New Features in Current LS-PrePost® and its Future Development

October, 2016

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Livermore Software Technology Corp.

Outline of Talk

- Current status of LS-PrePost and the different releases
- New Features in LS-PrePost 4.3
- Current and future developments

Current Version 4.3

- Version 4.3 is frozen and has been released this last summer (July, 2016), bugs still will be fixed in this version
- This may be the last version to support the old interface (version 2.4 style) users can toggle between old interface and new interface by F11 function key. Do not expect new features to be in old interface
- Support both Linux and Windows 64bits only (Windows 32bits has been dropped), Apple Mac OSX
- Continue to improve in stability, robustness and features

Development Version 4.5

- Version 4.5 is available for download
- New features and requests will be implemented in this version
- The new features mentioned in this presentation will be available in this version
- Download 4.3
  http://ftp.lstc.com/anonymous/outgoing/lsprepost/4.3
- Download 4.5
  http://ftp.lstc.com/anonymous/outgoing/lsprepost/dev

Graphics and Rendering

- From version 4.0 and after, LSPP employs new graphics rendering scheme to speed up graphics performance. It is called “Fast Rendering” mode
- Fast Rendering mode can be many times faster than the Normal (old) rendering for very large model
- Requires certain level of hardware/software for the fast rendering. e.g. OpenGL 3.3 and later
- Enter Cntl->L twice before loading data will toggle between fast and normal rendering modes
- Cntl->O will save a file called LS-PrePost_info.txt, this file shows the hardware/software configuration as well as LSPP configuration

New features and improvements in LS-PrePost 4.3

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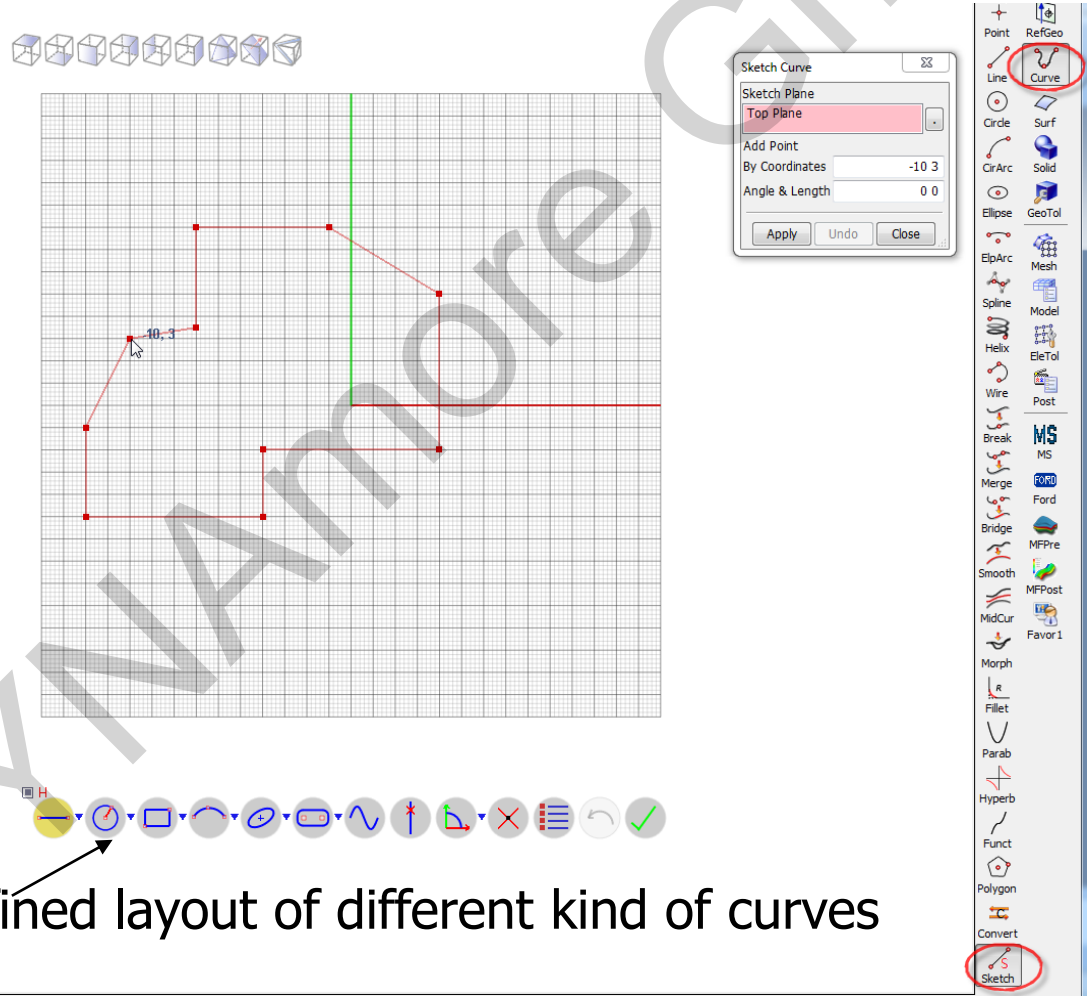
New and Enhanced features in Geometry

A 2-Dimensional tool to create curves on a sketch pad with precise measurement is available

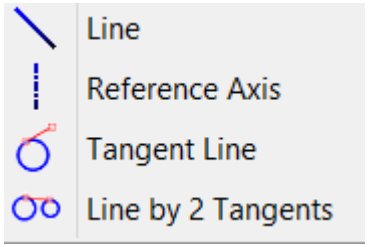


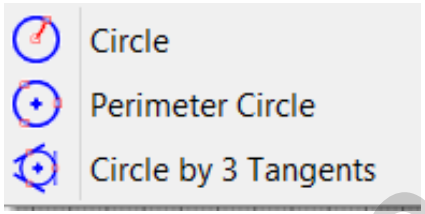
Pre-defined layout of different kind of curves

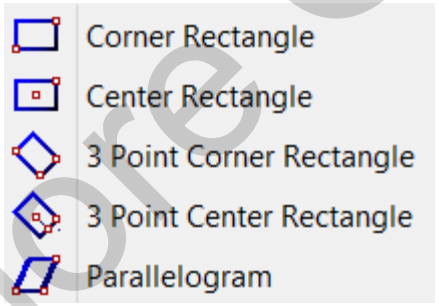
New and Enhanced features in Geometry

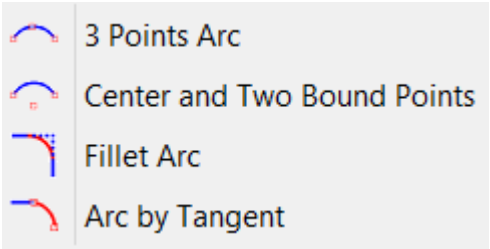
- Sketch

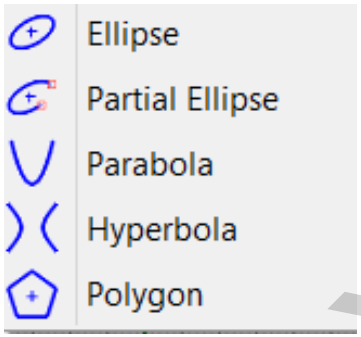
  All Sketch tools are layout in graphics region. It's totally transparent. Sub tools shows after button clicked.

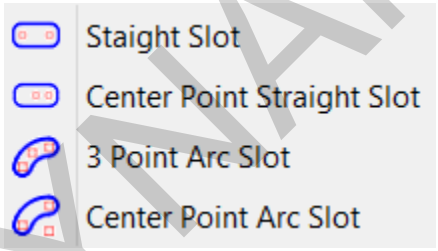


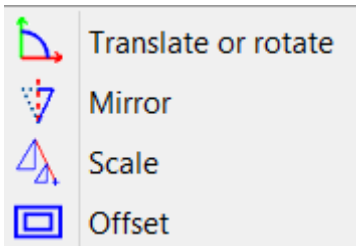


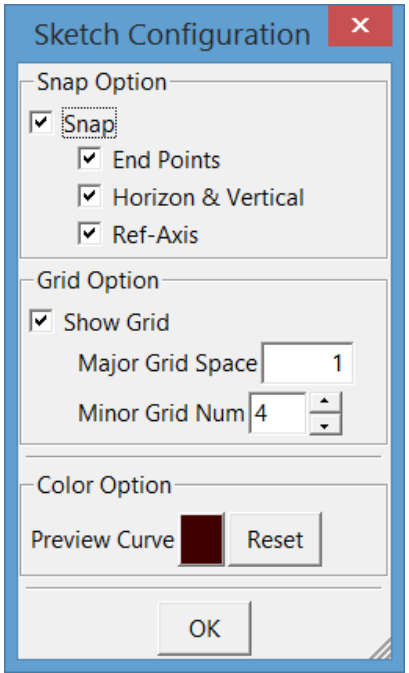






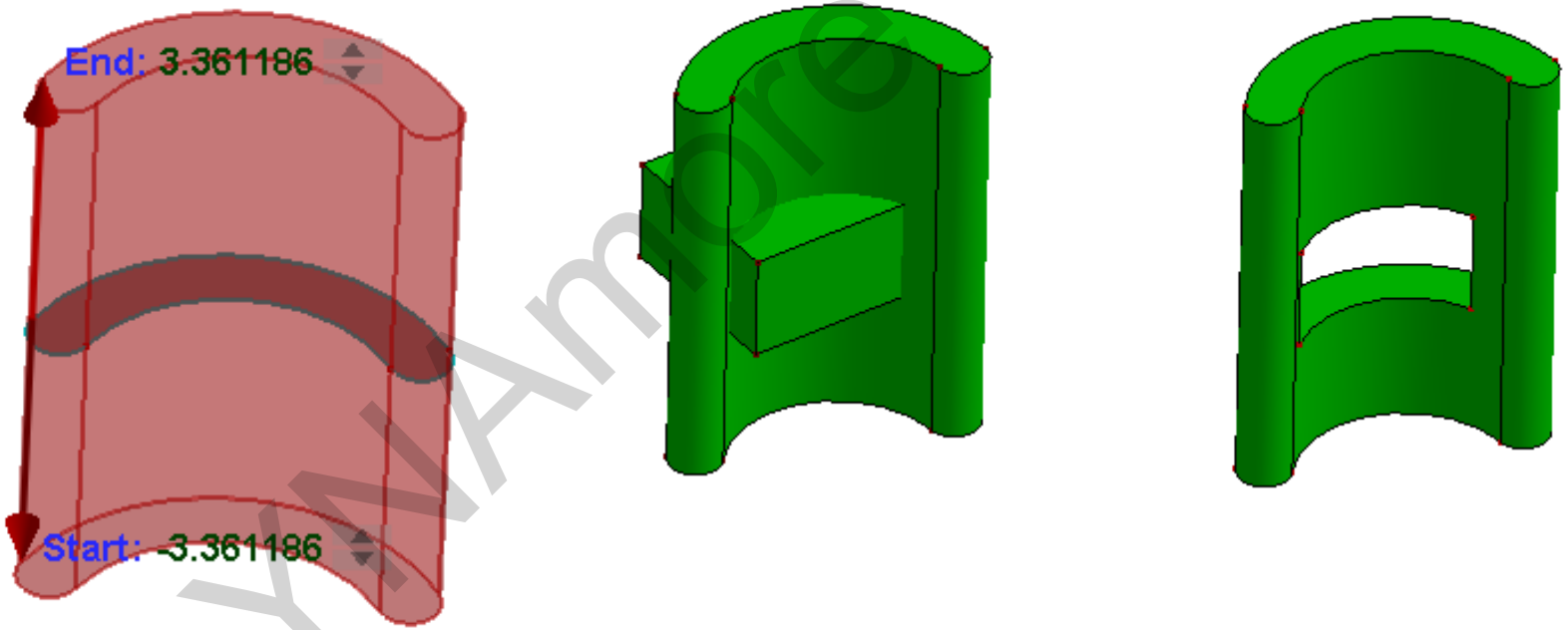






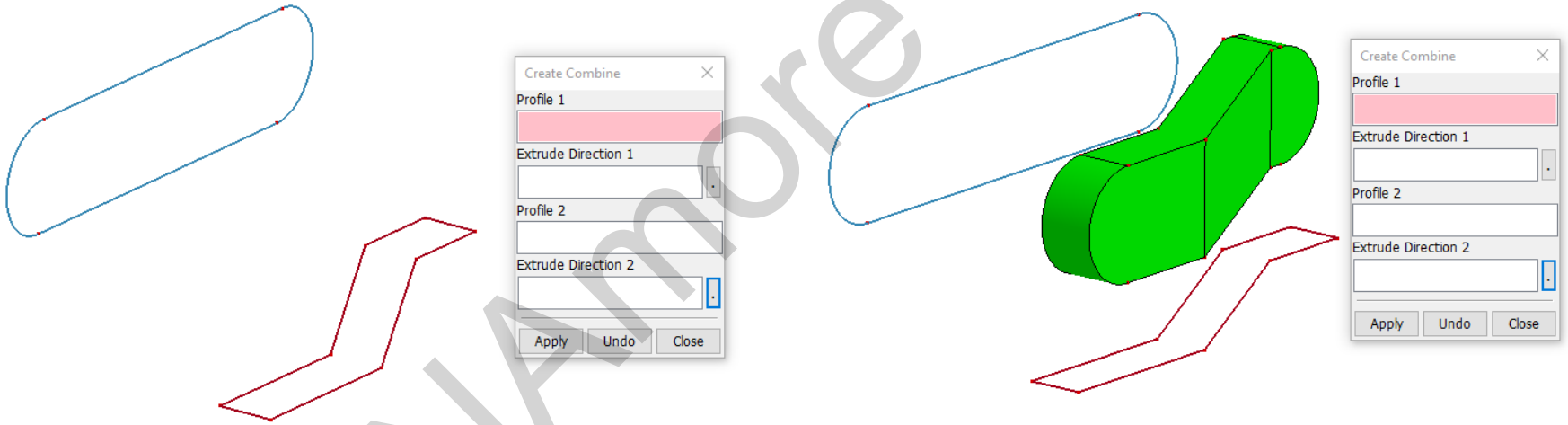
New and Enhanced features in Geometry

- Solid Extrude – in symmetric option
- Solid Boolean – speed up operation



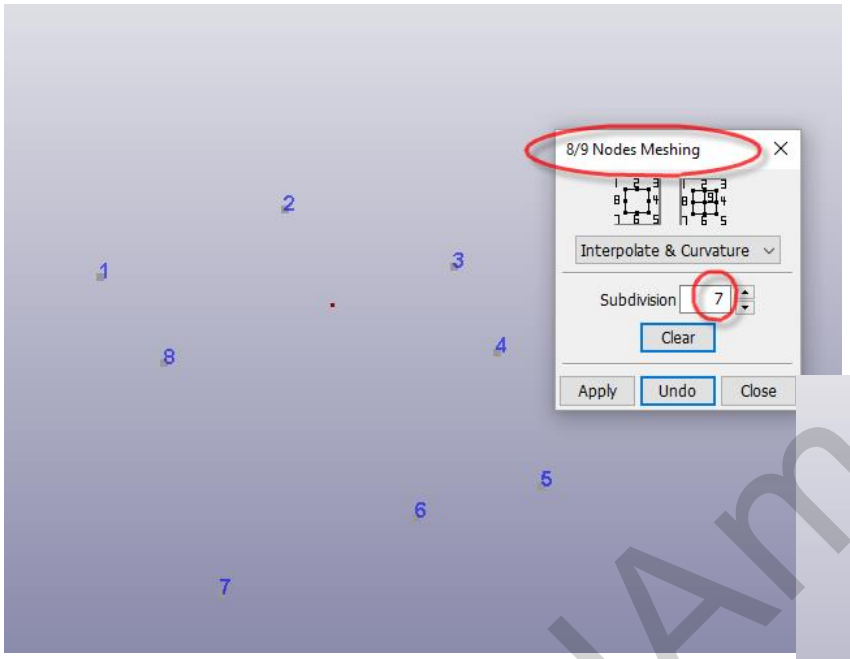
New and Enhanced features in Geometry

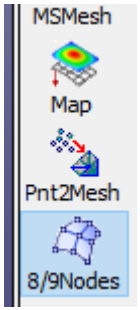
- Solid Combine – combine 2 profiles into a solid model

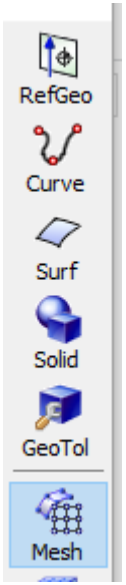


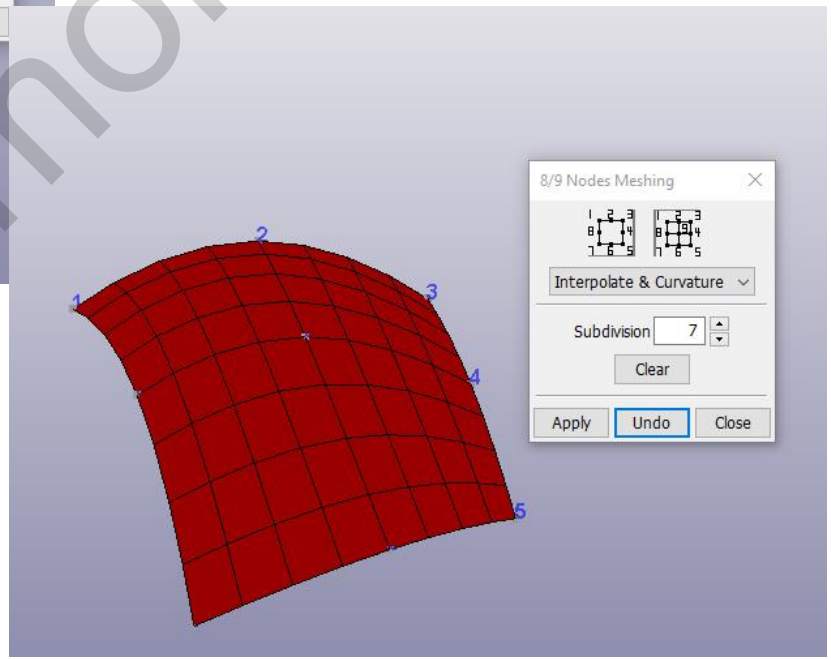
New Features in Meshing

Create mesh from 8 or 9 points



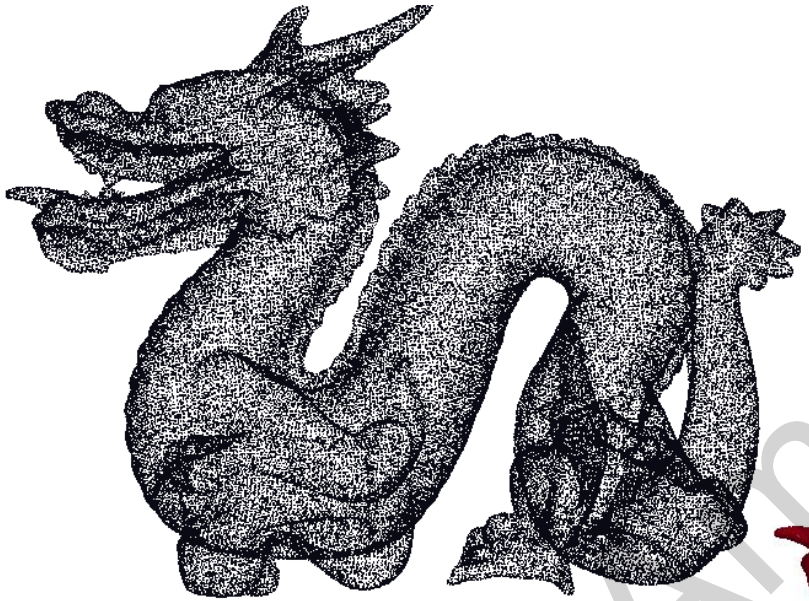


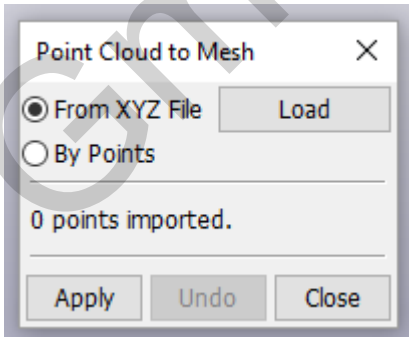


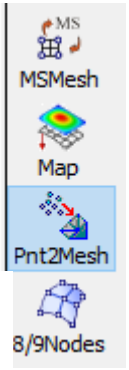


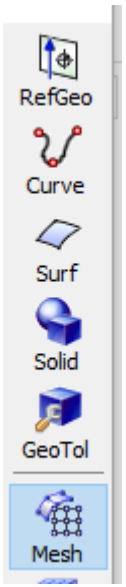
New Features in Meshing

Create triangular mesh from point cloud





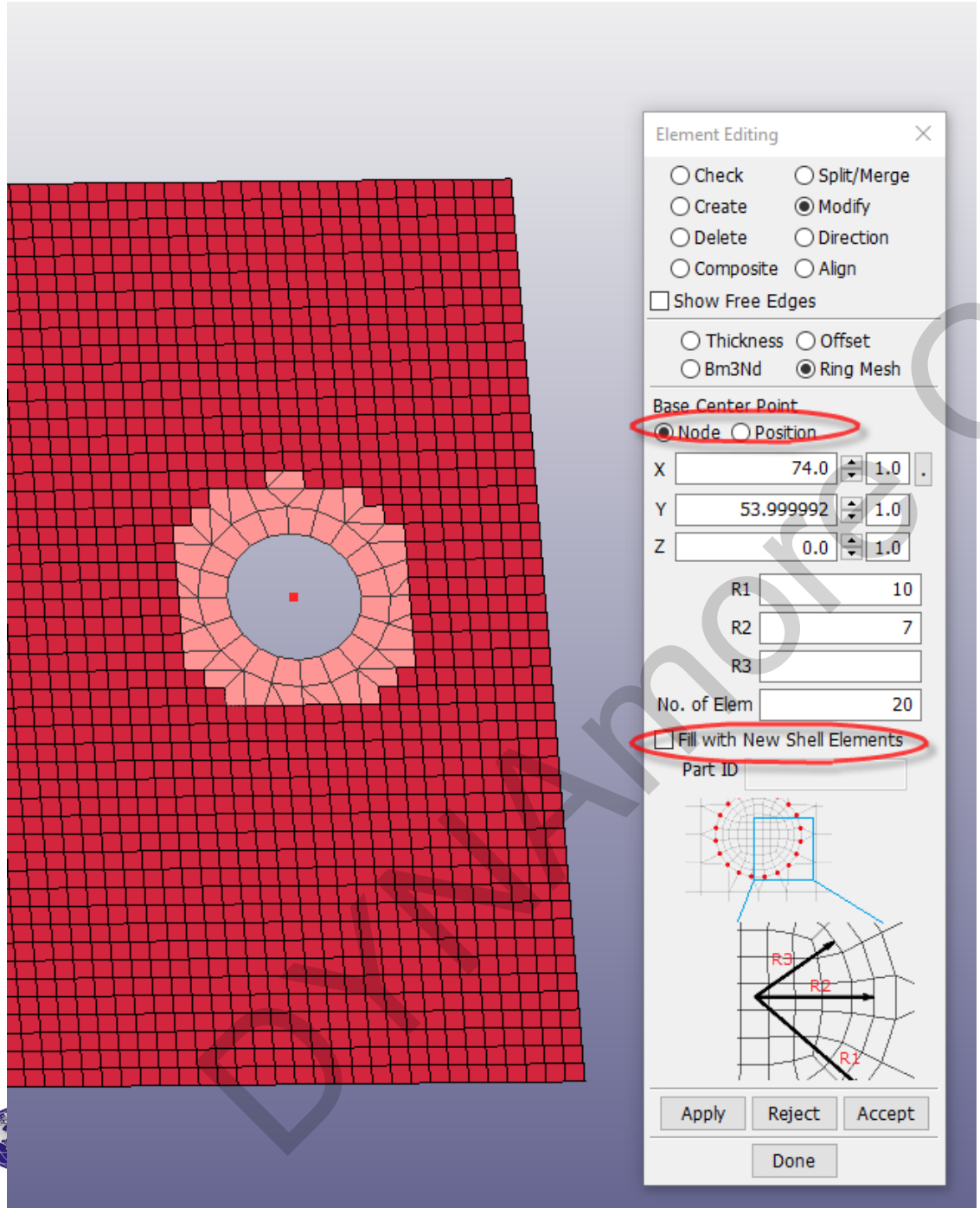




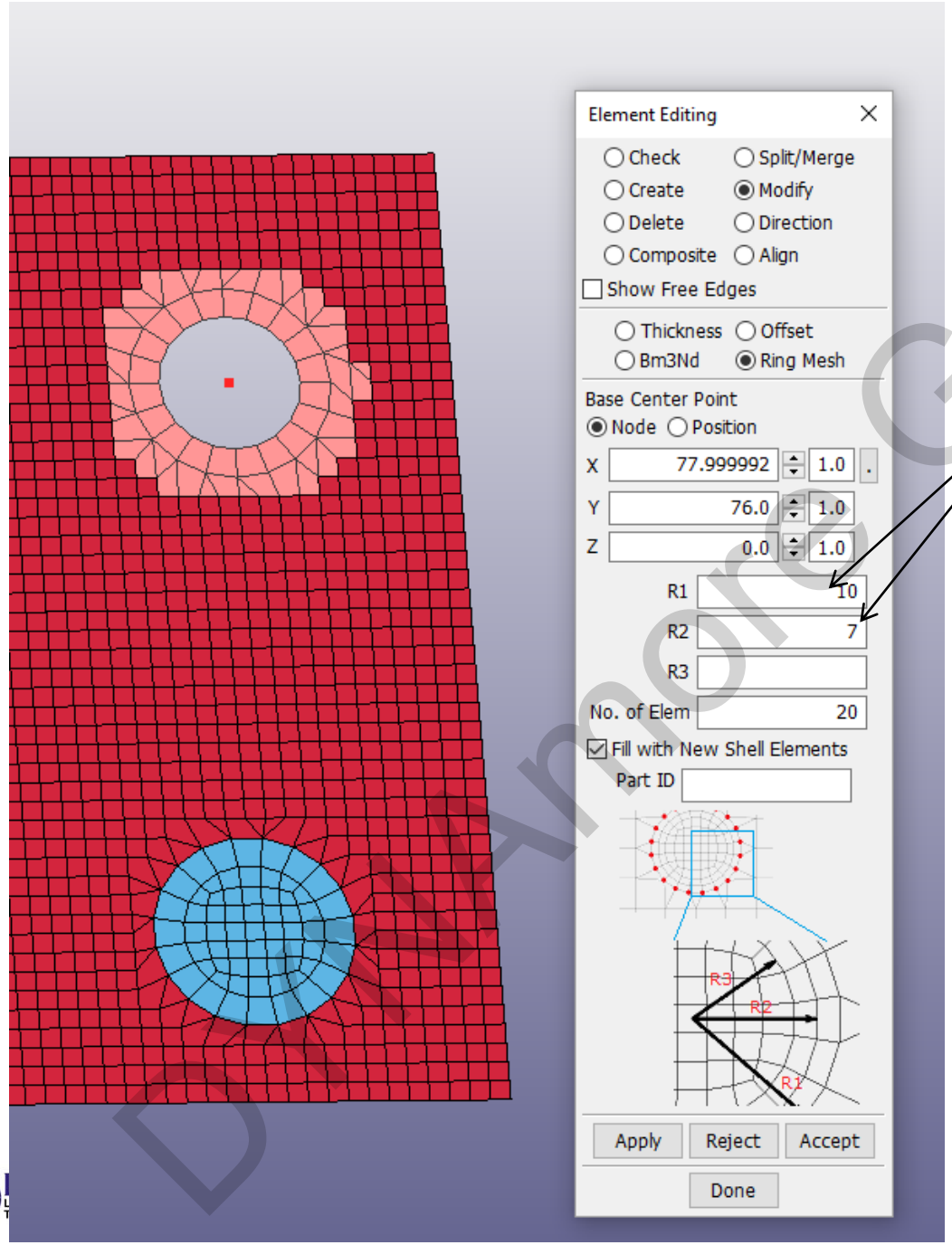
New Features in Meshing

Creation of Ring Mesh

- Element Edit->Modify->Ring Mesh
- Pick a location to define the center of the ring mesh
- Define R1, R2, R3, R1 must be input, R2, R3 can be blank. If R3 is blank, there will be 2 rings, if R3, R2 are blank, there will be only 1 ring. If R2 is blank, R3 is not blank, then it will be 3 rings, but with equal space between the rings
- Option to fill the center of the ring with elements or without element
- If fill with elements, option to assign to a new part ID



- Option to pick node or position as center of the ring mesh
- Option to create multiple rings
- Option to create rings without filling the center with elements

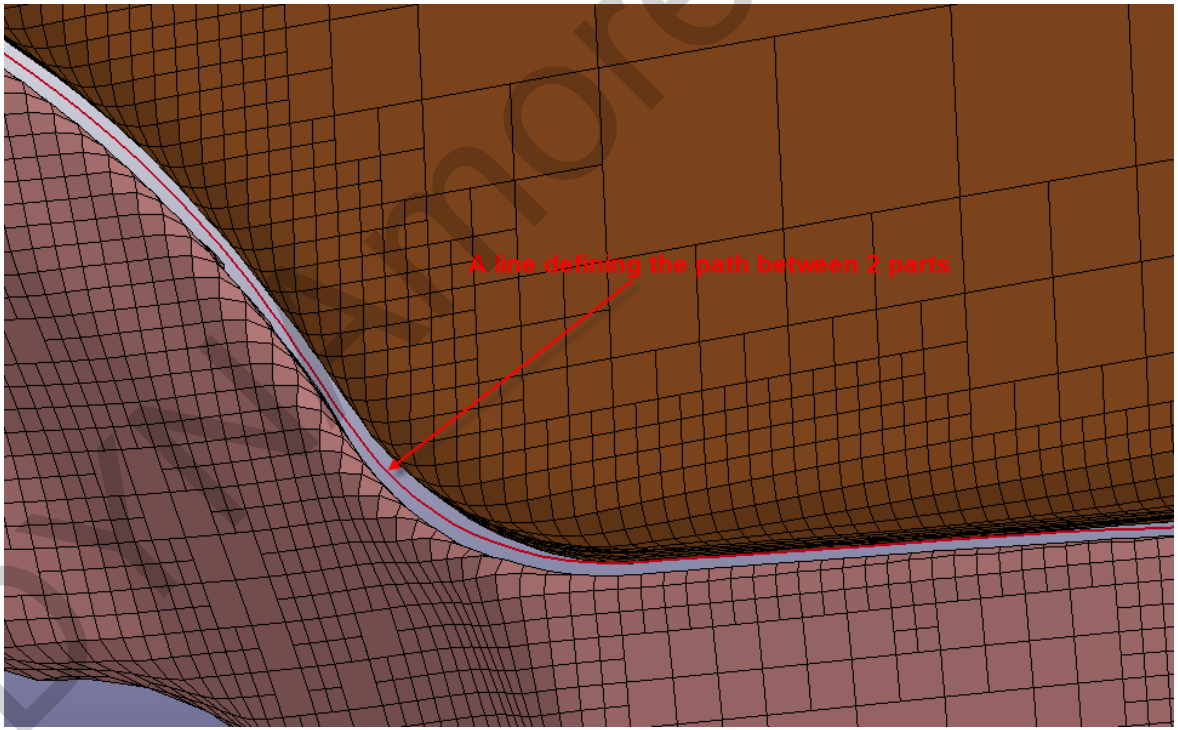


- Option to fill center hole with elements
- 2 Rings with specified radii

New Features in Meshing – 3D Solid for Laser Weld

3D solid mesh creation to simulate laser weld

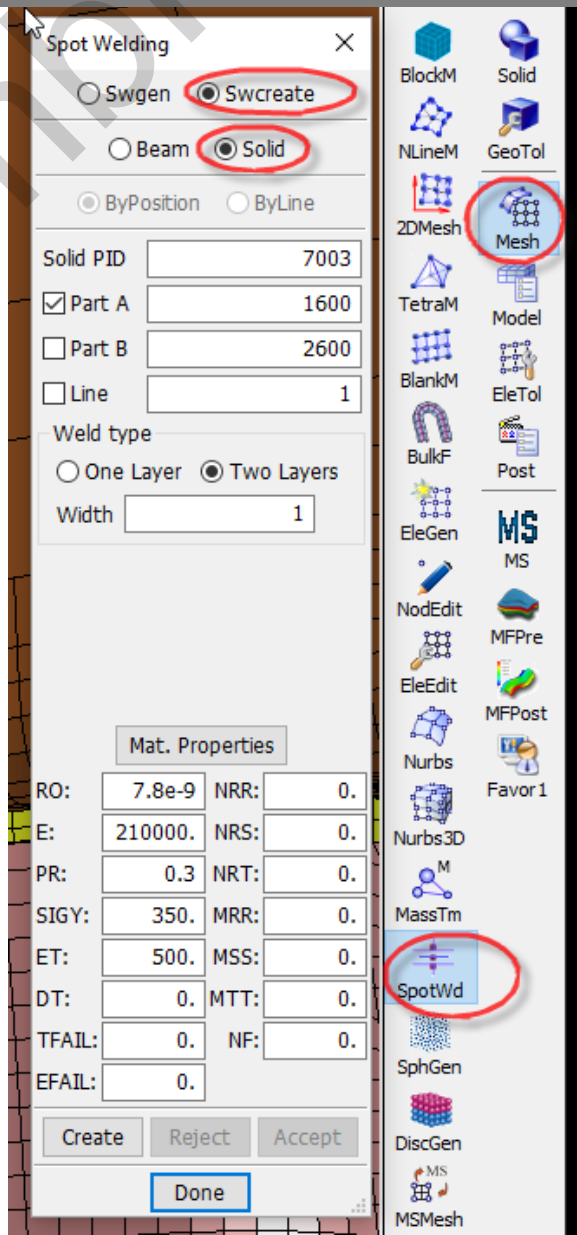
- Very often 2 parts will be jointed together by laser weld, this can be modeled by 3D solid elements created from a line defining the weld



New Features in Meshing – 3D Solid for Laser Weld

3D solid mesh for laser weld

- Pick 2 parts that the laser weld will be interacted with
- Pick a line to define the path
- Define1 layer or 2 layers of solids
- Define the width of the solid element
- Material properties can also be defined
- ***Contact_Tied_Shell_Edge_to_Surface** will be created



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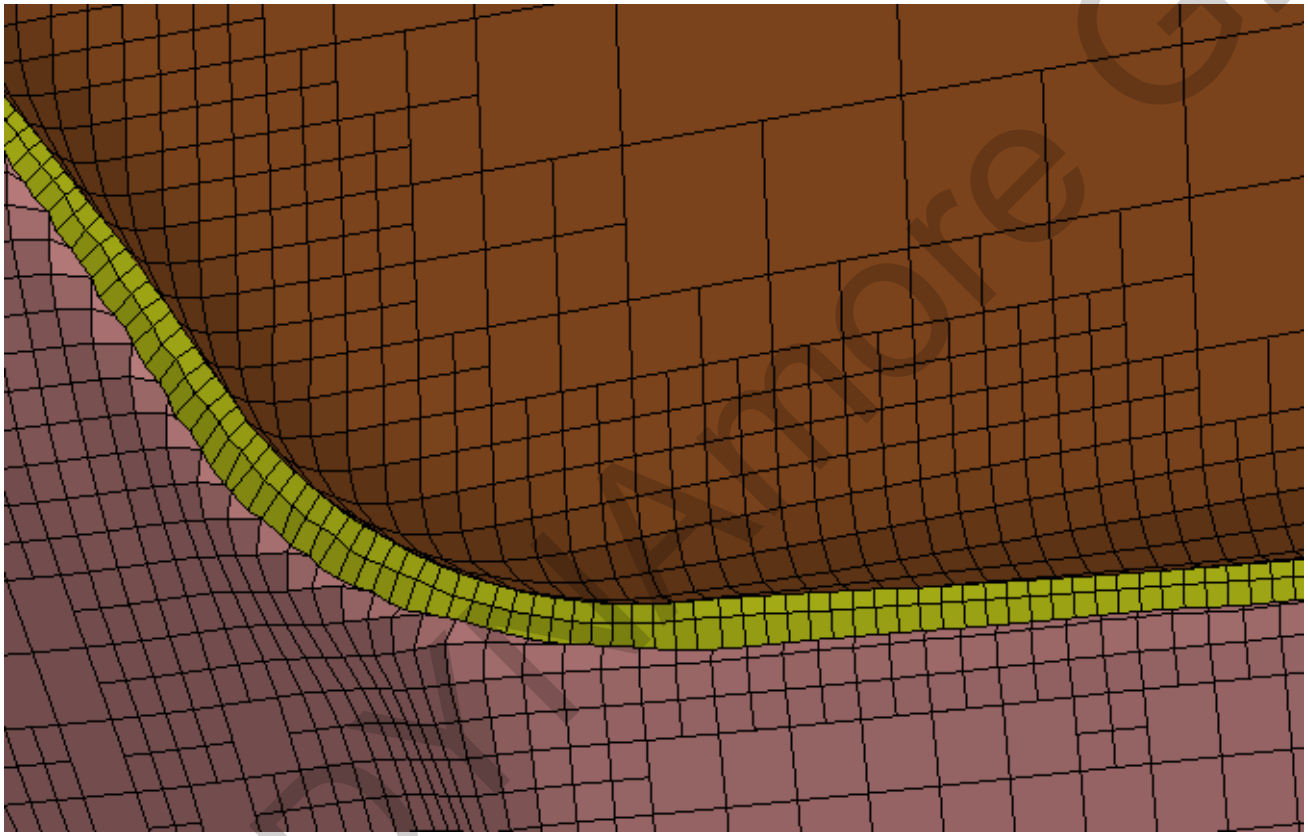
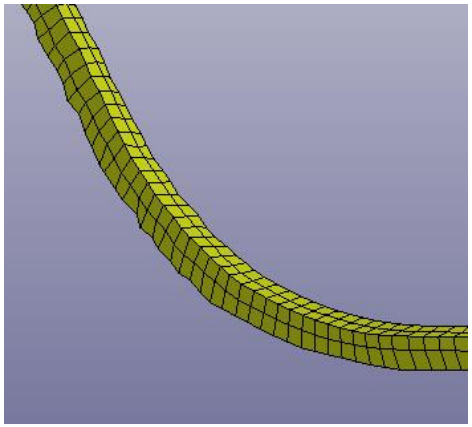
New Features in Meshing – 3D Solid for Laser Weld

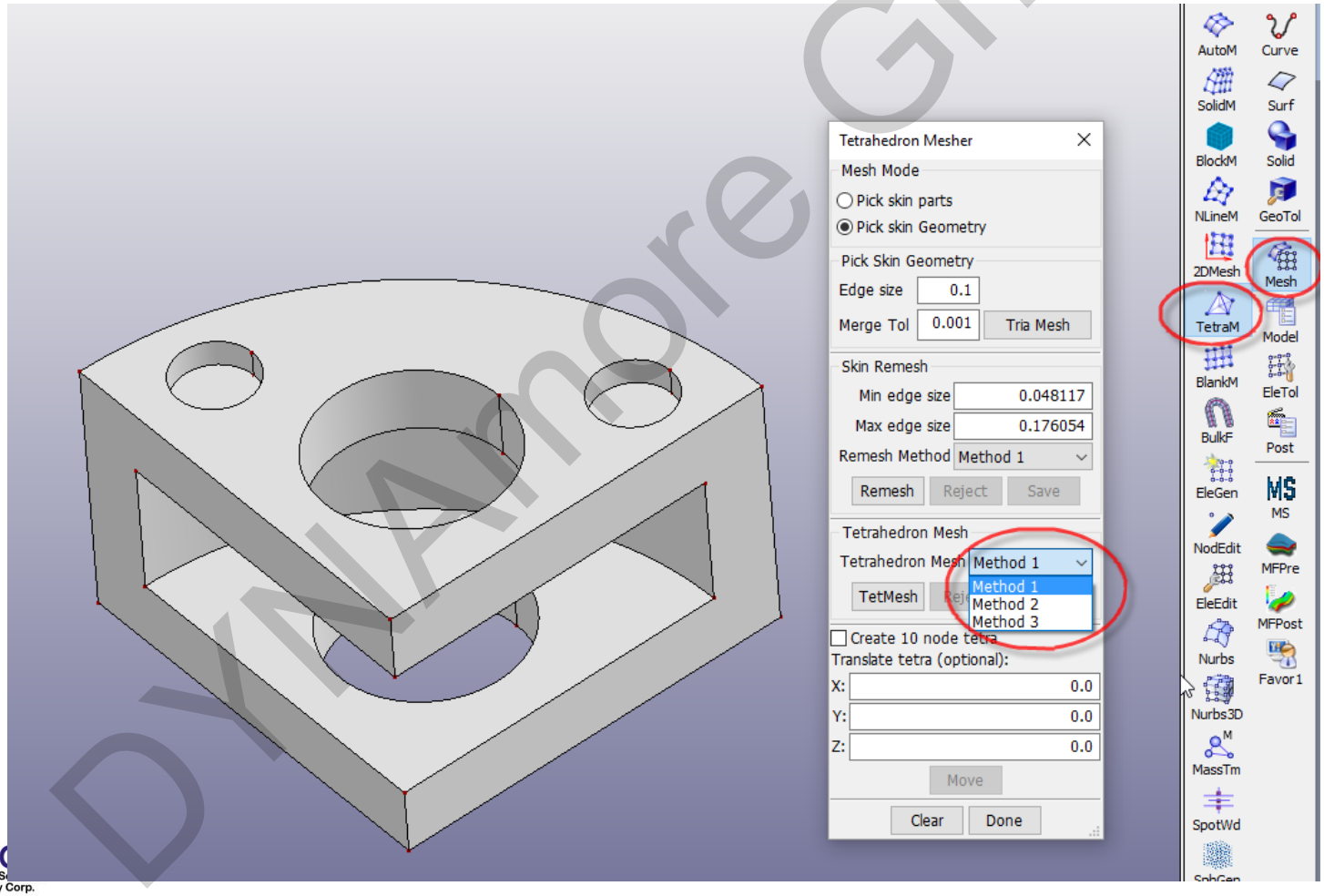
The solid elements will be created with variable thickness that conform to the gap between the 2 parts





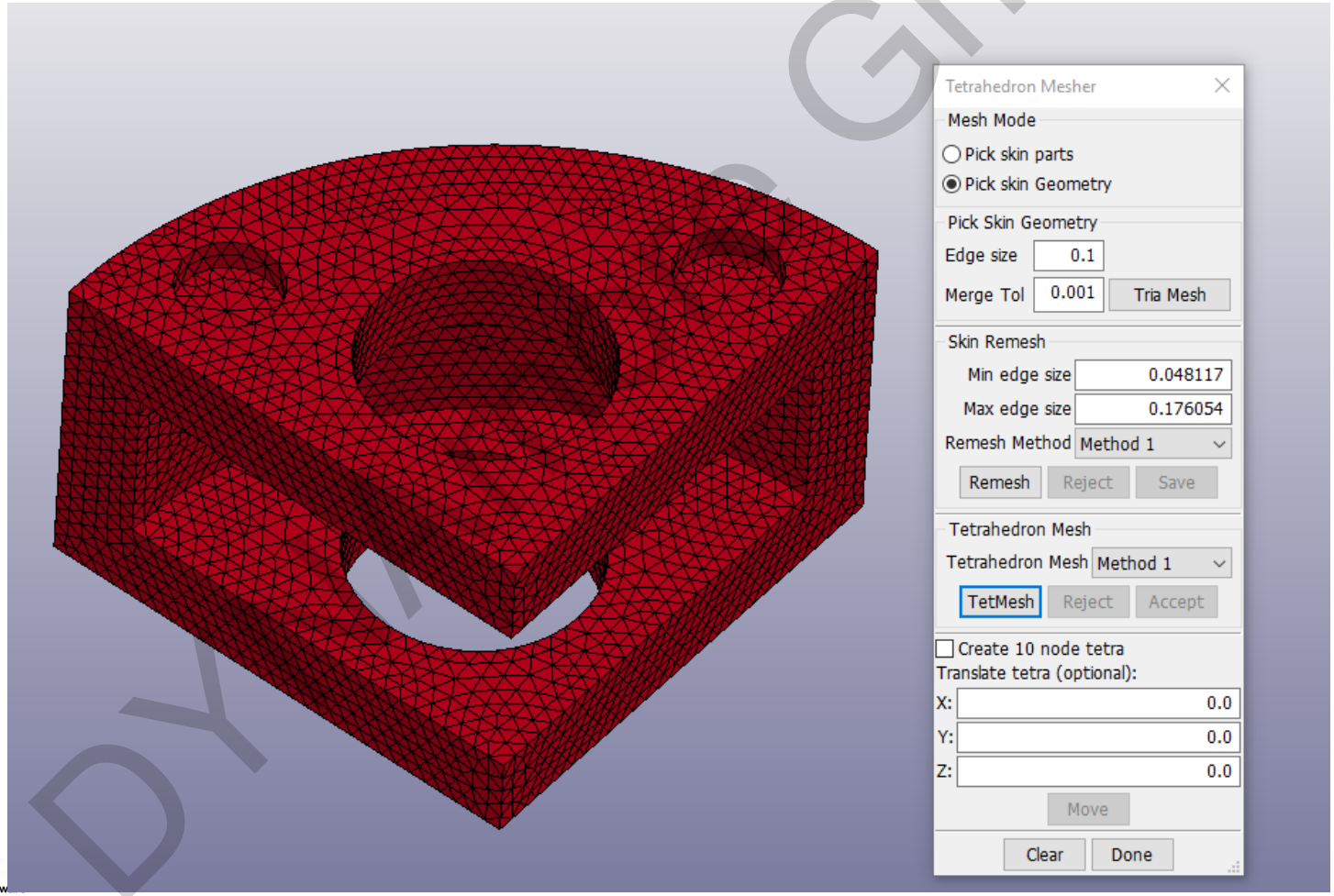
New Features in Meshing

Two new Tetrahedron Meshing methods to provide better mesh result



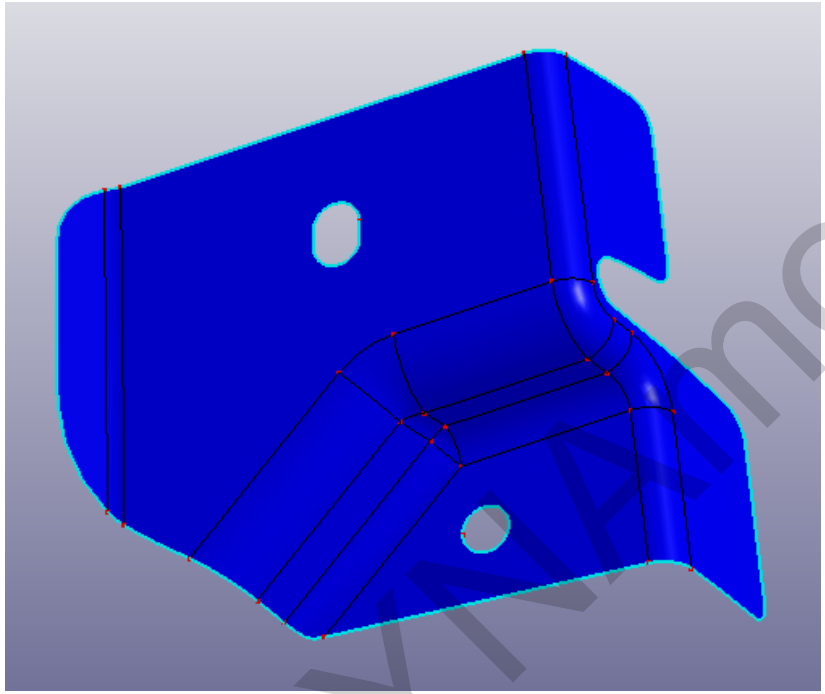
New Features in Meshing

In general method 1 and 2 are more robust than the old tet-mesher which is method 3

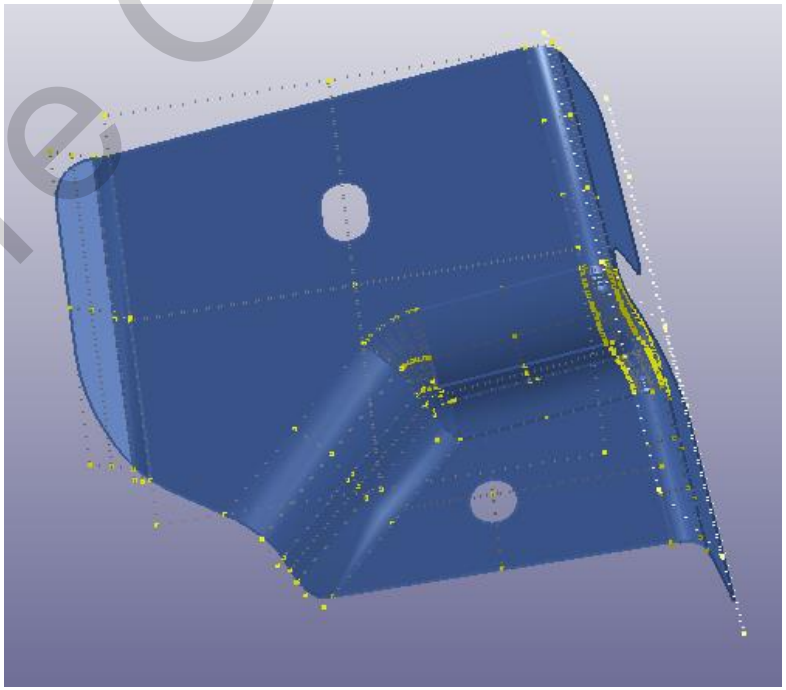


New Features in IGA (Iso-Geometry)

Create trimmed NURBS elements from trimmed surface geometry



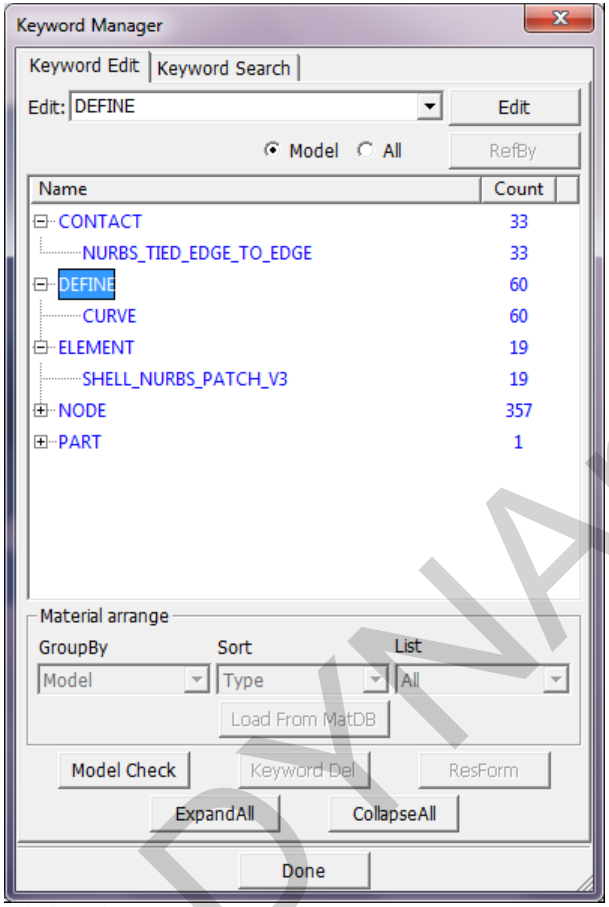
Geometry surfaces

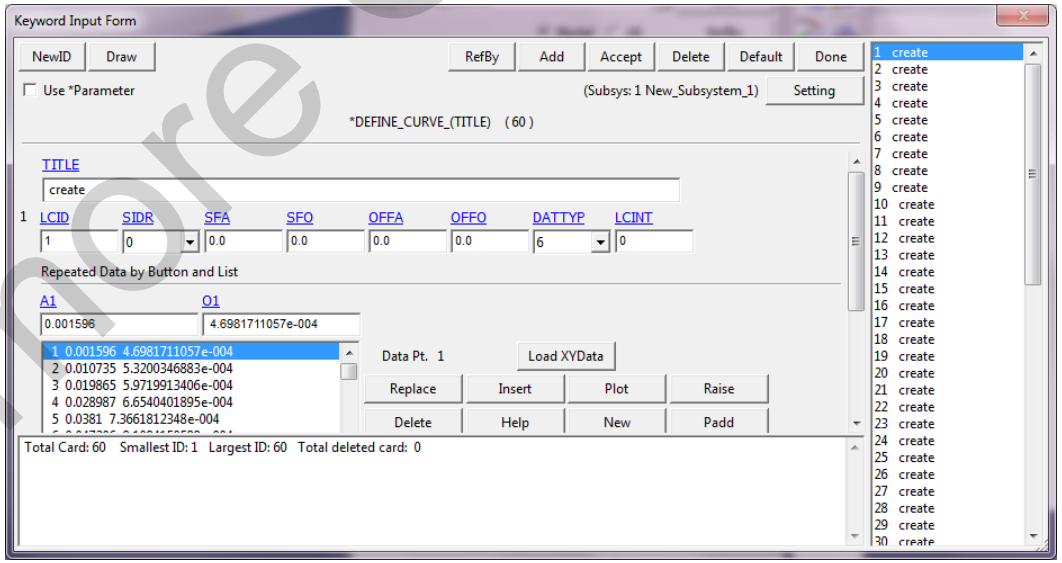


Nurbs patches

New Features in IGA (Iso-Geometry)

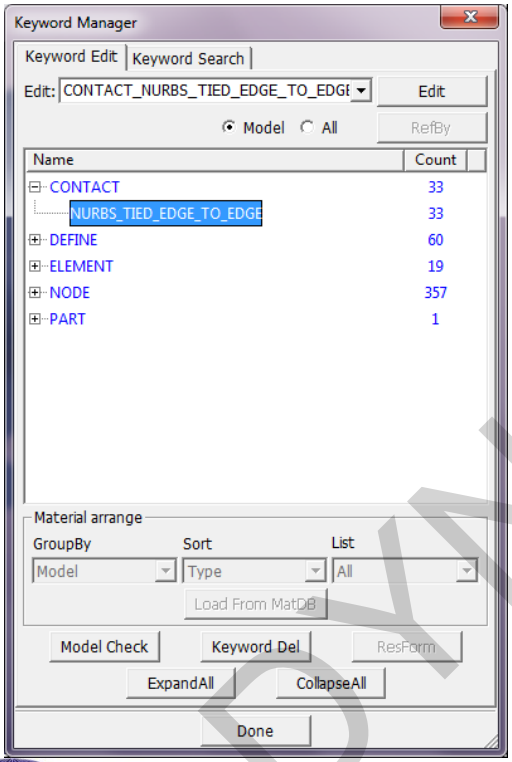
Trimmed NURBS element: The trimming curve is defined by *DEFINE_CURVE

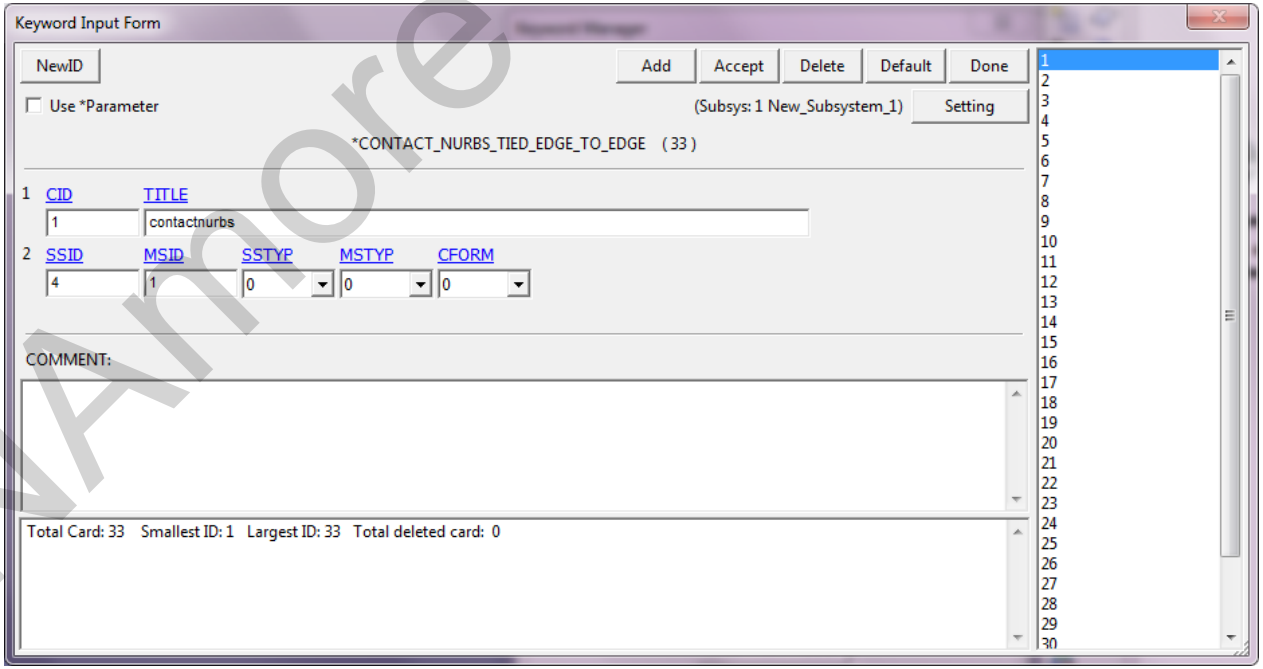




New Features in IGA (Iso-Geometry)

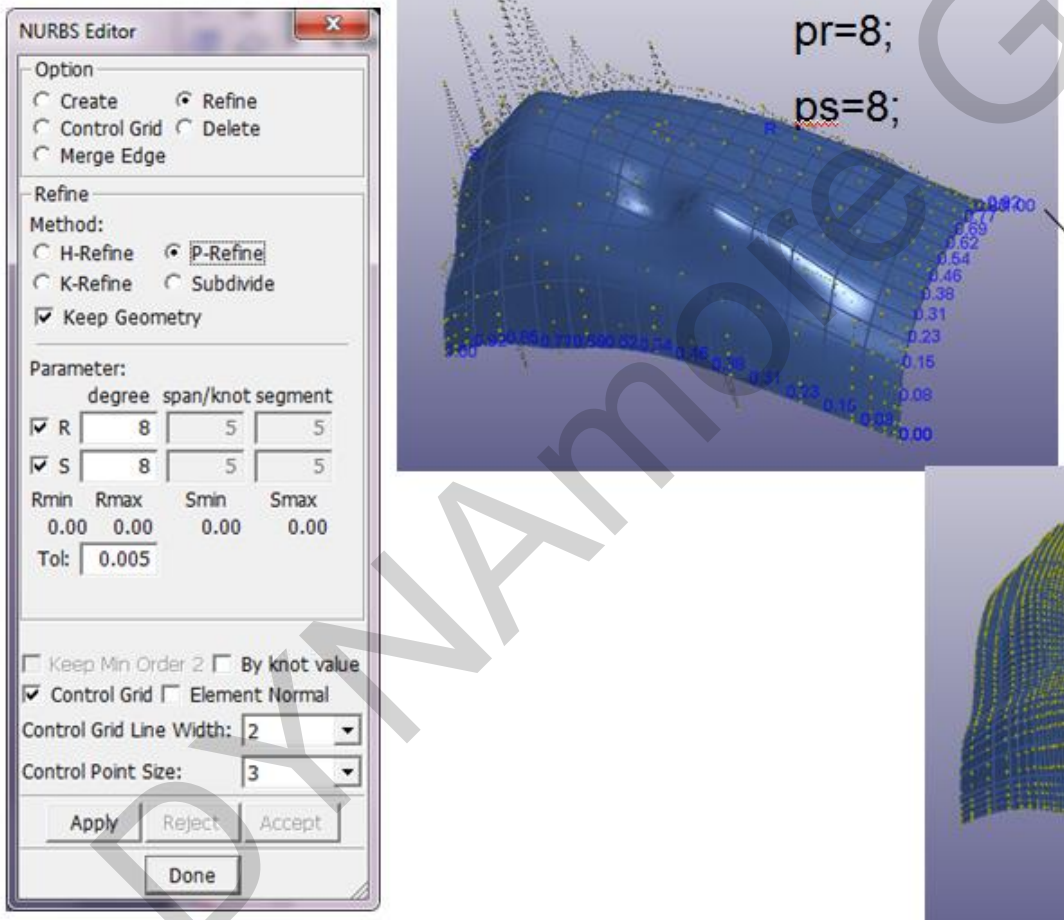
Trimmed NURBS element: The topology information is stored in *CONTACT_NURBS_TIED_EDGE_TO_EDGE



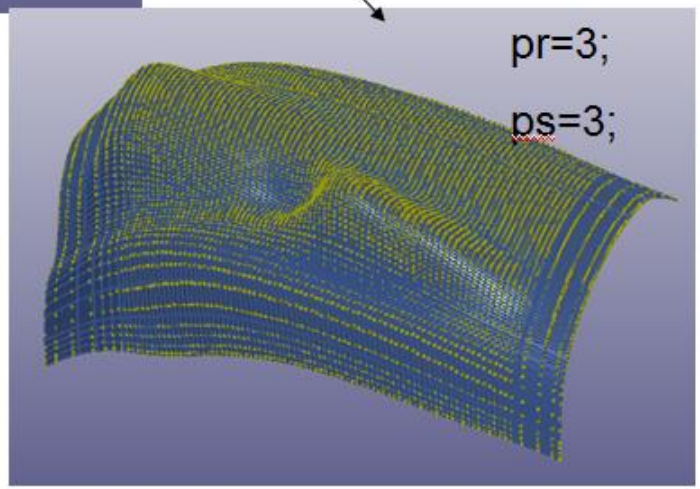


New Features in IGA (Iso-Geometry)

Degree reduction for NURBS elements

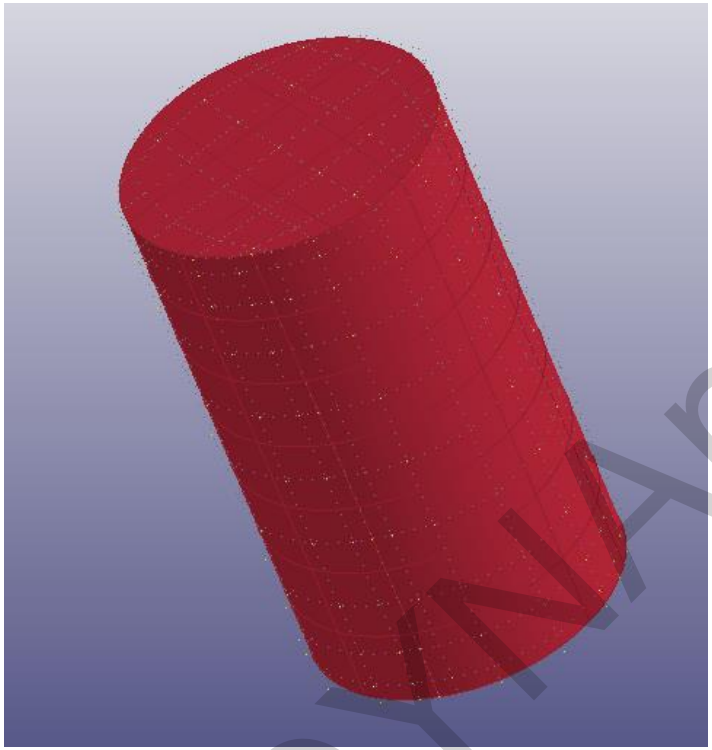


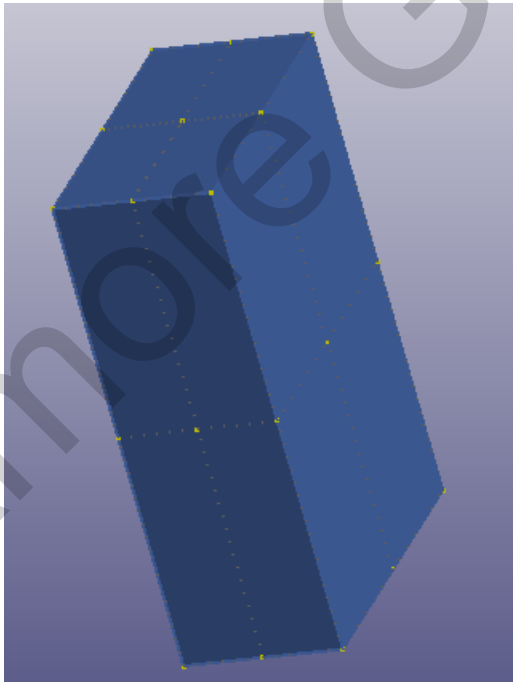
Degree reduction

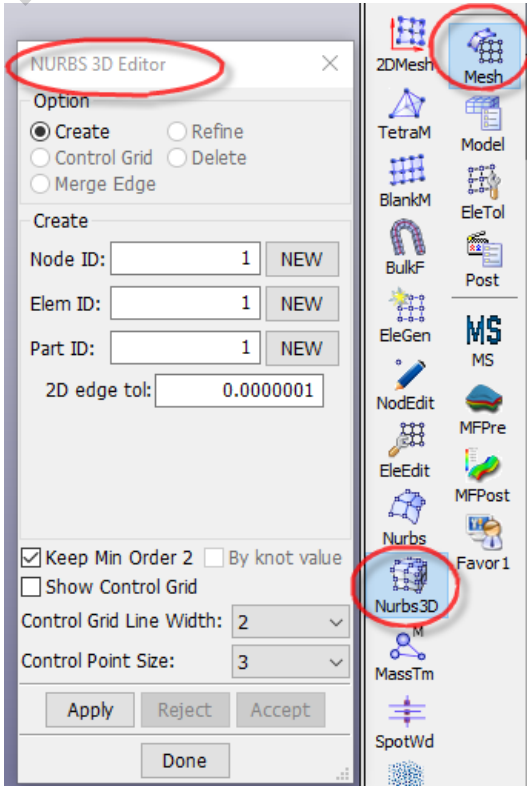


New Features in IGA (Iso-Geometry)

3D Solid Nurbs Element import and creation







New Features – Keyword Replace Command

Purpose: To replace a particular field in one of the keyword data

Keyword replaceint KeywordName IDRange FieldID NewValue OldValue

KeywordName – Name of Keyword, e.g. SECTION_SHELL

IDRange – a range of ID in the keyword data to be replaced. e.g. first:last:inc, 2001:4001:1, or “All”

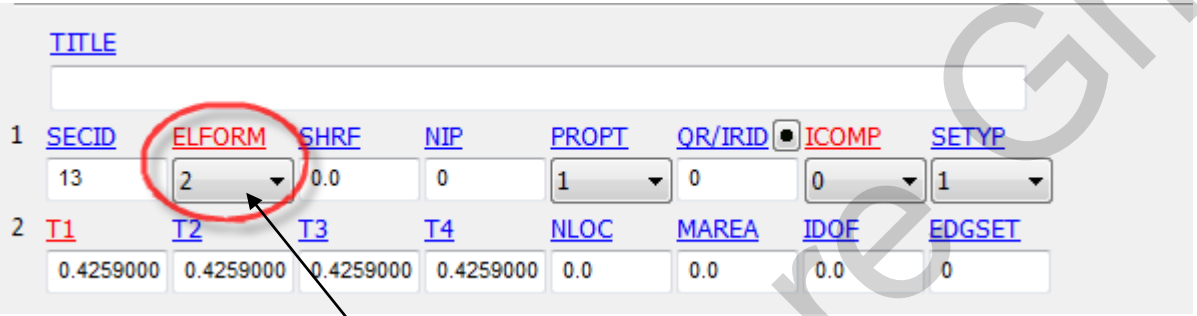
FieldID – The field ID starting from 0, not 1

NewValue – the new value will be assigned to that field

OldValue – This is an optional input used as a filter, if the existing data match this value, then it will be replaced, otherwise skip. If omitted, all data in the ID range will be replaced

New Features – Keyword Replace Command

Keyword replaceint KeywordName IDRange FieldID NewValue OldValue



Example: To replace all section shell formulation (ELFORM) from 2 to 16 (elform value not equal to 2 will not be changed)

Command Syntax:

Keyword replaceint SECTION_SHELL all 1 16 2

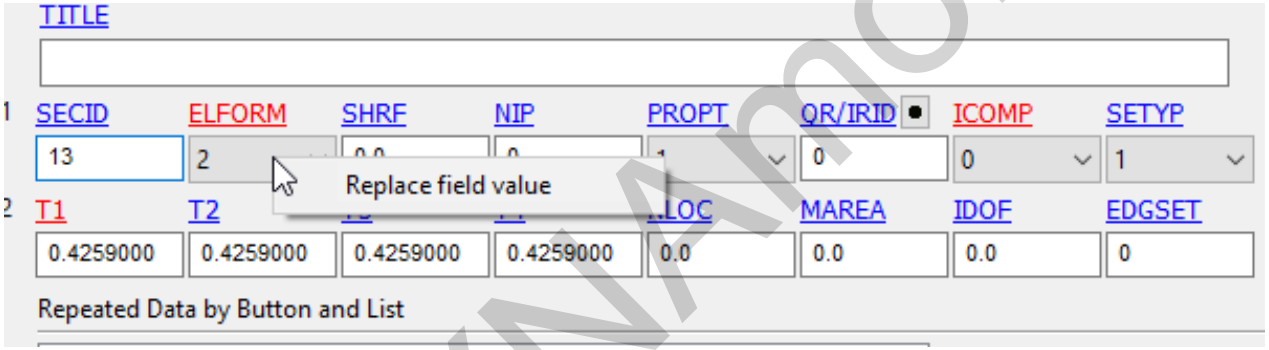
The IDfield is 1 because it is the second field

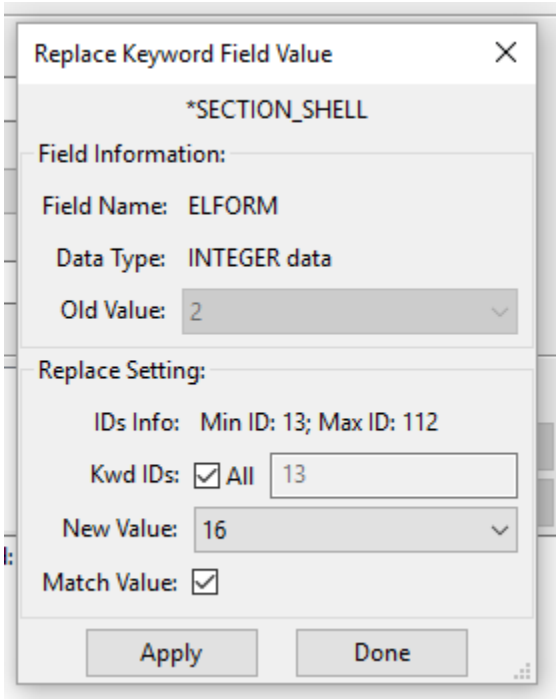
New Features – Keyword Replace Command

The keyword replace command is powerful but the command structure and syntax is not possible to remember

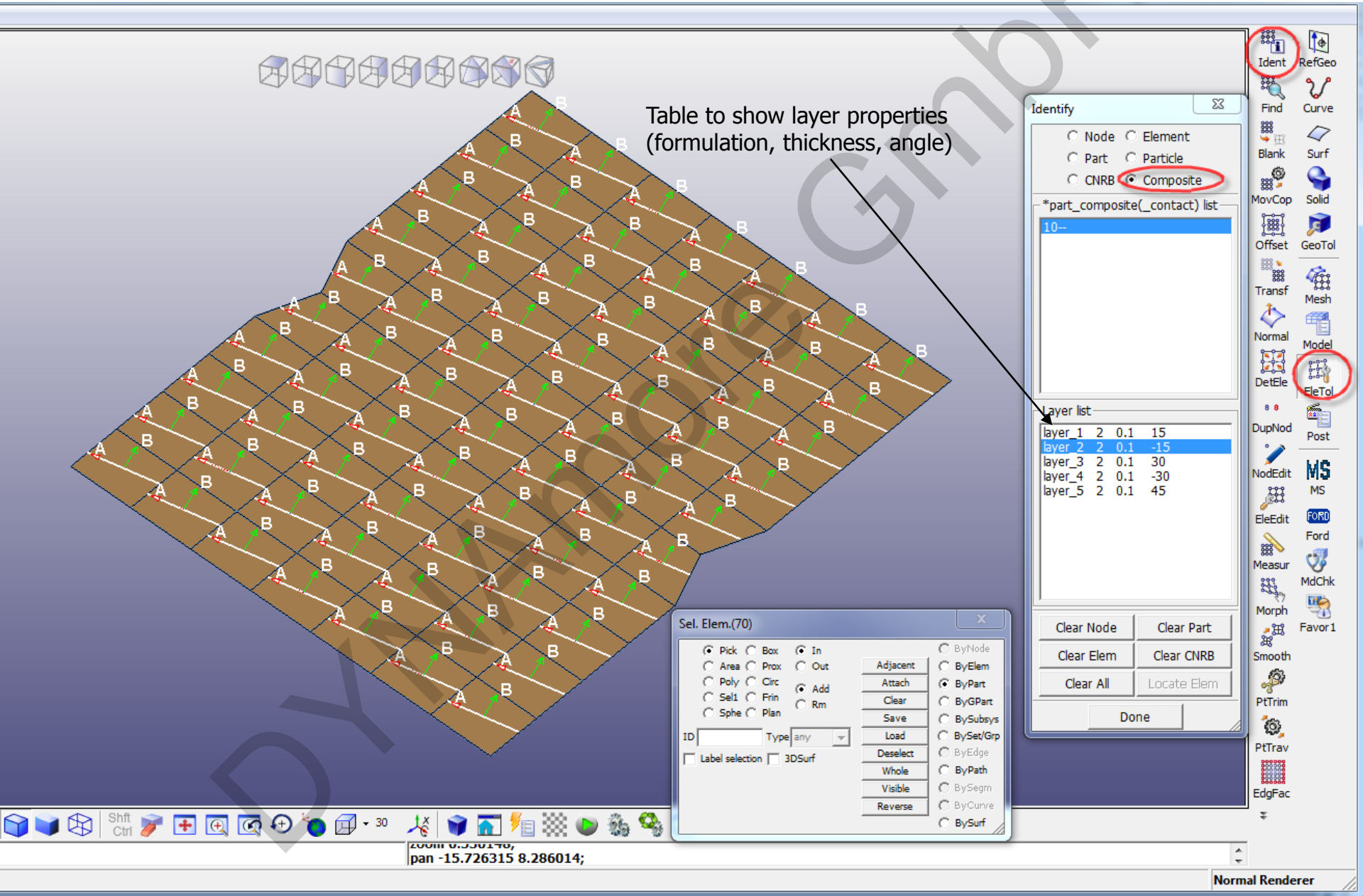
Now this can be done with the help of the GUI

Right click on any data field to activate the interface



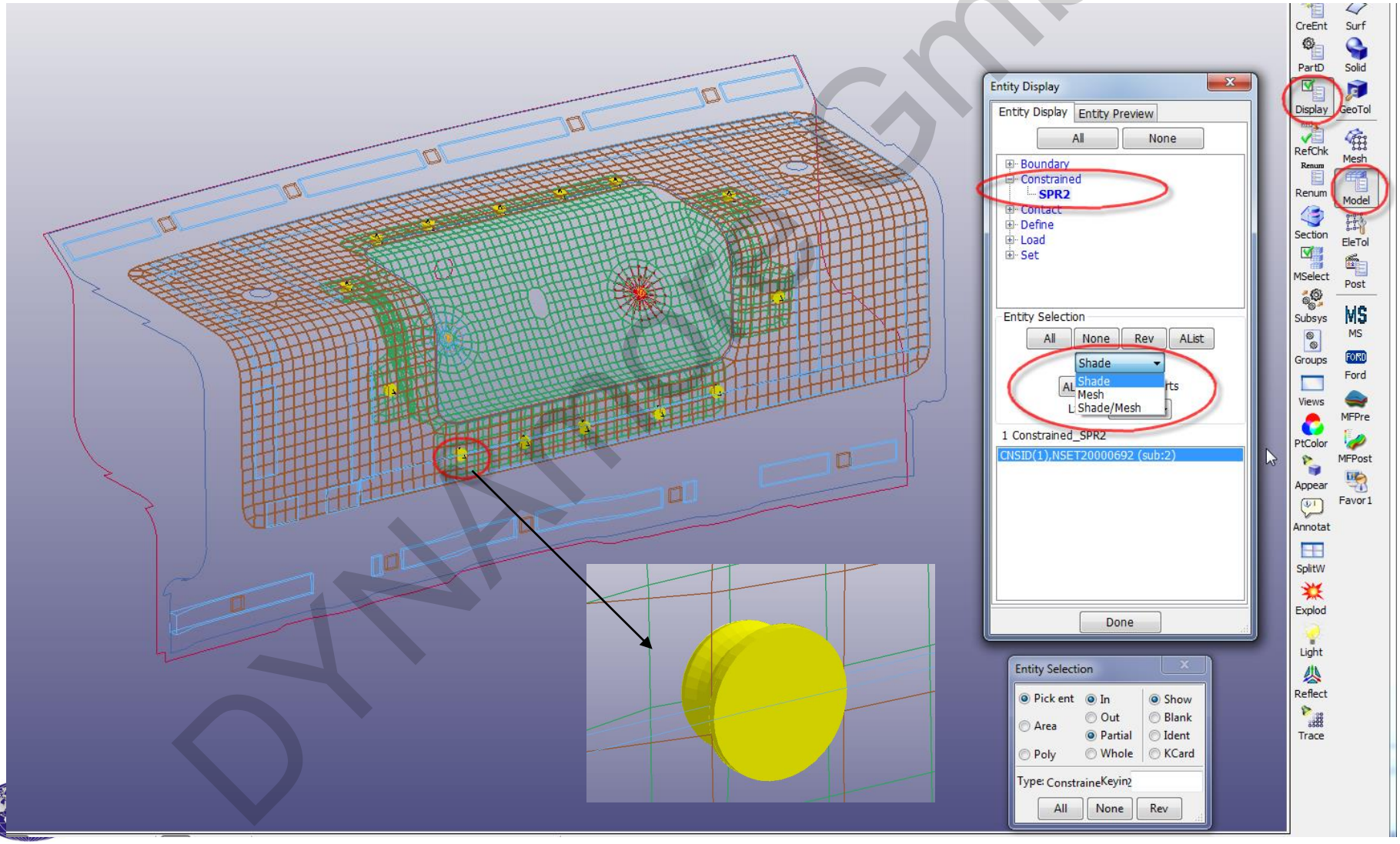


New Features – Composite Material by Layer



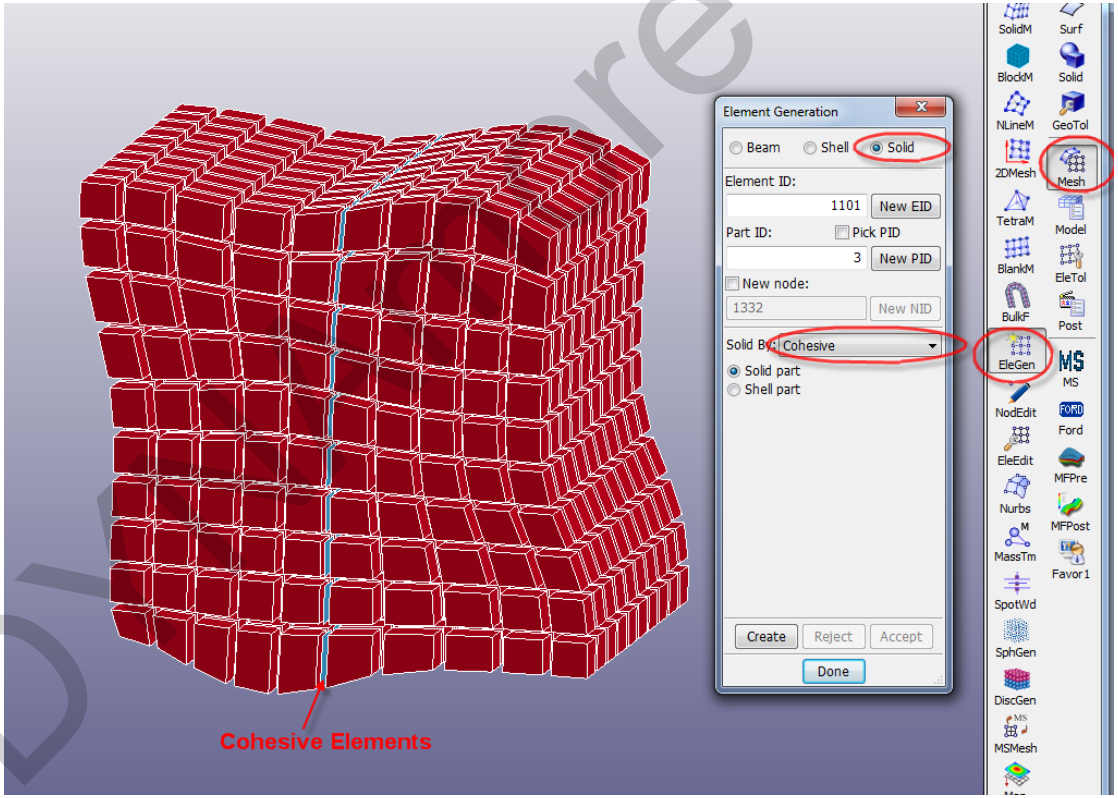
New Features – Improved SPR2 Display

A Constrained SPR2 can be drawn in different modes



New Features – Creation of Cohesive Elements

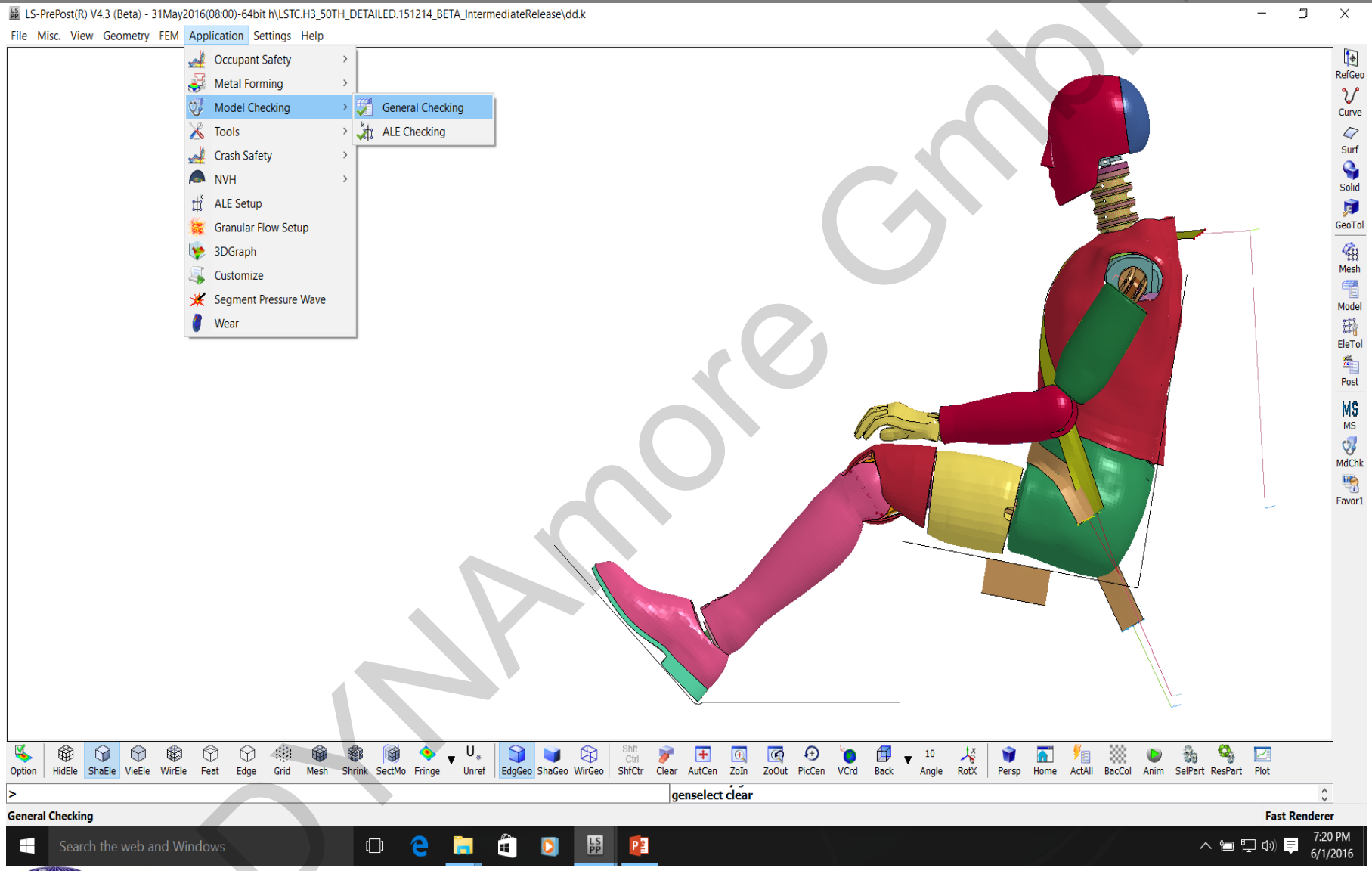
- First create a beam part (for shell cohesive) or shell part (for solid cohesive)
- Then select the shell or solid part and the pre-created beam or shell part



New Features – Snapping Nodes

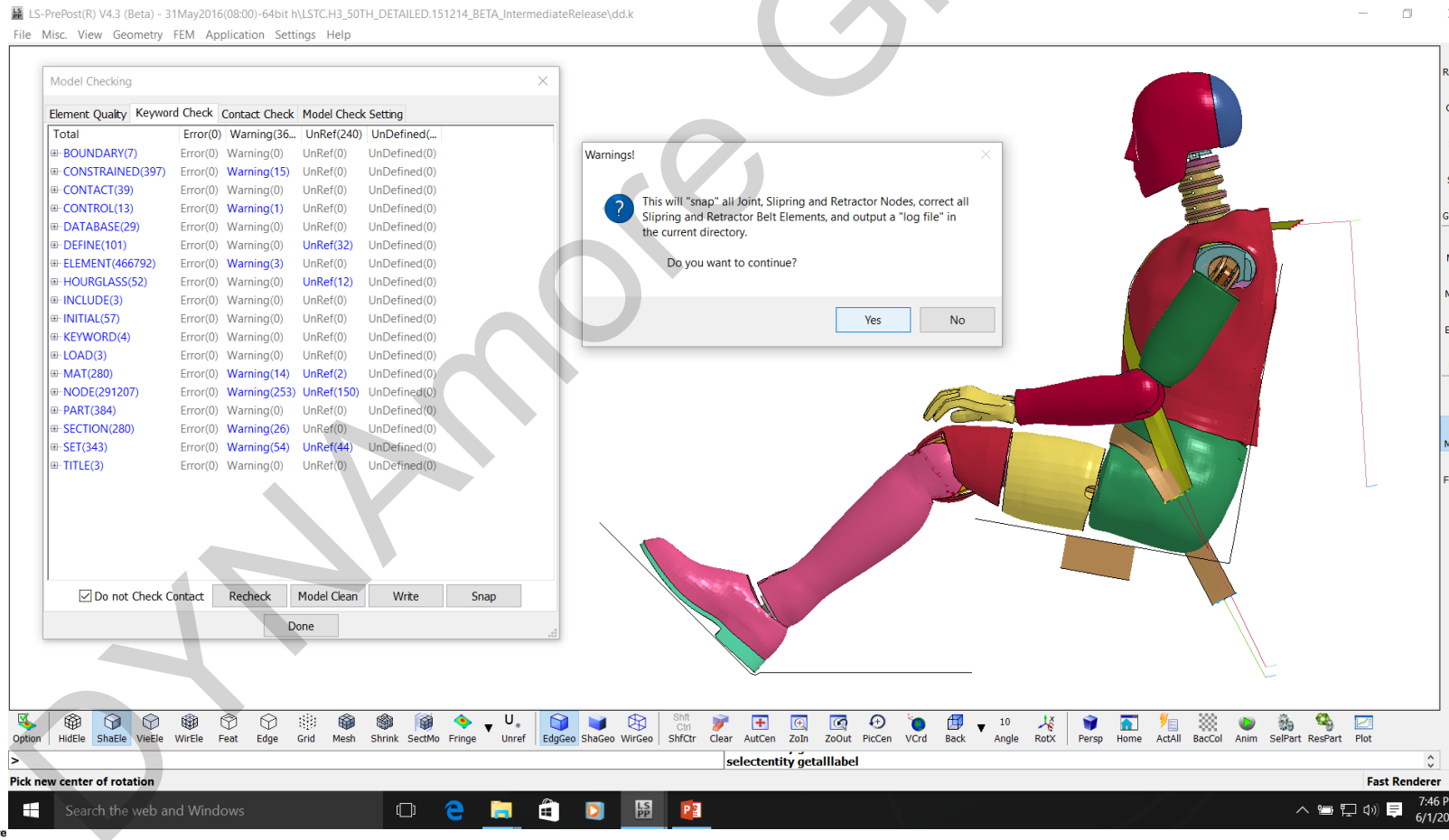
- All Joints, Sliprings and Retractors have “Node Pairs”.
- LS-Dyna would ideally like these Node-Pairs to have “**identical coordinates**” to the last place of decimal. That would ensure **maximum numerical accuracy**.
- Minor inaccuracies lying within the tolerance are accepted by LS-DYNA but anything beyond that could cause “Error Termination”.
- These are very difficult to correct “manually”.
- LSPP now has the ability to scan through the entire Model and “snap” these Node Pairs together. Done at the “Model Checking” phase. A “log file” is written out giving complete information as to what was done.

New Features – Snapping Nodes



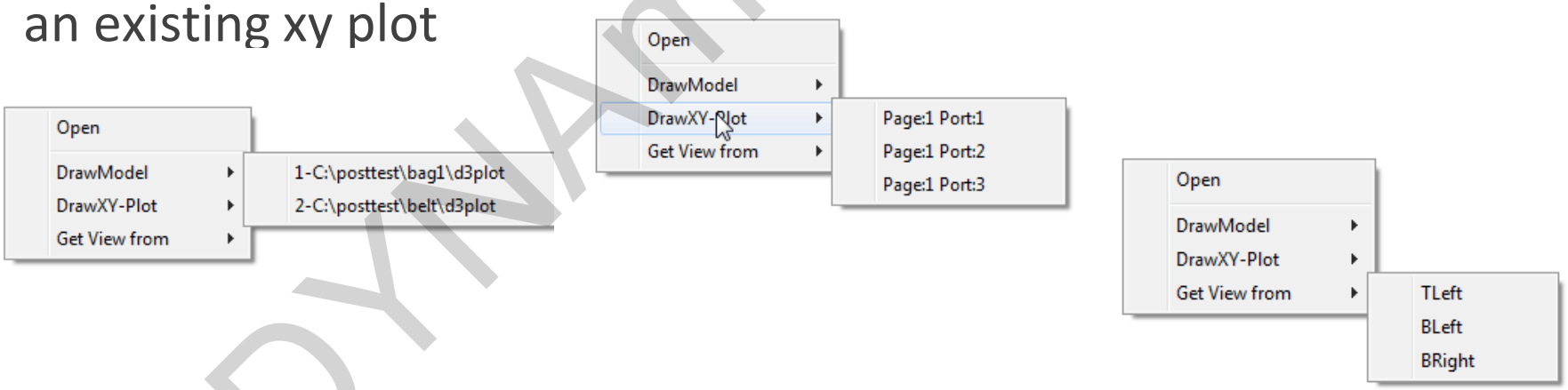
New Features – Snapping Nodes

In the “New Pop-up Window” press the “Yes” Button. This will “snap” all Joint, Slip-ring & Retractor “Node Pairs” in the Entire Model.

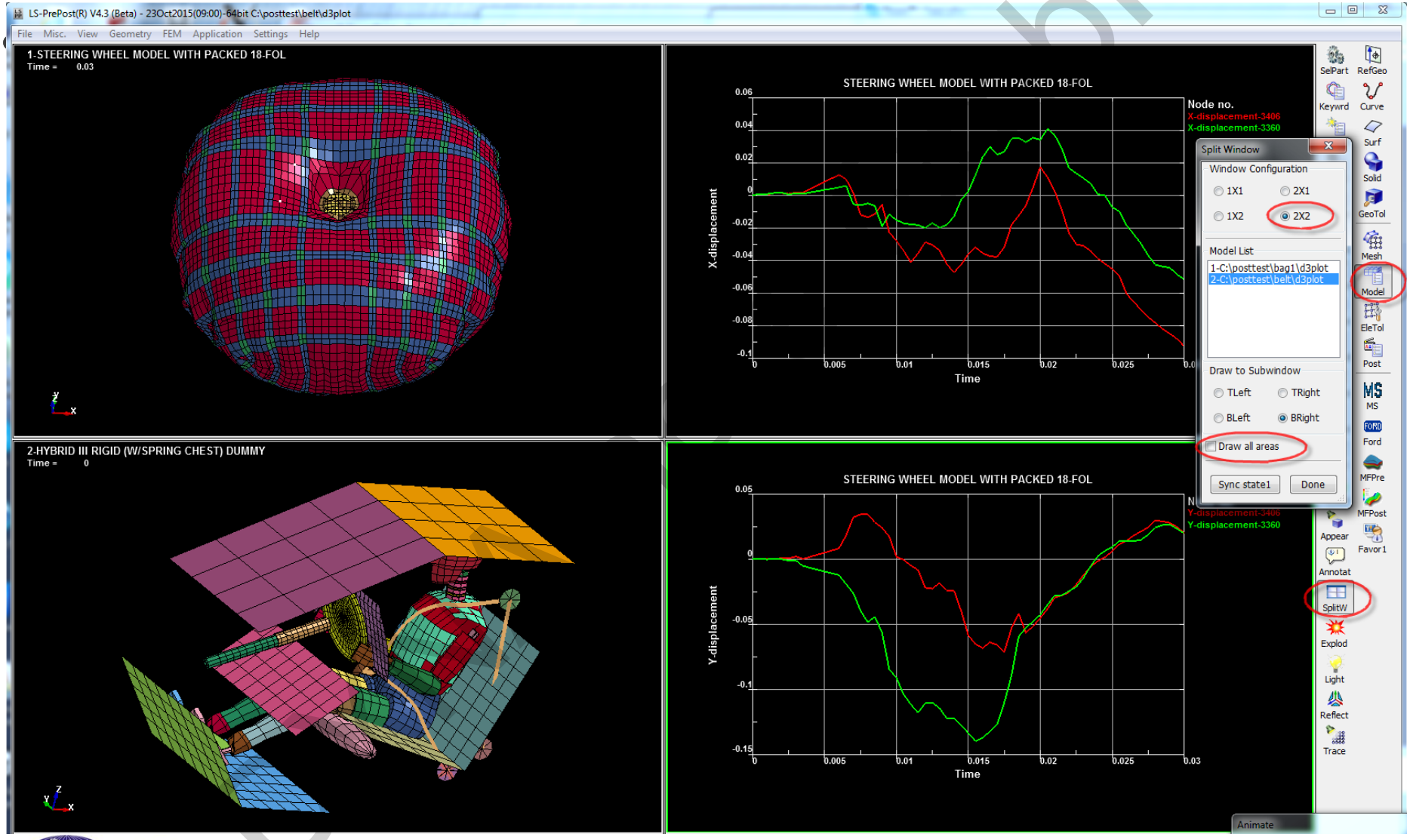


New Features – Improved Split Window Operations

- Multiple models will be assigned to each sub-windows automatically
- If “Draw All Areas” is check, then most of the operations like “Ac”, Select part, Blanking, Identify will be done to all the models
- Right click on the sub-windows pop up operational menu that allow different model to be drawn to this sub-windows, or load the viewing matrix from another sub-windows, or load a xy graph from an existing xy plot

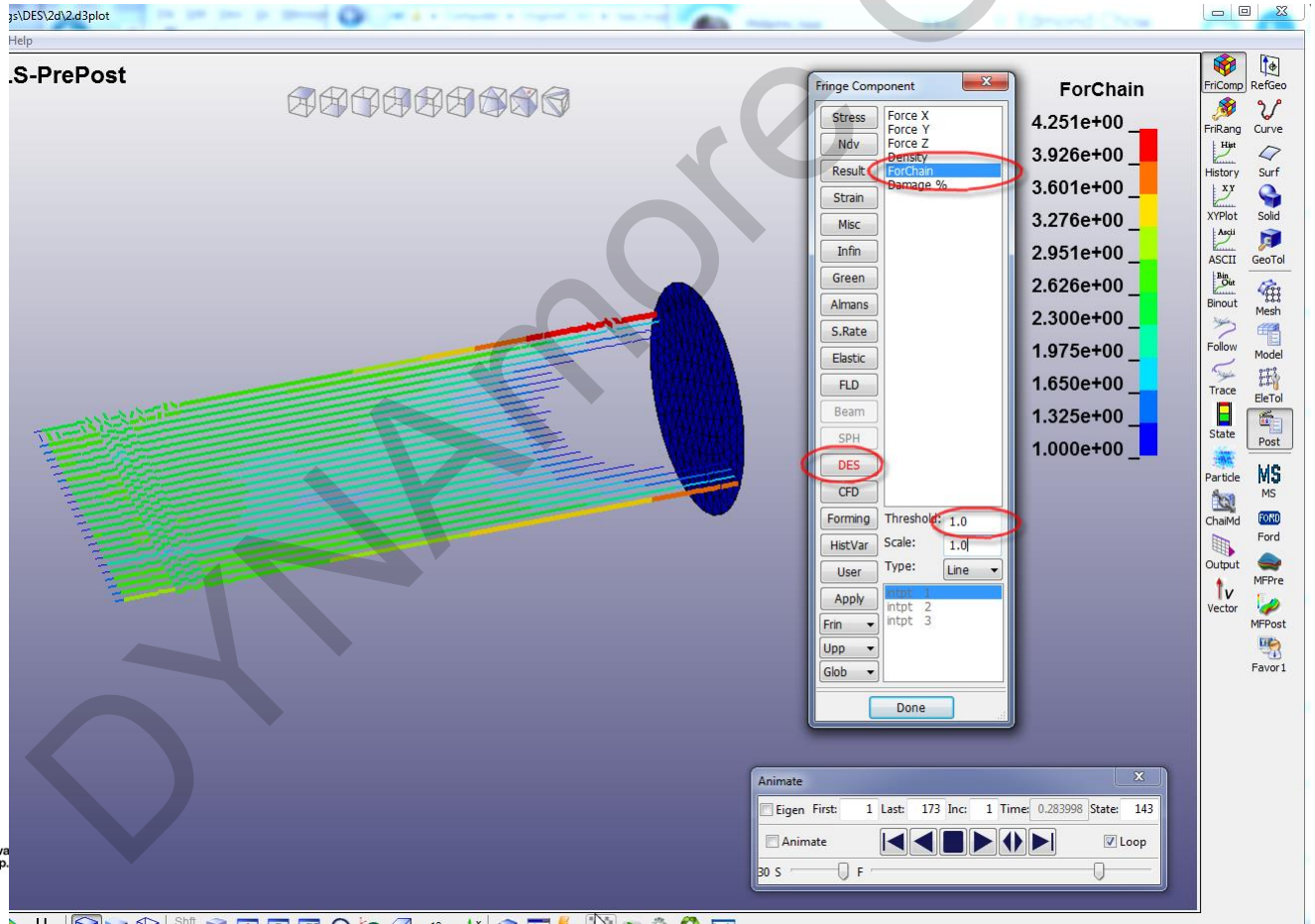


New Features – Improved Split Window Functionalities and Operations



New Features – DES Element Force Chain

A vector (with direction) and magnitude (in color) will be drawn for the force acting on the DES particles to show the chain of force



New Features – NVH Database Support

- *DATABASE_FREQUENCY_BINARY_{OPTION}

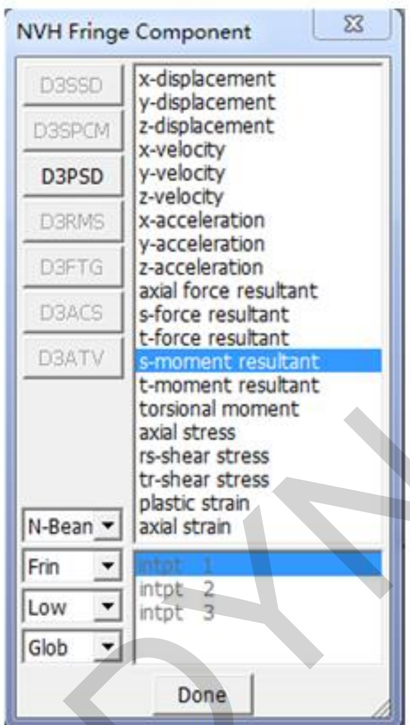
Database	LSPCode	Data Contents
D3SSD	21	Steady state dynamics
D3SPCM	22	Response spectrum analysis
D3PSD	23	Random vibration PSD
D3RMS	24	Random vibration RMS
D3FTG	25	Random vibration fatigue
D3ACS	26	FEM acoustics
D3ATV	27	BEM Acoustic Transfer Vector

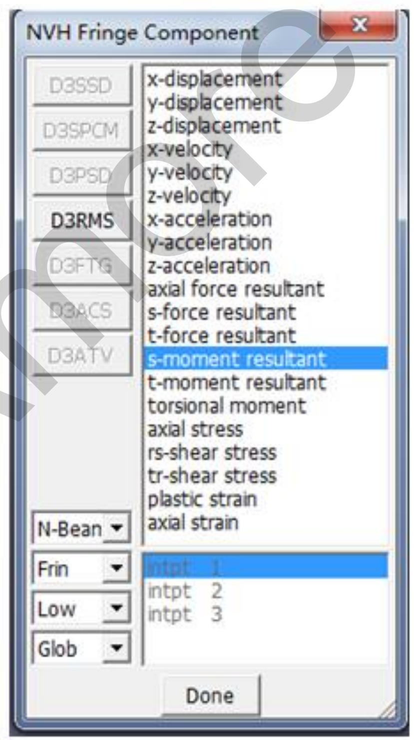
- Ascii Databases

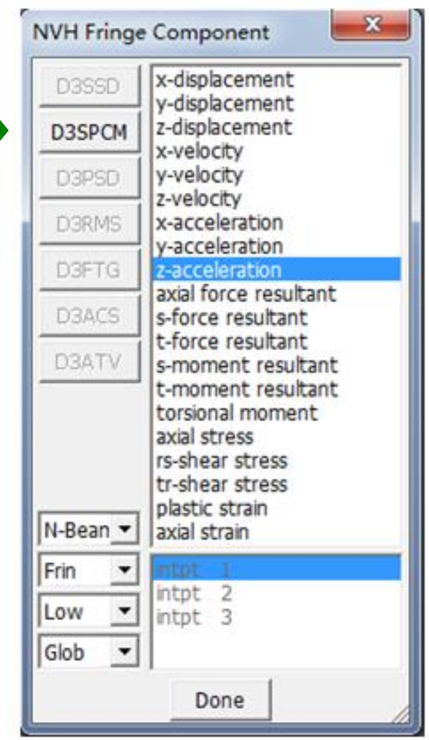
FRF: frf_amplitude, frf_angle, frf_real, frf_imag
BEM acoustics: Press_Pa, Press_dB, bepres, fringe_*, panel_contribution_NID,
SSD: elout_ssd, nodout_ssd, …

New Features – NVH Post-Processing

- Each analysis type has its own interface, unique fringe components
- LS-PrePost will automatically recognize the analysis type and pop up the corresponding interface

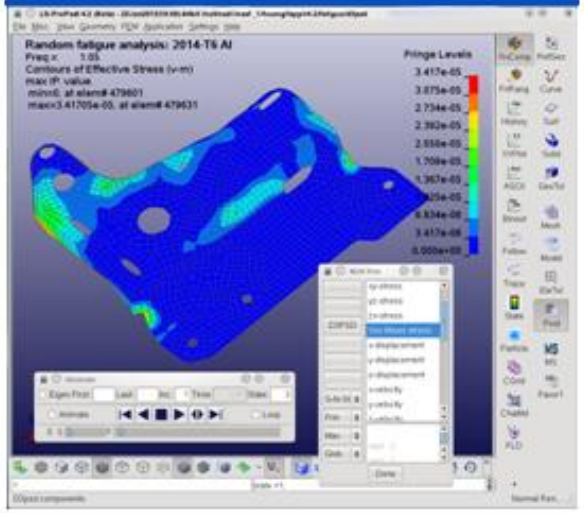




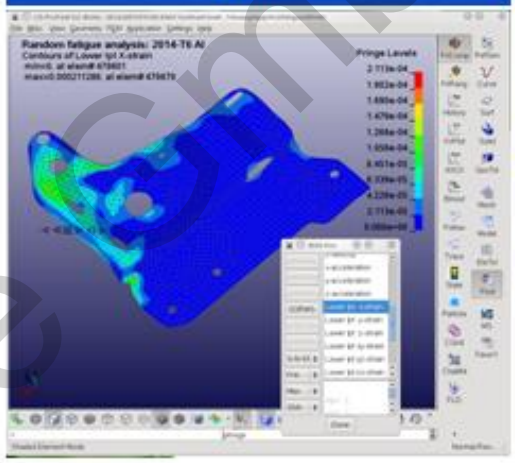


New Features – NVH Post-Processing

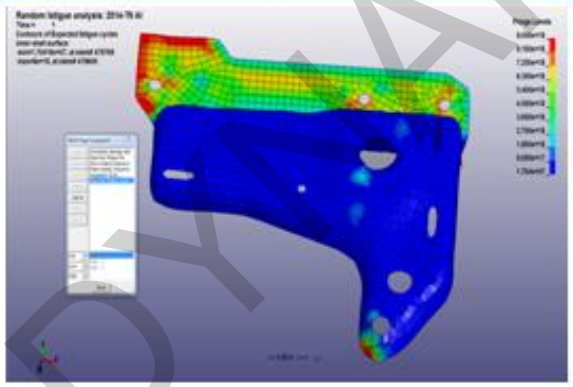
D3PSD



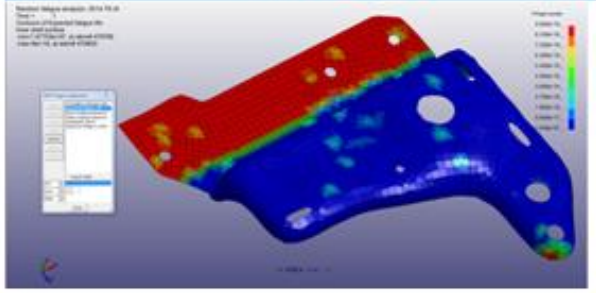
D3RMS



D3FTG Fatigue Cycle

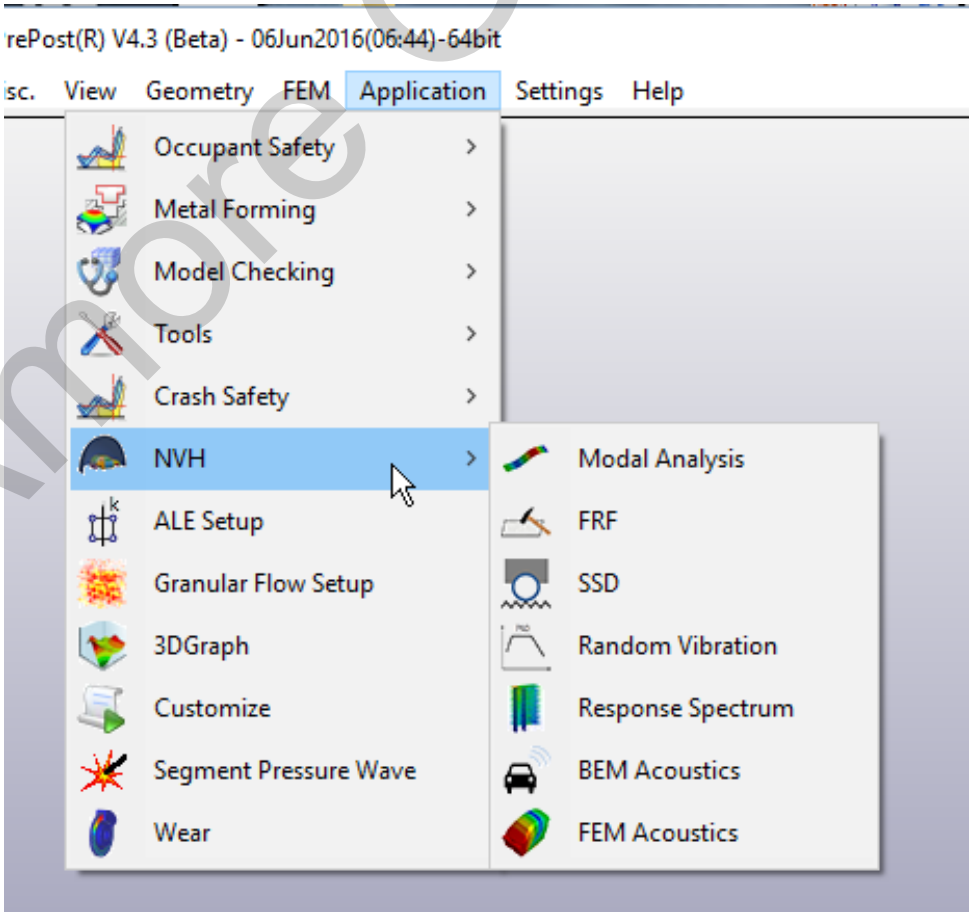


Fatigue Life



New Features – NVH Job Setup

- All NVH Analyses can be setup in LS-PrePost without knowing the detailed keyword data
- Modal Analysis can also be setup first before any of the NVH
- Application->NVH

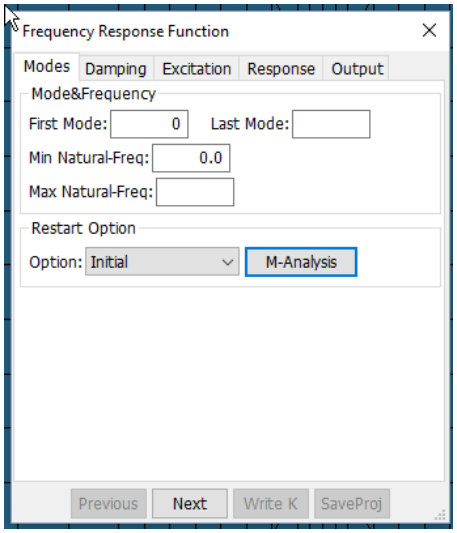


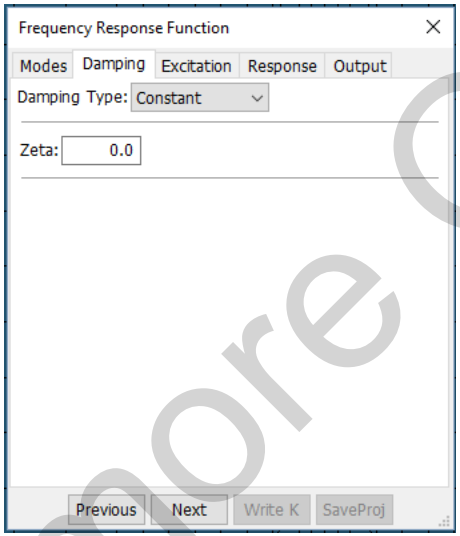
New Features – NVH Job Setup

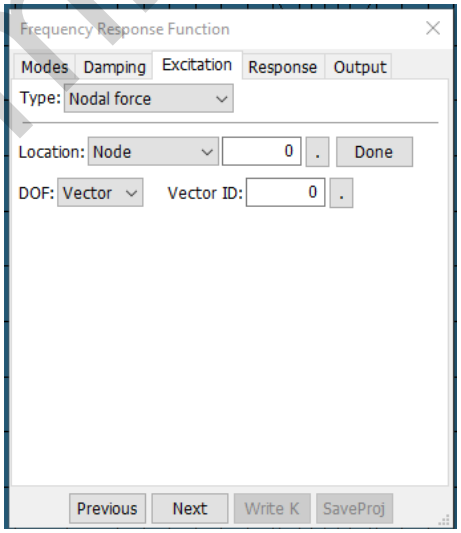
- The 6 NVH analyses are:
  - FRF – Frequency Response Function
  - SSD – Steady State Dynamic
  - Random Vibration Analysis
  - Response Spectrum Analysis
  - BEM – Boundary Element Method for Acoustics
  - FEM – Finite Element Method for Acoustics
- Users should not have to know all the necessary keyword data for each type of analysis. LS-PrePost will create all required keyword cards

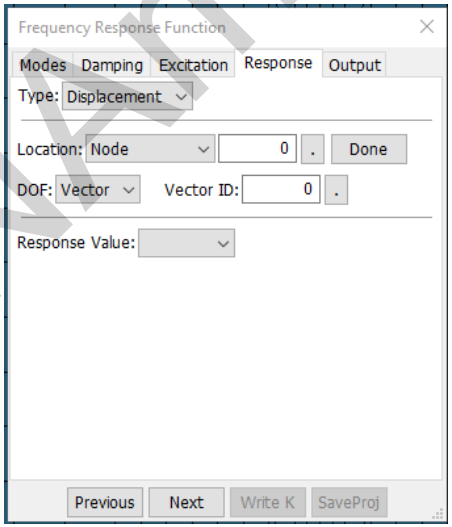
New Features – NVH Job Setup

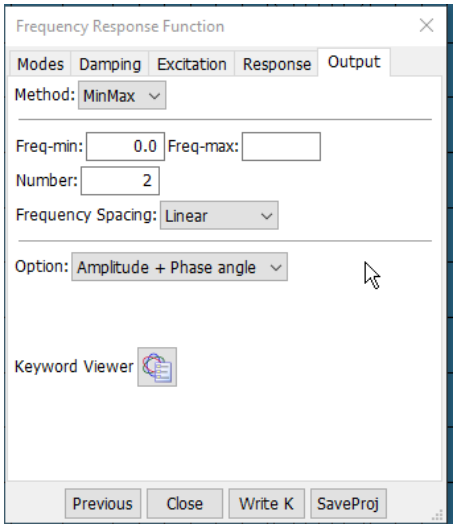
An example of the Interface to setup FRF analysis











New Features – ICFD Post-Processing

- Since the official release of the ICFD solver in LS-DYNA R7.0 version, developments have been continuous and the number of users has been steadily growing.
- Currently LS-PrePost offers some tools in order to post treat the results from the ICFD solver based on its solid mechanic counterpart.
- However, the requirements for CFD post treatment are often quite different and challenging. This meant that a radically new approach was needed for LS-PrePost to meet those specific requirements.
- LS-PrePost 4.2 will be the first version to incorporate post treatments specific to the ICFD Solver and to CFD solvers in general.
- LS-PrePost 4.3 has further improved its capabilities in the post-treatment of ICFD results

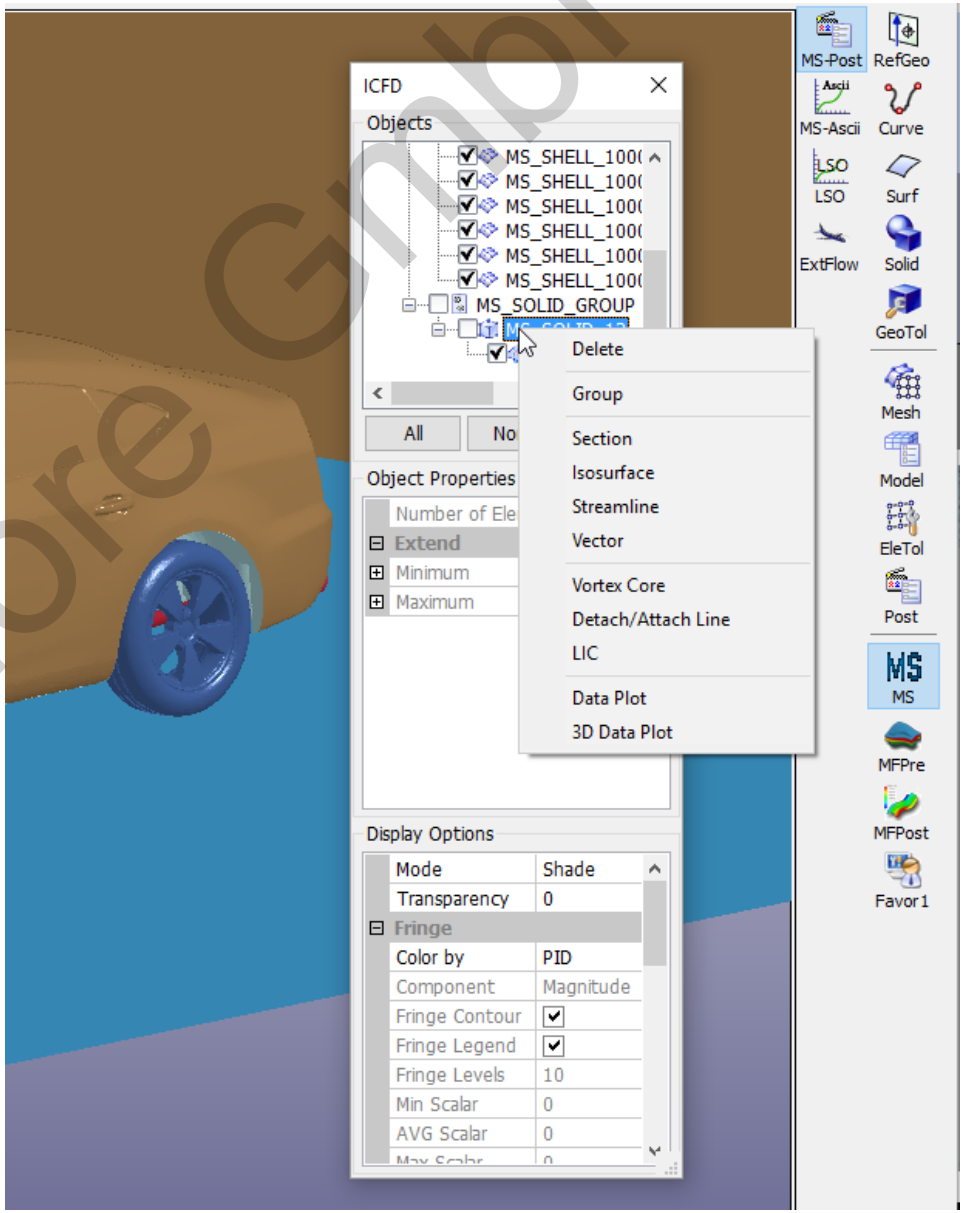
New Features – ICFD Post-Processing

The MS Button activates the new ICFD post-processing interface

Each part is an object, right click on the object to select property, multiple properties can be applies to the object

Each property will has its own display options

The properties are section plane, iso-surface, streamline, vector, vortex core, detach/attach line, LIC, data plot, and 3D data plot



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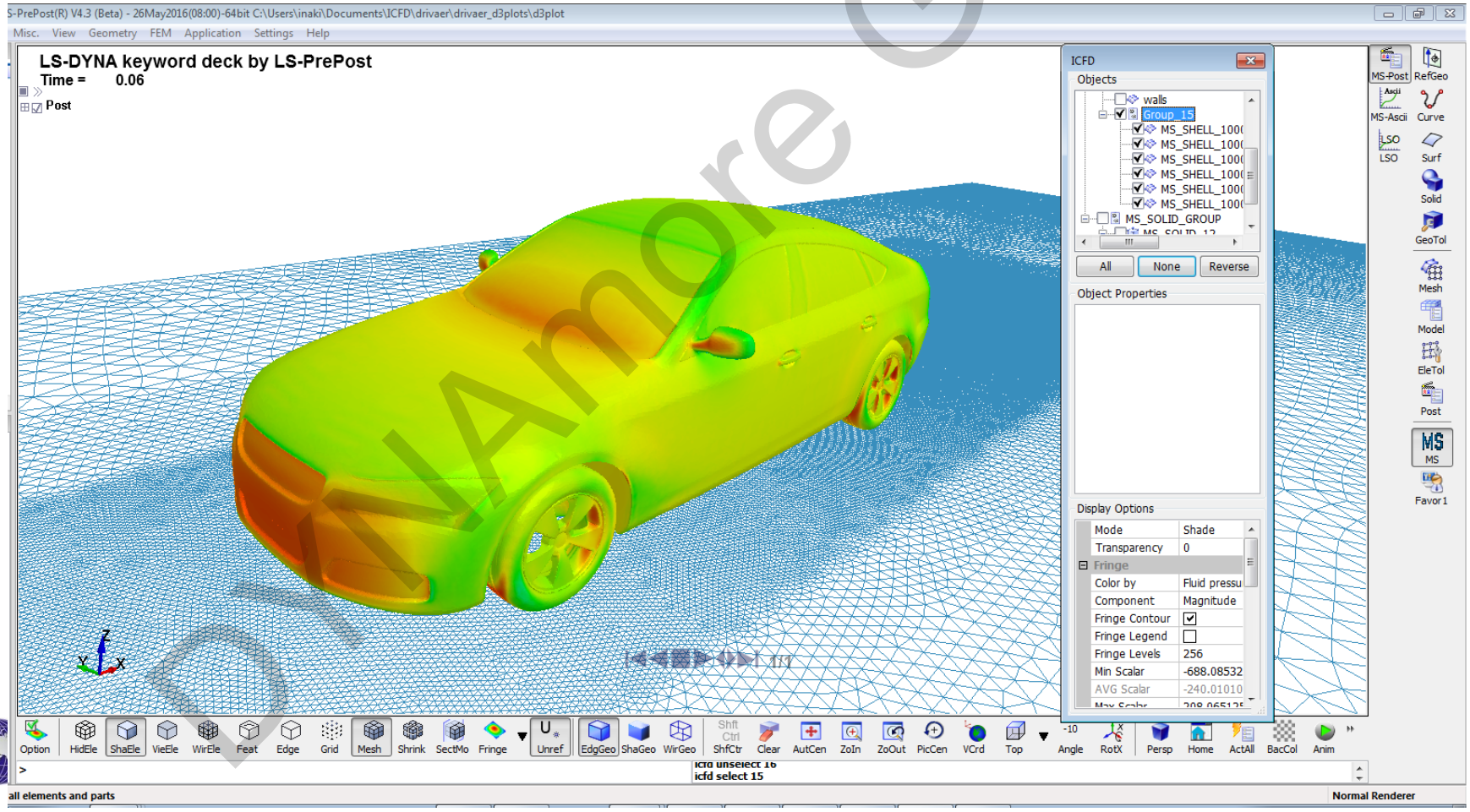
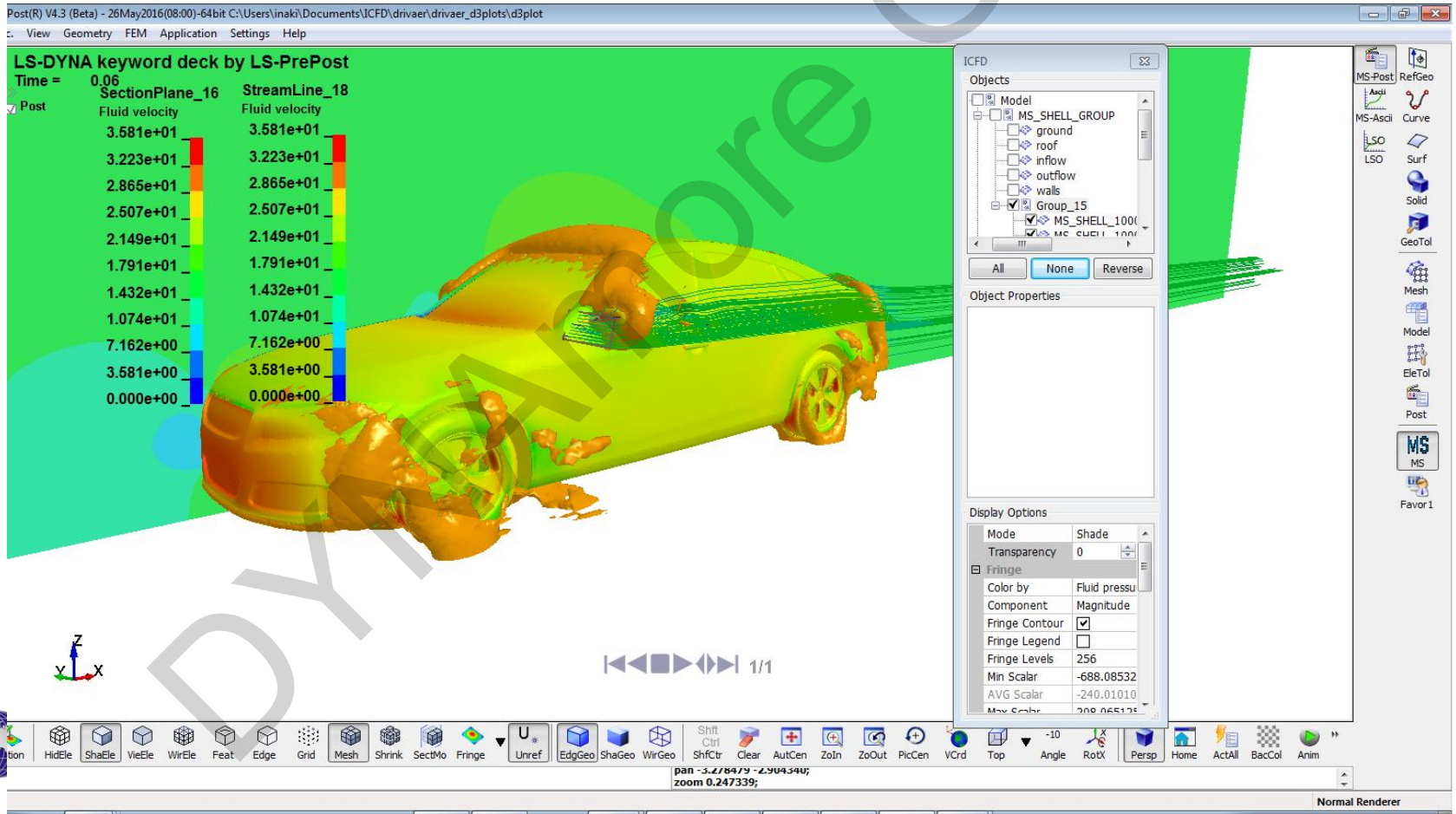
New Features – ICFD Post-Processing

In the present case, the surface parts composing a road vehicle colored by the pressure field, along with the domain floor, displayed in Wire mode



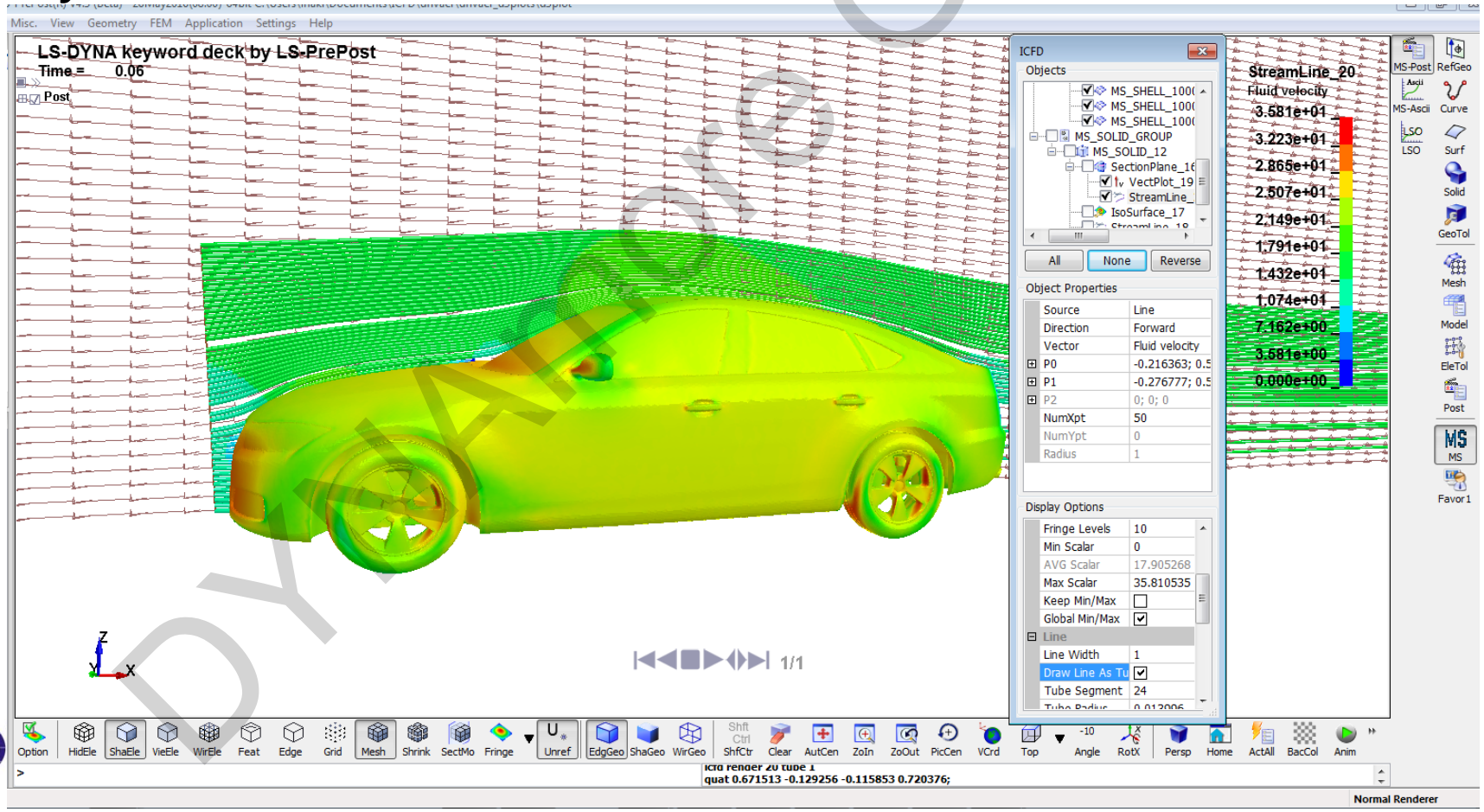
New Features – ICFD Post-Processing

In the present case, a section plane, streamlines and an iso-surface have been applied on the fluid volume. Note that the Streamline and Section Plane have been colored by velocity and each has its own independent fringe bar



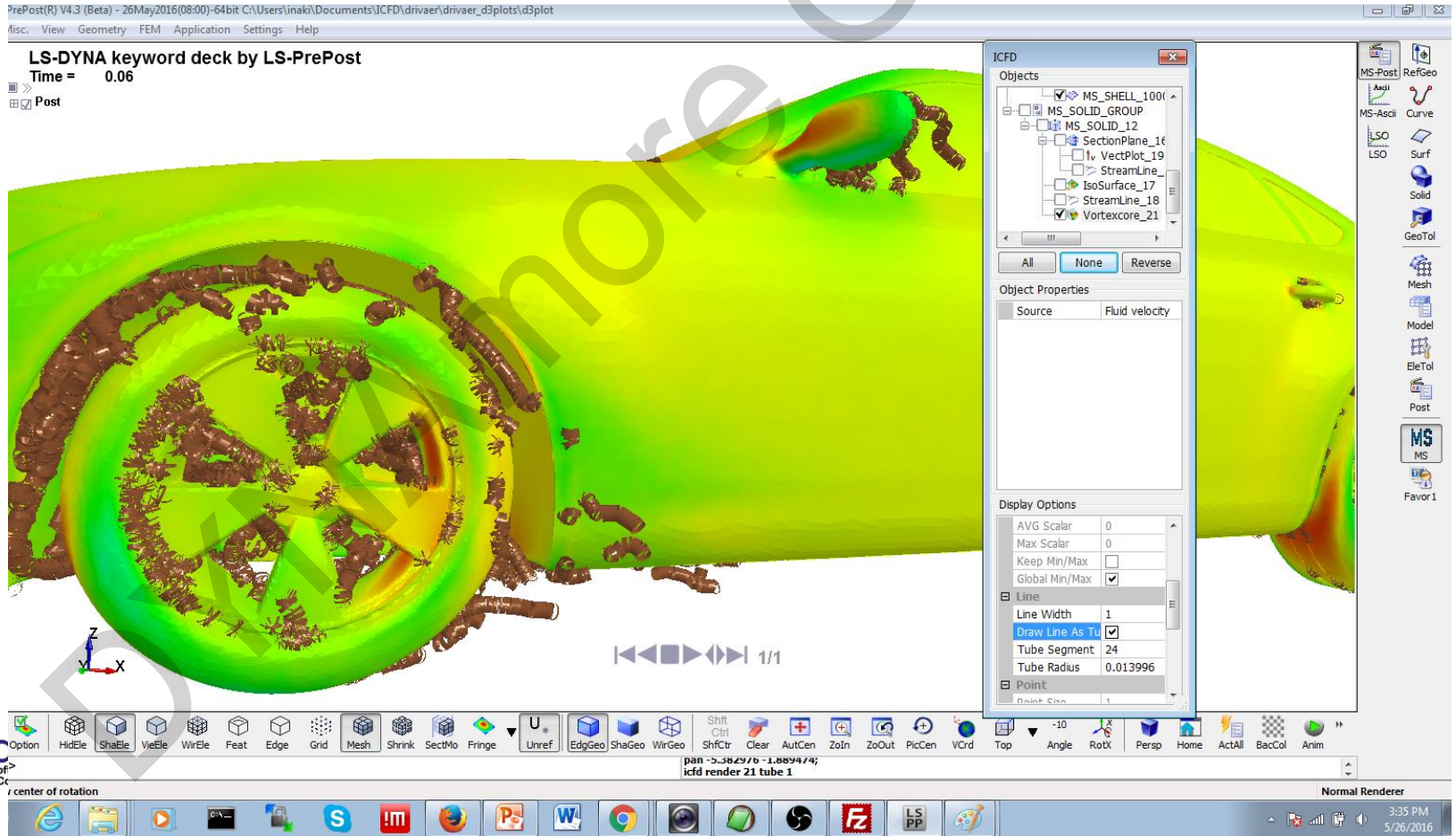
New Features – ICFD Post-Processing

Another example, here Vectors and Streamlines objects have been created by applying on the Section Plane rather than on the volume. Again, the streamlines have been colored by velocity



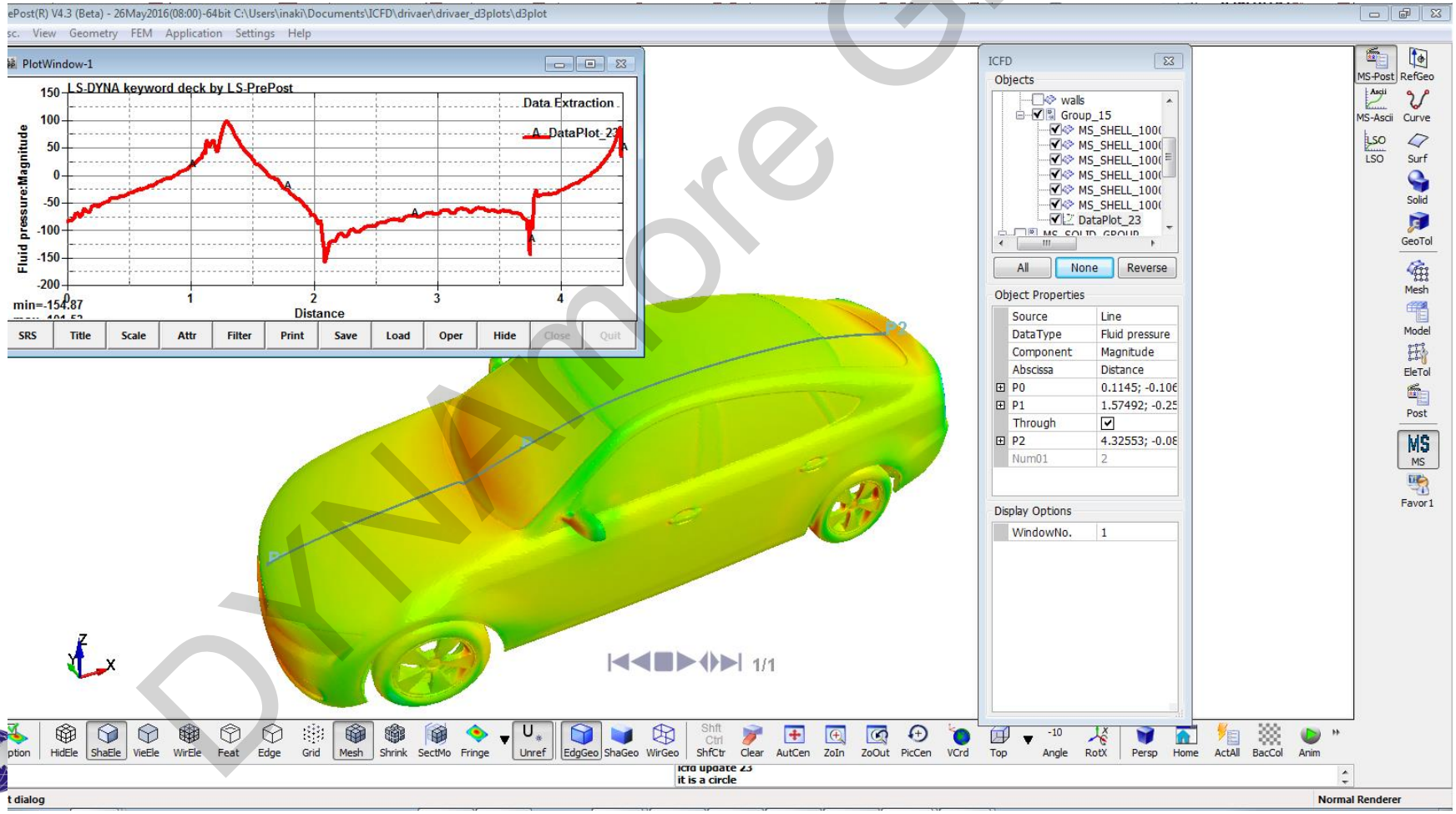
New Features – ICFD Post-Processing

More advanced tools are available for a better comprehension of the flow. In this case, the Vortex Cores are captured and displayed allowing the user to quickly identify regions of interest, where flow separation or turbulent effects may occur



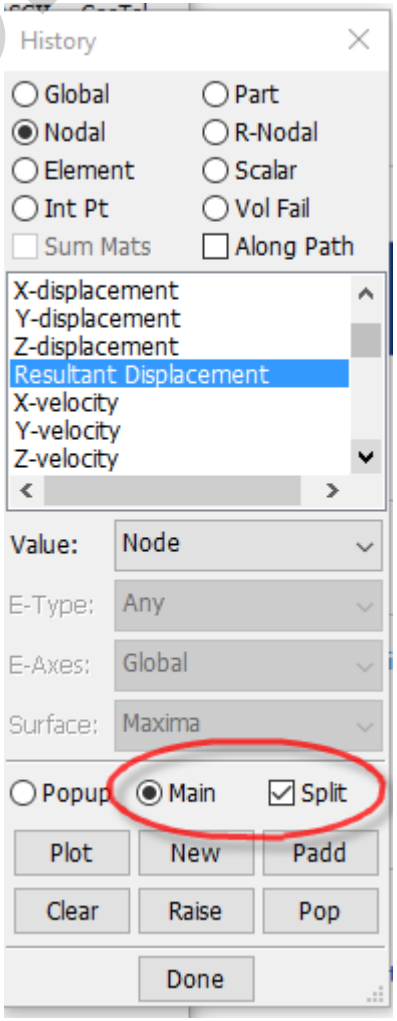
New Features – ICFD Post-Processing

Data extraction is also made easier. In this case, the Pressure along the vehicle body is plotted function of the distance (along a line on the body). This is a very typical CFD post-treatment.

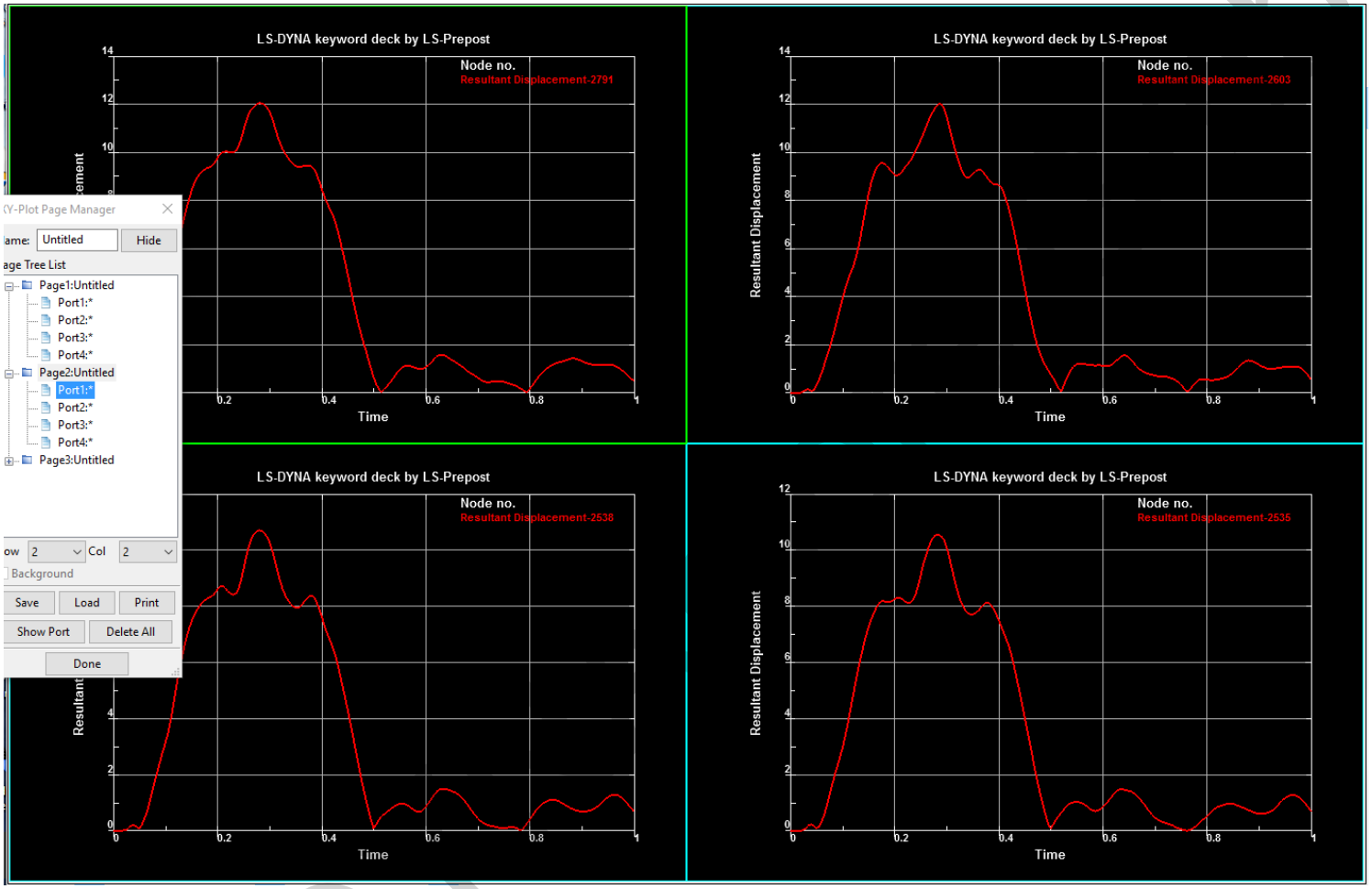


New Features – Splitting Curves

- When multiple curves to be plotted in the new XY plotting (Main) interface, a split option allows LSPP to plot one curve per window instead of all the curves into one single window
- This will ends up with many ports and many pages
- This option only available in the “History” interface in verison 4.3
- It will be available for ASCII, BINOUT in version 4.5



New Features – Splitting Curves



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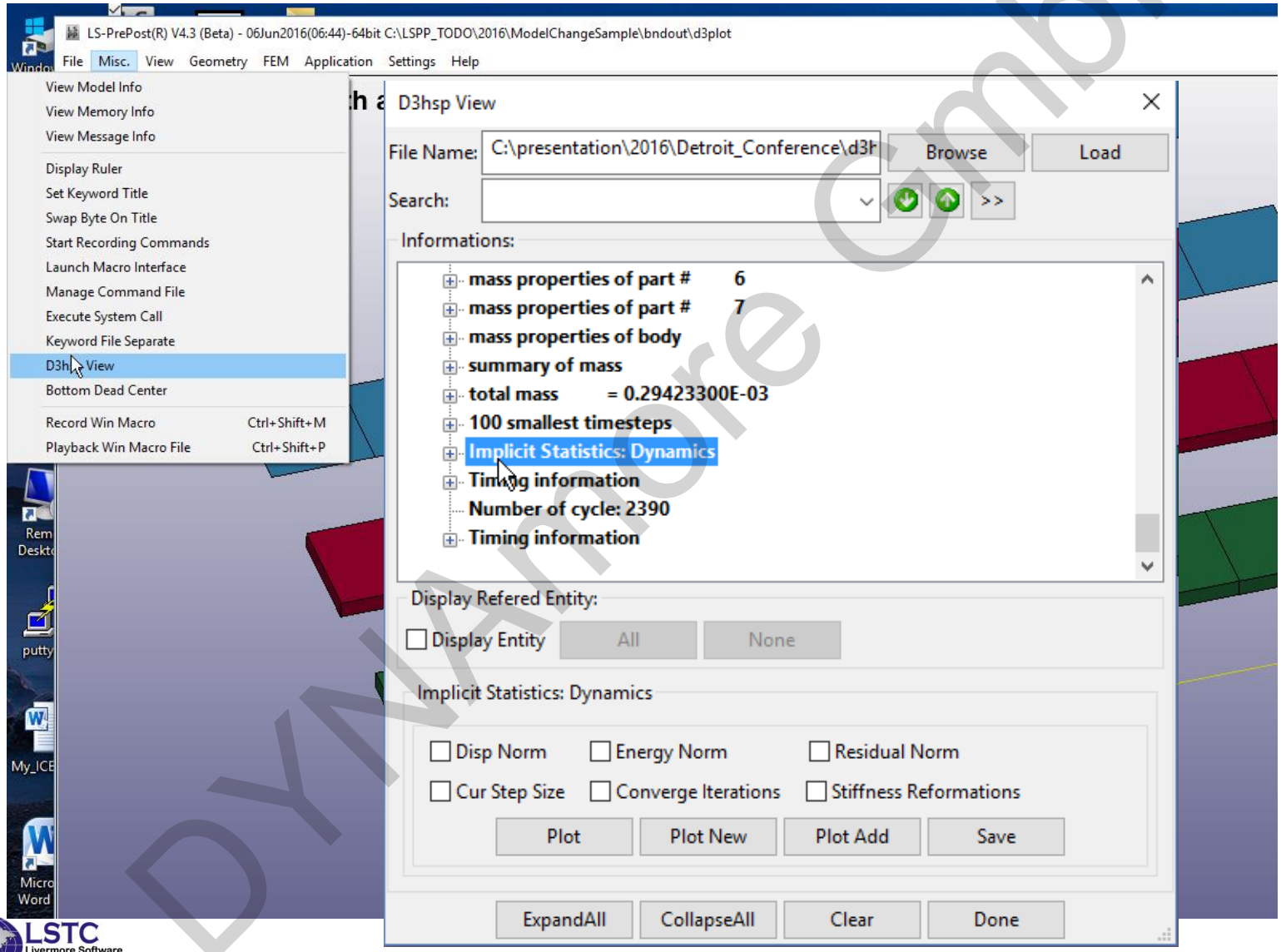
New Features - D3HSP file viewing

Purpose: To look the content of d3hsp file in an organized way

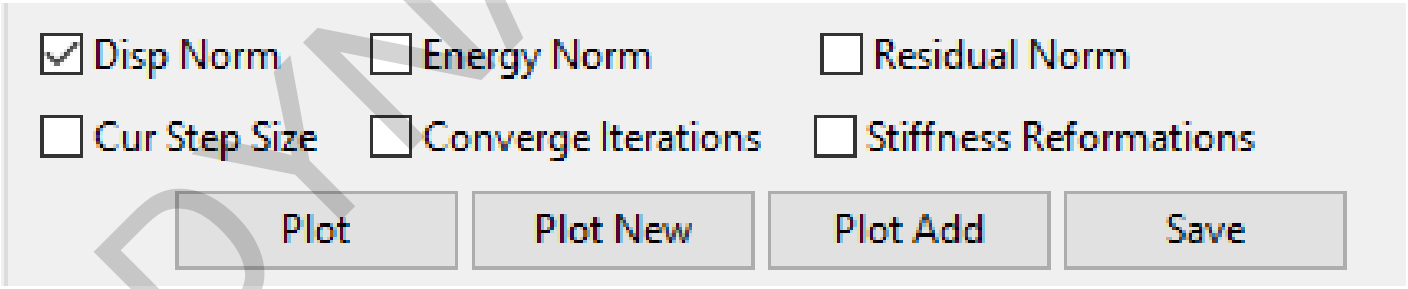
- d3hsp file contains a lot of information from the LS-DYNA run, this file can be many MB in size
- LS-PrePost reads the information from this file and organizes them into a tree/list structure for easy reading and understanding
- Key phase search is possible
- Launch d3hsp view in Misc pull down menu
- New statistics for Implicit Analysis now available in LS-PrePost 4.3

New Features - D3HSP file viewing



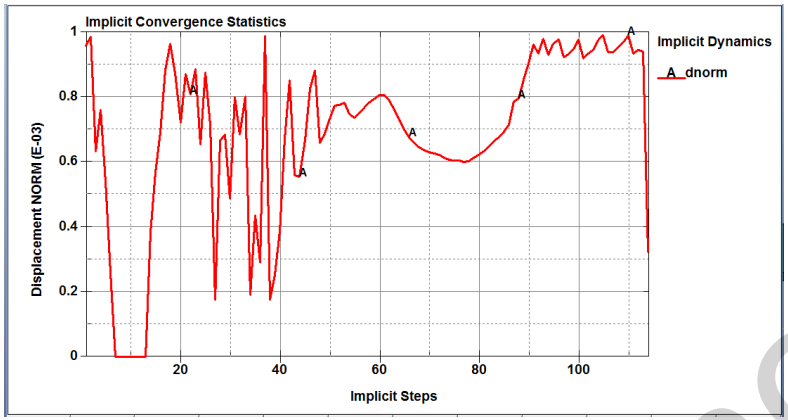
New Features - D3HSP file viewing

- There are 6 quantities control the convergence of an implicit run that can be plotted
- These are control parameters defined in *CONTROL_IMPLICIT_SOLUTION
  - Displacement Norm, Energy Norm
  - Residual Norm, Current Step Size
  - No. of Iterations to convergence
  - No. of Stiffness reformations

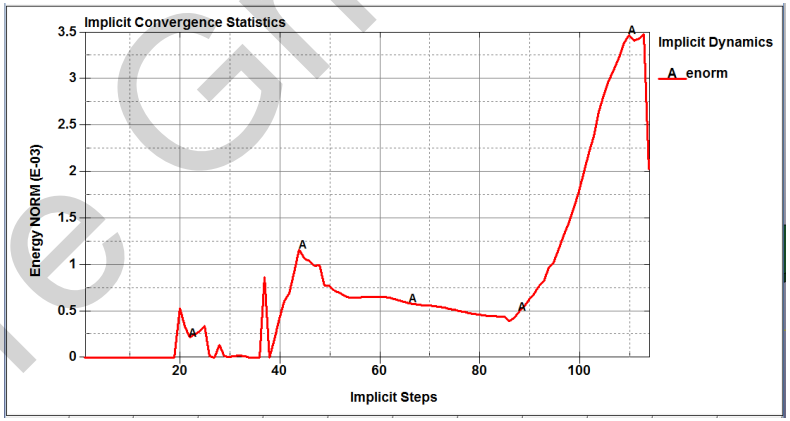


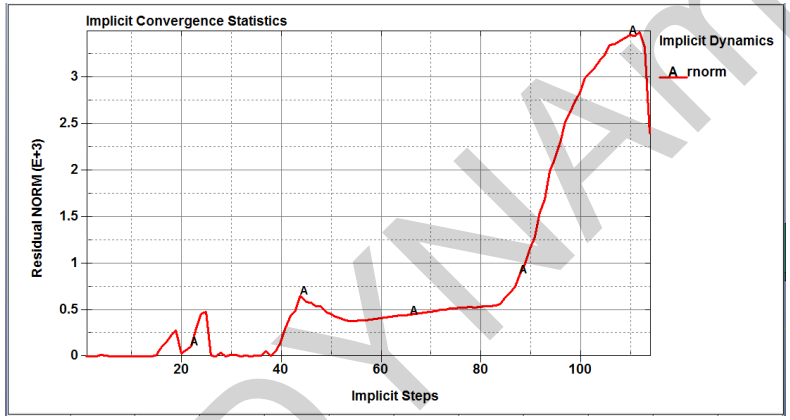
New Features - D3HSP file viewing

Displacement Norm

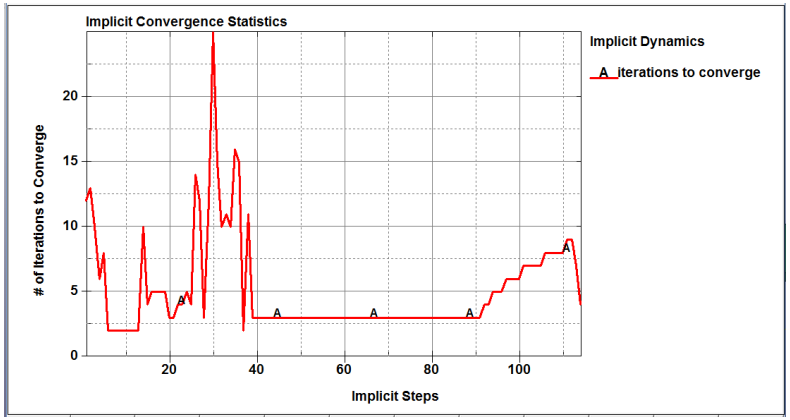


Energy Norm





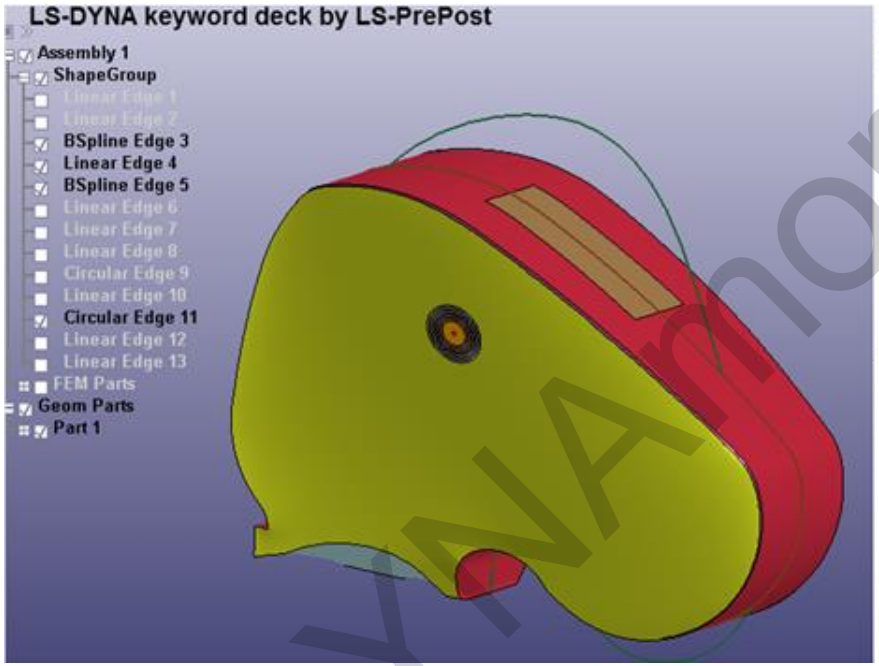
Residual Norm



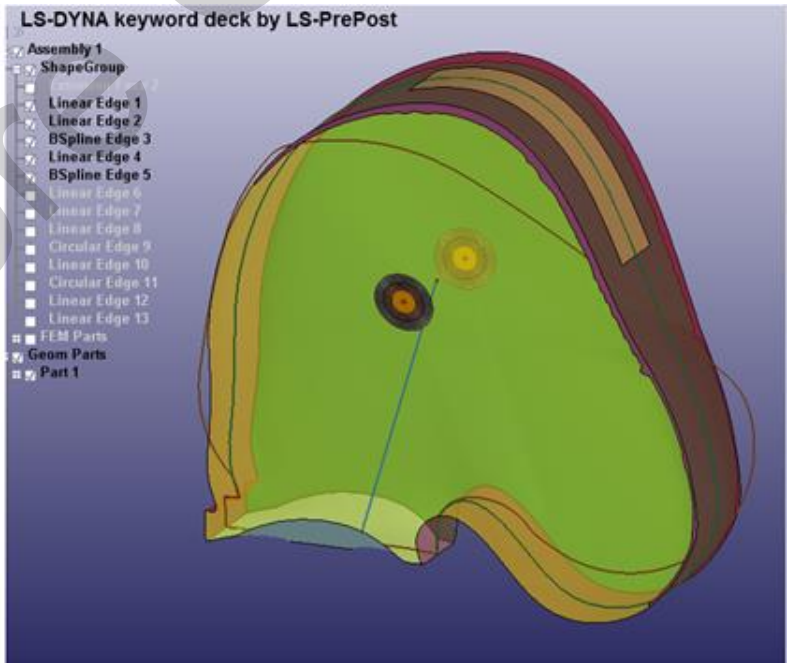
No. Of Iterations to Converge

New Features - PAB Morphing

- Wenyu Lian (GM, now Google) and Amit Nair (LSTC) had developed a polar morphing method to quickly morph a passenger airbag to a required profile



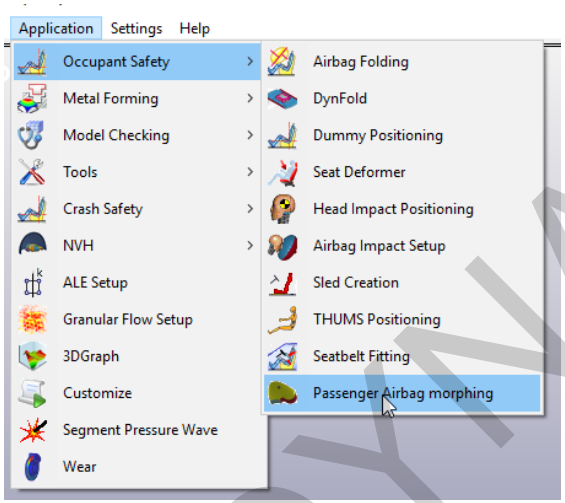
Original PAB Profile

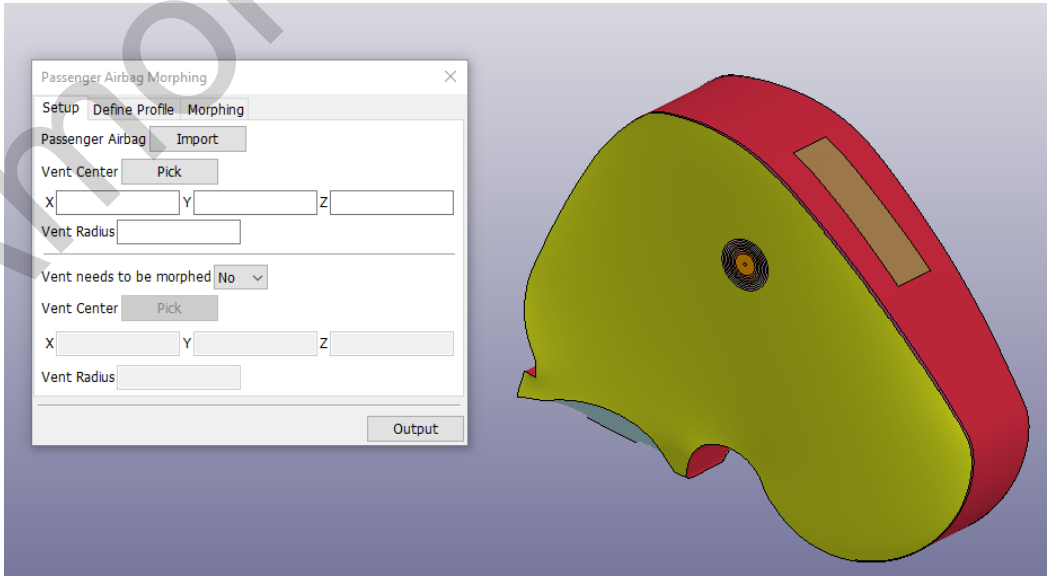


Polar Morphed PAB New Profile

New Features - PAB Morphing

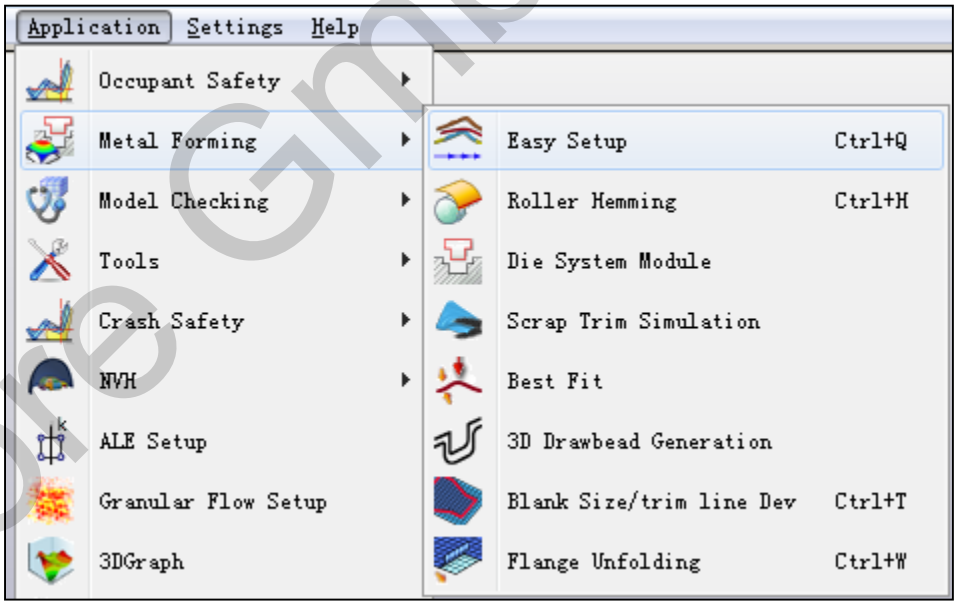
- We have incorporated this polar morphing method in LS-PrePost as an Application
- With a single interface, user can easily input the parameters and setting up the new profile to create a new PAB geometry





New Features in Metal Forming

- Multi-Stage Setup
  - Enhancing the progressive die simulation
  - Automating the springback compensation process
- Springback Compensation Setup
  - The drawing tools compensation
  - The trim die compensation
- Lancing Setup
  - Adding the lancing operation in the process of forming
- Best fit Module
  - Assessing the springback prediction accuracy with the scan data
- 3D Draw bead Module
  - Generating the real bead mesh based on the line beads for accurate springback prediction

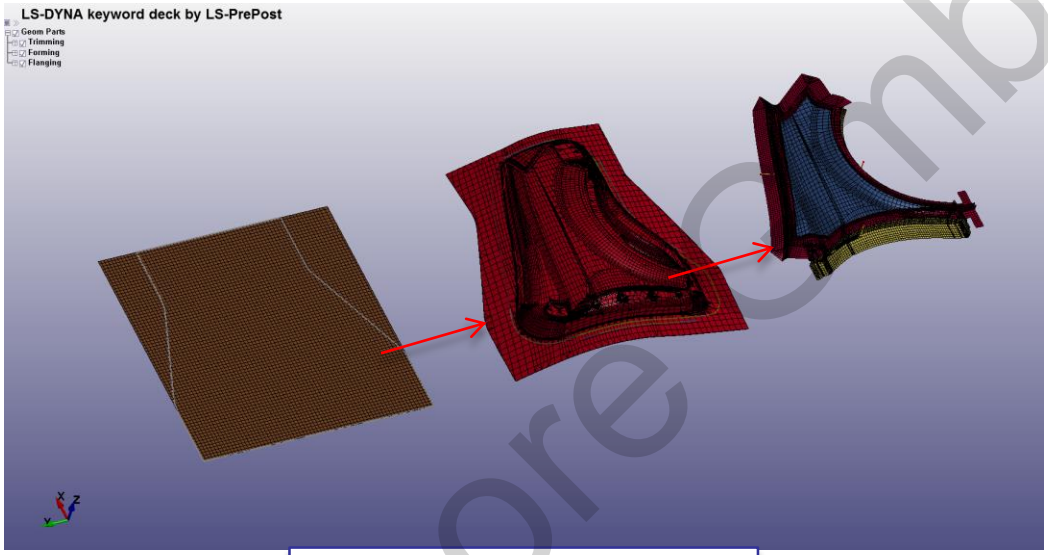


Metal Forming – Multi-Stage Setup

Same processes can be repeated (e.g. trimming, gravity, spring back)

Drawing and redrawing processes with different tools can be defined as many as necessary

Various stages can be defined

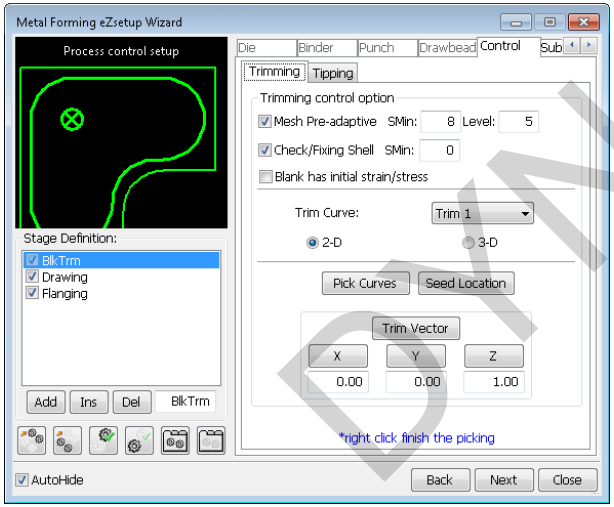


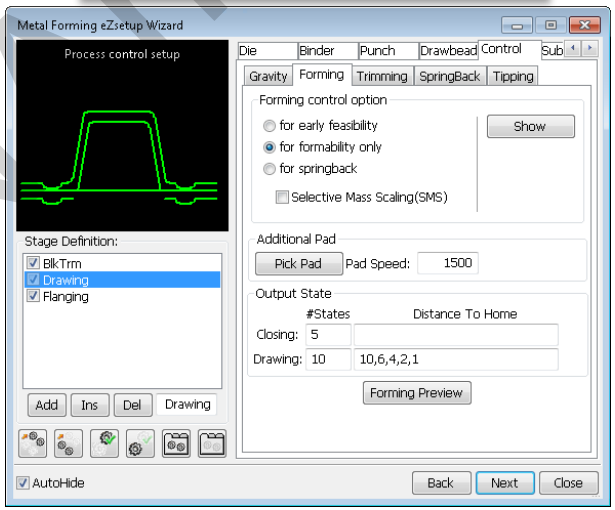
The draw types can be different between stages

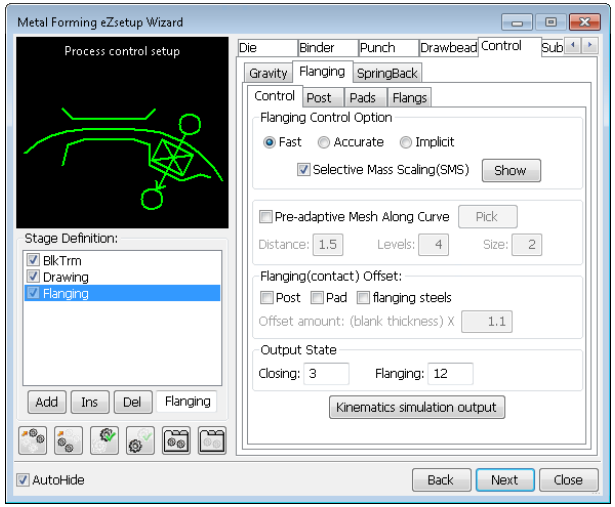
Multiple blanks are supported in the blank definition

Tipping can be used to transfer the forming part between stages

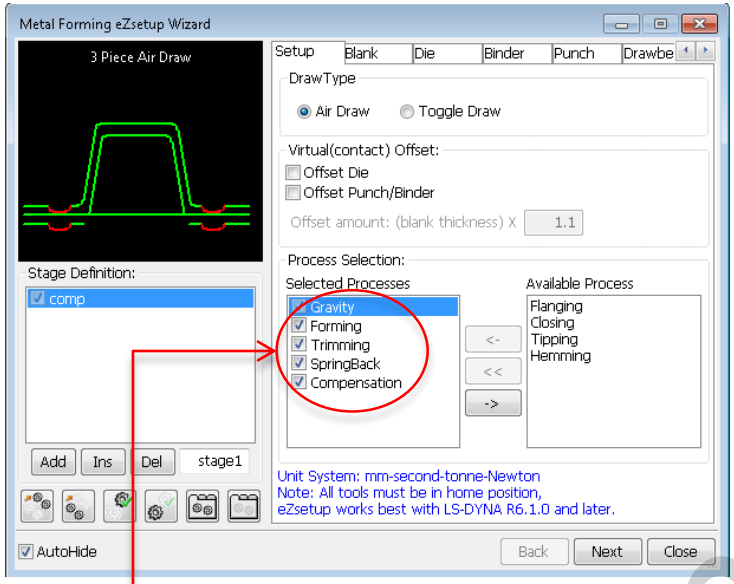
Flexible flanging definition

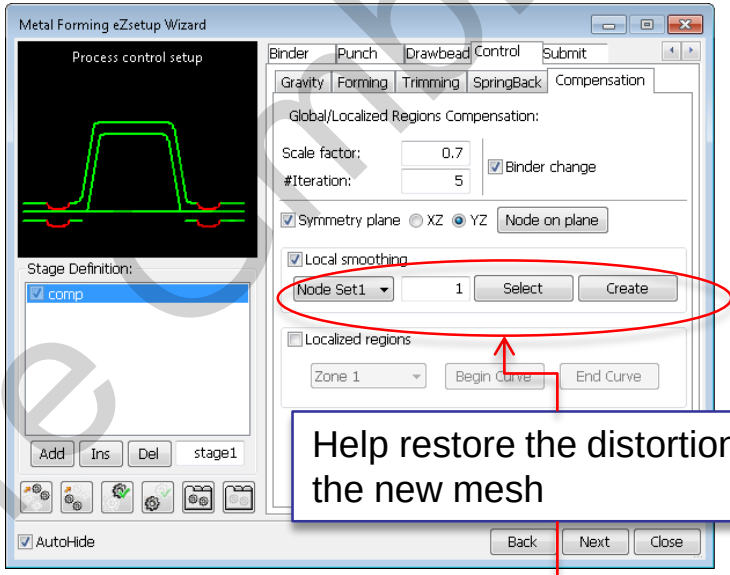




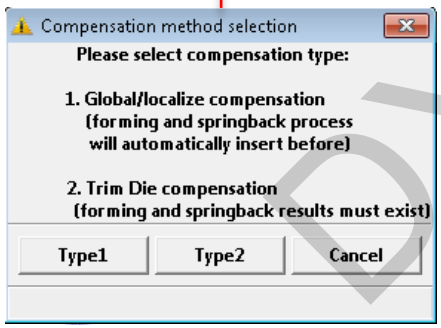


Metal Forming – Spring Back Compensation





Starting Compensation will automatically add the supported baseline processes

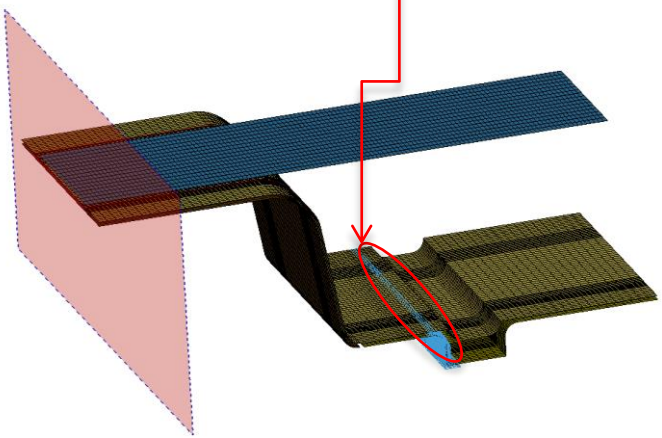


Scale Factor: determines how much of the shape deviation is compensated in one compensation simulation

Binder Change: Whether the binder change will be modified in the compensation.

Localized regions: only the selected regions of the tools will be modified.

Help restore the distortion in the new mesh

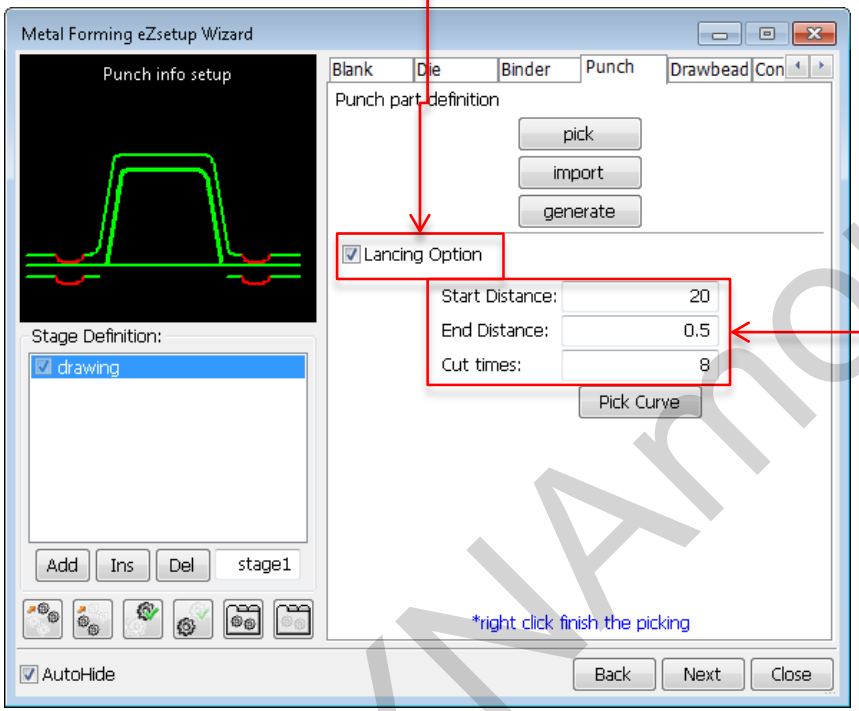


Automatic submission can be performed as the multi-stage simulations

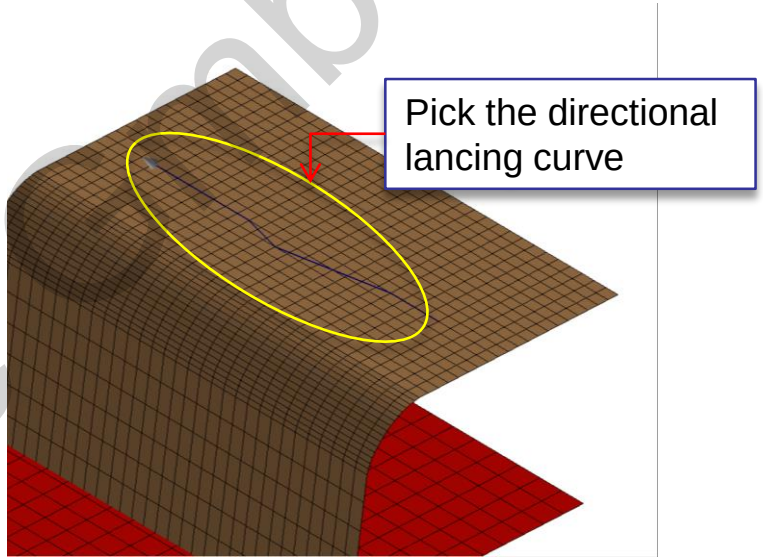
Symmetry of the tools can be considered

Metal Forming – Lancing Setup

Adding lancing in the forming process

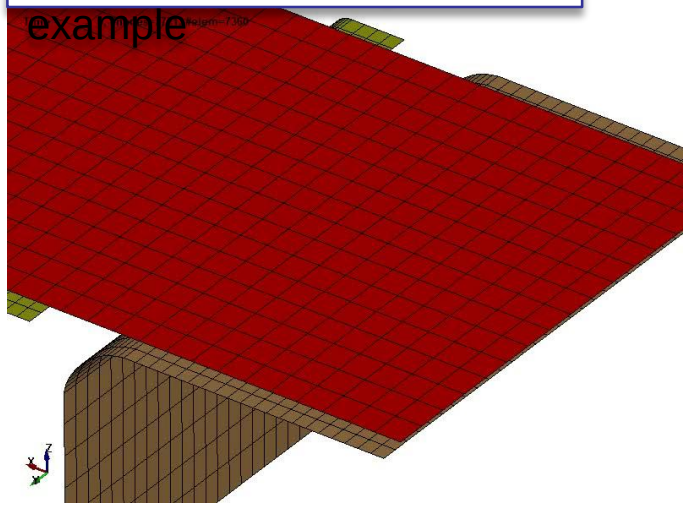


Instant : Only starting location needed (from the home position)
Progressive: Starting and ending locations along with cut times

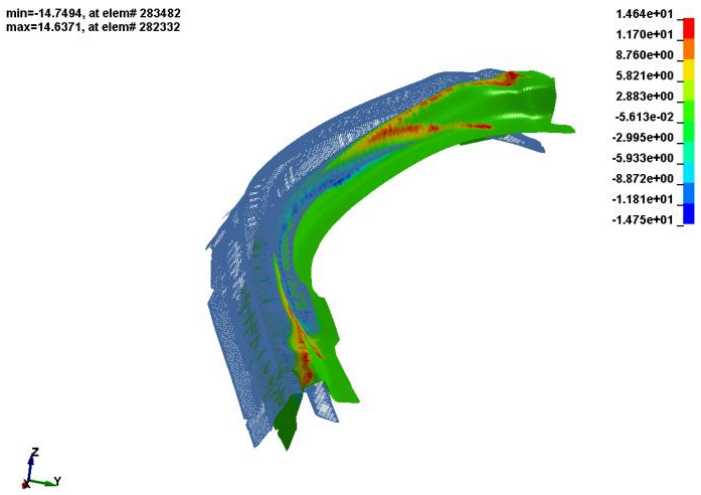


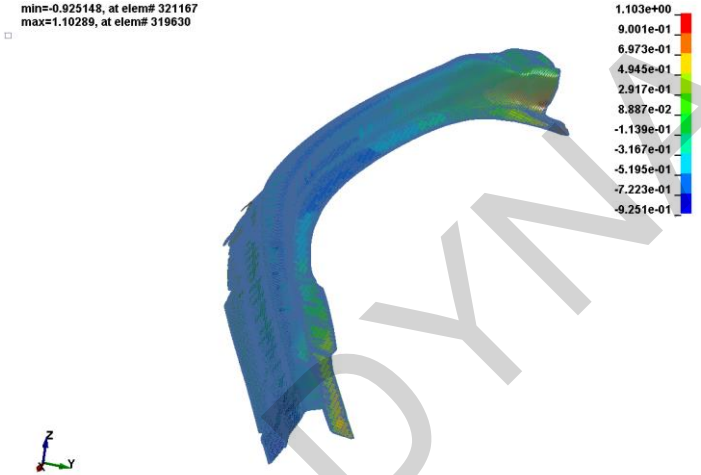
Pick the directional lancing curve

Progressive lancing example

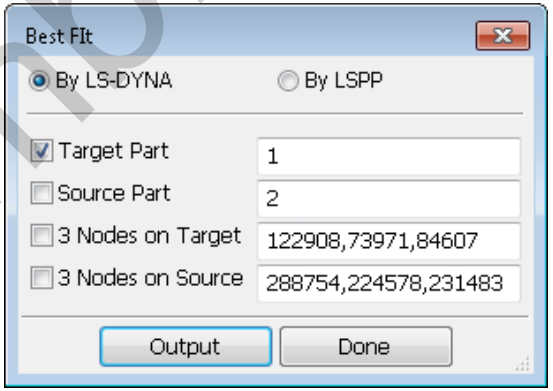


Metal Forming – Best Fit Setup





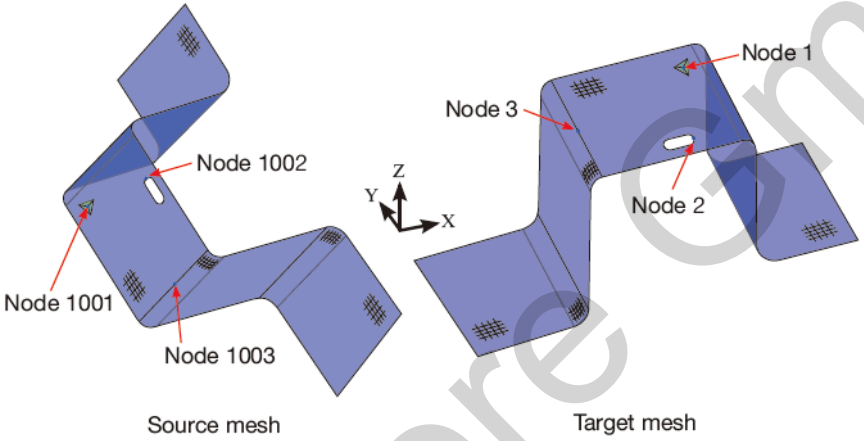
Deviation
Before: (-14.75, 14.64)
After: (-0.925148, 1.10289)

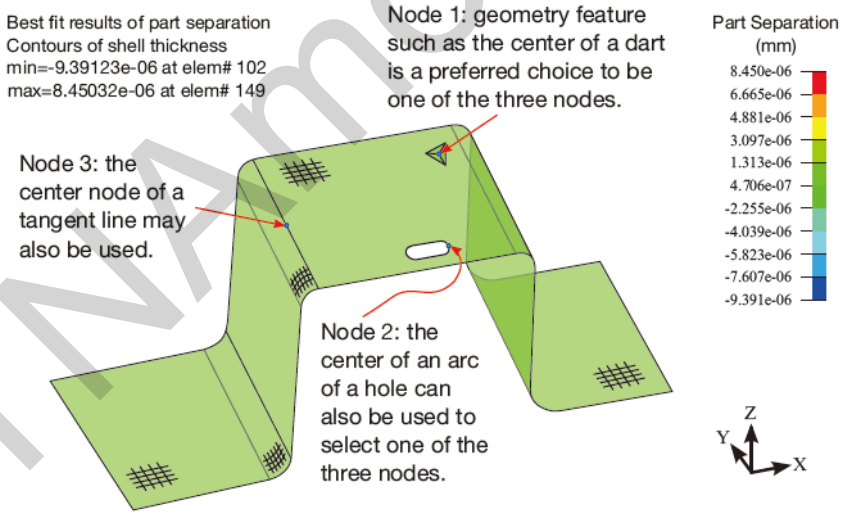


Procedures:
1. Picking the target (e.g. scan data);
2. Pick the source (e.g. predicted mesh);
3. Three optional pairs of nodes to assist the searching procedure (e.g. the angle of the two parts is larger than 30 degrees)
4. Output the keyword file for submission.

Submission:
1. Double Precision Solver (Beta version);
2. Result file: “Bestfit.out” (Post->FriComp->Thick->Thickness)

Metal Forming – Best Fit Setup





Best fit results - color contour of part separation plotted with "thickness" from the output file "Bestfit.out"

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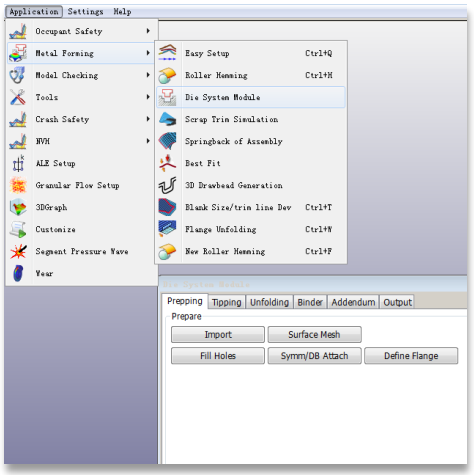
*More details in LS-DYNA Keyword User's Manual Vol.

New Features in Metal Forming (DSM)

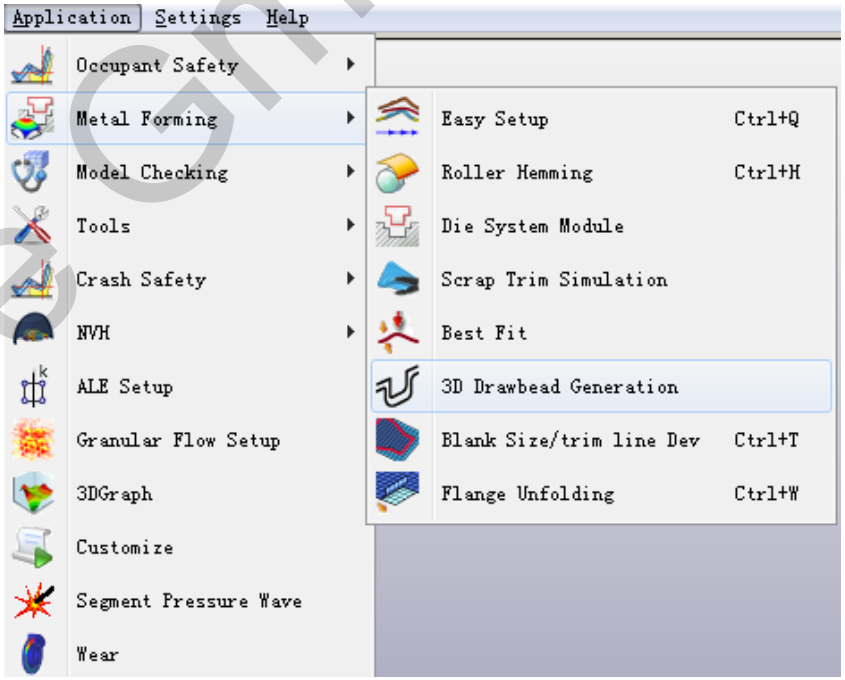
Die System Module (DSM) in LS-PrePost 4.3 for our users to create tooling surface when the final part is provided



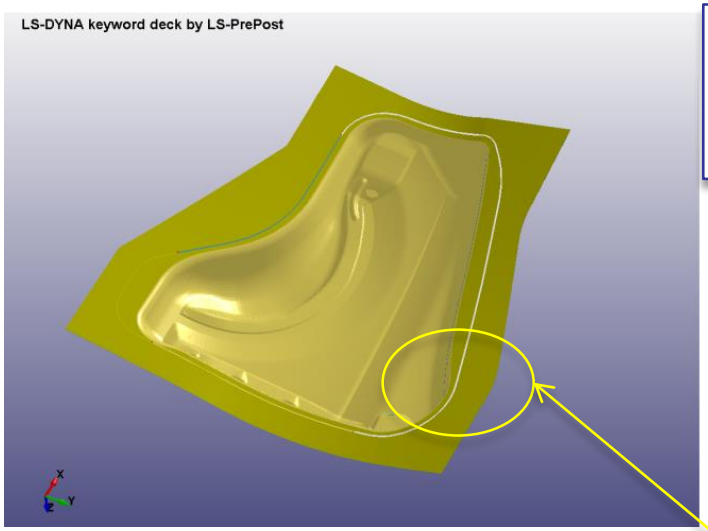
- ➢Prepping
  - *Prepare the given part for further processing*
- ➢Tipping
  - *Tip the part (the flanges excluded) to the desired draw position*
- ➢Unfolding
  - *Specify how to process the defined flanges*
  - *repair the boundaries*
- ➢Binder
  - *Create the binder profiles and generate the binder*
- ➢Addendum
  - *Create the addendum profiles and patches to generate the addendum*
- ➢Output
  - *Save the created tools and the curves to files*

Metal Forming – 3D Draw Bead

- Real bead modeling is necessary for the accurate spring back prediction after the formability simulation.
- With the line beads as the center lines, 3D Draw bead module directly generates the real bead mesh on the tooling mesh.
- Flexible functions:
  - Multiple section profiles
    - Smooth transition automatically generated
  - Open or close loop beads
    - Tail section can be created for open beads
  - Two bead types
    - More parameters allowed

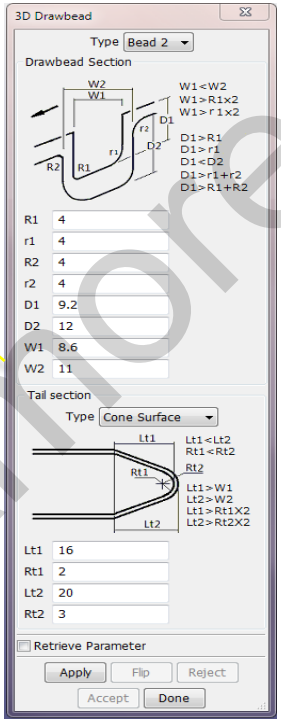


Metal Forming – 3D Draw Bead

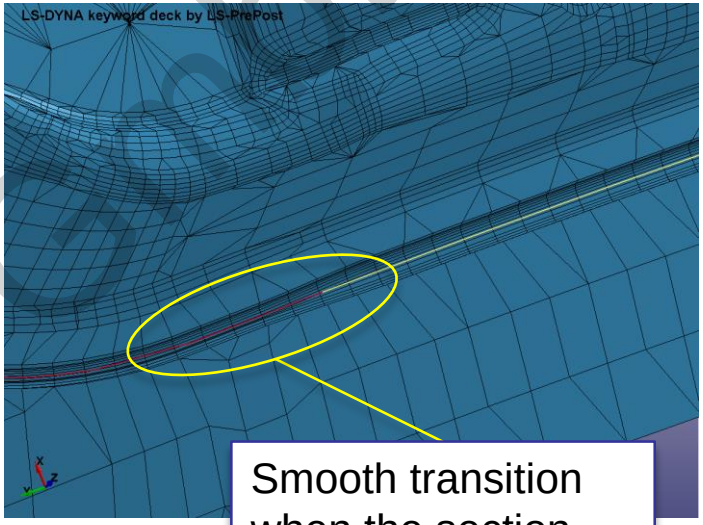


Section cut of the generated real bead mesh

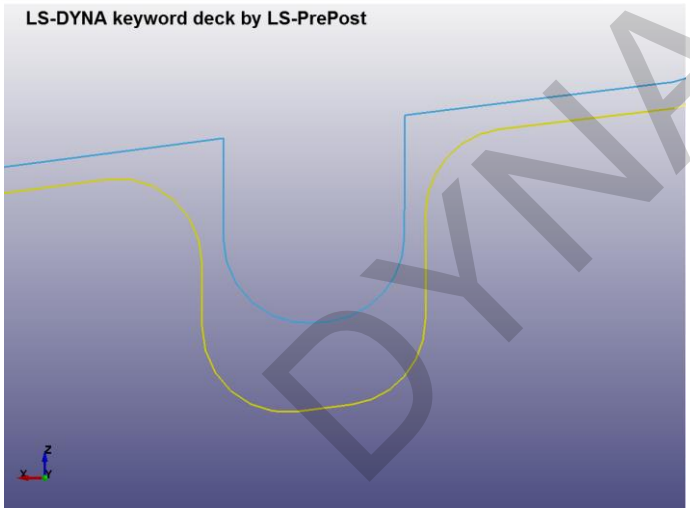
Pick the line bead after specifying the section parameters

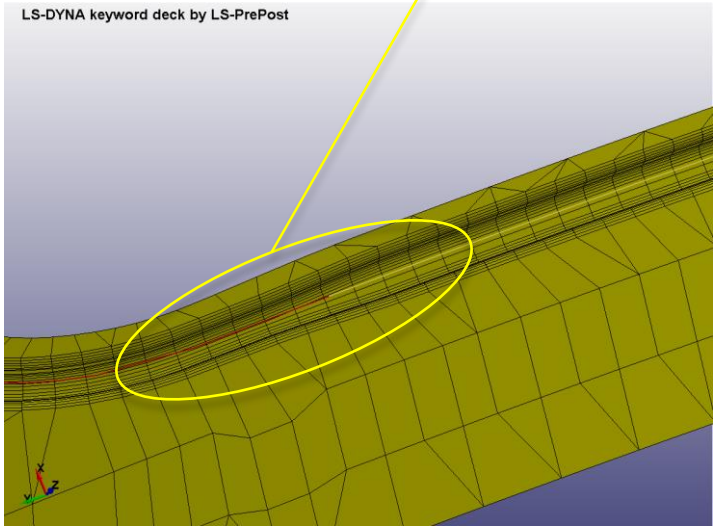


Section parameter check to avoid conflicting bead geometry



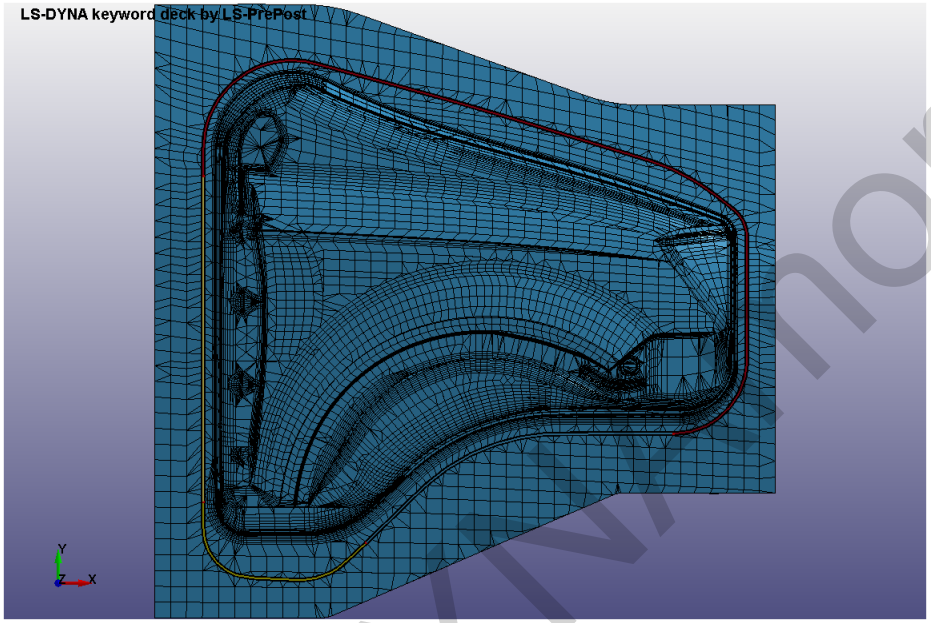
Smooth transition when the section profiles are different

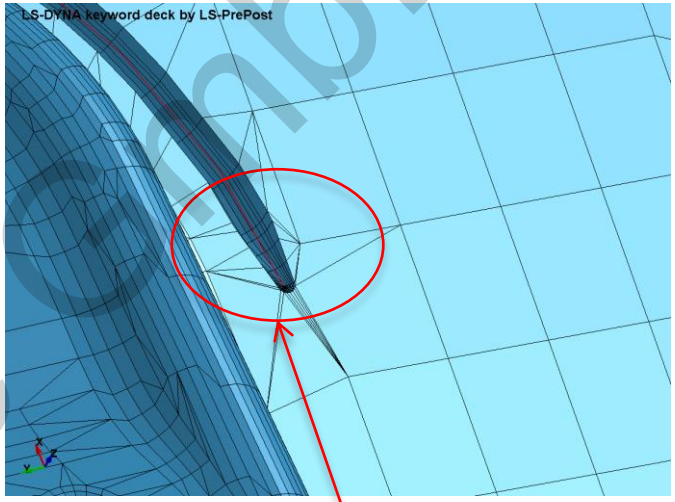




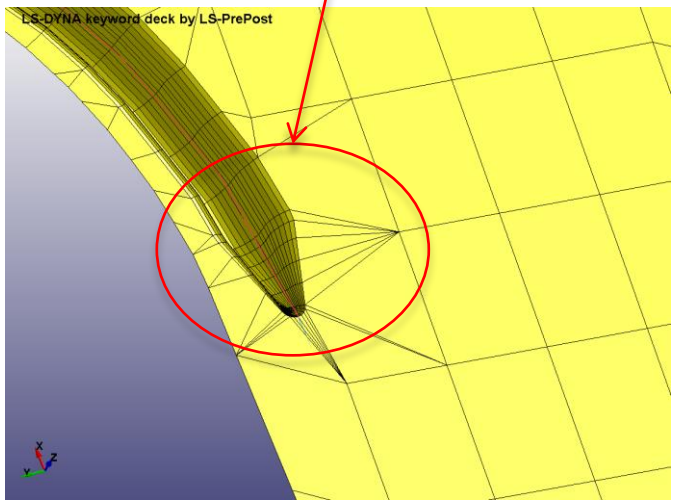
Metal Forming – 3D Draw Bead

Close-loop bead mesh





Tail Sections for the open-loop beads



Current and Future Developments in version 4.5

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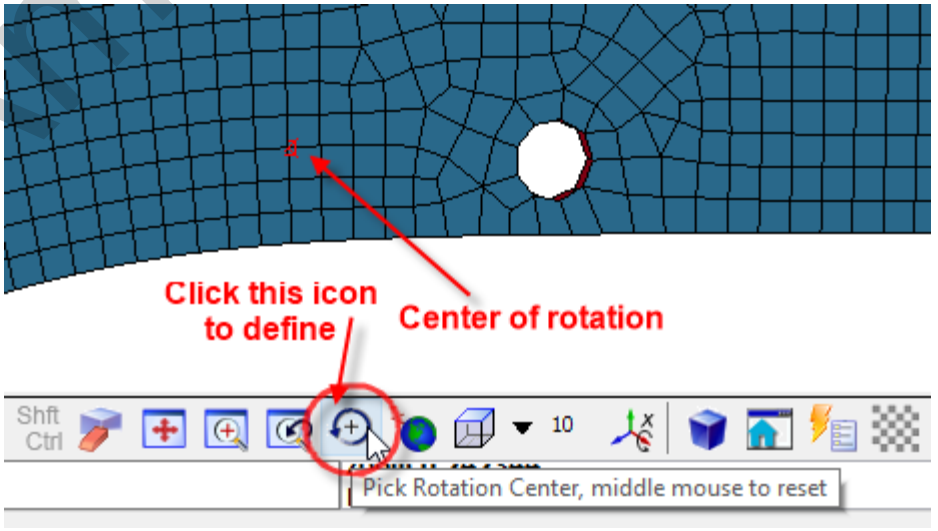
Current Development – Rotation center

Define center of rotation

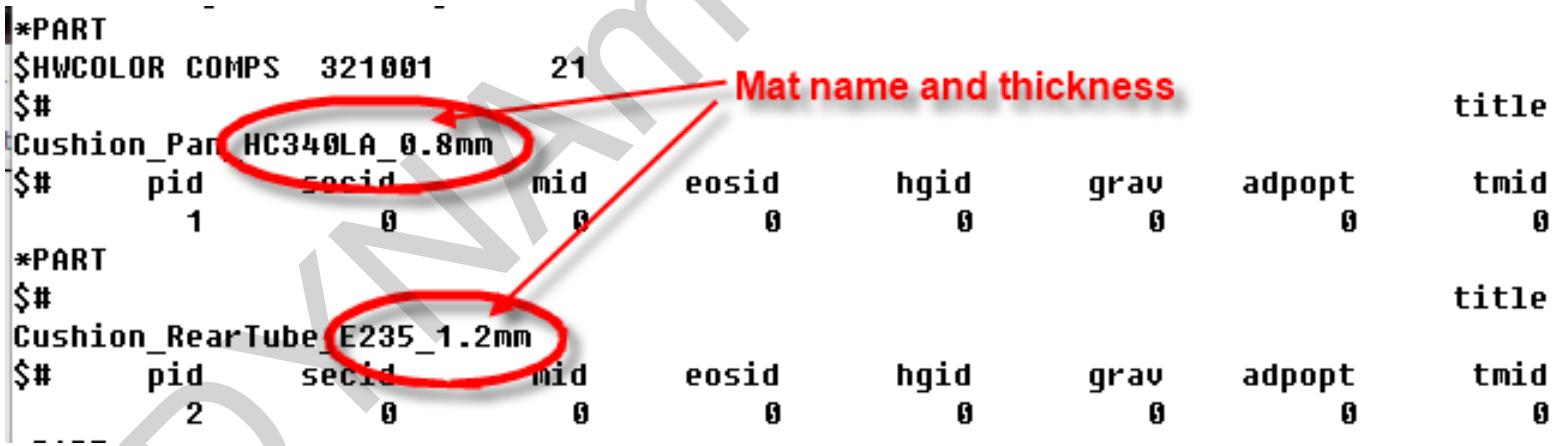
- Before one has to click the rotation center icon first before one can pick a point on the model to define the center of rotation
- Now, a middle mouse click on the model will define the center of rotation,
- Another middle mouse click will cancel the center of rotation definition



Current Development – Part Prop Assignment

Easy *MAT and *SECTION properties assignment

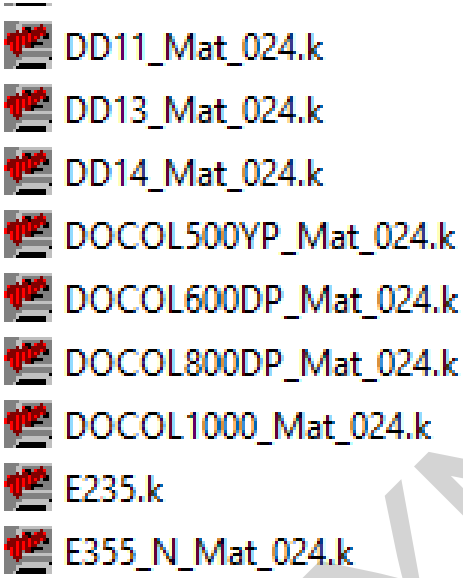
- Establish a directory and put all the often used material data (regular LS-DYNA keyword data) in this directory. One material per file. The file name reflects the material type and kind
- Use the PART title to define which material this part is going to us. Also define the shell thickness on the part title



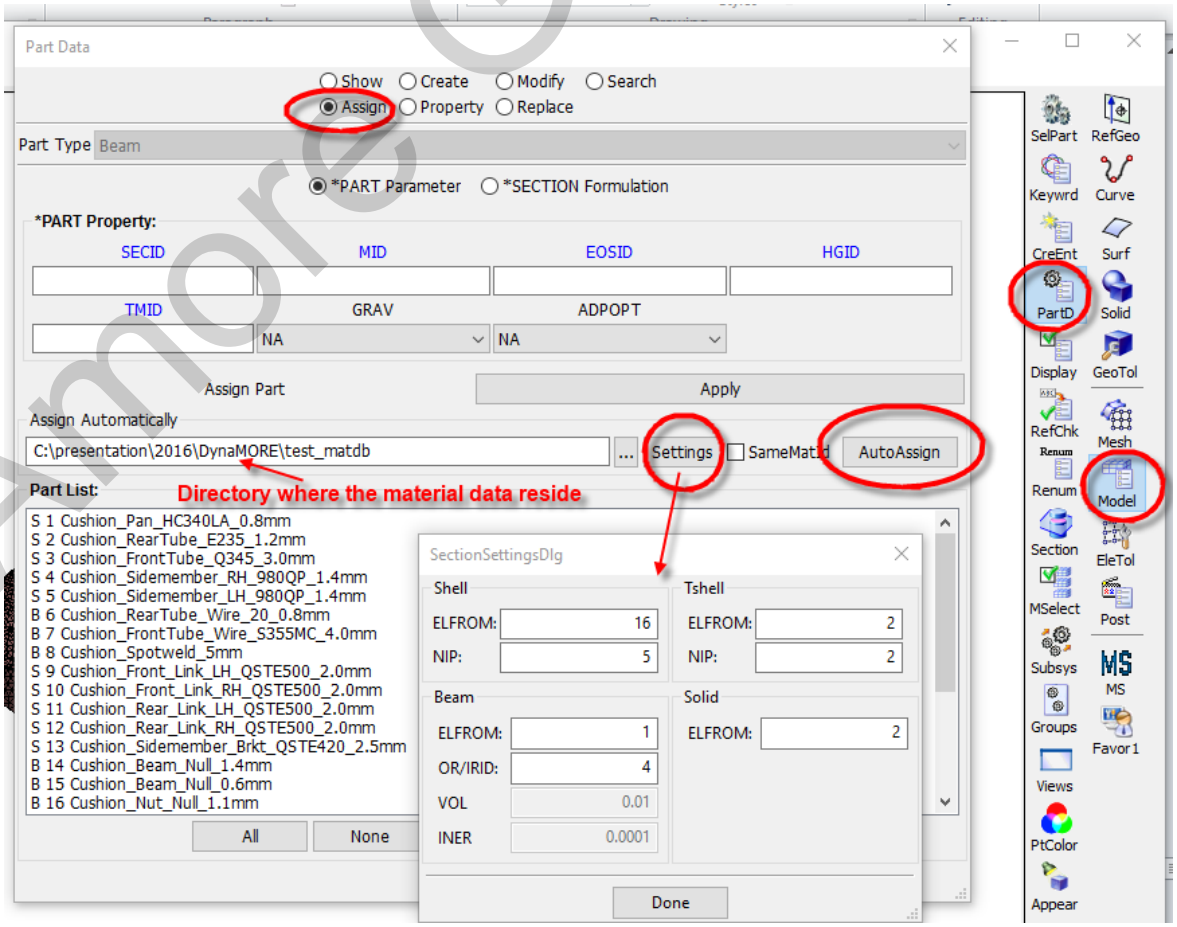
Current Development – Part Prop Assignment

Easy *MAT and *SECTION properties assignment

- AutoAssign will search the directory and read the file with the same name as on the *PART title card



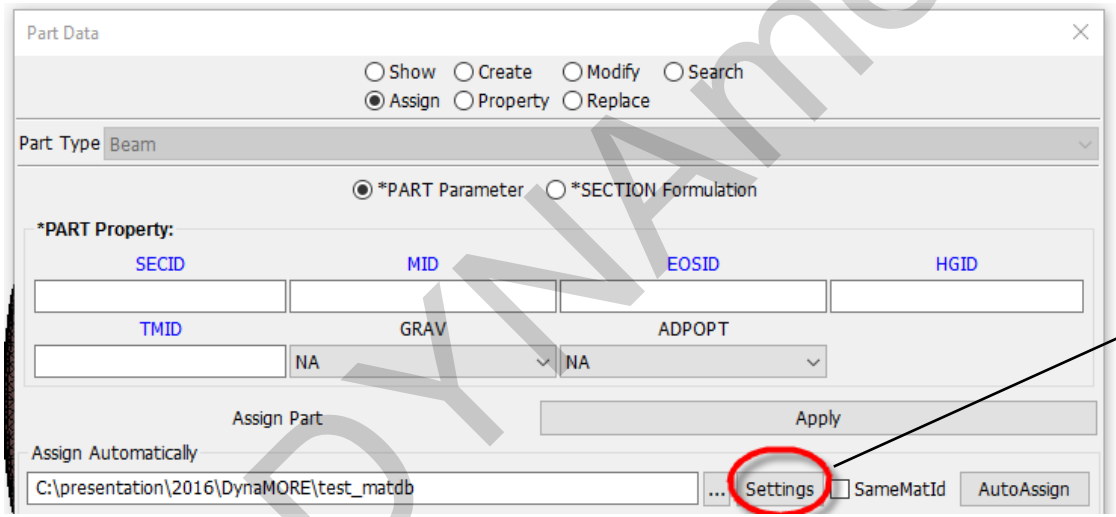
Files in Directory

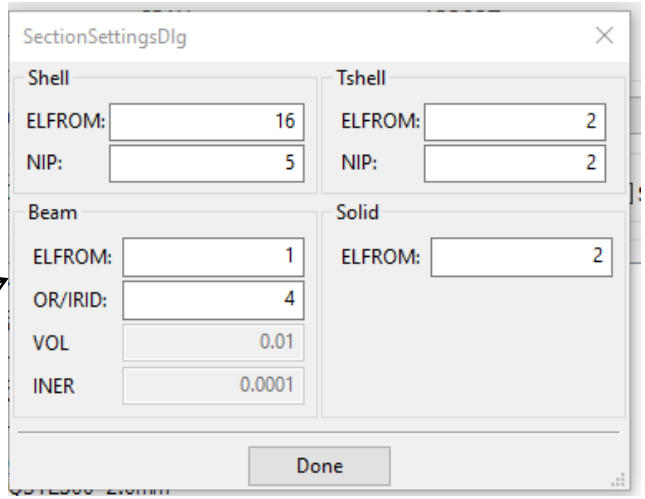


Current Development – Part Prop Assignment

Easy *MAT and *SECTION properties assignment

- The material directory will be recorded in the configuration file
- Setting also allow *SECTION data to be defined beside the thickness which is coming from the *PART title card

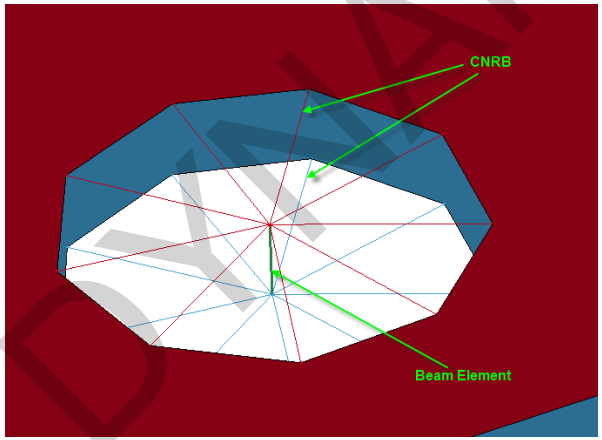


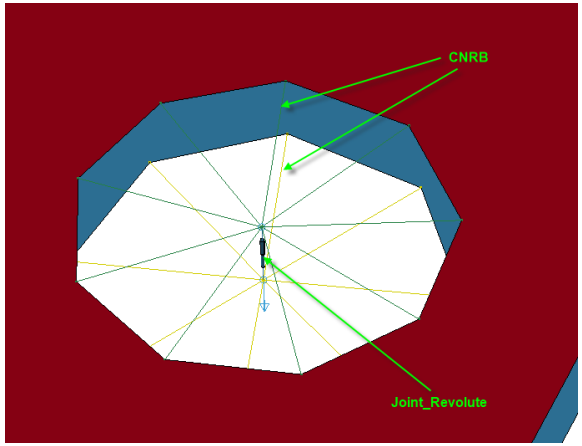


Current Development – Connector Creation

Bolt and Joint creation

- Bolt can be constructed with a Beam elements and 2 set of Constrained nodal rigid bodies (CNRB)
- Joint can be constructed with a Joint_Revolute and 2 set of Constrained nodal rigid bodies (CNRB)
- In the example shown, once click on one of the circle will create a bolt consists of 2 CNRB and a beam element or a joint with 2 CNRB and a Joint_revolute

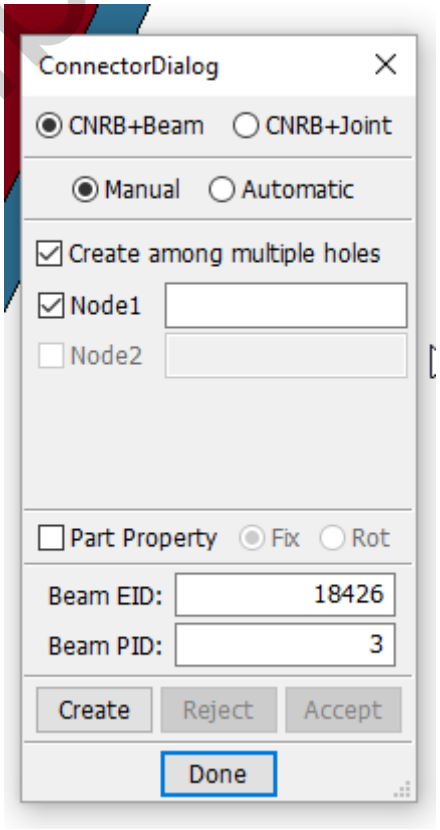




Current Development – Connector Creation

Bolt and Joint creation

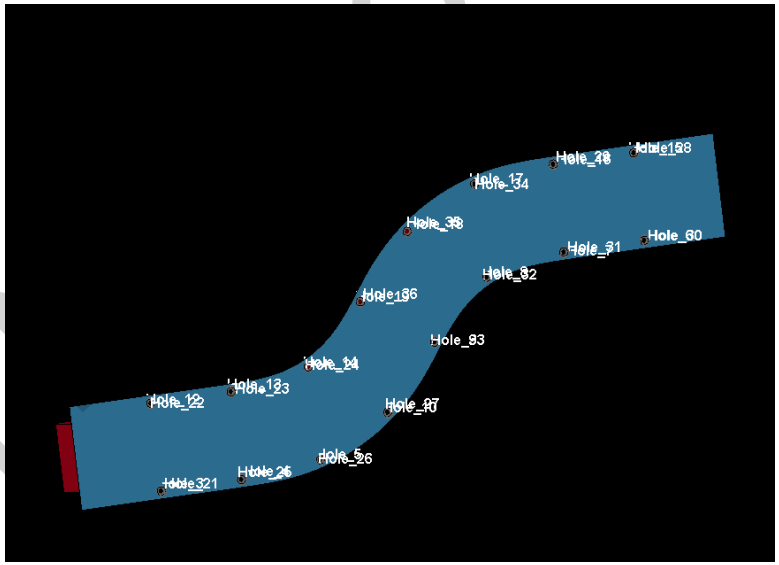
- For Bolt creation – Manual option allows user to pick one node on the boundary of one hole, and another node on the other hole
- If “Create among multiple holes” is checked, then only pick one node is sufficient, the code will automatically search other holes (can be more than 2)

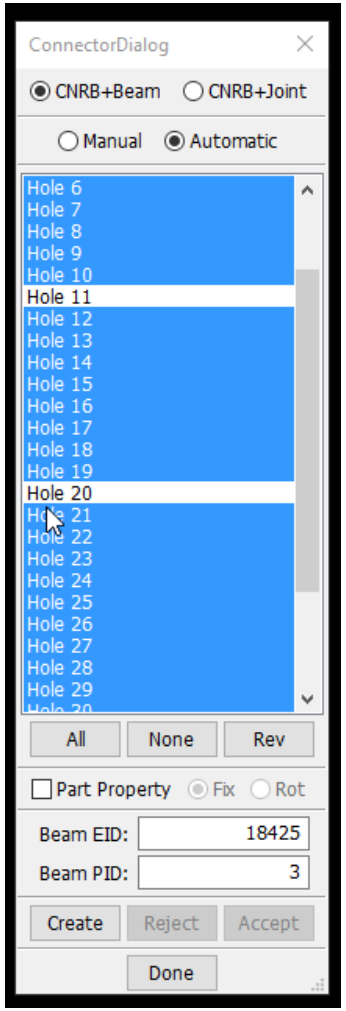


Current Development – Connector Creation

Bolt and Joint creation

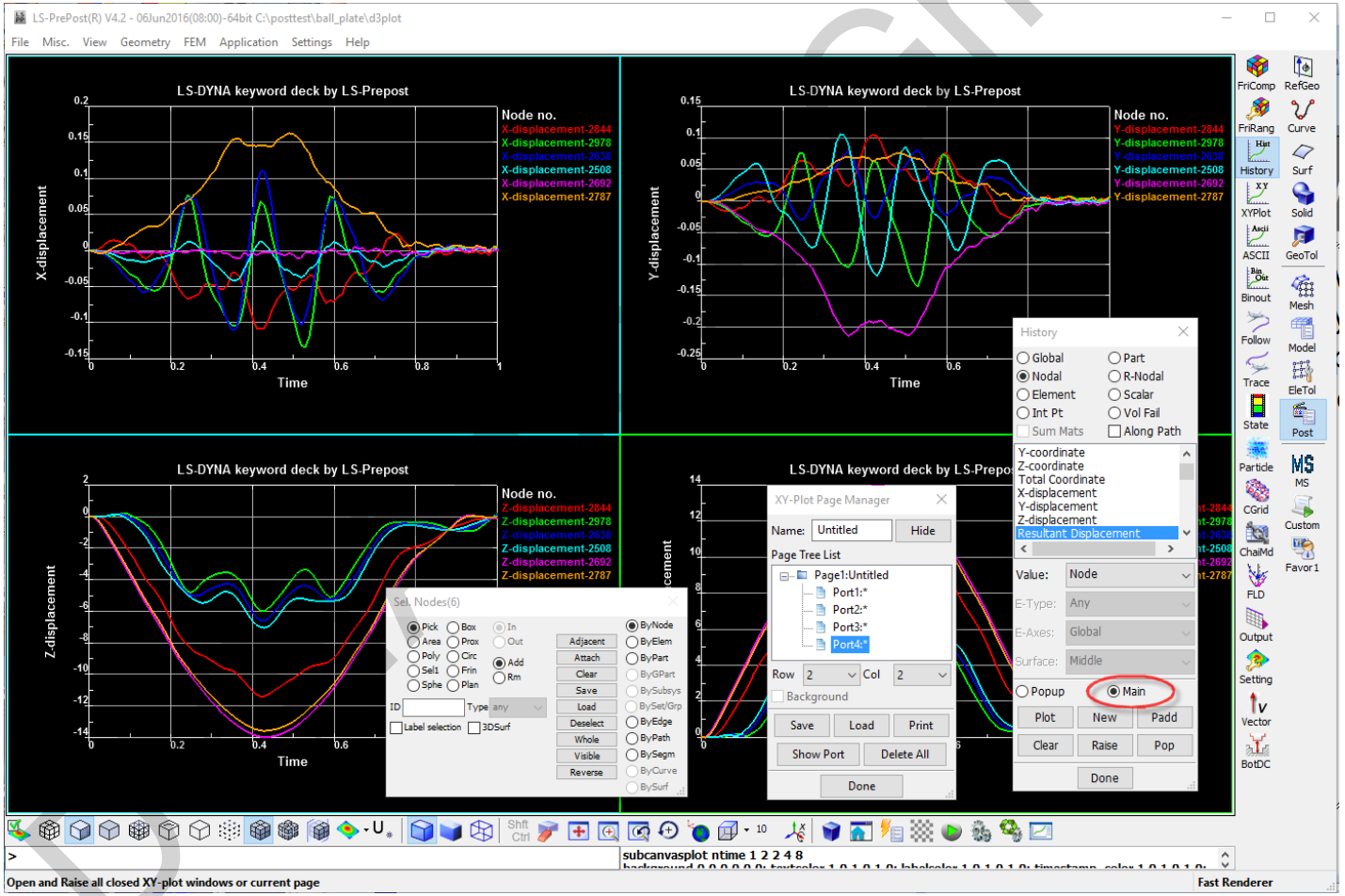
- If there are hundreds (or even thousands) of such bolts to be created, then use the “Automatic” option will highlight all the holes automatically. User can uncheck holes from the list that bolt will not be created





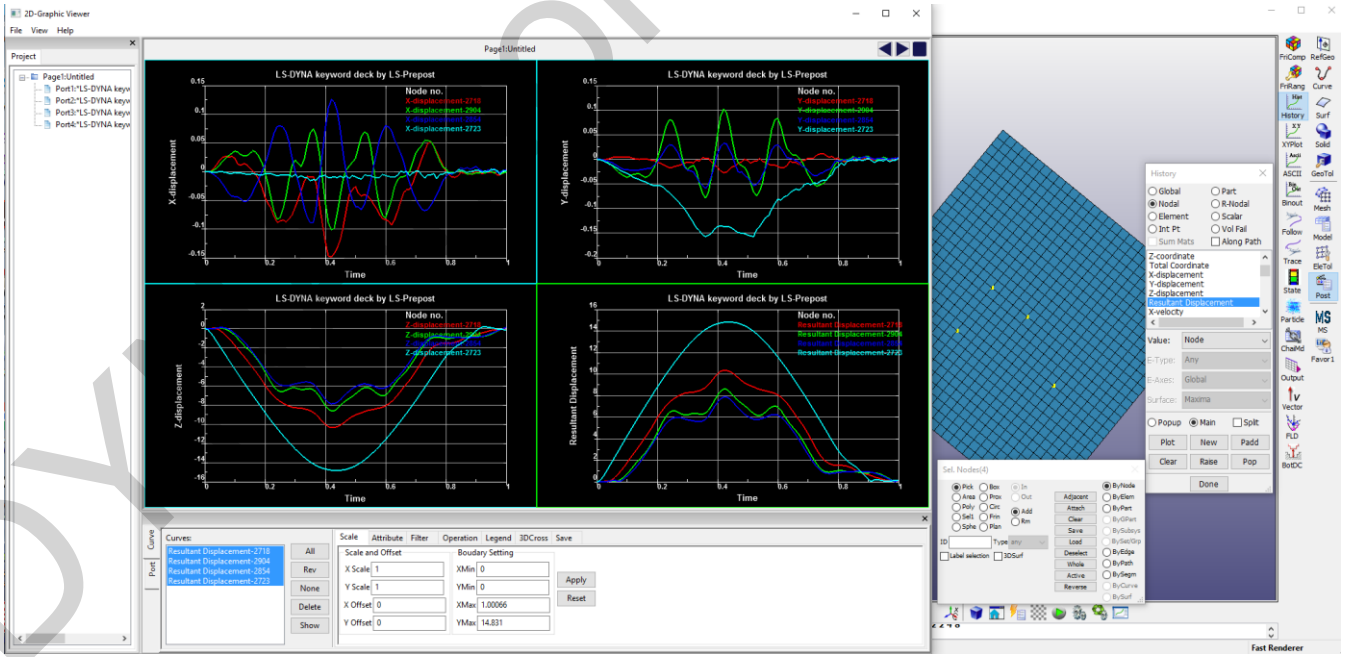
Current Development – New XY Plot

- The old (2nd generation) interface has too many pop ups and also occupy the same graphics area as the model



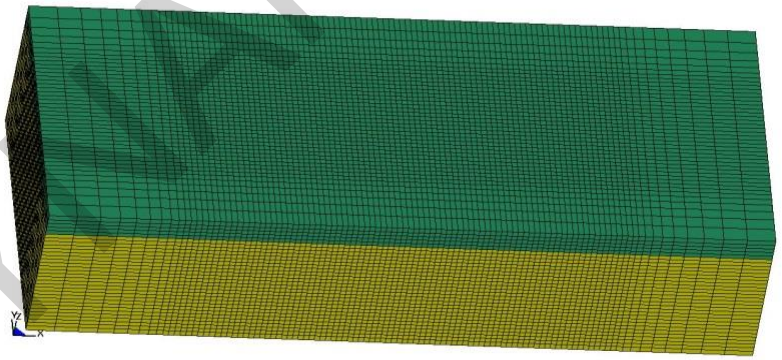
Current Development – New XY Plot

- The 3rd generation XY plotting interface will draw XY graphs on a completely new graphics window. This is perfect for user has dual monitors
- The dialogs are dock able. It works the same way as in the 2nd generation interface
- Will use template for repetitive and batch operations



Current Development – Structural ALE

- In the new structural ALE (S-ALE) in LS-DYNA the ALE part that used to be modeled by SOLID elements will be replaced by just a few parameters and indices. This will result in a huge reduction of the keyword input data, and the post-processing data
- A new post-processing database is also created by LS-DYNA that will only store data for elements that has mixed volume fraction data. LS-PrePost will have to support this database

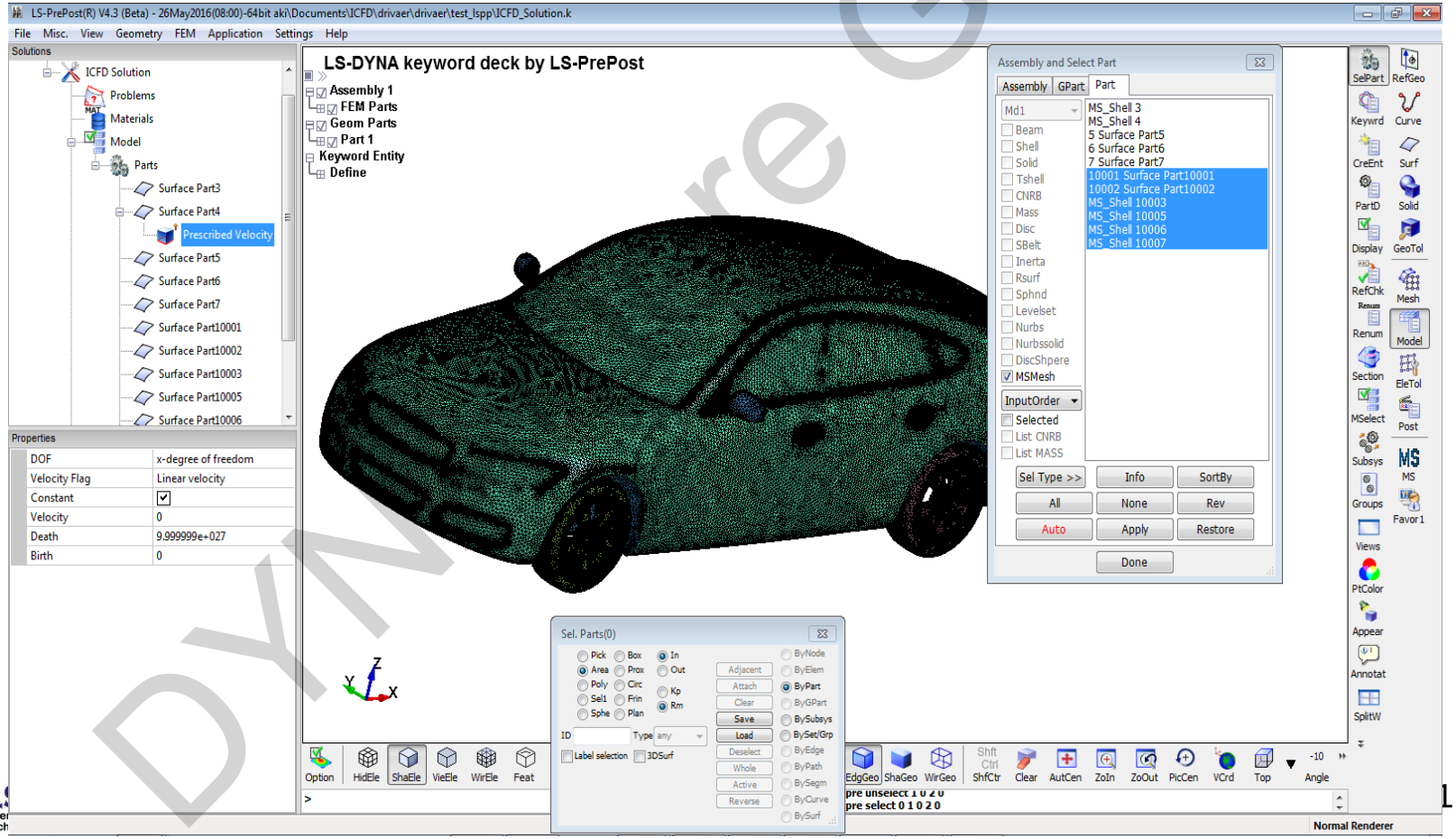


Current Development – One Step Forming

- Onestep forming or inverse forming is used during early stages of vehicle design, development and manufacturing process.
- It is used for initial blank shape estimation and to map plastic strain and thickness in crash simulation
- Amit Nair has developed a Script to automate this OneStep forming process. The process will involve setting up LS-DYNA input file and multiple steps in LS-PrePost and running the script.
- We will incorporate the processes in the script into a single interface in LS-PrePost such that all steps will be done within LS-PrePost and no script will be needed

Current Development – ICFD Pre-Processing

A specific interface in order to set up a CFD input deck is also under development. It follows a similar Tree structure and it aims at providing the CFD user with a friendly environment to define his/her problem and allow easy checking on the models for error and inconsistencies between keywords.



Future Direction

- Old style Interface (F11) will go away in the future version of LS-PrePost which will give a faster startup in GUI and better user interface
- Most of the floating interface dialogs will be dockable
- The entire model data will be represented by a tree structure which provides a better view to the user
- Very little or no LS-DYNA keyword knowledge is needed to create entities and setup a complete model
- Metal Forming will be a separated program which provides complete analysis for stamping applications including pre-, solver, and post-processing

Conclusion

- LS-PrePost has been keeping up with the rapid development of LS-DYNA, both in the post-processing of results and pre-processing of input keyword setup.
- Many features and capabilities were implemented based on users' requests and suggestions
- We are committed to work with our customers to provide the tool they need and reduce the burden of processing the LS-DYNA data
- We are open to advice and happy to listen to our customers for their needs

A User's Comments

"*We build LS-DYNA models in other interfaces but then quickly pivot to LSPP. The reality is that no single interface supports all the capabilities of LS-DYNA* ***better*** *than LSPP. For post-processing, LSPP is super-fast and is amazing with what you can do with it. We enjoy all the really cool things you can do and if there is something you really need from an engineering basis, the team will seriously consider it and most likely implement it. And if you find a bug, the LSTC team will kill it and get you a fixed revision the next week*."

George Laird, PhD, PE,
Principal Mechanical Engineer
Predictive Engineering

FINITE ELEMENT ANALYSIS
Predictive Engineering

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