Connect to All

RECURDYN

Particleworks CFD DEM FEA MBD MFBD Control MBS-FE Coupling FMI CoLink Simulink SimulationX AMESim Simplorer EDEM

- **Welcome**
- **Multibody Dynamics Platform Vision**
- **What's New in RecurDyn V9R3**

Brant Ross

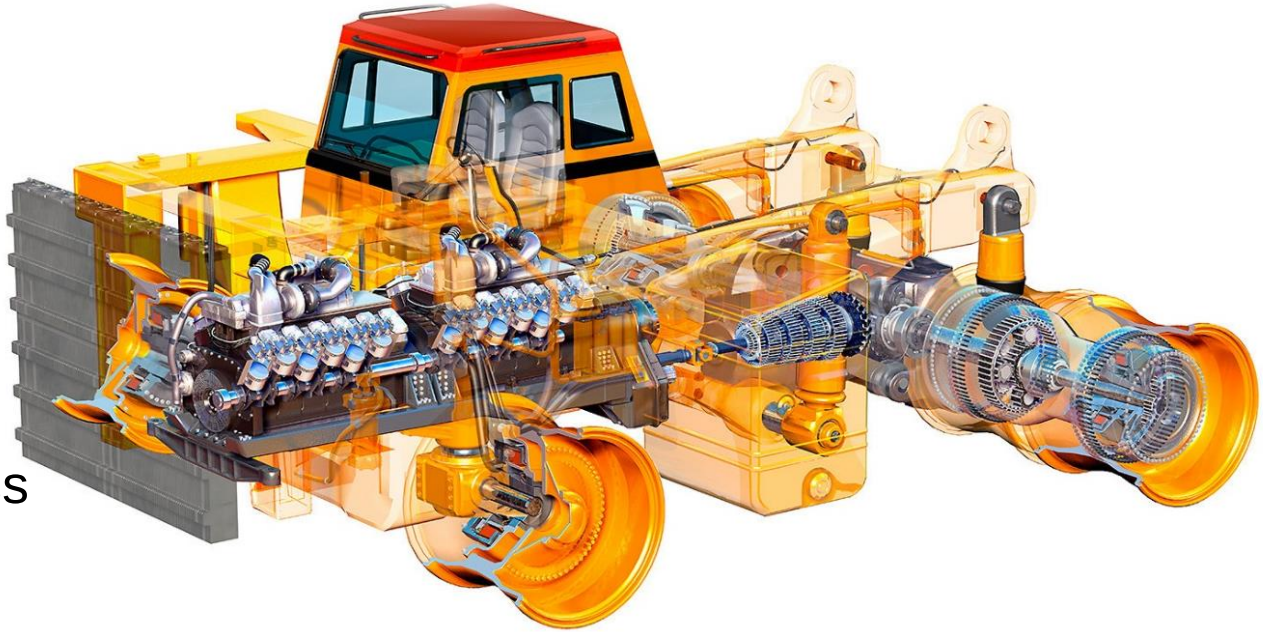
Business Manager

Wednesday, September 25th

10:00 am EDT (8:00 am MDT)	Welcome, Review of Schedule	Brant Ross
10:15 am EDT (8:15 am MDT)	RecurDyn as a multi-physics simulation platform, V9R3: RecurDyn/Professional and ProcessNet.	Brant Ross
12:00 pm EDT (10:00 am MDT)	Break	
1:00 pm EDT (11:00 am MDT)	V9R3: RecurDyn Toolkits, Controls, and Co-simulation Interfaces	Nelson Woo
2:00 pm EDT (12:00 pm MDT)	V9R3: RecurDyn/FFlex and Mesher.	Zach Smith
3:00 pm EDT (1:00 pm MDT)	Review of Logistics for the Thursday Tutorials	Brant Ross
3:15 pm EDT (1:15 pm MDT)	Adjourn	

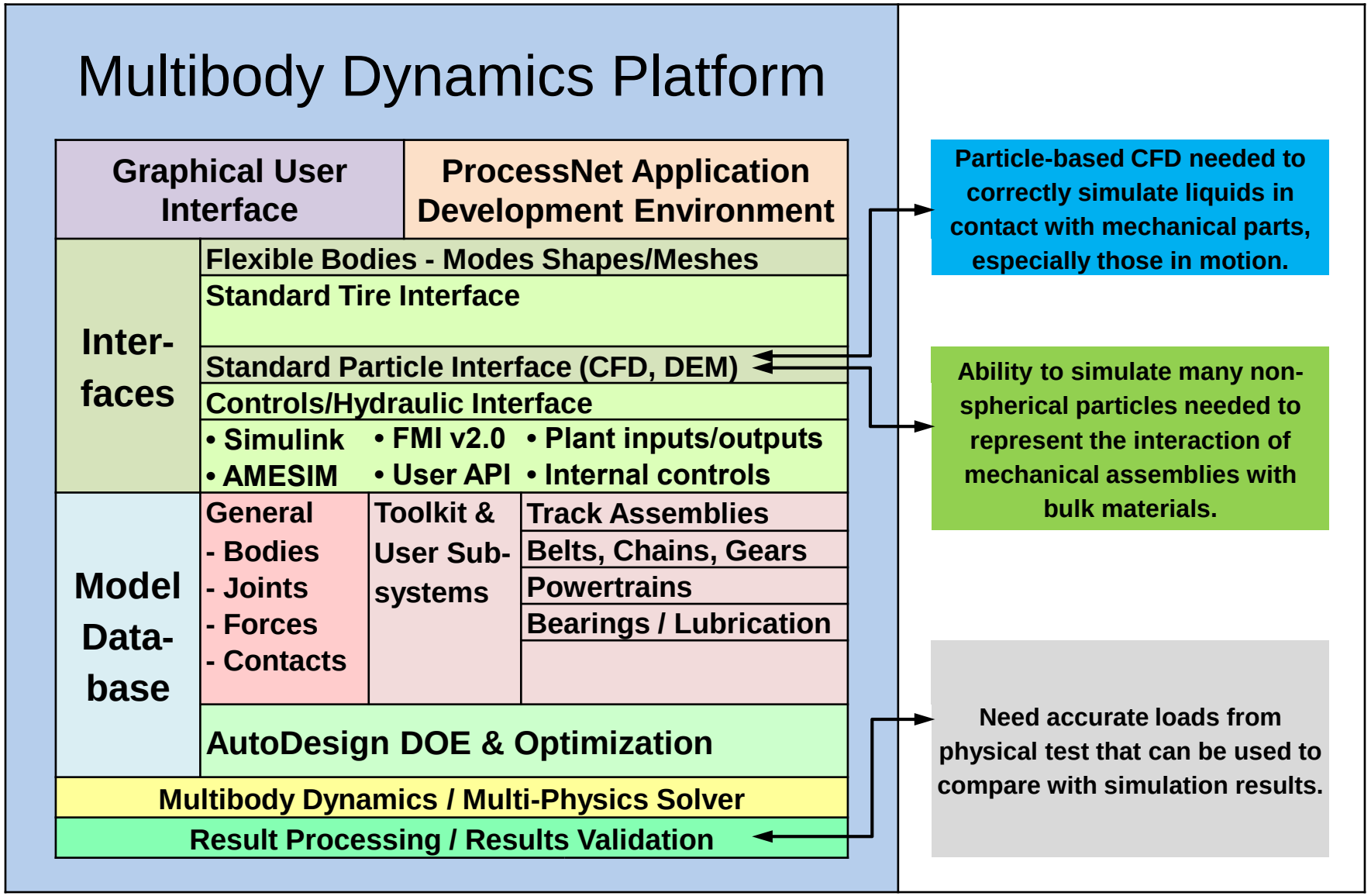
Capabilities Needed for System-Level Simulation

- (80's) Multibody Dynamics (MBD) – Rigid Bodies
- (90's) MBD – Linear Flexible Bodies, Controls
- (00's) MBD – Process Automation, Nonlinear Flexible Bodies, Hydraulics,

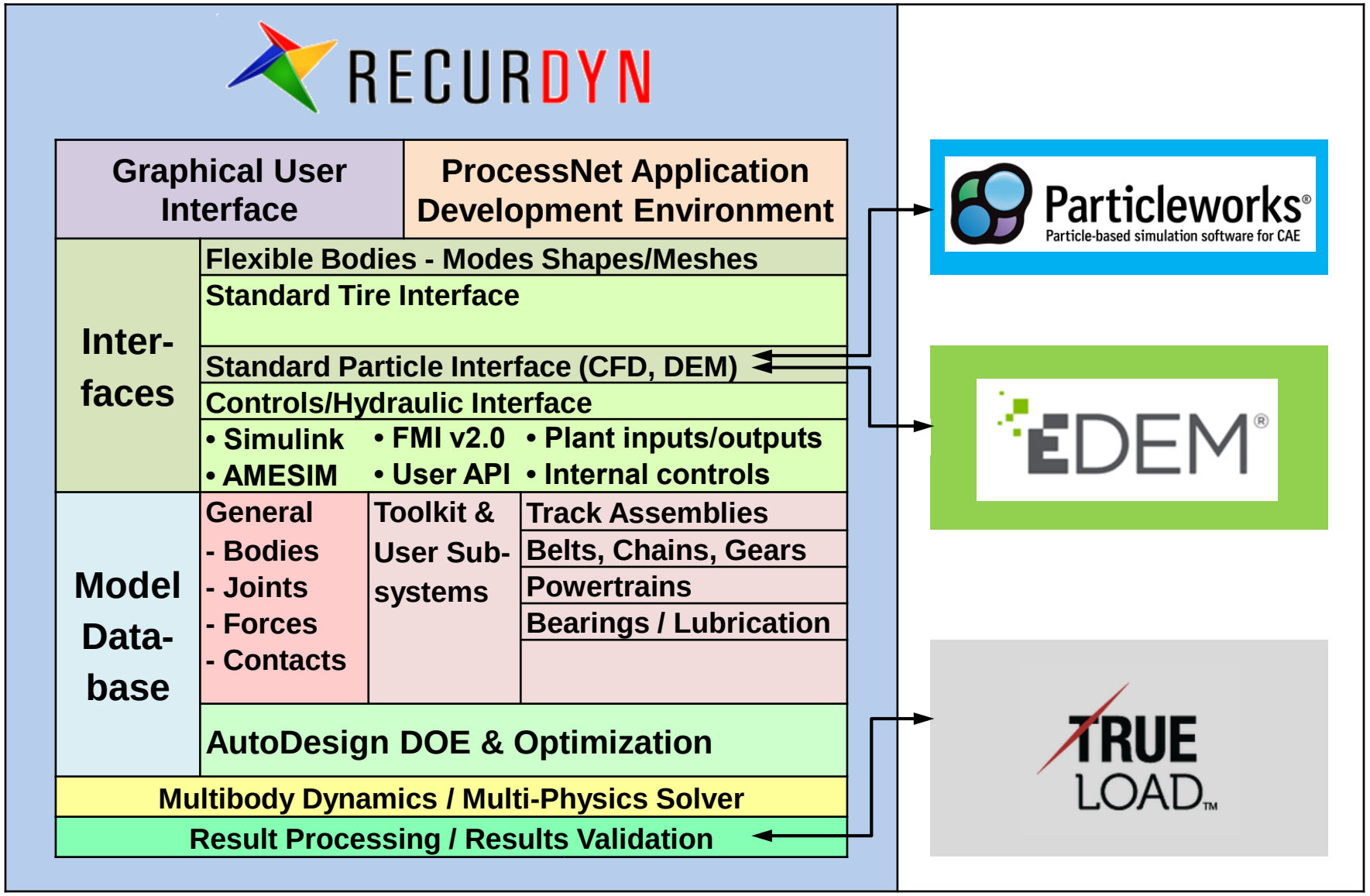


- (10's) Extended multi-physics simulation through co-simulation with CFD & DEM
- (20's) MBD is now Model-Based Design, emergence of Model-Based Engineering. Multibody dynamics is a key enabler of MBD and MBE for products that include assemblies in motion.

Multi-Physics Platform for Assemblies in Motion

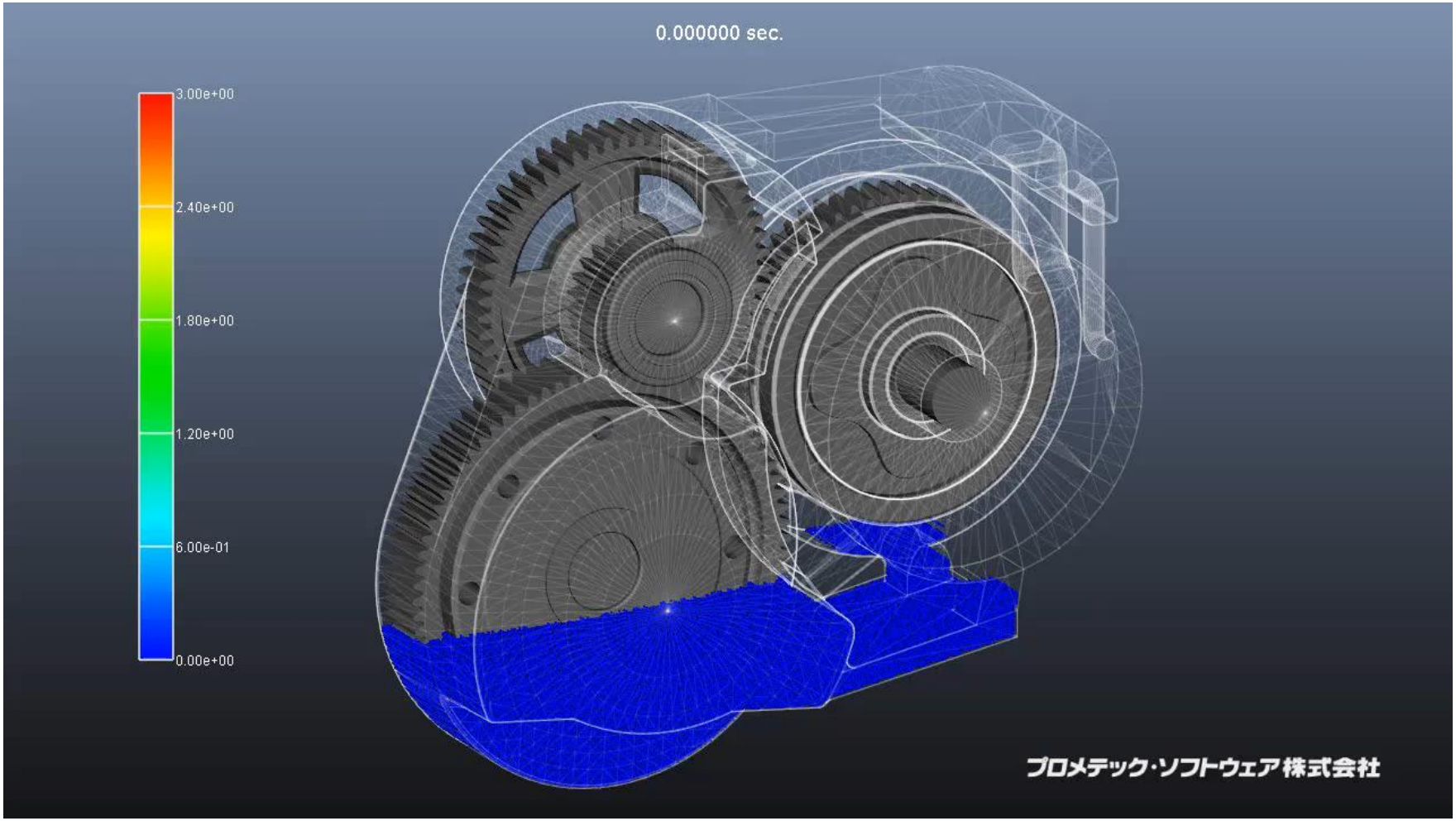


Multi-Physics Platform for Assemblies in Motion



Oil Sloshing Within a Transmission

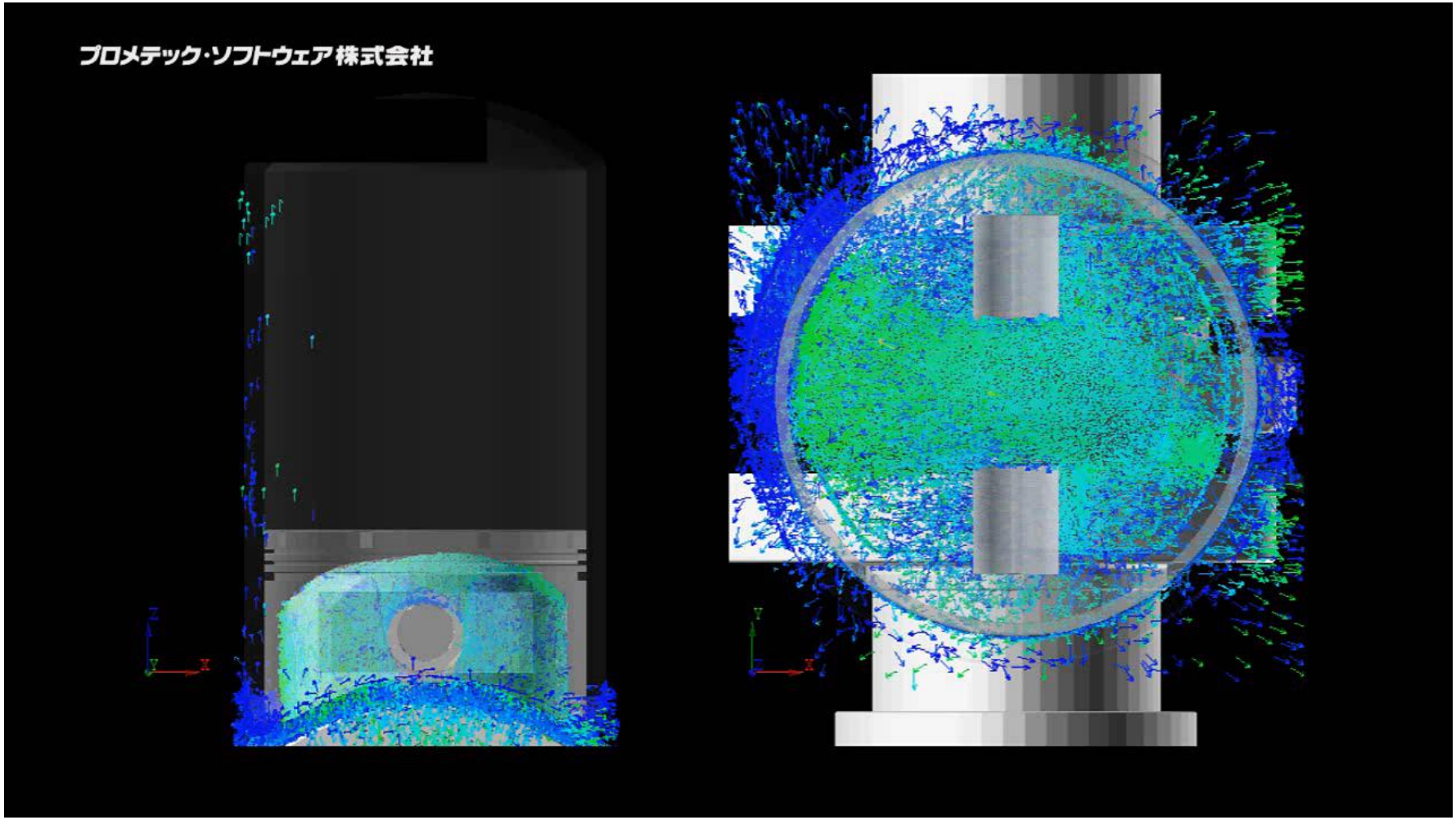
RECURDYN × Particleworks



RECURDYN × Particleworks

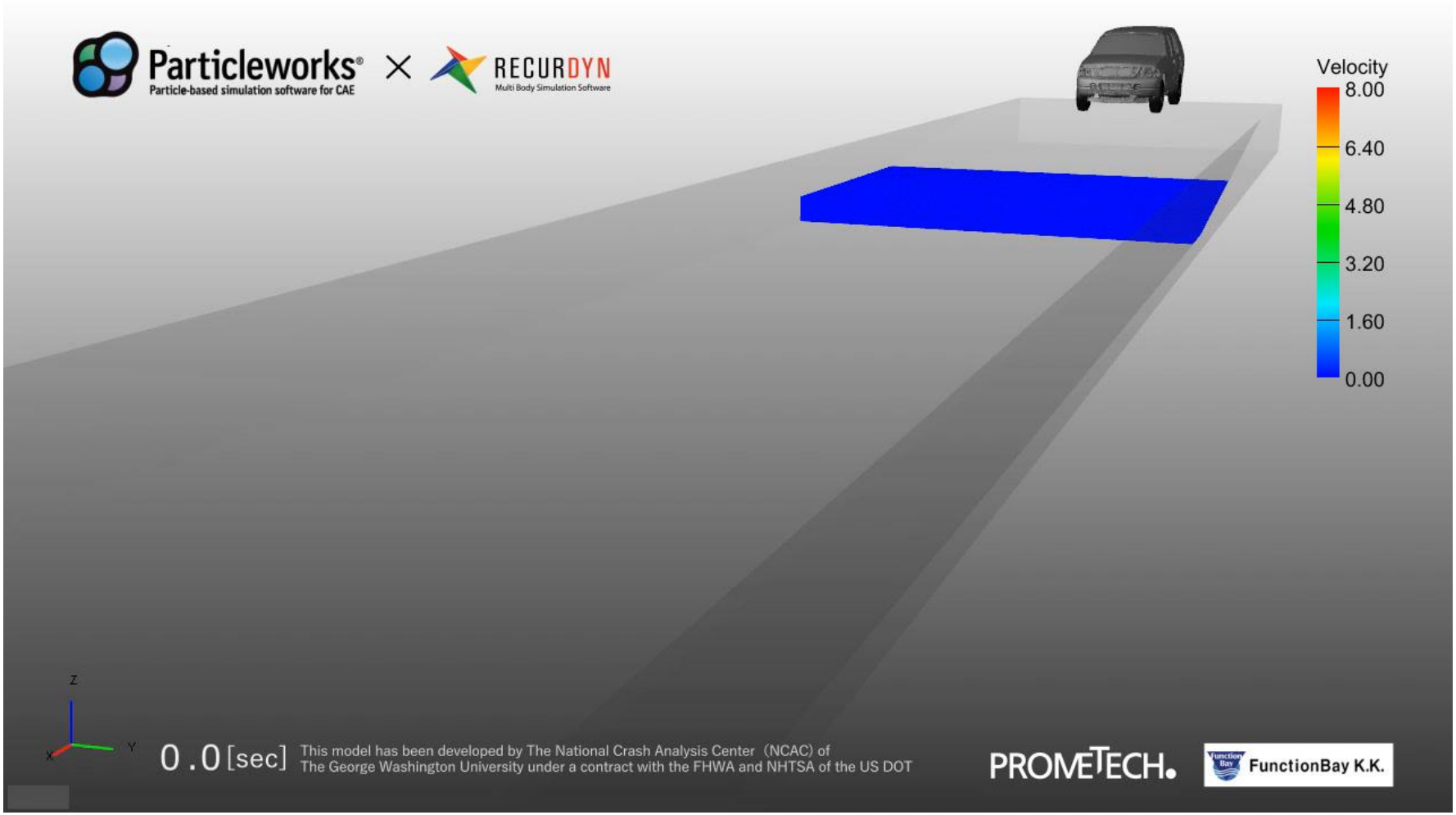
Oil injection on a connecting rod

RECURDYN × Particleworks



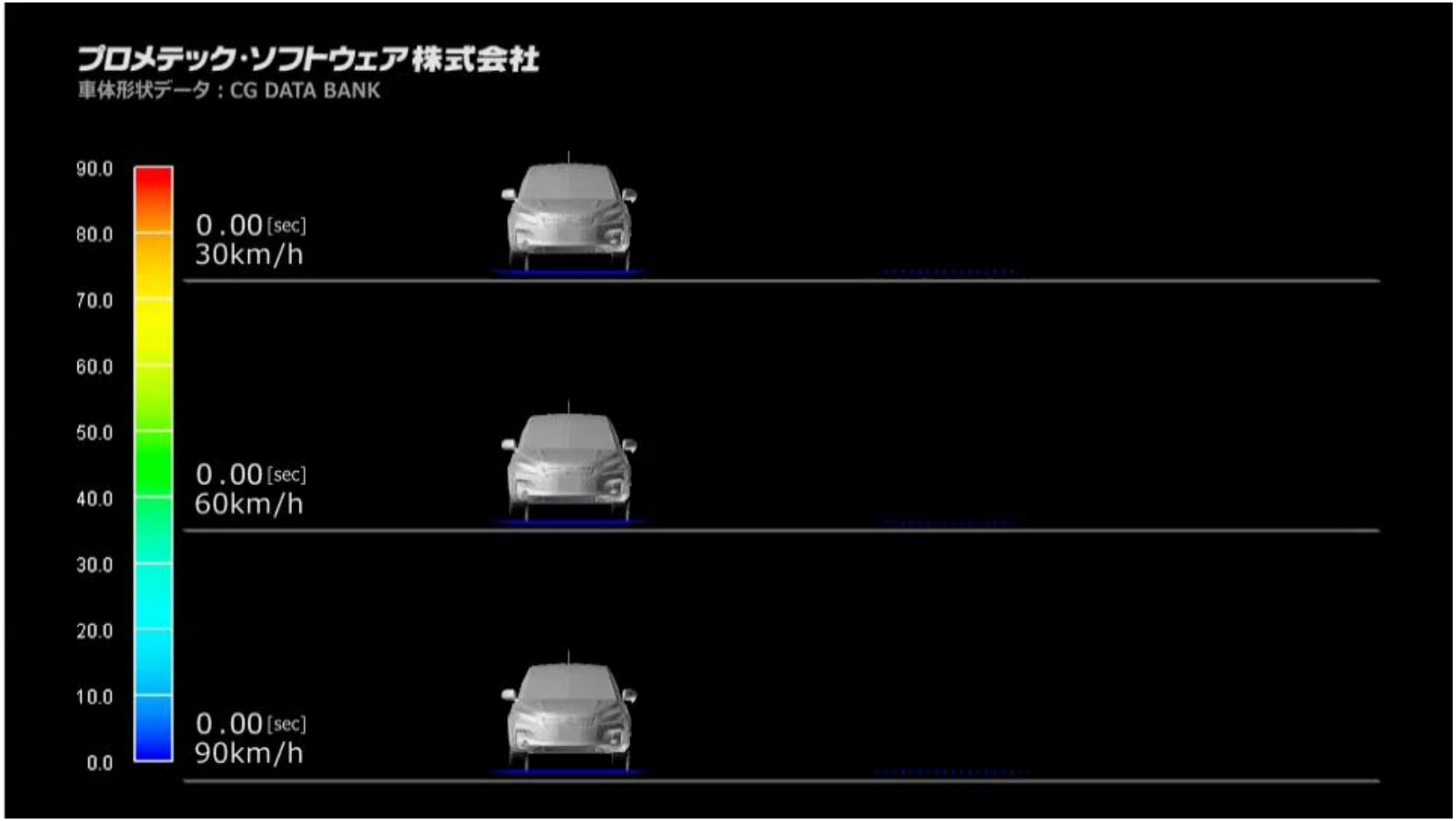
Vehicle on a flooded road

RECURDYN × Particleworks

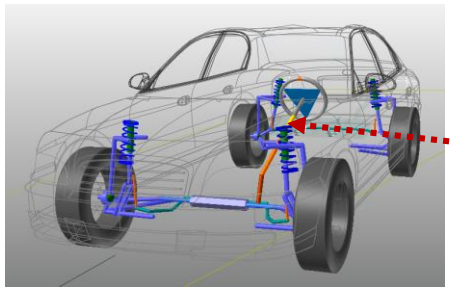


Car Water Splash vs. Velocity

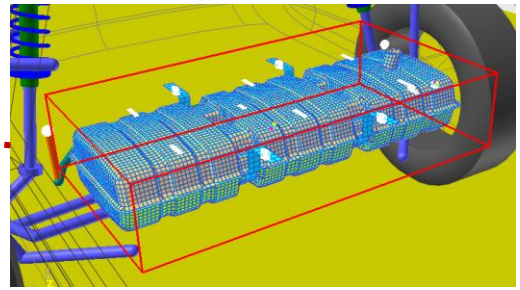
RECURDYN × Particleworks



Fuel Tank Sloshing (Flexible body)

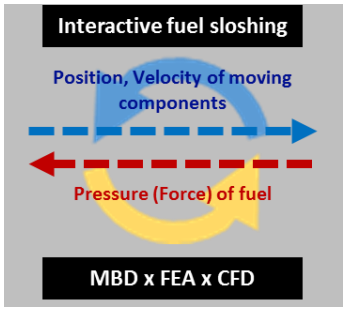


Vehicle Dynamics (RecurDyn)

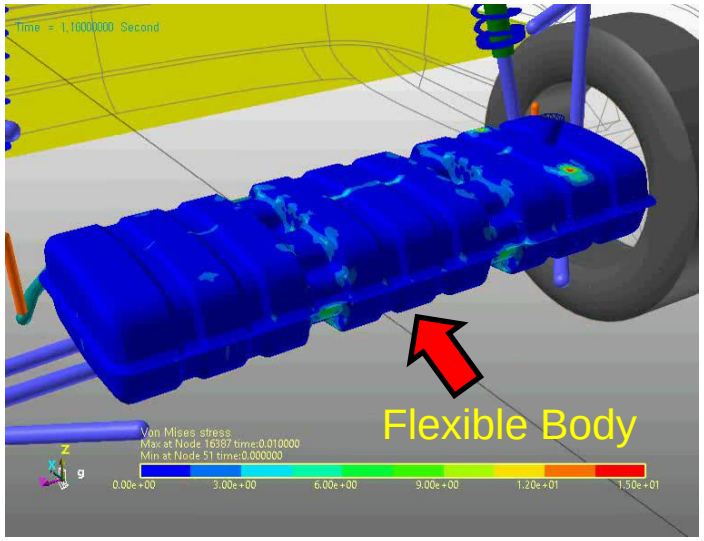


Fuel Tank (RecurDyn / Nonlinear Flex)

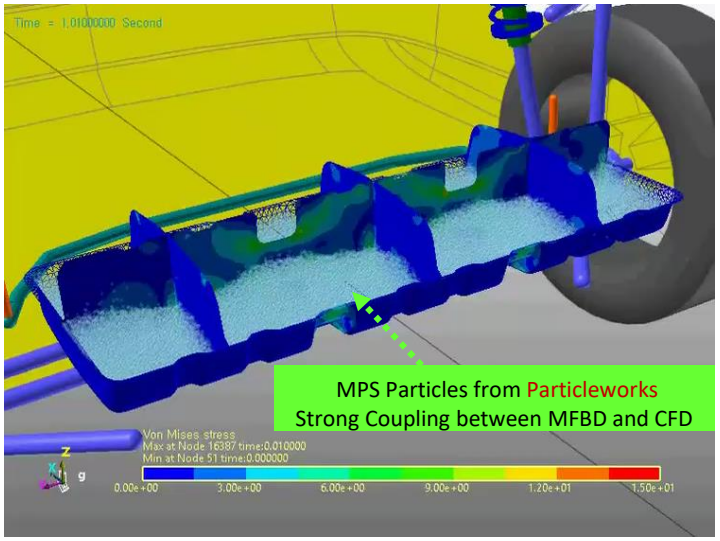
Rigid Bodies + Flexible Bodies



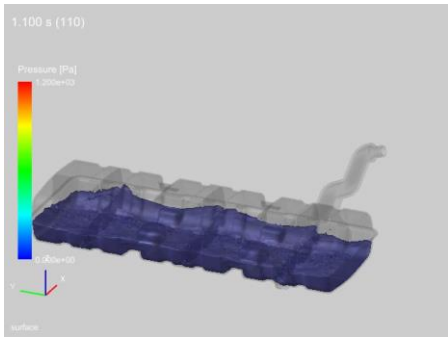
Incompressible Fluid Particles



Outside View (Double Lane Change)



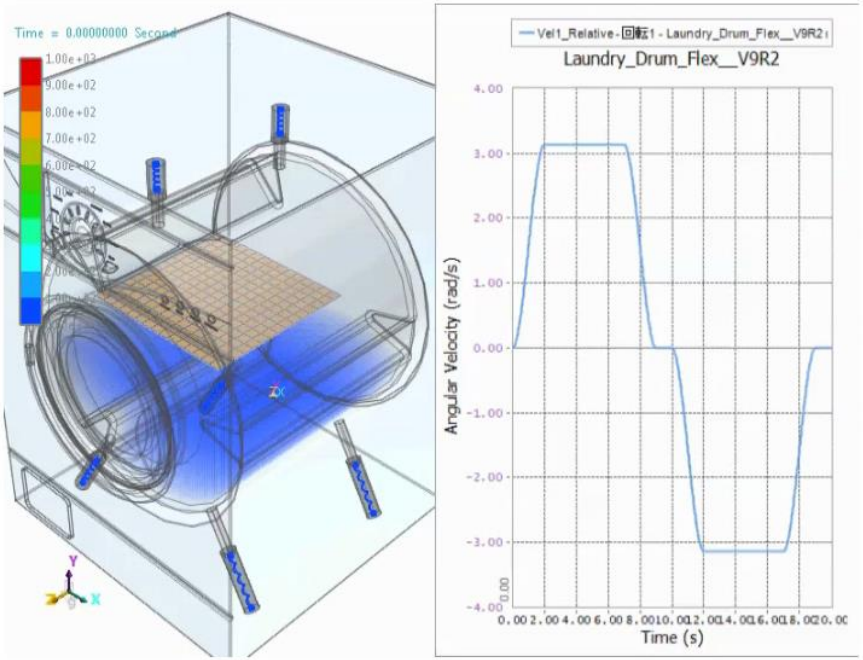
Transparent View (Double Lane Change)

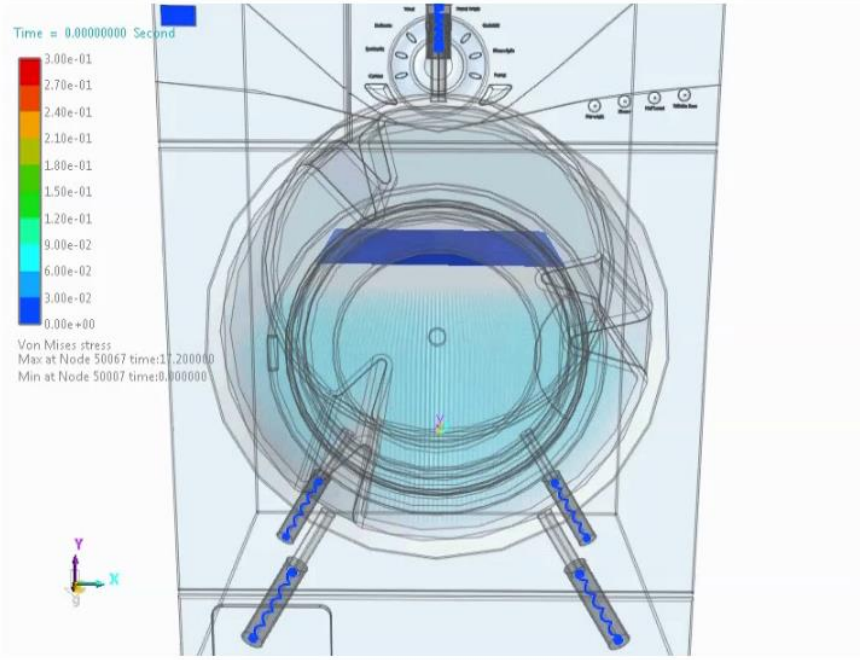


Surface Rendering of the Particles

Washing Machine (Front loading)

RECURDYN × Particleworks





Washing Machine (Front Loading Type) – Coupled simulation with MPS (Particleworks) and Shell element (RecurDyn)

Simulation by FunctionBay K. K.

Why include the impact of bulk materials?

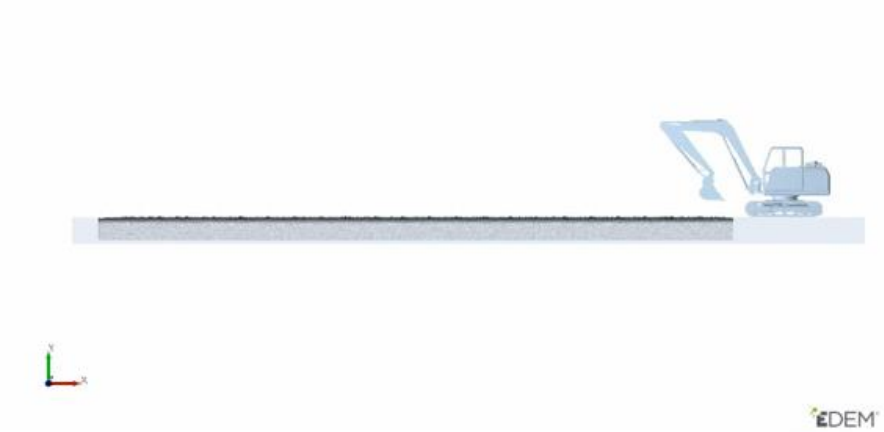
- Material type and behavior imparts loading on equipment
- Material loads affect the mechanical systems and machine performance

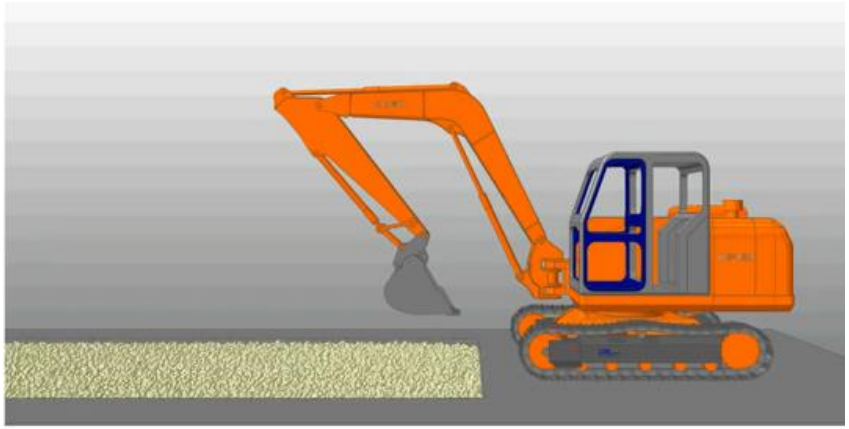
- Bulk materials have complex behavior.
- Predicting the effect of material on equipment is challenging
- Assumptions can lead to expensive mistakes

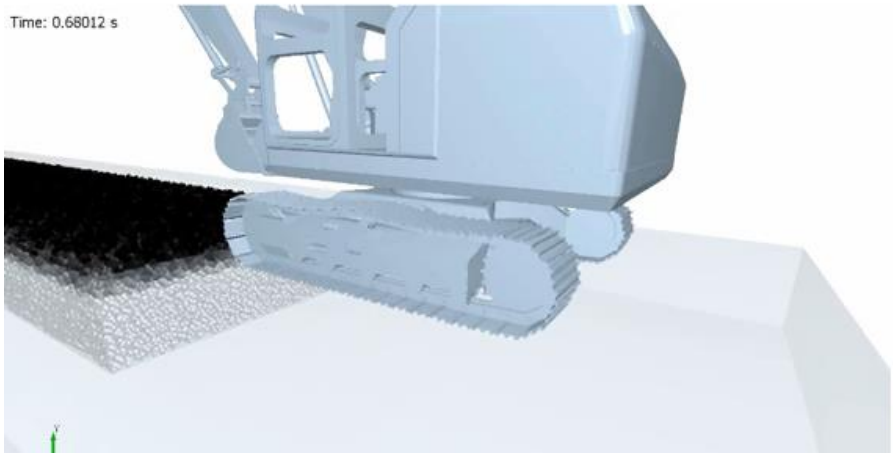
EDEM™

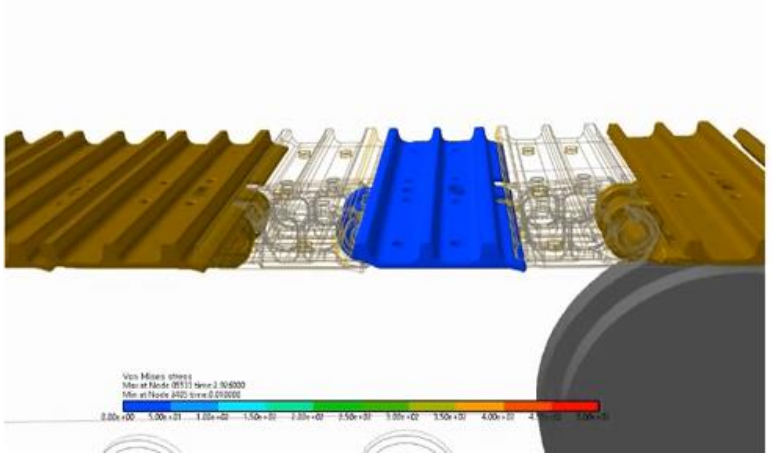
Off-Road Transit of Excavator

RECURDYN × EDEM™









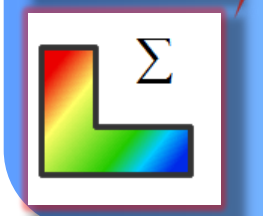
4-Wheel Drive Loader

Wolf Star Products

True-Load

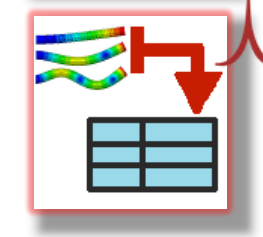
TRUE LOAD™

Turns Components into load transducers



TRUE QSE™ ***Q**uasi-**S**tatic **E**vents*

Linearly Superimpose results via user defined functions



TRUE LDE™ ***L**inear **D**ynamic **E**vents*

Post-Process linear dynamic solutions

Time, Frequency, PSD Domain

FEA Fatigue Software

FEA based fatigue

Connect to All RECURDYN

motion PORT

Motivation

Wolf Star Technologies
True-Load

1. What's the load?
2. True-Load provides
   - Strain correlated loading
   - Full field knowledge from a handful of strain gauges
   - Easy interface to FEA Durability SW
3. First to market solution

Products and Loading

Wolf Star Technologies

True-Load

Connect to All RECURDYN

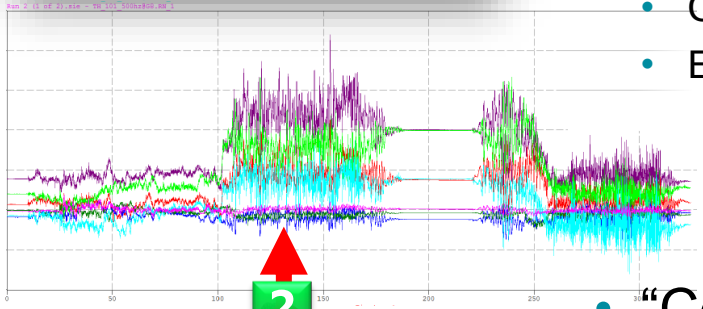
MOTION PORT

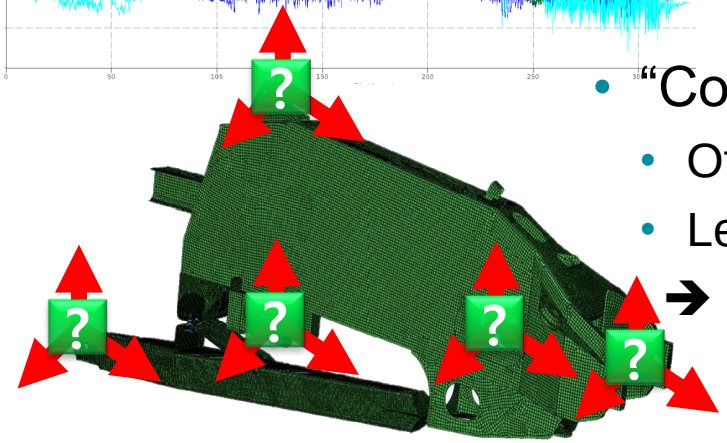
Historical Concerns with Loading

- Loading profile is biggest unknown in analysis (GIGO)
- Poor loading drives extra iteration cycles ➔ $$$
- Traditional load measurement:
  - Is expensive ➔ Load transducers can cost $10,000+
  - Is expensive ➔ Requires modifications to mount transducers
  - Is inaccurate ➔ Changing structure changes loads & load paths
  - Not aligned with analysis ➔ Needs to 're-work' data & FEA

Historical Concerns with Strain Measurement

True-Load





- Strain gauge placement from heuristic knowledge
- Simulation (FEA) does not match test data
  - Many hours spent post-test to “adjust” loading
  - Only one or two points / channels of data are targeted
  - Entire event is not well understood
- “Correlated” load cases used for future designs
  - Often missing key elements of loading influence
  - Leads to wasted iterations in hardware

➔ Wasted Time, Wasted $$$

What's Wrong?

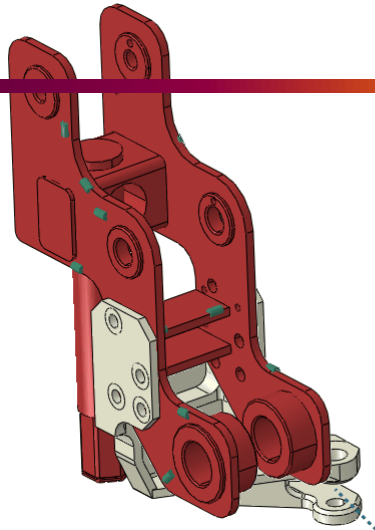
True-Load

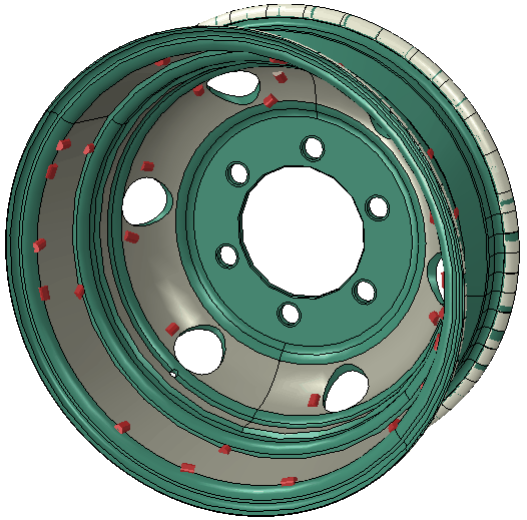
- ✓ High Fidelity Models
  - ✓ Skilled FE Analysts
  - ✓ World Class FEA Software
- ✓ High Fidelity Testing
  - ✓ Instrumentation
  - ✓ Equipment
  - ✓ Data Processing
- ✓ High Fidelity Fatigue
  - ✓ fe-safe®
  - ✓ Design Life
  - ✓ Safe Design

- ✘ Too many variables to manage
  - ✘ Gauge Locations
  - ✘ Load Cases
  - ✘ Quantity of Data
  - ✘ Unique loading for each data point
- ✘ Impossible to perform manually

Poor loading knowledge causes extra design iterations = $$$$

The Solution – True-Load™

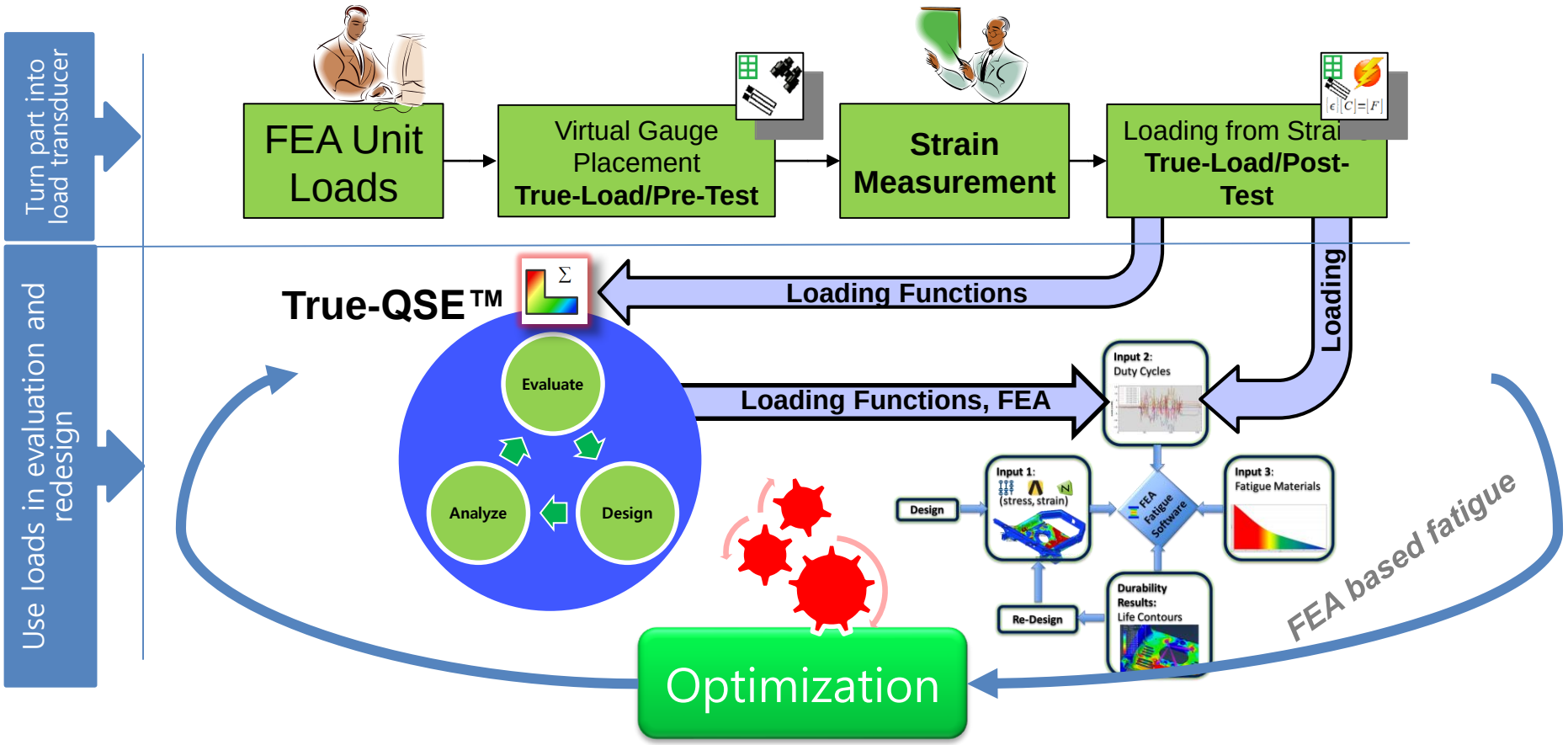




- In-situ load measurement
- Turns complex components into multi-channel load cells
- Leverages FEA Model and Test Data
- Works with all FEA
- Optimal placement of Strain Gauges
- Direct interface to FEA-based fatigue

The True-Load™ Workflow

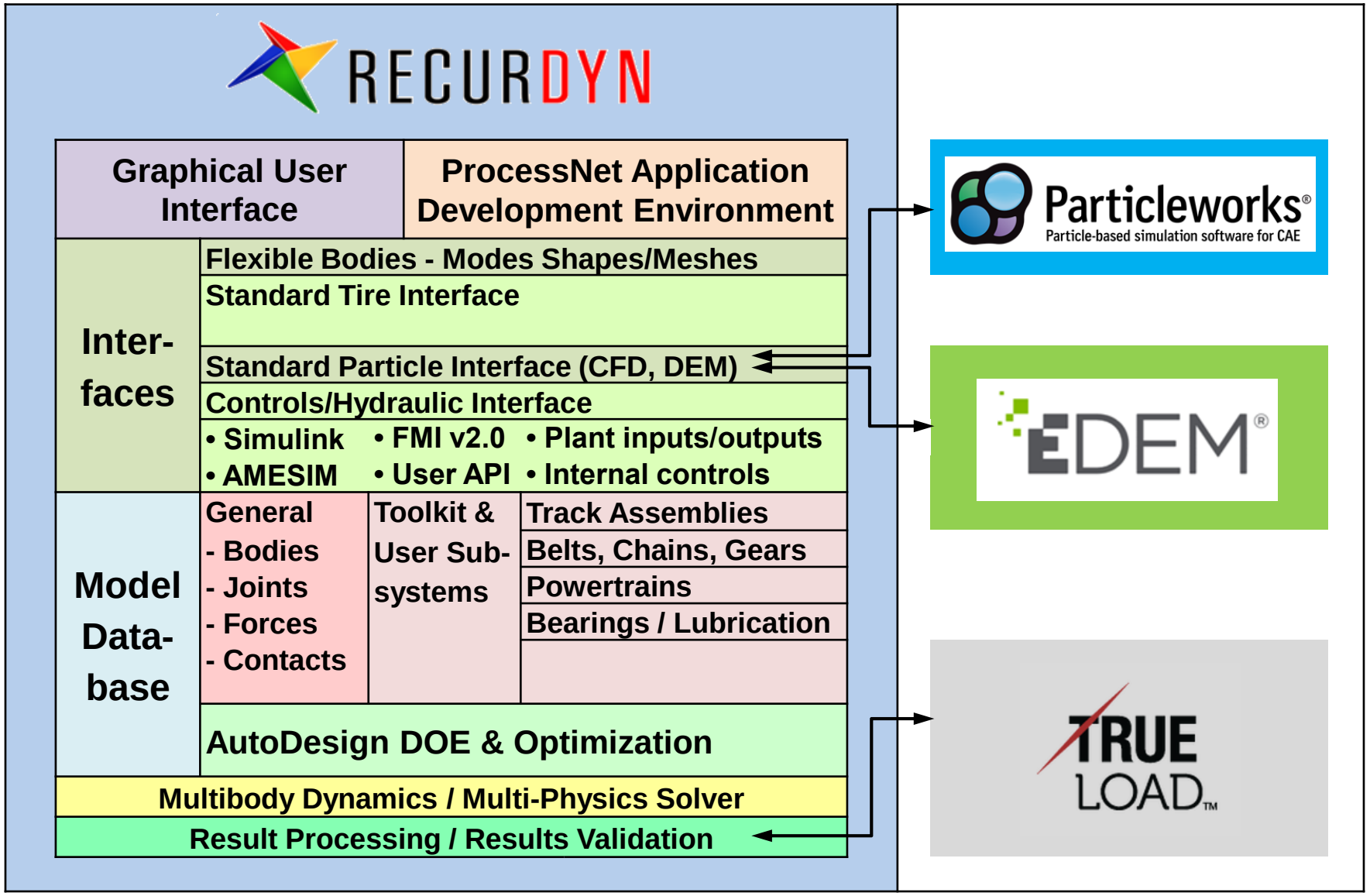
Wolf Star Technologies
True-Load



Connect to All RECURDYN

motion PORT

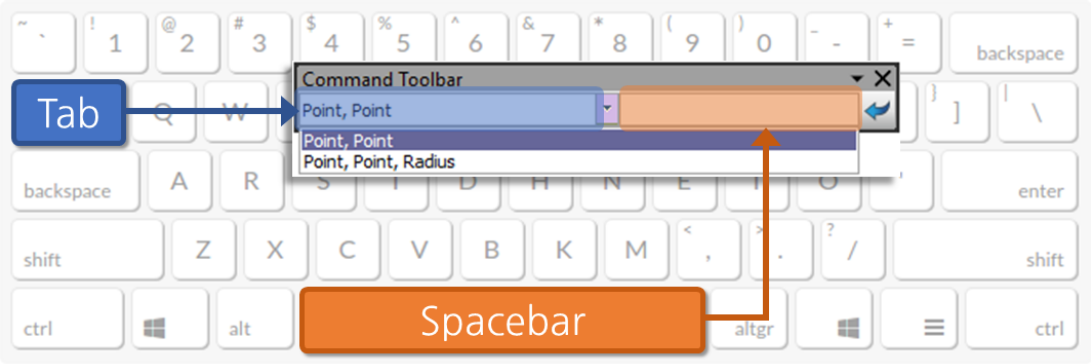
Multi-Physics Platform for Assemblies in Motion



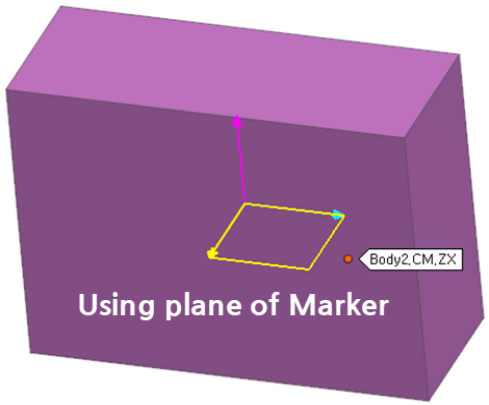
RecurDyn/Professional

1. View Operation Enhancement (1)

1. **Input shortcut for Modeling Option**
   1) Users can change the Creation Method and enter a value in the Input Window with a keyboard shortcut (Tab + Spacebar)



2. **Reference point selection for Zoom (Ctrl+Mouse Scrolling)**
3. **View at Plane and Change to Plane**

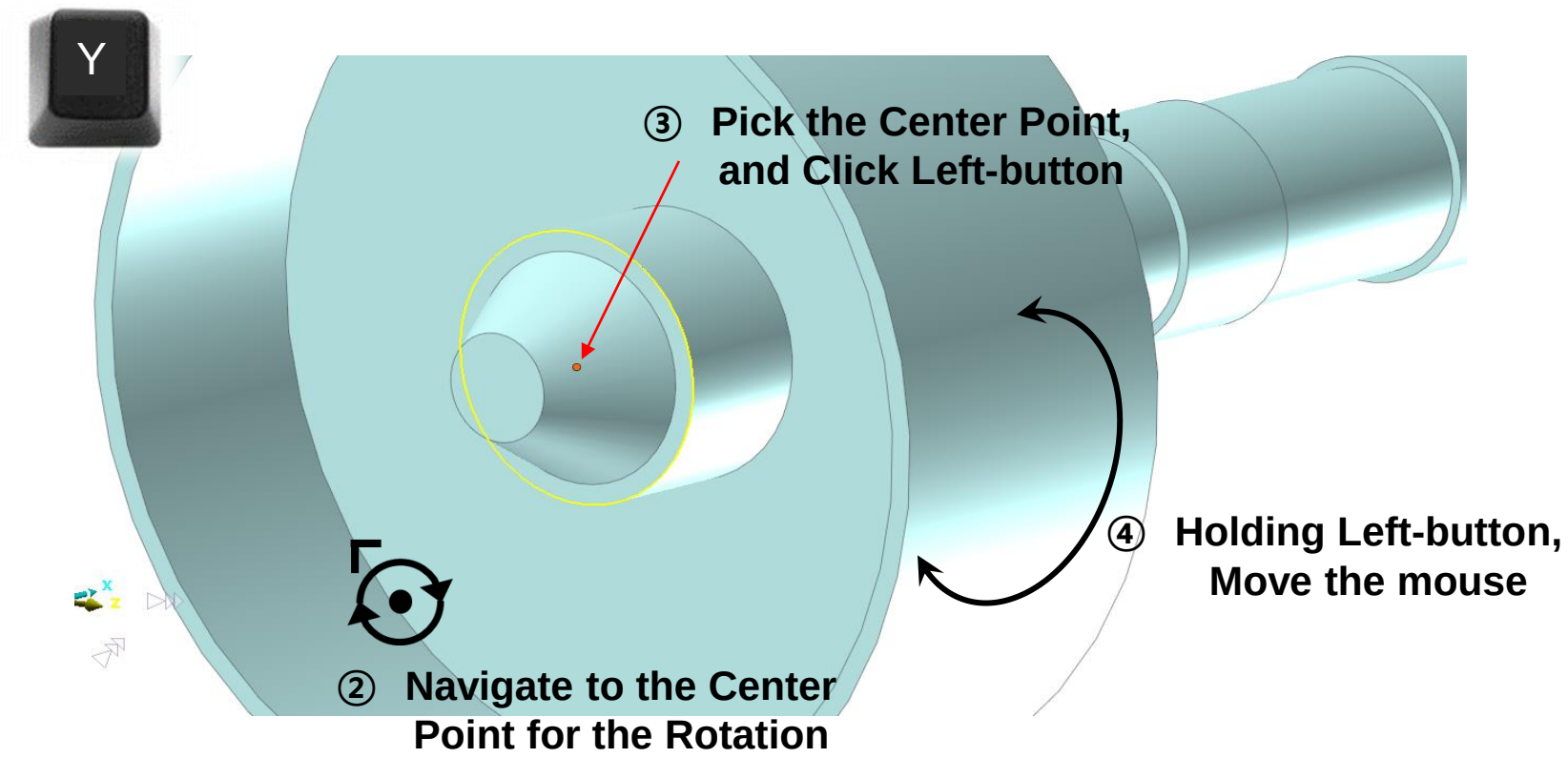


1. View Operation Enhancement (2)

4. Rot. View Operation Upgrade

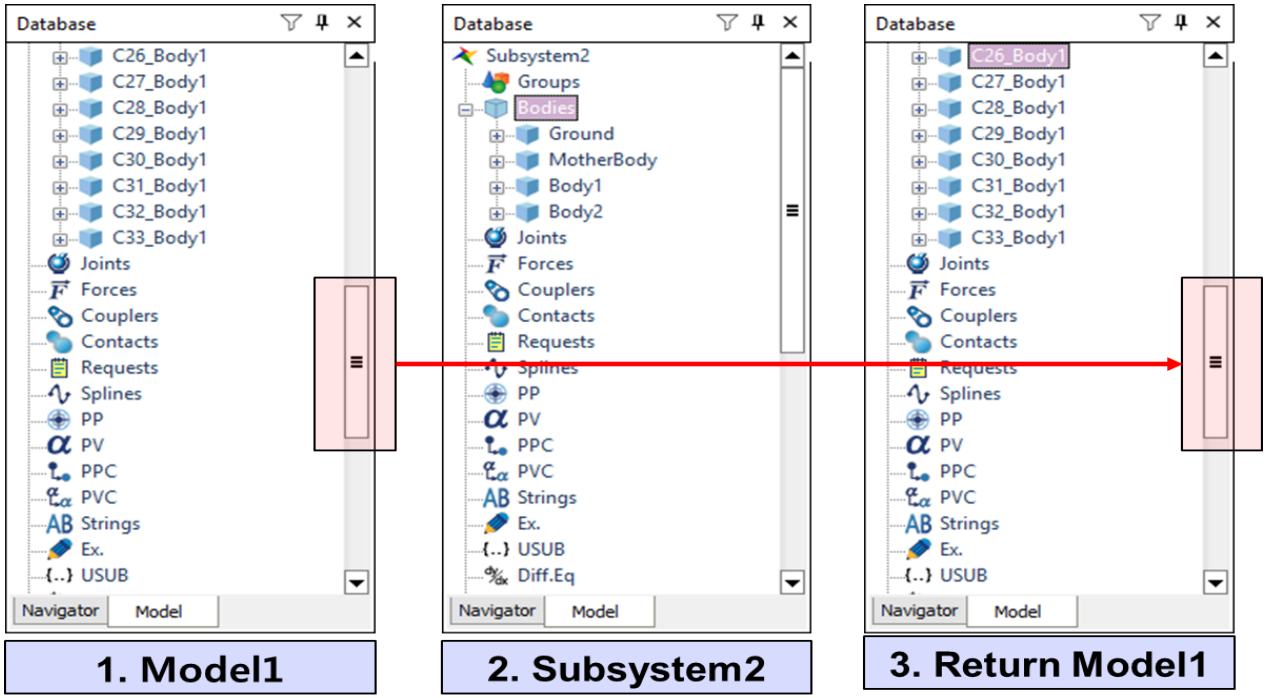
User can pick a Geometry Point as desired during Rotation View Operation to define the Center Point for Rotating the View

① **Press the "Y" key**



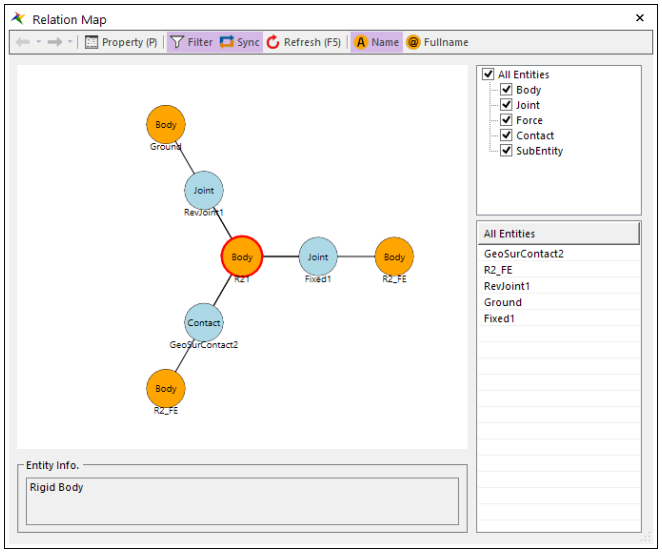
2. Database Convenience

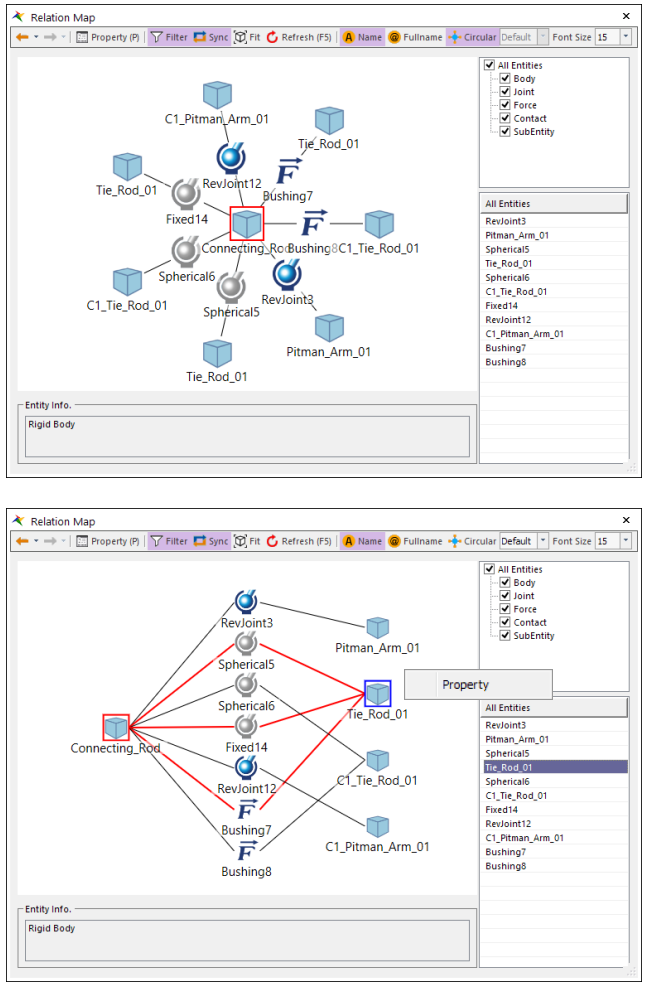
The Database window remembers and keeps the last spot of the scroll bar when moving to the Edit Mode.



3. Relation Map Enhancements

1. Intuitive icons
2. Highlight the selected relations
3. Property Dialog using pop-up menu



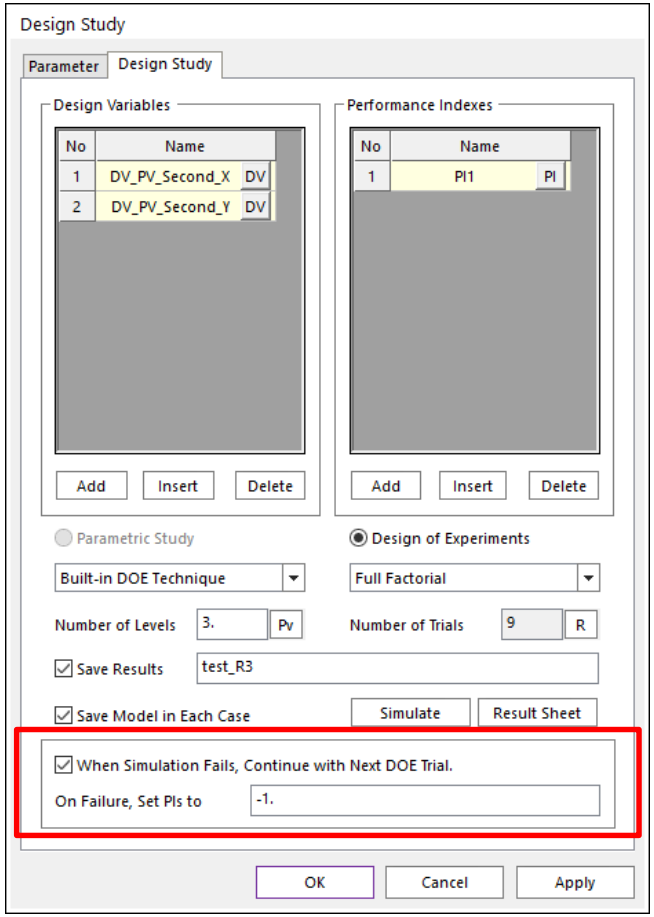


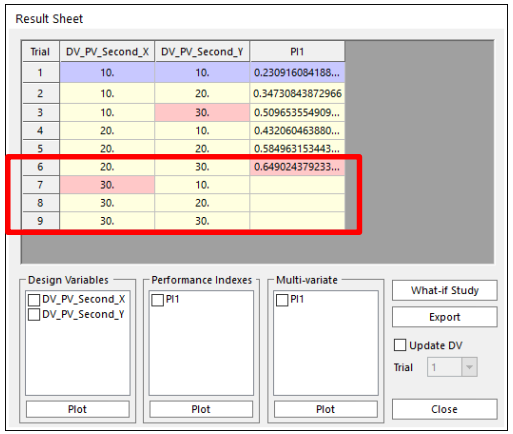
V9R2 **V9R3**

4. Exception handling for interrupted trial during DOE

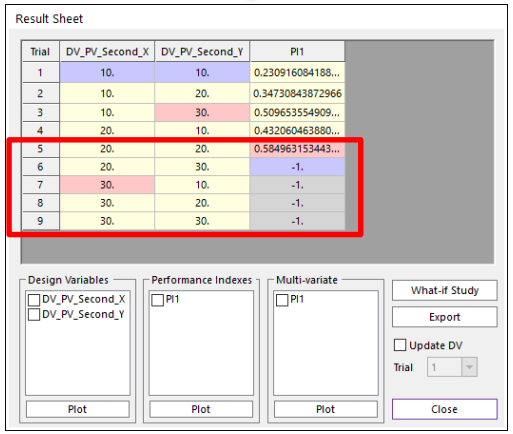
A DOE simulation may be interrupted due to an error in a specific trial.

In this case, an exception handling function has been added so that the entire DOE completes to the end and is not interrupted.





V9R2

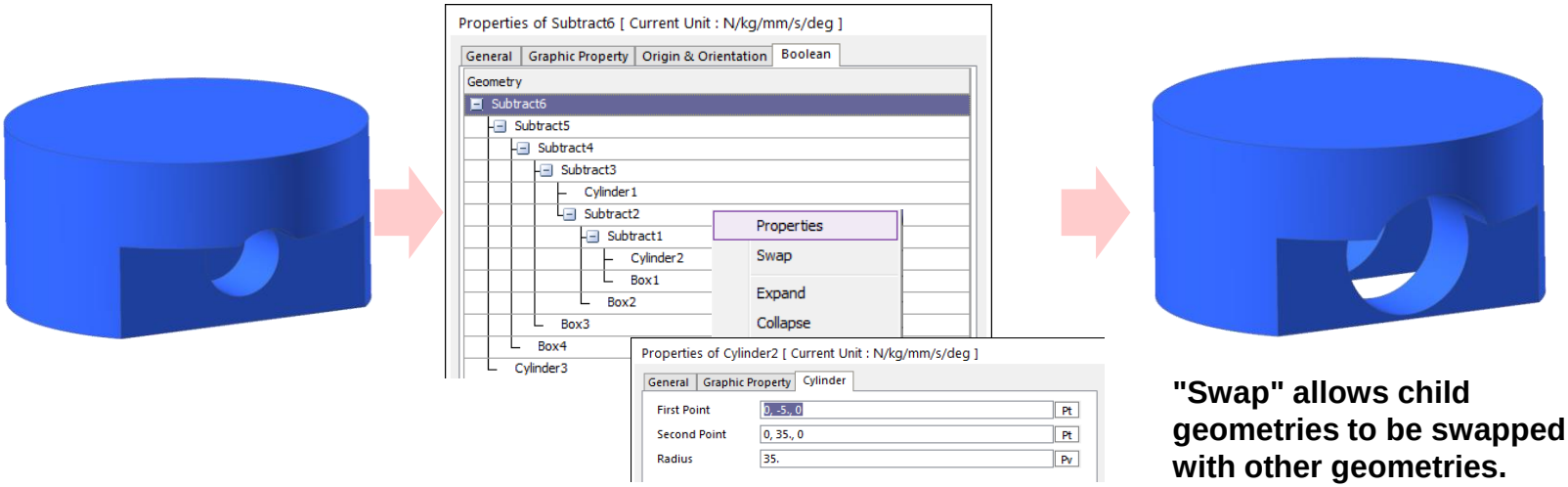


V9R3

5. CAD Enhancements: Boolean and Local

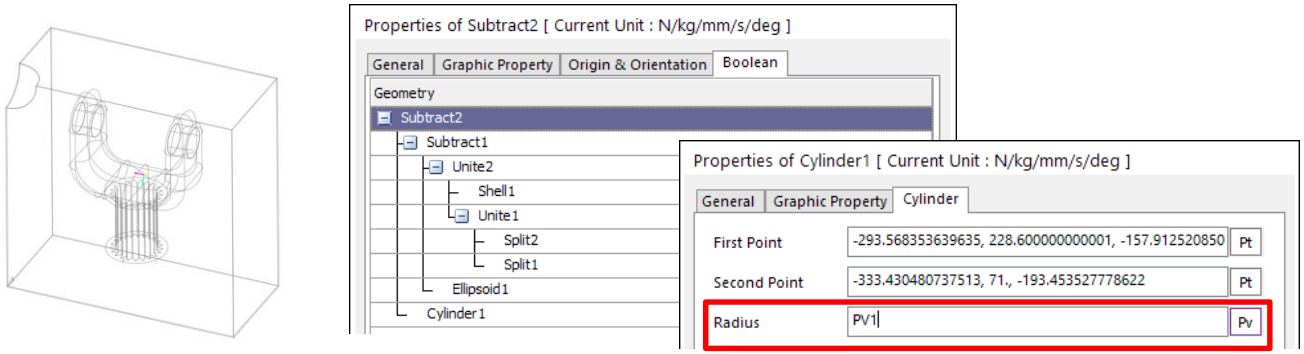
1. Support Modification

1) Parameters for Local/Boolean can be modified



"Swap" allows child geometries to be swapped with other geometries.

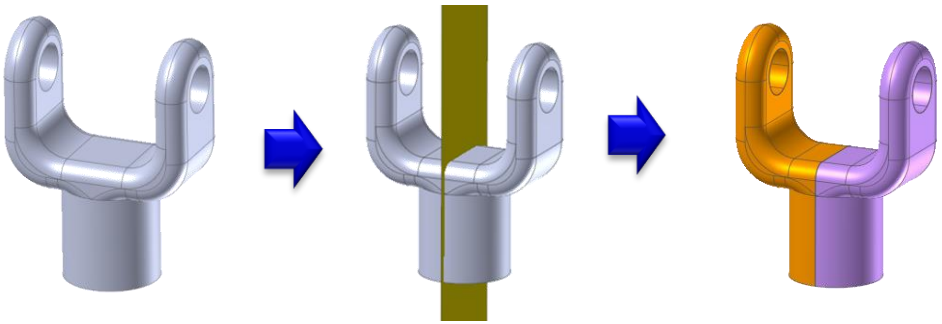
2. Parametric Value is supported (Parametric Modeling)

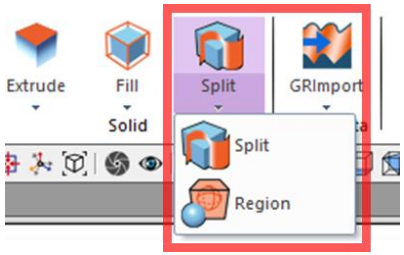


6. CAD Enhancements: Split Solid, Create Solid with Region

1. Split

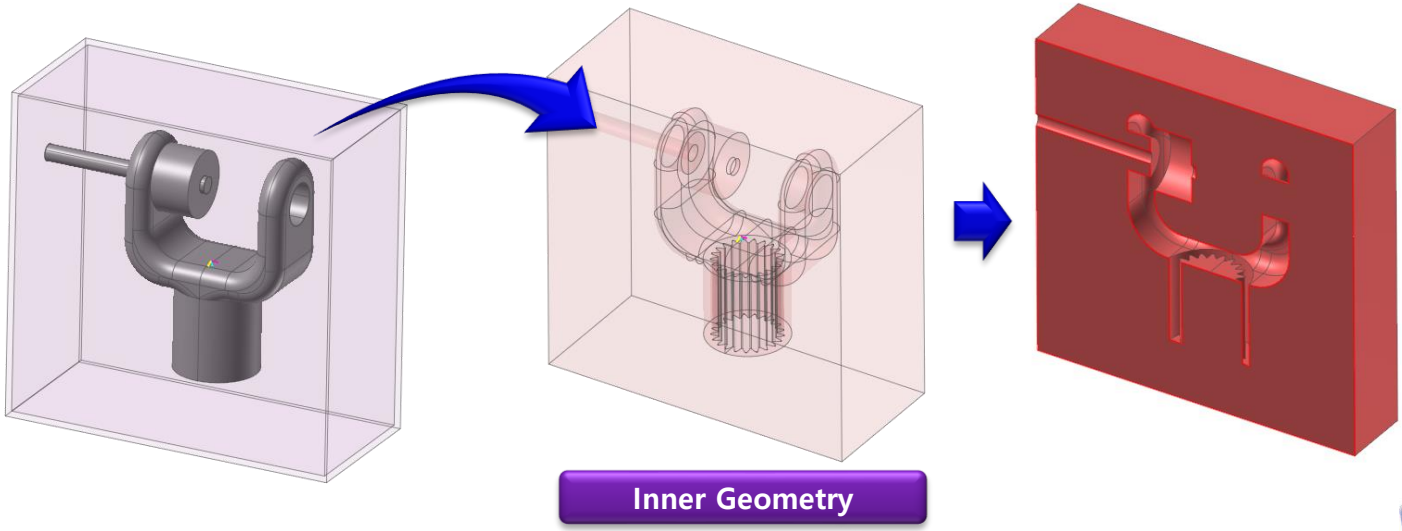
1) The Split Solid separates solids using a surface





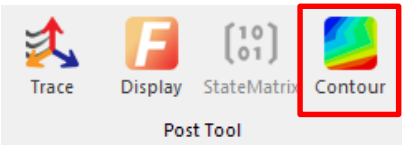
2. Region

1) This operation is similar to the casting manufacturing process

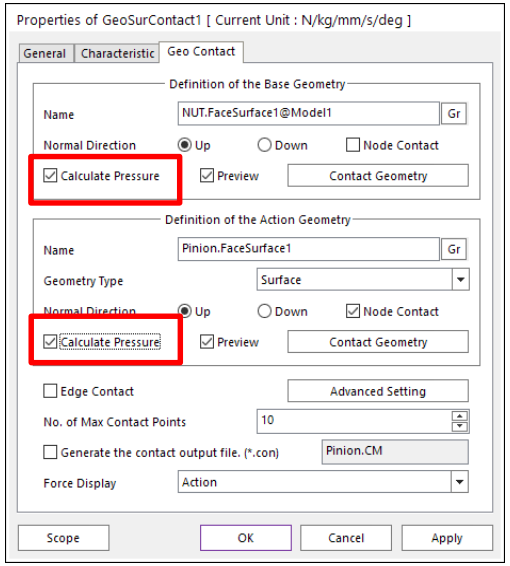


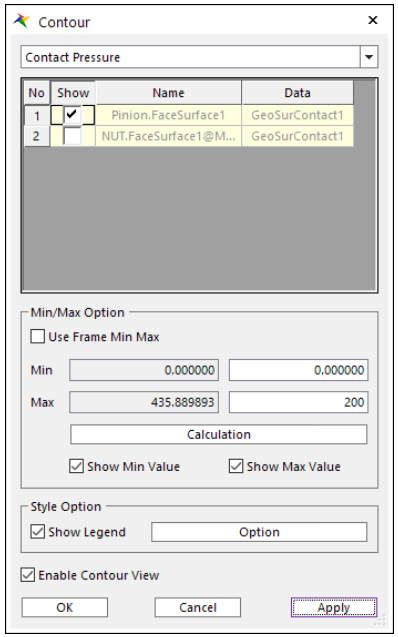
7. Contour and Contact Pressure for Rigid Body

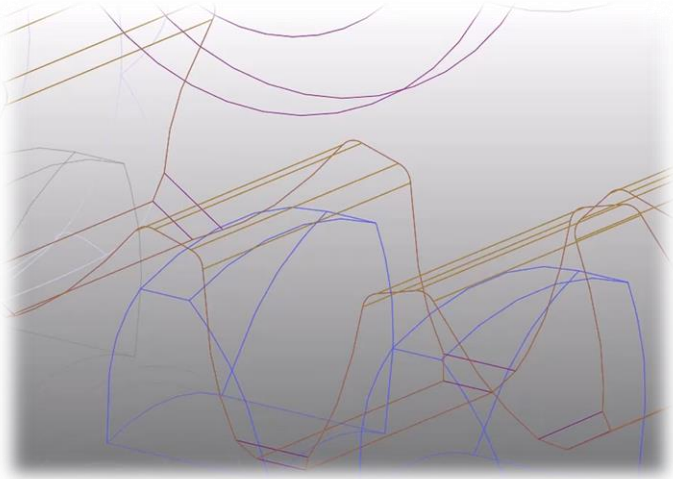
1. **It is now possible to calculate the Contact Pressure for a rigid body using a Geo Surface Contact**
   1) Geo Surface, Geo Sphere, Geo Cylinder
   2) Gear Involute
   3) UV-Surface To Sphere



2. **Calculate Pressure must be checked**



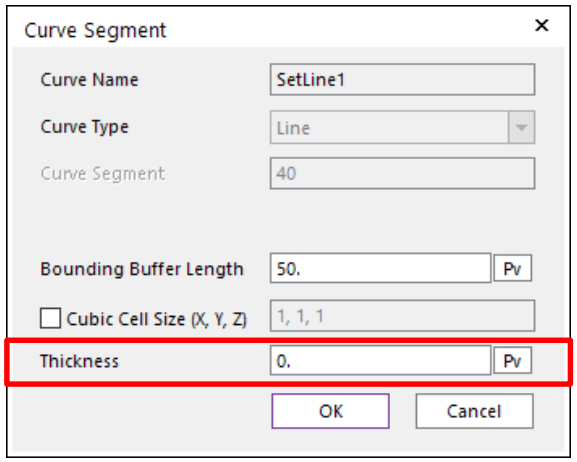




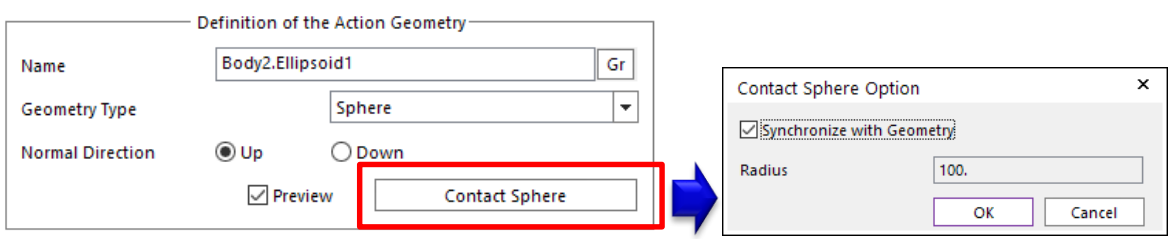
8. Added Thickness and Radius Setting for Geo Contact

1. Thickness of a curve for Geo Curve-Surface

1) the curves of rigid bodies and line sets of flexible bodies

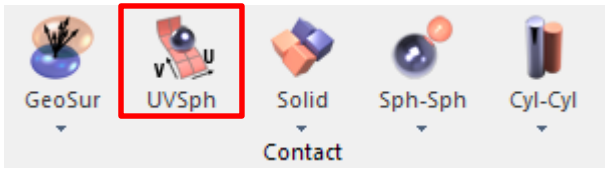


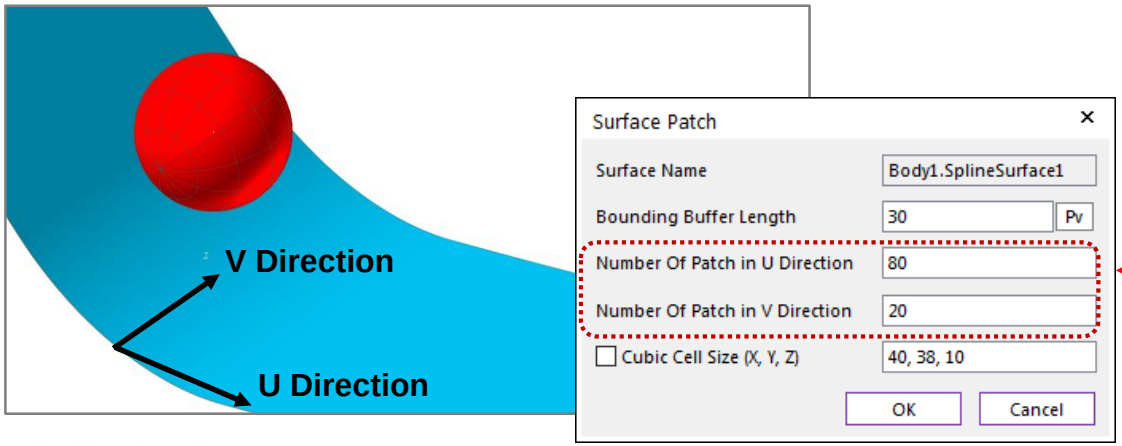
2. Sphere Radius for Geo Sphere Contact

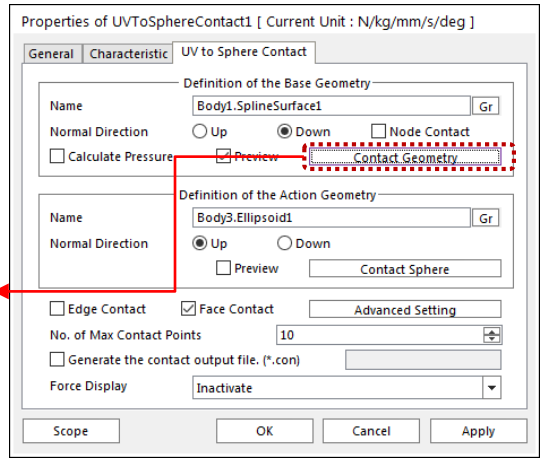


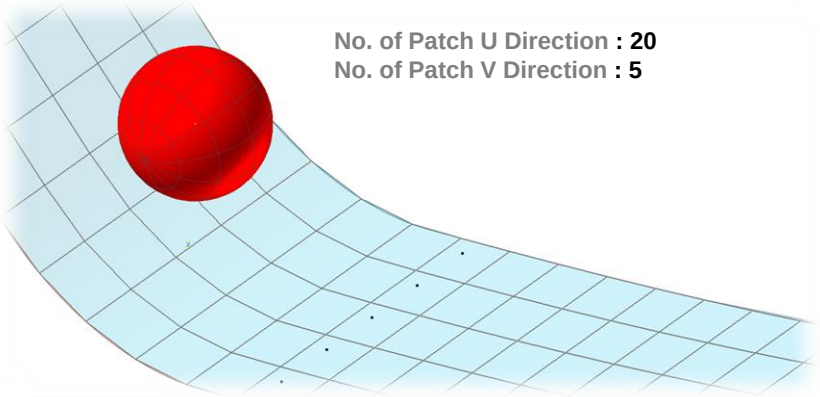
9. UV Surface to Sphere Contact

Smooth and fast contact using UV parameters (UV mapping)

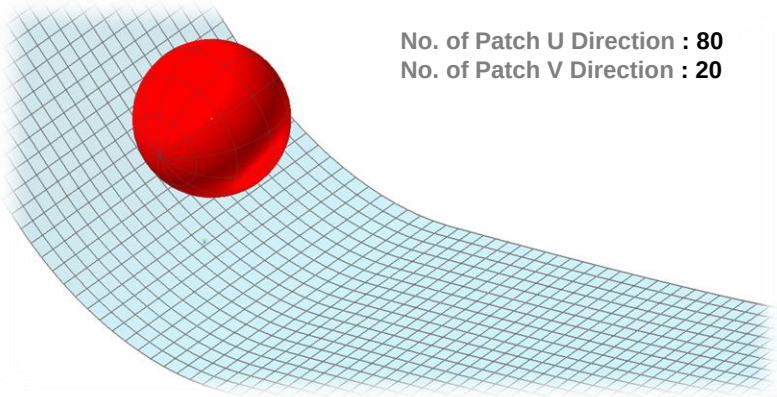






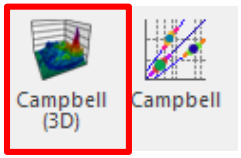


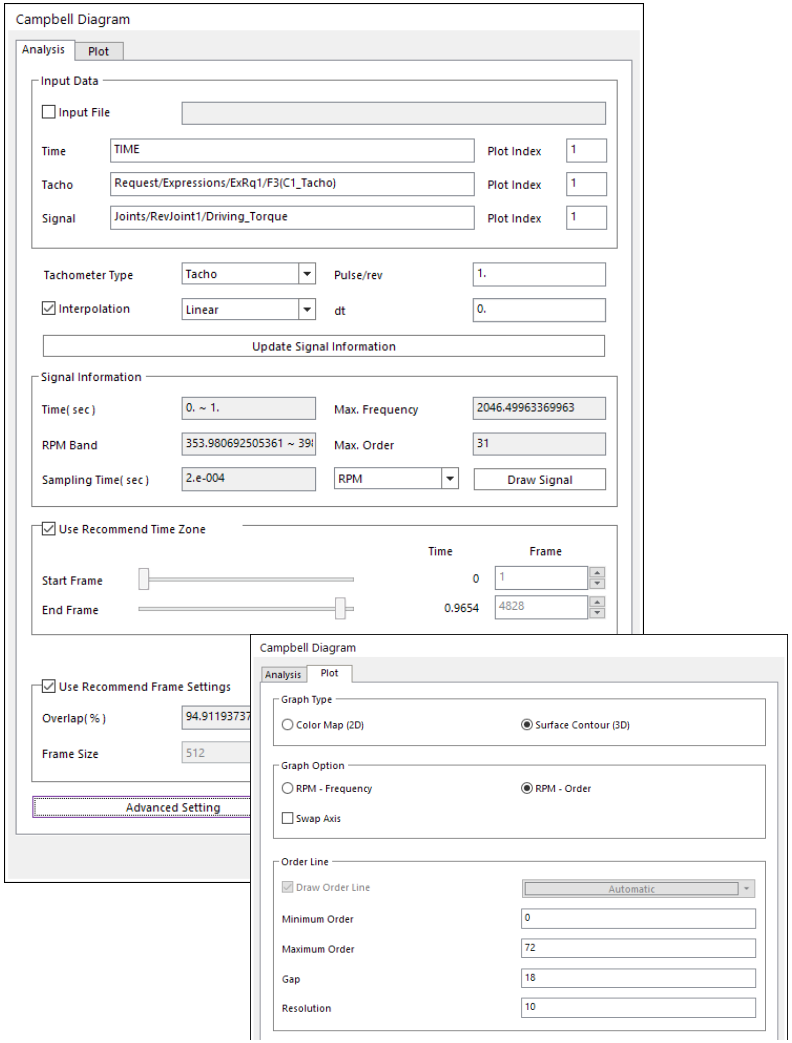
No. of Patch U Direction : **20**
No. of Patch V Direction : **5**

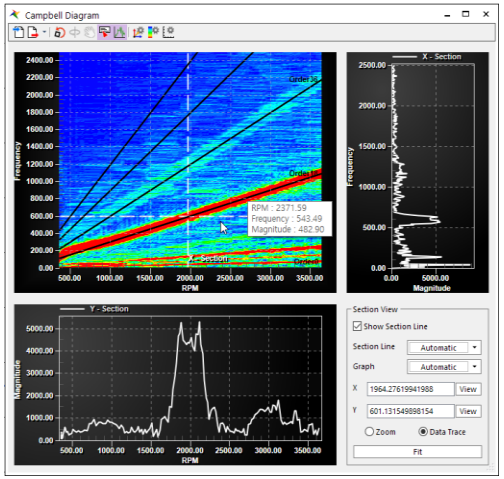


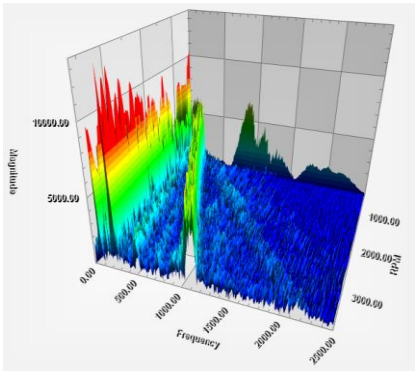
No. of Patch U Direction : **80**
No. of Patch V Direction : **20**

10. Campbell Diagram (3D)

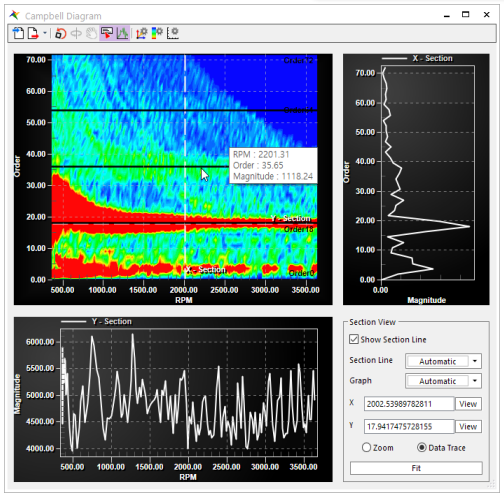


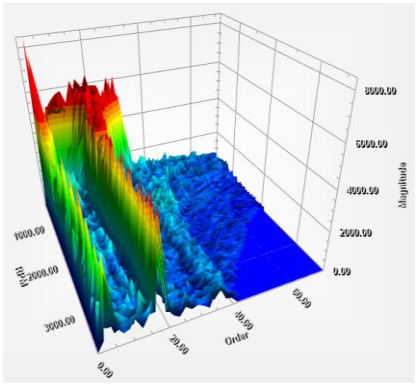






RPM vs Frequency

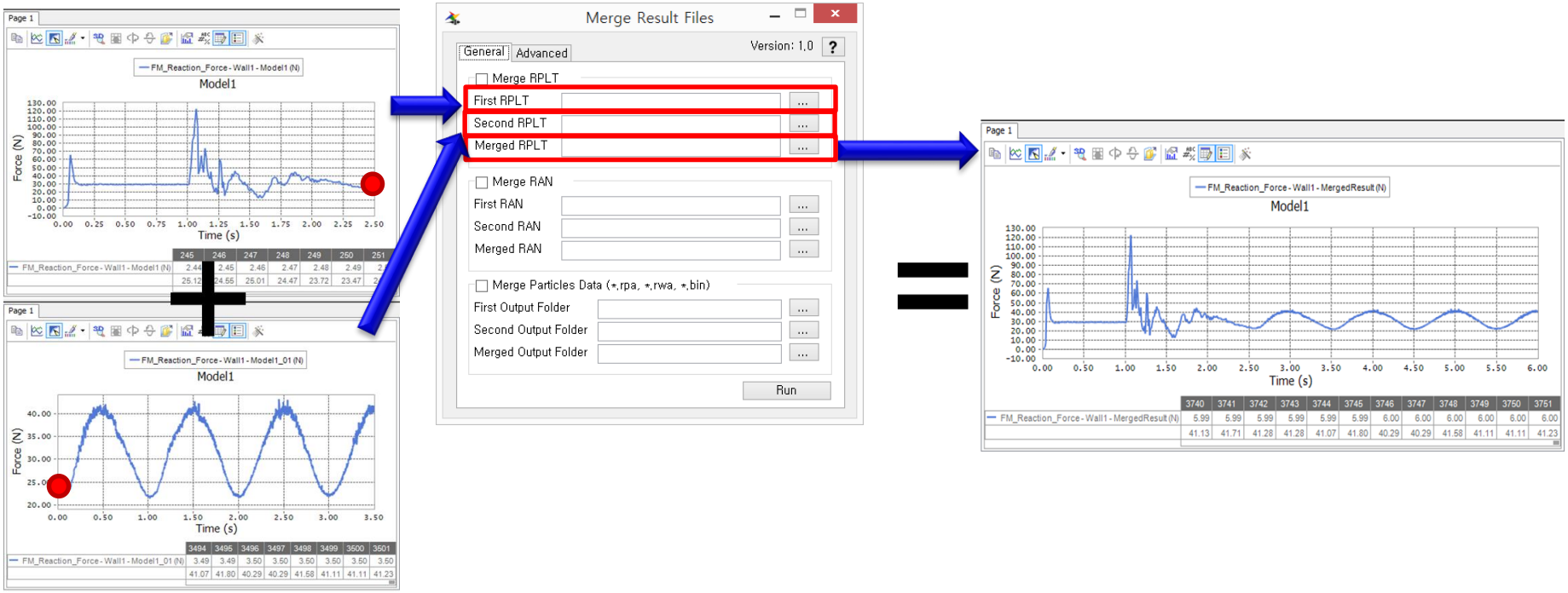




RPM vs Order

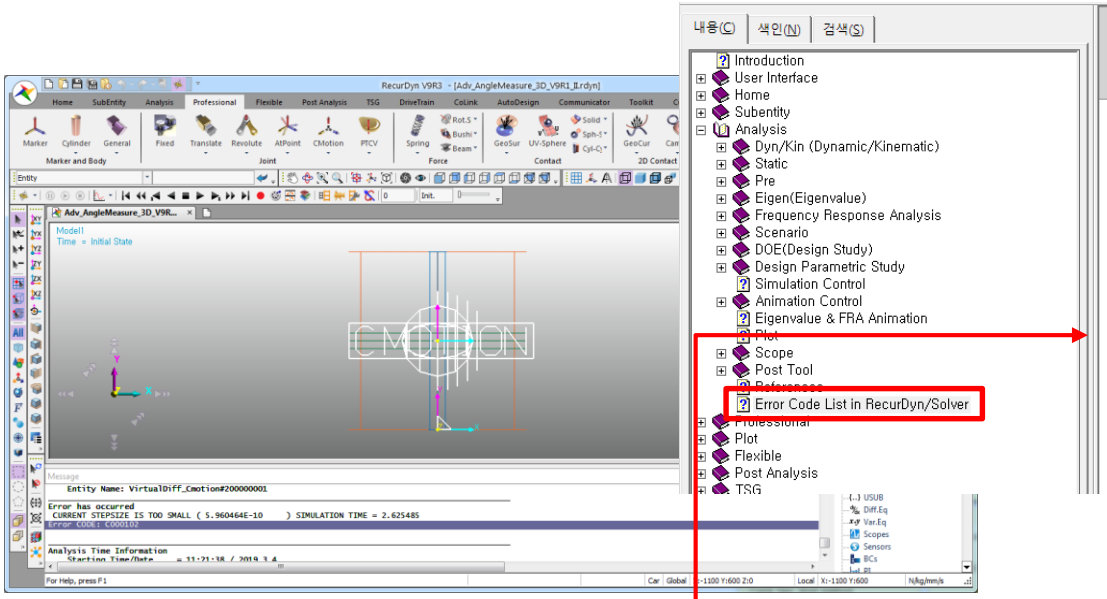
11. Merge Result Files

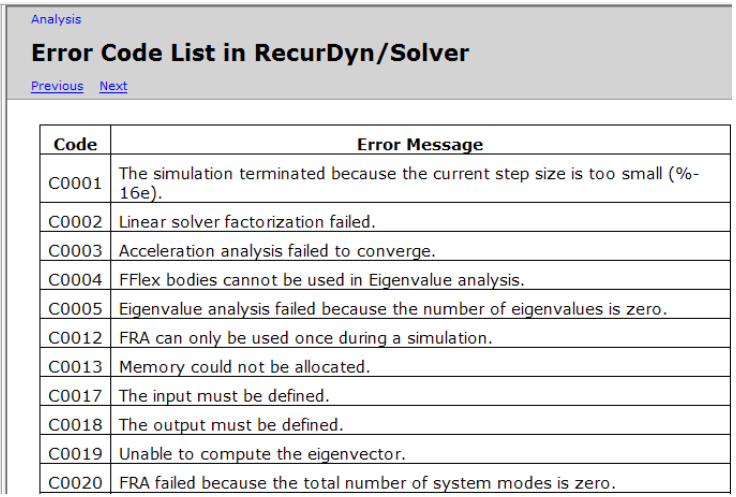
1. **Merge two RecurDyn analysis result files into one result file.**
   1) RPLT, RAN, Particles Data (rpa, rwa, bin)



12. RecurDyn/Help – Error Code description

Solver Error Code description in Help





Analysis

Error Code List in RecurDyn/Solver

Previous Next

Code	Error Message
C0001	The simulation terminated because the current step size is too small (%-16e).
C0002	Linear solver factorization failed.
C0003	Acceleration analysis failed to converge.
C0004	FFlex bodies cannot be used in Eigenvalue analysis.
C0005	Eigenvalue analysis failed because the number of eigenvalues is zero.
C0012	FRA can only be used once during a simulation.
C0013	Memory could not be allocated.
C0017	The input must be defined.
C0018	The output must be defined.
C0019	Unable to compute the eigenvector.
C0020	FRA failed because the total number of system modes is zero.

13. Other New Functions in RecurDyn/Professional (1 of 2)

- (G092) **"ModelName_mck.m" file containing the mass, stiffness, and damping matrix of the "Rigid-RFlex" system can be generated, after performing "State Matrix", "Eigenvalue analysis", or "FRA analysis".**
- (G102) **"Starting Time" and "Starting Date" are printed in the message file (*.msg), when starting a simulation.**
- (G313) **"View Center", "Rotate with Point", "Zoom", "Zoom with Ctrl key", "Change to Plane", and "View at Plane" functions are available while an animation is playing.**
- (G314) **"Offset Edge Imprint" function is added. It can imprint an edge with the offset value in the solid and surface geometries.**
- (G313) **"View Center", "Rotate with Point", "Zoom", "Zoom with Ctrl key", "Change to Plane", and "View at Plane" functions are available while an animation is playing.**
- (G321) **"Sort By Type" function is added to arrange the entities on "Database Window". The entities are sorted by entity types.**
- (G414) **Apart from what is defined in a *.rmd file, there is an option file that allows you to set the number of threads and whether to create a ran file in "Standalone Solver".**

14. Other New Functions in RecurDyn/Professional (2 of 2)

- (32634) **“Improvement Pre Analysis Accuracy” option is added in “Simulation Setting” dialog to improve accuracy for Pre-Analysis. It is useful when the results of “Dynamic Analysis” are incorrect because of the accuracy of Pre-Analysis.**
- (33617) **The view status of a body or a subsystem is maintained when moving into “Body Edit Mode” or “Subsystem Mode”, if “Auto Fit for the Change for Working Window” option in “Display Setting” is turned off.**
- (33512) **The center of a sphere is available when navigating a point.**
- (32565) **A menu to open “Utility Folder” is added on the ribbon help menu.**
- (32943) **“User-Subroutine” examples are included in Linux install package.**
- (32967) **“CMOTION” expression function is added.**
- (31888) **The shortcut “Shift + I” is supported to exit edit modes or subsystem modes.**
- (30994) **"Result Sheet Export" function in “Design Study” supports *.csv formatted file.**

15. RecurDyn/ProcessNet - New Functions

- (G093) **“Frequency Response Analysis” is supported in ProcessNet.**
- (G281) **New “IBody.FileExportGeometry” function exports geometry to “Parasolid File (*.x_t or *.x_b)”.**
- (G333) **“CloneBodyChange.dll” is added in “<Install Dir>/Bin/Addin” folder. The “CloneBodyChange.dll” changes clone bodies of the toolkit assembly to general bodies with general connectors such as “Geo Contract” and “Bushing Force” by using ProcessNet.**
- (G341) **"ProcessNet Helper" is added in RecurDyn/Help to help you to find ProcessNet functions.**
- (32662) **New “IBNPBody2DGuideLinear.NormalDirection” sets the normal direction of “2D Linear Guide” in the Belt toolkit.**
- (32693) **New “IFFlexBody.LayerNumber” sets the layer number for a FFlex body.**
- (32693) **New “IRFlexBody.LayerNumber” sets the layer number for a RFlex body.**
- (33304) **A property to set the color is added in following functions**
  - **IDisplaySettingPropertyComponent**
  - **IDisplaySettingElementComponent**
  - **IDisplaySettingNodeSet**
  - **IDisplaySettingElementSet**
  - **IDisplaySettingPatchSet**
  - **IDisplaySettingLineSet**

15. RecurDyn/ProcessNet - New Functions

- (32975) **New "IRFlexToolkit.SwapBodyGeneralRefFrame" function is added to set the reference frame when importing a *.rfi file.**
- (33173) **New "IParametricPoint.Text" function to get or set the text information directly in "Parametric Points".**
- (32563) **"IMTT3DSubSystem.CreateSensorTension2", New functions are added. to create a tension sensor with a point, a sensed entity, and the range.**
- (32712) **"IFFlexPatchSet.AutoAdjust", "IFFlexPatchSet.AutoSwitch", and "IFFlexPatchSet.ManualSwitch" functions are added to change the normal direction of a patch set.**
- (32712) "**IFFlexLineSet.AutoAdjust", "IFFlexLineSet.AutoSwitch", and "IFFlexLineSet.ManualSwitch" functions are added to change the normal direction of a line set.**
- (32713) **"GetReferenceByIndex", "NumOfReferences", and "DeleteAll" functions are added to "IParametricValueConnector" interface.**
- (34065) **"CreateSensorTensionEx" function and "ISensorTensionEx" interface are added to set "Type" of "Tension Sensor" in Chain.**
- (34285) **"IPlotDocument.DeleteRPLT" function is added to delete a rplt file in "Database Window" of Plot.**
- (33752) **"CreatePlantOutputWithArguments" function is added to create a Plant Output with an argument list.**

15. RecurDyn/ProcessNet - Upgraded Functions

- (G345) **Namespaces are included in the ProcessNet example: “ProcessNet/Help”.**
- (32665) **New “IBNPBodyBeltBeam.Geometry.UseUpdateGeometryInformationAutomatically” function.**

RecurDyn/eTemplate

New Functions

- (32549) Simulink interface functions are added. They are also added in “General Co-Simulation Simulink” interface.
- (30944) A *.rfi file can be imported to define a RFlex Body.

Upgraded Functions

- (32365) “ADVHYBRID” and “HYBRID” integrators are added.
- (33527) “Parametric Value” can be used in “Simulation Setting”.
- (34511) When executing eTemplate with “eTemplateForAutoRun” program or “Drag & Drop function”, “ToolkitSubsystemName” must be set on the template file.

Fixed Problems

- (33737) When importing a *.rfi file, if the file path was set to a relative path, it was not imported.

RECURDYN Connect to All

Thank you

Thursday, September 26th

10:00 am EDT (8:00 am MDT)	RecurDyn/Acoustics updates and Tutorial	Nelson Woo
12:00 pm EDT (10:00 am MDT)	Break	
1:00 pm EDT (11:00 am MDT)	Tutorial of RecurDyn setup for co-simulation with Particleworks with model including FFlex bodies, review of results	Zach Smith
3:00 pm EDT (1:00 pm MDT)	Conference review, Solicitation of input for the next conference	Brant Ross
3:15 pm EDT (1:15 pm MDT)	Adjourn	

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Follow-up on the True-Load software:

- Can you share this information with someone in your test group?
- There will be an overview True-Load Webinar next week (Thursday, 10/3 @11 AM CST). Contact Brant for the link to join the webinar.

Connect to All

Multidisciplinary integrated analysis solution implemented in one environment

Self-contained solution for multidisciplinary integration including MFBD, CoLink and AutoDesign

Scalability through connection with analysis solutions

- **FEA** – MFBD, G-Modeling, Durability, MBD for ANSYS
- **CFD** - Particleworks (fluid particles) EHD (lubrication)
- **Control** – CoLink, Simulink, FMI, AMESim, SimulationX, Simplorer
- **DEM** - EDEM (solid particles)
- **Optimization** – AutoDesign, Mode Frontier
- **Customization** – Excel, C#
- **Others –** KISSsoft (Gear/Bearing), TSG toolkit (experimental data)