

V9R1 New Functions

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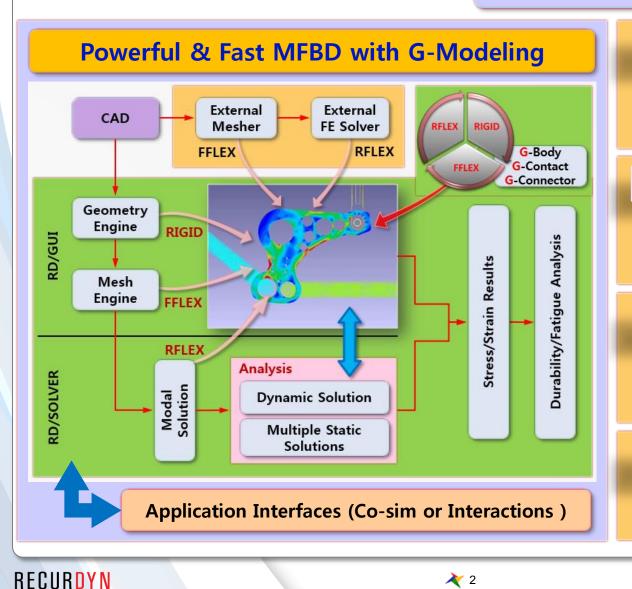




II. RD Product Strategy of V9

1. Development Strategy of V9

Best RecurDyn Ever !!!



FEA Enhancement

- Enhanced Mesher 1.
- 2. Enhanced **FEA**
- 3 Thermal Deformation

Solving Performance

- 1. C++ Structure (**RSolver**)
- **Parallel** Computing (HPC) 2.
- 3. Enhanced **Contact** Analysis

Application Interface

- Solid/Fluid Particles 1.
- 2. **FMI**
- 3 Kisssoft or BearinX Interface

Post-Processing

- 1. Powerful **Post** Functions
- 2. Standalone **Plot**

Index

- I. RecurDyn V9R1 New Functions
 - 1. RecurDyn Development Environment Upgrade
 - 2. Easy & Efficient Modeling Enhancement
 - 3. MFBD Enhancement
 - 4. Solving Performance
 - 5. Application Interface
 - 6. Toolkits

RecurDyn V9R1 Development Environment Upgrade

- RecurDyn Development Environment Upgrade
 - : Visual Studio 2010 \rightarrow Visual Studio 2015

1) GUI Environment Upgrade

- A. Compiler & Library Version Upgrade
- B. Parasolid Kernel Version Upgrade : V24 → V29
- C. FlexNet Version Upgrade : v11.13.1.2 \rightarrow v11.14.0
- D. CAD(InterOp) Translator Upgrade : InterOp R25 Sp1 → 2017.1.0(R27)

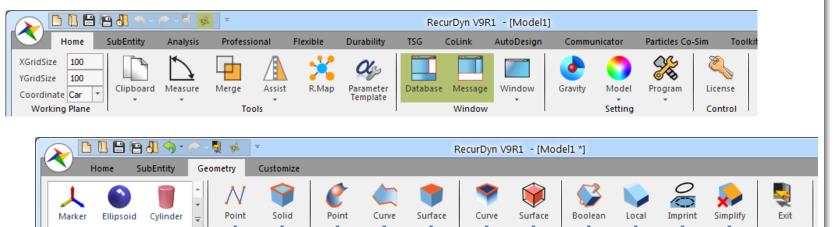
2) Solver Compiler & Library Upgrade

- A. Intel Fortran Compiler Version Upgrade
- B. MKL(Math Kernel Library) version upgrade
- Therefore, *RecurDyn V9R1* can fully Support for *Windows 10*

1. Easy & Efficient Modeling

✤ V9R1 GUI

- Layout Design Improvement
 - ✓ Windows 10 Style Design
 - ✓ Big Icon Style Design

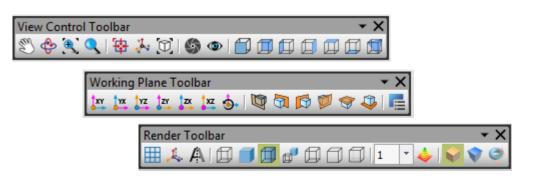


Solid

Surface

✓ Toolbar re-arrangement

Solid and Marker



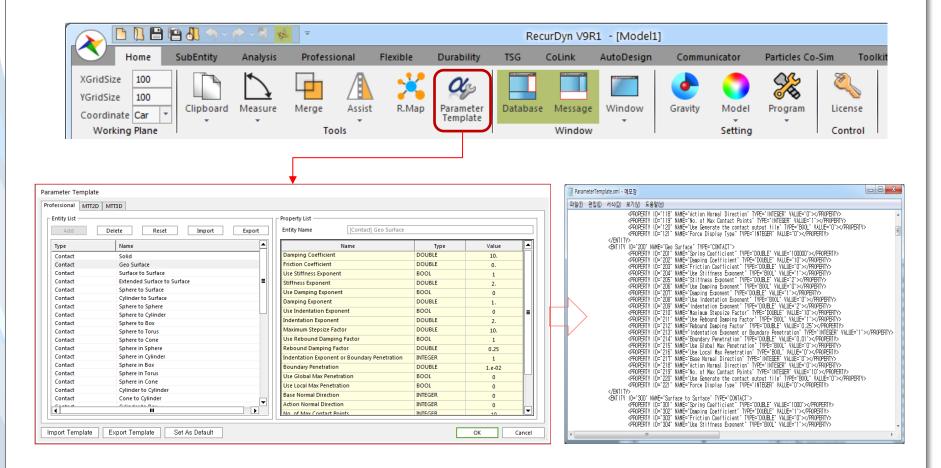
Curve

Exit

Assist

✤ Parameter Template

This function can modify the default parameter settings by user. For example, user can set the default parameters such as contact stiffness/damping value as user's own values. And also, it supports the text file format, too.

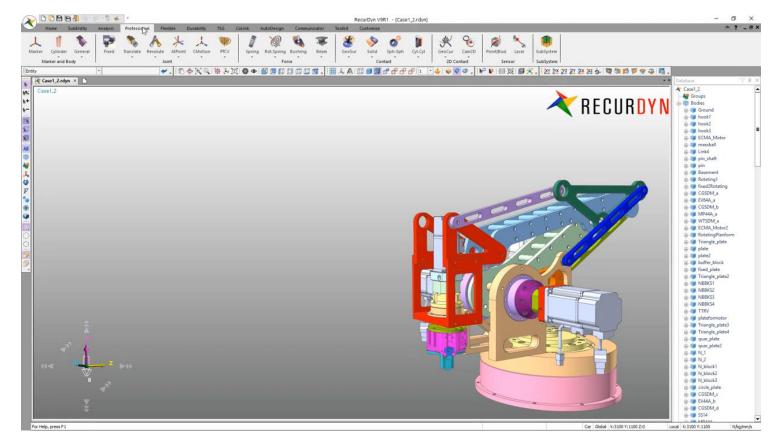


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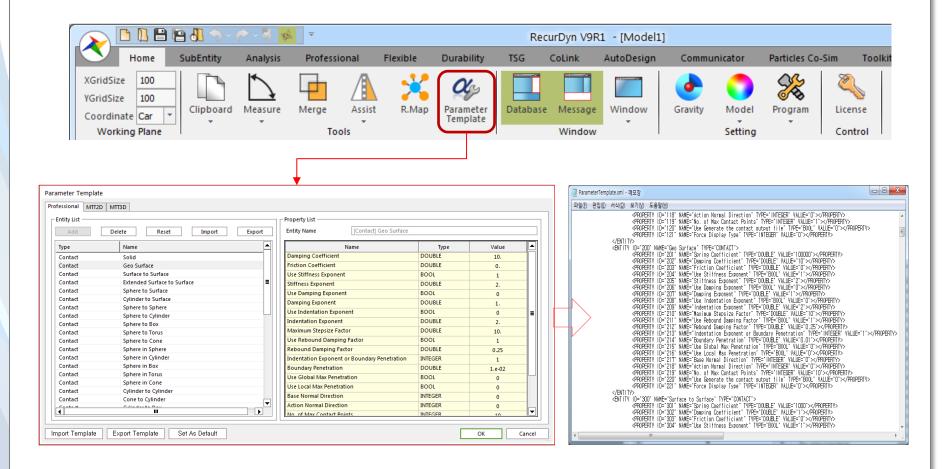
Parameter Template

- user-define 'default values' can be used.
- Parameter Templates can save a lot of time, reduce the mistakes
- improve the effectiveness of collaboration at work.



Parameter Template

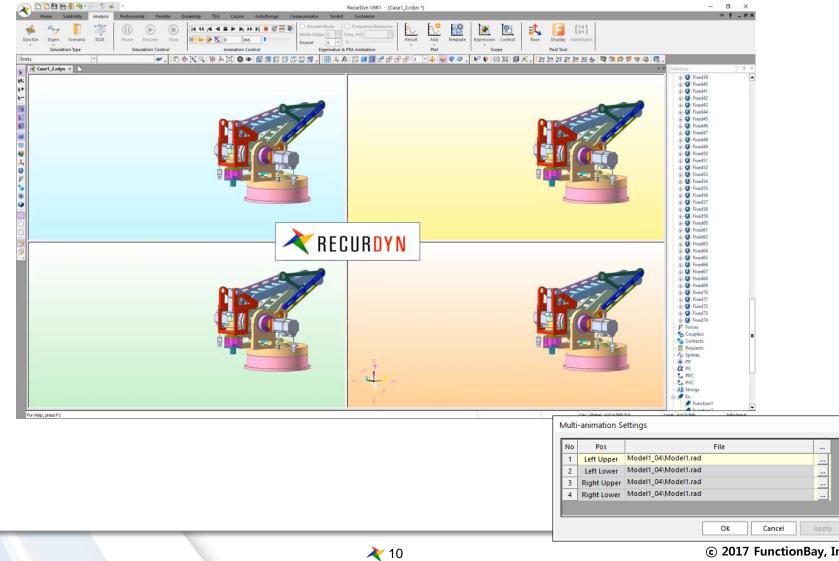
- user-define 'default values' can be used.
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Easy & Efficient Modeling and Analysis – Multi-Animation

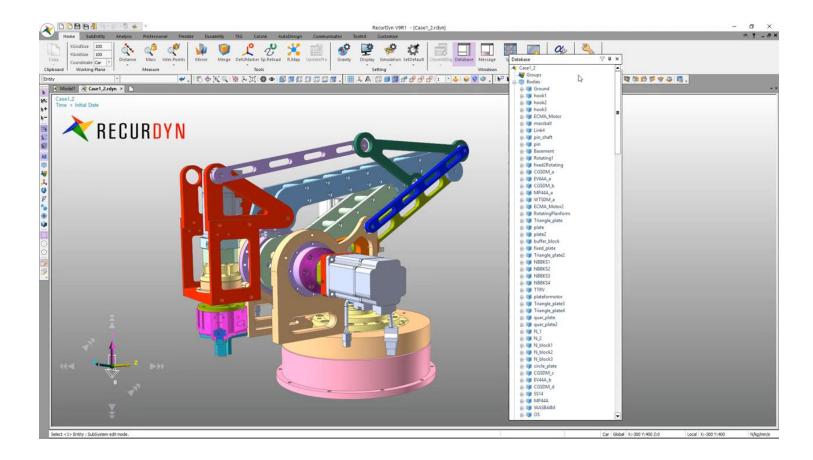
- Up to four animations can be simultaneously viewed -
- Easier comparison of the motion of multiple simulations -



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Database Filter

- The list of entities in the database can be simplified.

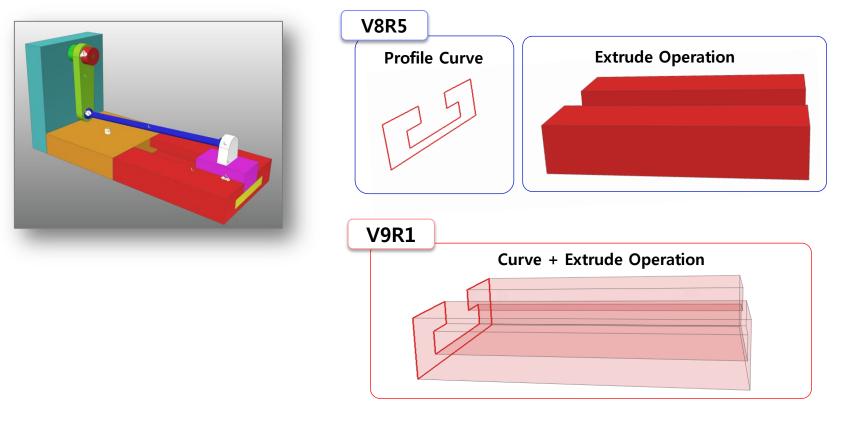


Body-Edit Mode Enhancement(1/4)

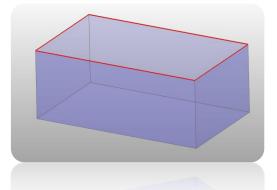
: In V9R1, many functions of Body-Edit mode are developed. So, user can easily create or modify the their CAD geometry data in RecurDyn V9R1.

General Geometry Handling

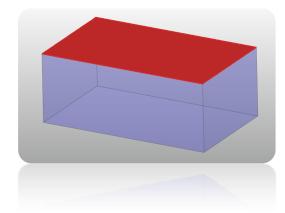
- Removed Profile Mode in V9R1
- Extrude, Spin, Sweep Functions are available by General Curve

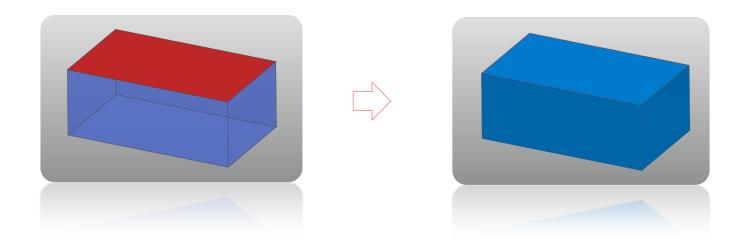


- Body Edit Mode Enhancement(2/4)
 - Closed Curve to Surface

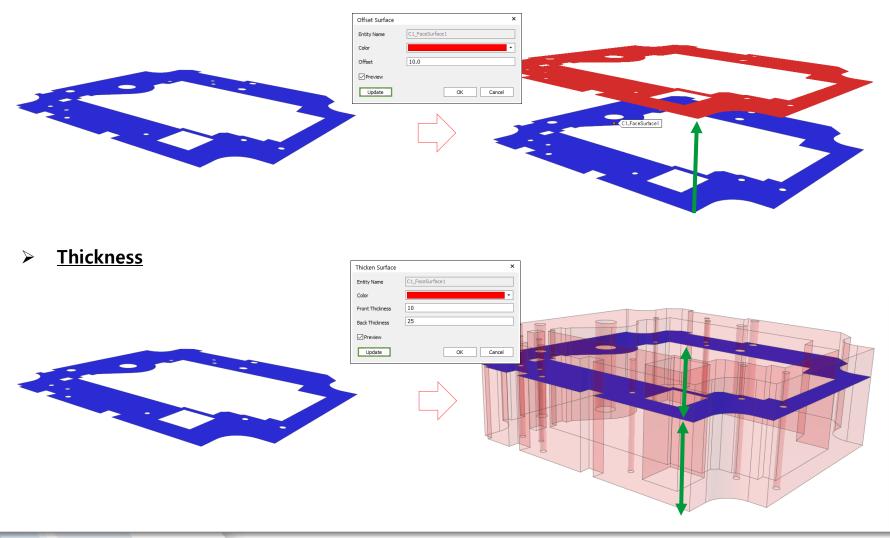








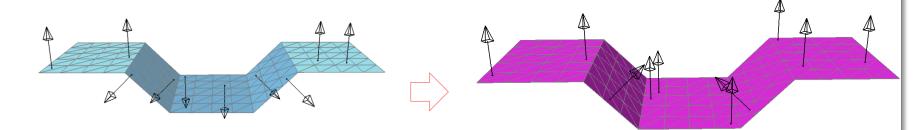
- Body Edit Mode Enhancement(3/4)
 - Offset Surface



Body Edit Mode Enhancement(4/4)

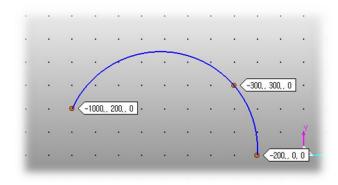
Surface Sewing

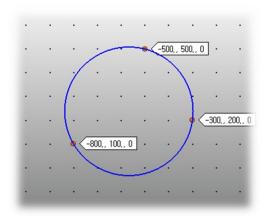
: This function unifies the normal direction when the surfaces have different normal direction



> <u>3-Points Arc & Circle Creation Method</u>

: When user don't know the center point of Arc/Circle, user can create the Arc/Circle using these 3-Points Arc





RECURDYN



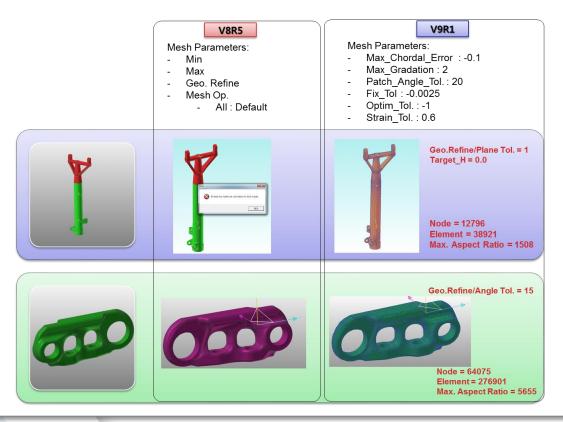
2. MFBD Enhancements

MFBD Enhancement

Mesher Enhancement (1/4)

Robust Auto Mesh

- Mesh Core is upgraded, therefore user can get the more reasonable mesh quality
 - 32bit → **64bit**
 - Mesh Core Version : 4.4.0 \rightarrow 4.7.0
 - More advanced mesh options and more acceptable default values
 - Remesh and MIN/MAX mesh size will be applied more accurately

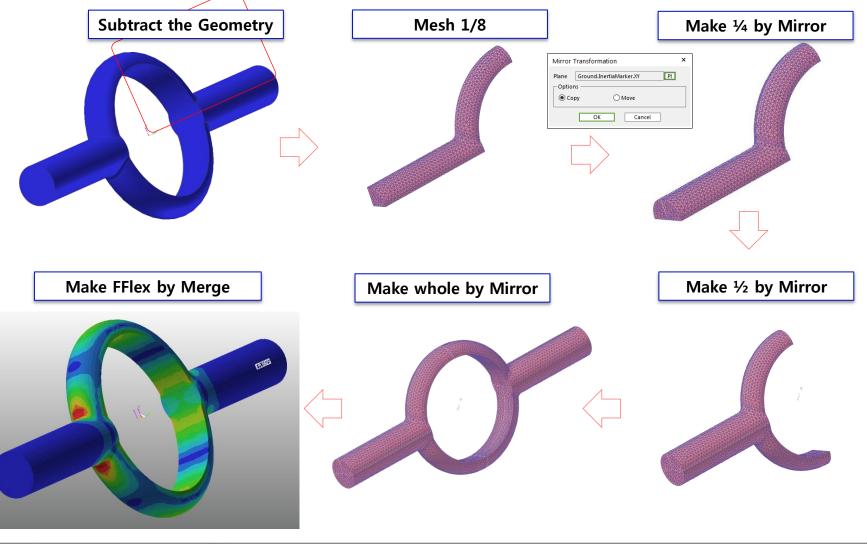


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MFBD Enhancement

Mesher Enhancement (2/4)

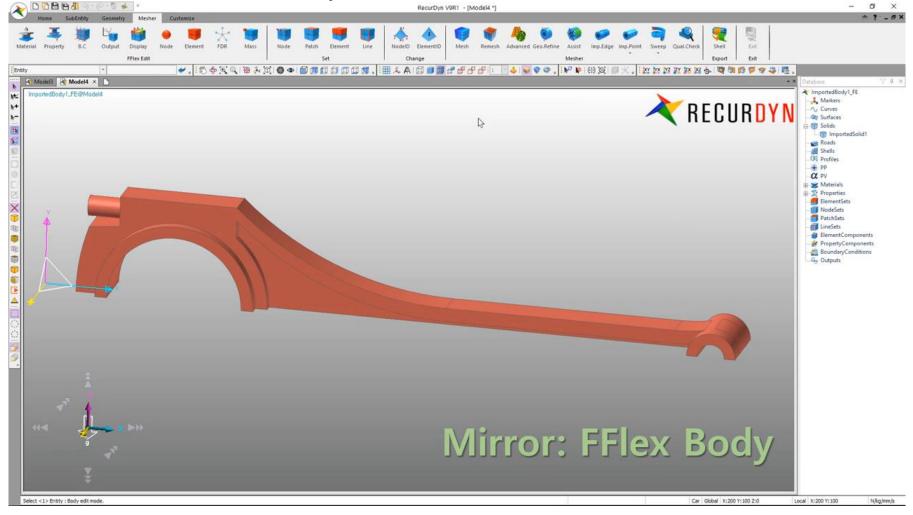




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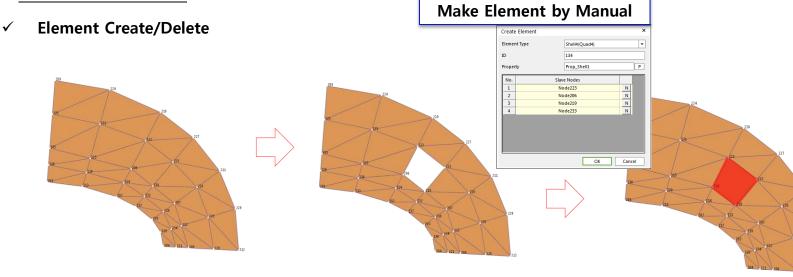
Enhanced FFlex Body handling

- Modification of the elements (Creation, Modification, Deletion)
- Mirror of the FFlex Body

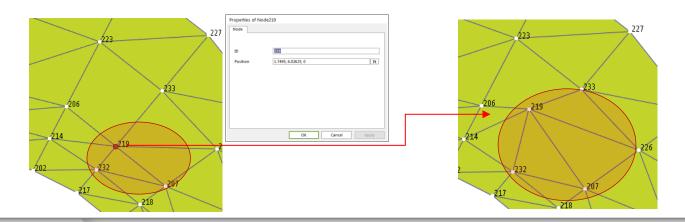


MFBD Enhancement

- Mesher Enhancement (3/4)
 - Mesh Modification



✓ Node Modification

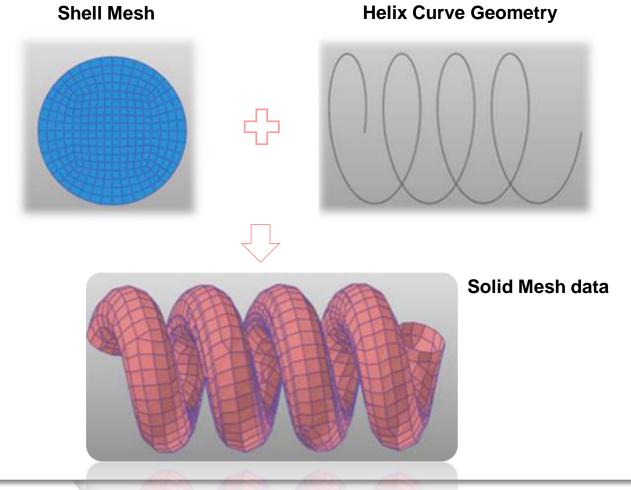


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MFBD Enhancement

- Mesher Enhancement (4/4)
 - Manual Mesh Improvement
 - ➤ Sweep mesh



Mesher Enhancements

- Upgraded mesh engine that is faster and produces higher quality meshes
- Powerful geometry refinement.
- Mesh options to improve the quality of the mesh

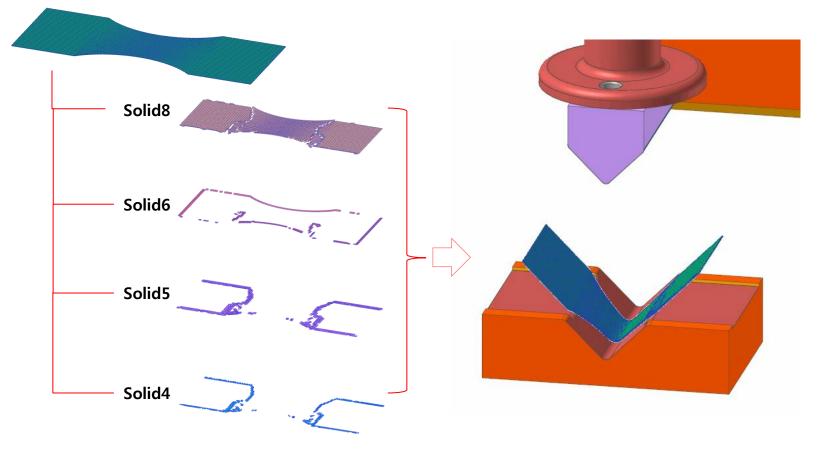
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MFBD Enhancement

- Enhanced FEA
 - Non-Linear Material
 - Plastic Analysis

Hexa-Dominant Meshed FFlex Body



MFBD Enhancement

- Enhanced FEA
 - Non-Linear Material
 - Hyper Elastic/Mooney Rivlin Minus Value parameter input
 - RecurDyn Potential Energy Function

 $U = C_{10} (\overline{I}_1 - 3) + C_{01} (\overline{I}_2 - 3)$ = $C_1 (\overline{I}_1 - 3) + C_2 (\overline{I}_2 - 3)$ (Incompressible model) Initial shear modulus

 $G = 2 C_{10} + C_{01}$

Initial bulk modlus

$$\kappa = \frac{2}{D}$$

Modified Validation Check

 $C_{10}+C_{01}(=C_1+C_2)>0$

Hyperelastic - N	Hyperelastic - Mooney-Rivlin							
	0.1151 Pv							
	0.1013 PV							
Density	1.13e-006 Pv							
Damping Ratio	1.e-004							
	Close							

3. Solver Performance

Solver Performance

✤ C++ Solver

- C++ Solver Development for MFBD
 - ✓ Alternative (Not Default) Solver for Special Purpose First
 - ✓ Solution will be changed during V9 period in order to expand the C++ solver continuously

Home SubEntity	Analysis	⇒ Professional	Flexible	Durability	TSG	CoLink	AutoDesign	Commu	nicator	RecurD Particles Co-S	iyn V9R1 - [Mid im Toolkit
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Solver Performance

✤ Time Integrator Enhancement

- ➤ Enhanced G-Alpha Integrator (more accurate results in time integration) → Reduce the numerical damping → More Accurate Dynamic Analysis
- > Enhanced Integration for Variable Equation and Differential Equations
- ➤ Adjustable Maximum Angle Limit for each time step → This will be helpful for more accurate analysis for 3D high speed rotational problems.
- ➤ Adjustable Maximum Convergence Count to increase the time step → Default will be changed from 10 to 5. (Optional)

Advanced Solving Options	
Limit of Angle in each Solving Step (deg)	30.
Maximum Convergence Count	5

✤ 3D Rotational Joint Formulation Enhancement

- > Use of Euler Parameter instead of Euler Angle for spherical and floating joint.
- This will make more stable and accurate results for the high speed 3D rotational problems.

✤ Use of "Sparse for MBD"

- > In V8R5, for some models, this option was not perfect.
- From V9R1, this option will be used always. So, option will be removed.

Solver Function

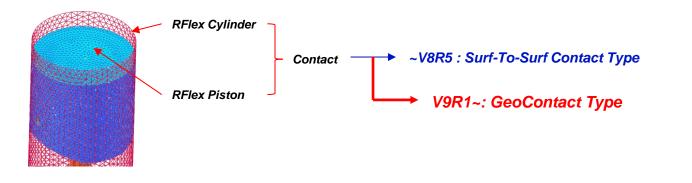
FBHQ is continuously trying to develop the efficient contact algorithm and contact entities for the fast calculation and accurate contact results to the various contact problem. Hence, in V9R1, there are some contact issues are developed by GeoContact algorithm.

> 2D Geo Circle Contact



> Using Geo RFlex Contact In Piston Toolkit

Until V8R5, the contact entity between RFlex piston and RFlex cylinder is used by surf-to-surf contact elements. However, that contact results are not satisfied. Therefore, FBHQ is determined to use the GeoContact that contact problem.



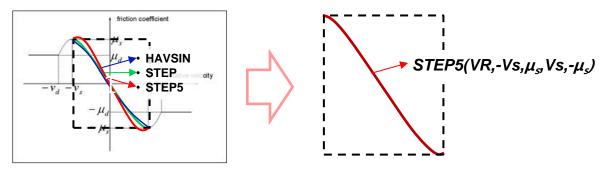
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Solver Function

In V9R1, the contact function are improved:

Consistent Friction (STEP5)

: Especially, the friction coefficient of the range from -Vs to +Vs is determined by the expression. Then, the expressions are defined by various types such as HAVSIN, STEP & STEP5. And, each contact entity is adopted by different expression for friction coefficient. Therefore, the contact force can be little different according to contact entity till V8R5. However, in V9R1, FB decides only one expression to get the friction coefficient(STEP5) and it will give user same results.



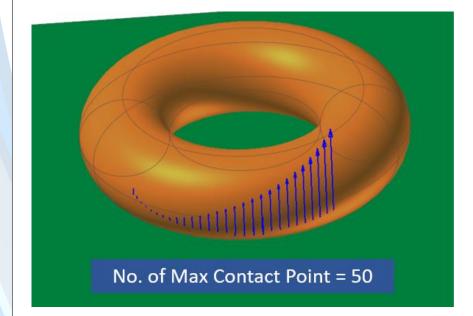
Contact Outputs

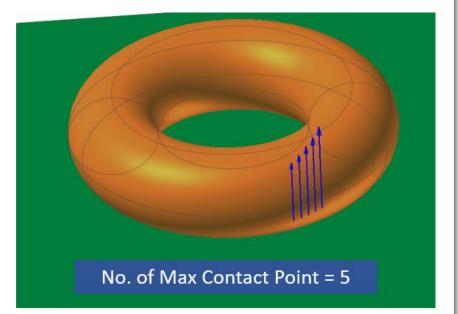
• In the *.con(contact output file) file, the contact output results are arranged and written by its contact force magnitude order.

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3 0	.000E+00	0.1																					
4 5	.000E-05																						
5 1	.000E-04		1																				
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Solver Function - Contact Point Sorting

- The Contact Point data that is written to the *.con file will be sorted from largest magnitude to smallest.

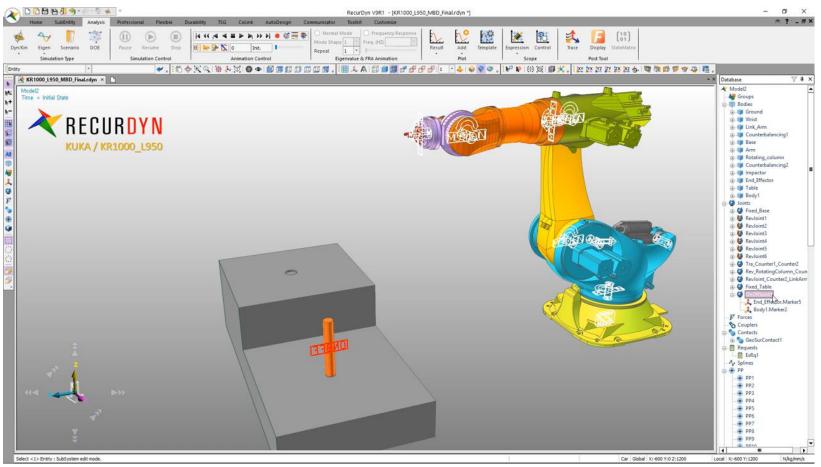






Solver Function - OnOff Joint

- The constrained degrees of freedom (0~6) can be enabled/disabled during the simulation depending on the condition. (by Function Expression)
- The OnOff Joint can be used to increase the speed of computation when it can be used instead of a contact element



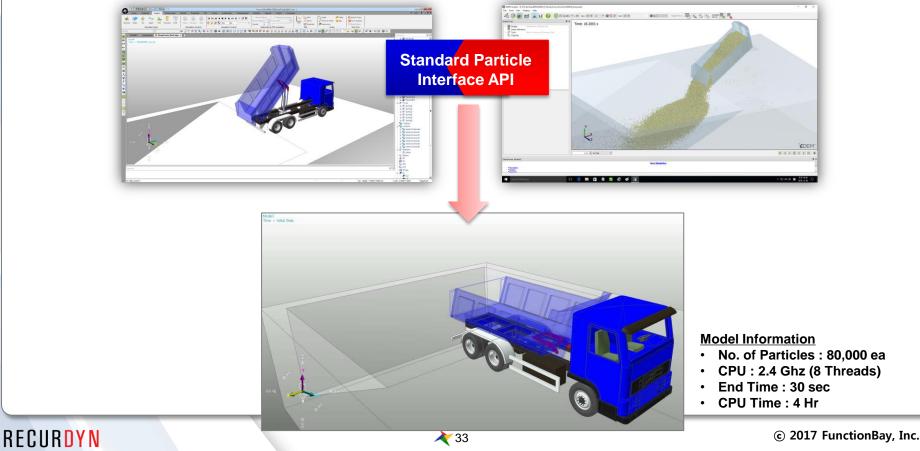
4. Application Interface

Application Interface

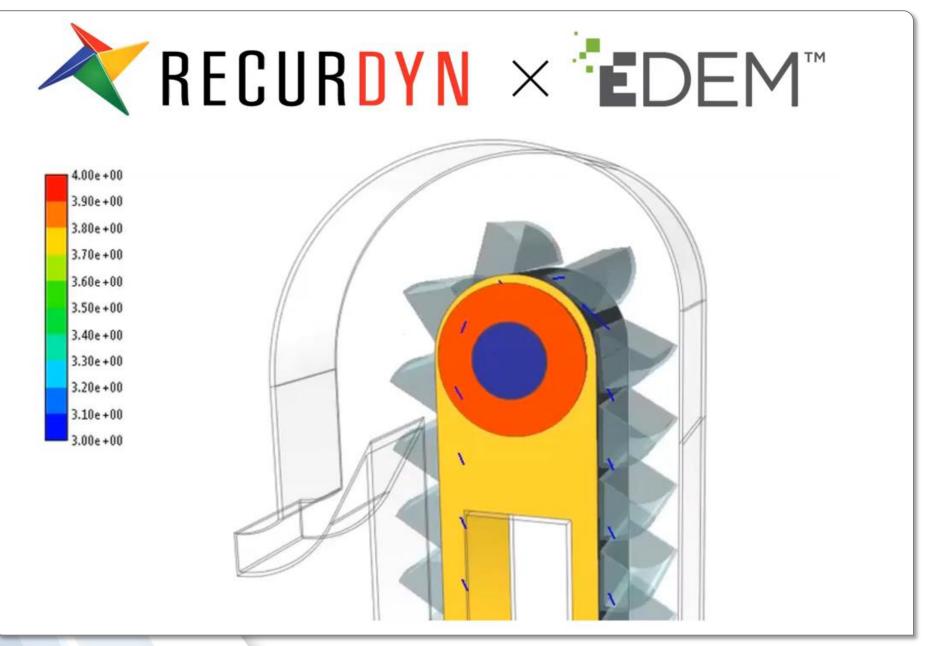
- Standard Particle Interface
 - > For the efficient development for communication between RecurDyn and other Particle S/W.

EDEM IF using Standard Particle Interface

So, using the Standard Particle Interface API, Particle S/W company can efficiently develop the interfacing code with RecurDyn. Therefore, EDEM(One of DEM Particle S/W) interface is developed in V9R1.



Co-simulation interface between RecurDyn and EDEM





Application Interface

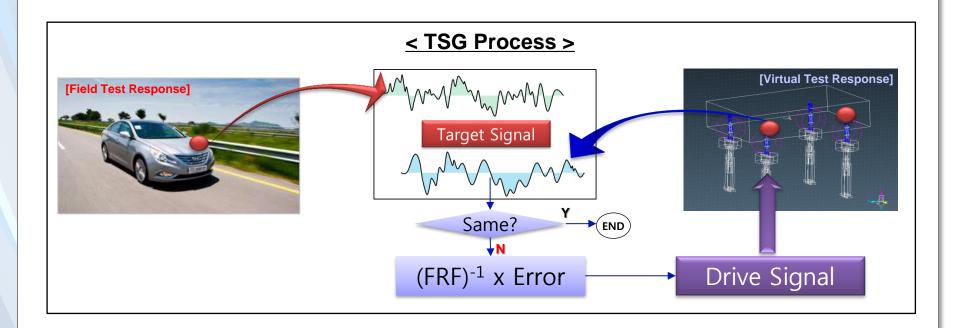
- ✤ FMI 2.0
 - FMI 2.0 will be supported in V9R1. Therefore, user will be able to use the function of FMI 2.0 for communicating between RecurDyn and other S/W.

V8R5	V9R1
VBRS	FMI CoSim Environment Import Export Interface Version 1.0 Model File 2.0 Plant File Name mouse Plant File Name Plant Ouput (FMU -> RecurDyn) Interface Time Step 1.e-03 Waiting Time (seconds) 200. Create a FMU File Export
OK Cancel Apply	Delete CoSim Information OK Cancel Apply FUNCTIONAL MOCK•UP INTERFACE

5. Toolkits

New Toolkits

- ✤ TSG (Time Signal Generator) Toolkit
 - ➤ With any measured response (target signal) of vibration in physical test, TSG finds any input signal (drive signal) for virtual test rig. → Eventually, this can be used for Durability Analysis.
 - For example, TSG can make the driving signal for the actuator of car suspension test-rig to get the same response with the field testing signal. Then, using these driving signal, user can run the MBD, MFBD & Durability analysis.



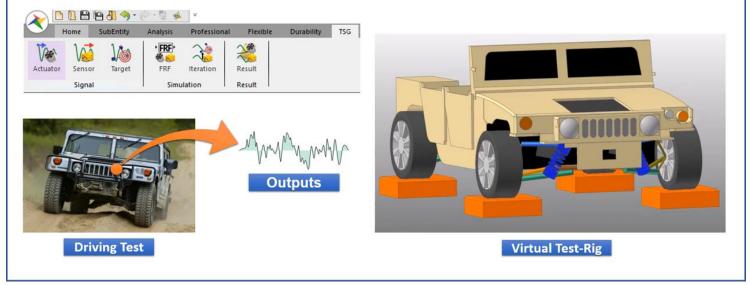
RecurDyn/TSG (Time Signal Generation)

- New toolkit
- Find the Drive Signal that reproduces the Target Signal

TSG (Time Signal Generator) Toolkit



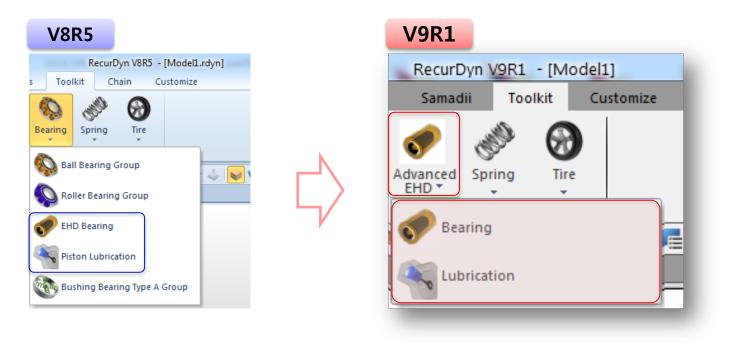
The TSG (Time Signal Generator) toolkit has been added to RecurDyn. The TSG finds a Drive Signal that causes the MBD system in RecurDyn to produce a measurable system response that is similar to a user-defined Target Signal. The MBD system response can be any value, such as a displacement, a velocity, an acceleration, a force, or a sensor output.





New Toolkits

- Independent EHD Toolkit
 - ➤ V8R5
 - ✓ It is one of bearing entity/function in Bearing Toolkit
 - ➢ V9R1
 - ✓ It will be one of important toolkit in RecurDyn V9R1. So, it is developed as independent EHD Toolkit. Then V9R1 EHD toolkit supports the EHD journal bearing & EHD lubrication functions.



RecurDyn/EHD (Elasto-Hydrodynamic Lubrication)

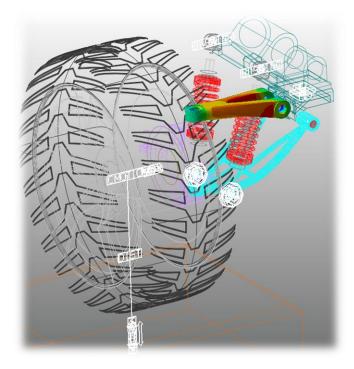
- New toolkit
- Rotational Lubrication for journal bearing
- Piston Lubrication for Piston/Cylinder

Recurdyn_EHD Recurdyn_EHD Projection Type Contour BD Surface Type Contour		* ? - #
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Projection Type 3D Surface Type Contour	Subsystem Toolkit	
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Select <1> Entity : SubSystem edit mode.	Contour Plot Contour Plot Contour Plot	

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Toolkit Improvement

- Durability Toolkit
 - > Importing durability result file



Fatigue Evaluation							
Axial Mode	Uni-Axial	O Bi-Axial			Eatic		alculation
Life Criteria					гацу	jue c	alculation
Stress - Based	🔿 Strain - Base	ed 🔿 Safety Factor	I				
Life Criterion	User	Defined 🔻					
Mean Stress Effect	Goo	dman 🔻	📐 Pr	rogre			
BVVI Weld	class	B		ogic			
Num of Std.Deviations	2.		1				Elapsed Time : 0 min, 99.50 %
Searching Increment	5 De	-					
Material			1				
S-N Curve < mm-N >	User	Defined S-N			Course	440.0	
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Summary of RecurDyn V9R1

Integrator enhancement improved the accuracy

- 1. The numerical damping effect is reduced a lot.
- 2. The accuracy of High speed rotation problem is improved

UI Convenience

RECURDYN

Parameter template, Multi-animation, Database filtering

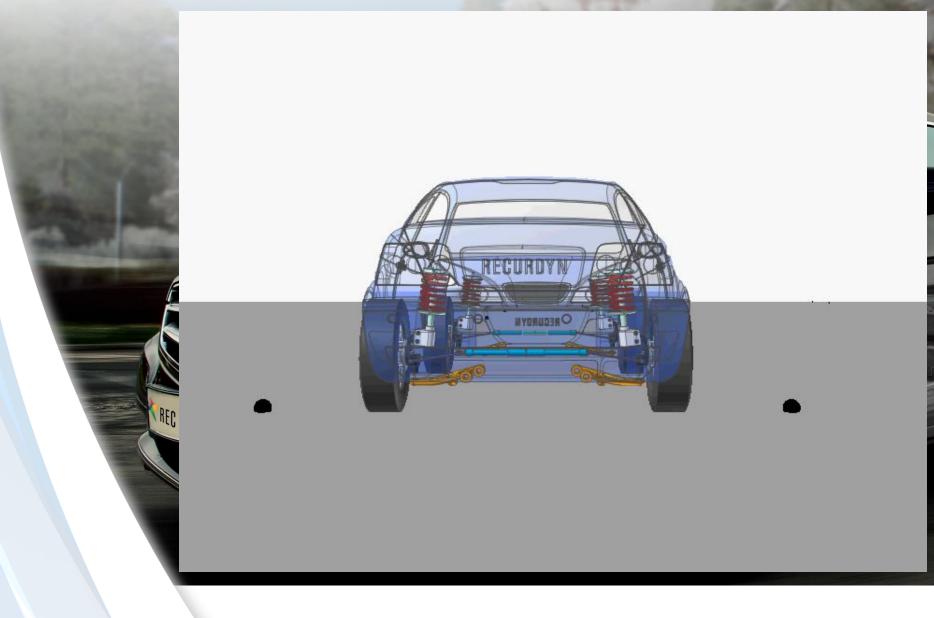
MBD enhancements

Contact Point Sorting, OnOff Joint, 2D Geo Circle Contact

MFBD enhancements Mesher enhancements, enhanced FFlex bo	ody handling
Multi-disciplinary	ody handling
EHD, TSG, EDEM interface, FMI 2.0	100+ improvements

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Thanks for your attention!

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