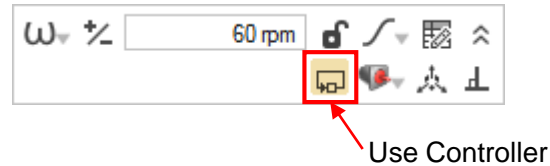


MotionView

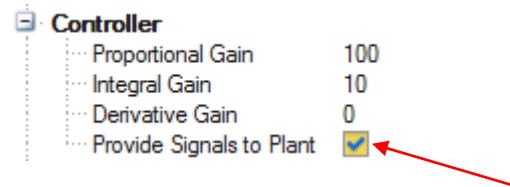


CO-SIMULATION WITH 1D MODELING

Motors and **Actuators** have a built-in controller which can be enabled or disabled.



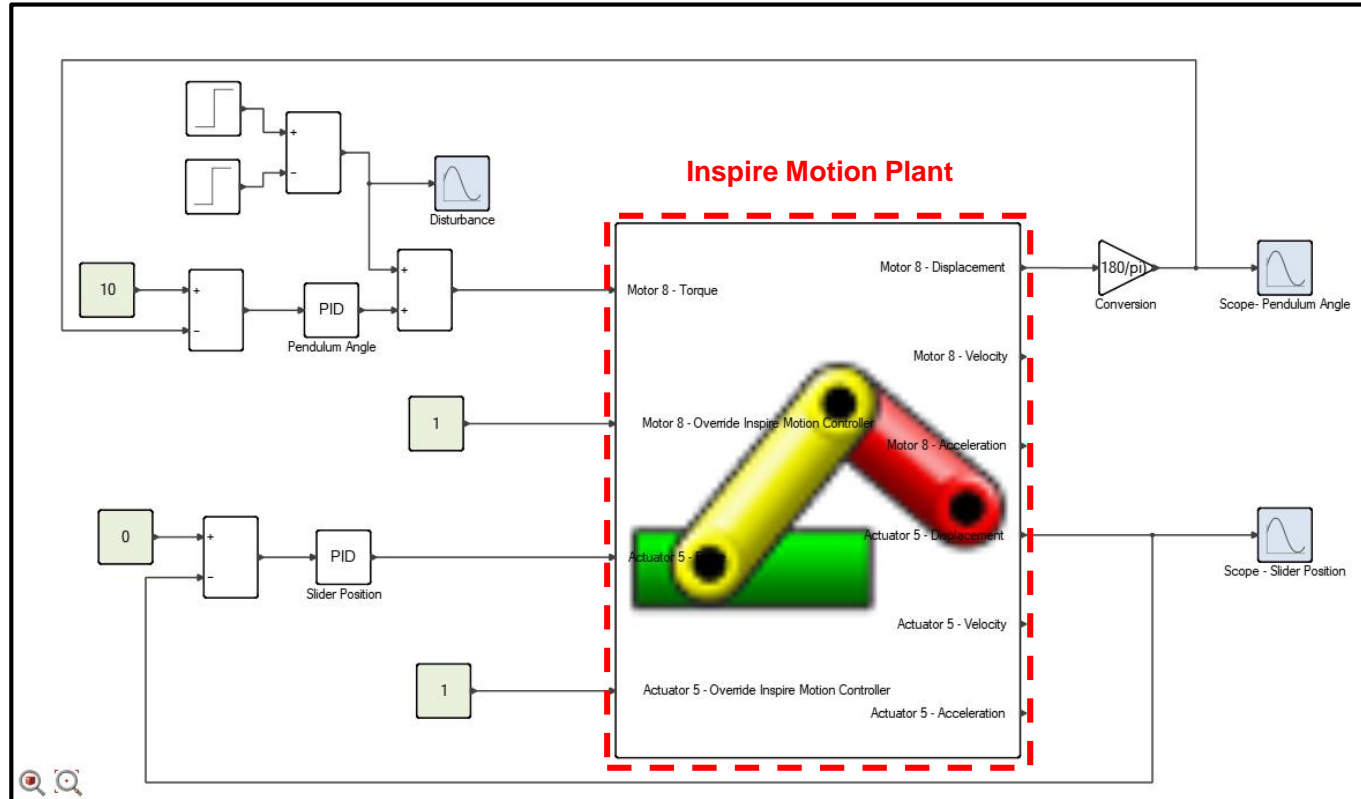
The Controller option allows a plant model to be exported for external control with a product like Activate



Plant block will be output upon exporting (.MDL)



CO-SIMULATION WITH 1D MODELING



CO-SIMULATION WITH 1D MODELING

As seen in Inspire Motion

Controller	
Proportional Gain	100
Integral Gain	10
Derivative Gain	0
Provide Signals to Plant	<input checked="" type="checkbox"/>

As seen in MotionView

Pendulum Motor	sys_Motor_5
Data Sets (1)	
Forces (1)	
Motor Force I	force_ij
Markers (2)	
Outputs (3)	
Points (2)	
Solver Arrays (2)	
Motor 5 - Plant Outputs	poutput
Motor 5 - Plant Input(s)	pinput
Solver Diff Equations (2)	
signal_error	signal_error
signal_deriv_error	signal_deriv_error
Solver Variables (8)	
Motor 5 - Displacement	displacement
Motor 5 - Velocity	velocity
Motor 5 - Acceleration	acceleration
Desired Signal	desired_signal
Actual Signal	actual_signal
Error Variable	error_variable
Motor 5 - Override Inspire Motion Controller	override_signal
Motor 5 - Torque	command_signal



USE CASE - VOLVO CONSTRUCTION EQUIPMENT

What?

- Model / analyze new Soil Compactor designs

Why?

- Determine loads and accelerations for use with durability

How?

- Use Inspire Motion for primary model building and MotionView for added fidelity needs (flex bodies)



“What separates Inspire from the older existing engineering tools is its modern and appealing user interface that unfolds an integrated set of comprehensive engineering design and optimization tools. Its distinction lies in a well thought GUI that integrates geometric modeling, Loads engineering, Finite Element Analysis and structural optimization. It is an essential tool for design engineers and inventors...”

- Ashraf Zeid, Simulation Engineer, VCE -



USE CASE – JOHN DEERE

What?

- Model / analyze various linkages

Why?

- Determine reaction loads and spring requirements

How?

- Inspire Motion / MotionView workflow



I'm quite satisfied with using Inspire because it was a tool I did not know and I learned to use it in a lot less time than any other CAD or CAE software. The commands are very simple and the product has many useful applications for day to day engineering...

- John Deere Company-



USE CASE – MAXION WHEELS

What?

- Model / analyze various linkages

Why?

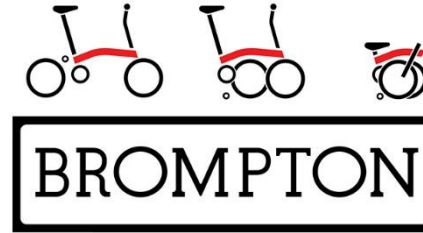
- Predict behavior of manufacturing equipment to ensure correct tolerances of final product

How?

- Use Inspire Motion for primary model building (contact analysis) and MotionView for added fidelity needs



USE CASE – BROMPTON BIKES



What?

- Understand load paths for optimization of components (e.g. chain tensioner), and for better understanding of design before manufacturing (e.g. rolling road test)

Why?

- Altair Inspire seamlessly integrates motion, structural analyses, and topology optimization, all in an intuitive and user-friendly interface especially for designers with little FE experience

How?

- Altair Inspire Motion, Structural and Optimization



Join Us in Training Room A
3:00 to 5:00

Inspire Motion Hands-on Workshop

