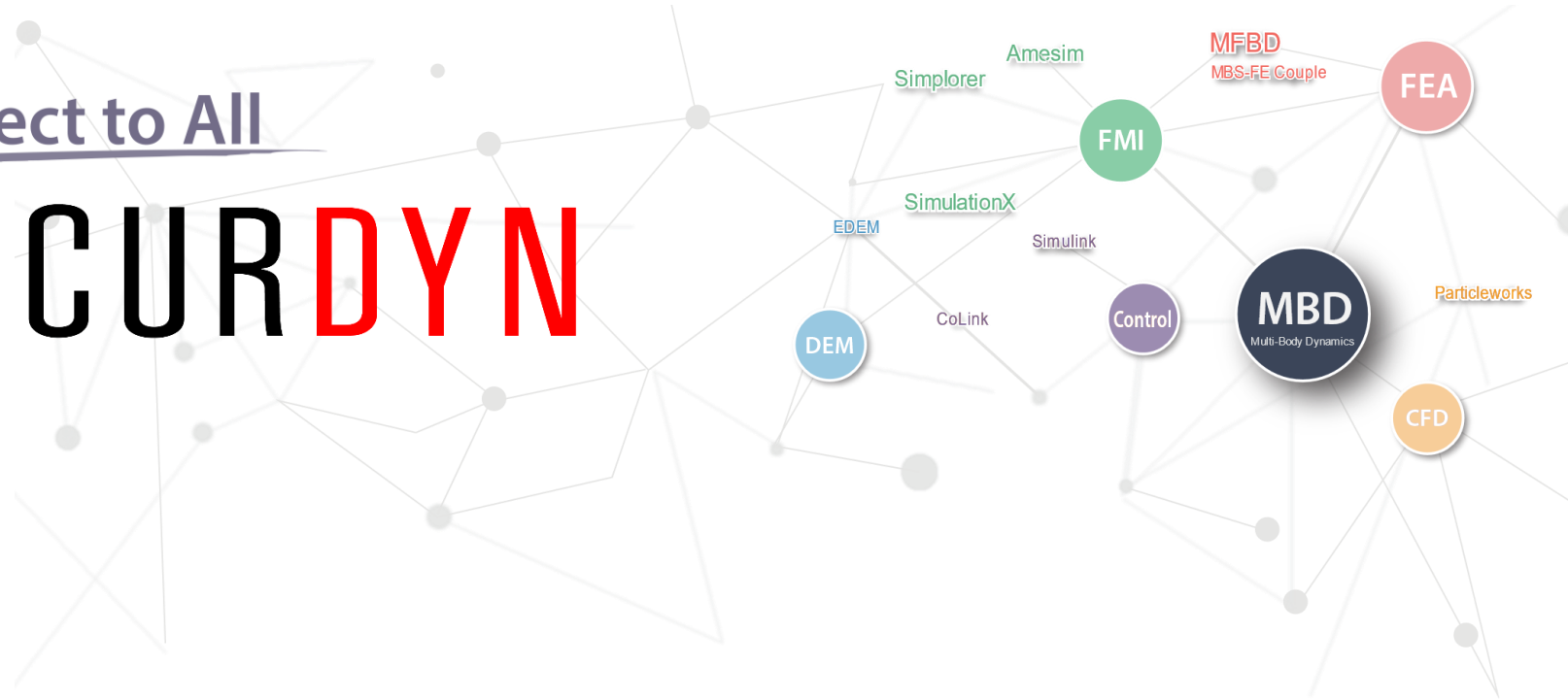


Connect to All

RECURDYN



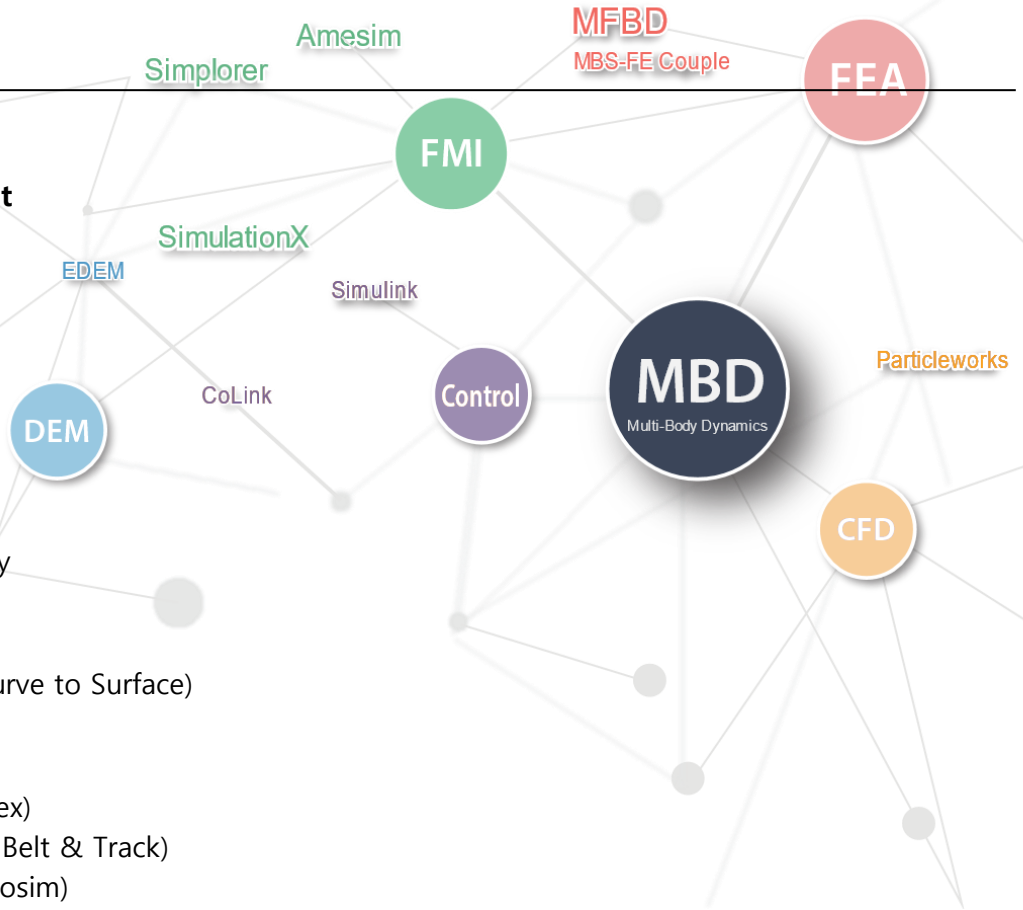
V9R2 New Functions

Inho, Song

FunctionBay, Inc. DA Team
Principal Research Engineer

Index

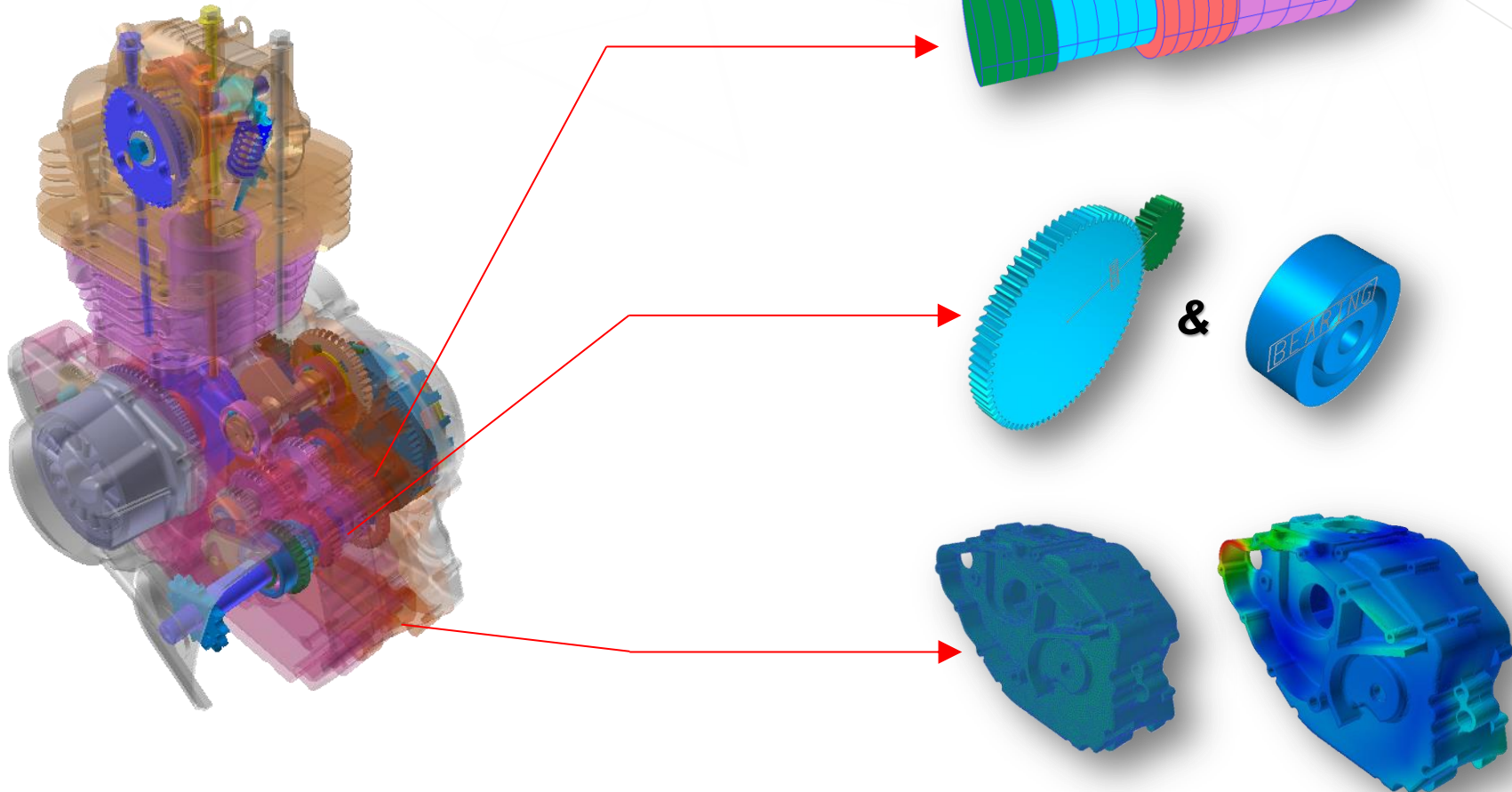
- ❖ **Gear NVH**
- 1. **Easy & Efficient Modeling Enhancement**
 - 1) CAD Handling Functionality
 - 2) General Group Function
 - 3) System Navigator
 - 4) Imprint Function
 - 5) Model File Folder
- 2. **MFBD Enhancement**
 - 1) Mesher Enhancement
 - 2) Thermal Stress/Strain Effect(Try-Dev)
 - 3) Static Stress Superposition in Durability
- 3. **Solving Performance**
 - 1) Advanced Hybrid Integrator
 - 2) Geo Contact Enhancement (3D Geo Curve to Surface)
 - 3) C++ Solver Development for MFBD
- 4. **Application Interface**
 - 1) Supporting Flexible Wall (Rflex and Fflex)
 - 2) Tpart for Particle Cosimulation (Chain, Belt & Track)
 - 3) General Co-Sim Development (Multi-Cosim)
 - 4) Tire Interface
- 5. **Toolkits**
 - 1) EHD Solving Speed Improvement
 - 2) Gear Toolkit Enhancement
 - 3) Colink Enhancement
 - 4) Chain Toolkit Enhancement
 - 5) Pnet



V9R2 Main Key Function : Gear NVM



- Shaft Modeler (in Gear NVH)
- KISSsoft Interface (in Gear NVH)
- RFlex Enhancement for Efficient Housing Analysis
- Acoustic Toolkit for Noise (Sound) Analysis



RECURDYN Connect to All



1. Easy & Efficient Modeling

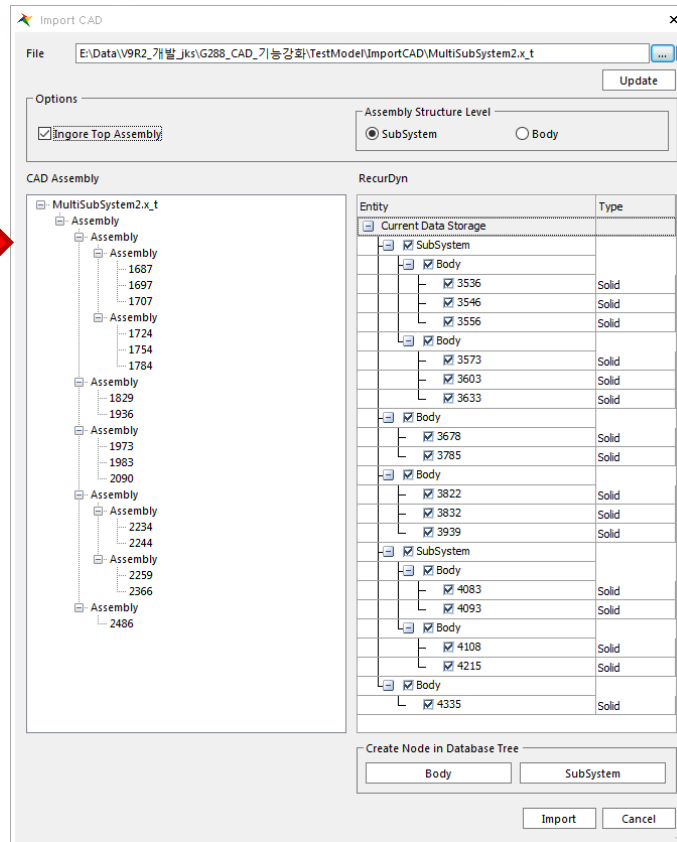
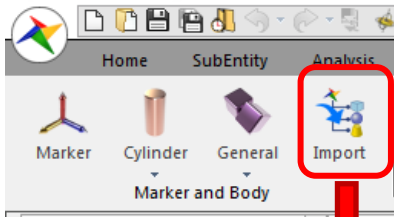
- ✓ *CAD Handling Functionality*
- ✓ *General Group Function*
- ✓ *System Navigator*
- ✓ *Imprint Function*
- ✓ *Etc.*

CAD Handling Functionality



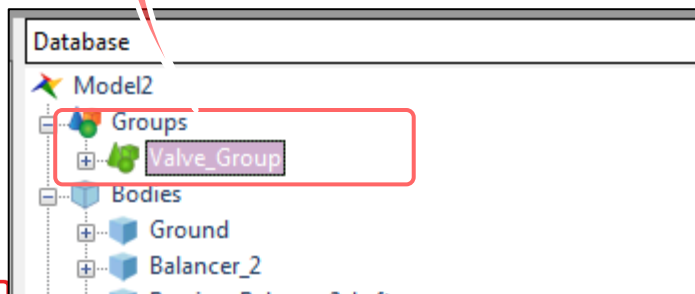
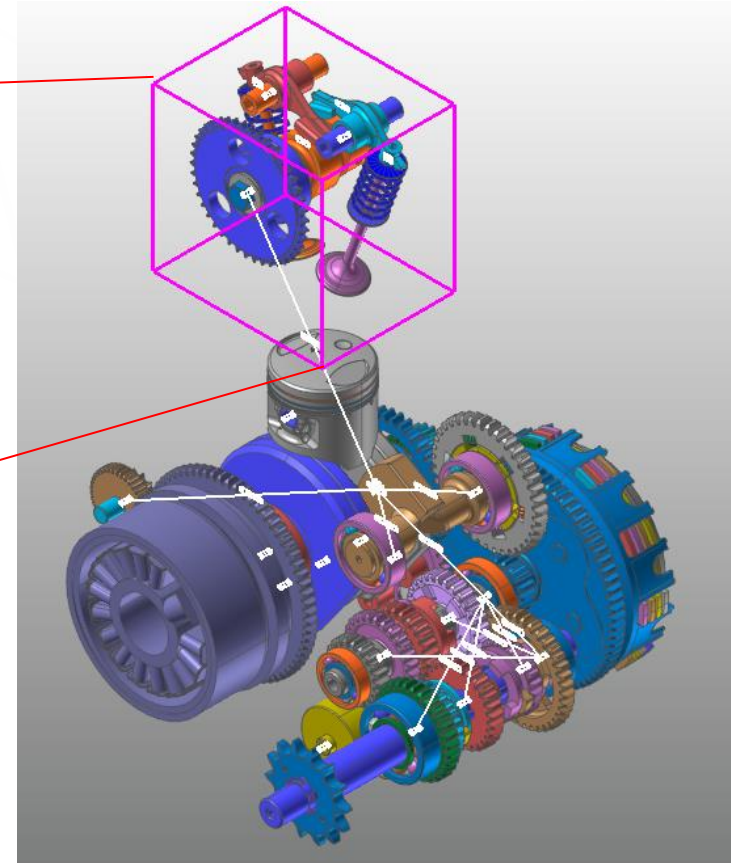
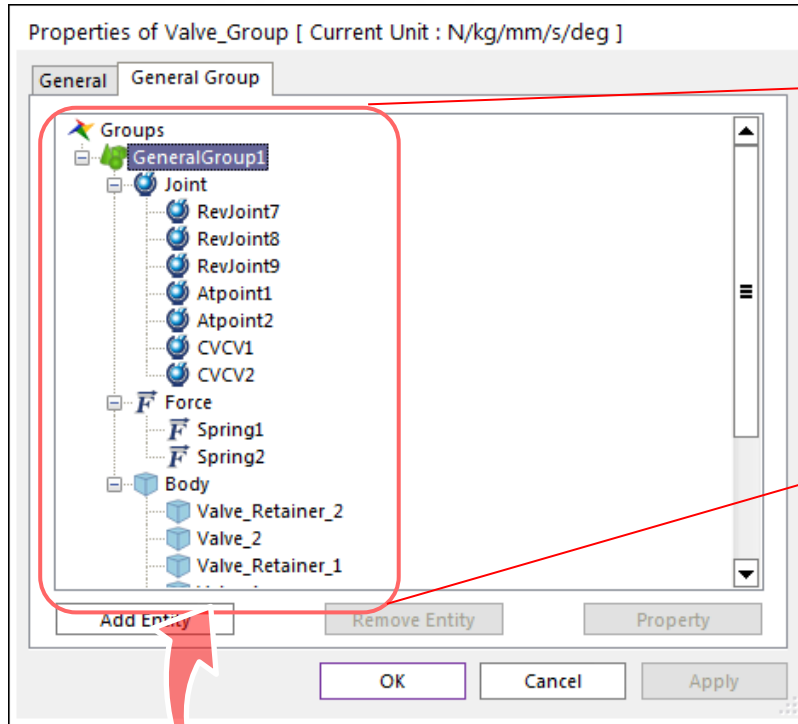
➤ CAD Import Enhancement

- 1) Assembly Hierarchy (CAD)
- 2) Various Import Methods
 - A. All Separation
 - B. Keep the Assembly Information
 - C. User defined.



General Group Function

- **“General Group”** function can support the grouping for the user selected entities. Therefore, user can manage the entities more easily and access the entity more quickly.

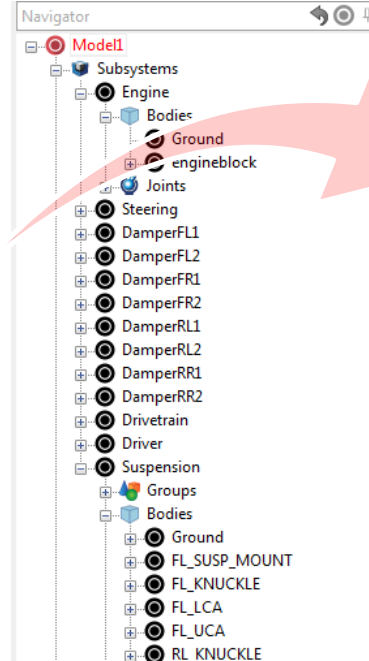
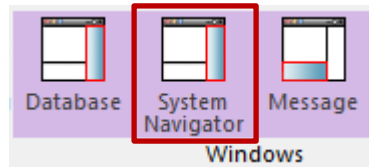
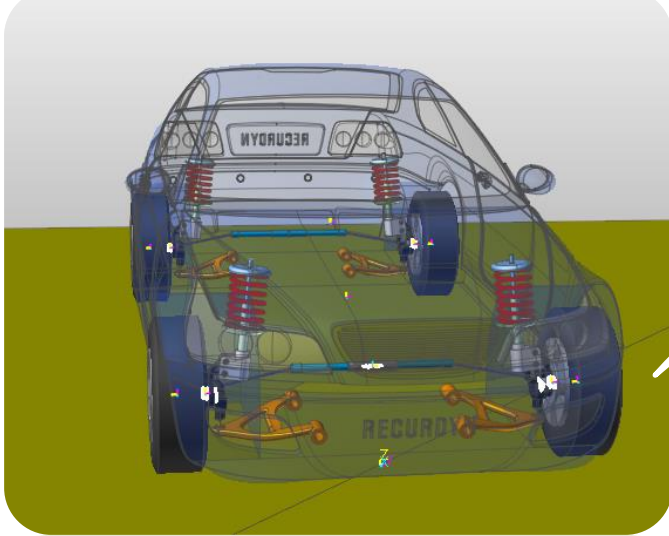


System Navigator

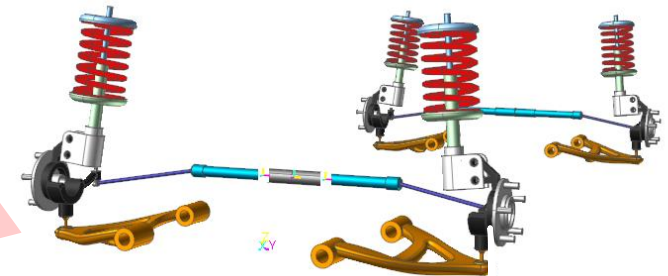


- Subsystem modeling method is efficient and quickly build up the model. However, when user change the subsystem (subsystem → main working plane or another subsystem), it is not easy to move.
- At that time, this "System Navigator" function is very useful to move the subsystem

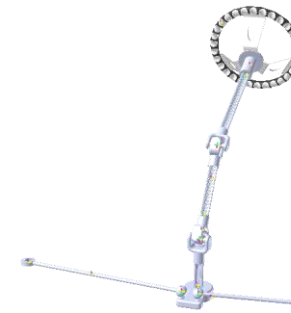
Main Working Plane (Assemble Condition)



Suspension Subsystem



Steering Subsystem

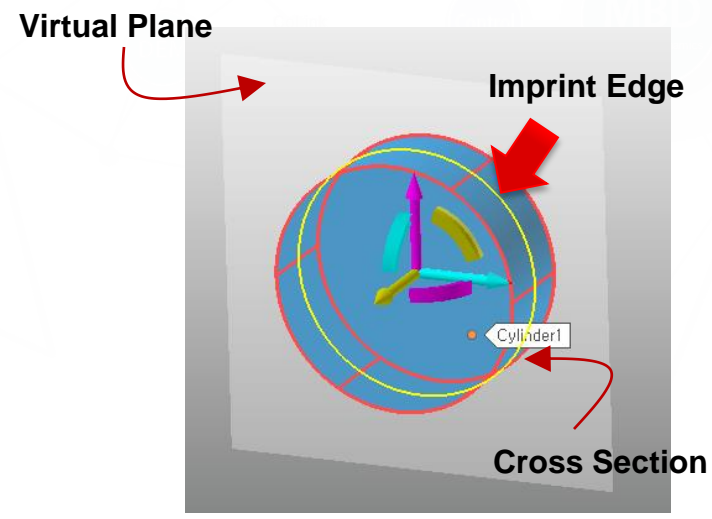
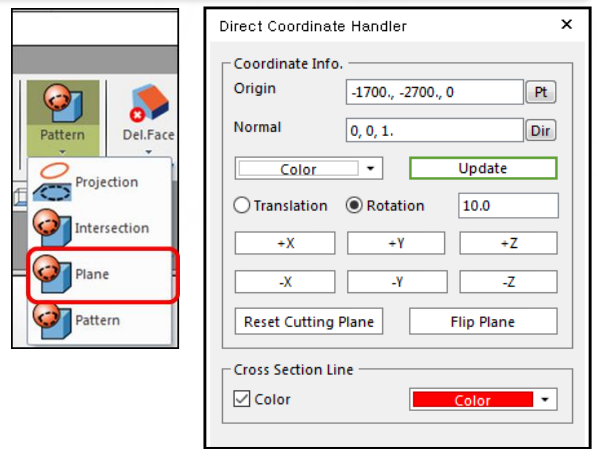


Directly move to Steering Subsystem Without returning main working plane!

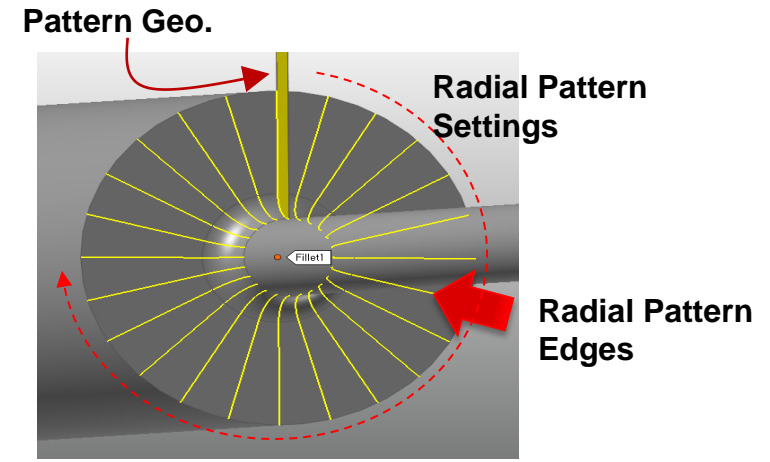
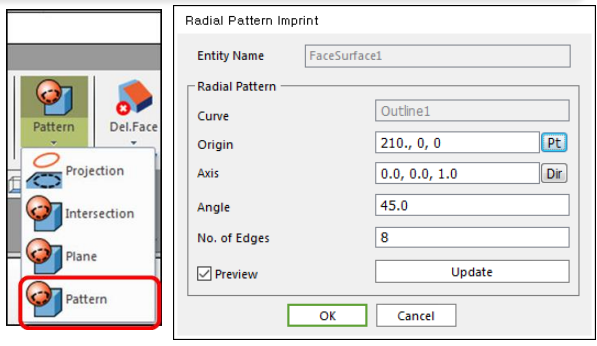
New Imprint Functions

- V9R2 provides two new imprint functions. And, it will help user to get the more good mesh quality

Imprint function with Virtual Plane



Imprint function with Radial Pattern



Model File Folder



- User can move the current model file folder by clicking the “Model File Folder” button in dialog

The screenshot displays the RecurDyn V9R2 software interface. The main window shows a 3D model of a car chassis. The top menu bar includes Home, SubEntity, Analysis, Professional, Flexible, Post Analysis, TSG, GearNVH, CoLink, and AutoDesign. The left sidebar contains various tool icons. The bottom status bar shows the current entity and coordinates.

Two 'Export' dialog boxes are overlaid on the interface. The top dialog shows the current directory as 'This PC > 3D Objects', which is labeled as a 'Strange Directory' because it contains no items. The bottom dialog shows the current directory as 'V9R2 > TireInterface > GTire_UA', which is labeled as the 'Current Directory' and contains several folders. A red arrow points from the 'Model File Folder' button in the top dialog to the 'GTire_UA' folder in the bottom dialog. A red starburst with the word 'Click' is positioned near the 'Model File Folder' button in the top dialog.

Name	Date modified	Type	Size
Fiala_Turn	2018-02-12 오후 1:...	File folder	
Fiala_Sub	2018-02-12 오후 1:...	File folder	
Fiala_USUB	2018-02-12 오후 2:...	File folder	
GTire_UA	2018-02-12 오후 3:...	File folder	
TNO_Tire	2018-02-12 오후 3:...	File folder	
UA_JTurn	2018-02-12 오후 2:...	File folder	

RECURDYN **Connect to All**



2. MFBD Enhancements

- ✓ *Mesher Enhancement*
- ✓ *FFlex Beam Element Property UI Improvement*
- ✓ *Thermal Stress/Strain Effect(Try-Dev)*
- ✓ *Static Stress Superposition in Durability*
- ✓ *RFlex & RFlexGen Enhancement*

Mesher Enhancement(1)

- Local Remesh Enhancement including Remesh information & "Fit CAD Geometry" Option

irks

The image shows a 3D model of a gear with a purple mesh. Two specific faces are highlighted with red circles and yellow arrows. A dialog box titled 'Local Remesh' is open, showing a table of selected faces. The table has the following data:

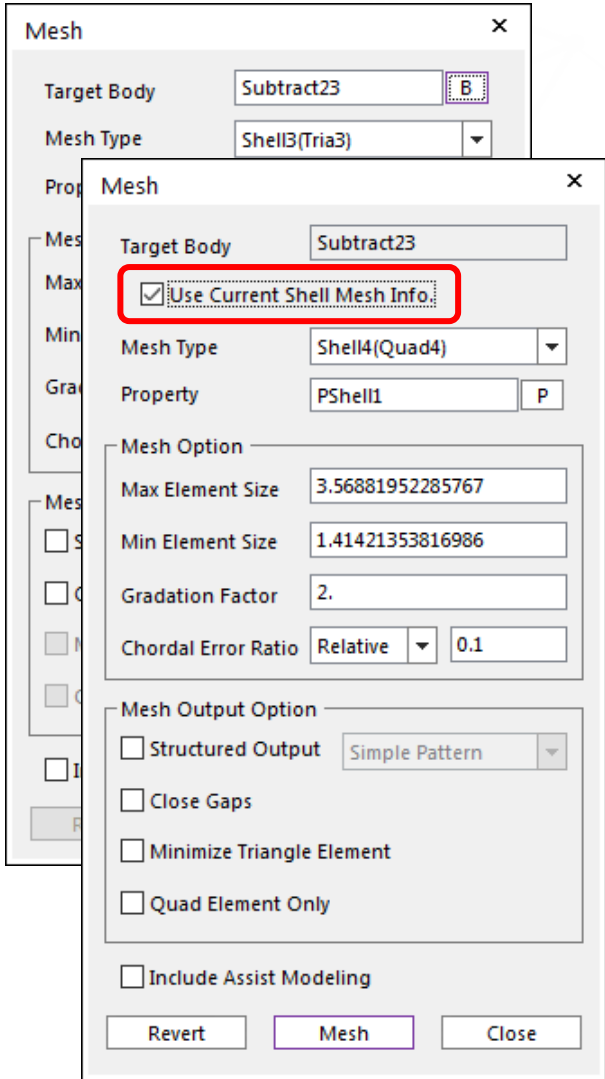
Name	Max Element Size	Min Element Size	Fit
Subtract23.Face20	2	1	True
Subtract23.Face40	1	0.5	True

The dialog box also includes a 'Global Mesh Option' section with 'Max Element Size' set to 3.56881952285767 and 'Min Element Size' set to 1.41421353816986. There are 'Add', 'Remove', 'Revert', 'Mesh', and 'Close' buttons.

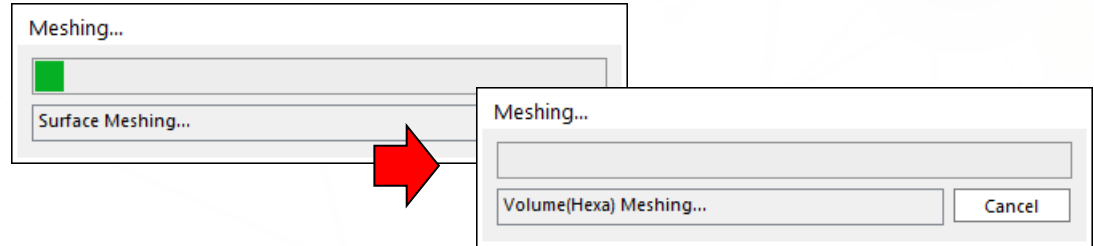
Mesher Enhancement(2)



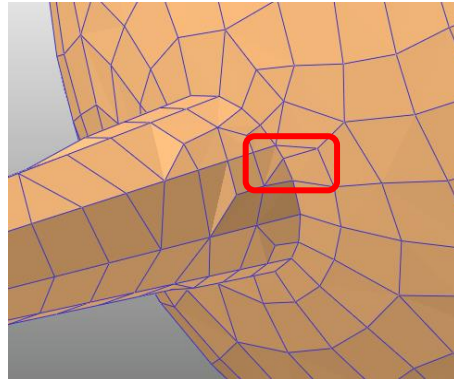
➤ "Use Current Shell Element Information" option



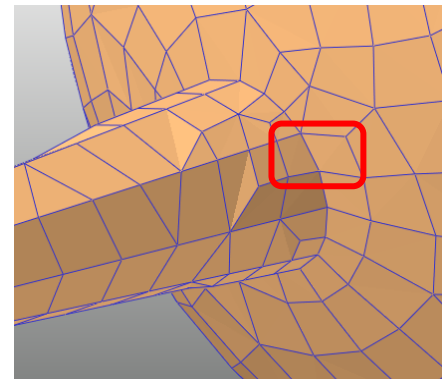
Automatic (V9R1)



V9R2



Shell Mesh



Shell Mesh Modification

➔ Solid Mesh (V9R2)

Mesher Enhancement(3)



➤ Quality Check and Modification

Quality Check

Aspect Ratio > 3.

Angle (deg.) > 100.

< 45.

Skewness (deg.) > 60.

Warping (deg.) > 18.

Tapering > 0.5

Max Value 8.052897

Min Value 1.001053

Preview

OK

Quality Check

Element Check

Aspect Ratio > 3.

Angle (deg.) > 100.

< 45.

Skewness (deg.) > 60.

Warping (deg.) > 18.

Tapering > 0.5

Max Value 0.

Min Value 0.

Preview

Tip Text Max No. 10

Update Select

Line Check

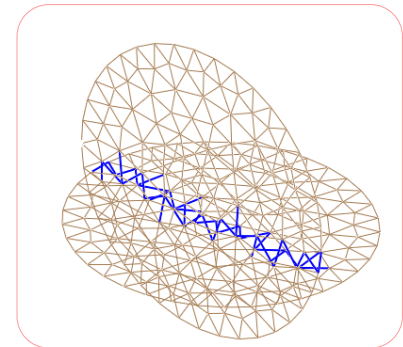
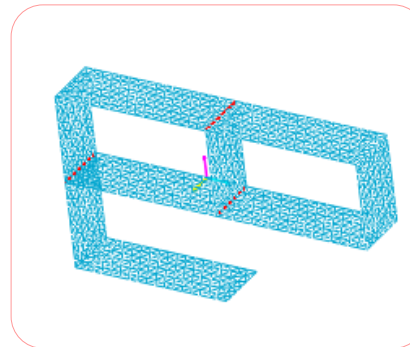
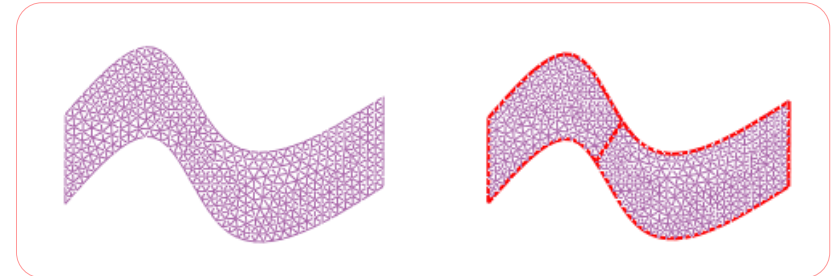
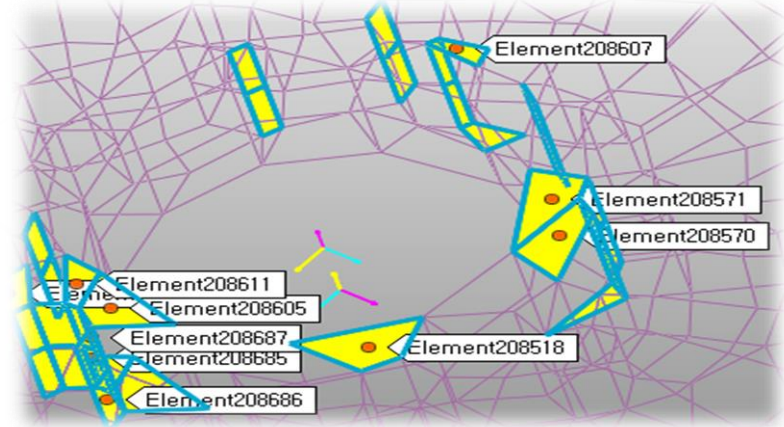
Free Line Color

T-Connection Line Color

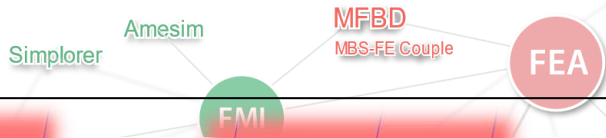
Intersection Color

Preview Update

OK Cancel



Mesher Enhancement(3)



➤ Modification

Node Merge

Options

Select Type

Node Line Element

Node Position

Mid Edge First to Second

Auto Operation

Combine Shell3 Elements

Options

Select Type

Line Element

Split Shell4 Element

Options

Select Type

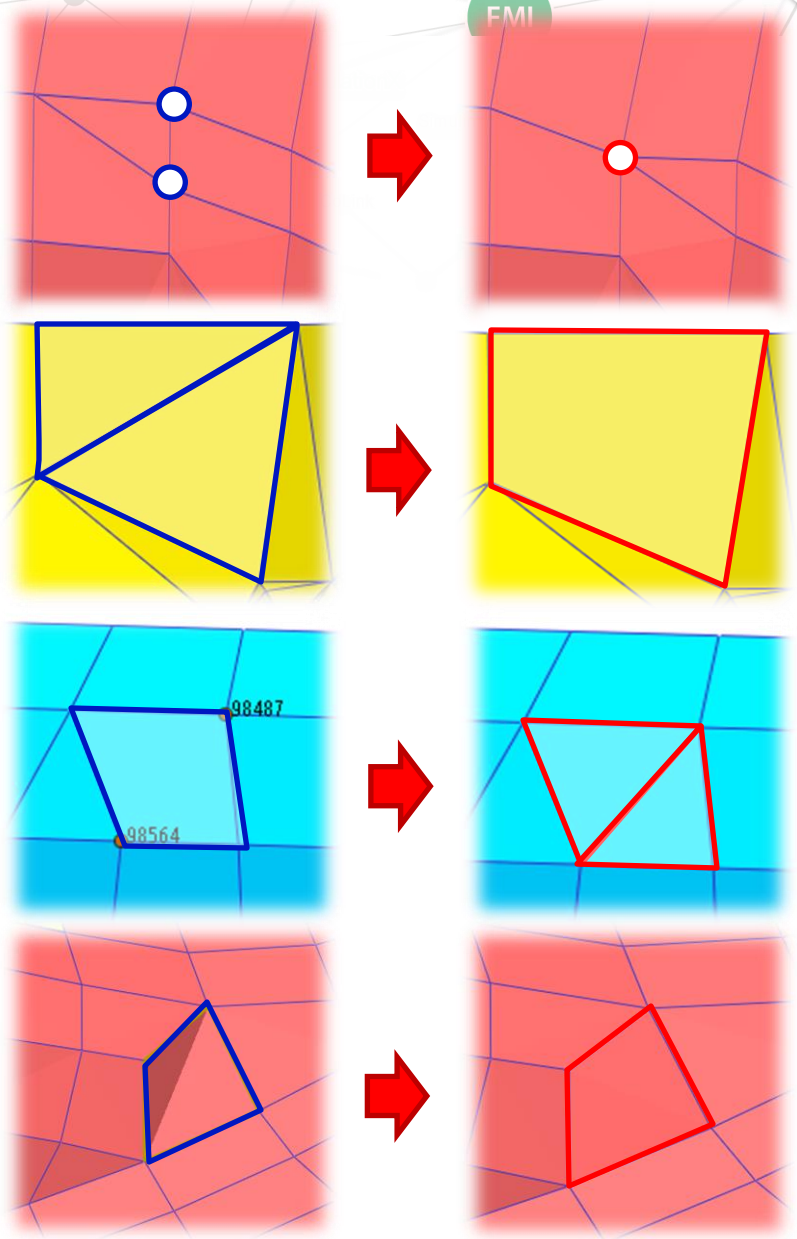
Node Element

Node Sequence Rotation

Options

Direction

Clockwise Counterclockwise

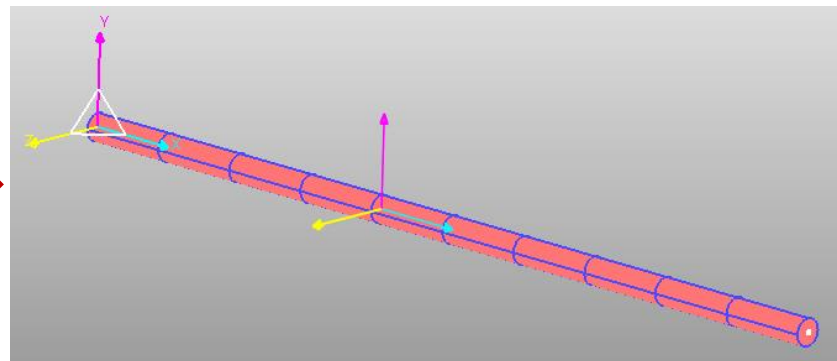
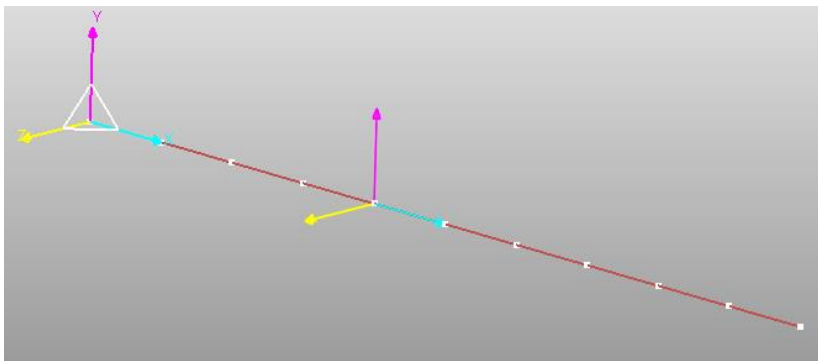


FFlex Beam Enhancement



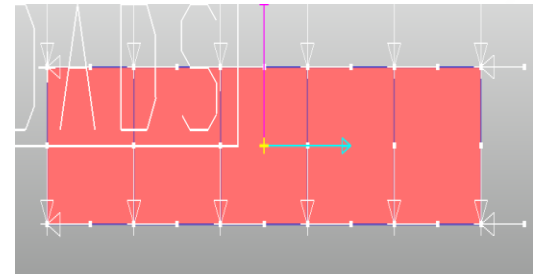
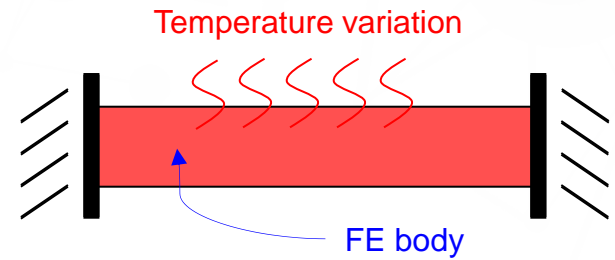
- FFlex Beam Property Input UI Enhancement
 - 1) This enhancement issue is also very important to support the "Shaft Modeler" for Gear NVH
 - 2) There are two main issues
 - A. Support Cross Section Library like BeamGroup in Professional
 - a. Until V9R1, there was no functionality to use the cross section library
 - b. In V9R2, Fflex beam property will support the "Cross Section Type"
 - B. Support 3D Geometry Display for Beam Element Cross Section
 - a. Only Circular Shapes are supported.

Points	Y	Z
1(C)	10.	5.
2(D)	-10.	5.
3(E)	-10.	-5.
4(F)	10.	-5.



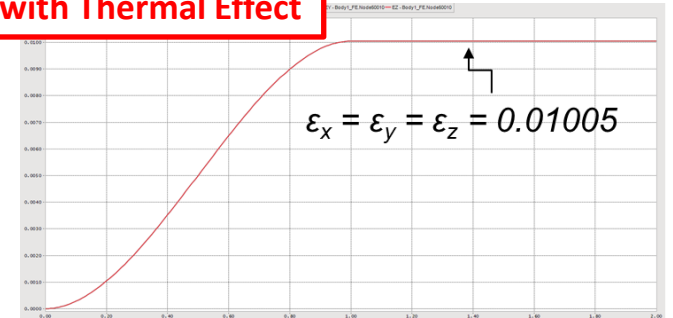
Thermal Load Effect

1. Thermal stress is very important because it can cause very large stress on the materials when the temperature variation occurs
2. Main target is the thermal stress effect by thermal deformation in V9. Therefore, thermal analysis such as conduction, convection, and radiation should be performed in other software
3. Thermal Stress/Strain Effect by using
 - 1) Thermal Expansion Coefficient
 - 2) Reference Temperature
 - 3) Given Field Temperature
4. Target version : V9R2(Try-Dev) or V9R3



Thermal Expression = 20.0*step(time,0,1,1,1.5)

Stress Result with Thermal Effect



□ Fundamental equation

$$\hat{\sigma} = \mathbf{D}(\hat{\epsilon} - \hat{\epsilon}_t)$$

$\hat{\epsilon}_t$: thermal strain
 $\hat{\epsilon}$: total strain
 $\hat{\epsilon}_{elastic} = \hat{\epsilon} - \hat{\epsilon}_t$

□ Isotropic Thermal Expansion:

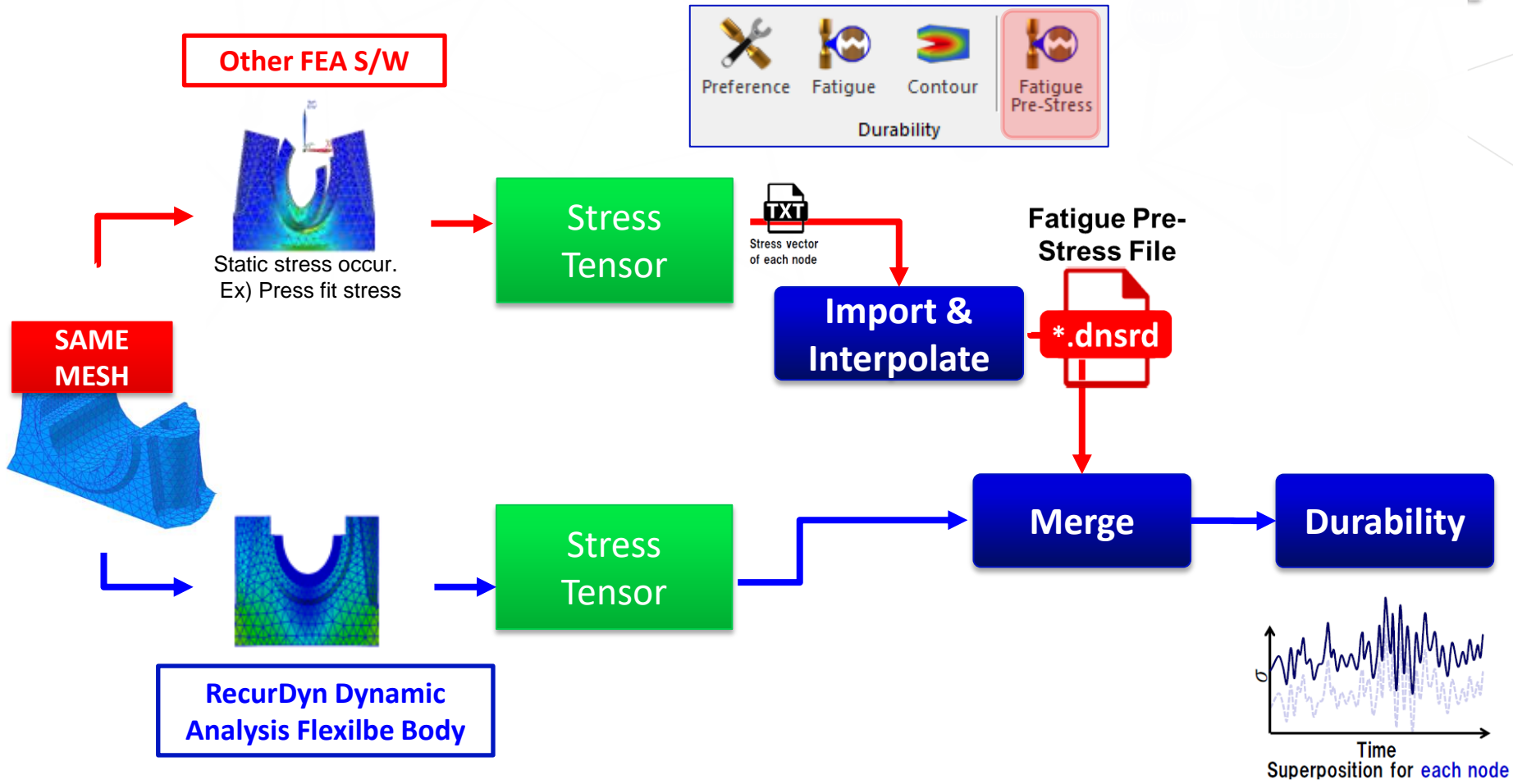
coeff. of thermal expansion

$$\hat{\epsilon}_t = \alpha T \begin{bmatrix} 1 & 1 & 1 & 0 & 0 & 0 \end{bmatrix}^T$$

change in temperature

Static Stress Super-Position in Durability

- Considering FEM (Static) Calculated Stress in Safety Factor Calculation



RFlex & RFlexGen Enhancement



1. RFlex Enhancement

1) RFI Optimizer (Remove Modes)

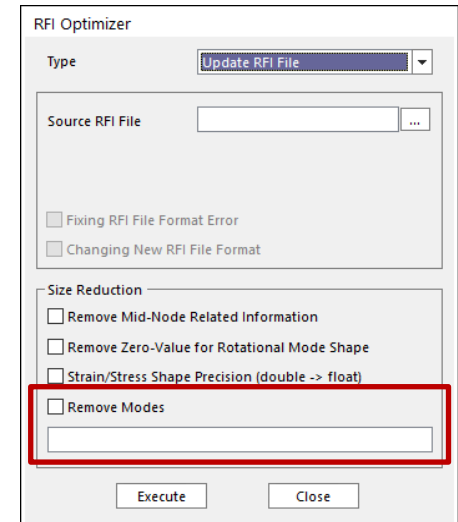
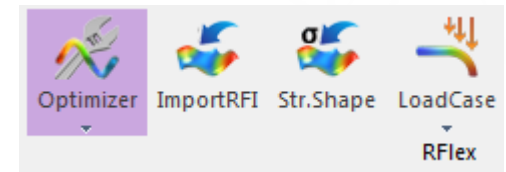
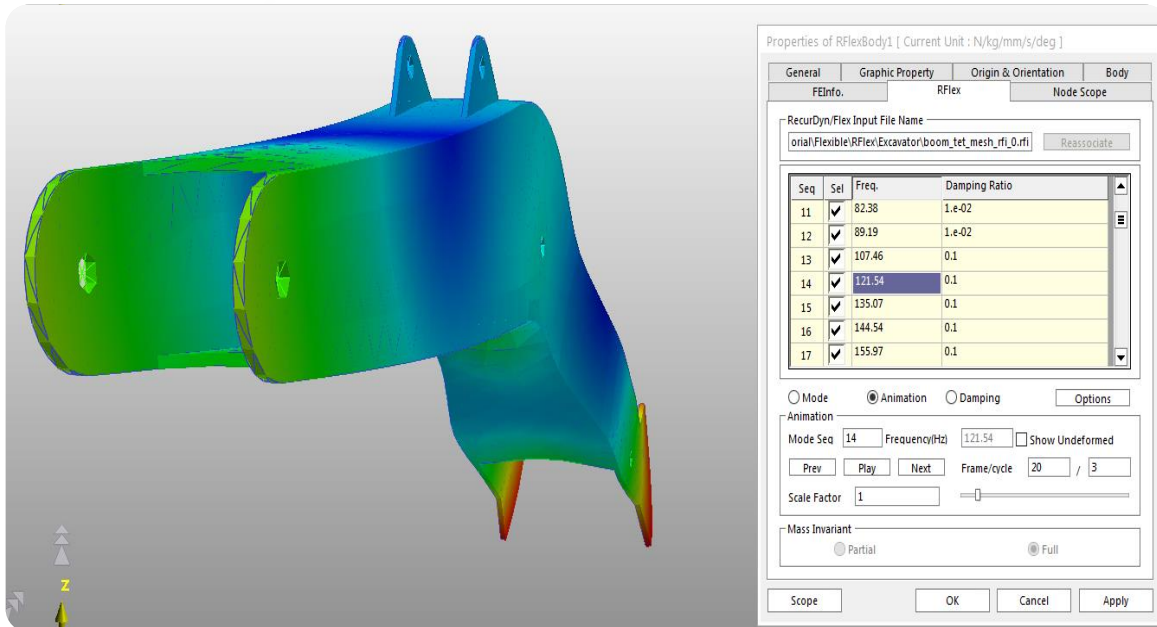
A. When the user want to remove some modes, the user can use RFI Optimizer from V9R2

2. RFlexGen

1) Support GenRDRFI_API in Linux

2) License Integration in RecurDyn

A. FBHQ has an agreement to integrate the RFlexGen solver license into RecurDyn. So, the handling of RFlexGen solver will be much convenient from V9R2



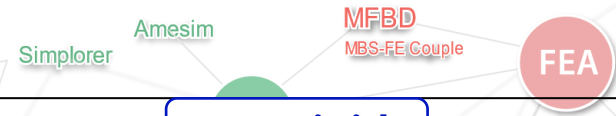
RECURDYN Connect to All



3. Solver Performance

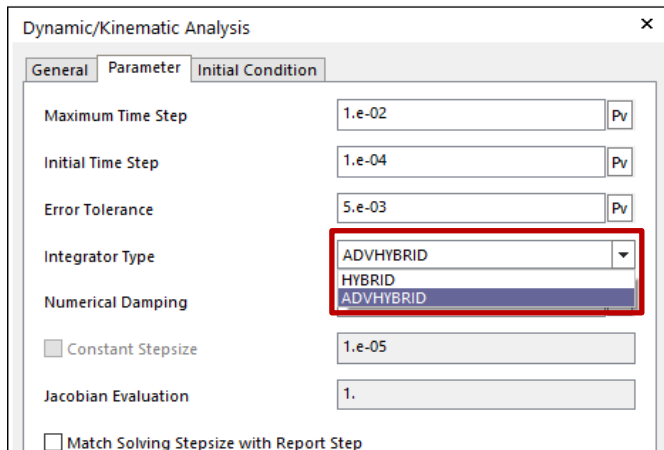
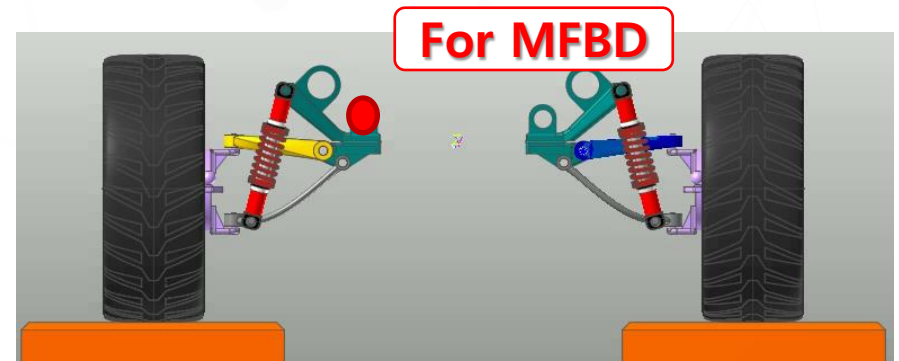
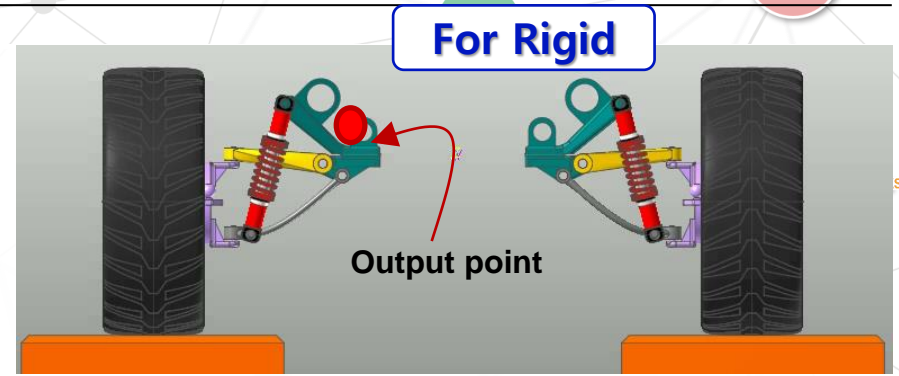
- ✓ *Advanced Hybrid Integrator*
- ✓ *C++ Solver Development for MFBD*
- ✓ *Geo Contact Enhancement (3D Geo Curve to Surface)*

Advanced Hybrid Integrator

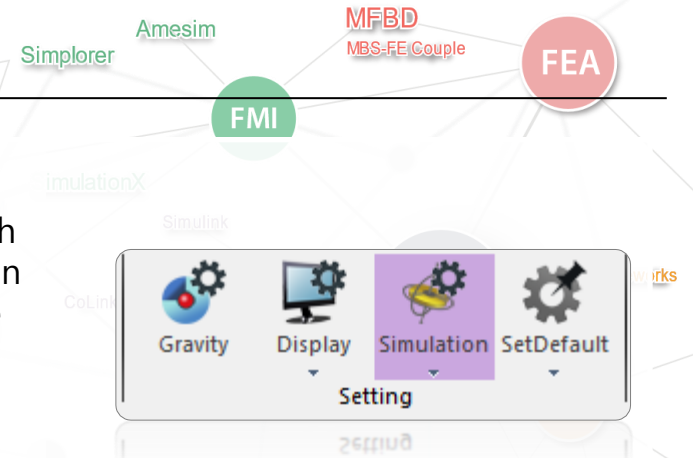


- V9R1
 - For Rigid and Rflex models, G-Alpha Time Integrator are used.
 - For Fflex model, Hybrid Integrator are used.
 - Depending on the model, the RecurDyn integrator was changed. However, the characteristics of the integrator is little different. Sometimes, this is not good to accept the solution

- V9R2
 - FBHQ are developing an advanced Hybrid integrator which can be used for any kind of models. This will give more accurate and consistent solution



C++ Solver Development for MFBD

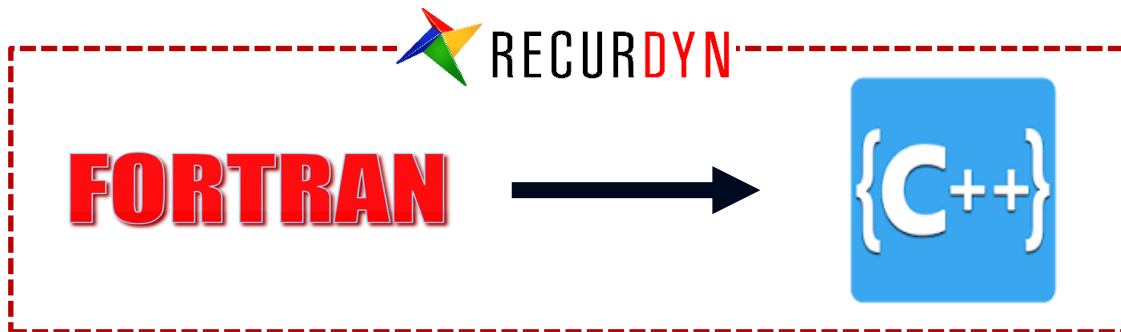
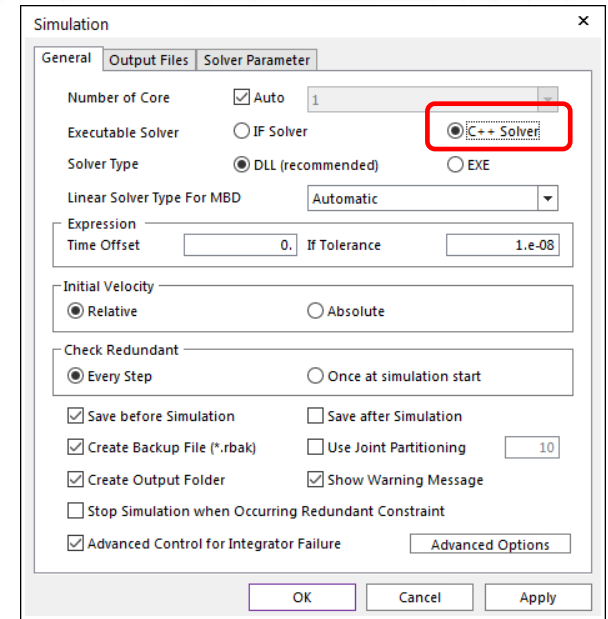


1. C++ Solver (Try-Dev or Hidden)

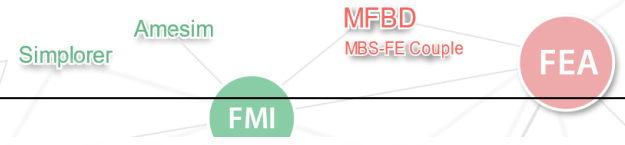
- 1) This solver will be continuously tested and improved with code refactoring and optimization during V9 period as an alternative solver. This if C++ solver becomes acceptable by all customers, FB will change the solver from Fortran solver to C++ solver. That will be V10 (Maybe 3~4 years later).
- 2) The solution of C++ solver can be changed during V9 period in order to optimize the solution efficiently.
- 3) **First Target is MFBD (V9R2 or V9R3).** FB will continuously expand the coverage for the solutions step by step during V9 period.

2. Advantages of C++ Solver

- 1) Solving speed enhancement expected
- 2) Speed-up of development on demand from customers
- 3) Easy connection with various C++ libraries → Easy extensions and interfaces



Geo Contact Development

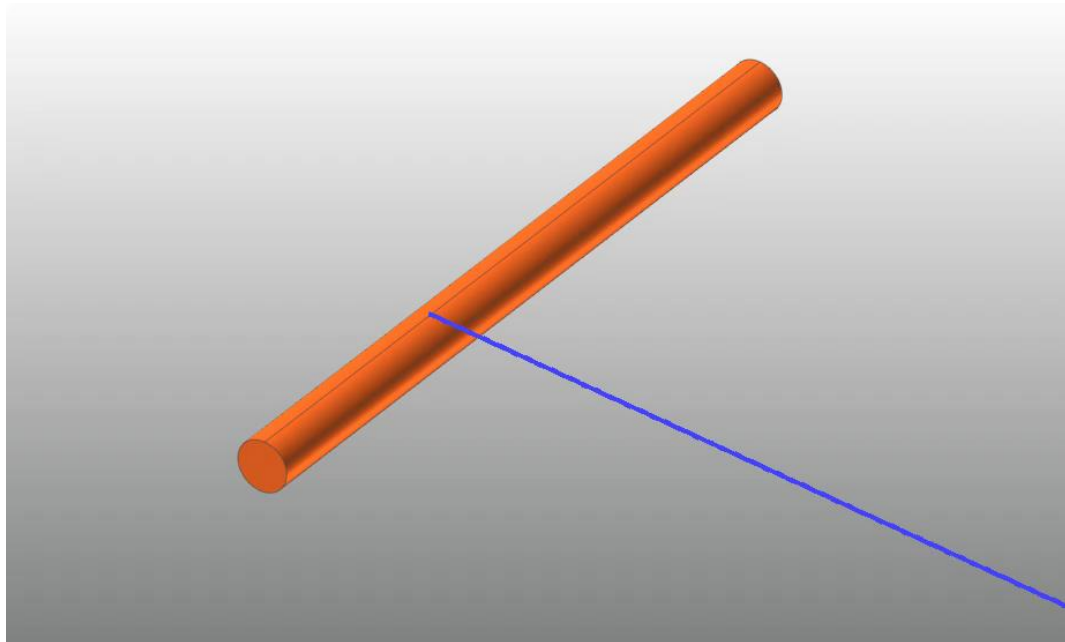


➤ Geo Contact

- 1) FB is are trying to improve the contact element with Geo Contact. In V9R2, we developing the 3D Geo Curve to Surface contact



- 2) Geo Curve to Surface Contact (with 3D Curve)



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4. Application Interface

- ✓ *Supporting Flexible Wall (Rflex and Fflex)*
- ✓ *Tpart for Particle Cosimulation (Chain, Belt & Track)*
- ✓ *General Co-Sim Development (Multi-Cosim)*
- ✓ *Tire Interface*

Supporting Flexible Wall (RFlex and FFlex)

Amesim

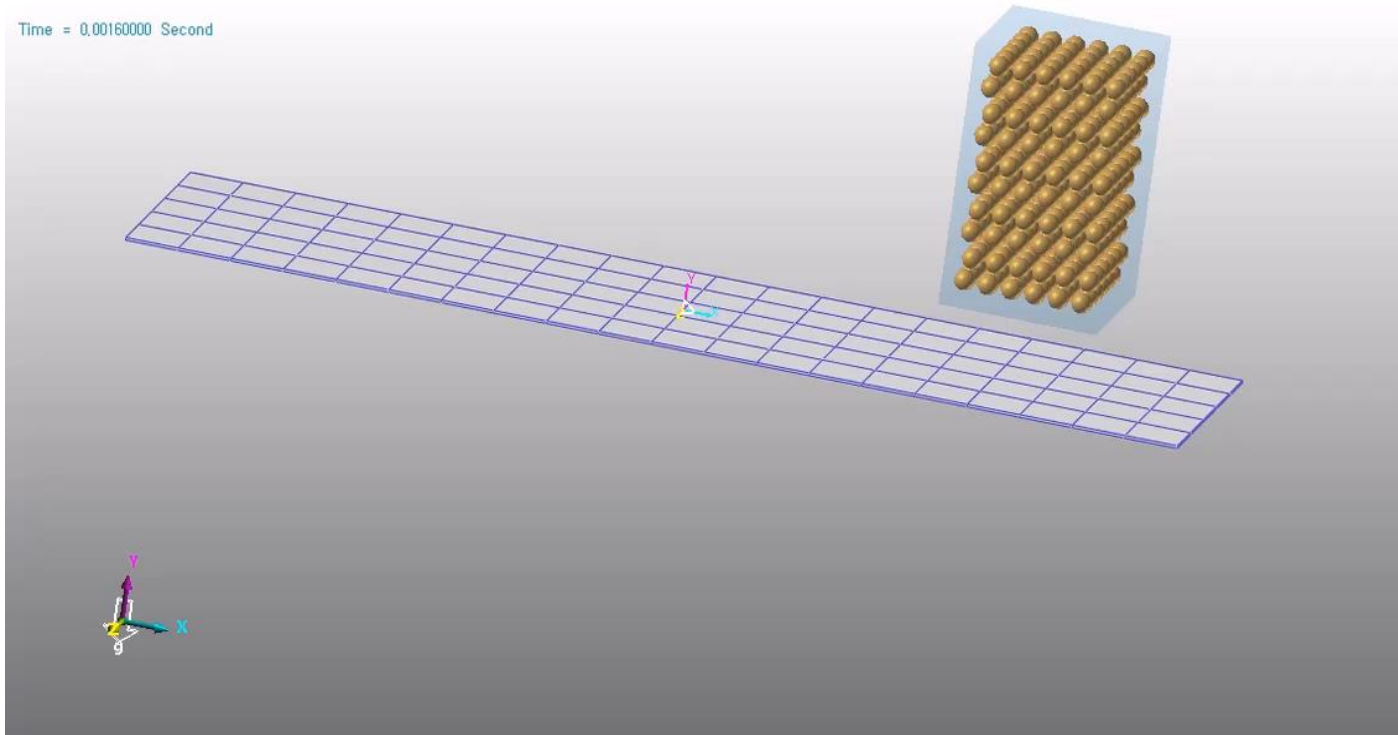
MFBD
MBS-FE Couple

FEA

FMI

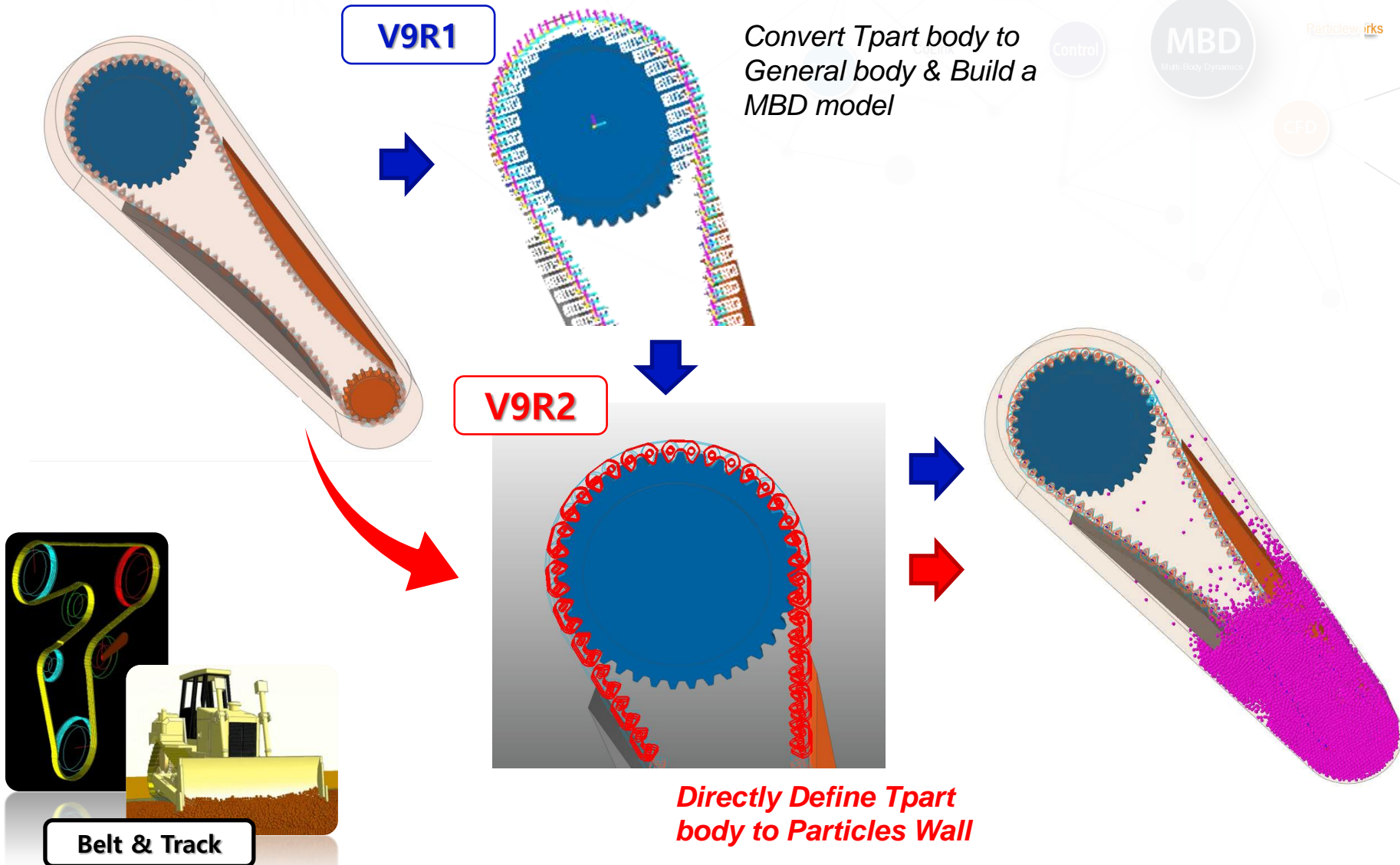
irks

- In V9R2, the Particles interacts with **Flexible Wall**
- Wall contour display are supported.



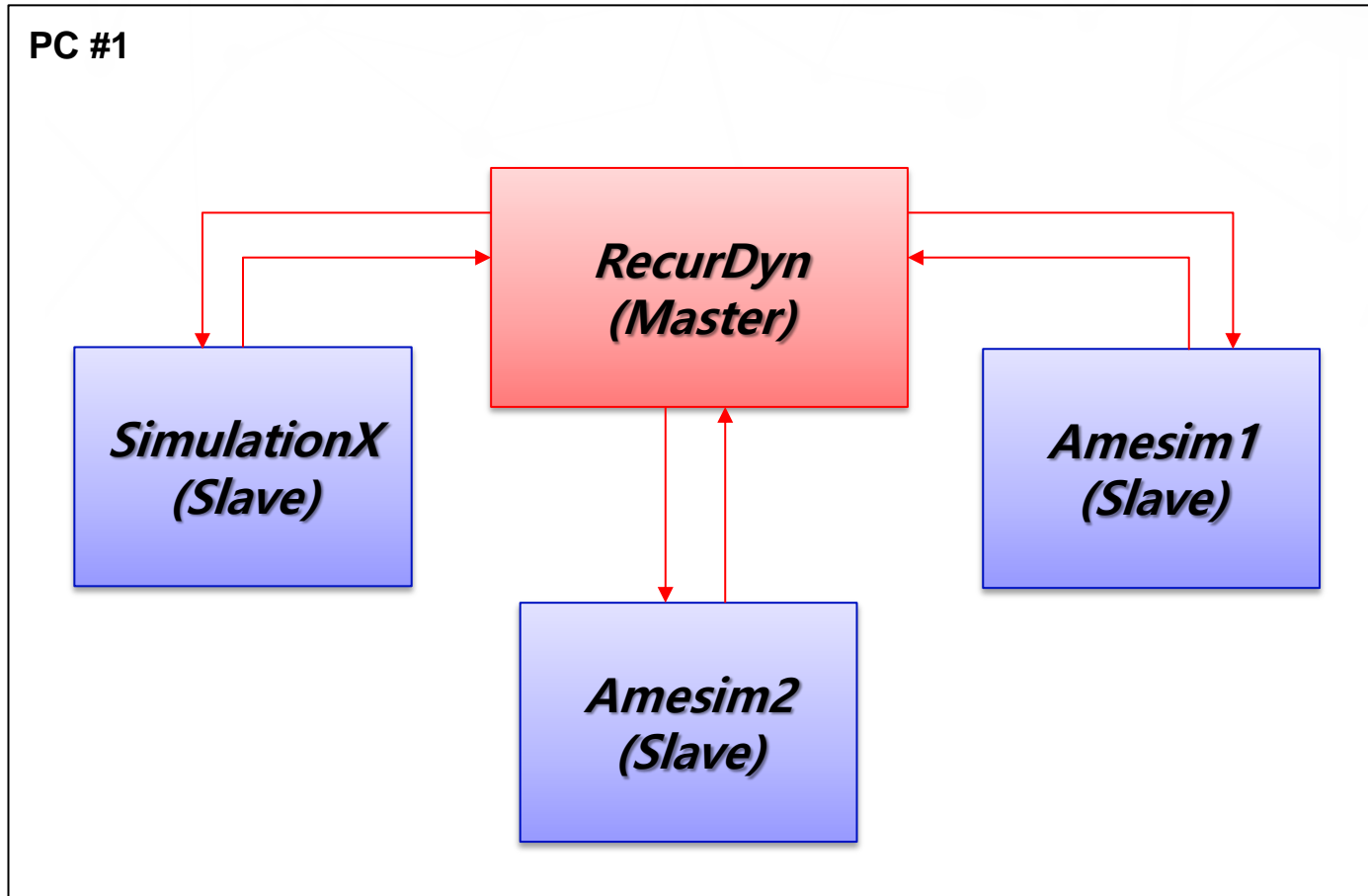
Tpart for Particle Cosimulation (Chain, Belt & Track)

- User can directly define the clone-body to wall for particle interaction in V9R2



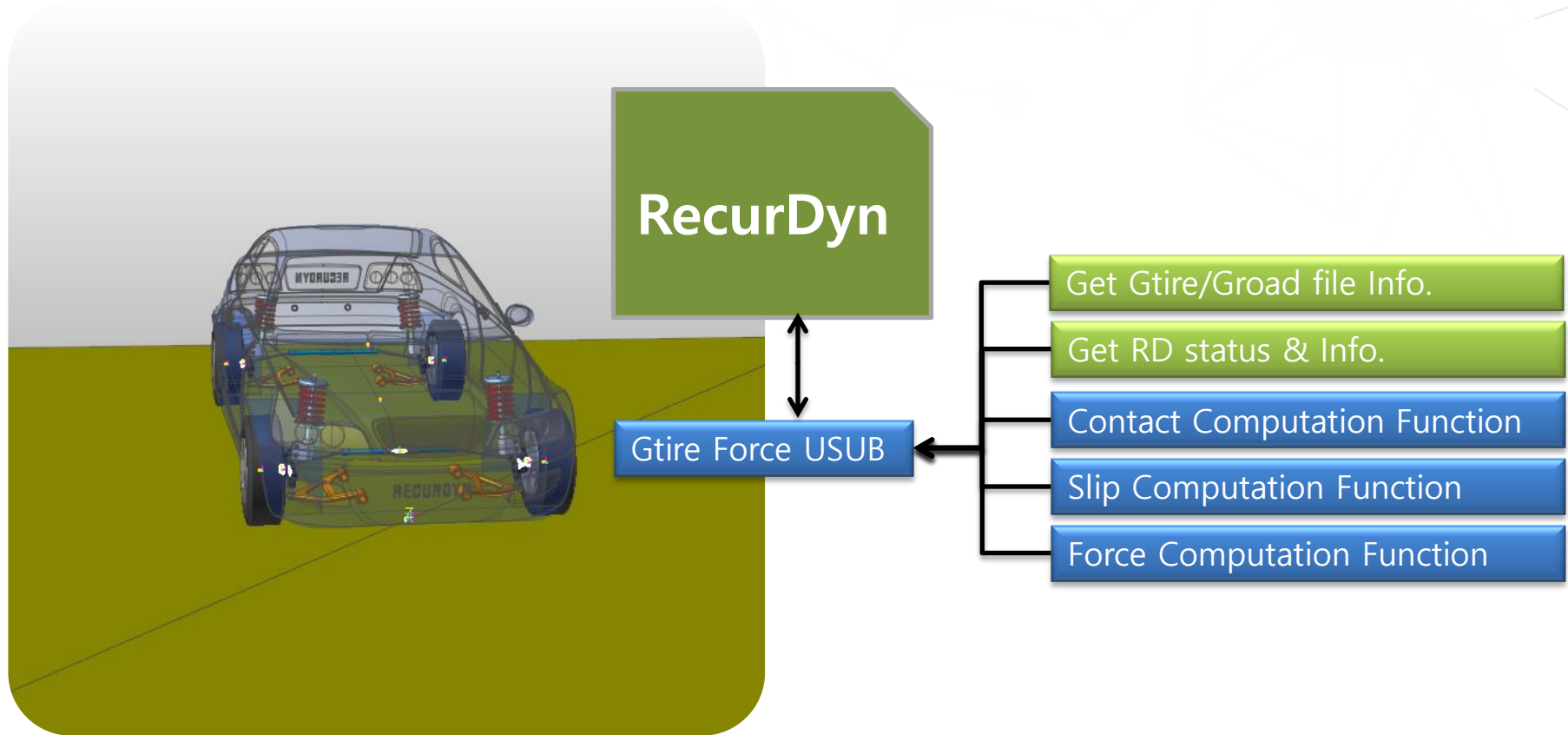
General Co-Sim Development (Multi-Cosim)

- Multiple Co-Sim function are developed in V9R2. Using this function, user can run the multiple co-simulation between RecurDyn and Other S/W(or RecurDyn)



Tire Interface

- Tire Interface is developed for the Interfacing with External Tire Module.



RECURDYN Connect to All

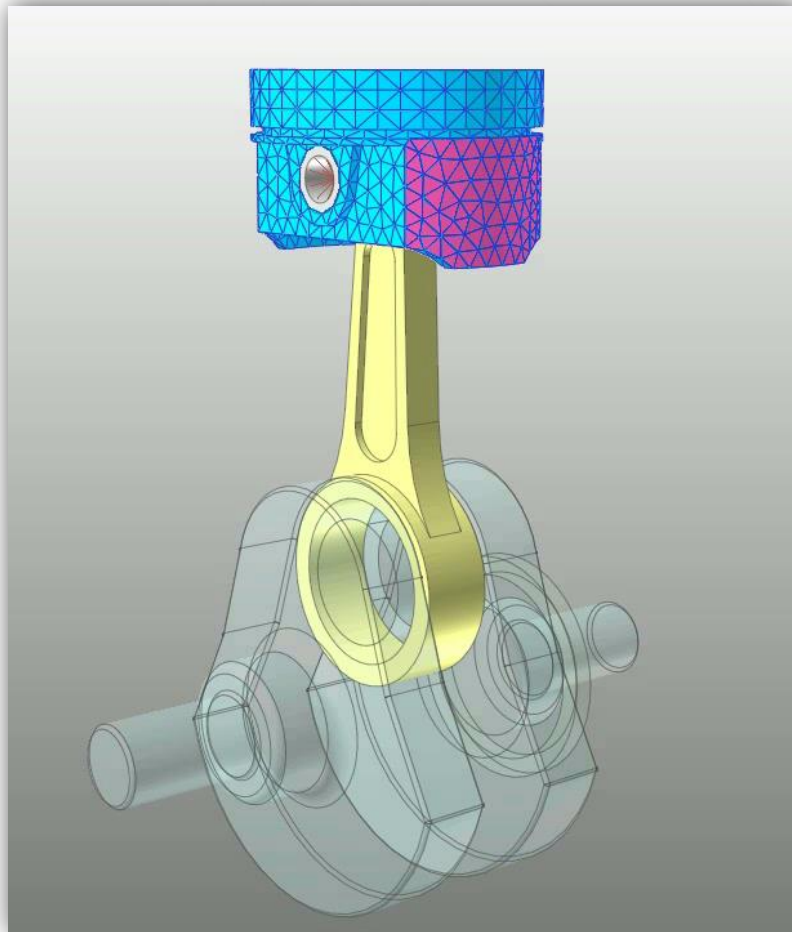


5. Toolkits

- ✓ *EHD Solving Speed Improvement*
- ✓ *Gear Involute Analytic Contact Entity Development*
- ✓ *Colink Enhancement*
- ✓ *Chain Toolkit Enhancement*
- ✓ *Pnet*

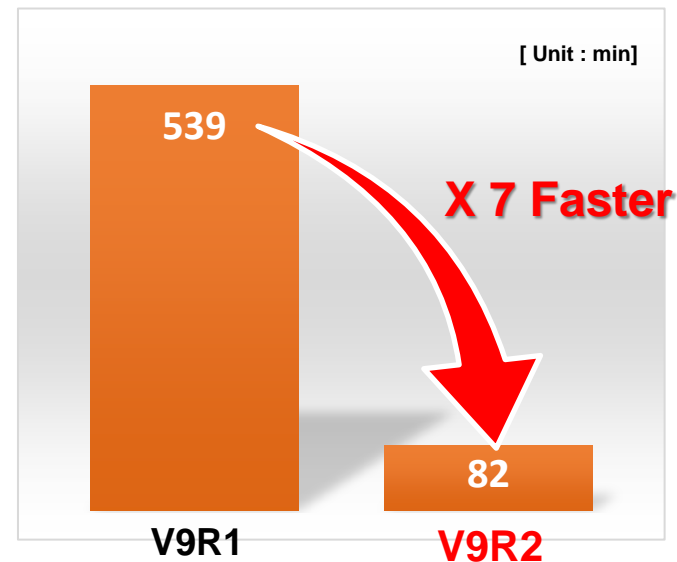
➤ Piston Lubrication EHD

➤ Solving Speed Improvement



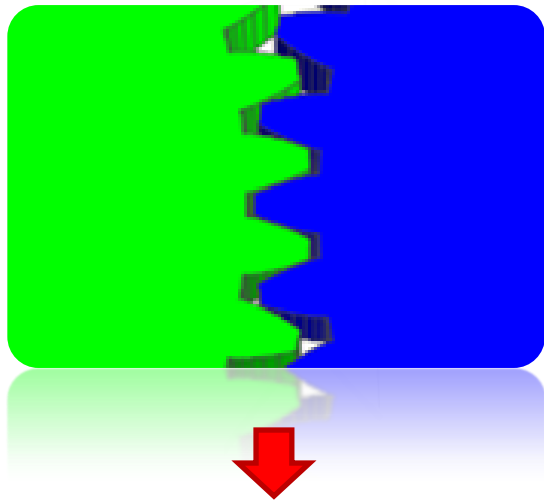
EHD Model Information

No. of RFlex	2 EA - Piston - Cylinder
No. of EHD	3 EA - 1 Piston Lubrication - 2 Rot. EHD
End Time	0.12 sec
Steps	1000 steps

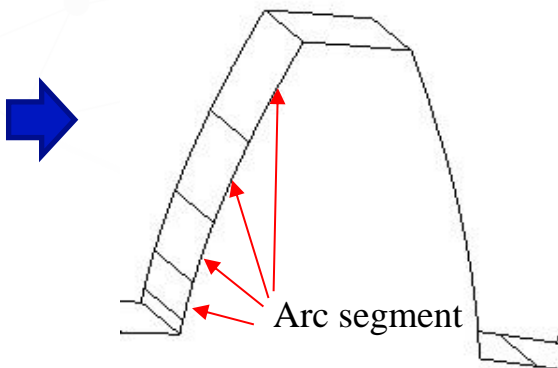


Gear Toolkit Enhancement

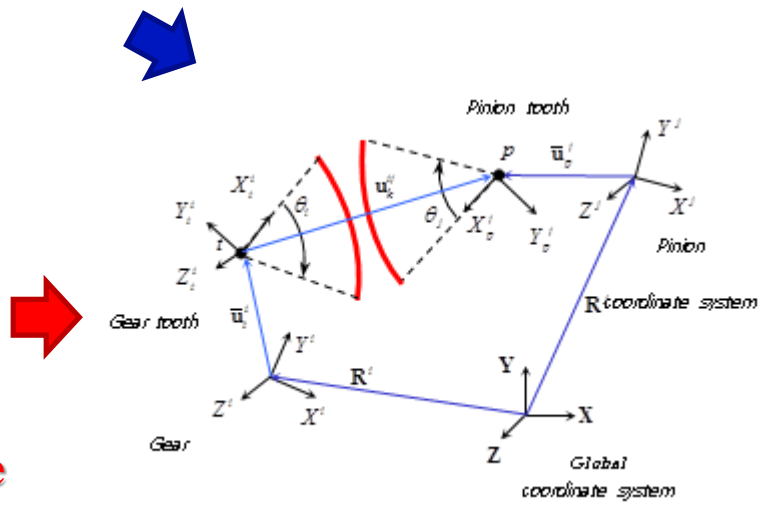
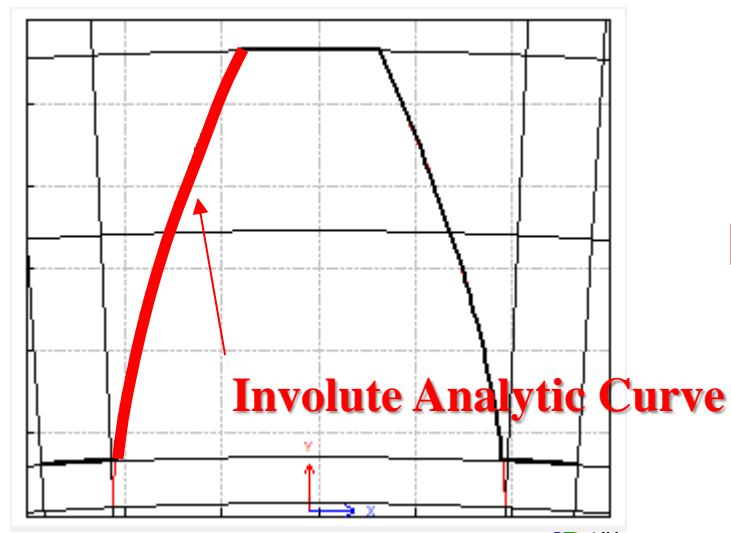
➤ Gear Involute Contact



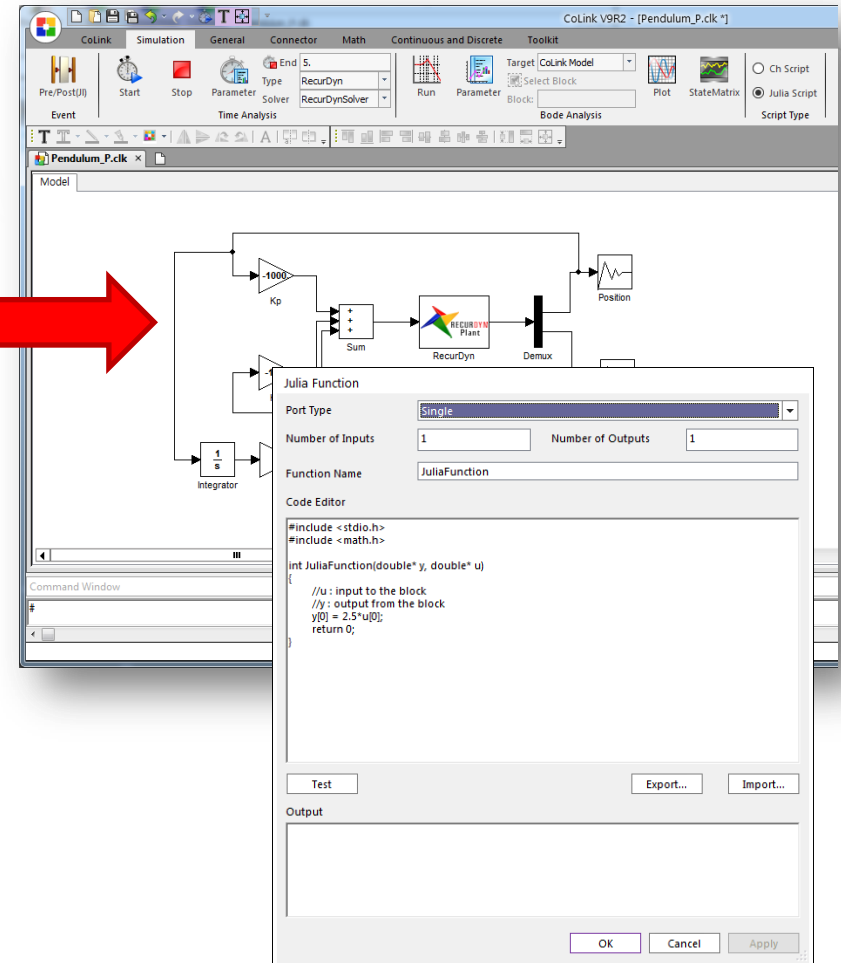
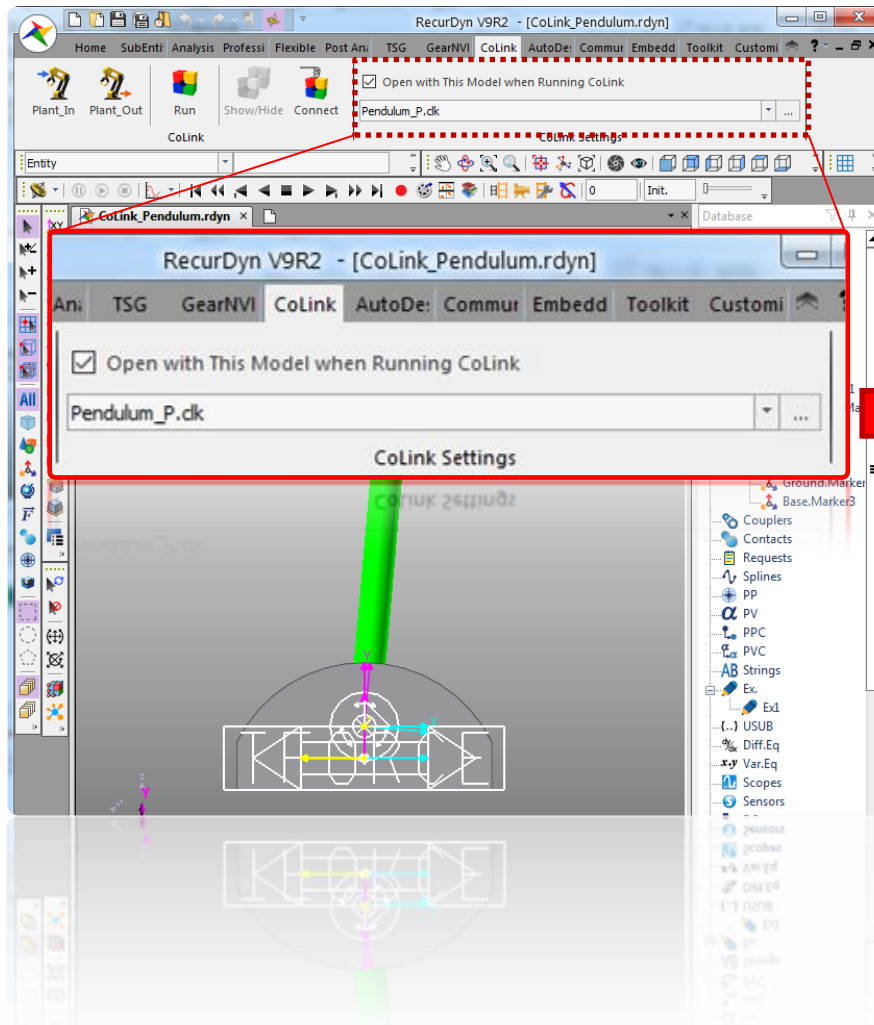
V9R1 Gear 2D Contact



V9R2 Involute Analytic Contact



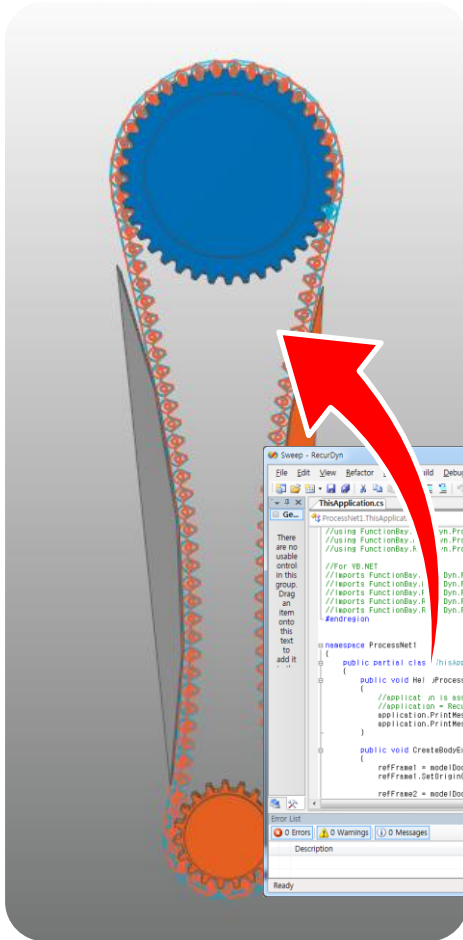
- Define the CoLink Model file in RecurDyn/GUI
- Julia Script



Chain Toolkit Enhancement



- Chain PNet Supporting
- Chain Bushing Force Display



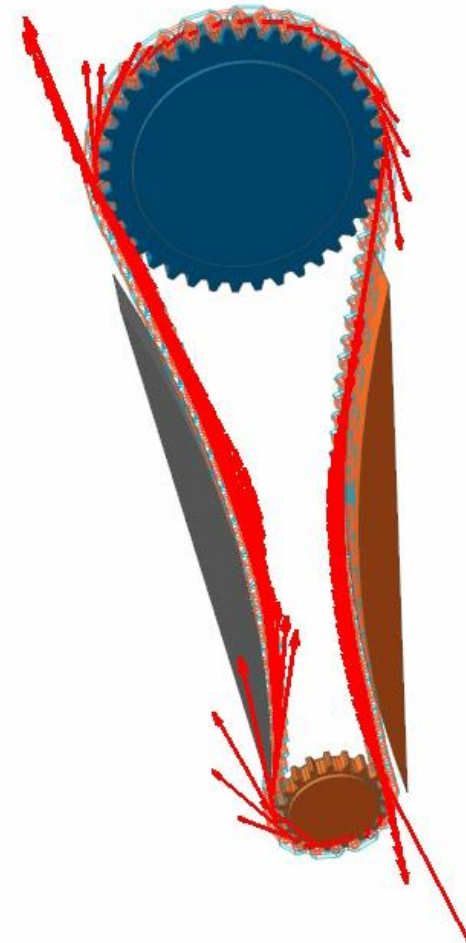
```
//ThisApplication.cs
//ProcessNet1.ThisApplication
//HelloProcessNet2

//Using FunctionBay:
//Using FunctionBay.K
//Using FunctionBay.L
//Using FunctionBay.R

//For VB.NET
//Imports FunctionBay:
//Imports FunctionBay.K
//Imports FunctionBay.L
//Imports FunctionBay.R
//Imports FunctionBay.R

#reference
namespace ProcessNet1
{
    public partial class ThisApplication
    {
        //application is assigned at Initialize() such as
        //application = RecurDynApplication as Application;
        application.PrintMessage("Hello ProcessNet");
        application.PrintMessage(application.ProcessNetVersion);

        public void CreateBodyExample()
        {
            refFrame1 = model.Document.CreateReferenceFrame();
            refFrame1.SetOrigin(100, 0, 0);
            refFrame2 = model.Document.CreateReferenceFrame();
        }
    }
}
```

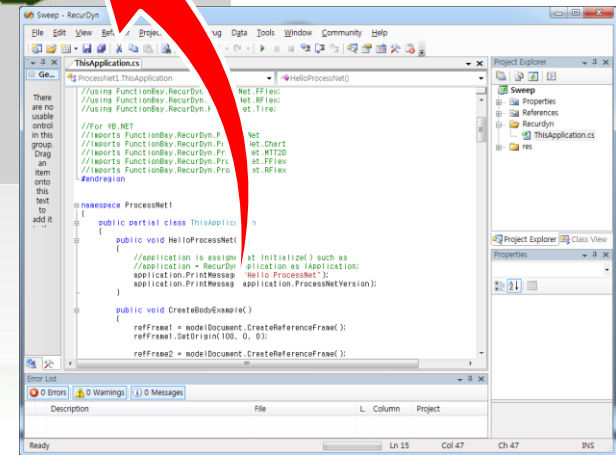
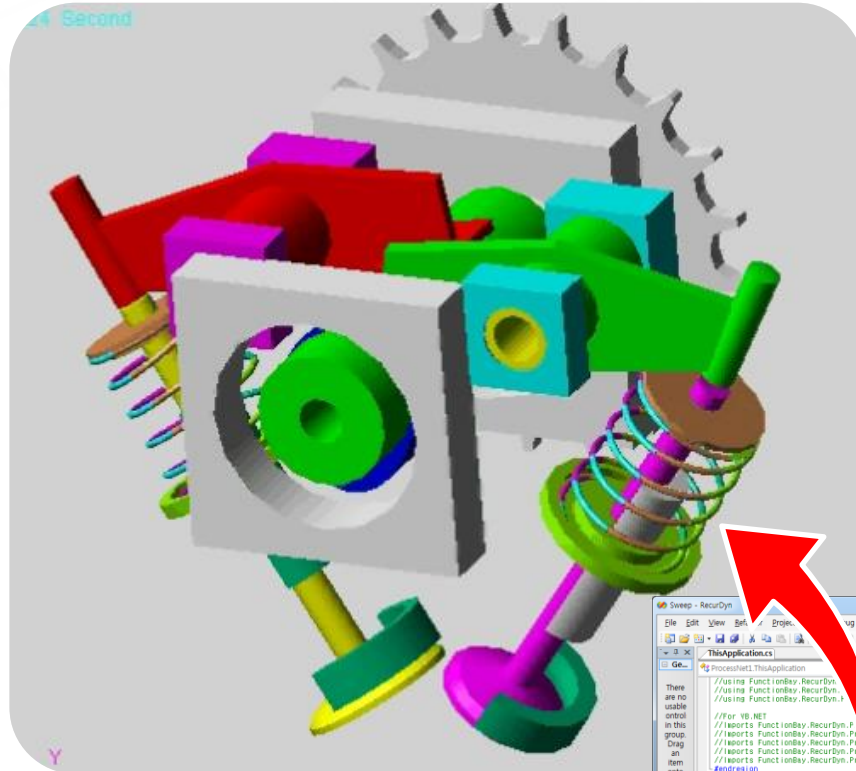
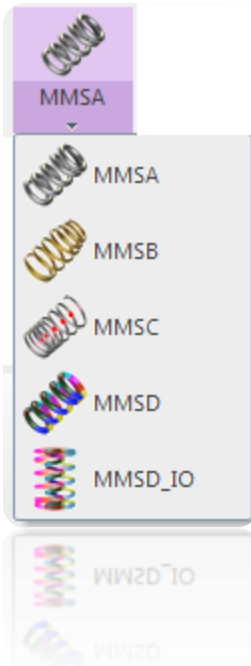


PNet Enhancement



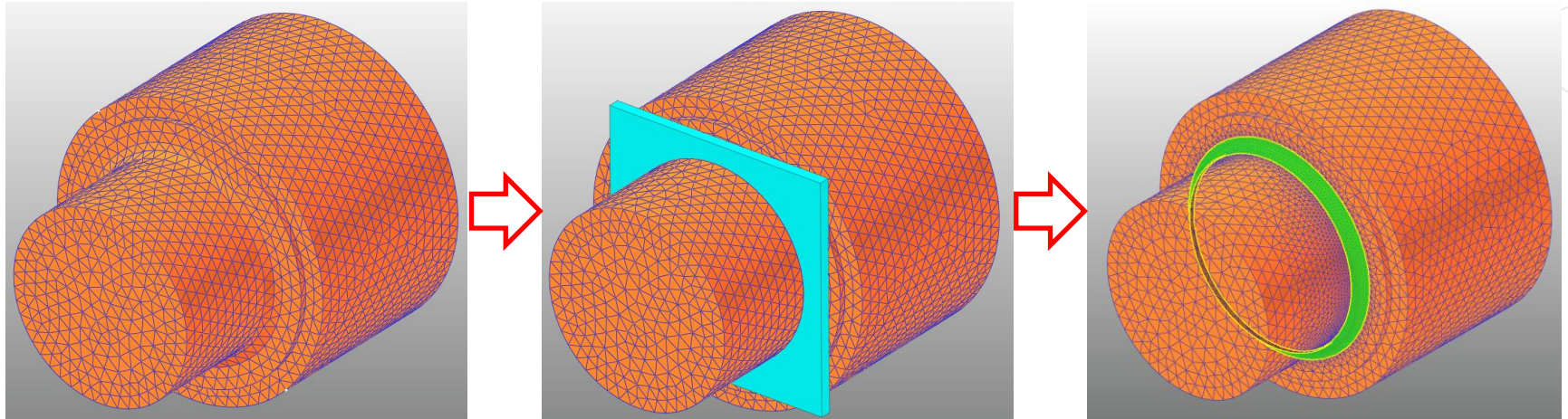
- MMS Toolkit PNet is supported in V9R2

irks



➤ FFlex/RFlex PatchSet Creation Scripts

V9R1 – PatchSet Cration by Pnet only for FFlex



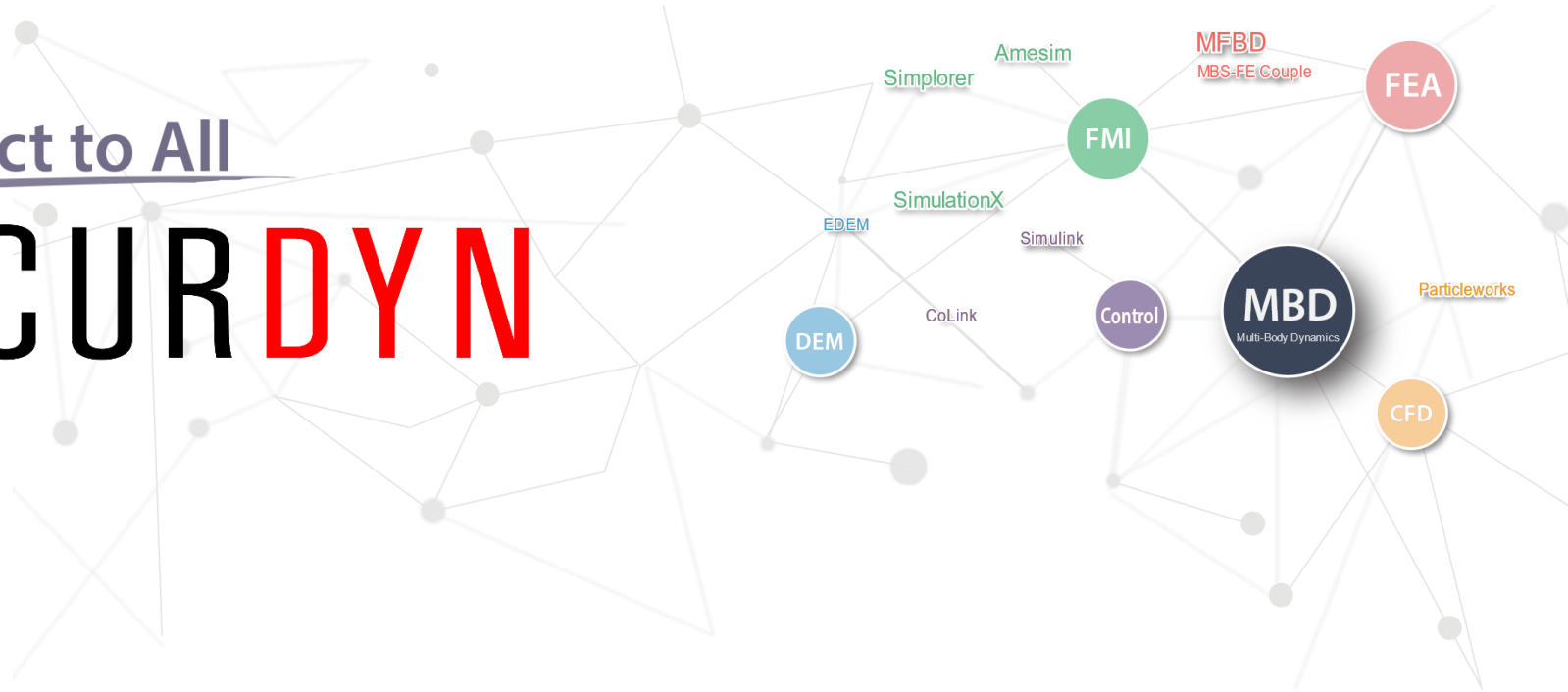
V9R2 – Additional creation methods

IFFlexBody, IRFlexBody

```
CreatePatchSetWithNodeSet(string strName, IFFlexNodeSet pNodeSet);  
CreatePatchSetWithPatchesIndices(string strName, int[] arrPatchesIndices);  
CreatePatchSetWithPatchesIndicesContinuous(string strName, int[] arrPatchesIndices, double dAngle, bool bCheckReverse);  
CreatePatchSetWithElementsIDsContinuous(string strName, int[] arrElementID, double dAngle, bool bCheckReverse);  
CreatePatchSetWithBox(string strName, IReferenceFrame pRefFrame, double dWidth, double dHeight, double dDepth)
```

Connect to All

RECURDYN



Thank you