# PRIMER 21.1

# PRIMER 21.1 – Contents
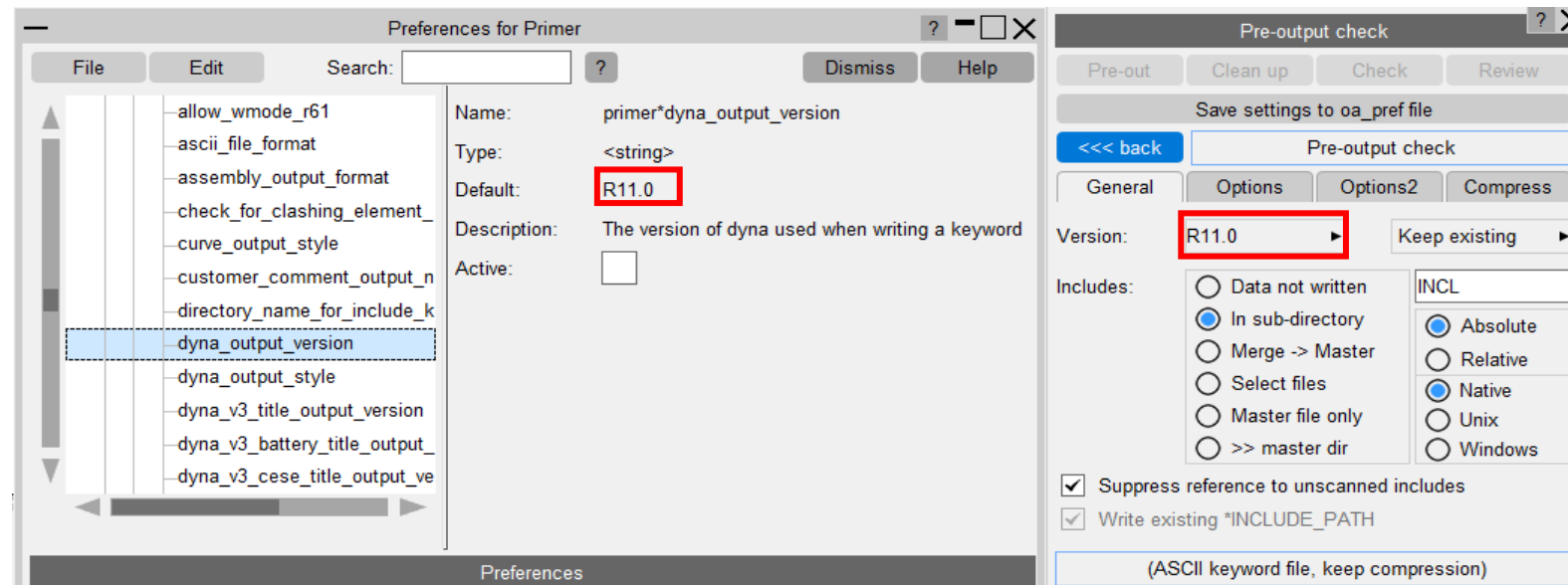
PRIMER

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# Changes to Input and Output

# LS-DYNA Keyword Support
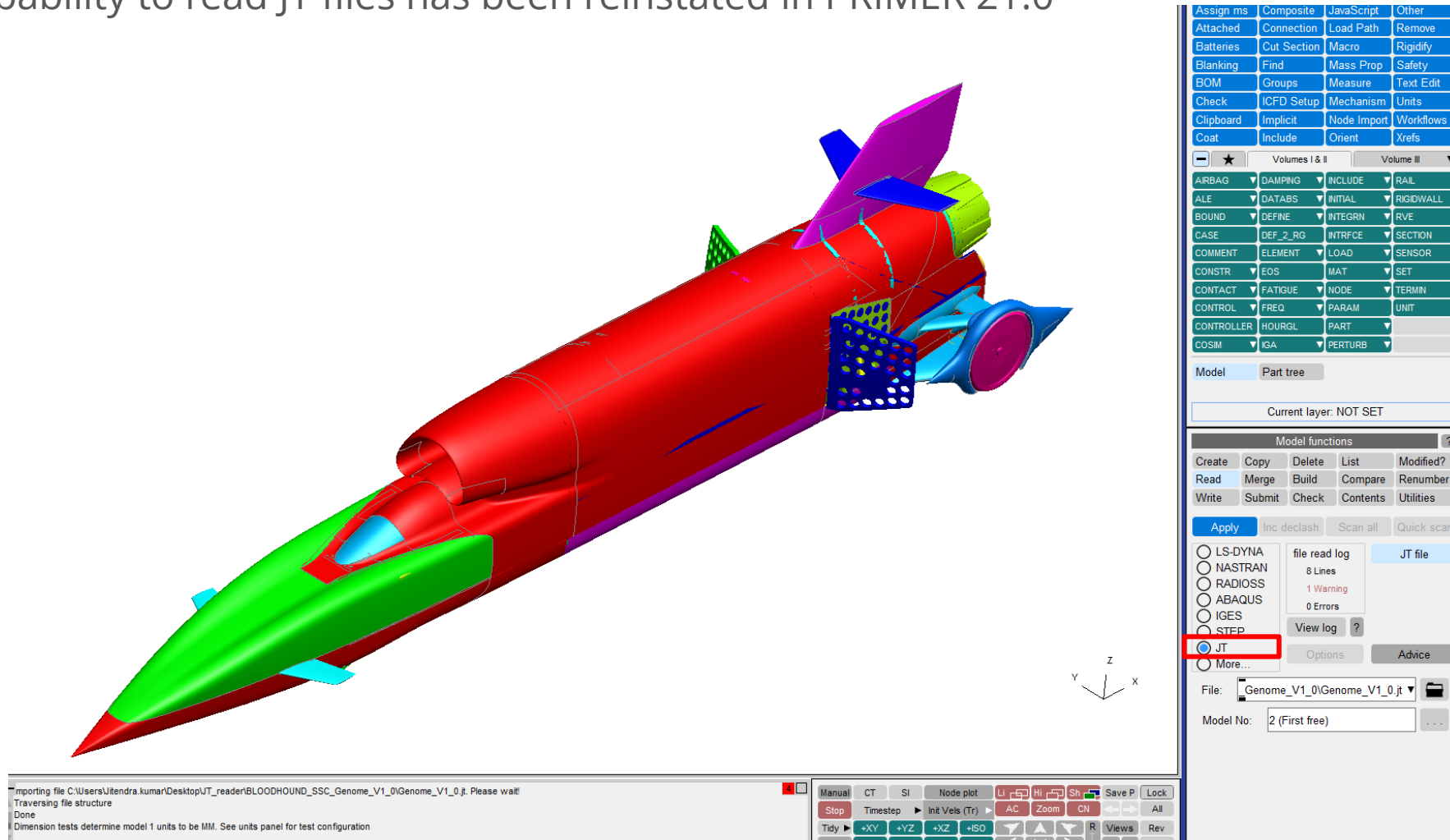
- PRIMER 21.0 keywords:

  - LS-DYNA up to and including R14 fully supported.

  - Some LS-DYNA R15.0 additions and modifications to commonly used keywords supported.

  - Default output version remains R11.0 (later versions including R15.0 can be selected).

# JT™ Reader

# JT Reader

- The capability to read JT files has been reinstated in PRIMER 21.0

# CAD/IGA Rendering Improvements

# CAD/IGA rendering improvements

- Previously, the rendering of curves and surfaces was achieved by discretising them into a fixed number of segments. This led to excessive numbers of trias for small surfaces, which could slow down graphics, and low resolution of curved features for large surfaces.

- Now, this discretisation varies depending on a set of segment sizing and surface matching criteria. This improves resolution of curved features on large surfaces, while reducing trias in flat areas.
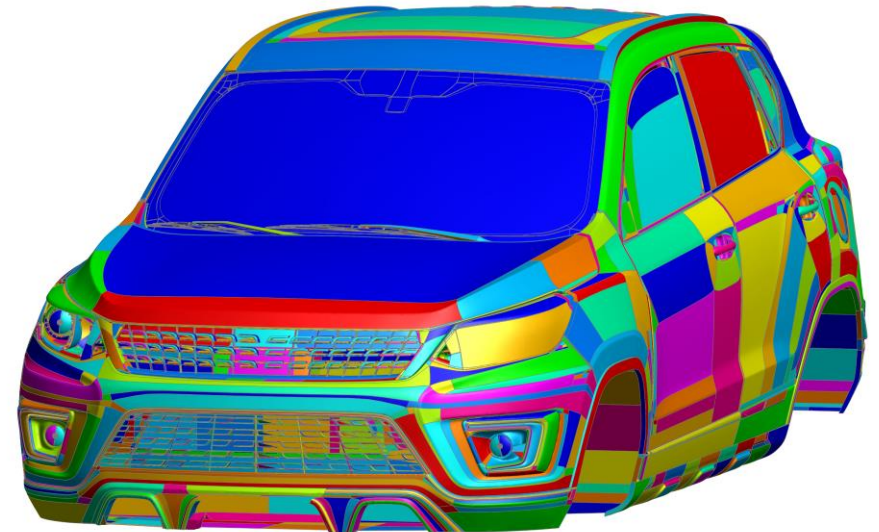
# CAD/IGA rendering improvements

- The sizing criteria can be set via the Display → Options panel:

  - Curve/Surf max seg/edge gives the maximum length of a segment or tria edge, used to render a surface;

  - Curve/Surf min seg/edge gives the minimum length of a segment or tria edge;

  - Max separation gives the maximum separation allowed between a segment/tria and the CAD surface.

- All options are factors of the overall model length: e.g. for a model that is ~1m long a value of 0.01 will yield a length of ~10mm

- All options can be saved as preferences.

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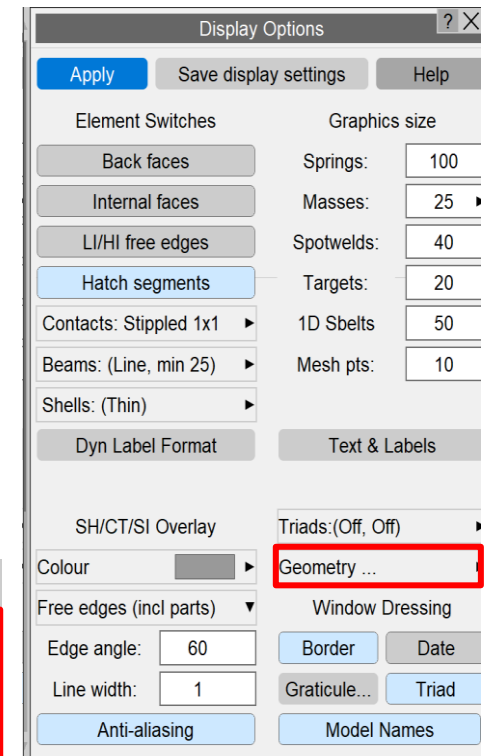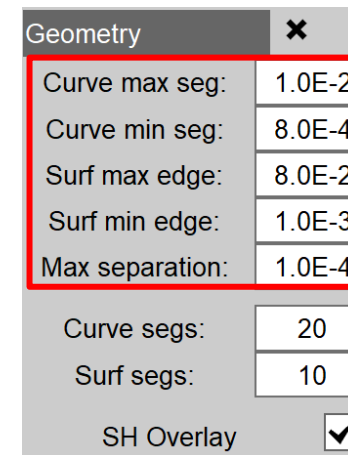
# CAD/IGA rendering improvements – additional improvements

- Previously, reading a STEP/IGES file could produce many errors in the dialogue box if surfaces failed to render.

- Now, these errors have been consolidated and a single error message is printed stating how many surfaces, out of the total number, failed to render.

- To make it easier to visualise which surfaces failed to render, PRIMER can now automatically highlight the trim curves of failed surfaces in a separate model.

- This option is controlled by a preference, `primer*geometry_highlight_failed_surface_boundaries`, which is off by default.

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# DUALCESE and COSIM Includes

# **\*DUALCESE\_<INCLUDE\_>MODEL** and **\*INCLUDE\_COSIM** improvements

- Previous versions of PRIMER would store the filenames specified by **\*DUALCESE\_INCLUDE\_MODEL**, **\*DUALCESE\_MODEL**, and **\*INCLUDE\_COSIM** cards but would ignore the contents of those additional files.

- PRIMER 21.0 affords a similar treatment for these cards as for regular structural includes and ensures the contents of the additional files are also read.

- Include and Part Tree support have also been added.

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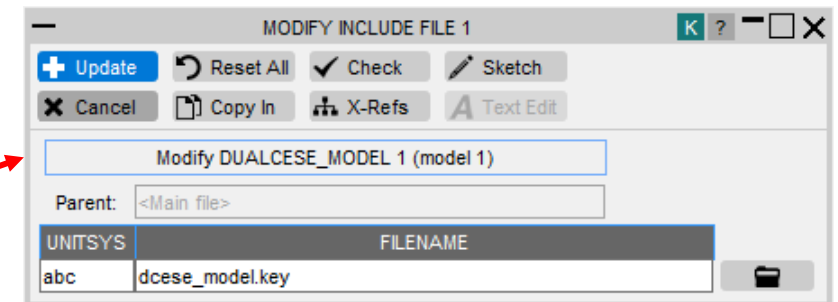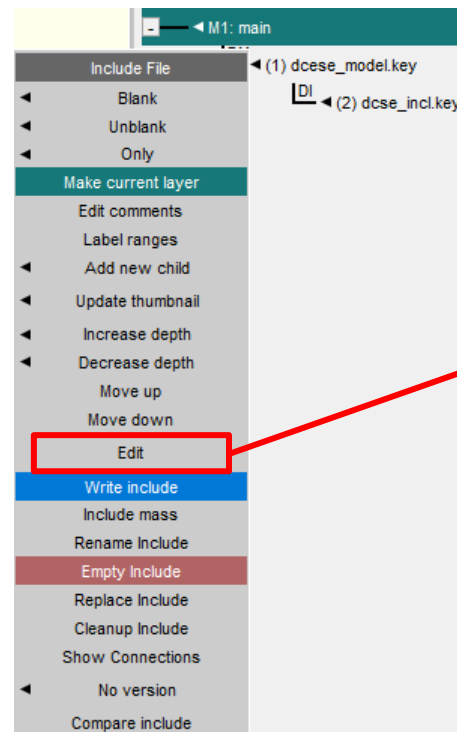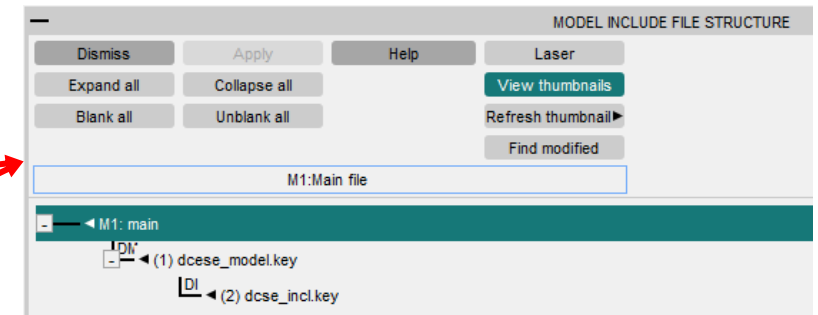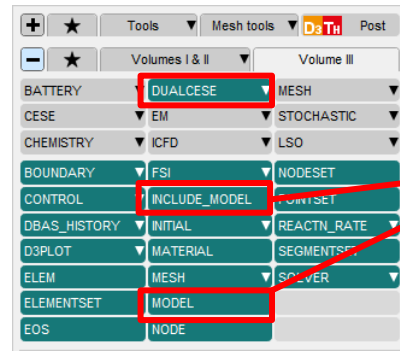
# *DEFINE_CURVE_FUNCTION

# String parsing for **\*DEFINE_CURVE_FUNCTION**
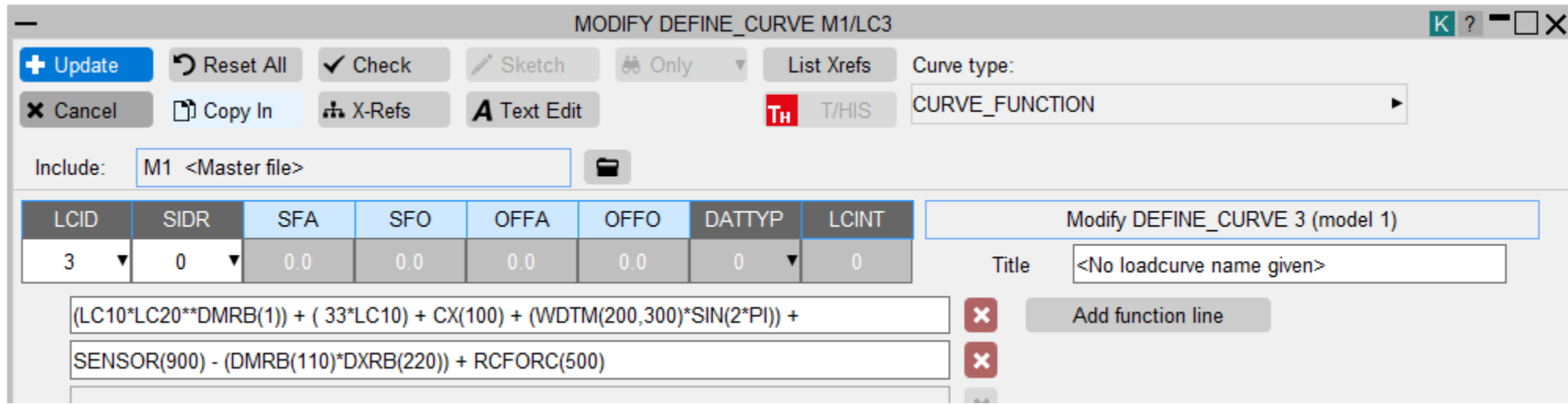


- In previous versions **\*DEFINE_CURVE_FUNCTION** entries were treated simply as a string.

- In PRIMER 21.0 entries are parsed to determine type e.g. node, part, load-curve, etc.

- Cross references to **\*DEFINE_CURVE_FUNCTION**s are created so items cannot be accidentally deleted.

- External label changes of Node, Part, etc. updates the **\*DEFINE_CURVE_FUNCTION** string.

- Check function reports unrecognised tags.

- Parameter usage for labels is supported, e.g. LC&CLAB, SENSOR(&SLAB).

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# Modified Includes and Missing Files in Model Build

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# Writing modified includes

- The following process describes writing modified includes and the meanings of the highlighting colours:

  - Find modified red-lights modified include(s);

  - The master file is always red-lit on assumption that include will be written to a modified name;

  - Write the modified include to an incremented filename Include is now grey lit;
    Write to same name removes red-lighting;

  - Write the master file removes grey-lighting to restore un-modified status.
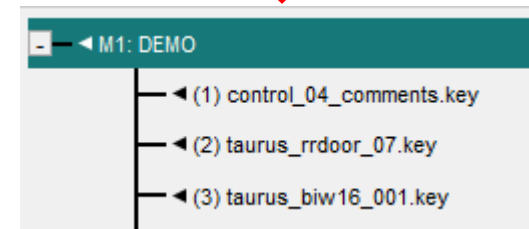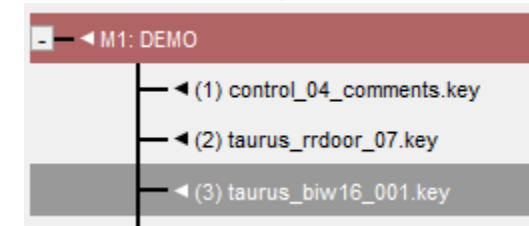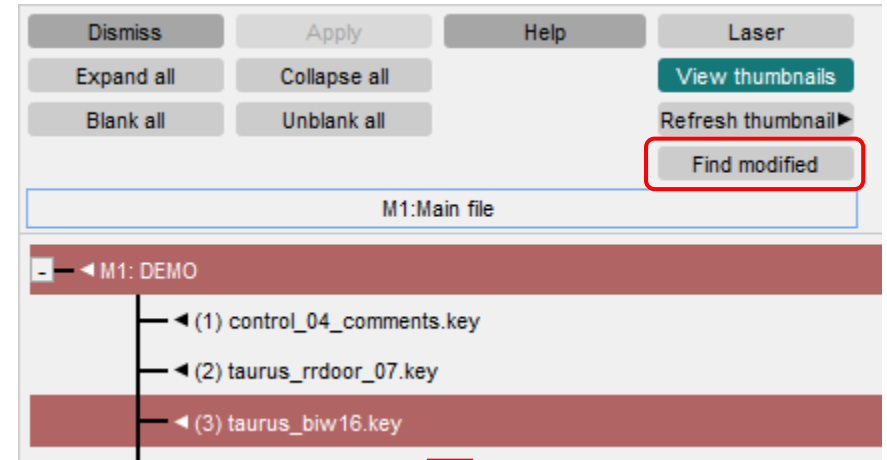
# Detection of missing files for model build (1)
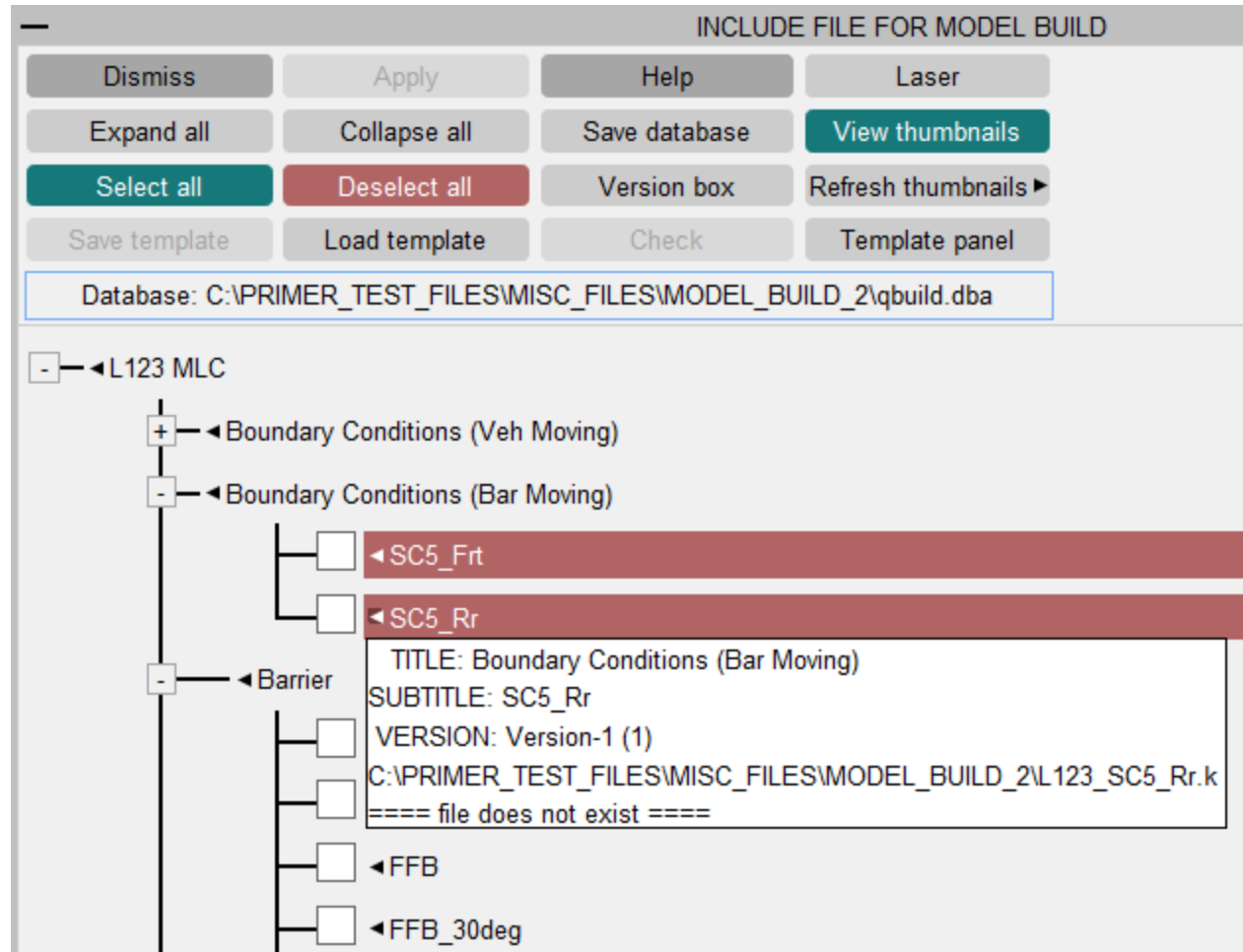


- Model build tree red-lights components when file is missing.

- These components should not be selected for model build.

- Hover text gives full path filename.

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# Detection of missing files for model build (2)
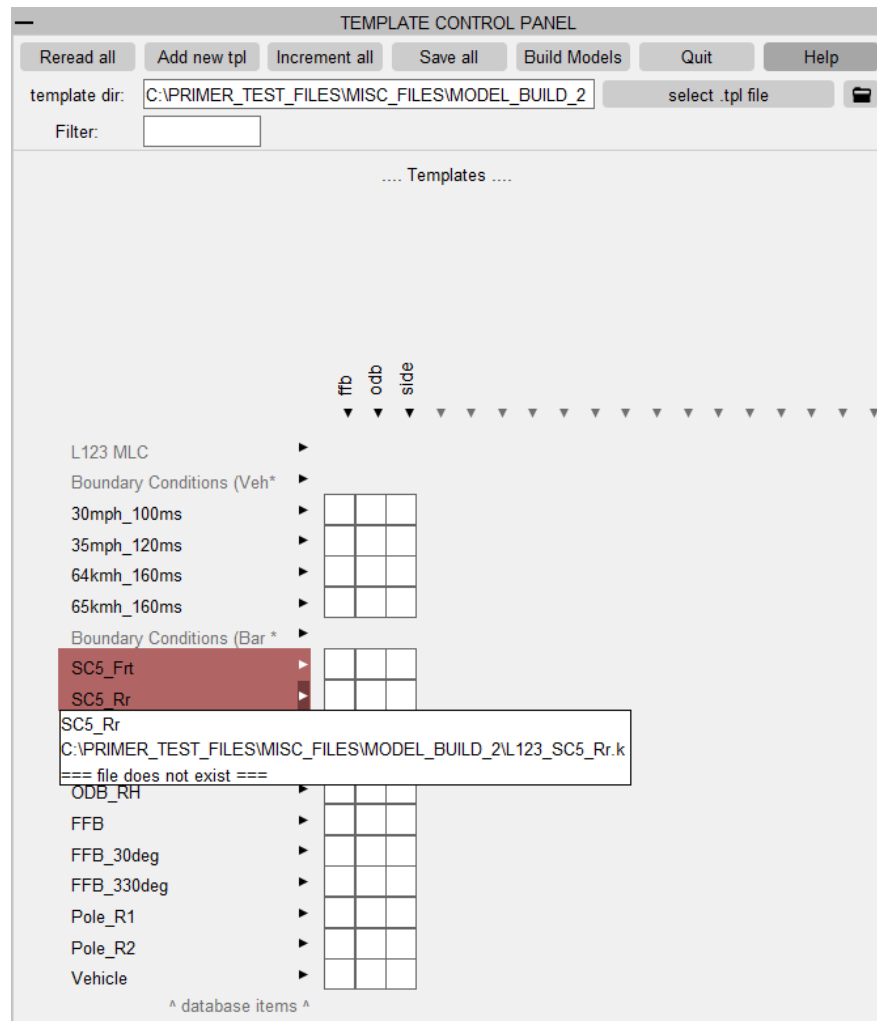


- Model build template panel red-lights components when file is missing.

- Hover text gives full path filename.

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# *SET_PART_TREE in Treeview

# *SET_PART_TREE in Treeview

- ***SET_PART_TREE** is a special type of set that can have:

    - Parts (*negative entries in the set*);

    - Child set part trees (sub-branches) (*positive entries in the set*).

- This keyword was previously supported, but from PRIMER 21.0 the hierarchy is also available in the part tree treeview.
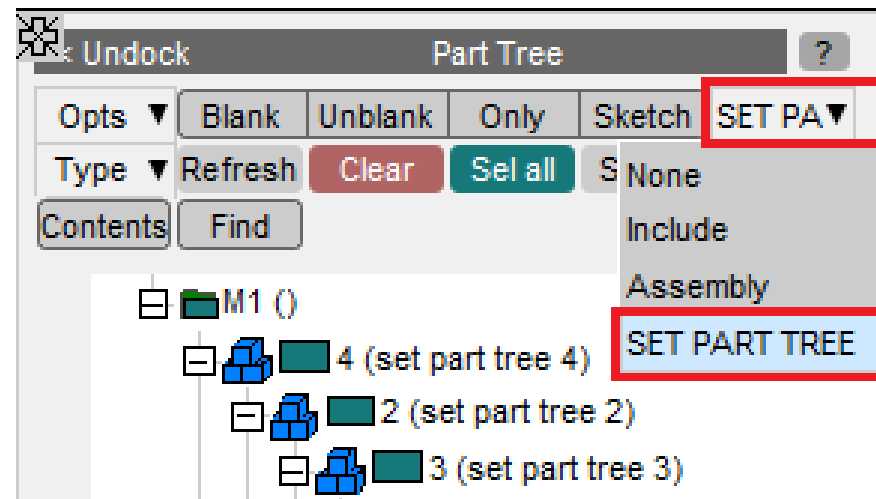
# *SET_PART_TREE in Treeview

- Changes in the keyword editor are automatically reflected in the treeview and vice-versa.

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# Renumber Selection

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# Renumber Selection using "start at label"



- Label clashes can be resolved in any of the following ways using "start at":

  - Move all clashing (unselected) items to above highest label of type;

  - Apply offset to shift clashing labels above the sequential target range;

  - Relabel selected items to first free slot (won't necessarily respect start label);

  - Relabel selected items as a block to the first range that can accommodate them (new PRIMER 21.0 option).

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# Renumber Selection using "offset label"



- Label clashes can be resolved in any of the following ways using "offset":

  - Apply offset after moving all clashing (unselected) items to above highest label of type;

  - Offset selected items as a block to first found free space that can accommodate them (new PRIMER 21.0 option).

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# NASTRAN Support

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# New and modified options for NASTRAN write

- New: Suppress elements for rigid parts

- New: Fix clashing nodal rigid bodies before export

- Tied contact to RBE3 is now on by default

- New: Poisson ratio supplied if uncalculated

- New: Zero length beam/vector "scaled" for NASTRAN compatibility

- New: MAT_169 (Arup Adhesive) converted to MAT_03 parts

| | |
|---|---|
| ✔ | Write HM comments |
| ✔ | Suppress write of elements of rigid parts |
| ✔ | Fix clashing Nodal Rigid Bodies |
| ☐ | Write continuation strings |
| ✔ | Convert tied contact to RBE3 [?] |
| `<?>` | Typical shell edge length |
| ☐ | RBE3 with 2 indep nodes for node on shell edge |
| ☐ | RBE2 if tied node projects onto reference node |
| 0.95 | Qualifying weight factor |
| ☐ | Convert MIG to 2 RBE3s [?] |
| 0.0 | Node Offset % |
| ☐ | Convert MIG to CBUSH [Properties] |
| ✔ | Translate matl with undef poisson ratio |
| 0.3 | Poisson's ratio |
| ☐ | Scale Beam |
| 1.0E-3 | Minimum beam length |
| ☐ | Scale Beam Orient Vector |
| 1.0E-3 | Minimum beam orient vector length |
| ✔ | MAT_169 into new MAT_03 parts by thickness |

# New NASTRAN write-out/reading options

- Translate matl with undef poisson ratio:

  - Materials with no poisson's ratio are translated to MAT_01 with a user defined value for PR. If no value is given, default value of 0.001 is used.

- Scale Beam:

  - Beams are scaled to a user defined value if you check the option ON.

- Scale Beam Orient Vector:

  - Beam orientation vectors are scaled to a user defined value if you check the option ON.

  - If the beam length is zero and the orientation vector is not set, it will be automatically created in the direction that is perpendicular to the beam axis with a unit magnitude.

# New NASTRAN write-out/reading options

- If MAT_67 cards are present in the model and you write out the model in NASTRAN format, you will now be given options to write MAT_67 with stiffness values present in NASTRAN write out → properties panel & save it as a preference or abort the writing process.

- NASTRAN's RBE2 can now be written and read in wide format in PRIMER correctly.

- PRIMER can now read in NASTRAN's PLOAD2 card. They are converted to LOAD_SHELL keywords inside PRIMER.

- MAT_169 into new MAT_03 parts by thickness:
  - Option to correct the stiffness of parts using MAT_ARUP_ADHESIVE. MAT_ARUP_ADHESIVE can adjust the stiffness of elements using the BTHK parameter to account for adhesive being thicker in models than reality. But this stiffness correction is lost when the model is written out for NASTRAN. Now, we move bond elements into different parts with scaled stiffness depending on their thickness.

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# Translation of Rigid Parts to CONM2 + RBE2

- `primer*nastran_write_suppress_rigid_elements: ON`
  - CONM2 created, elements suppressed for all rigid parts

- `primer*nastran_write_rigid_element_limit: N`
  - Rigid bodies with >N elements, RBE2 written only to connected points
  - N = 0, RBE2 written to all (external) nodes of rigid body



LS-DYNA Rigid body + Extra_nodes

N = 0

N = 1

CONM2 + RBE2
all rigid nodes

CONM2 + RBE2
attached nodes
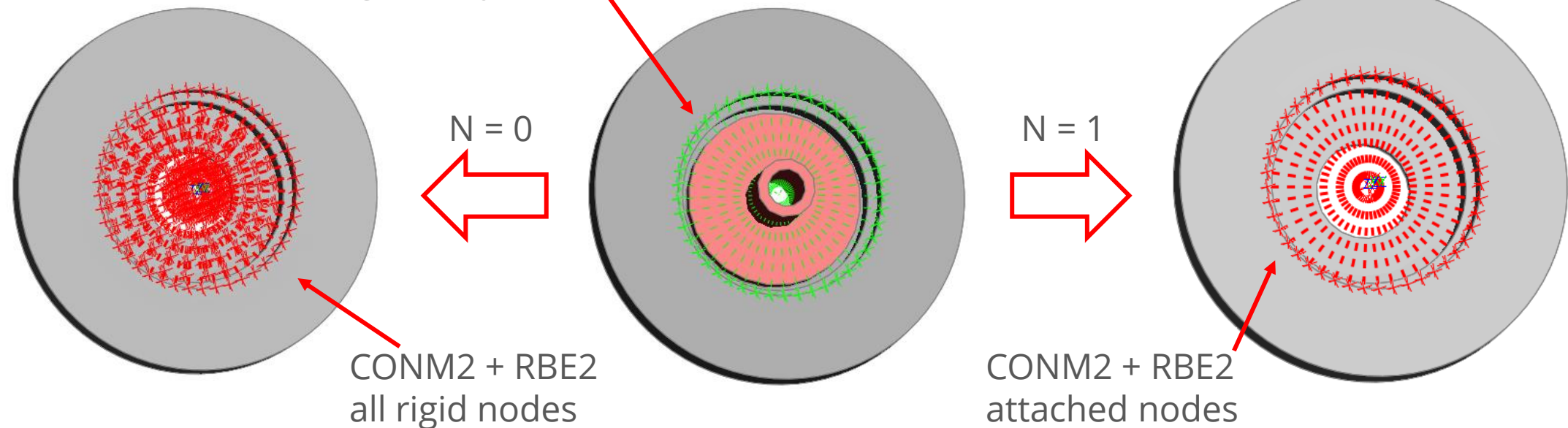
# Include control for RBE3s generated from tied contacts

- RBE3s are created from DYNA tied contact

- A new preference controls the include file for such

  entities:

  `primer*nastran_write_contact_rbe3_placement`

- The following options are possible:
  - `DNODE`: use include of element of dependent node (default)
  - `INODE`: use include of element to which node ties
  - `CONT`: use include of contact

INODE

DNODE

# Precision Improvements

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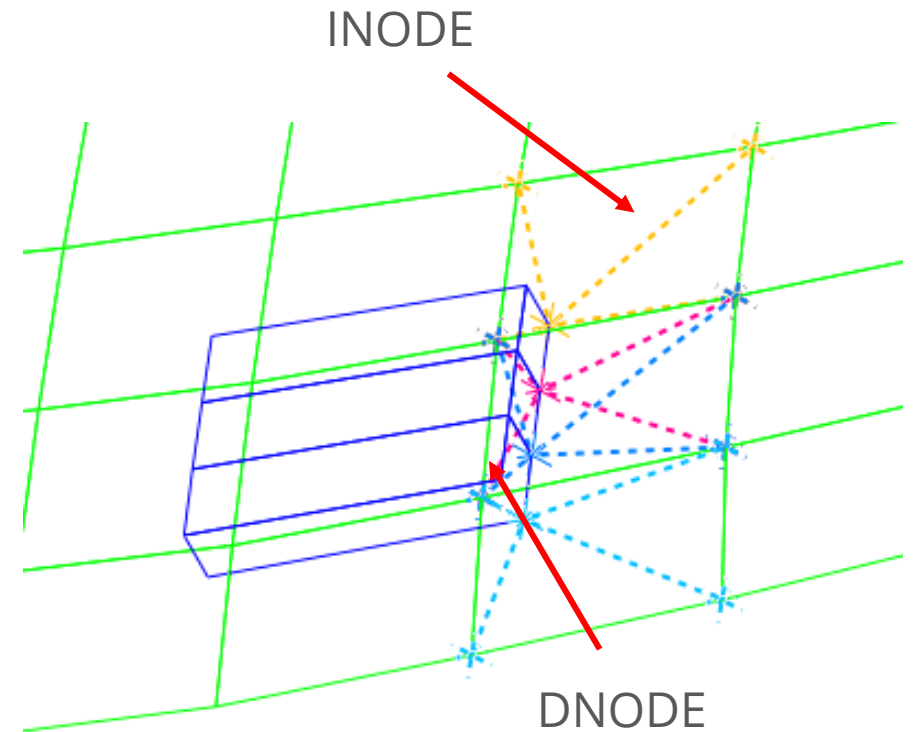
# Precision Improvements: Nodal coordinates

- PRIMER 21.0 now stores all nodal coordinates in 64 bit double precision floats:

| Attribute | Old 32 bit storage | New 64 bit storage |
|---|---|---|
| Mantissa precision | 7 reliable decimal digits<br>8th digit "noisy" | 15 reliable decimal digits<br>16th digit "noisy" |
| Exponent range | Roughly E+/-38 | Roughly E+/-308 |
| Output precision | 8 sig figs by default | 16 wide fields typically give 12 or 13 sig figs plus exponent<br>20 wide fields default to 15 rounded sig figs plus exponent |
| Internal transformations | Used a mixture of double and single precision arithmetic | Now performed entirely in double precision |

- This change has improved the accuracy of internal Orient and Transform operations.

- In addition where PRIMER is part of a workflow it will no longer truncate the precision of coordinates provided at more than 8 digits of precision.

- Memory use for a typical model has increased by typically 3% to 5%; speed is not affected.
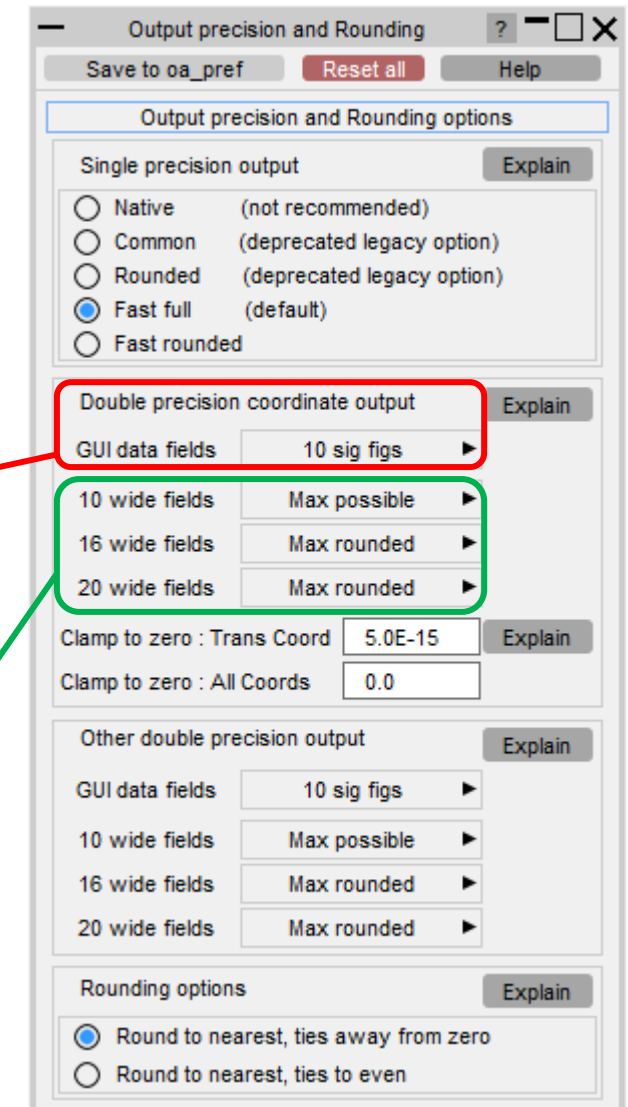
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# Precision Improvements: Nodal Coordinates

- Coordinate precision in the GUI is controllable, the default being to show 10 significant figures (easier for humans!).
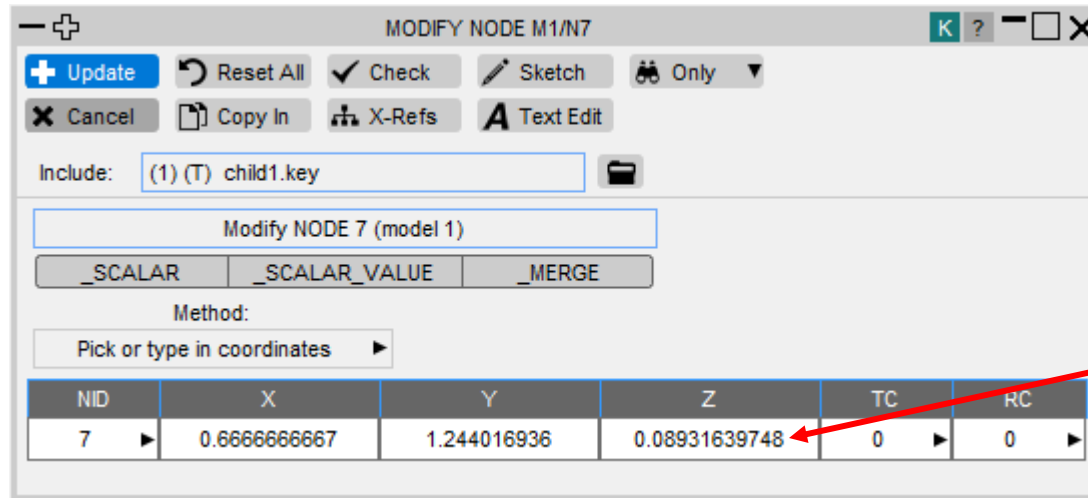


- Coordinate output in the keyword file is separately controlled.

```
*NODE
$:   nid                   cx                   cy                   cz
       7.666666666666671.24401693585629.089316397477040
```
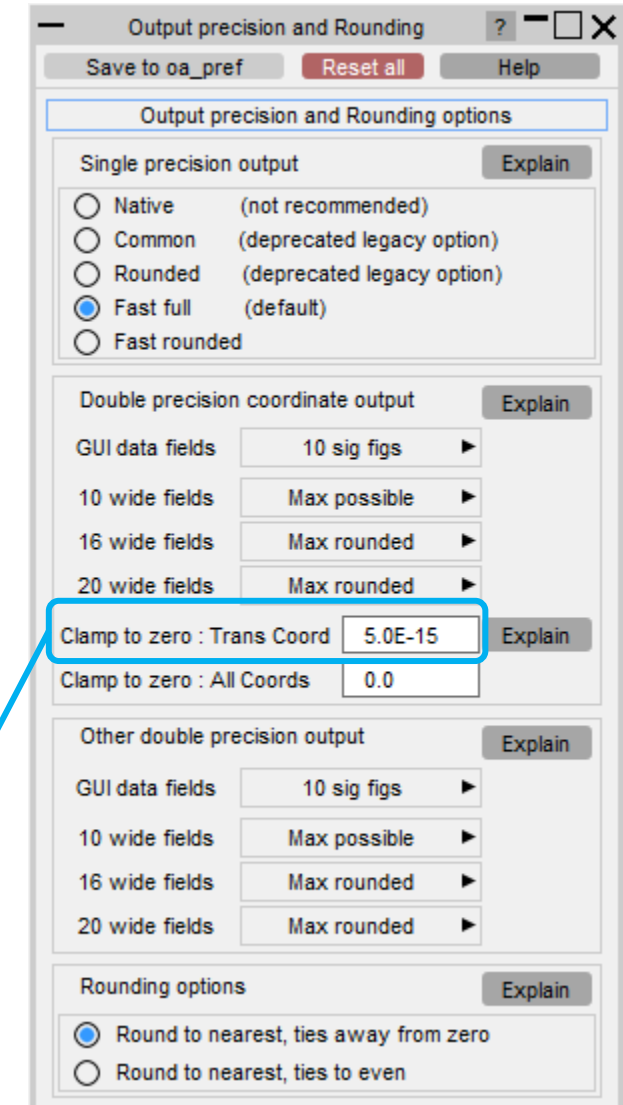
# Precision Improvements: Clamp to zero

- "Clamp to zero" deals with residual errors after transformations.

| Keyword | Read model | Write model | Result |
|---|---|---|---|
| *INCLUDE_TRANSFORM *NODE_TRANSFORM *PART_MOVE | Orient to "as transformed" position | Inverse orient to "untransformed position" | Small differences at the 15th or 16th significant figure |

- For non-zero values any differences at the 15th or 16th sig fig get rounded away when the value is written to a 16 wide field, typically at 12 or 13 sig figs precision. So output equals original input.

- However an initial value of 0.0 that goes through this process may end up as a small residual value, e.g. 1.0e-15, which both looks unwieldy and is a change to the input.

- "Clamp to zero: Trans Coord" clamps transformed nodal coordinates to zero if |coordinate | is <= clamp value.  Default value = 5e-15.
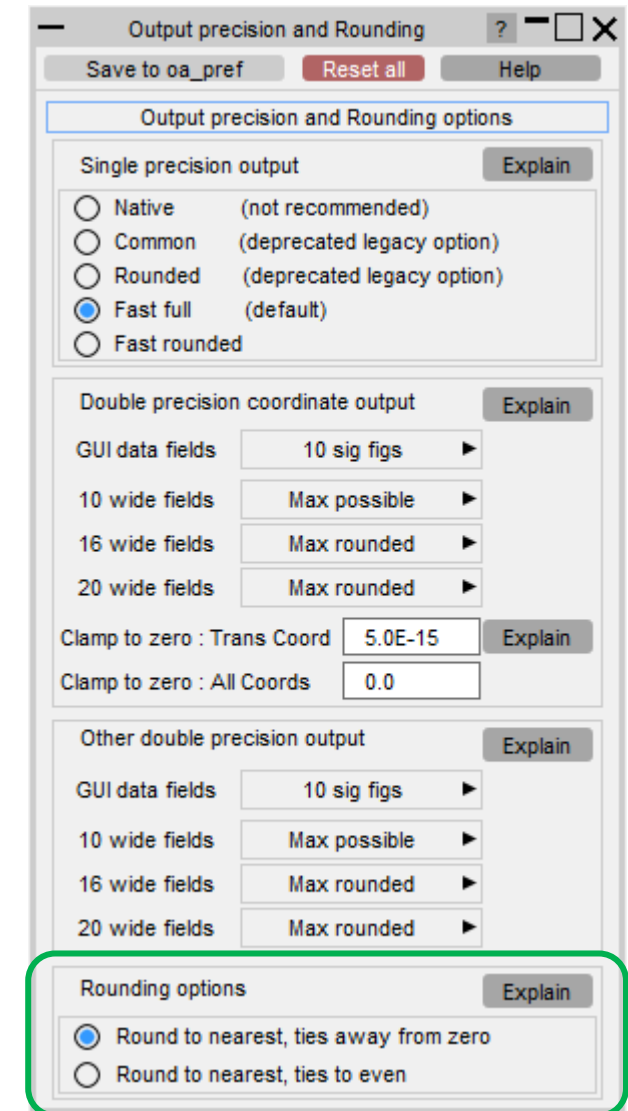
# Precision Improvements: Rounding

- The IEEE 754 standard defines how values should be rounded. In all cases this is "round to nearest value" but this does not address the tied case exactly between upper and lower bounds.

- In this tied case the standard gives two options for decimal values, typical results shown in the table below:

| Value | Tie away from zero (permitted for decimal values) | Tie to even (default) |
|:---:|:---:|:---:|
| +2.5 | +3.0 | +2.0 |
| +3.5 | +4.0 | +4.0 |
| -2.5 | -3.0 | -2.0 |
| -3.5 | -4.0 | -4.0 |

- PRIMER defaults to "Tie away from zero" since it is more intuitive for decimal values, but this can be changed if compatibility with "Tie to even" is required.

# Precision Improvements: Cut section properties
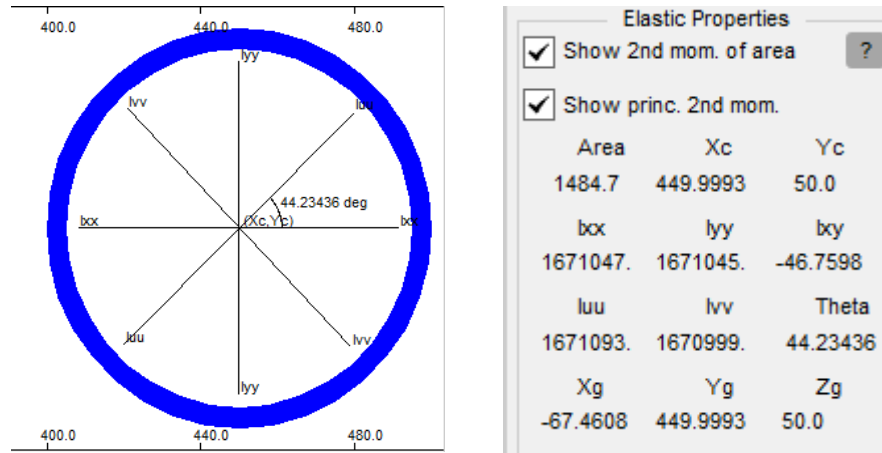


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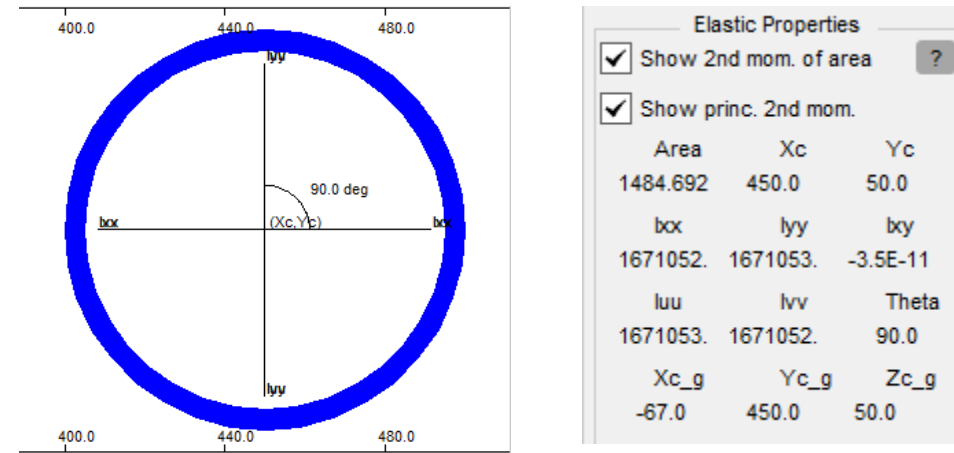


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- The cut section property calculation was mathematically correct but numerically sensitive when the origin of the section was remote from the centre of the piece of structure being cut.

- The doubly symmetric section above should have Ixx = Iyy and Ixy = 0.0 but there is a small error in the PRIMER 20.0 case on the left above.

- In PRIMER 21.0 the calculation is approximately 8 orders of magnitude more accurate.

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# Keyword Editor and Editing Panels

# Keyword Editor

- Previously, in the Keyword editor panel the width of the fields were fixed.

- It was therefore difficult to view fields with long entries, e.g. in the "Incl" and "Suffices" columns.

- Now columns can be resized by clicking and dragging the right edge of the column header.

- Additionally, double clicking resizes the column width to fit the longest entry in the column.
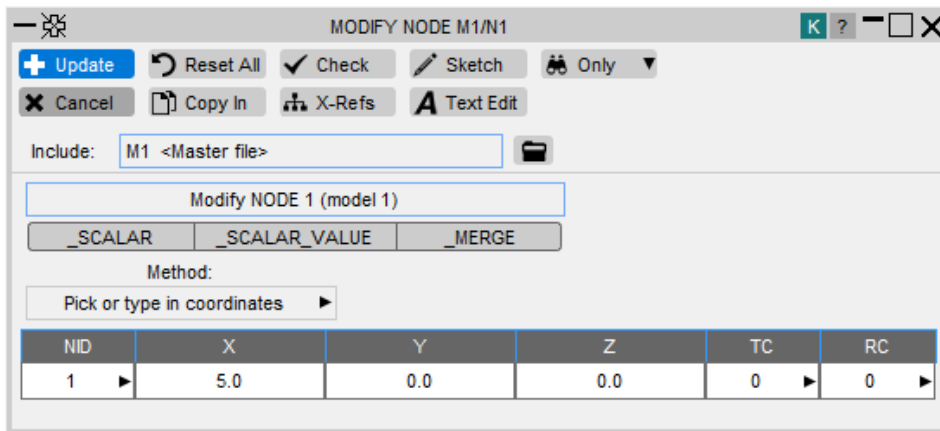
# Keyword Editor

- "Auto fit cols" - Resizes all the column widths to fit the longest entry in the respective column.

- "Reset cols" - Resets all the column widths to the default size.

# Prevention of duplicate editing panels #1

- Historically PRIMER has allowed you to have multiple scalar editing panels open for the same item which has the potential to cause confusion:





**First editing panel on Node #1**

Changes made here and saved…
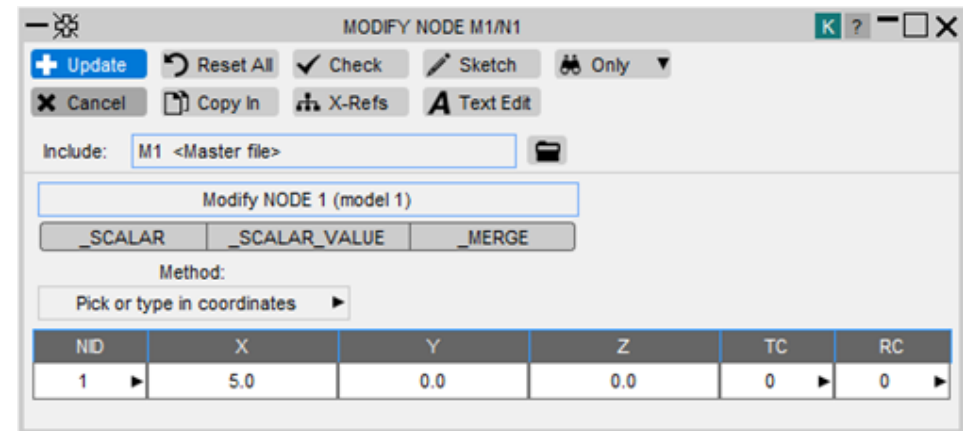
**Second editing panel on Node #1**

… will be overwritten if this panel is then closed and saved.

# Prevention of duplicate editing panels #2

- The default behaviour is now that the second and subsequent editing panels opened on an item will be in read-only "browse" mode which will not modify the definition:
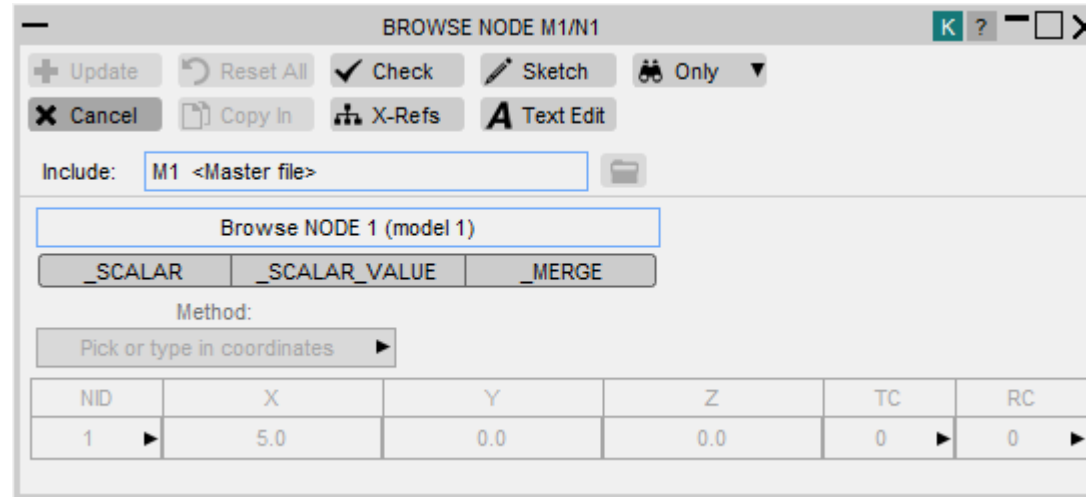


- This default can be changed in **Options, Panel behaviour**
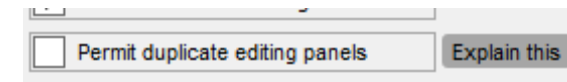


- It can also be controlled by preference `primer*permit_duplicate_edit:` `true | false`

# Changes to User Interface

# Initial View

- You can now control the initial view when PRIMER opens. By default, PRIMER opens with a plan view, +XY. If you wanted to change this to an elevation +XZ, for example, you can now change the default by setting the preference:

```
primer*initial_view_orientation: +XZ
```

Default +XY view



+XZ view set via preference

# Ambiguous Pick Behaviour

- When enabled, the ambiguous pick menu is displayed if multiple entities are close to the clicked location.

- From PRIMER 21.0 this is switched off by default, apart from for plies.

- The menu can be switched on with preference `primer*query_ambiguous` or via Options → Pick & Select opts → Ambiguous pick menu.
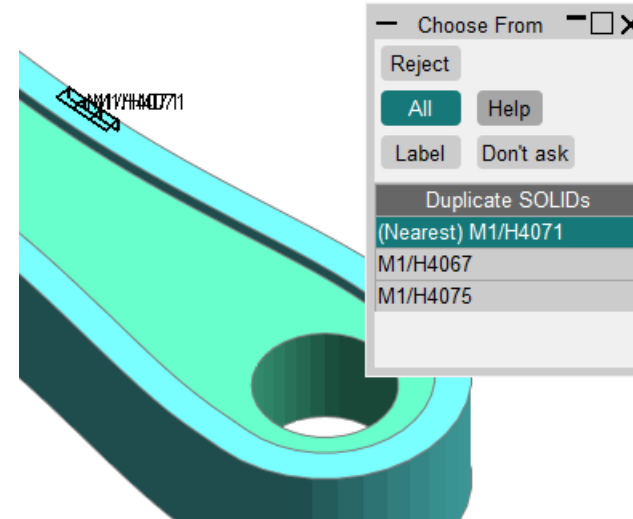
# Object Menu Expansion Behaviour

- In previous versions, object menus were set to auto-undock by default. This behaviour has been modified.

- From PRIMER 21.0, expansion and undocking are turned OFF by default.

- This behaviour can be controlled using the preference `primer*menu_expand` or via Options → Panel Behaviour → Expand menus
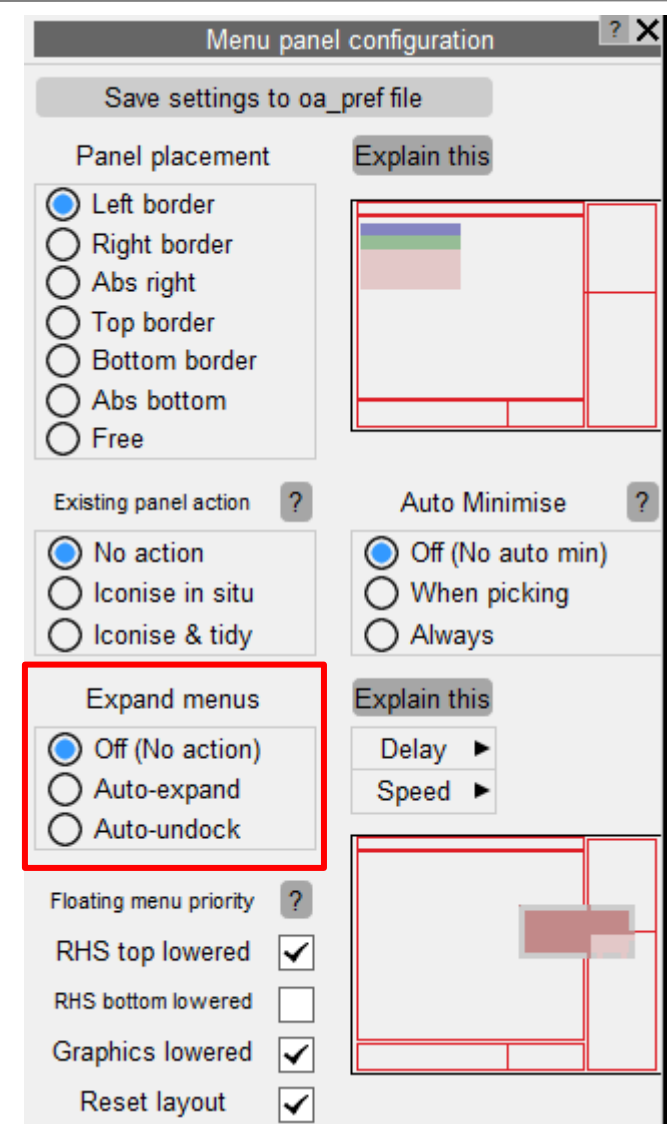
# Screen Pick / Vis menu

- When entities are screen-picked, the Screen Pick menu is auto-populated and gives you further information on the entities picke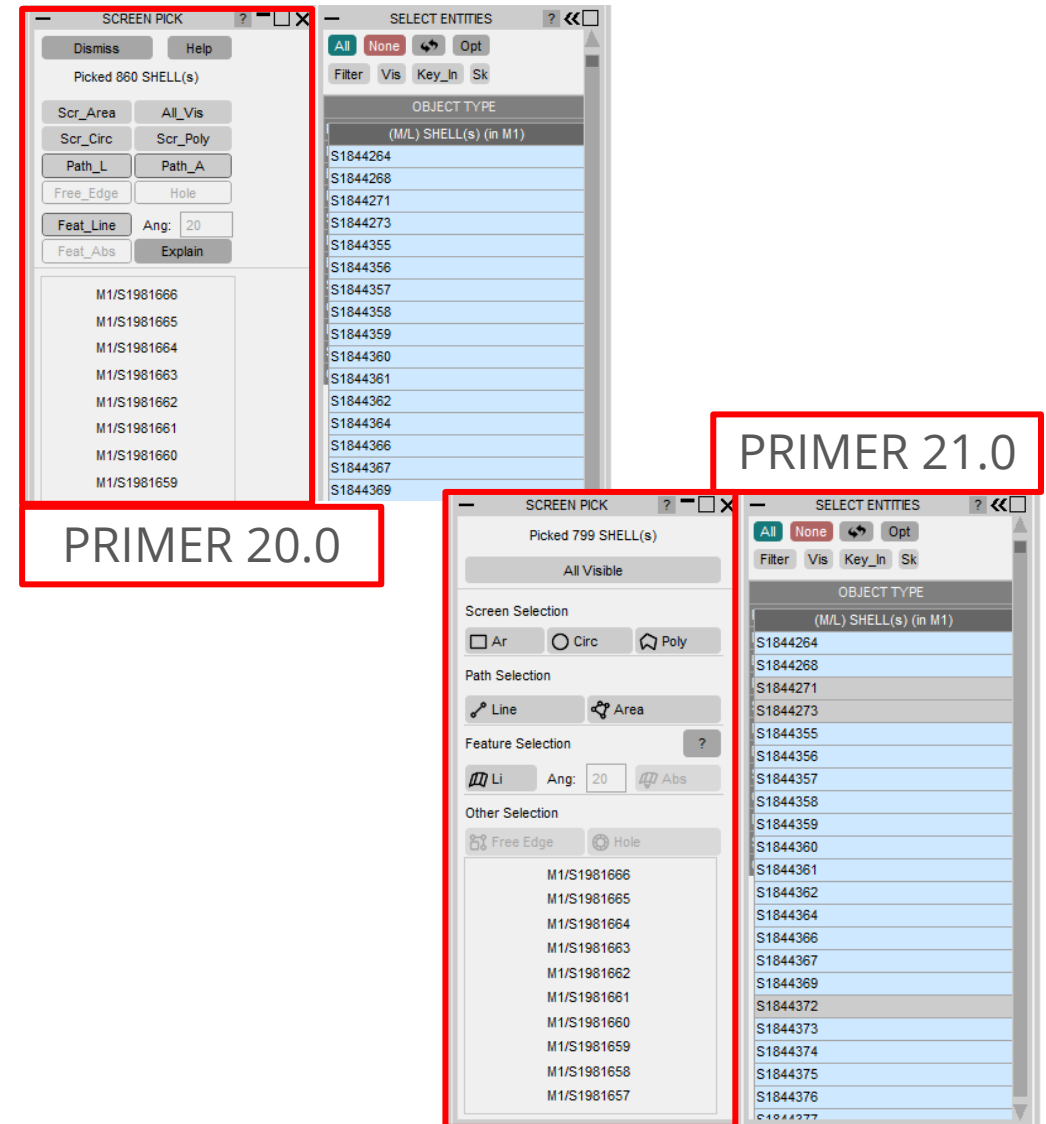d. This menu also includes options to refine picking and can be explicitly invoked by clicking **Vis** in any object menu.

- The **Vis** (screen pick) menu has been redesigned to make various options more accessible and intuitive. Buttons have been reorganised, icons introduced, and hover text added.
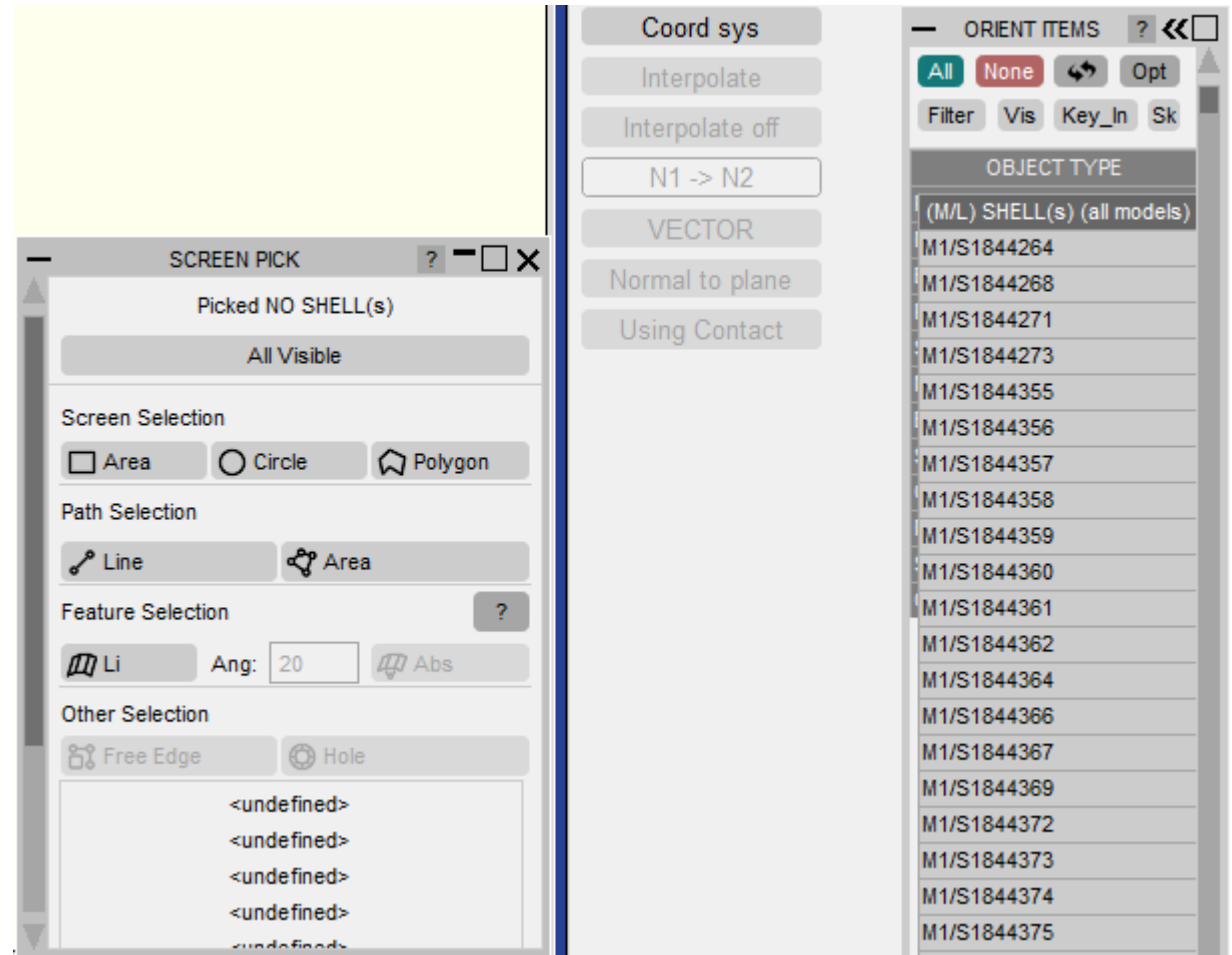


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# Screen Pick / Vis menu

- By default, the updated screen pick menu is displayed as a docked menu as it was in previous versions but can, optionally, be made a floating menu by setting the preference `primer*vis_menu_position` and giving it the value "FLOATING"



Floating Vis menu

# Swap Foreground and Background

- A quick way to change the foreground and background colour has been introduced by adding a **Swap Fore/Back** button under the Display menu.

- This feature has also been added to the Programmable Shortcut Keys list so it can be assigned a shortcut key.

Graphics with White Background ➡ Display → Swap Fore/Back ➡ Graphics with Black Background
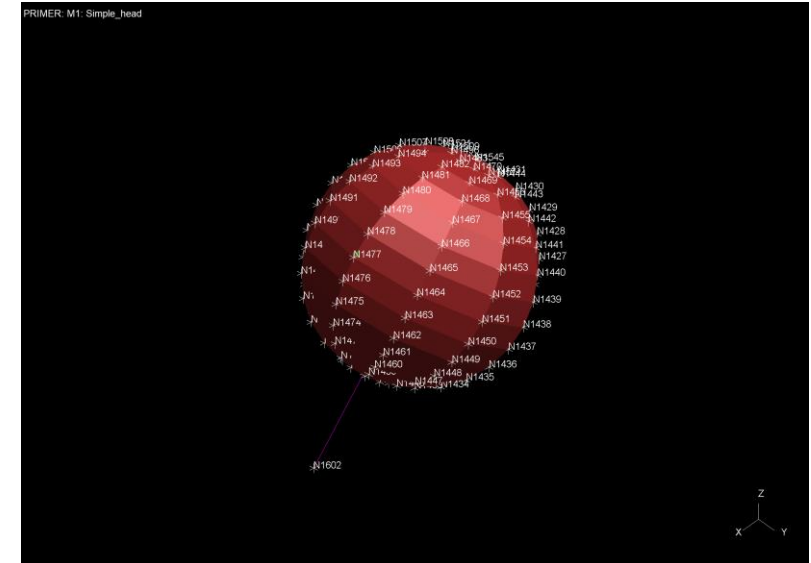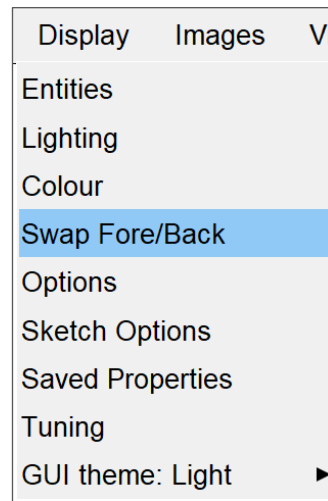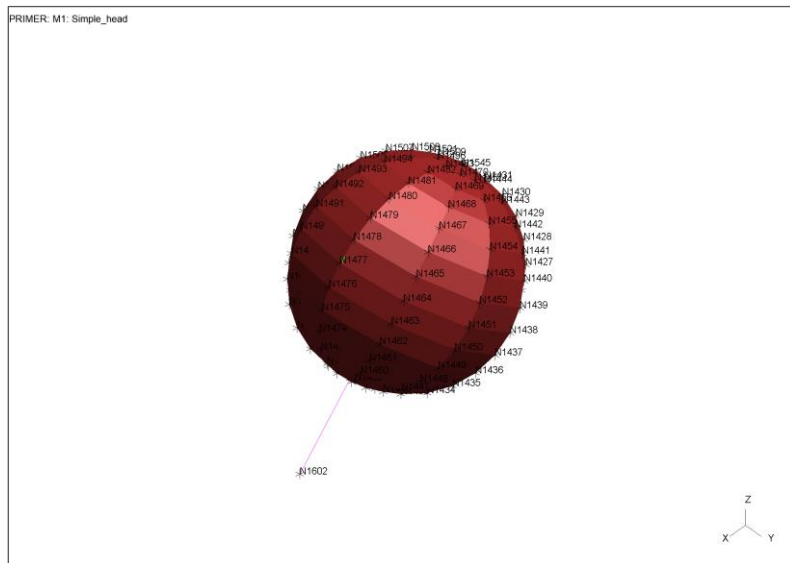
# Controls for graphics text and labels
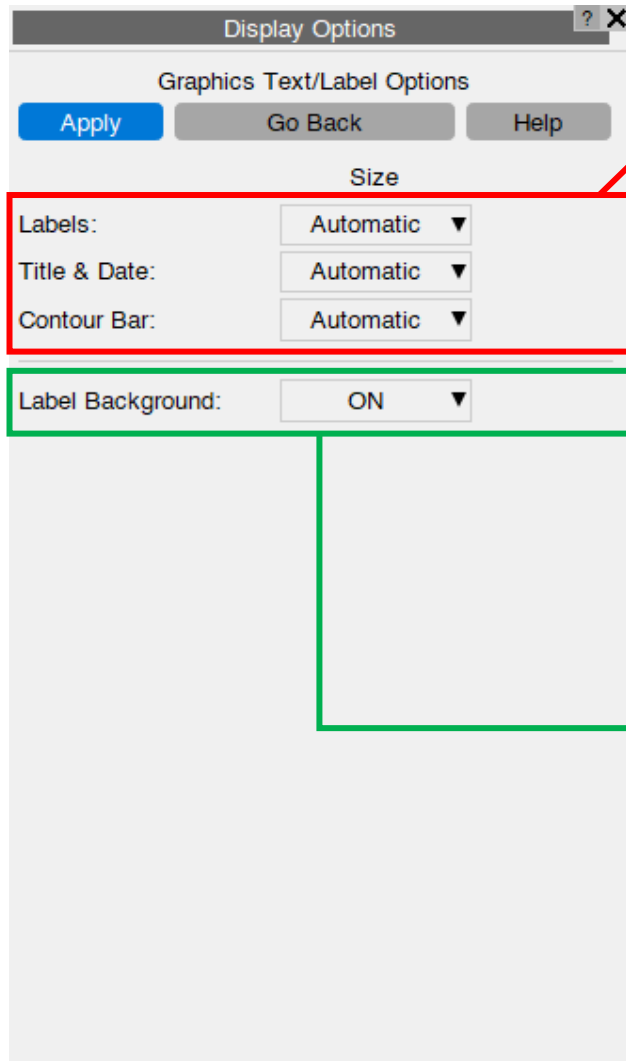


- Controls for the appearance of text and labels in the graphics window have been updated to be more consistent with the rest of the Oasys Suite. New options can be found under

  Display → Options → Text & Labels.

- Now, by default, text in the graphics window will scale with the window.

- Alternatively, a point size can be specified, and text size will remain fixed.

- Controls to toggle the label background on/off. Display for label background is set to 'ON' by default.

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# Label Background

- Labels now have a background to increase the legibility of the text.

- The background can be turned off in Display Options → Text & Labels → Label Background or by setting a preference: `primer*label_background`.
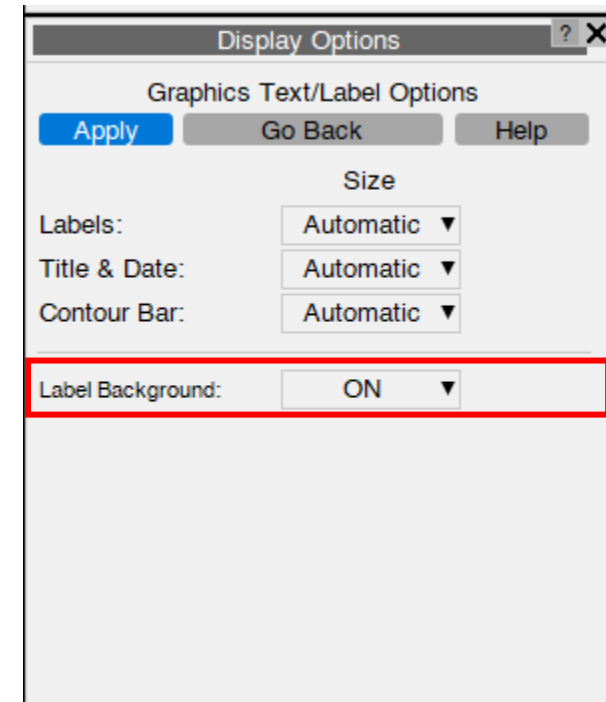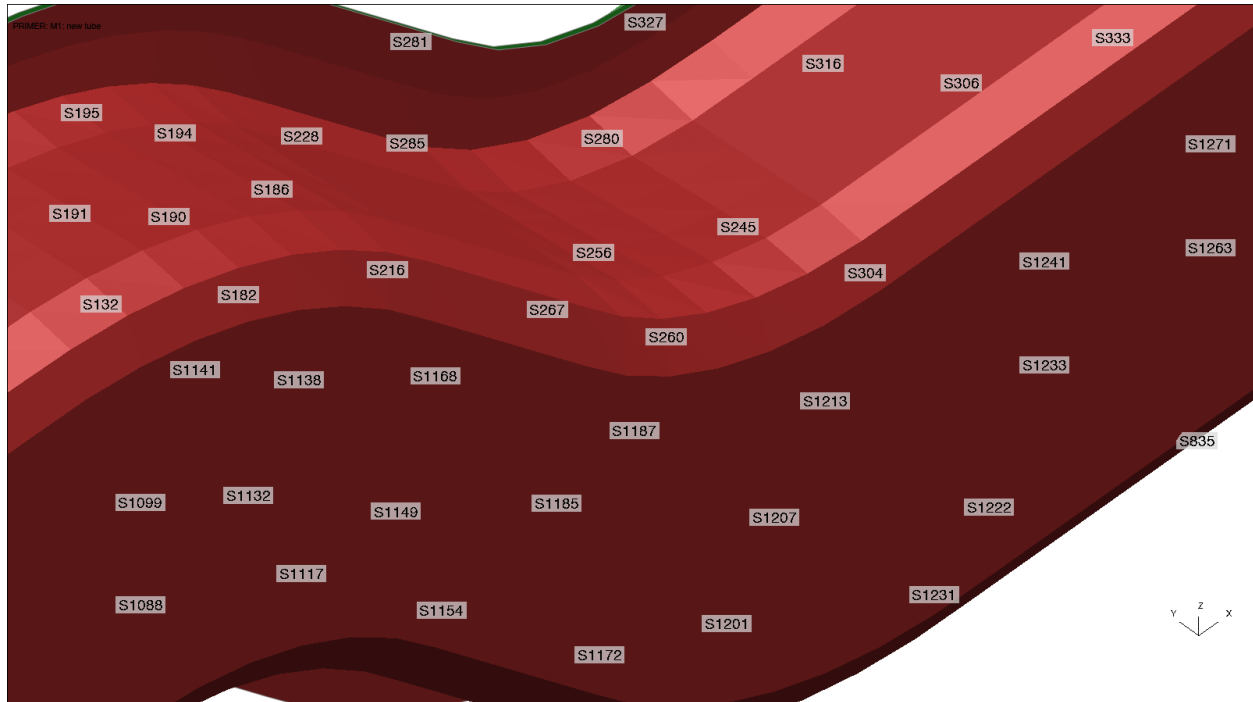
# Additions to Quick Pick

- ICFD_PART and ICFD_PART_VOL are now available in Quick pick and for visual selection in object menus.
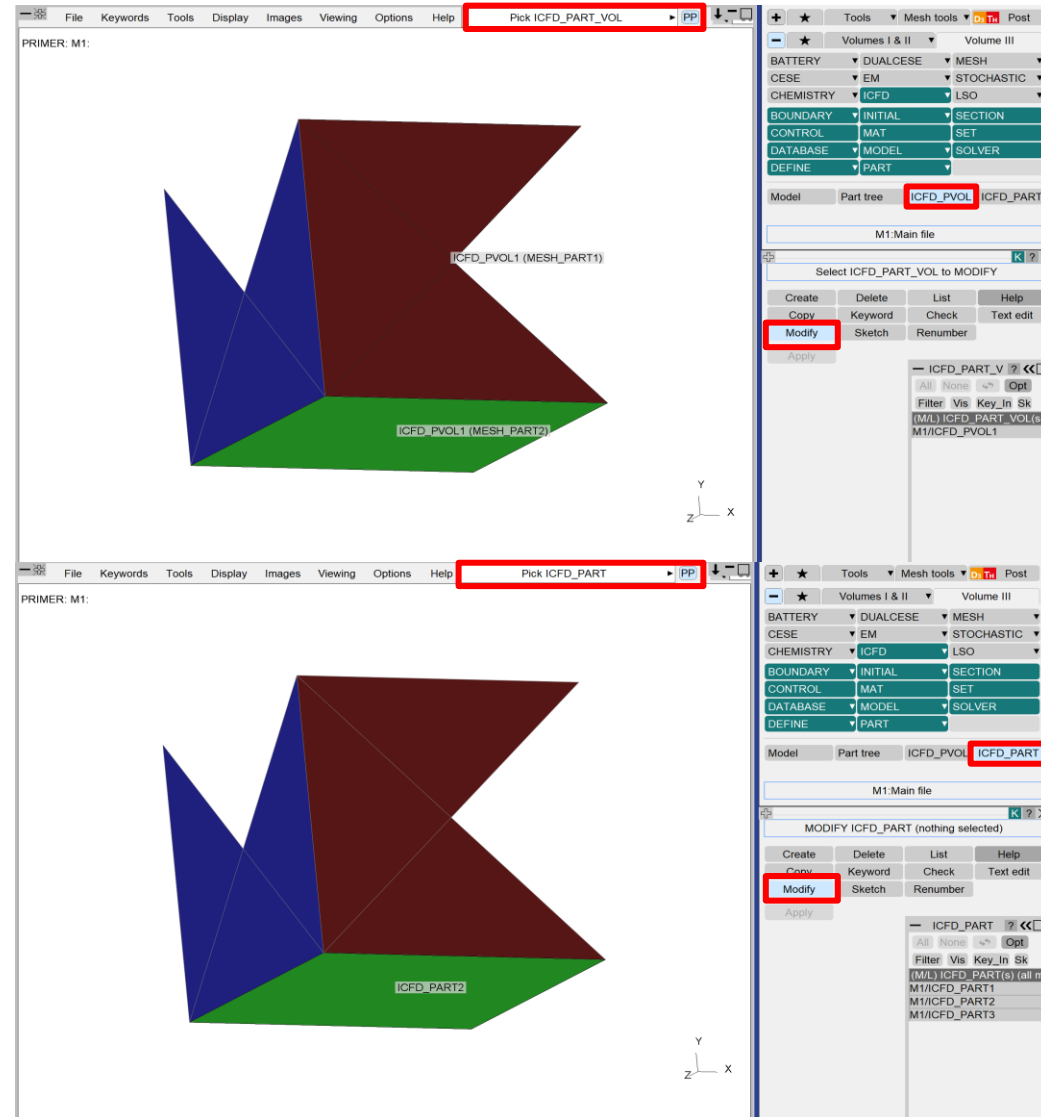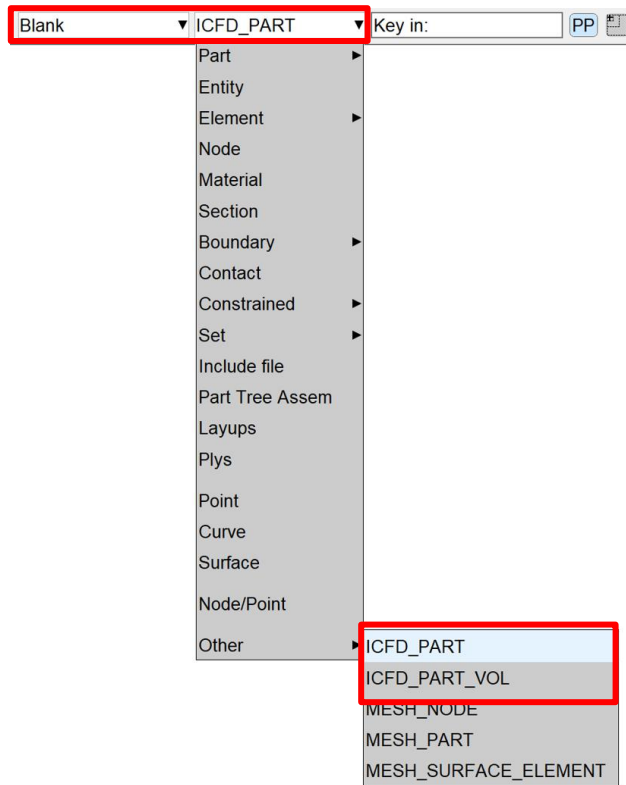
# Favourite Tools & Keywords
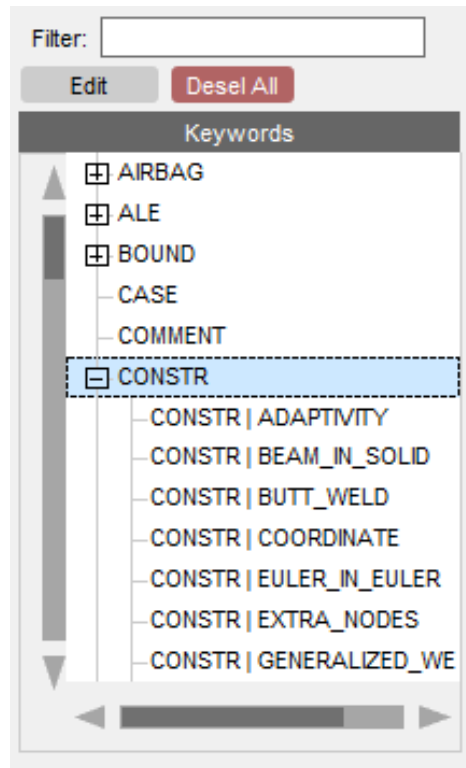


- When selecting from existing Tools and Keywords buttons to add to your Favourites, the options are now displayed in a tree widget to provide a better representation of the existing structure and better support non-ASCII characters in button names.

- Additionally, the maximum number of buttons that can be added to your Favourite Tools or Keywords is increased to 100.

# Per-Monitor DPI Awareness

(Windows platforms only)

# Per-Monitor DPI Awareness

- Windows 10 allows monitors of different resolutions to be used on a single desktop. For example, when a high-resolution laptop is attached to a lower-resolution monitor, you will see something like this in Windows "Display Settings":

## Rearrange your displays

Select a display below to change the settings for it. Press and hold (or select) a display, then drag to rearrange it.

**Desktop monitor using 1920 x 1200 on a 24" screen has a DPI value of ~96**

**Laptop at 3840 x 2400 resolution on a 15" screen has a DPI value of ~240**

2

1

*Oasys*
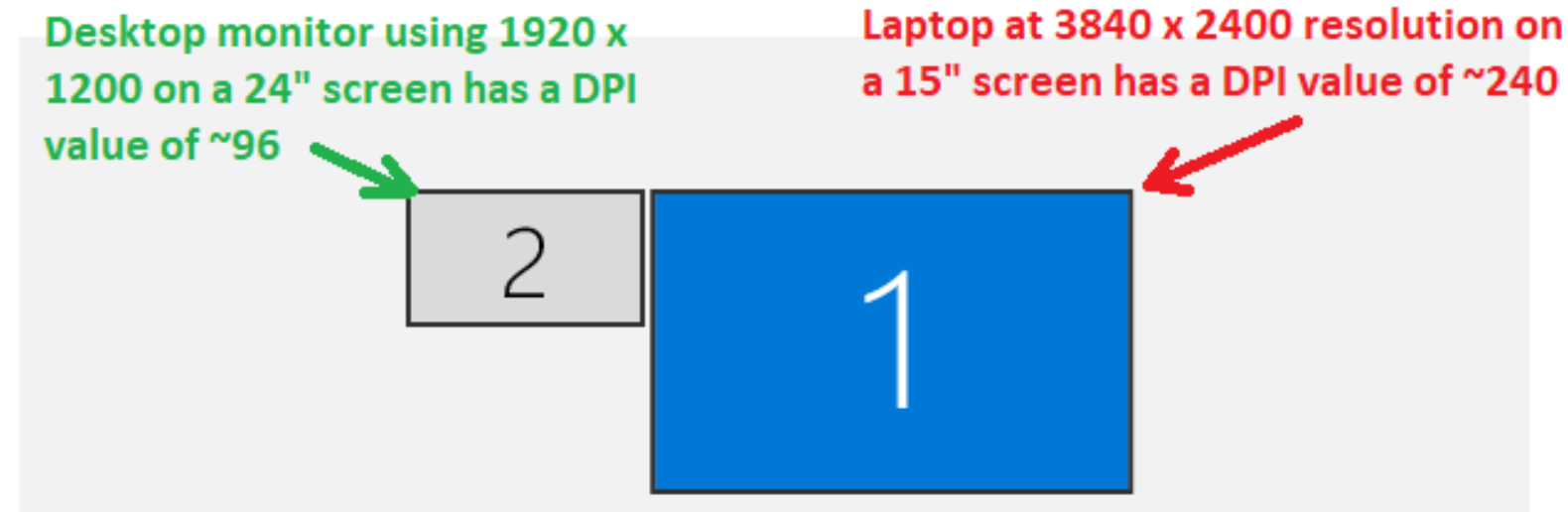
# Per-Monitor DPI Awareness

- When the monitors have very different Dots Per Inch (DPI) values, windows will look either "too big" or "too small" when moved to a different monitor unless the application adjusts its fonts and other scaling. This was a problem with Oasys Ltd software before Oasys Suite 21.0.
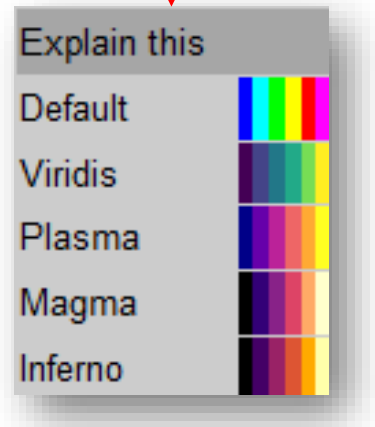
- From Oasys Suite 21.0 onwards, Oasys Ltd applications will detect when they are moved to a different monitor and will resize themselves and their contents to fit correctly. Specifically:

  - The master application window will resize;

  - Fonts will resize;

  - Line widths and spacing in the user interface will resize.

- The appearance may not be identical, since fonts scale in integer steps of point size, but it should be close. Bear in mind that images are captured at the resolution of the monitor so consider this when creating images.

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# Data Plotting

# Data plotting – Contour Ramp Options

- New contour ramp colour options have been added to the contour LEVELS panel in PRIMER 21.0

- There are currently 5 options:

  - Default

  - Viridis

  - Plasma

  - Magma

  - Inferno

- The image on the right currently shows the default rainbow ramp

# Data plotting – Contour Ramp Options



Viridis

Plasma

Magma

Inferno

Oasys
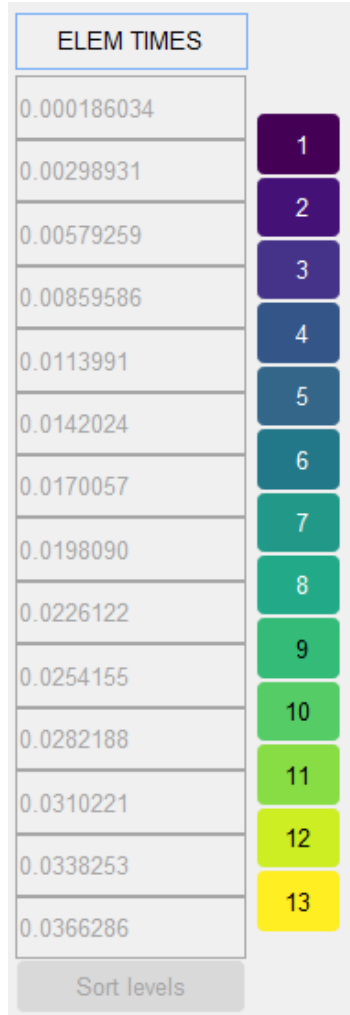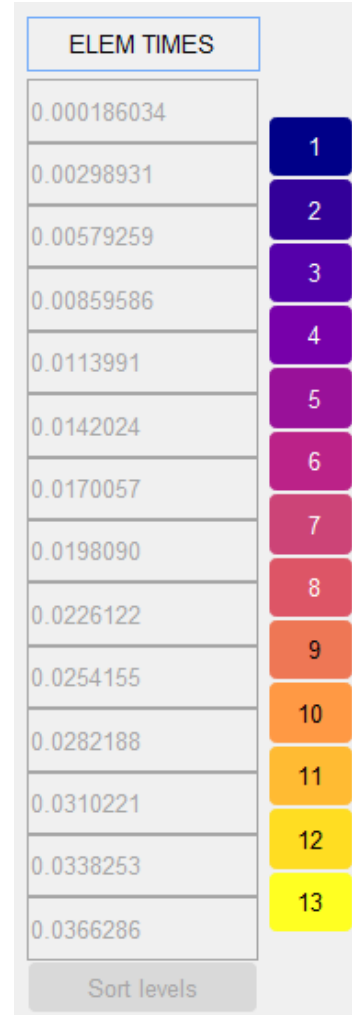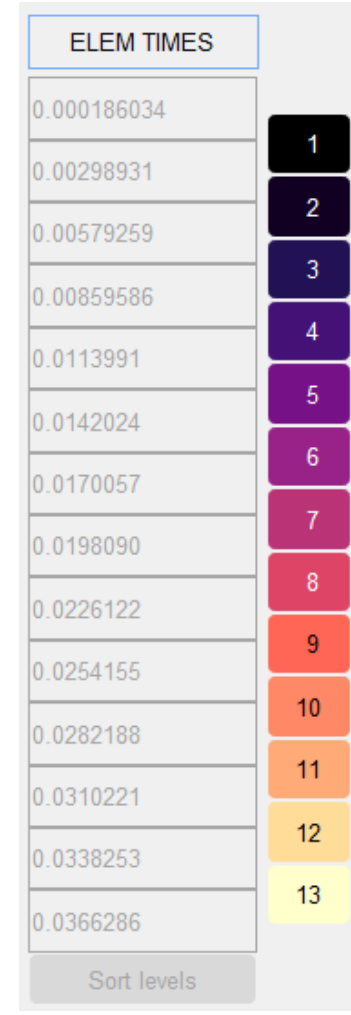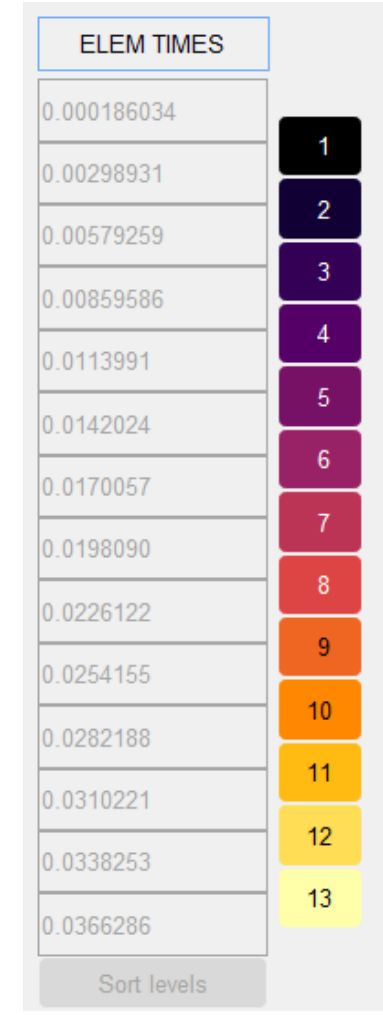
# Data plotting – Contour Level Options

- A new radio button for contour level options has been added to the contour LEVELS panel in PRIMER 21.0

- There are currently 2 options:
  - Automatic levels (default)
  - User-defined levels

- The image on the right currently shows the "Automatic levels" mode
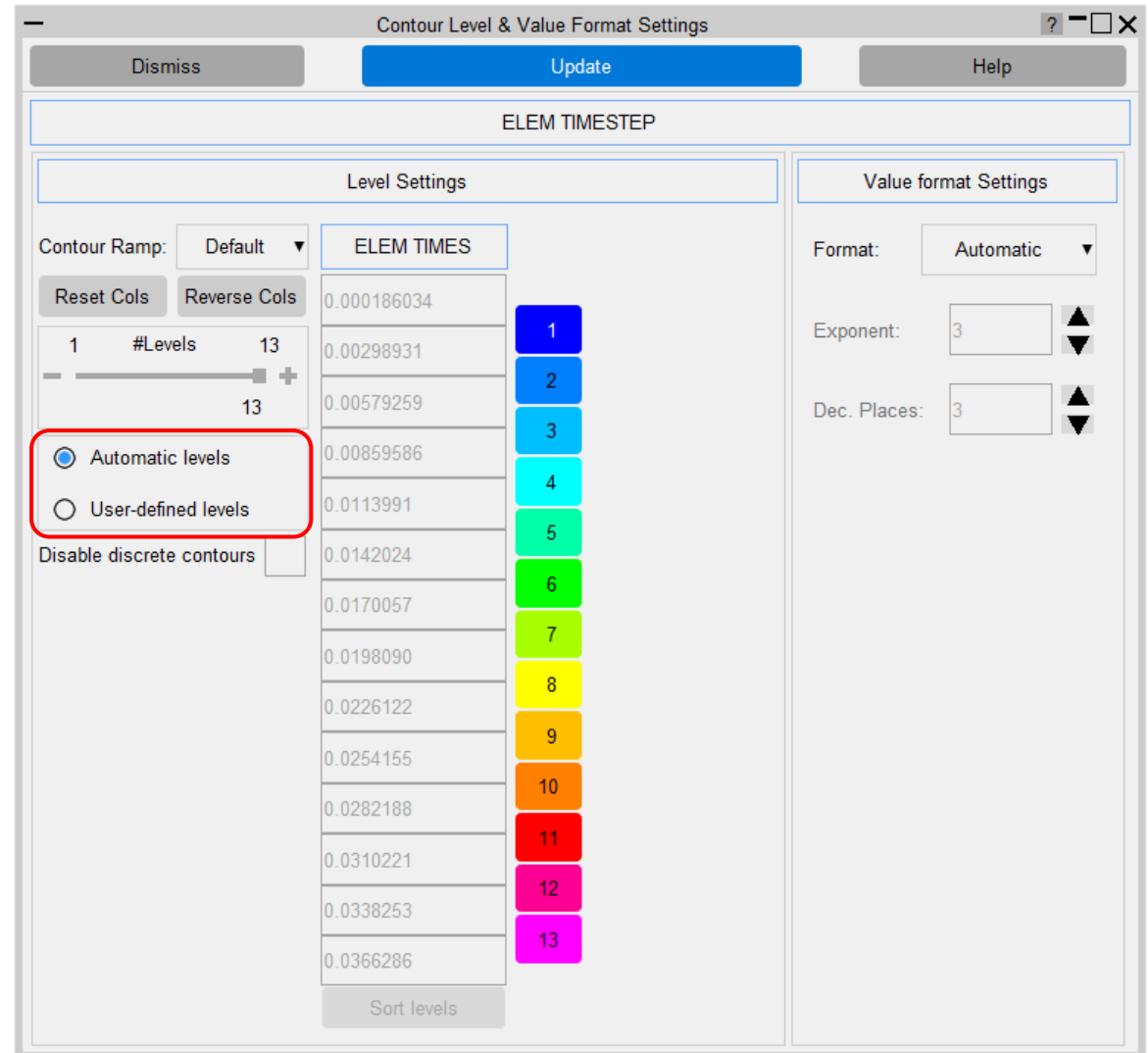
# Data plotting – Contour Level Options: Automatic levels

- This is the default option

- This is the original behaviour from PRIMER 20.0 and earlier

- Contour level values are uniformly distributed based on the maximum and minimum values specified in the relevant contour SETTINGS panels

- Number of contour levels can be modified by the #Levels slider
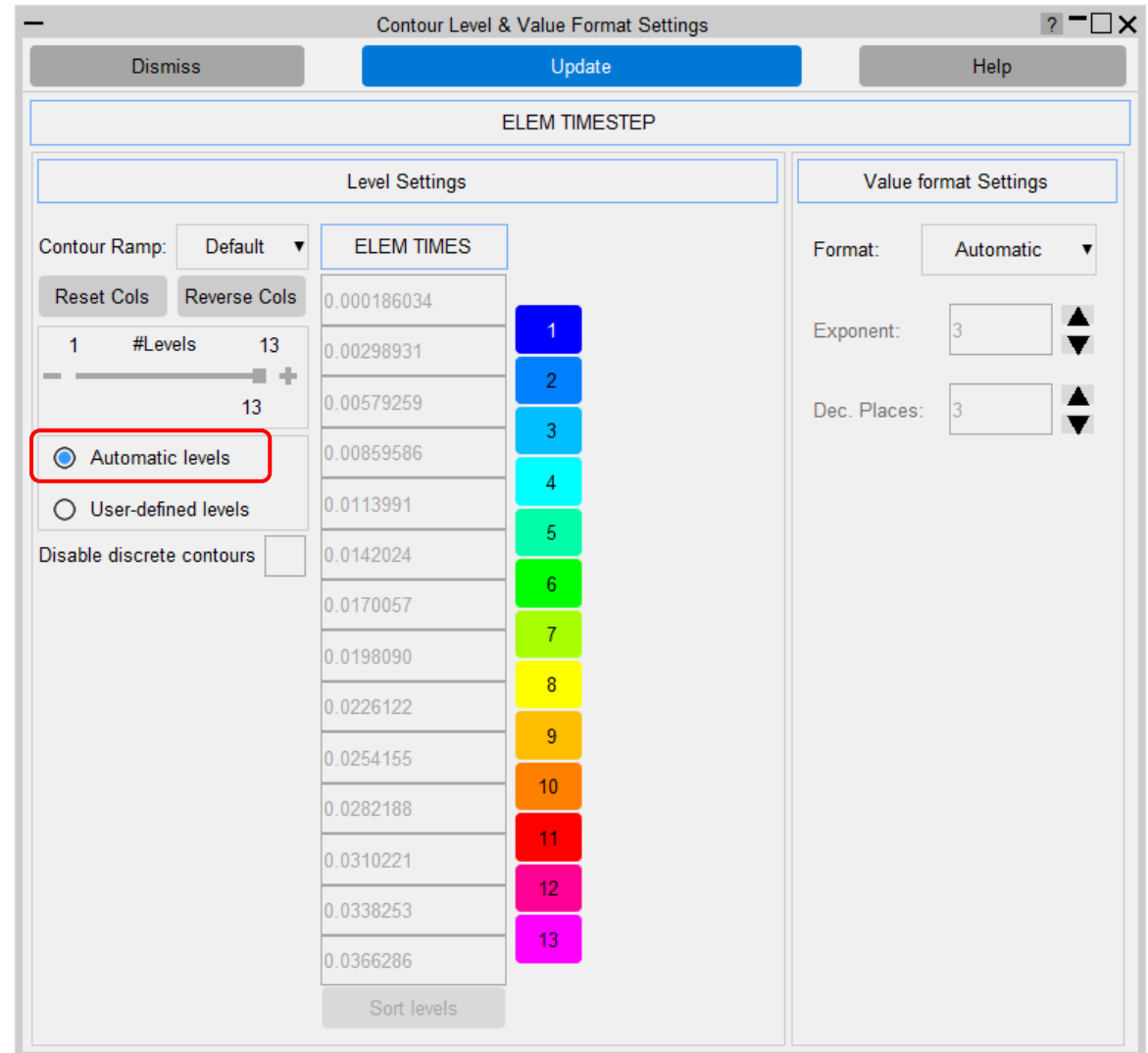
# Data plotting – Contour Level Options: User-defined levels

- In this mode, users can modify the contour values manually:
  - When the values are unordered, the "Sort levels" button is enabled and can be used to sort the values into ascending order;
  - This mode is not available when the data component being contoured is integer data
  - If a component has discrete data, this mode will only be available when discrete contouring is disabled

- Levels can be added/deleted with the popup menu from the value textboxes
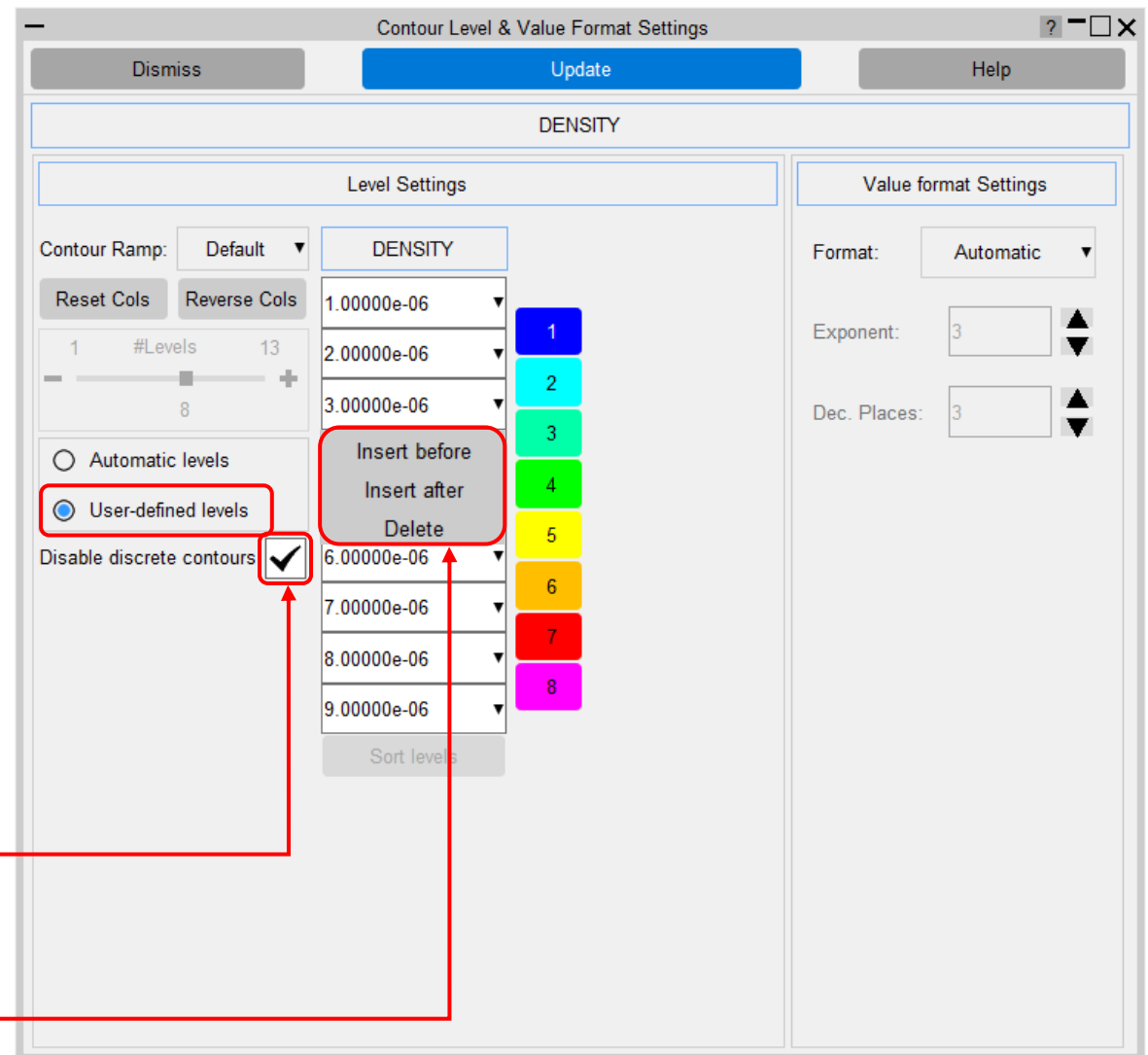
# HBM Trees

Image acknowledgements:

THUMS - Toyota Motor Corporation

GHBMC - Elemance

*Oasys*

# Supported GHBMC models – detailed

- Tree files help position and prepare HBMs for LS-DYNA analysis.

- These are available for the most popular GHBMC models.

- Tree files are free to PRIMER users and available from your local Oasys distributor.

  - **Detailed occupants:**

    - **F50-O v6.0.1**

    - F05-O v5.1/v6.0

    - M50-O v5.1/v5.1.1/v6.0/**v6.1**

    - M95-O v5.1/v6.0

  - **Detailed pedestrians**

    - F05-P v1.2/v5.3.4

    - M50-P v1.6/v5.3.1/v5.3.4

    - M95-P v1.2/v5.3.4

F05-O  F50-O  M50-O  M95-O  F05-P  M50-P  M95-P
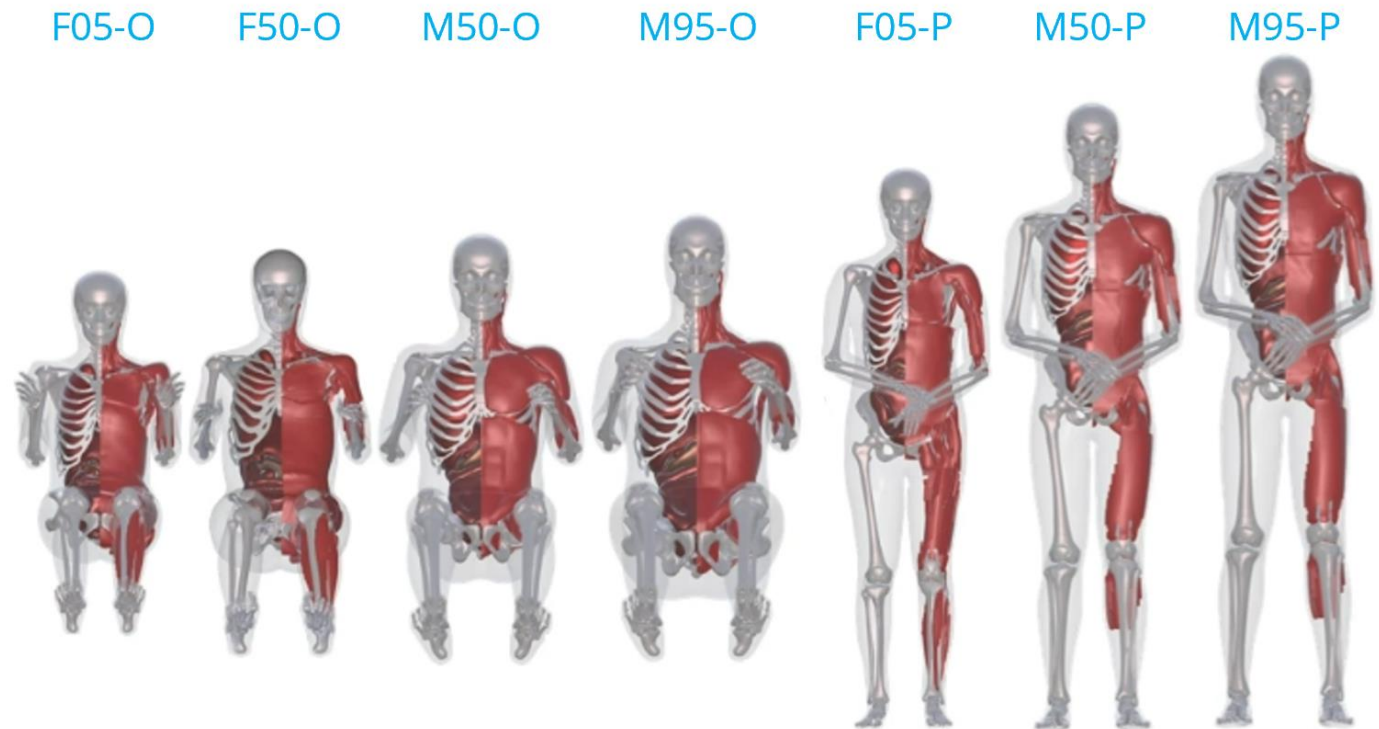
Detailed occupants                    Detailed pedestrians

# Supported GHBMC models – simplified

- **Simplified occupants:**
  - **F50-OS v2.3.1**
  - F05-OS v2.3
  - M50-OS v2.3
  - M95-OS v2.3
- **Simplified pedestrians:**
  - F05-PS v1.8/v5.3.4
  - M50-PS v1.8/v5.3.4
  - M95-PS v1.8/v5.3.4
  - 3YO-PS v1.8
  - 6YO-PS v1.8
  - 10YO-P v1.8
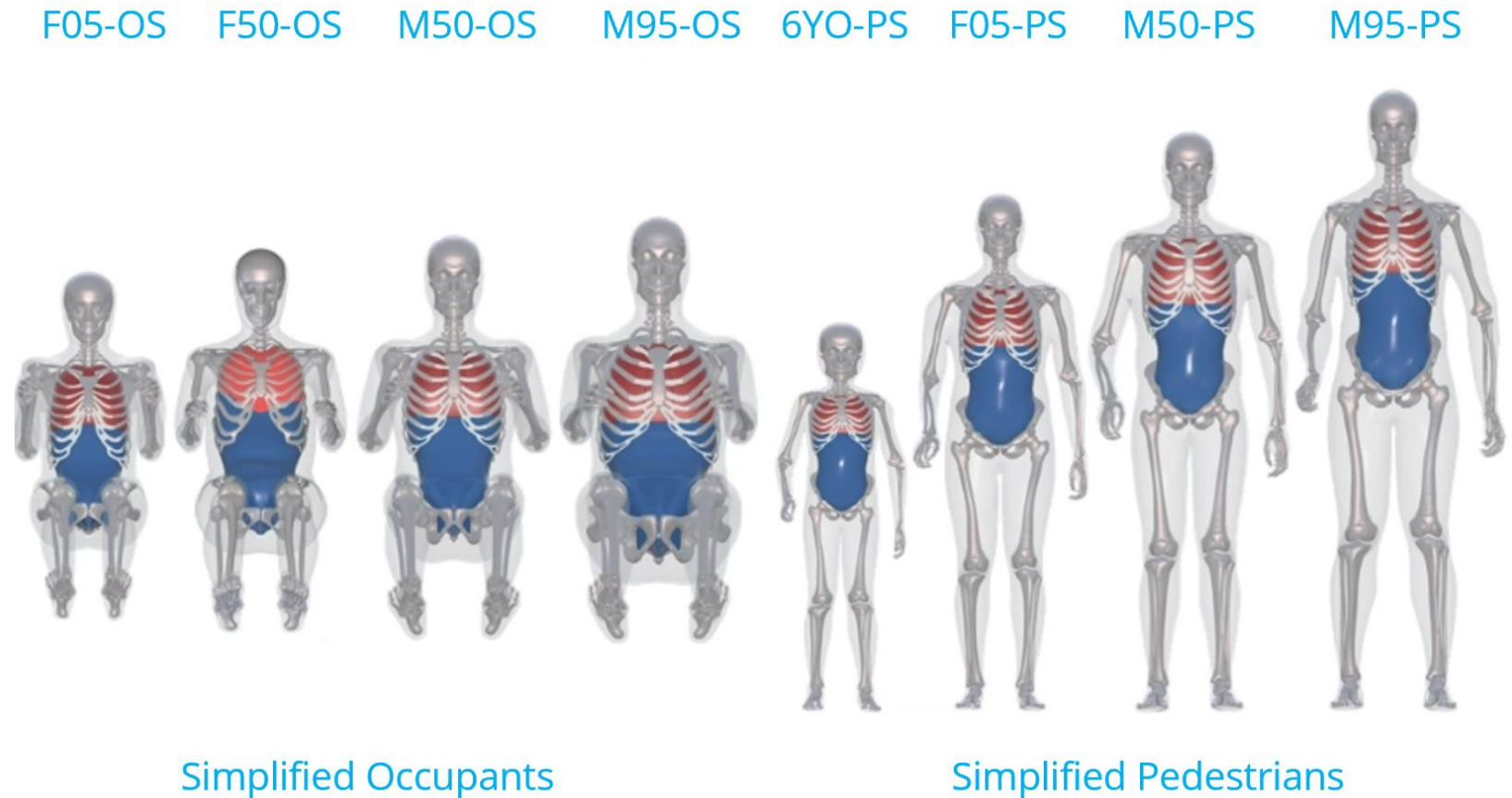
F05-OS   F50-OS   M50-OS   M95-OS   6YO-PS   F05-PS   M50-PS   M95-PS



Simplified Occupants        Simplified Pedestrians

https://www.oasys-software.com/dyna/models/hbm-trees/

Oasys

# Supported THUMS models

- Tree files are free to PRIMER users and available from your local Oasys distributor.



3YO  6YO  10YO  AF05  AM50  AM95



3YO  6YO  10YO  AF05  AM50  AM95

- **Version 4 Pedestrians**:

  - AF05-P v4.0.2

  - AM50-P v4.0.2

  - AM95-P v4.0.2

  - 3YO/6YO/10YO v4.0

- **Version 4/5/6/7 Occupants**:

  - AF05-O v4.1/v5.0.3/v6.1/**v7**

  - AM50-O v4.1/v5.0.3/v6.1/**v7**

  - AM95-O v4.1/v5.0.3/v6.1/**v7**

  - 3YO/6YO/10YO v4.0
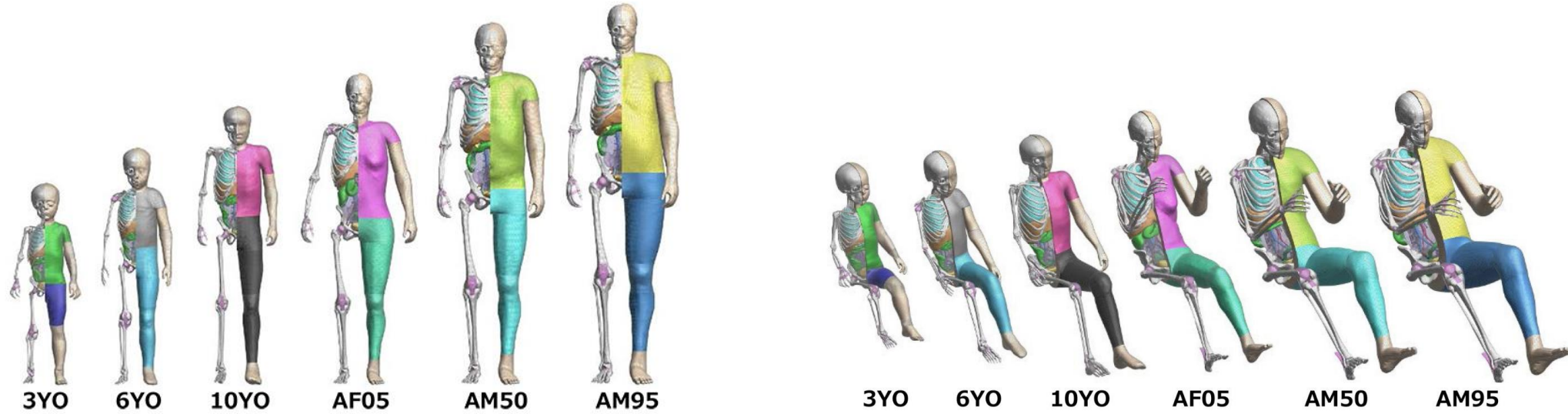
# Supported THUMS models

• Tree files are free to PRIMER users and available from your local Oasys distributor.

• **Seatback Reclined (25/35/45 Deg.):**

  • **AF05-O v7**

  • **AM50-O v7**

  • **AM95-O v7**

• **Others:**

  • **Elderly AF50/AM50 V4.0**

  • **Whiplash F50/AM50 V4.0**

  • **Obese BMI35 V4.0**



25 degree    35 degree    45 degree

**Reclined Posture (Version 7)**

https://www.oasys-software.com/dyna/models/hbm-trees/#thums

*Oasys*

# HBM Visualisation Entities

Image Acknowledgements

GHBMC - Elemance

# HBM Visualisation entities file for D3PLOT

- It is now possible to view Human Body Model (HBM) visualisation entities, created by the HBM Visualisation table, in a D3PLOT session using a "D3PLOT groups file" (*.vis).

- A model specific "D3PLOT groups file" can be created from the Visualisation table in PRIMER, using the newly added buttons under the "Create D3PLOT groups file" label.
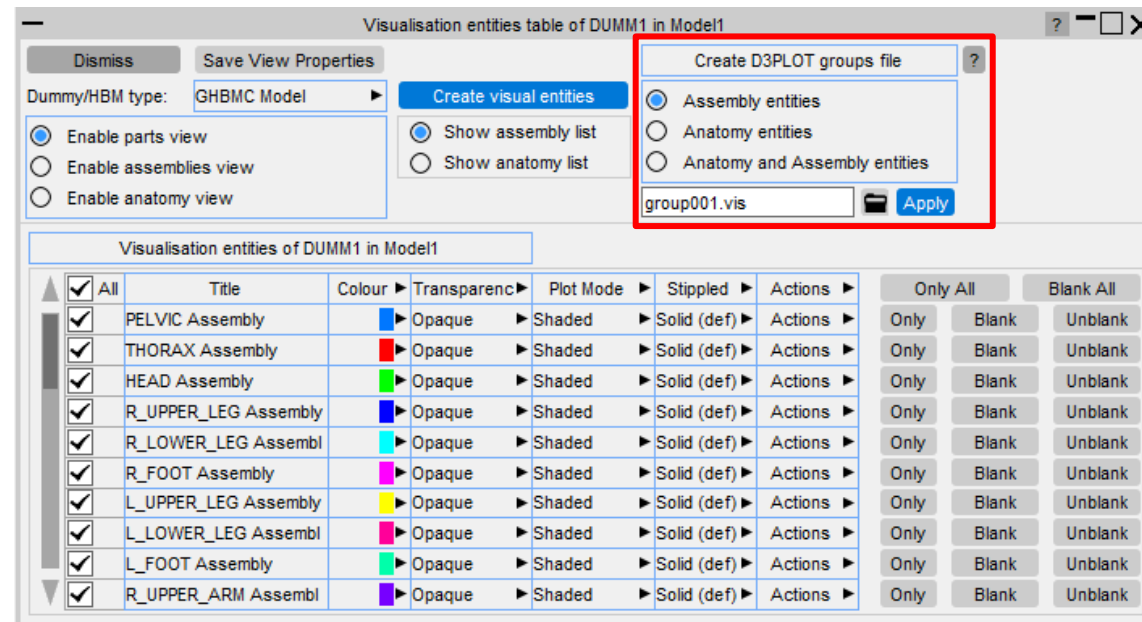
# HBM Visualisation entities file for D3PLOT

- The radio buttons provide an option to choose the type of HBM visualisation entities, that you want to view in D3PLOT.

  - **Assembly entities:** Creates a D3PLOT groups file with only those entities that are viewed in an "Assembly view".

  - **Anatomy entities:** Creates a D3PLOT groups file with only those entities that are viewed in an "Anatomy view".

  - **Assembly and Anatomy entities:** Creates a D3PLOT groups file with all the entities that are viewed in both the "Assembly" and "Anatomy" views.

- "Apply" will create a D3PLOT groups file with a filename (*.vis) specified in the adjacent textbox.

- This groups file can be loaded into a D3PLOT session on the LS-DYNA results of the same model.

Oasys

# Create HBM Visualisation entities file for D3PLOT



**5.** Create HBM visual entities

**6.** Select the type of entities to be written out into the groups file

**7.** Give a filename. (A default filename is always shown, you can change if you wish to)

**8.** Apply to create D3PLOT groups file

**9.** Check the confirmation message in the Dialogue box

# View HBM Visualisation entities in D3PLOT

**1.** Load the LS-DYNA results (*.ptf/d3plot file) of the model into D3PLOT, for which you have the **\*.vis** file.

**4.** Select the *.vis file of the model

**5.** Apply will load the HBM visual entities from the file and applies them on the model in the graphics area.



Full Body Model (GHBMC)

# View HBM Visualisation entities in D3PLOT

- In Groups menu, you can see the list of HBM entities and perform various operations like Only, Sketch etc.



**7.** Select the Group name from object menu

PRIMER

*Oasys*
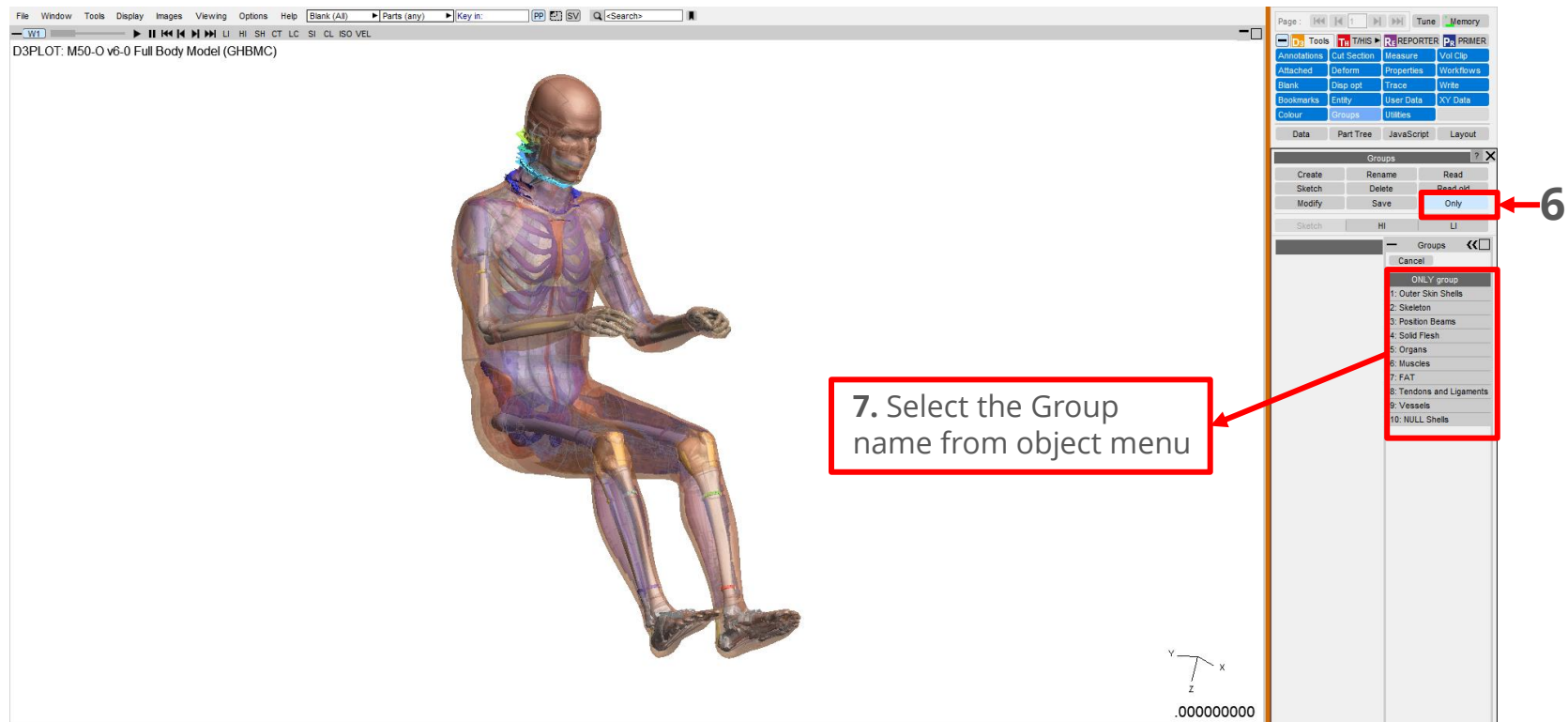
# HBM Tool Updates

Oasys

# New Dialogue command to write DAF

- A new dialogue command **WRITE_DUMMY_ANGLE** is added to allow you to write out a Dummy Angles File when working with Dummies/HBMs in Command-line mode.

- PRIMER writes out a Dummy Angles File for the selected Dummy, when you enter the following command in the dialogue box:

  - DUMMY >>> WRITE_DUMMY_ANGLE <filename>

| WRITE_DUMMY_ANGLE | Specify a *filename* | Writes out the Dummy Angles File, for the selected Dummy, with the specified filename. |
|---|---|---|

# Positioning of Assemblies with Multiple parents

- In previous version of PRIMER, Dummy/HBM assemblies can have multiple parents. The extra connections between assemblies is achieved with PIN/LINE/HINGE. This creates circular connections amongst assemblies in a dummy construct.

- From PRIMER 21.0, it is possible to use the **Rotate Angles** positioning method to position such assemblies.
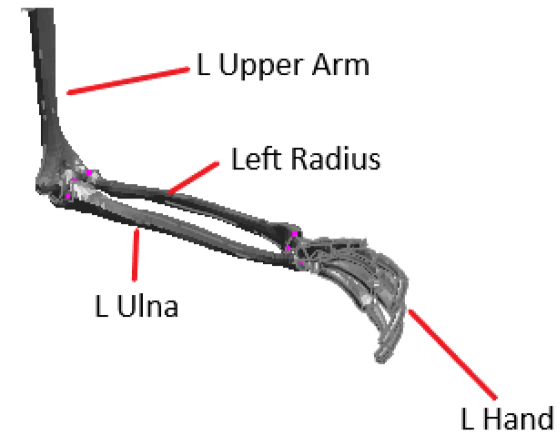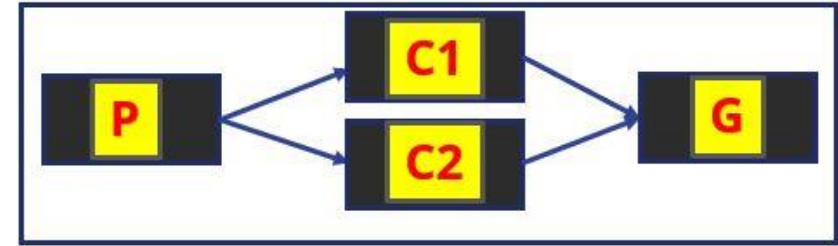


**Image Acknowledgement: THUMS – Toyota Motor Corporation**

# Positioning of Assemblies with Multiple parents

- The angle rows of all the assemblies with circular connections are displayed with a grey background in the "Rotate angles" panel.



- In the Assembly list, the indications (R), (E) and (M) against the assembly names indicate the following:

  - (R): The indicated assembly is the Root Assembly.

  - (E): One or more child/grandchild assemblies of the indicated assembly have Mechanism style connections.

  - (M): The indicated assembly has multiple parent assemblies and therefore connected with the parents in mechanism style connections.

- For Circular connections, the feature of dragging using a particular mouse button to rotate about a particular axis is not applicable. Instead, if you drag an assembly with any mouse button, PRIMER rotates that assembly about any axis as per your mouse movement.

PRIMER

Oasys

# Cut Sections

Oasys

# Cut sections improvements

- In PRIMER 20.0 the numbers of parallel cut planes in positive and negative directions for uniform (non-custom) spacing were concatenated into one text box.

- In PRIMER 21.0 there are separate text boxes for both numbers of planes.

- In previous versions, cut section custom spacing positions were sorted immediately after editing. This is unintuitive when editing several positions in a row.

- In PRIMER 21.0 positions will remain where they are after editing even if they are then no longer in ascending order.

- The new **Sort positions** button can then be used to sort the positions into ascending order.

# New cut section properties

- Two new properties have been added to the 'Cut Section Properties' panel:

  - Plastic equal area axes (Xe_g, Ye_g, Ze_g);

  - Fully plastic equal force axes (Xf_g, Yf_g, Zf_g).

- Changed the labels of the centroid global coordinates from (Xg, Yg, Zg) to (Xc_g, Yc_g, Zc_g)

# Battery Setup Tool

Oasys

# Battery Setup Tool

- The battery setup tool is a new feature in PRIMER 21.0 which is accessible through the 'Batteries' button from the Tools panel.

- It can be used to set up a pouch battery structure from scratch and combine it with relevant **\*EM_RANDLES** keywords to model Randles circuits within the battery cell.

- The workflow is split into five steps as follows:

1. Selecting the modelling scale → 2. Creating the layers structure → 3. Creating the tabs structure → 4. Defining the Randles parameters → 5. Activating / Creating analysis keywords

➢ Micro scale
➢ Meso scale
➢ Macro scale
➢ Meshless scale
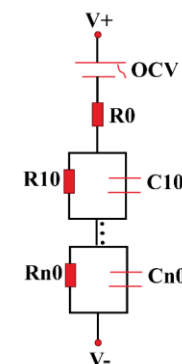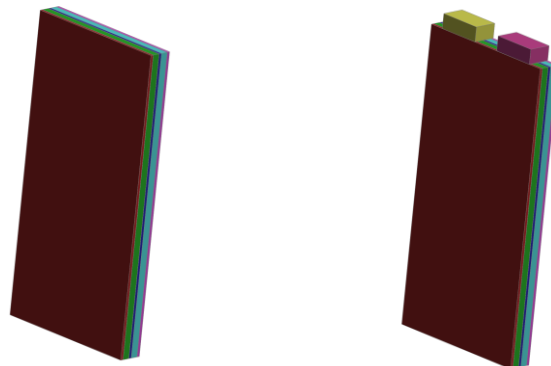


➢ Structural analysis
➢ Thermal analysis
➢ EM analysis

*Oasys*

# Battery Setup Tool

## 1. Geometry & Scale:

- The tool supports all 4 possible scales for modelling a battery cell using the *EM_RANDLES LS-DYNA keyword:
  - *Micro scale*: uses **\*EM_RANDLES_SOLID**
  - *Meso scale*: uses **\*EM_RANDLES_TSHELL**
  - *Macro scale*: uses **\*EM_RANDLES_BATMAC**
  - *Meshless scale*: uses **\*EM_RANDLES_MESHLESS** and could be connected to a Macro scale structure. Otherwise, steps 2 and 3 will be skipped and no physical structure will be created.
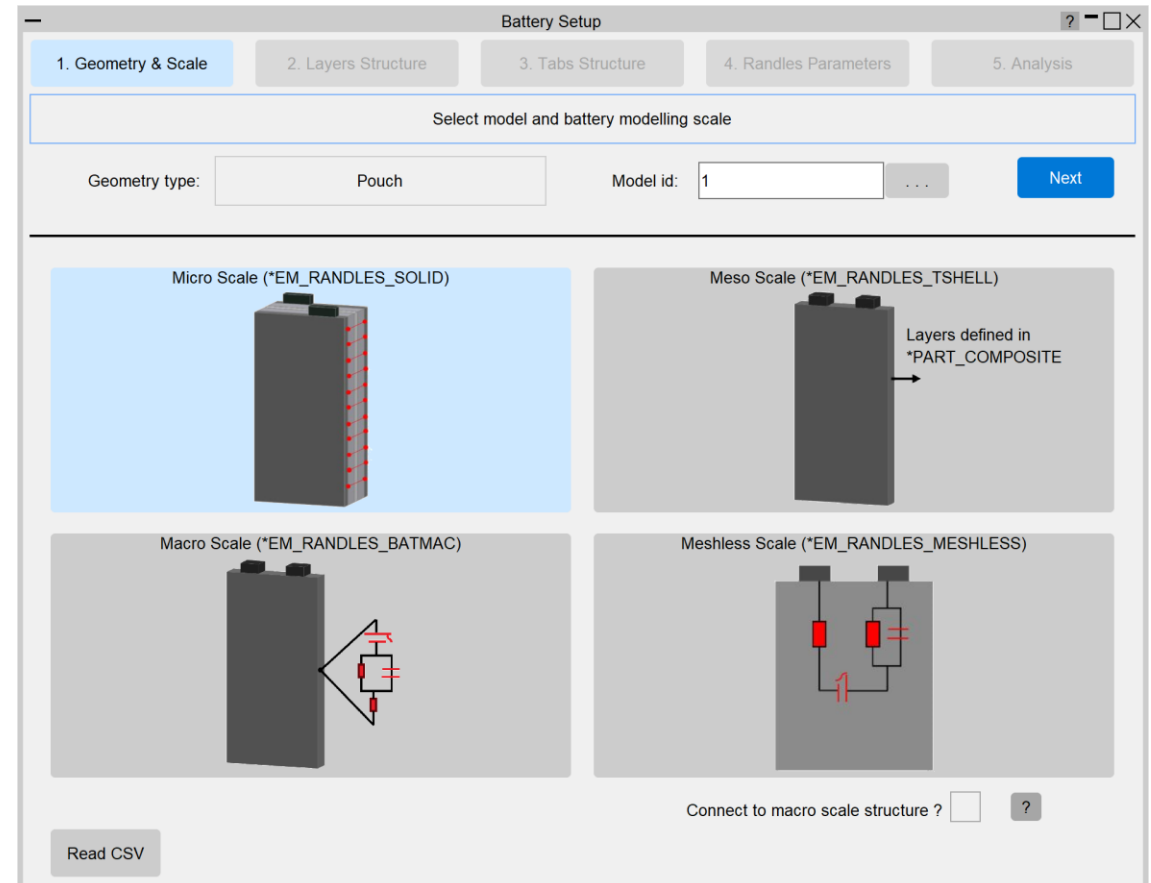
# Battery Setup Tool

## 2. Layers structure:

- Once the modeling scale is selected, the structure of the battery internal layers can be created by providing the dimensions, origin, meshing density, how many unit cell repetitions are needed, the material and thermal material information, thickness, and the initial conductivity for the two current collectors.

- For the Micro and Meso scales, the material and thickness properties of each layer must be provided separately, while for the Macro and Meshless (connected to Macro structure) scales, these properties must be provided for the unit cell as a whole.

Oasys
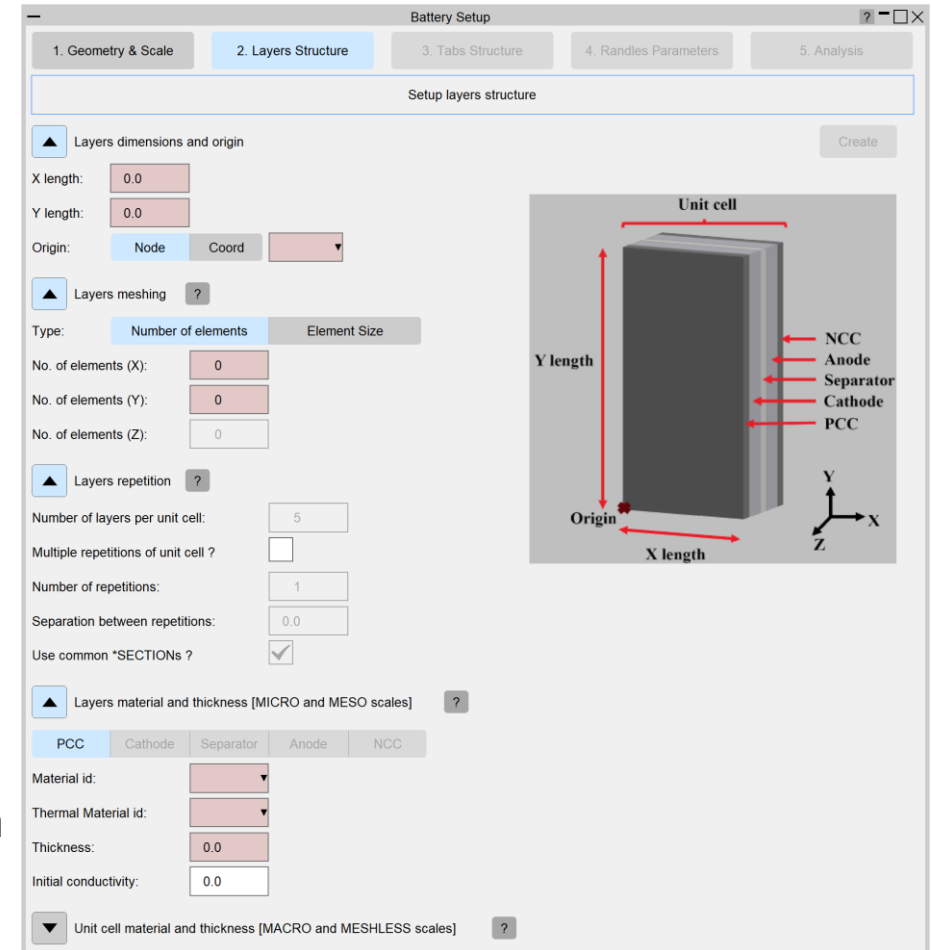
# Battery Setup Tool

## 2. Layers structure:

- The type and number of parts that will be created per unit cell will depend on the selected scale.

- PRIMER will also automatically associate the generated parts to **\*EM_MAT** cards to define the electromagnetic properties of corresponding materials and set the initial potential of current collectors.

**Micro**

**Meso**

**Macro**

NCC (solid **\*PART**)

Anode (solid **\*PART**)

Separator (solid **\*PART**)

Cathode (solid **\*PART**)

PCC (solid **\*PART**)

Unit cell
(**\*PART_COMPOSITE_TSHELL**)

*Can be composed of as many layers as needed*

Unit cell (solid **\*PART**)

**\*EM_MAT_001** for each layer type

**\*EM_MAT_006** for the unit cell

*Oasys*
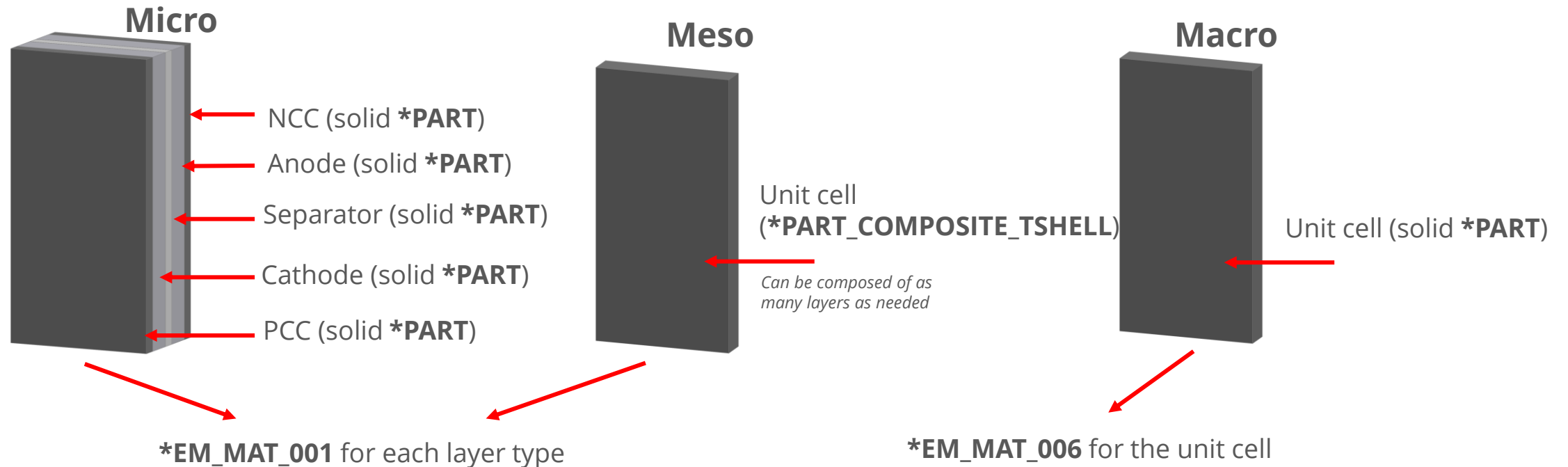
# Battery Setup Tool

**2. Layers structure:**

• Multiple repetitions of the unit cell can be created for any scale.

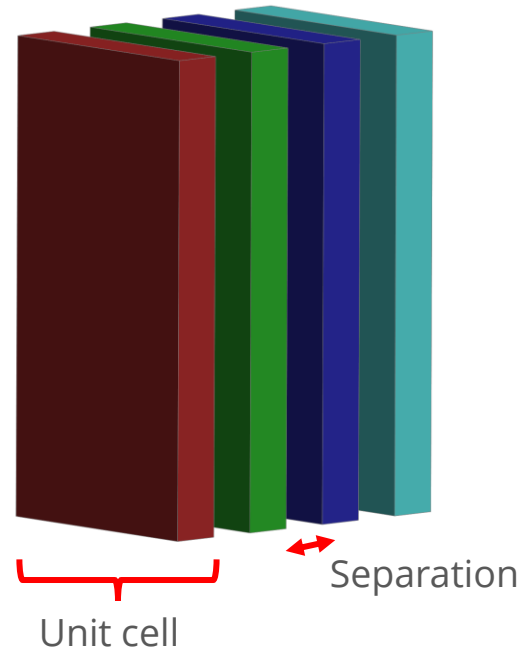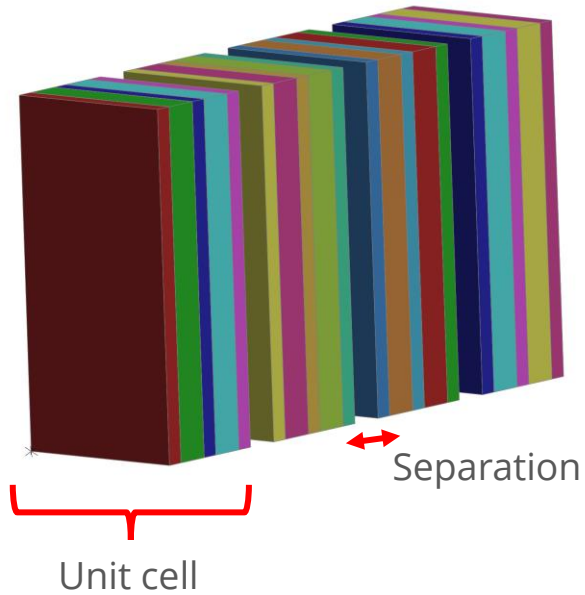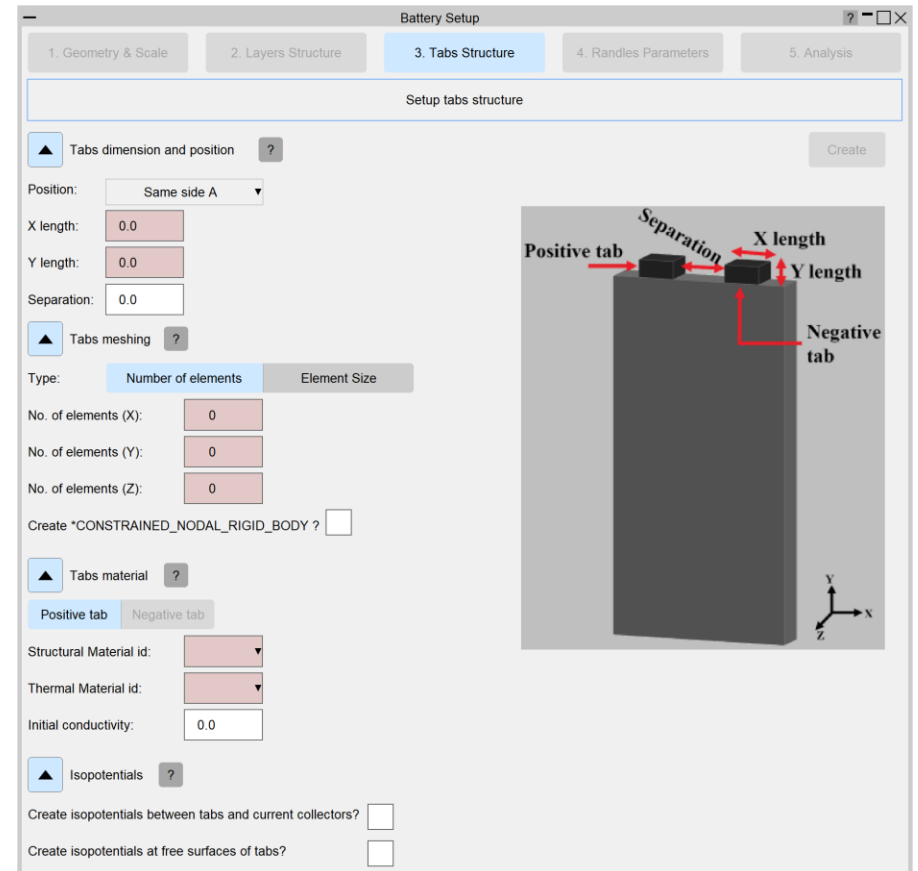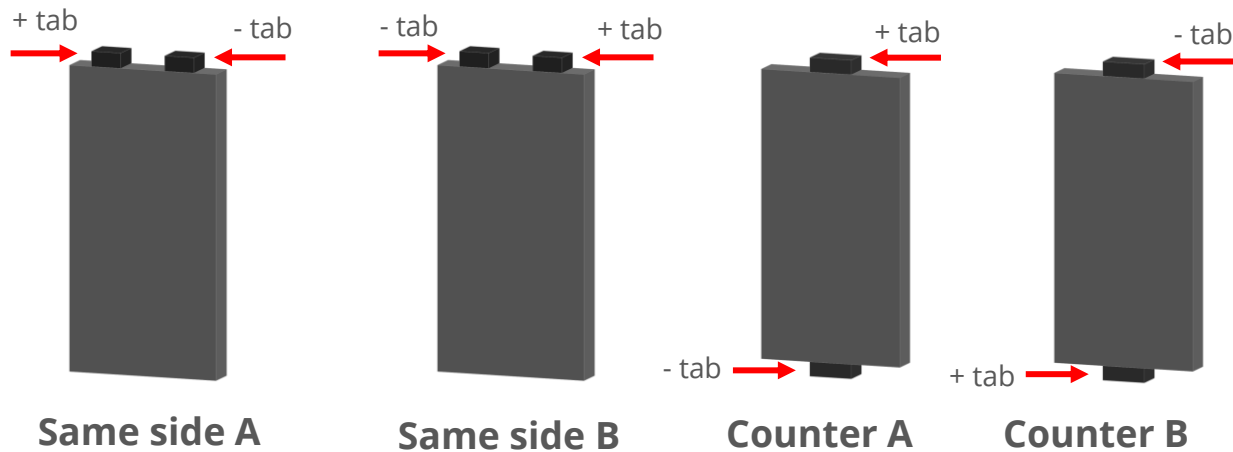# Battery Setup Tool

## 3. Tabs structure:

- Once the layers structure is created, the structure of the positive and negative tabs for each unit cell can be created by providing the dimensions, meshing density, the material and thermal material information.

- Tabs are always modeled as solid **\*PART**s for all scales.

- Four different configurations of tab positioning relative to the layer unit cell are available.



**Same side A**   **Same side B**   **Counter A**   **Counter B**

# Battery Setup Tool

## 3. Tabs structure:

- Each tab structural material will automatically be associated to an **\*EM_MAT_001** card to define its electromagnetic properties.

- PRIMER can automatically connect the tabs to the layers structurally by generating **\*CONSTRAINED_NODAL_RIGID_BODY** cards at each tab-layer connection that include all nodes on the common tab-layer surface.

- PRIMER can also automatically connect the tabs to the layers electrically by generating **\*EM_ISOPOTENTIAL** cards at each tab-layer connection by constraining overlapping nodes to have the same scalar potential value.

- An **\*EM_ISOPOTENTIAL** card can also be generated for each tab to include nodes at the free surface (not connected to the cell). These could then be easily used to connect the different tabs using **\*EM_ISOPOTENTIAL_CONNECT** cards.

# Battery Setup Tool

## 4. Randles parameters:

- Once the tabs structure is created, the Randles parameters from the relevant **\*EM_RANDLES** keyword will need to be defined.

- The layers parts (CPPPART, CCNPART, SEPPART, PELPART, NELPART) from card 1 of **\*EM_RANDLES_SOLID** and the part set (PSID) from card 1 in **\*EM_RANDLES_TSHELL** and **\*EM_RANDLES_BATMAC** will automatically be referenced by PRIMER based on what has been generated at the '2. Layers Structure' stage.

- If in 'Meshless connected to Macro structure' mode, an extra **\*EM_ISOPOTENTIAL_CONNECT** card with CONTYPE = 5 will be created connecting the Randles circuit to the cell layers nodes overlapping with the tabs.

Oasys

# Battery Setup Tool

## 5. Analysis:

- The final step is to activate or create relevant analysis keywords by turning on the tick boxes next to the desired keywords and defining one or two fields. Once "Apply" is clicked, the selected keywords will be activated/created and can then be fully edited by clicking on the associated "Edit" button which will open up the corresponding modify panel.

# Battery Setup Tool

**Saving and restoring data:**

- The data from all 5 steps can be exported to a csv file using the "Write CSV" button in the '5. Analysis' panel, and imported back into a future session using the "Read CSV" button in the '1. Geometry & Scale' panel.
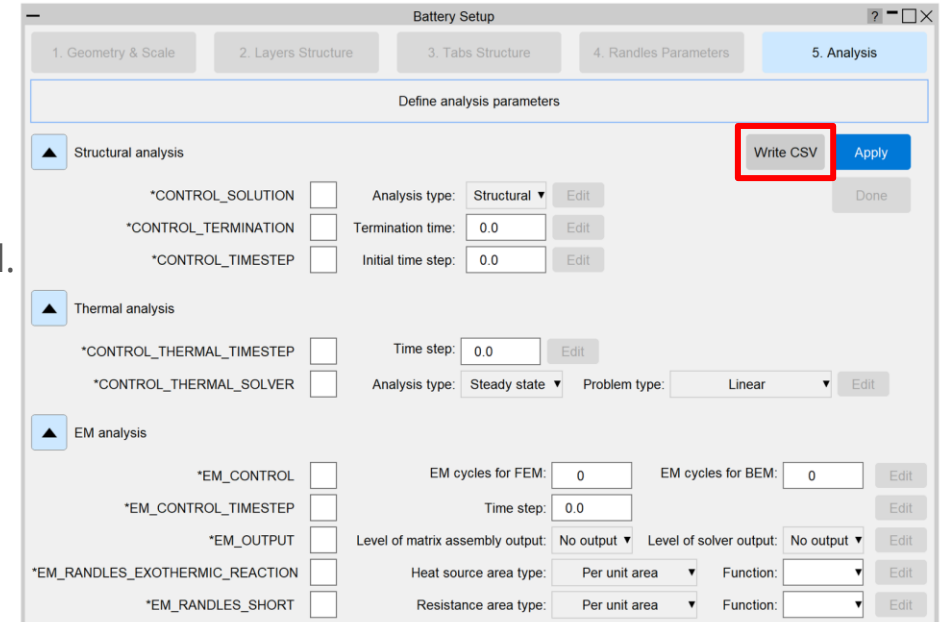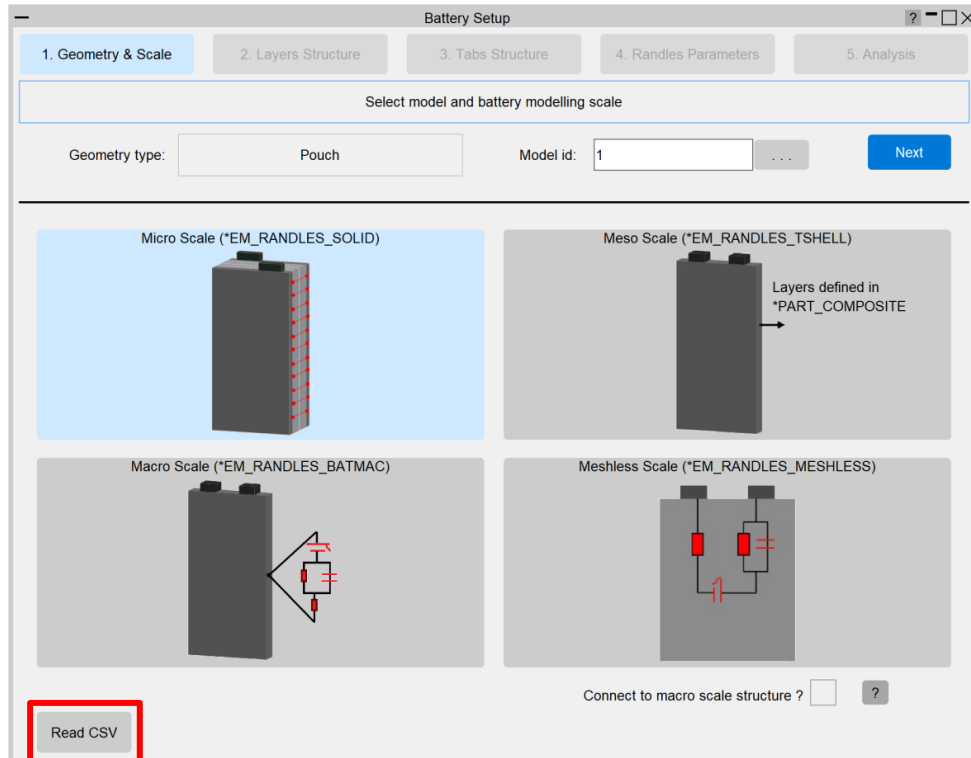
# Battery Setup Tool

**Extra steps and post-processing:**

- Once all 5 steps are completed, the tool can be closed. It might be necessary to connect the different unit cells (if multiple unit cells have been generated) and/or the battery cell to any external circuits, by using **\*EM_ISOPOTENTIAL_CONNECT** of resistance type for example, as an additional step. It might also be required to activate extra analysis keywords not listed in the final panel of the tool, after which the model should be ready to submit to LS-DYNA.

- An example of D3PLOT results for a Macro scale battery model generated by the tool is shown below.
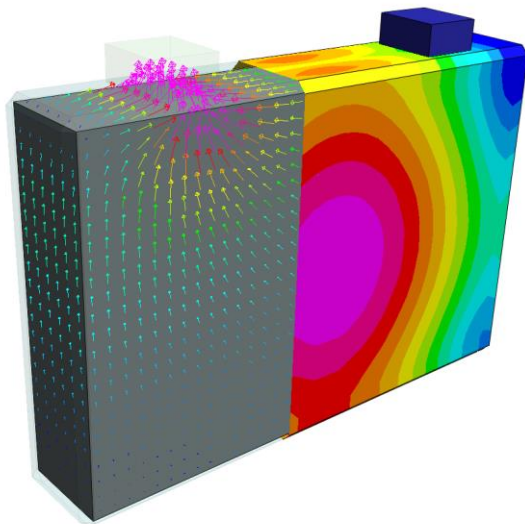
Oasys
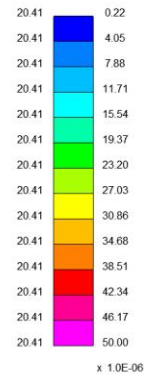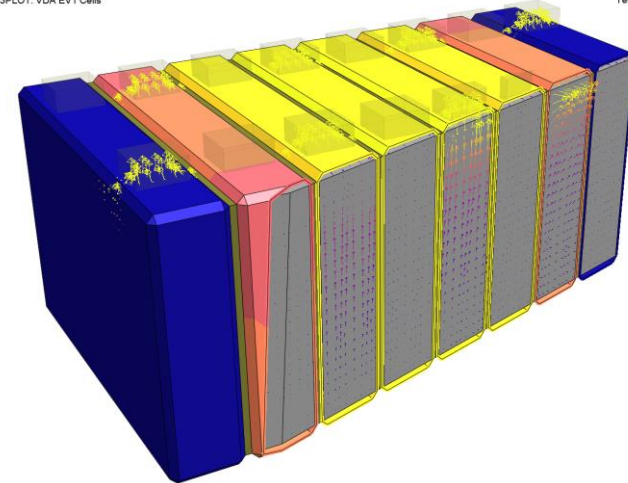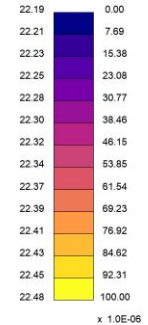
# Spotweld Remesh Improvements

# Skip preserving elements around a hole

- Previously, PRIMER would throw an error when attempting to preserve elements around a hole if it was positioned too close to spot welds.

- Now the elements around the hole are not preserved if they are close to spotwelds, such as those shown in the images below.

# Improved handling of meshing errors

- Previously, spot weld remeshing would terminate if the weld is close to a feature line or free edge, leading to subsequent problems.

- A check has now been added to handle such meshing errors.

- PRIMER will skip the creation and remeshing of such spot welds and continue with the other selected spot welds.

Feature line
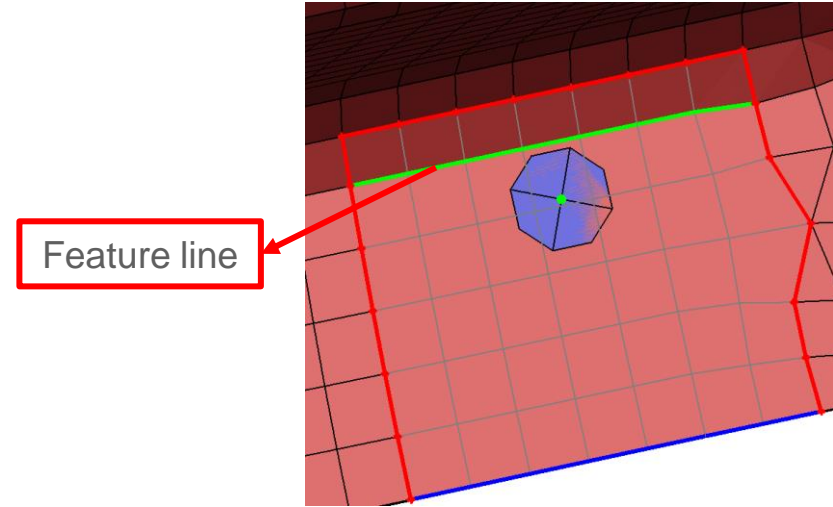
# HAZ Elements preserved if not selected

- In PRIMER 21.0 Heat Affected Zone (HAZ) rings around spot welds are preserved if they are not selected for remeshing.

- For example, the ring around CONX16 is now preserved if only connections CONX15 and CONX17 are selected for remeshing.

# Adding nodes around spotwelds

- This feature was added in PRIMER 20.0 and has been improved in PRIMER 21.0, including making it significantly faster.
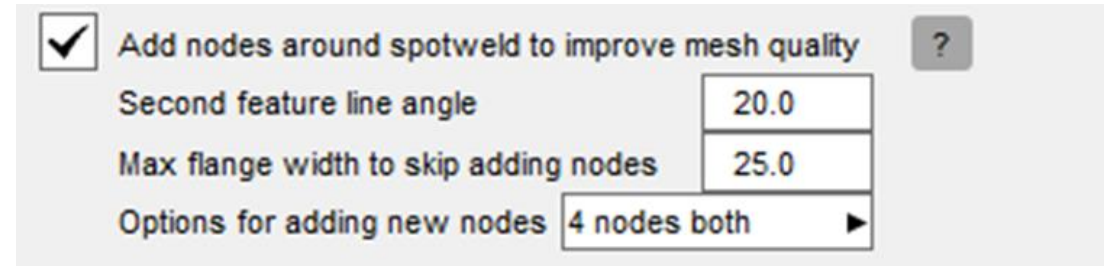


| | Add nodes around spotweld to improve mesh quality | ? |
|---|---|---|
| Second feature line angle | 20.0 | |
| Max flange width to skip adding nodes | 25.0 | |
| Options for adding new nodes | 4 nodes both | ► |

| ✔ | Add nodes around spotweld to improve mesh quality | ? |
|---|---|---|
| Second feature line angle | 2.0 | |
| Max flange width to skip adding nodes | 25.0 | |
| Options for adding new nodes | 4 nodes both | ► |

*Oasys*

# Adding nodes around spotwelds: Second feature line angle

- The Second feature line angle input should be greater than or equal to the Remesh feature line angle and less than HAZ mesh reconstruct feature line.

- PRIMER 21.0 has been made more robust to incorrect user inputs for the Second feature line angle.



| | |
|---|---|
| ☑ Add nodes around spotweld to improve mesh quality | ? |
| Second feature line angle | 20.0 |
| Max flange width to skip adding nodes | 25.0 |
| Options for adding new nodes | 4 nodes both ▶ |

# Adding nodes around spotwelds: skipping connections

- Based on input parameters, adding nodes around spotwelds can now be skipped

| | | |
|---|---|---|
| ✔ Add nodes around spotweld to improve mesh quality | | ? |
| Second feature line angle | 20.0 | |
| Max flange width to skip adding nodes | 25.0 | |
| Options for adding new nodes | 4 nodes both ▶ | |

%%% WARNING %%%
Skipped adding new nodes for connection 1 as there is no feature edge in the remesh region to put a node on. Specifying a suitable value for 'Second feature line angle' should help.

%%% WARNING %%%
Skipped adding few nodes for 'Add nodes around spotweld to improve mesh' option as local geometry close to connection 39 doesn't have two feature lines of different angles.

| | | |
|---|---|---|
| ✔ Add nodes around spotweld to improve mesh quality | | ? |
| Second feature line angle | 20.0 | |
| Max flange width to skip adding nodes | 25.0 | |
| Options for adding new nodes | 4 nodes both ▶ | |

%%% WARNING %%%
Skipped adding new nodes for connection 44 as the flange width is more than limit specified in 'Flange width limit' option

# Spotweld remeshing: Speed and efficiency improvements

- In PRIMER 21.0 significant improvements have been made to the speed of preserving elements around a hole, and now the entire process takes only a few seconds.

- All the elements around a hole are identified before remeshing, instead of checking each remesh shell individually for its position relative to the hole.

- In PRIMER 21.0, the mesh reconstruction stage has been made approximately 10 times faster than in previous versions.

- In PRIMER 21.0, a complete spot weld remeshing, including mesh reconstruction for a typical BIW, is now 3-4 times faster than in PRIMER 19.0 and 20.0.

- In PRIMER 21.0 spotweld remeshing using the "Always Align Flat Edge" option is more robust.

- An upgrade to the meshing engine has been made:

  - Negative area shells are no longer created during spot weld remeshing.

*Oasys*

# Solid Split Tool

# Solid Split Tool – New split method

- A new solid split type "Split and propagate" has been added under Mesh tools → Split → Solid.

- This splits solids from the selected face and propagates the split through the solids.

- Three types of split are available:

  - Split both axes

  - Split with one axis

  - Split direction normal to the selected face

- Selecting a face displays a preview of the split.

- The Align selected feature aligns the selected solids.

- Grow out face can be used to select all the elements on a surface (like the propagate feature in the Coat menu).

*Oasys*
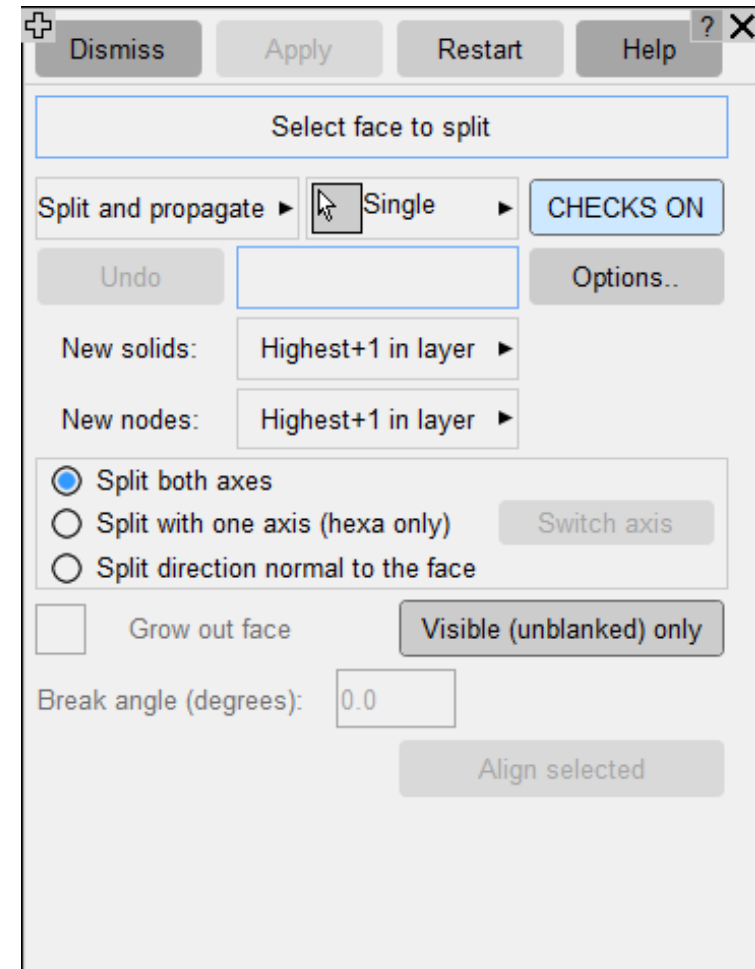
# Solid Split Tool – New split method
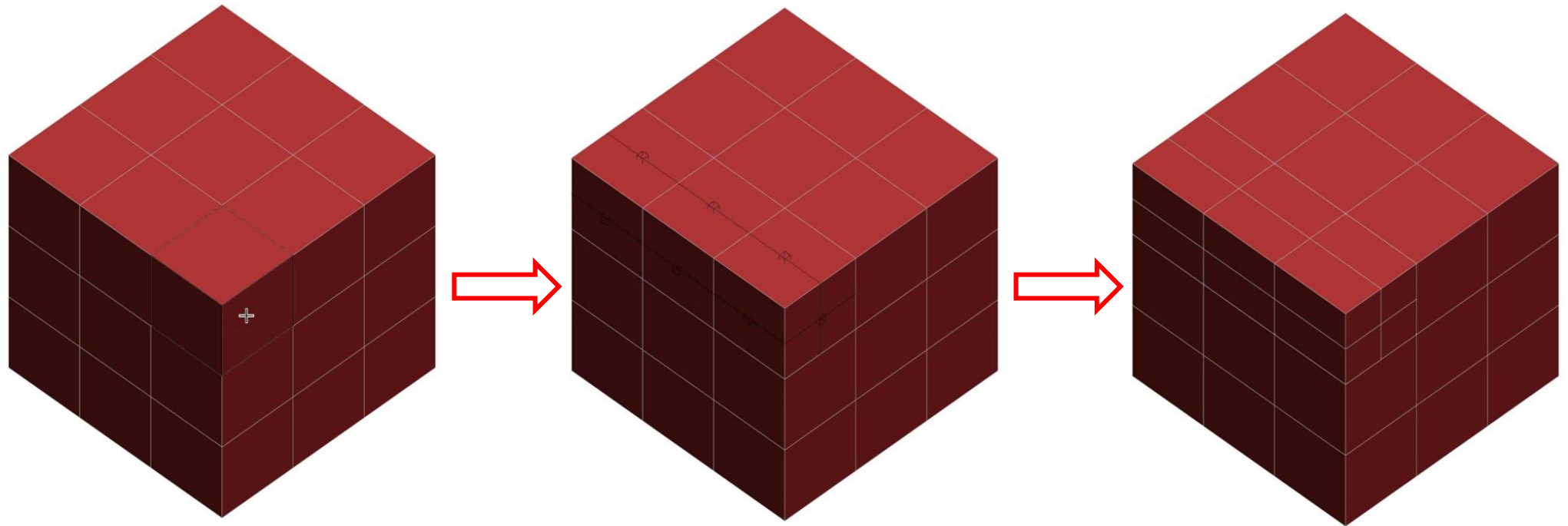


Click on a face of a solid element (example using 'Split both axes' option)

Preview the split

Press 'Apply' to split

# Seatbelts Enhancements

# Seatbelt enhancements – Explicitly meshed pelvis slipring panel

- The Explicitly meshed pelvis slipring panel gives you the ability to:

  - Quickly modify the initial path of the belt to ensure it fits within the slot of the pelvis slipring.

  - Automatically reposition the explicitly meshed pelvis slipring to an accurate location during the fitting procedure.

  - Create X-Sections around the pelvis buckle.

- The 'Adjust' button in the bottom section of this panel can be used to automatically adjust the initial path of the belt to fit within the slot of the pelvis slipring. This will create two base points at each end of the slot and adjust all twist handles in the correct configuration.

- All that is required is the information in the panel and to add a single base point near the top of the slipring (avoid creating more than one point near the slipring area) and then press the 'Adjust' button.
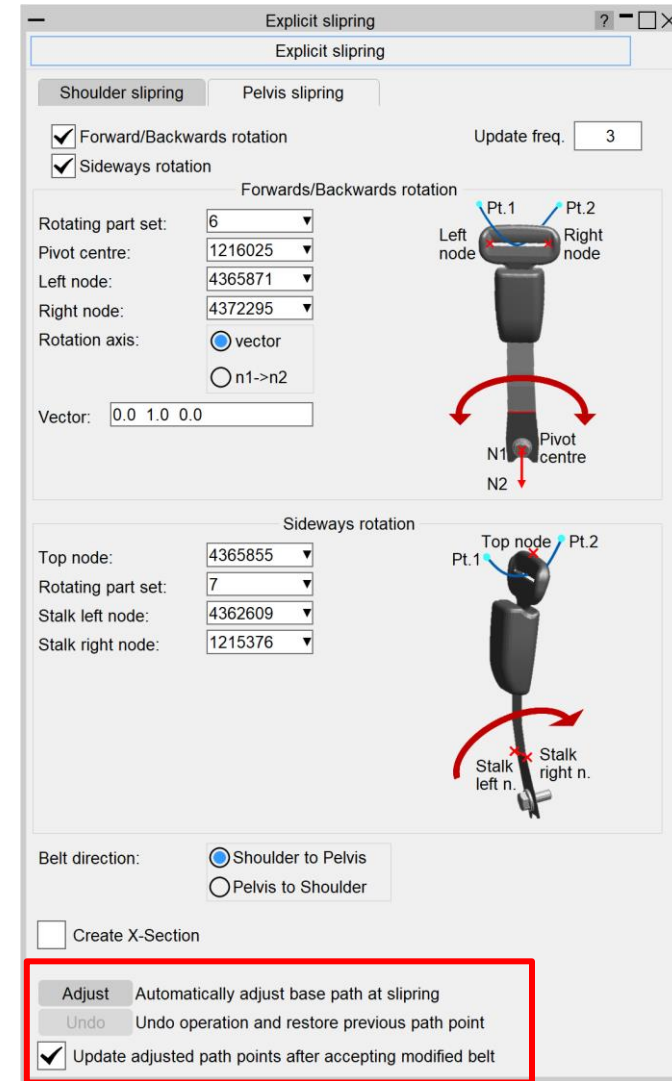
# Seatbelt enhancements – Adjust pelvis slipring initial path

- The below example shows how the 'Adjust' button affects the initial belt path at the pelvis slipring.



'Adjust'
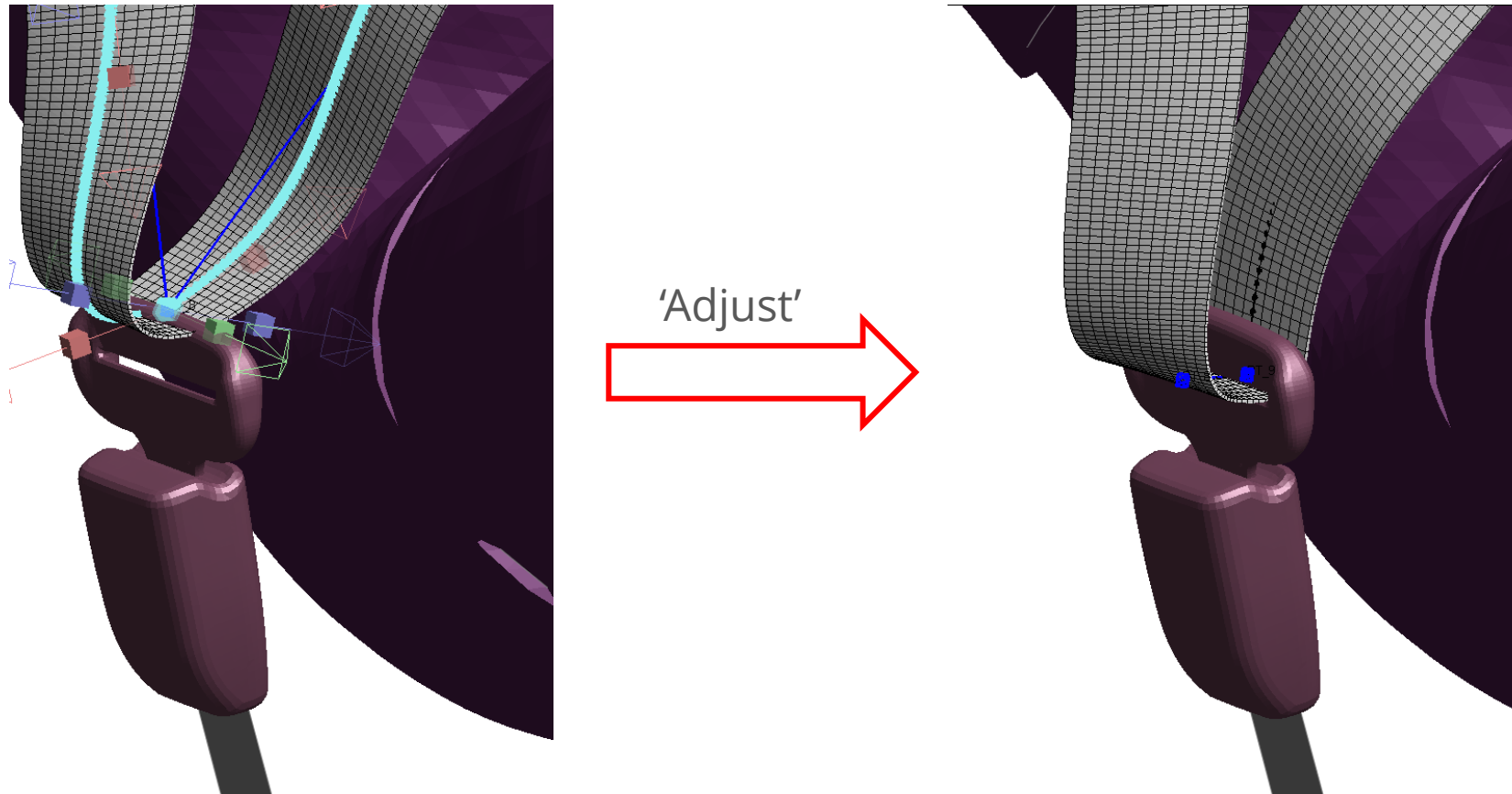
# Seatbelt enhancements – Explicitly meshed pelvis slipring

- This panel gives you the option to automatically move the pelvis buckle and slipring during the fitting process.

- You can select if the pelvis buckle should move in the forward/backwards, sideways direction or both simultaneously.

- Only possible if all required fields are provided.

- The 'Update freq.' field controls how often the slipring is moved during fitting, and it is automatically set to 3.

*Oasys*
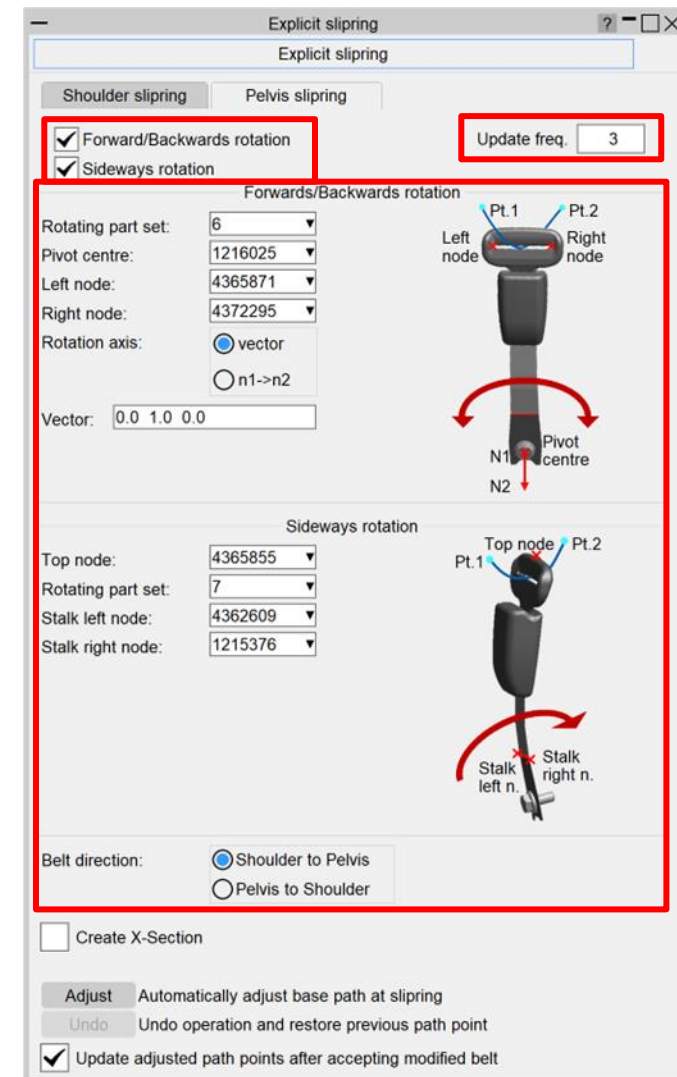
# Seatbelt enhancements – Explicitly meshed pelvis slipring

Forward\Backwards rotation
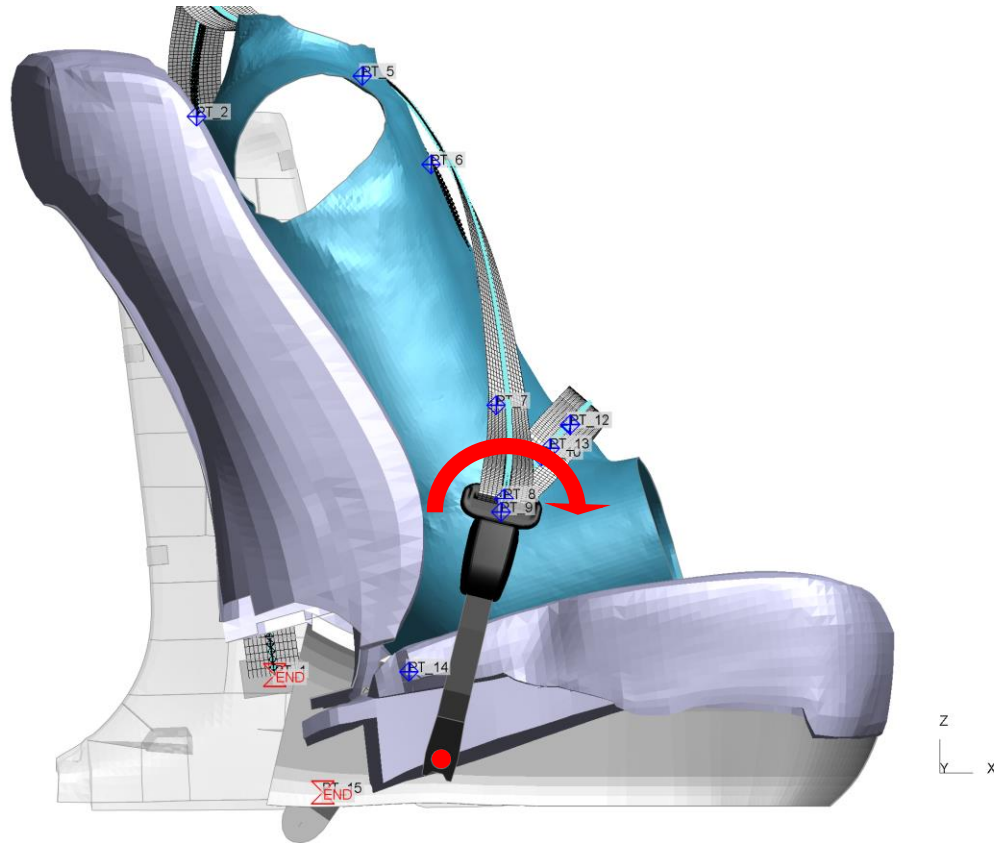
Sideways rotation



Forward\Backwards rotation rotates the whole stalk + buckle (black) around a pivot point (red)
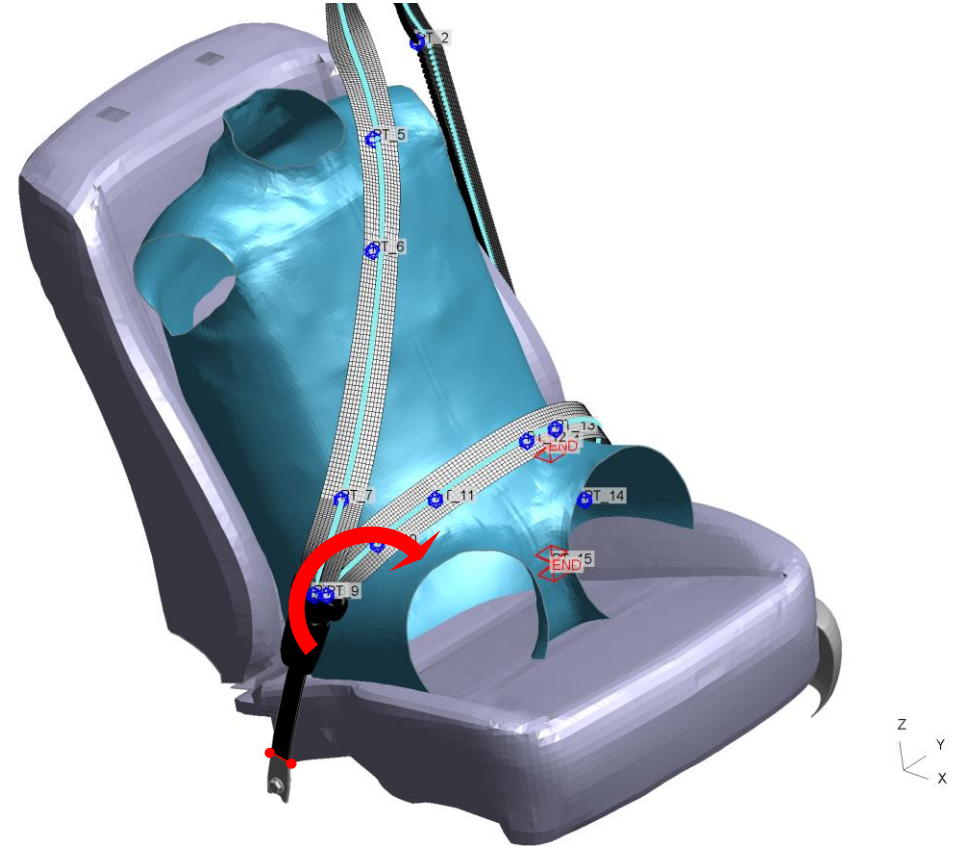
Sideways rotation rotates part of the stalk + buckle (black) towards the dummy until contact is made

PRIMER

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# Seatbelt enhancements – Explicitly meshed pelvis slipring

Original buckle position:
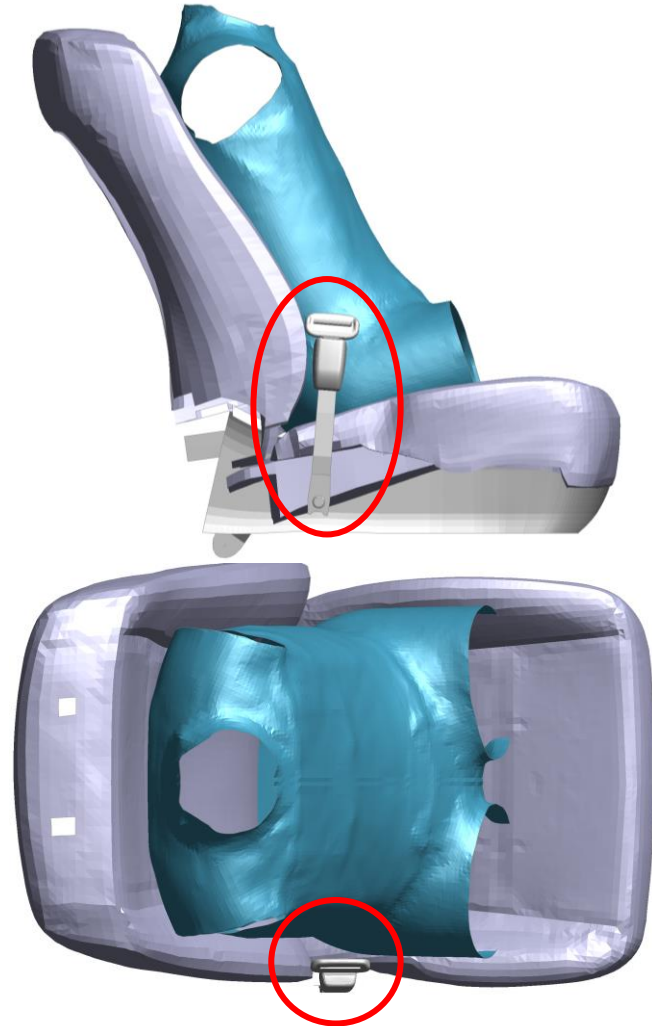
In the fitting process, the pelvis slipring shifts forwards to maintain the belt in the optimal position within the slot and moves sideways to establish contact with the dummy. Rotated position:
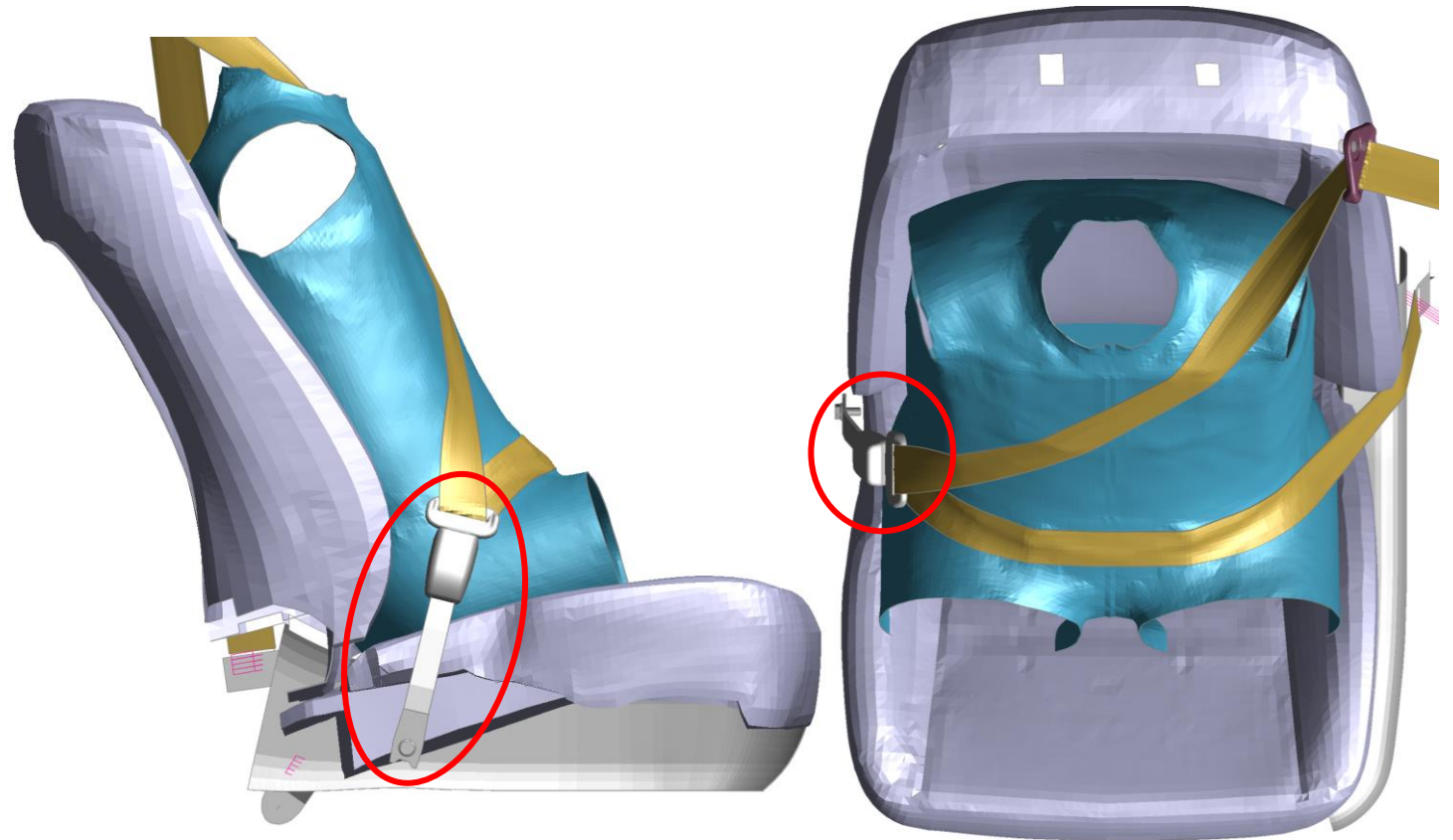
# Seatbelt enhancements – Improving shoulder slipring rotation
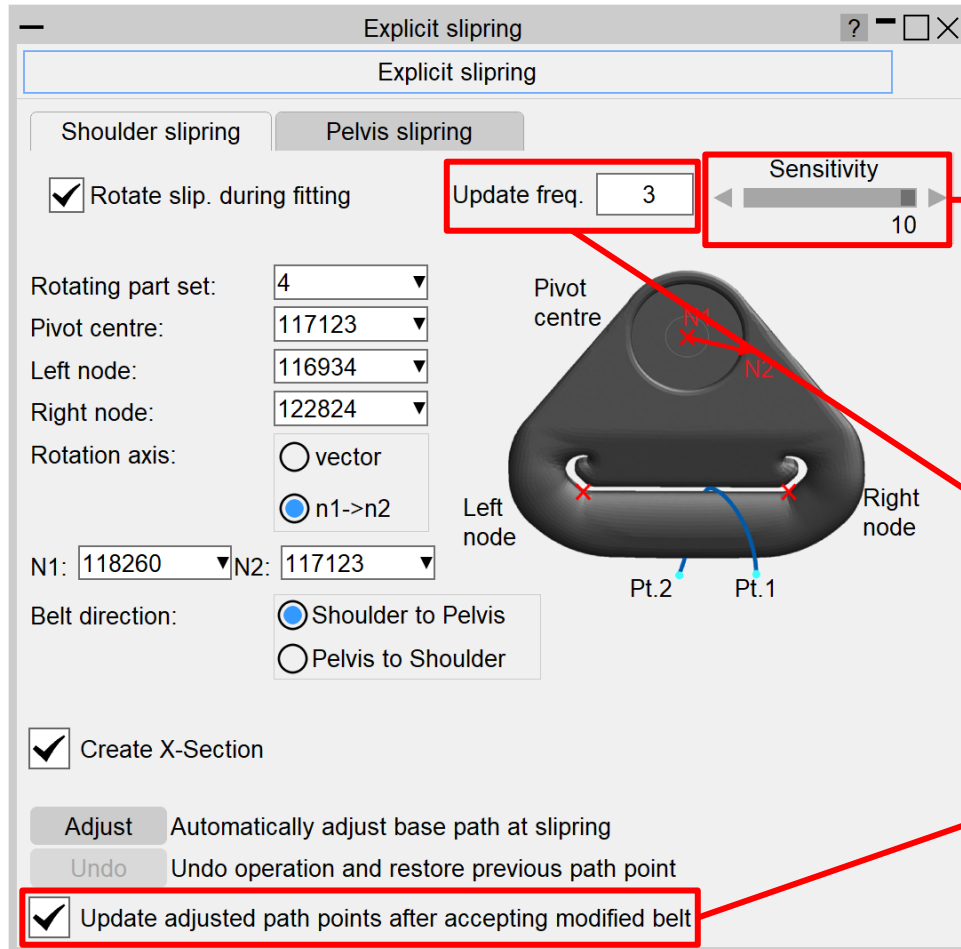


- The sensitivity setting dictates the reactivity of the slipring's rotation. A sensitivity level of 10 ensures uninterrupted slipring motion, making it ideal for remote starting points. At lower sensitivity, the pulling of the slipring will automatically stop and restart depending on the position of the belt in the slipring slot, improving the fitting speed.

- The number of belt fitting iterations between slipring rotations. A lower value gives a sturdier slipring rotation process, as it rotates more often, but takes longer to fit.

- Initial belt path points around sliprings can now update coordinates after the belt path was accepted in the main panel. Therefore, initial path points can remain positioned within slipring slots after sliprings are rotated.

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# Seatbelt enhancements – User Interface improvements

- Removed the 'Accept' button from the 'Explicit slipring' panel and used the generic 'Accept' button from the main 'Fit' panel to save any updates from the 'Explicit slipring' panel.

- Deactivated the 'Adjust' button when clicked to indicate that it can only be used once. It will get reactivated if 'Undo' is clicked.
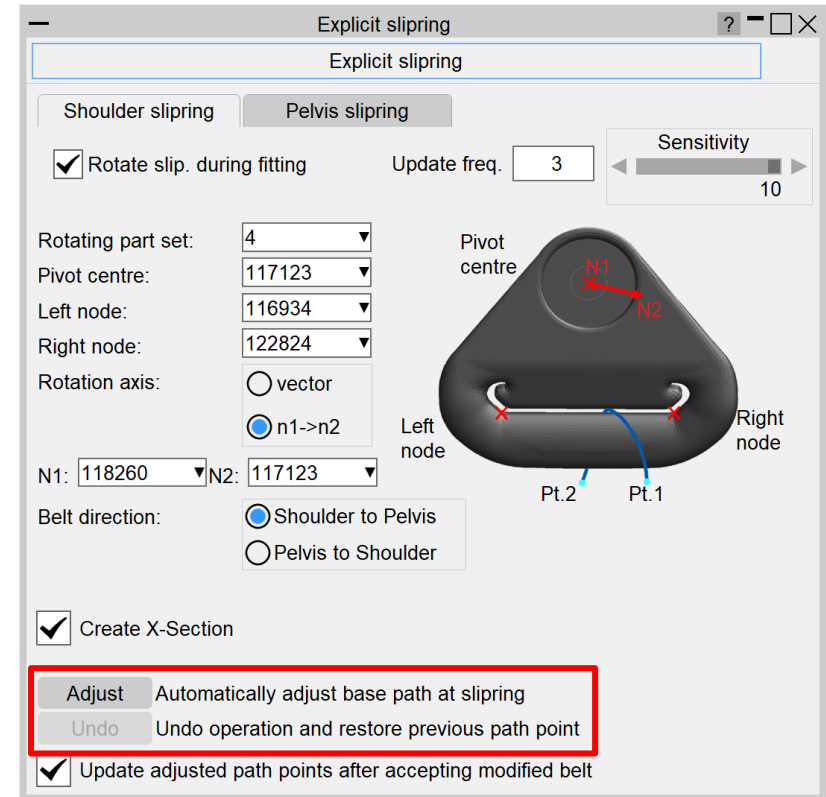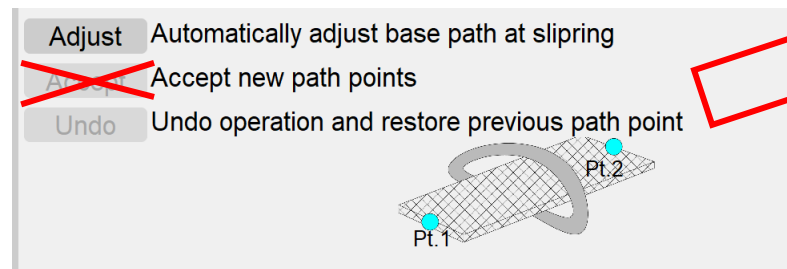
# Seatbelt enhancements – User Interface improvements

- Expanded the list of editable points in the 'Define path' panel (from 10 to 19 points) to make it easier for the user to visualise and edit the data.
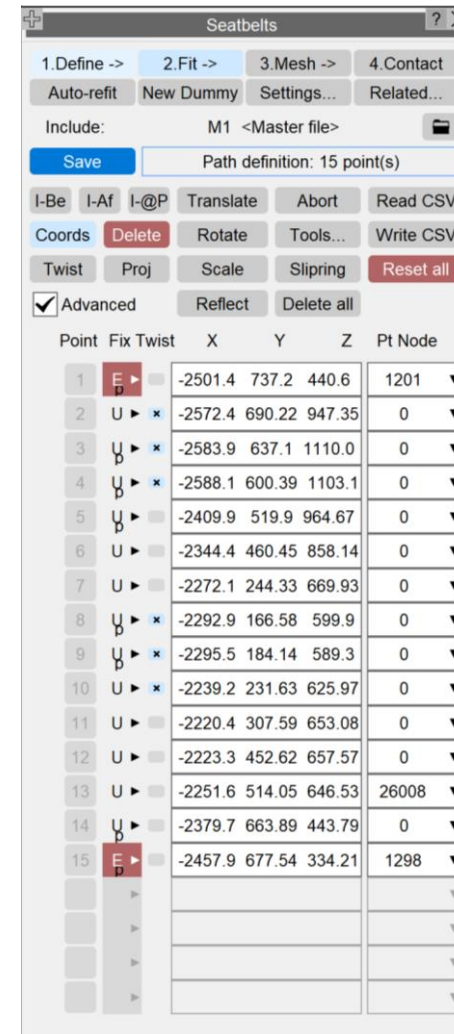
# Seatbelt enhancements – Cross Section for sliprings

- Added an option to create **\*DATABASE_CROSS_SECTION** for explicit slipring, accessible

  from Fit → Explicit slipring panel.
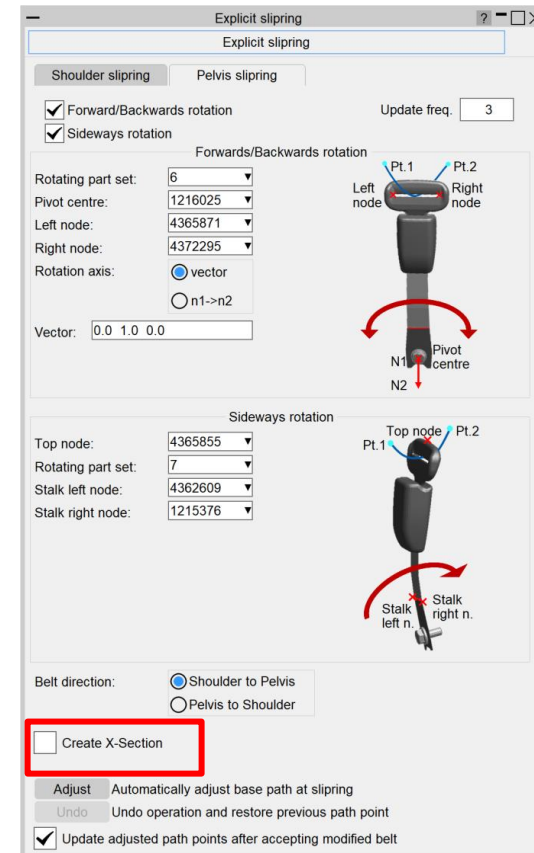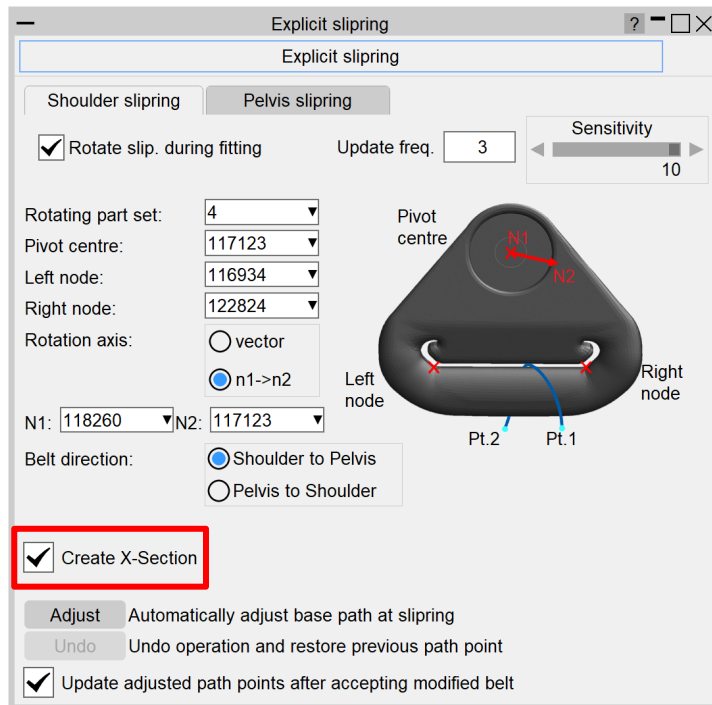
# Seatbelt enhancements – Cross Section title & auto-refit
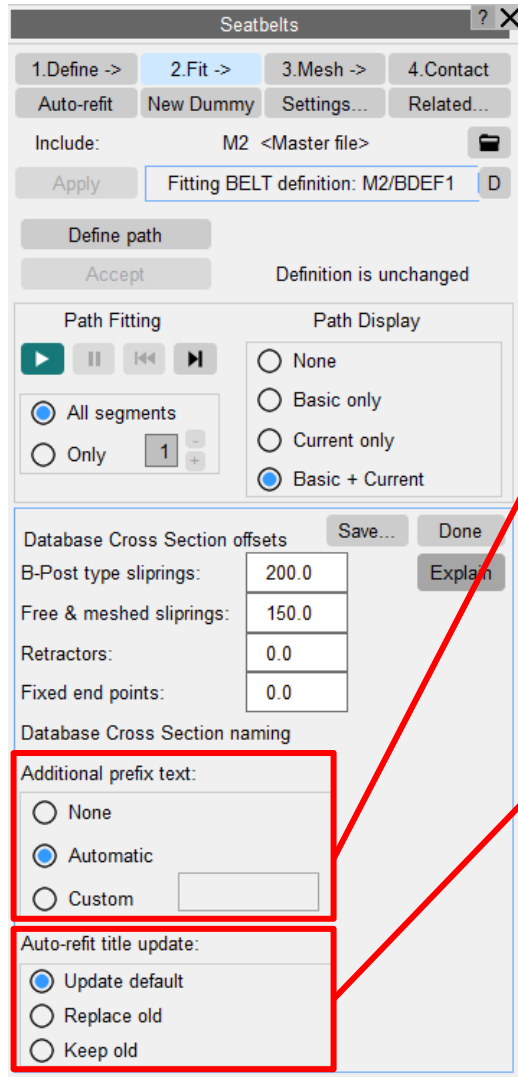
- Additional prefix text and auto-refit title update can be accessed from Fit → X-Section.

- You can now choose to have additional prefix text for the title of **\*DATABASE_CROSS_SECTION**s created on seatbelts. Options are:

  - None: No prefix text;

  - Automatic: Prefix text based on ISO standard (default);

  - Custom: User-defined prefix text.

- When doing a belt Auto-refit, the title of the existing X-Sections can now be reused. Options are:

  - Update default: Replace default part of the title keeping prefix text (default);

  - Replace old: Replace old title with new default title;

  - Keep old: reuse the old titles.

# Seatbelt enhancements – Sticky points
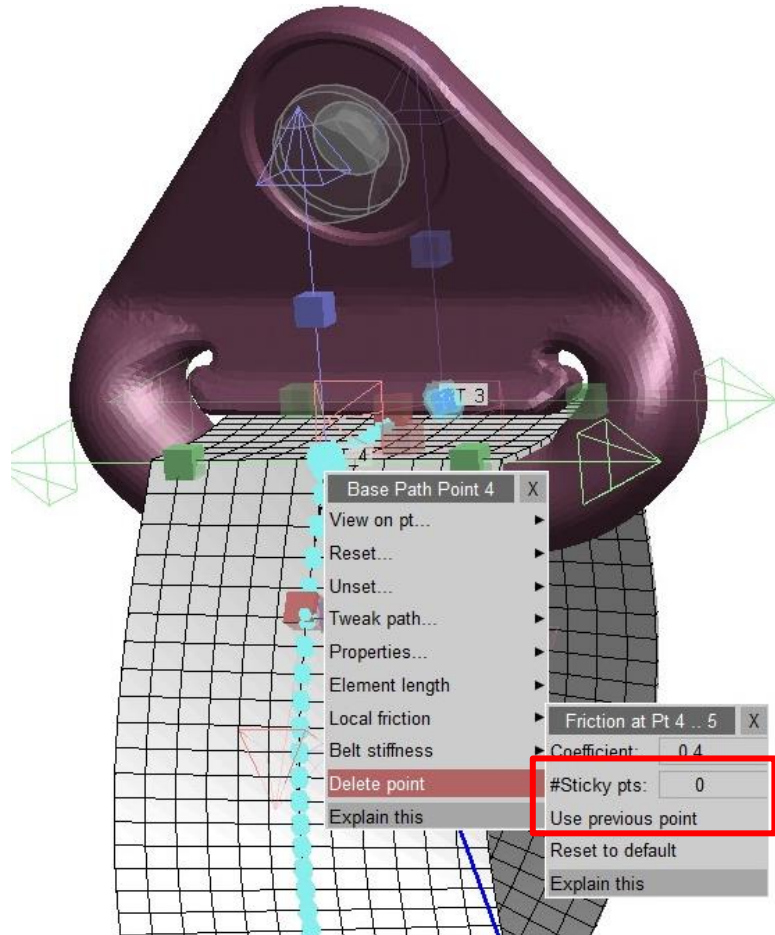


- If sliprings are not in the correct position, fitting the belt through a meshed slipring can lead the belt to drifting sideways and curl up against the side of the slot.

- To avoid this, central path points can now 'stick' when they make contact with the structure. This allows the outer edges of the belt to fit correctly while the belt's central path stays close to the initial contact point.

- The #Sticky pts value is the number of points along the centre of the belt, in between the current and next path points, that will stick to the structure.

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# Seatbelt enhancements – Mesh Density new Custom mode

- Added a new 'Custom' mode for the seatbelt mesh density in the 'Fitting options' panel that gets automatically selected if the related properties (Max curve angle, belt length and #rows) do not match any of the available modes, and if they do match a specific mode this will also be automatically selected.
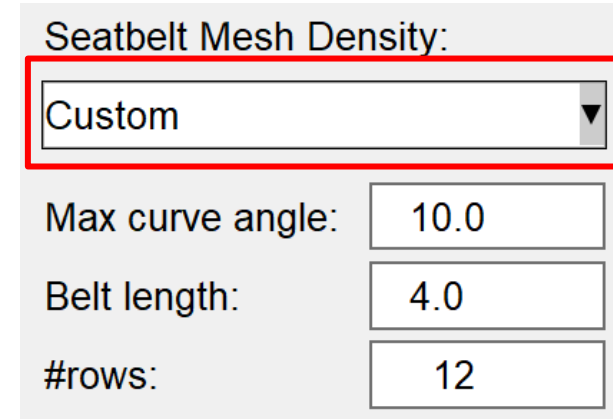
# Crash Test Setup Enhancements

# Crash Test Setup – Barrier Positioning Nodes

- Added a new barrier setting component in the 'Check Nodes' window that offers two methods for automatically configuring the positioning nodes on the barrier as follows:

  - If the "Existing" option is selected, the script will find the corner nodes at the lowest edge of the barrier front face (old method);

  - If the "New Nodes" option is selected, the script will automatically create new nodes at the intersections of the lower front edge and lower side edges. This can be useful for barrier models with curved lower corners providing more accurate positioning results.

*Oasys*
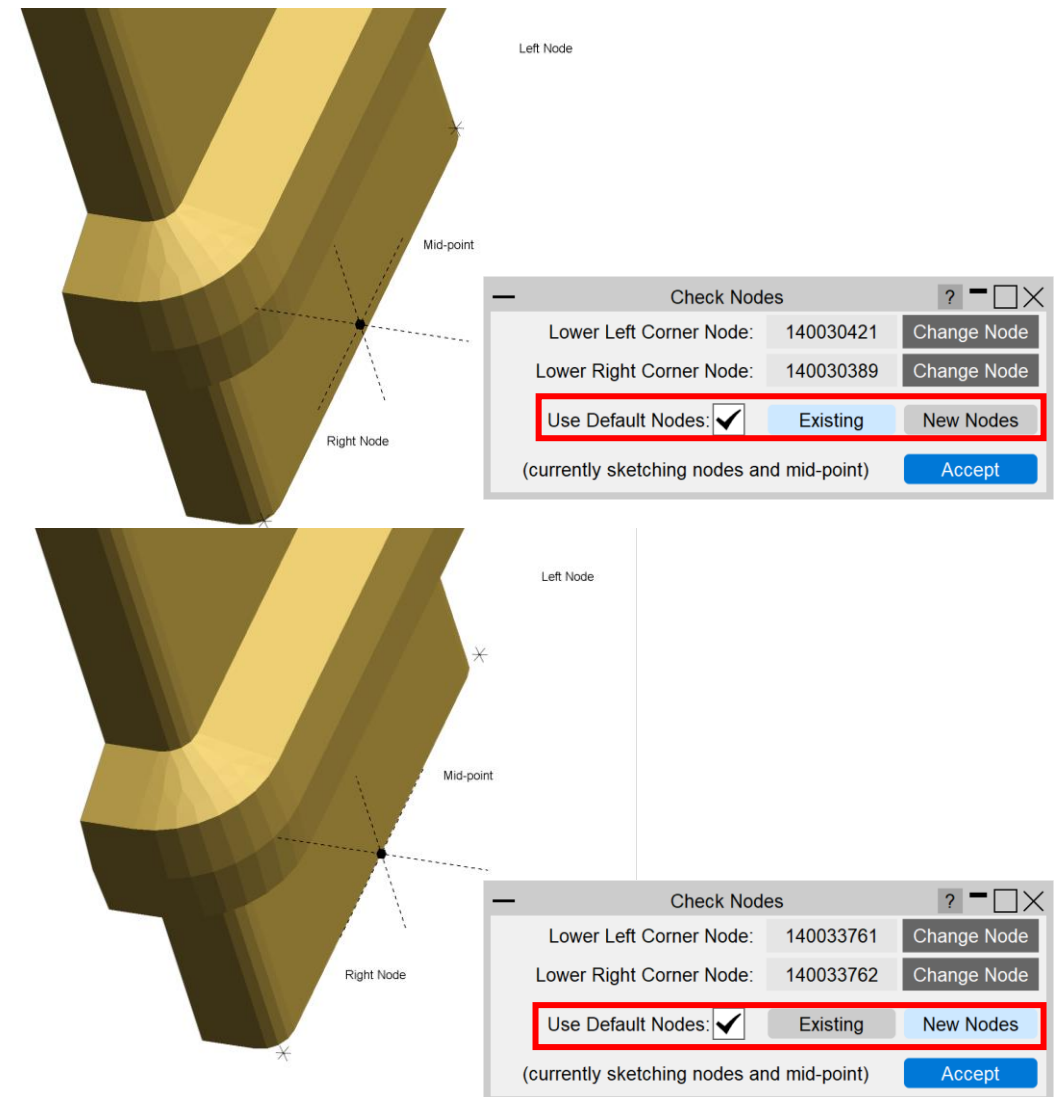
# Crash Test Setup – Barrier Positioning Nodes

- The mode selected in the 'Check Nodes' window can be saved at file scope as part of the Barrier settings.

- Both methods for automatically configuring the positioning nodes are supported in batch mode.

- The "New Nodes" option will create nodes at the first available labels, and these will be written to the barrier include file in the output model. There is no need to save these nodes for use in a new session as they will automatically be created if the mode is saved to "New Nodes" in the imported barrier settings.

# Crash Test Setup – Impact angle option

- New impact angle option has been added for the RCAR Low-Speed (Front) Case to allow the user to position the barrier along the z-axis.

# Pedestrian Markup Enhancements

# Pedestrian Markup Tool – New protocol support

- Support has been added for the GB 24550 202X

  markup protocol:

  - Selectable from the protocol list and command line

    options;

  - Windscreen zone can be calculated with or without

    an obscuration part;

  - If no obscuration part is provided, a pseudo-

    obscuration width can be specified to emulate the

    existence of an obscuration part.

*Oasys*
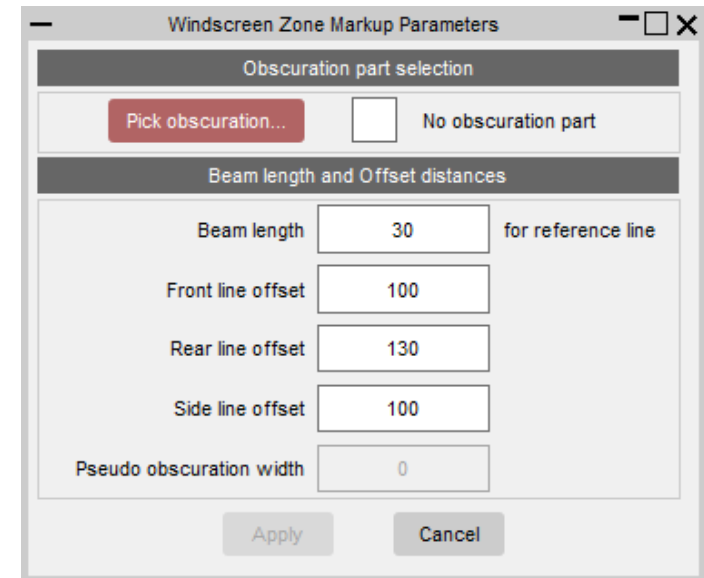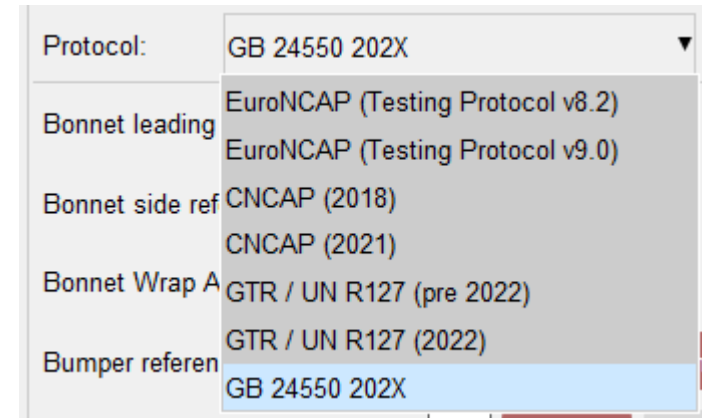
# HIC Area Calculator

# HIC Area Calculator

- Support has been added for UN R127.03, specifically the definition of the windscreen test zone.

- Windscreen test points are identified using the point name prefix 'W' or 'B'.

- Any input points that have names beginning with 'W' or 'B' will be used to defined a separate HIC zone when selecting the GTR / R127.03 regulation.



Bonnet Zone
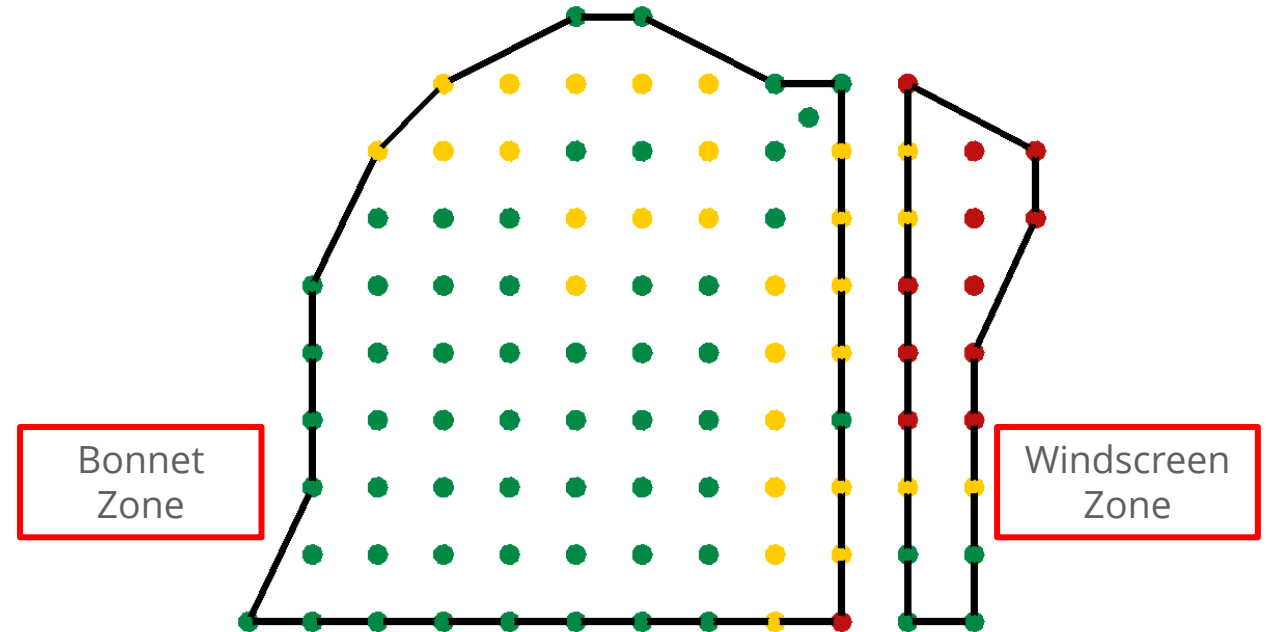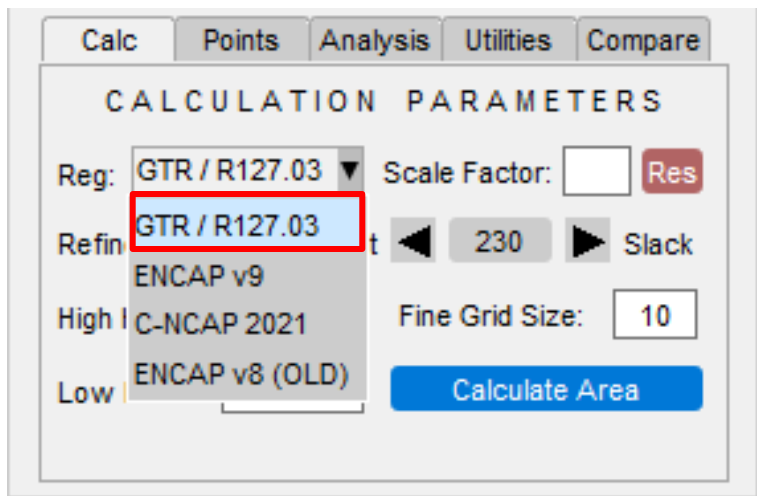
Windscreen Zone

# HIC Area Calculator

- The GTR/R127.03 results table includes new rows for the windscreen and bonnet (child and adult combined).

- Additional hover text has also been added to for the combined row, documenting exactly how the calculator arrives at it's combined HIC area %.

| | # of Points | | Low HIC % by | | >High |
|---|---|---|---|---|---|
| | <Low | >Low | # Points | Area | |
| Child | 28 | 5 | 84.8 % | 85.7 % | 0 |
| Adult | 27 | 21 | 56.3 % | 54.2 % | 1 |
| Bonnet | 55 | 26 | 67.9 % | 64.8 % | 1 |
| Windscreen | 4 | 15 | 21.1 % | 13.4 % | 11 |
| Combined | 59 | 41 | 59.0 % | 58.4 % | 12 |

Hover text

GTR / R127.03 % Area = 58.4%.

This is calculated by populating the test area with a regular grid of interpolation points (the 'small blobs').
Each interpolation point has an asscoiated HIC value, calculated via interpolation from its nearest input blobs.

For the current result there were a total of 7425 interpolation points used in the calculation:

2186 child interpolation points (viewable by selecting Child points only from the Points tab of the menu.)
6502 bonnet (child + adult) interpolation points (viewable by selecting Bonnet points only from the Points tab of the menu.)
923 windscreen interpolation points (viewable by selecting Windscreen points only from the Points tab of the menu.)

For the child zone, 1873 interpolated points had an interpolated value less than 1000 HIC. Thus: 1873 / 2186 = 85.7%.
For the bonnet zone, 4213 interpolated points had an interpolated value less than 1000 HIC. Thus: (1873 + 2340) / (2186 + 4316) = 64.8%
For the windscreen zone, 124 interpolated points had an interpolated value less than 1000 HIC. Thus: 124 / 923 = 13.4%.

Overall there were 4337 interpolated points with values less than 1000 HIC (1873 + 2340 + 124).
giving a combined % area of 4337 / 7425 = 58.4%.

In comparison, just taking the points in the input file generates: 59 / (59 + 41) = 59.0 %.

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# HIC Area Calculator

- Following the addition of the windscreen zone, it is now possible to input three different user defined perimeters: Bonnet, Windscreen and NCAP.

- Bonnet and Windscreen perimeters are used to define their respective test zones as used by the GTR/R127.03 regulation.

- NCAP is not used any regulation output but does define the area considered when contouring HIC (from the Analysis tab), while selecting the NCAP regulations.

- Support for user input WAL (e.g. child WAL to distinguish child and adult zones) has been improved and is now more robust than previous versions.
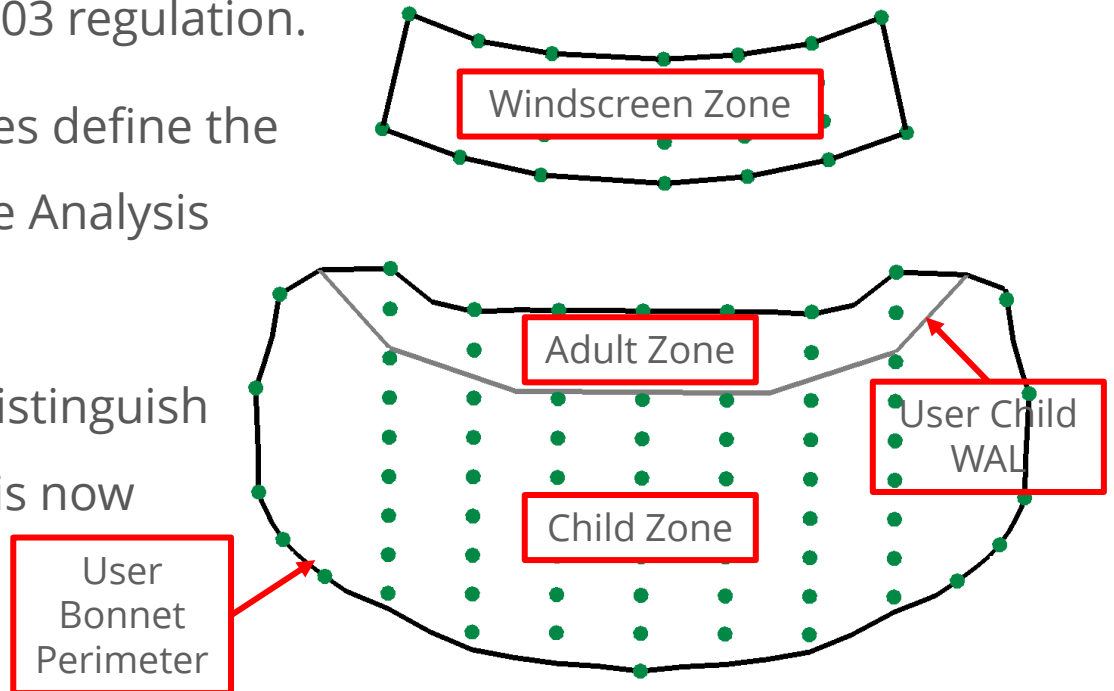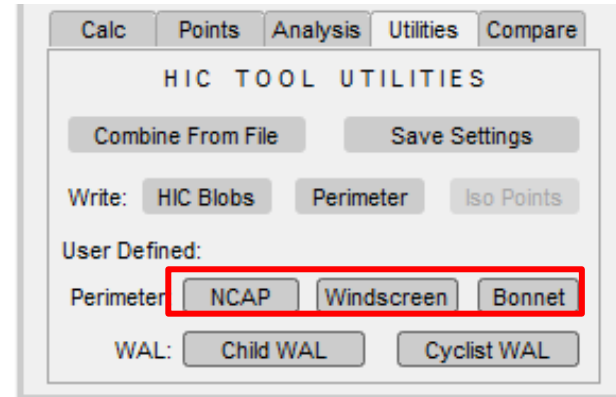
# HIC Area Calculator

- New functionality has been added to the 'Points'
  tab. Users can now:
  - *Query Point Data* – by selecting a point from the
    screen, a pop-up menu will display the respective
    input data.
  - *Open Directories* – by selecting a point from the
    screen, the tool will open a file browser window for
    the directory belonging to the point (only possible
    when a file path is included in point input data).
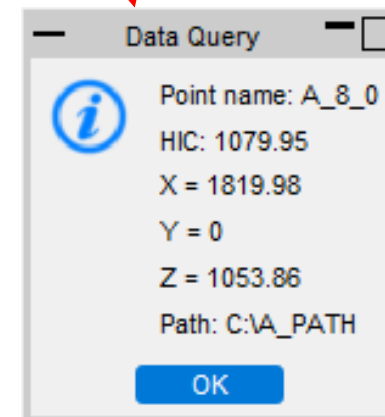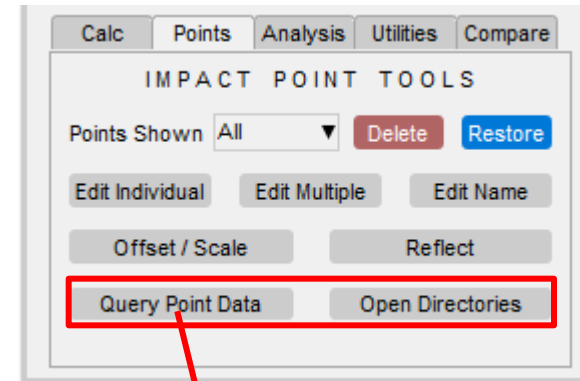
# Closures Setup Tool

# Closures Setup Tool

- The closures setup tool is a new feature in PRIMER 21.0 which is accessible through the JavaScript menu.

- The intended application of the tool is for vehicle closures (e.g. bonnets, doors, tailgates).

- The tool helps setup a model so that the position of a closure include file can be controlled by a single **\*PARAMETER**.

- This removes the need to maintain several models of the same closure in different positions and allows for more accurate positioning.

- The tool supports two types of hinges:

    - Simple hinge;

    - Four bar link.

# Closures Setup Tool

- For example, the position of the bonnet or door include file can be changed by modifying a single **\*PARAMETER**.
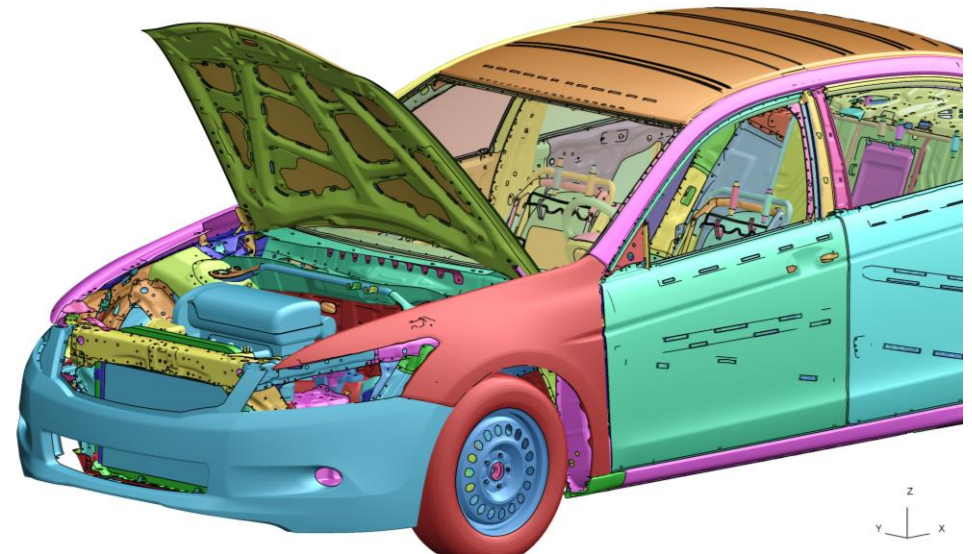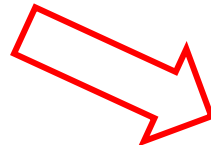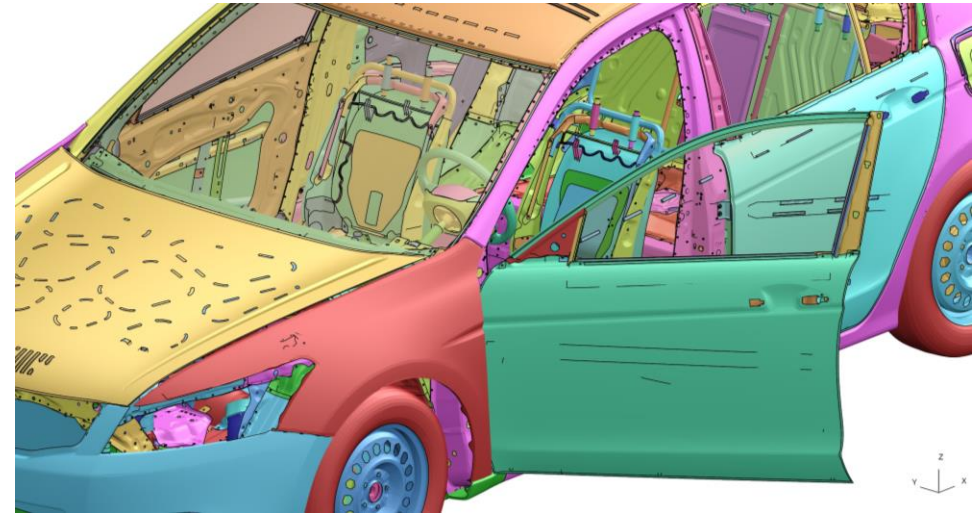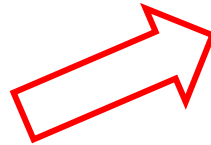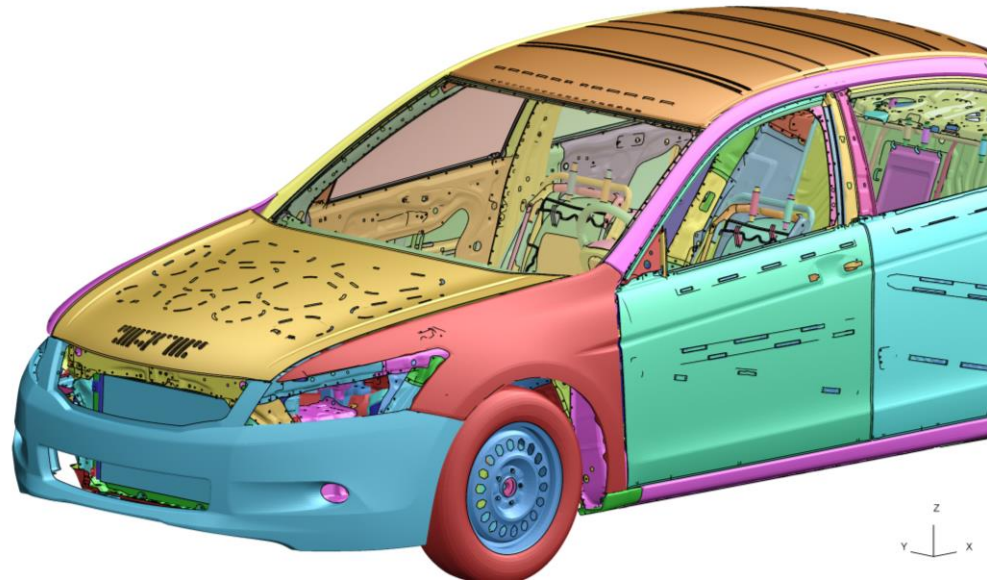
# Python

# New Python API

- The new Python API will allow you to do most things you can do from the JS API.

- Advantage: the Python scripts run outside the programs: from the same script it is possible to speak to PRIMER, D3PLOT, T/HIS and REPORTER, and to any other software that has a Python API. It also allows importing any Python module into the script.

- Install the Python packages:

    - https://pypi.org/project/Oasys.PRIMER/

    - https://pypi.org/project/Oasys.D3PLOT/

    - https://pypi.org/project/Oasys.THIS/

    - https://pypi.org/project/Oasys.REPORTER/

- There is comprehensive Python API documentation to help you start scripting.

# JavaScript API

# JavaScript API: Behaviour of scripts using windows

- The way that scripts that use windows/GUIs are run has changed in version 21.

- All programs that have a graphical user interface (GUI) use an "event loop" to process any mouse/keyboard events.
  PRIMER has a main "event loop" to process all of the program's events.

- In version 20 and before, if a script created and showed a window, PRIMER would start a new "event loop" to manage and process that JavaScript window.

- The script would not return from the window Show() call until the window was hidden/closed.
  i.e. showing the window would "block" execution of the script until the window was closed.

- When the window is closed, the script continues.

- When execution reaches the end of the script, the script is terminated.

# JavaScript API: Behaviour of scripts using windows

- For example, in version 20 and earlier, in the following script, "Hello, world!" will not be printed until the window is closed because the call to w.Show() will not return until the window is closed.

```
// Create a window with a widget
var w = new Window("Test", 0.5, 0.6, 0.5, 0.6);
var l = new Widget(w, Widget.LABEL, 0, 50, 0, 6, "Press X to close the window");

// Show the window and start event loop
w.Show();

// Print message
Message("Hello, world!");
```

- When the window is closed the message is printed and the script will then terminate as execution has reached the end of the script.

# JavaScript API: Behaviour of scripts using windows

- In version 21 the behaviour has changed.

- If a script creates and shows a window, PRIMER will **\*not\*** start a new "event loop" to manage and process that JavaScript window.

- The window will now be processed from the main "event loop" in PRIMER.

- The script now returns from the window Show() as soon as the window is shown, and execution of the script continues.
  i.e. showing the window no longer "blocks" execution of the script until the window is closed.

- When execution reaches the end of the script, the script is **\*not\*** terminated.

- The script continues running "in the background" as the script has shown a window.

# JavaScript API: Behaviour of scripts using windows

- For example, in version 21, in the following script "Hello, world!" will be printed immediately after the window is shown, because the call to w.Show() returns after the window is shown.

```
// Create a window with a widget
var w = new Window("Test", 0.5, 0.6, 0.5, 0.6);
var l = new Widget(w, Widget.LABEL, 0, 50, 0, 6, "Press X to close the window");

// Show the window
w.Show();

// Print message
Message("Hello, world!");
```

- When the message is printed, the script will **\*not\*** terminate when execution reaches the end of the script. The script will continue to run "in the background"

# JavaScript API: Behaviour of scripts using windows

- If a script that shows windows continues running "in the background", and does not terminate when execution reaches the end of the script, how/when does the script terminate?

- A script that uses windows **\*must\*** now call `Exit` to terminate the script.

```
// Create a window with a widget
var w = new Window("Test", 0.5, 0.6, 0.5, 0.6);
var l = new Widget(w, Widget.LABEL, 0, 50, 0, 6, "Press X to close the window");

// Exit when window closed
w.onClose = Exit;

// Show the window
w.Show();

// Print message
Message("Hello, world!");
```

# JavaScript API: Behaviour of scripts using windows

- To find what scripts are currently running there is a new "Running" tool in the JavaScript window.

- Any scripts that are currently running will be shown and can be terminated if required.

*Oasys*
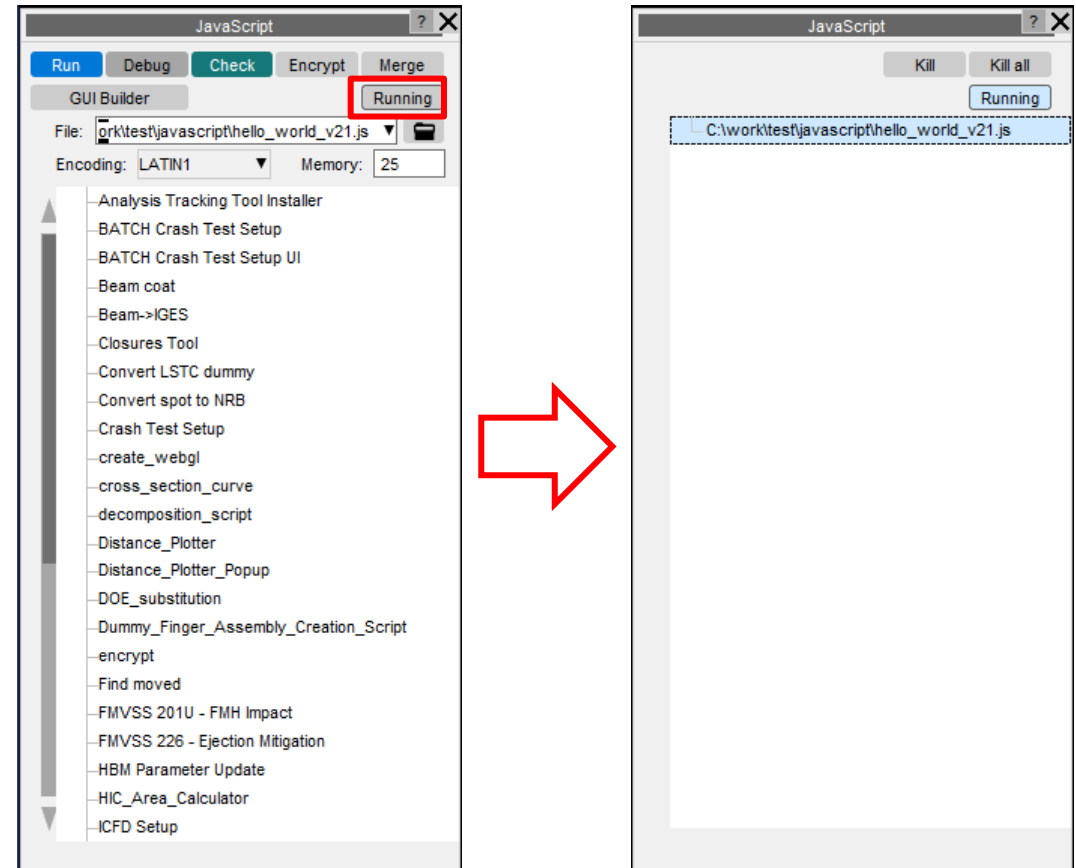
# JavaScript API: Behaviour of scripts using windows

- Why has this change been required?

- JavaScript is used extensively by clients to customize PRIMER and create their own workflows.

- It is also used by us to develop core tools/functionality in PRIMER.

- When multiple scripts are running at the same time, the way this was implemented in version 20 and before was causing issues.

- Scripts had to be closed/terminated in the reverse order to which they were started.

# JavaScript API: Behaviour of scripts using windows

- In version 20 and before, every time a script with a GUI is used, an "event loop" is created to process the script. Every "event loop" that is created is a "child" of the previous event loop.

- For example, the diagram on the right visualises the event loops in version 20, if script "A" and script "B" are both started.

- If the script "A" is closed, script "B" must also be closed as the "event loop" for script "A" is terminated, and the "event loop" for script "B" then has no "parent".

Main event loop.
Process core events

Event loop for script "A"

Event loop for script "B"
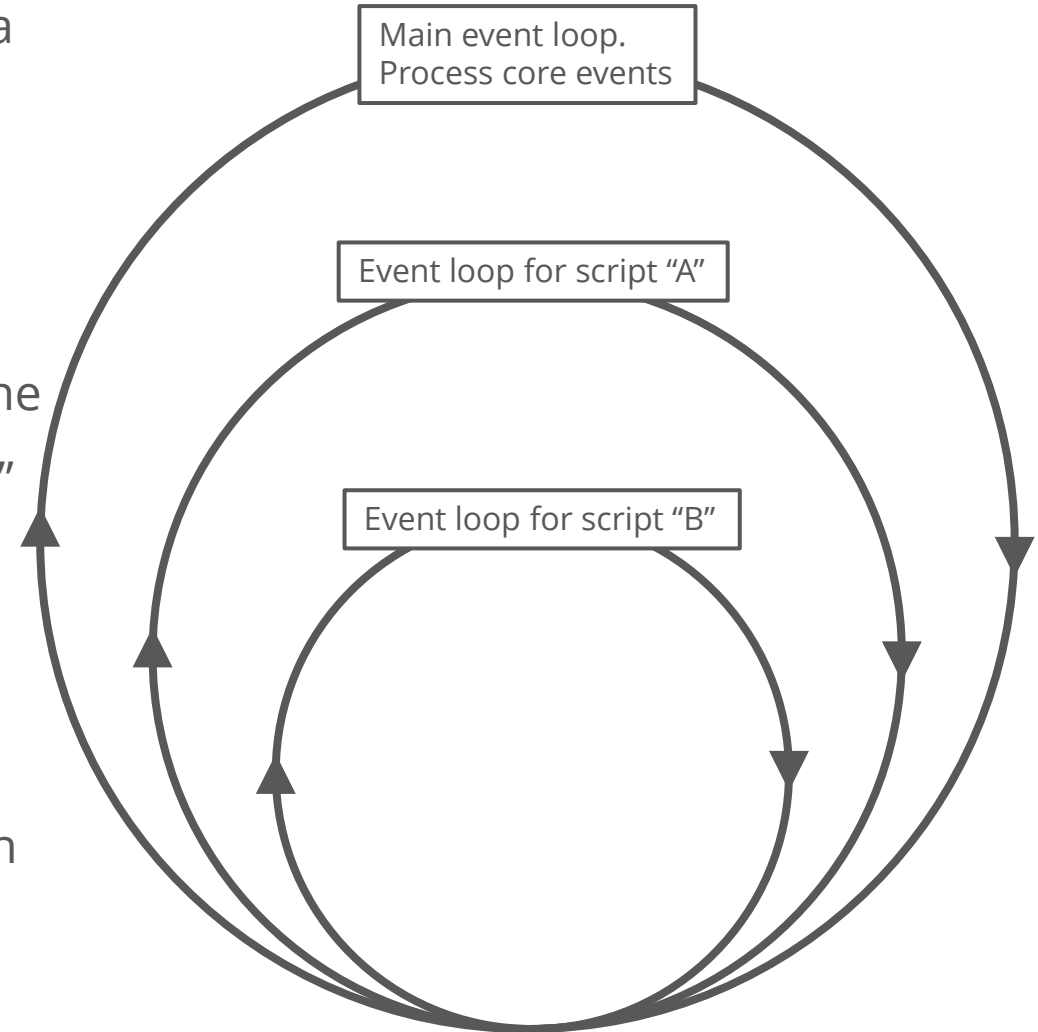
# JavaScript API: Behaviour of scripts using windows

- In version 21 we no longer create an "event loop" to process each script. Calling Window Show() returns instead of "blocking"

- The main "event loop" processes everything.

- For example, the diagram on the right visualises the event loop if script "A" and script "B" are both started.

- If the script "A" is closed, script "B" can continue to run as the "events" for it are all processed in the main event loop.

Main event loop.
Process core events

Process events for
script A

Process events for
script B
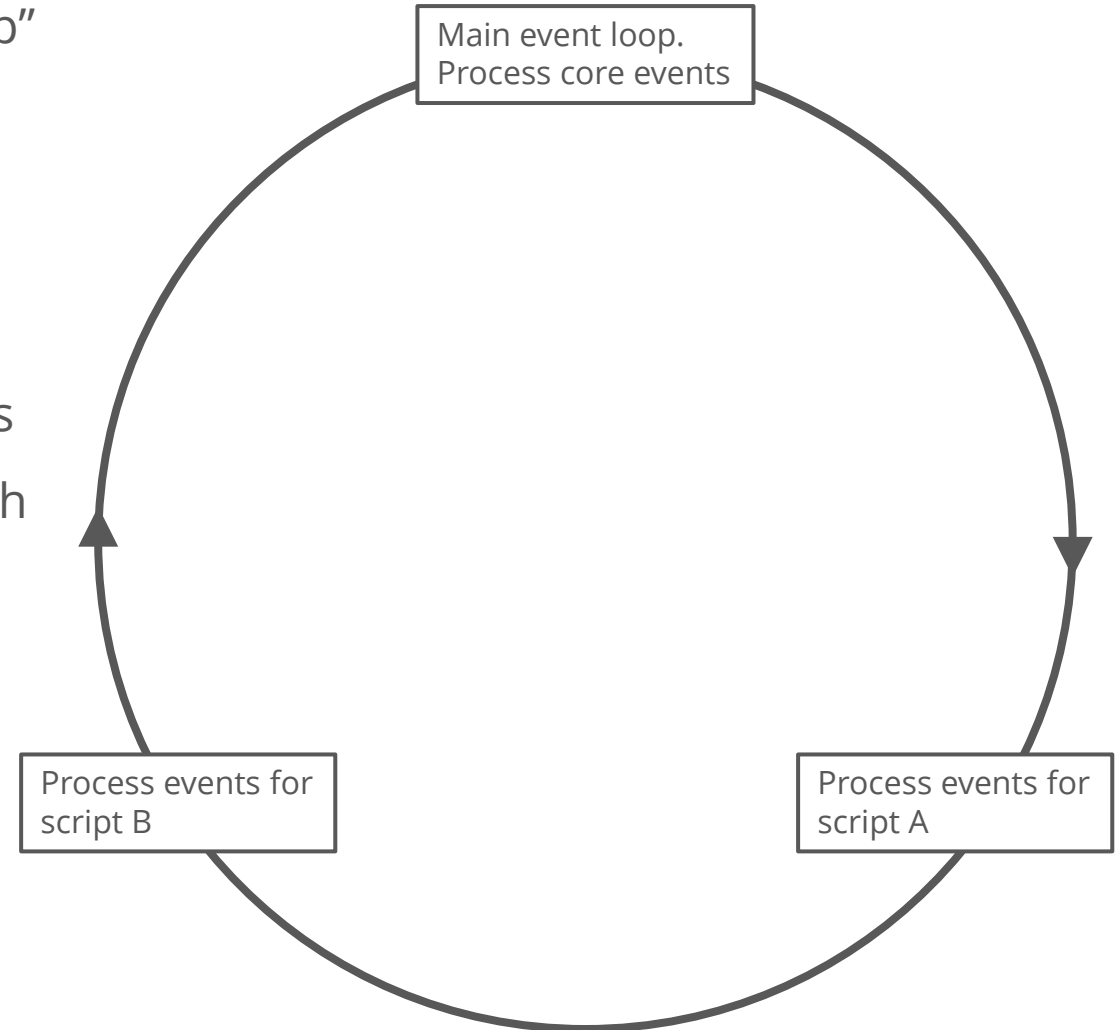
# JavaScript API: Cross section

- New member function added: CrossSection.Autosize(). This function autosizes the **\*DATABASE_CROSS_SECTION** such that it cuts all elements on the plane.

- New class function added: CrossSection.CreateAlongFeatureLine(). This function creates a series of **\*DATABASE_CROSS_SECTION**s along a free edge or feature line, starting at a specified node. The function also offers options to autosize the cross sections created.

- The constructor's arguments have been deprecated. The new argument list consists of the model and cross section type (as before), and a third argument in the form of an object. The properties of this object argument can define the old arguments, as well as some new optional properties to control autosizing for _PLANE cross sections

# JavaScript API: Workflows

- An extra optional argument has been added to Workflow.NumberOfModels().

  - If defined it returns the number of models that have data for the specified workflow.

  - If not defined it works as before where it returns the number of models that have data for the workflow selected by the user in the workflows menu.

- An extra optional argument has been added to Workflow.ModelIdFromIndex().

  - If defined it looks through the list of models that have data for the named workflow and returns the model id of the model at the specified index in the list.

  - If not defined it works as before where it returns the model id of the model at the specified index in the list of models that have data for the workflow selected by the user.

# JavaScript API: Workflows

- New methods added to the Workflow class:

  - Refresh() – scans for fresh workflow data;

  - ModelUserDataProgramFromIndex() – Returns the name of the program that the user data was written from;

  - ModelUserDataVersionFromIndex() – Returns the version of the program that the user data was written from;

  - ModelUserDataBuildFromIndex() – Returns the build number of the program that the user data was written from.

# Other JavaScript API changes

- An onHide event has been added to the Window class.

- Added new JS-API class for:

  - **\*FREQUENCY_DOMAIN_RANDOM_VIBRATION**;

  - **\*DAMPING_FREQUENCY_RANGE**;

  - **\*DAMPING_PART_MASS**;

  - **\*DAMPING_PART_STIFFNESS**;

  - **\*DAMPING_RELATIVE**.

- Added object types for:

  - **\*DAMPING_MODAL**;

  - **\*DAMPING_STRUCTURAL**.

# Workflows
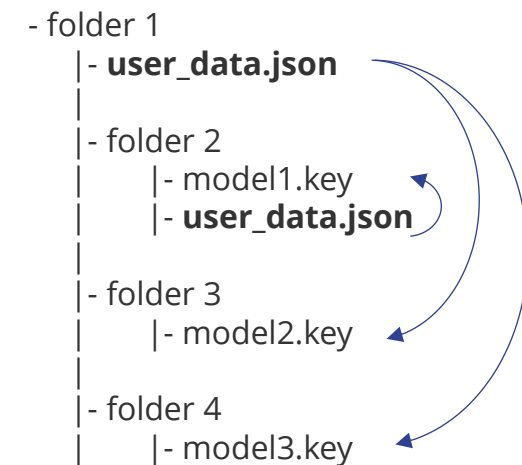
# Workflows User Data

- We have made it easier for you to save Workflows user data to be re-used by multiple models and LS-DYNA runs.

- In Oasys 20, the JSON user data file written by a workflow tool had to be saved in the same folder as the model/results. This meant that if you had multiple variations of a model, you had to have copies of the same JSON file in each model/results folder, which was time consuming if edits needed to be made to the data.

- In Oasys 21, JSON user data can now also be saved in the parent folders of models, meaning the same data can be used for multiple models. The model folder is searched first, and then parent and grandparent folders are searched for valid JSON files. Preference **oasys*workflow_max_upward_folder_search_depth** can be set to control the number of parent folders that are searched. The default is 4.

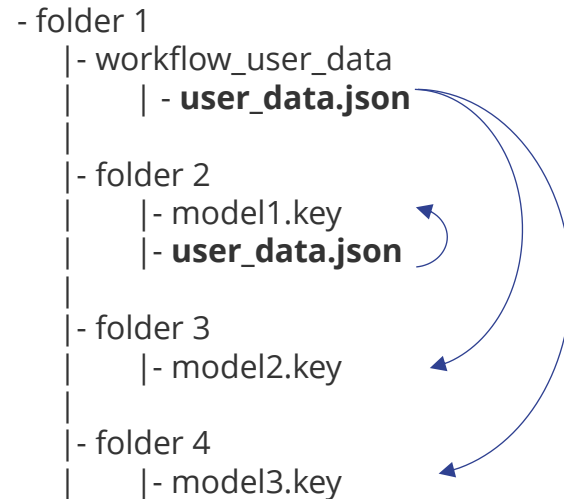In this folder structure [right], the user_data.json file in **folder 1** will be used for the models in folder 3 and folder 4, and the user_data.json file in **folder 2** will be used for the model in folder 2:

```
- folder 1
   |- user_data.json
   |
   |- folder 2
   |      |- model1.key
   |      |- user_data.json
   |
   |- folder 3
   |      |- model2.key
   |
   |- folder 4
   |      |- model3.key
```

# Workflows User Data

- The scan will also look for user data in a folder named '**workflow_user_data**' in the model folder and its parent folders.

- For example, in the folder structure below, the user_data.json file in **folder 1/workflow_user_data** will be used for the models in folder 3 and folder 4, and the user_data.json file in **folder 2** will be used for the model in folder 2:

```
- folder 1
    |- workflow_user_data
    |        | - user_data.json
    |
    |- folder 2
    |        |- model1.key
    |        |- user_data.json
    |
    |- folder 3
    |        |- model2.key
    |
    |- folder 4
    |        |- model3.key
```

- The name of the folder to search can be changed by setting the preference **oasys*workflow_user_data_directory_name**

# Automotive Assessments

In Oasys 21 the assessment values and scores are now presented in a table making it easier to view the results

# Far Side + VTC crash test

- New **Far Side + VTC** crash test has been added in the Automotive Assessments workflow to support Virtual Testing.

- Includes support for all 115 channels (Occupants + Structures) required for the Euro NCAP Virtual Far Side Simulation & Assessment Protocol
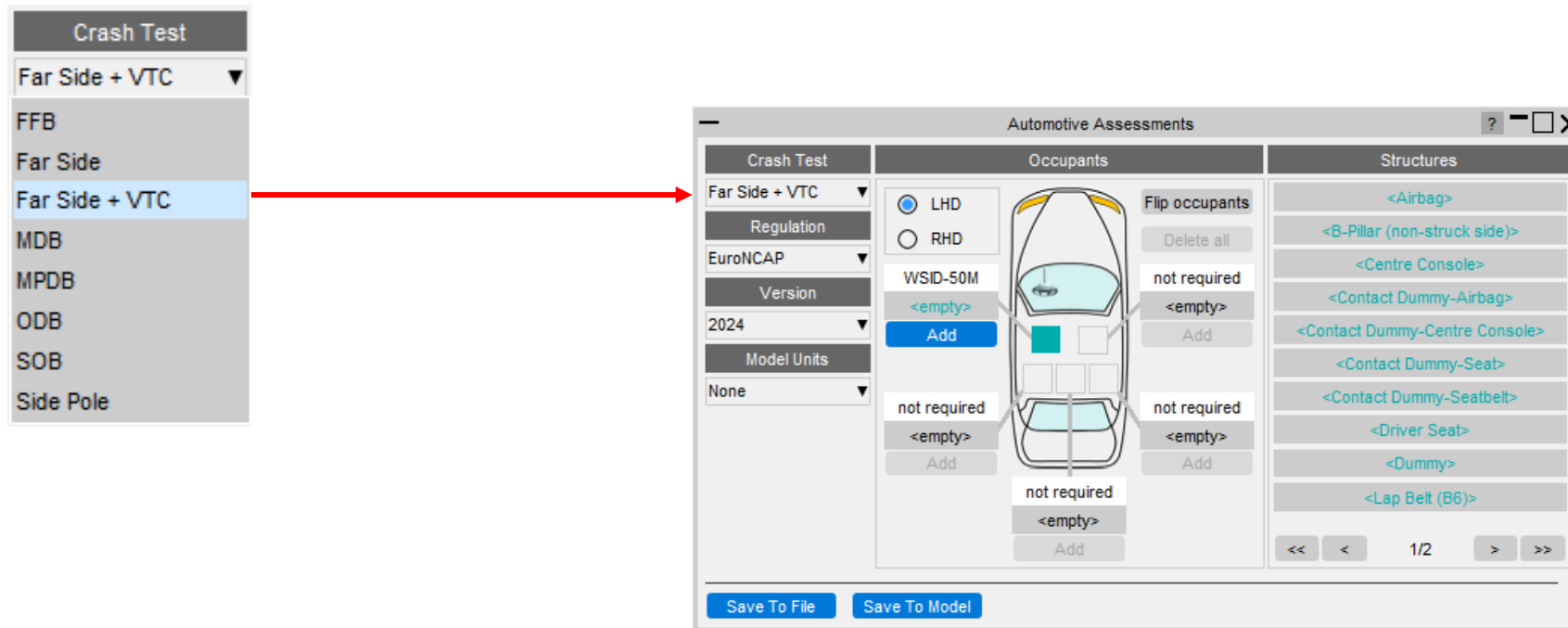
# Improved entity selection for multiple parts

- To facilitate multiple PARTs selection, new options have been added in the Automotive Assessments entity selection popup:

  1. Select by PART

  2. Select by SET_PART

  3. Select by INCLUDE

- In the Far Side + VTC crash test, these options are useful for selecting multiple PARTs for structural channels like Kinetic Energy, Internal Energy, and Hourglass Energy, for Airbag, Centre Console, Driver Seat and Dummy.

*Oasys*
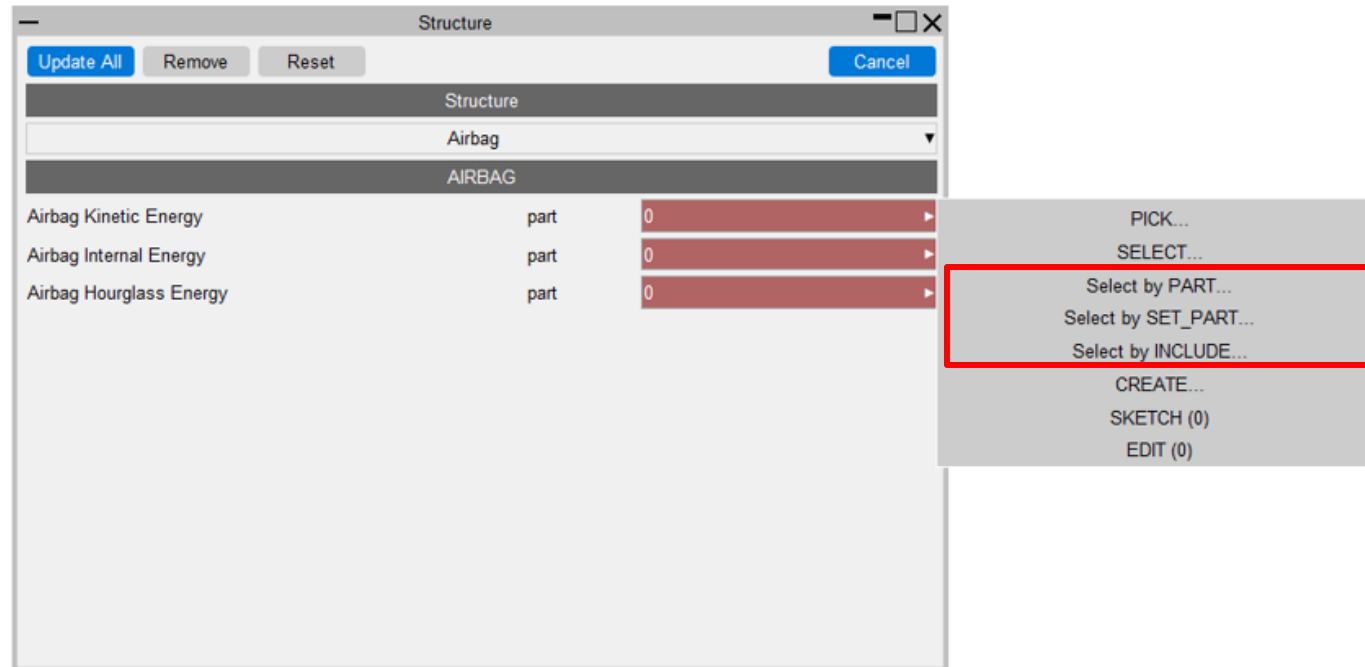
# Updated support for different occupant versions

- We now support the DYNAmore/PDB WorldSID 50M occupant in versions 4.0, 6.0, 7.6 and 8.0 for left-hand and right-hand drive.

- We have reviewed and corrected various entity IDs and history titles in occupant JSON files that are supported in Automotive Assessments workflow. The list of occupant JSON files and corresponding manual referenced for checking are listed in this [table](table).

*Oasys*

# Euro NCAP Virtual Far Side Validation Criterion 2

- Automotive Assessments can be used to check Validation Criterion 2 manually, according to Section 6.3 of the [Euro NCAP Virtual Far Side Simulation & Assessment Protocol](#).

- Validation Criterion 2 check can also be automated using [Euro NCAP Virtual Far Side 2024 VC2 (Assessment Criteria)](#) REPORTER template .
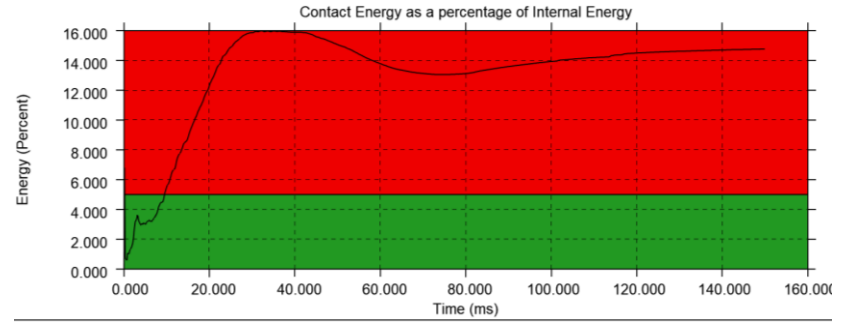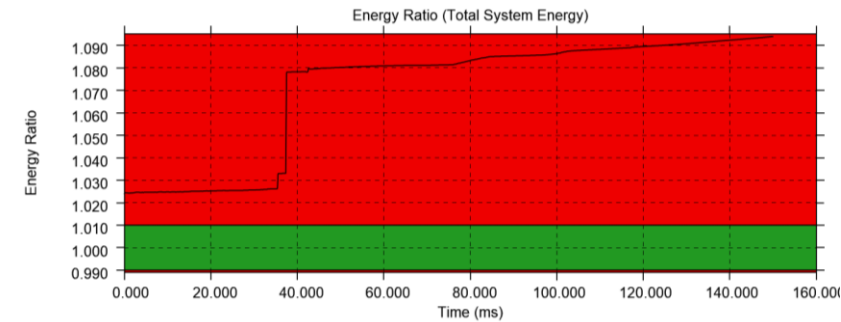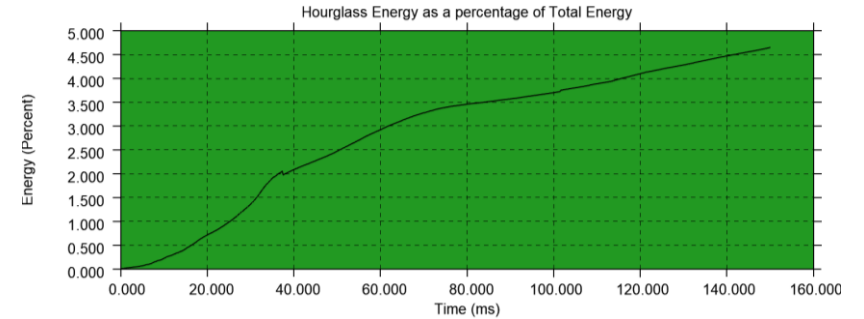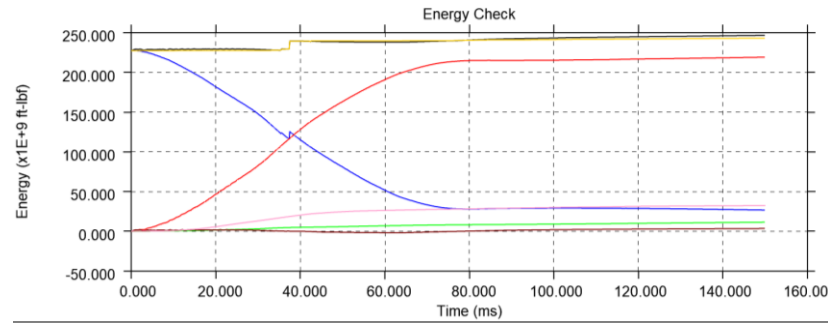
# New Protocols

- In Oasys 21.1, the following new protocols have been added to the Automotive Assessments workflow. Each of these represents a different loadcase required as part of the C-NCAP Management Regulation (2024 Edition).

| Crash Test | Regulation | Version | Description |
|---|---|---|---|
| Far Side + VTC | C-NCAP | 2024 (SID2-SBLD) | • Front passenger side impact, assessing driver (Far Side Occupant) injury. |
| Far Side + VTC | C-NCAP | 2024 (WSID) | • Injury scoring according to Chapter III section 1.2.1.5.3 of C-NCAP Management Regulation (2024 Edition) and Virtual Testing according to Appendix H.1.2.1.3. |
| Far Side Pole | C-NCAP | 2024 (ES-2re+WSID) | • Front passenger side impact, assessing driver (Far Side Occupant) injury according to Appendix H.1.2.2.2. |
| Far Side Pole | C-NCAP | 2024 (WSID+WSID) | • Injury scoring based on Chapter III section 1.2.1.5.4 of C-NCAP Management Regulation (2024 Edition). |
| Side Pole | C-NCAP | 2024 (WSID+ES-2re) | • Driver side impact assessing driver injury according to Appendix D. |
| Side Pole | C-NCAP | 2024 (WSID+WSID) | • Injury scoring based on Chapter III section 1.2.1.4 of C-NCAP Management Regulation (2024 Edition). |

# Energy Check

- Previously, the Energy Check tool simply plotted total, kinetic, internal and hourglass energy for your model. In Oasys 21, the tool now plots more energies, produces visual checks, and more.

# Entities of Interest

• Previously, the Entities of Interest tool was able to Only, Highlight and complete GLB Exports for selected entities grouped by Parts or Part Sets. In Oasys 21, you can now Zoom In, Colour By and produce Mixed-Mode Plots grouped by Parts, Parts by Set, Parts by Include and Parts by Group.
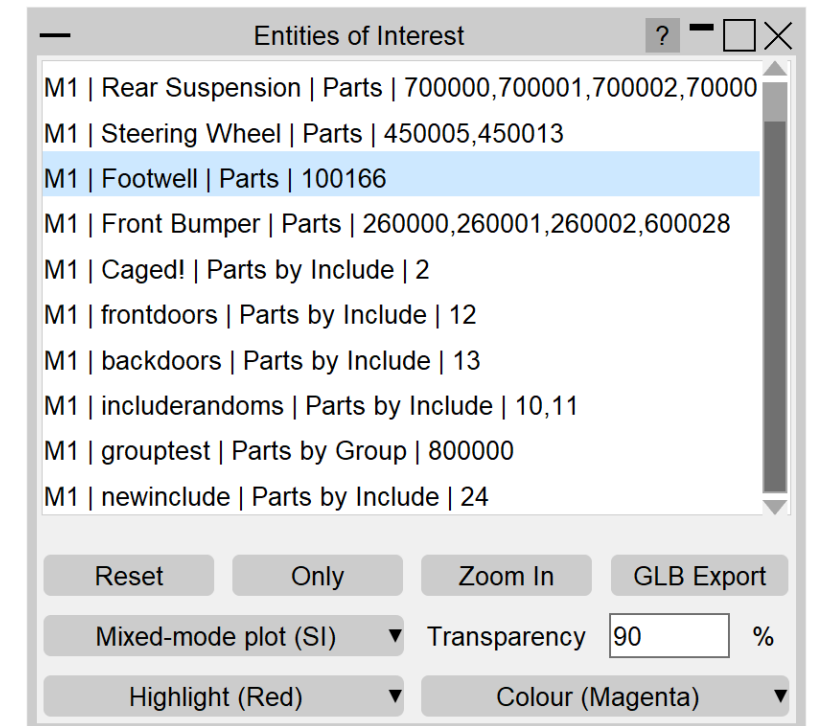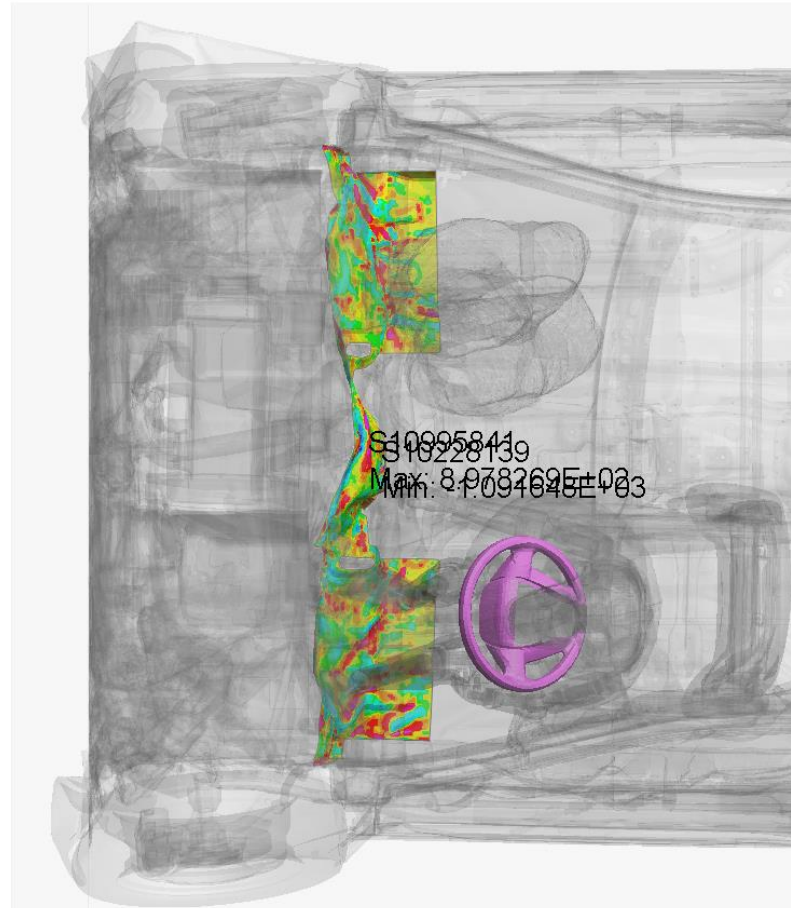


The image shown is an SI Mixed-Mode Plot on the Footwell and Coloured by Magenta on the Steering Wheel

# Seismic Workflows

Oasys 21 features new tools to power two of the most common seismic analysis workflows:

**Storey Drift**

In PRIMER, define drift nodes at different locations, for each storey.

In T/HIS, storey drifts are plotted for each location defined.

**Storey Force**

In PRIMER, define DATABASE_CROSS_SECTIONs for selected structural members grouped into SET_PARTs, for each storey.

In T/HIS, storey section forces are extracted for the cross-sections defined.
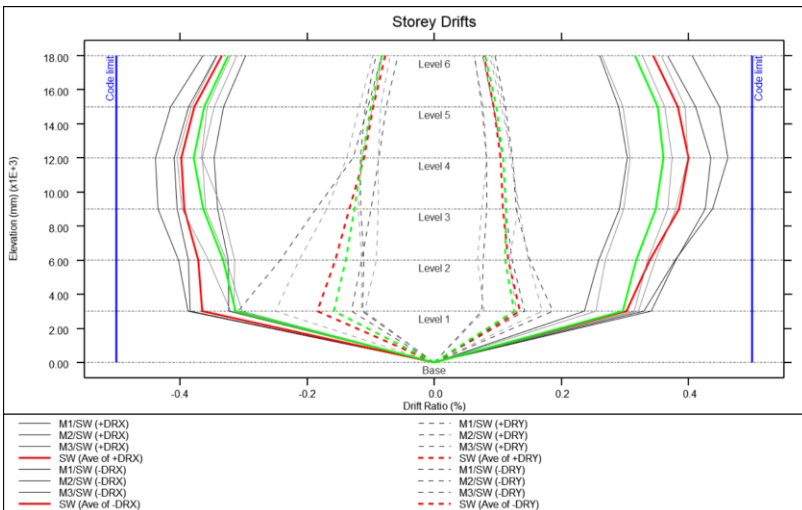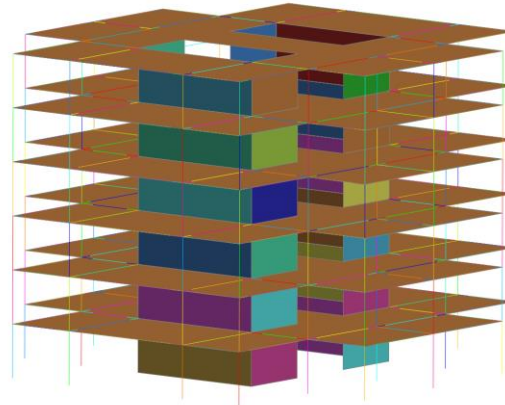
The Workflows can process a single model or a sweep of LS-DYNA runs for a set of ground motions.

Oasys
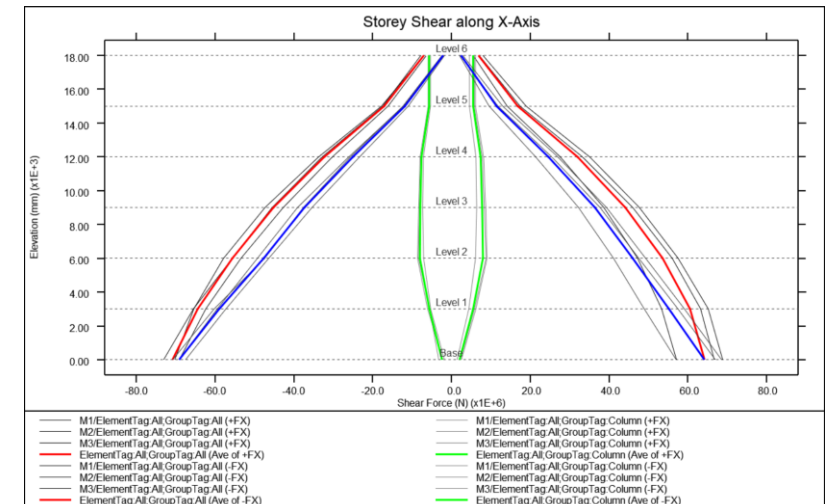
# Seismic Workflows

You can also generate automated reports with the REPORTER templates provided:

Oasys
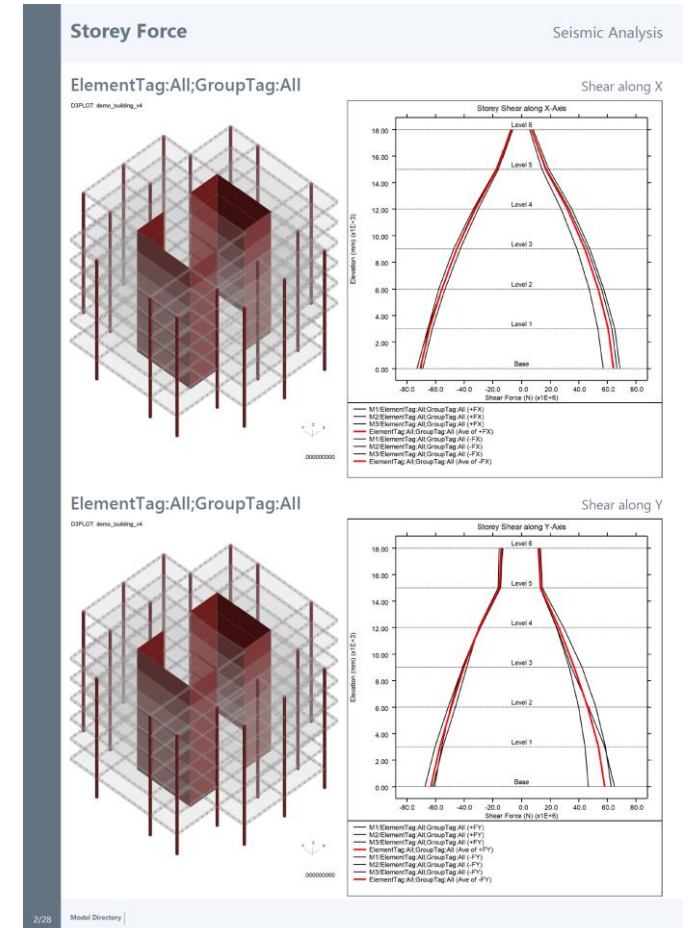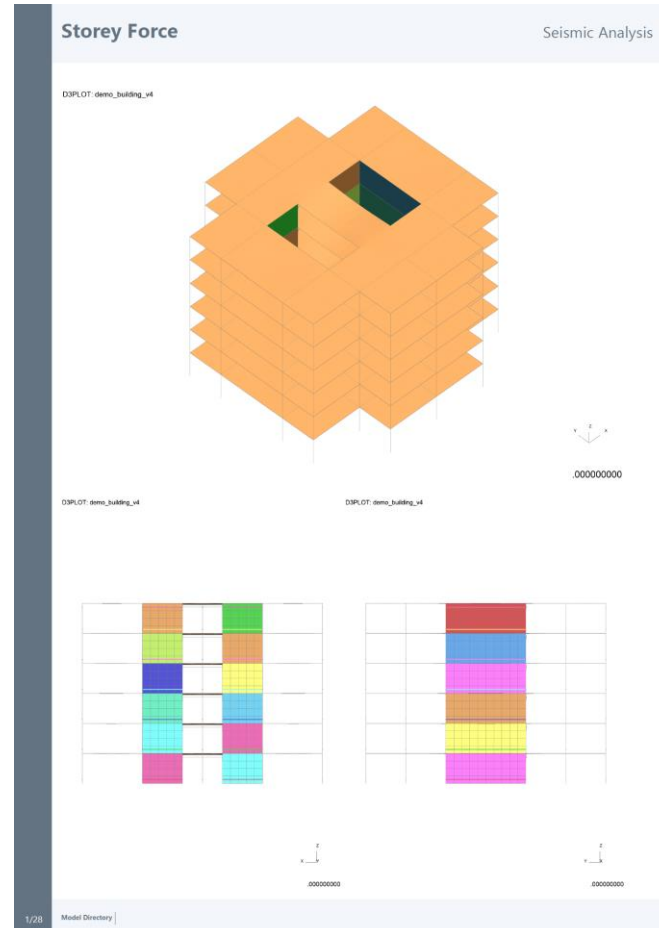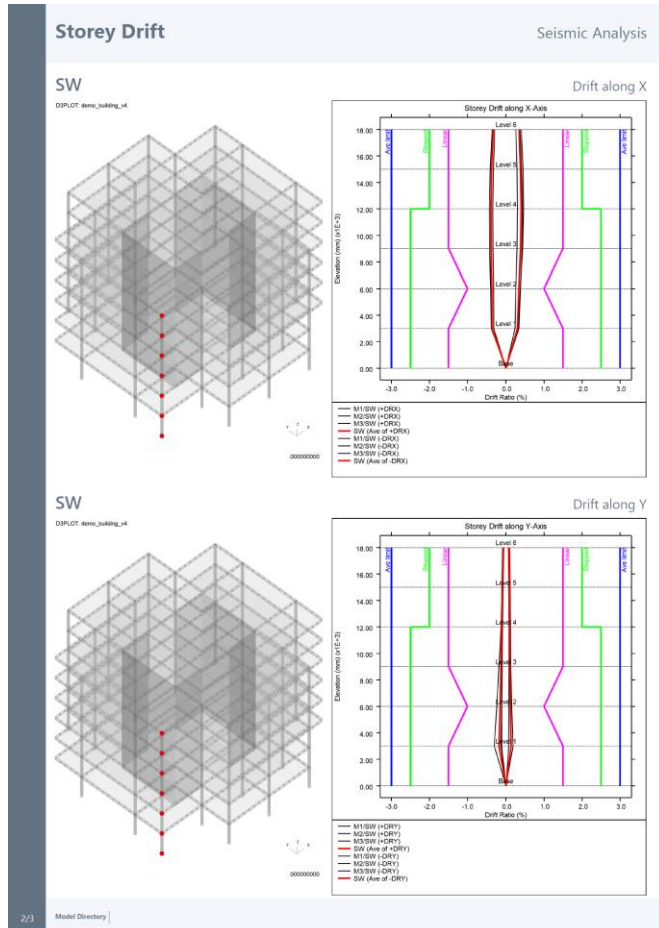
# Defined and Undefined Workflows

The Workflows menu has been split into two tabs:

- **Defined Workflows** – shows workflows that can be run in T/HIS and have the required data

- **Undefined Workflows** – shows workflows that could be run in T/HIS, but don't have the require data
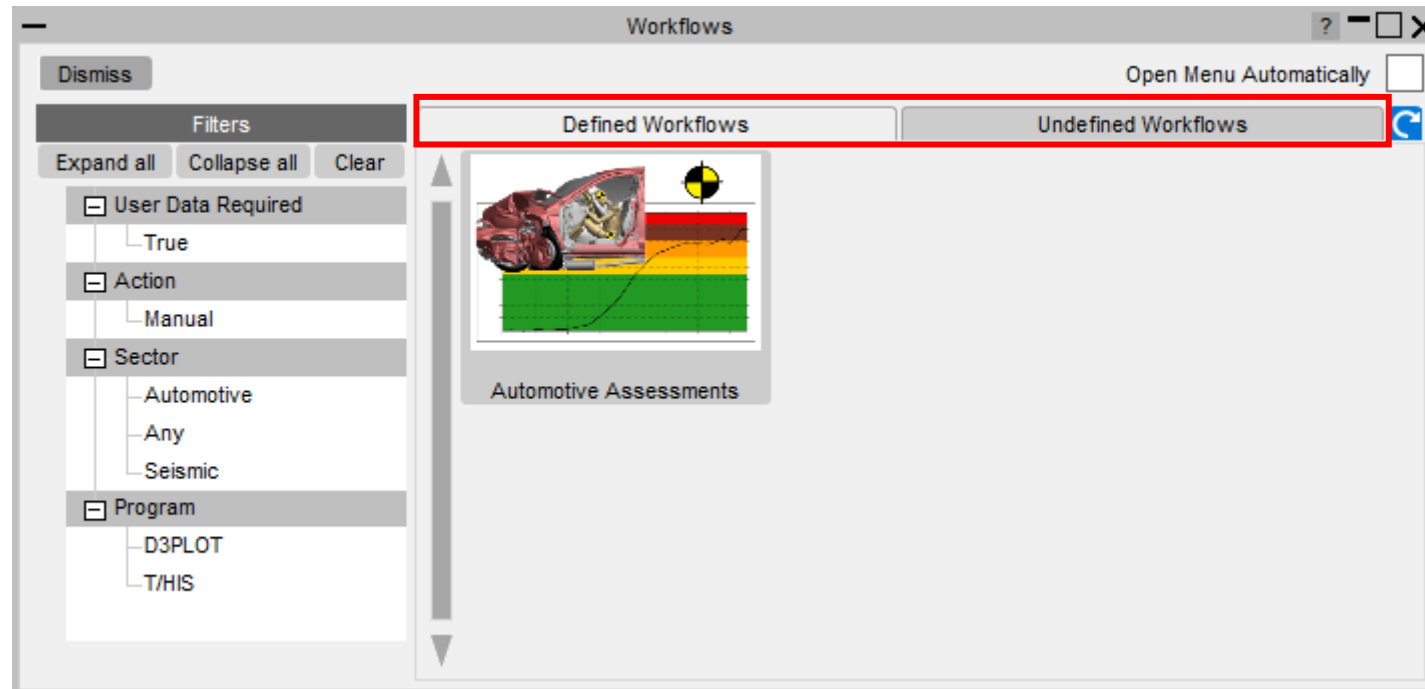
# Defined and Undefined Workflows

Selecting a workflow in the **Undefined Workflows** tab will open the model in PRIMER and start the workflow to select the required data.

In T/HIS, a window will open telling you to press **Refresh** ⟳ when the data has been saved. This will update the Workflows menu, moving the workflow to the **Defined Workflows** tab so it can be run in T/HIS.



PRIMER
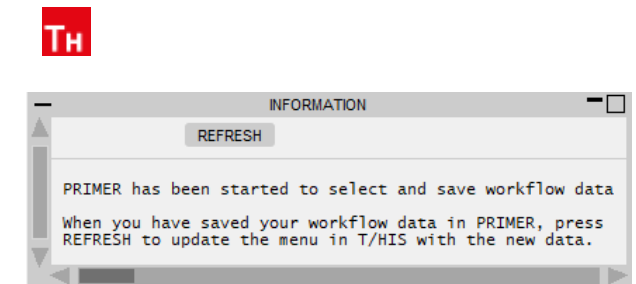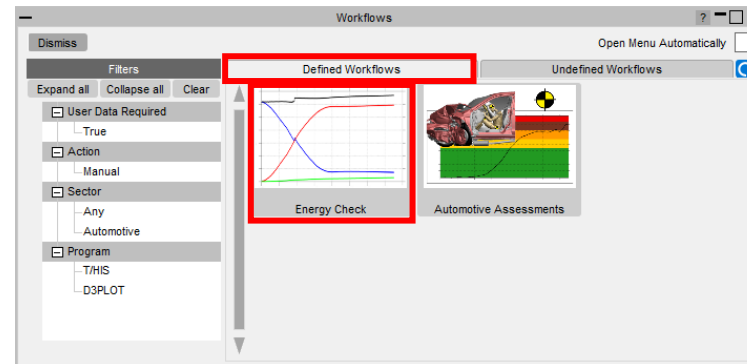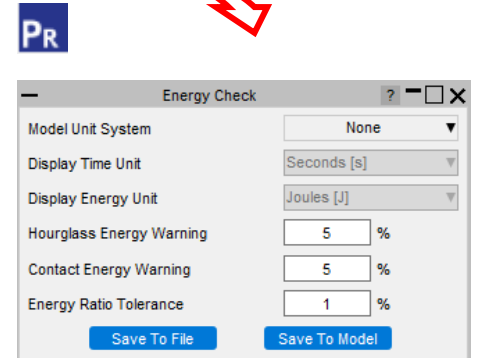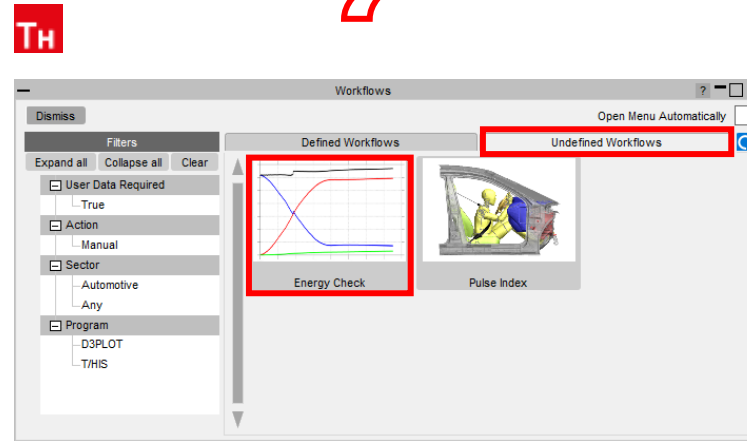
# Virtual Testing

# Virtual Testing

At Oasys Ltd., we are working on software features to support the upcoming Virtual Testing Crashworthiness protocols. The first protocols to be introduced are the <u>Euro NCAP Virtual Far Side Simulation & Assessment Protocol</u>, and <u>C-NCAP Management Regulation (2024 Edition)</u>, with others to follow soon.

Oasys 21 contains a set of integrated and complementary Workflow tools to power your Virtual Testing CAE workflows:

- **<u>Automotive Assessments</u>** (now supports the Euro NCAP and C-NCAP virtual testing protocols)
- **<u>LS-DYNA to ISO-MME</u>**
- **<u>SimVT</u>**
- **<u>VTC Quality Criteria</u>**
- **<u>VTC Videos</u>**
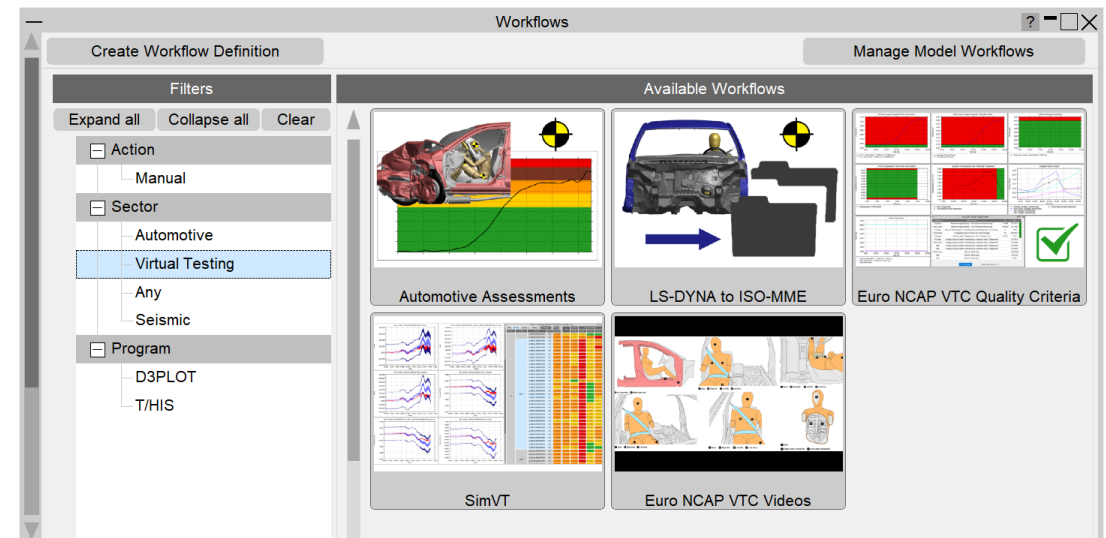
# Virtual Testing

Virtual Testing presents several challenges for CAE workflows:

**Q1.** **Good correlation is moving from beneficial to mandatory. As CAE teams, we can no longer rely on conservative assumptions. How do we ensure that physical tests perform as predicted?**

A1. SimVT is a powerful new tool for correlation analysis, providing flexibility, and the ability to interrogate correlation results in detail, to help you understand your models' accuracy, robustness, and sensitivity.

**Q2.** **How do we ensure that the format and quality of information is sufficient when submitting results to Euro NCAP? How to avoid rework and resubmission?**

A2. Use the VTC Quality Criteria tools to ensure your models meet the required standard. Use the VTC Videos tools to provide the video evidence required. Use the LS-DYNA to ISO-MME tool to export your results data in the required format.

**Q3.** **CAE teams will need to work more with physical test data, and safety teams will need to work more with simulation. We will also be dealing with more metrics than ever before. How do we improve collaboration and processing?**

A3. The LS-DYNA to ISO-MME tool provides seamless transition between simulation and test formats. SimVT supports test data stored in ISO-MME format as well as a configurable CSV format.

**Q4.** **How can we manage the large volume of data and processing required for Virtual Testing?**

A.4 SimVT helps you summarise the correlation analysis results for all the occupant and structures data channels, as well as providing the ability to sift through the data in more detail. Other tools include REPORTER templates to automate the processing of data. Results tables, graphs and scores can be exported in various formats to link with your team's data management tools and processes.

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# Virtual Testing

- All the new Virtual Testing tools can be accessed from the **Tools → Workflows** menus in PRIMER, D3PLOT and T/HIS by filtering for **Virtual Testing**.

- REPORTER templates can be found at **File → Open Library Template...** by selecting the **Automotive** tab and filtering for **Virtual testing**.

Oasys
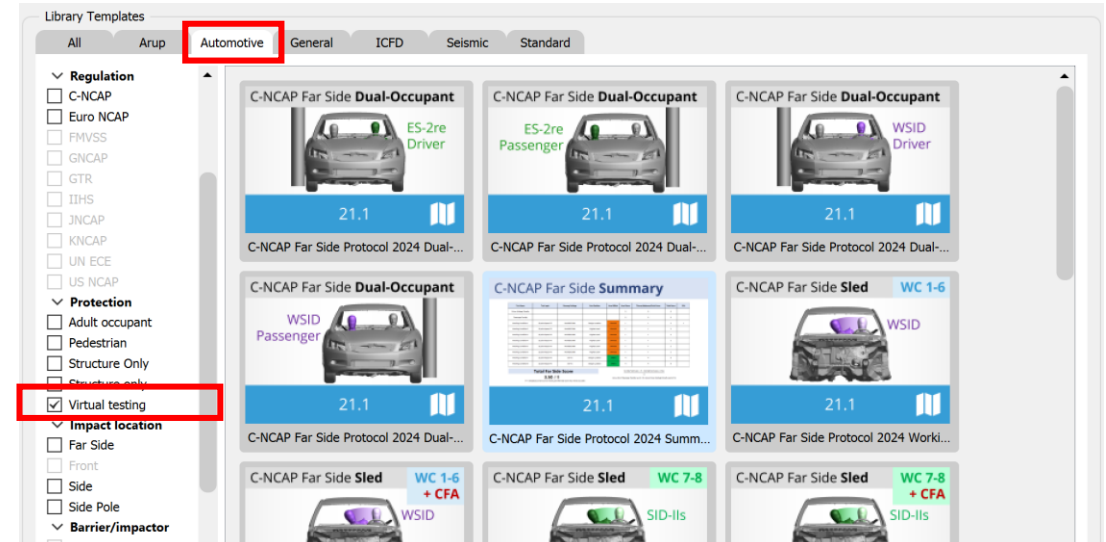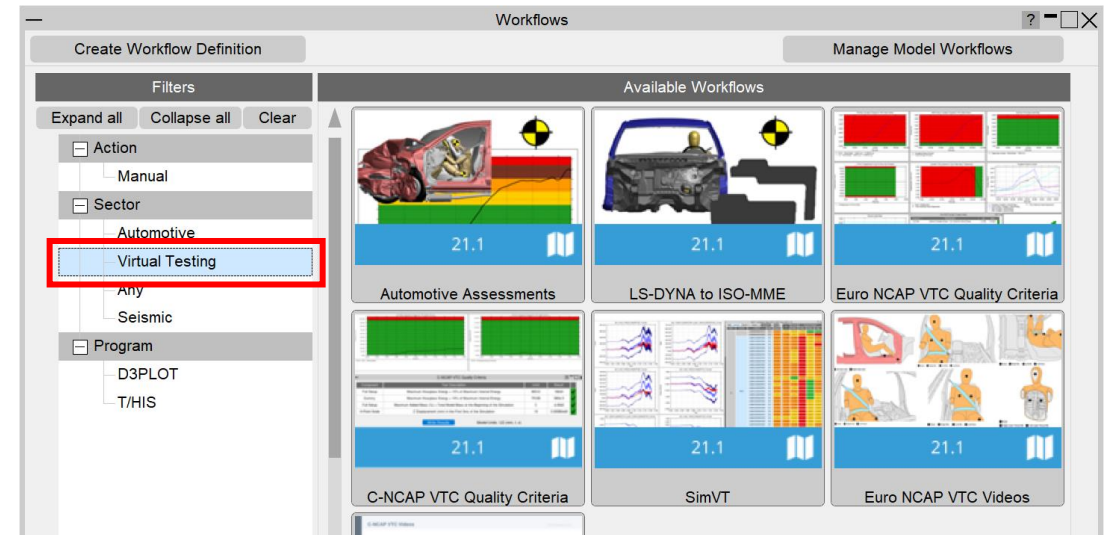
# LS-DYNA to ISO-MME

- "LS-DYNA to ISO-MME" is a new Workflow tool to convert LS-DYNA results into the ISO-MME format specified by the Euro NCAP Virtual Far Side protocol. It can also be used to export the channels required by the C-NCAP Far Side Occupant Protection Protocol.

- Automotive Assessments workflow user data removes the need to manually map LS-DYNA entities to ISO-MME channel codes.

  1. In **PRIMER**, populate all the fields required by the Euro NCAP or C-NCAP protocol. Contact data and Distance between head CoG and excursion lines can be populated automatically. When you save these, you can reuse the settings for subsequent LS-DYNA runs.

  2. In **T/HIS**, perform the export to ISO-MME format. Solver and simulation information can also be populated automatically.

# LS-DYNA to ISO-MME

- The LS-DYNA to ISO-MME Workflow can be automated using the REPORTER template provided. The report generated contains a summary of the ISO-MME file information and individual channel graphs, as well as highlighting any missing data for correction.

# SimVT

- SimVT is a powerful interactive tool for correlating simulation data vs test, or indeed any combination of: LS-DYNA models, ISO-MME data or CSV data.

- SimVT supports the Euro NCAP and C-NCAP Virtual Testing protocols and can be used to identify sensors that fail to pass Validation Criterion 1 or correlation fitting index requirements.
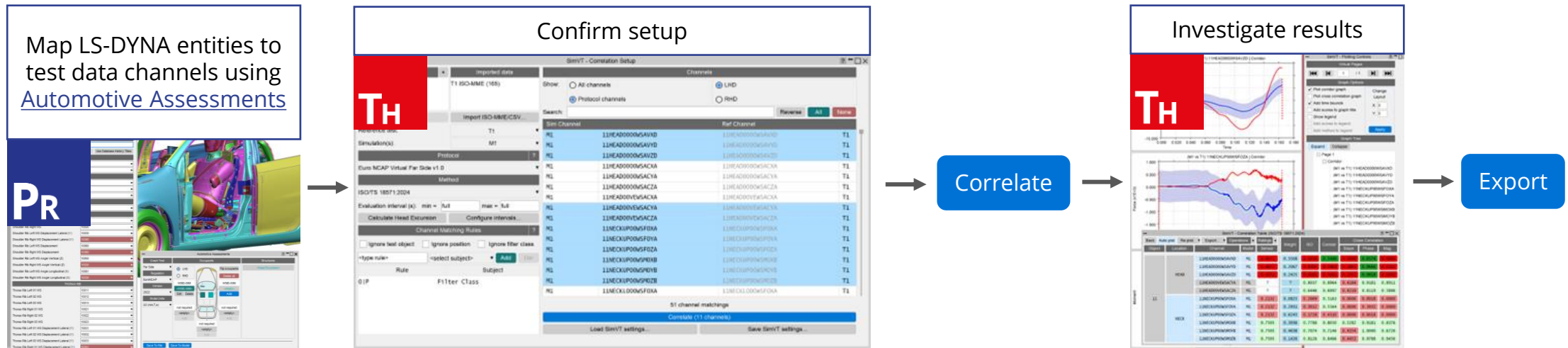


**The SimVT Workflow**

# SimVT

- SimVT seamlessly aligns simulation curves to tests using ISO-MME Channel Codes.

- You can create custom rules for pairing approximate matches.

- Hundreds of correlations are achievable with a single click.

- Results are displayed in a table and can be exported to CSV.

- Graphs of all correlations can be easily plotted and navigated.

- Settings files can be saved to restore previous sessions.

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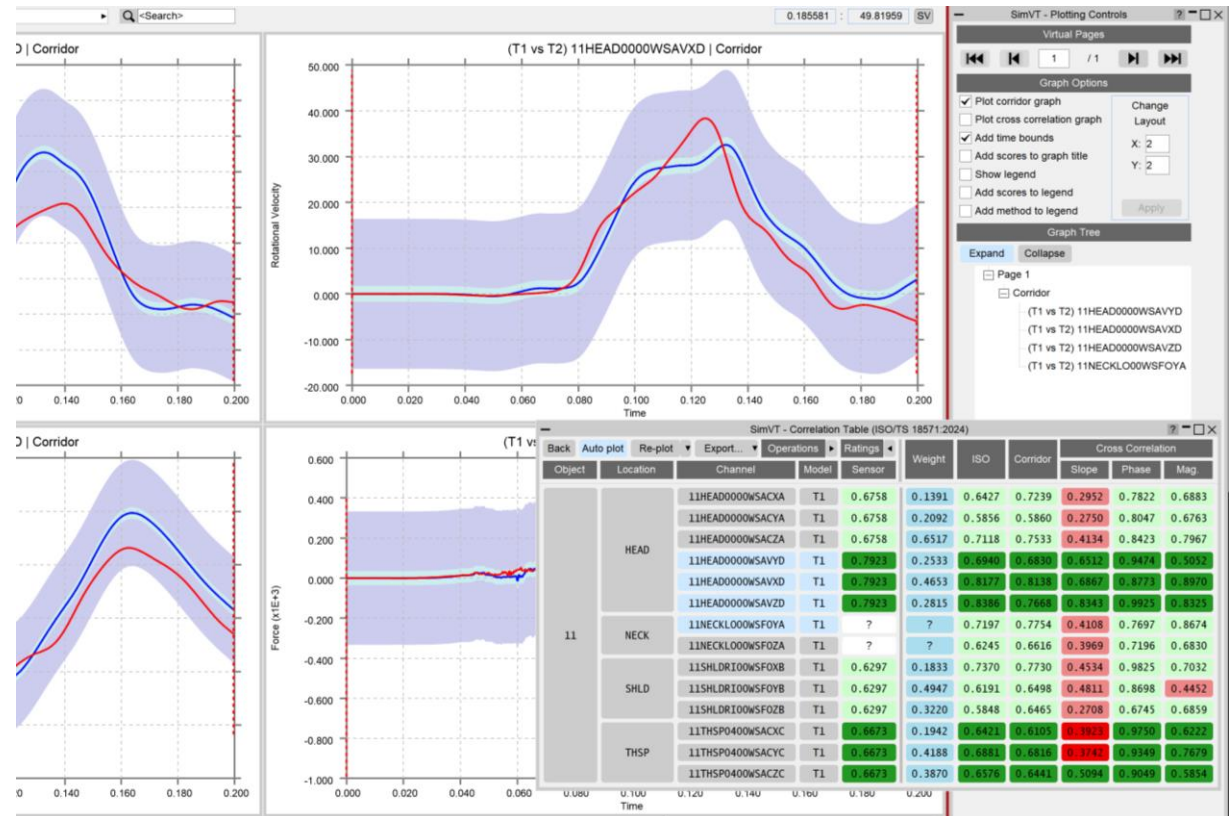
# Euro NCAP Virtual Far Side Validation Criterion 2

- The **Euro NCAP Virtual Far Side 2024 VC2 (Assessment Criteria)** REPORTER Template can be used to perform the Validation Criterion 2 (Assessment Criteria) check according to section 6.3.10 of the Euro NCAP VTC Simulation and Assessment Protocol v1.0.

- Before running the template, you need to set up user data in PRIMER's Automotive Assessments Workflow using the Euro NCAP 'Far Side + VTC' protocol.

- You can also perform VC2 manually in T/HIS.
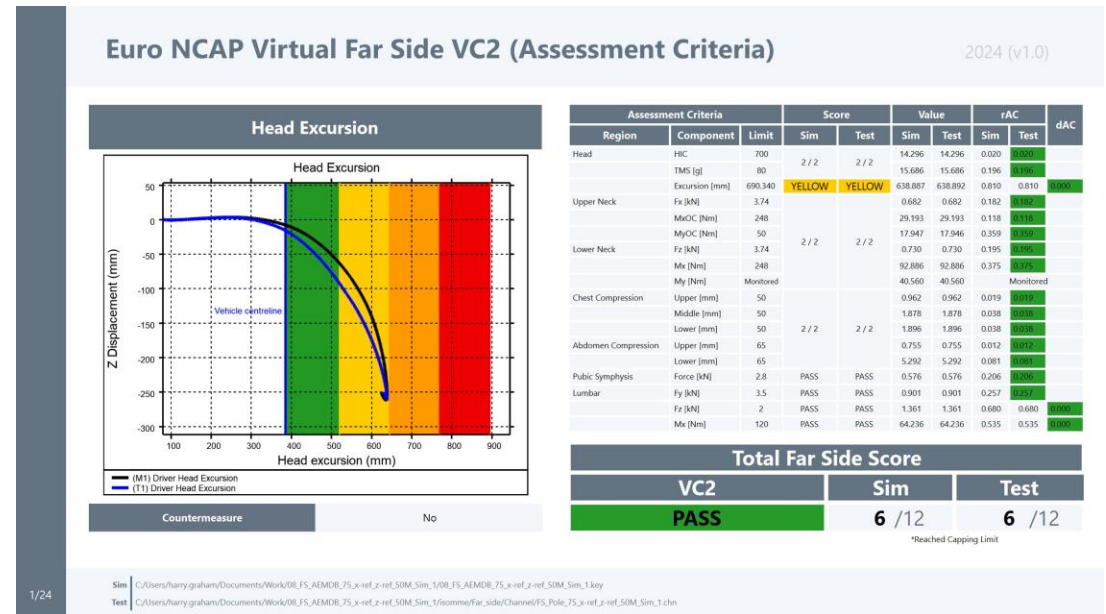
Oasys

# C-NCAP Management Regulation (2024 Edition)

Oasys 21.1 has new support for the various requirements of the C-NCAP Far Side Occupant Protection Protocol, including:

- For each of the eight Working Conditions:
  - Occupant injury assessment
  - ISO Correlation Fitting indices
  - Correction Factor A
- Dual-Occupant Penalty calculation
- ISO correlation fitting indices for the Virtual Assessment Certificate (prerequisite for the symmetry of far side occupant protection airbags)
- Overall score calculation

Read the documentation to learn more

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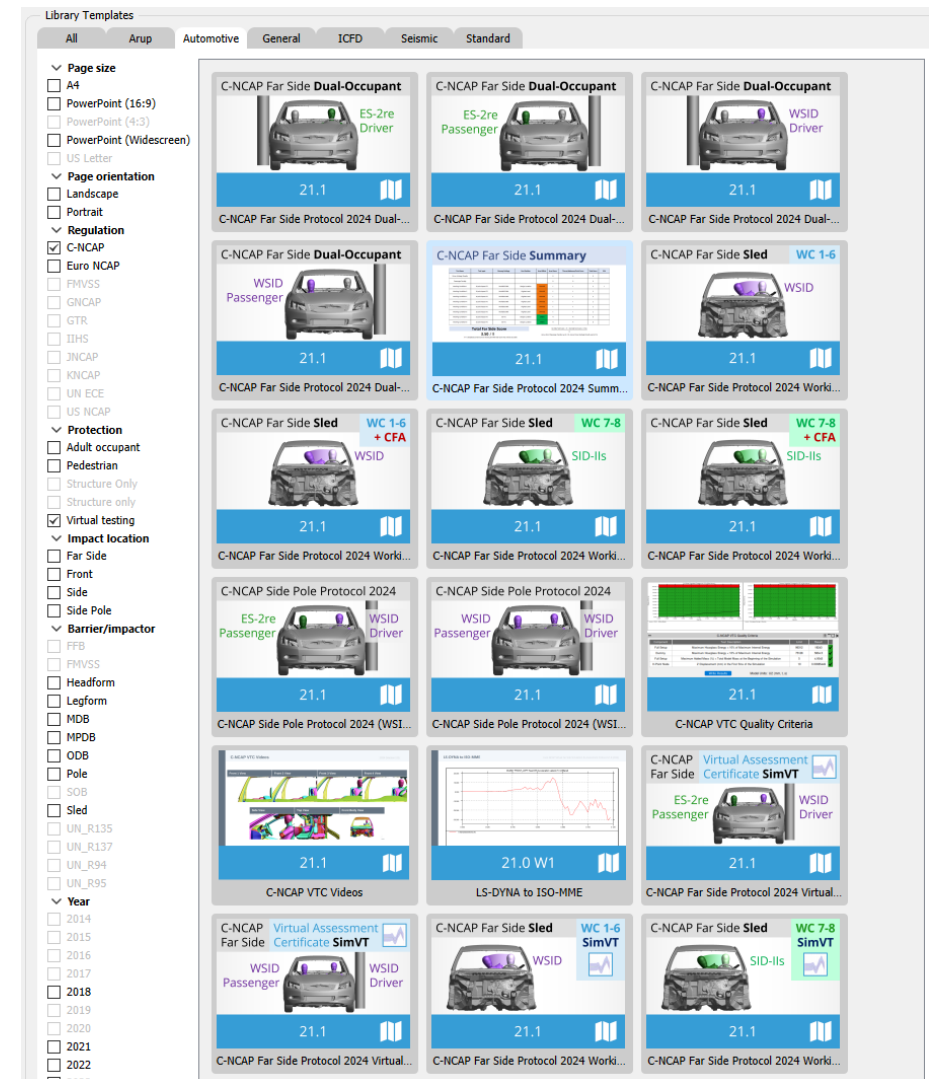
# Euro NCAP VTC Quality Criteria

- "Euro NCAP VTC Quality Criteria" is a new, convenient tool for assessing the quality criteria specified in section 6.1 of the Euro NCAP Virtual Far Side protocol.

1. In **PRIMER**, select the model entities required for the quality checks, and the relevant model and display units. Saved user data can be reused for subsequent LS-DYNA runs.

2. In **T/HIS**, the quality checks are calculated immediately. Graphs illustrate the results of each check. A summary table appears, with the option to write the results to a CSV file.
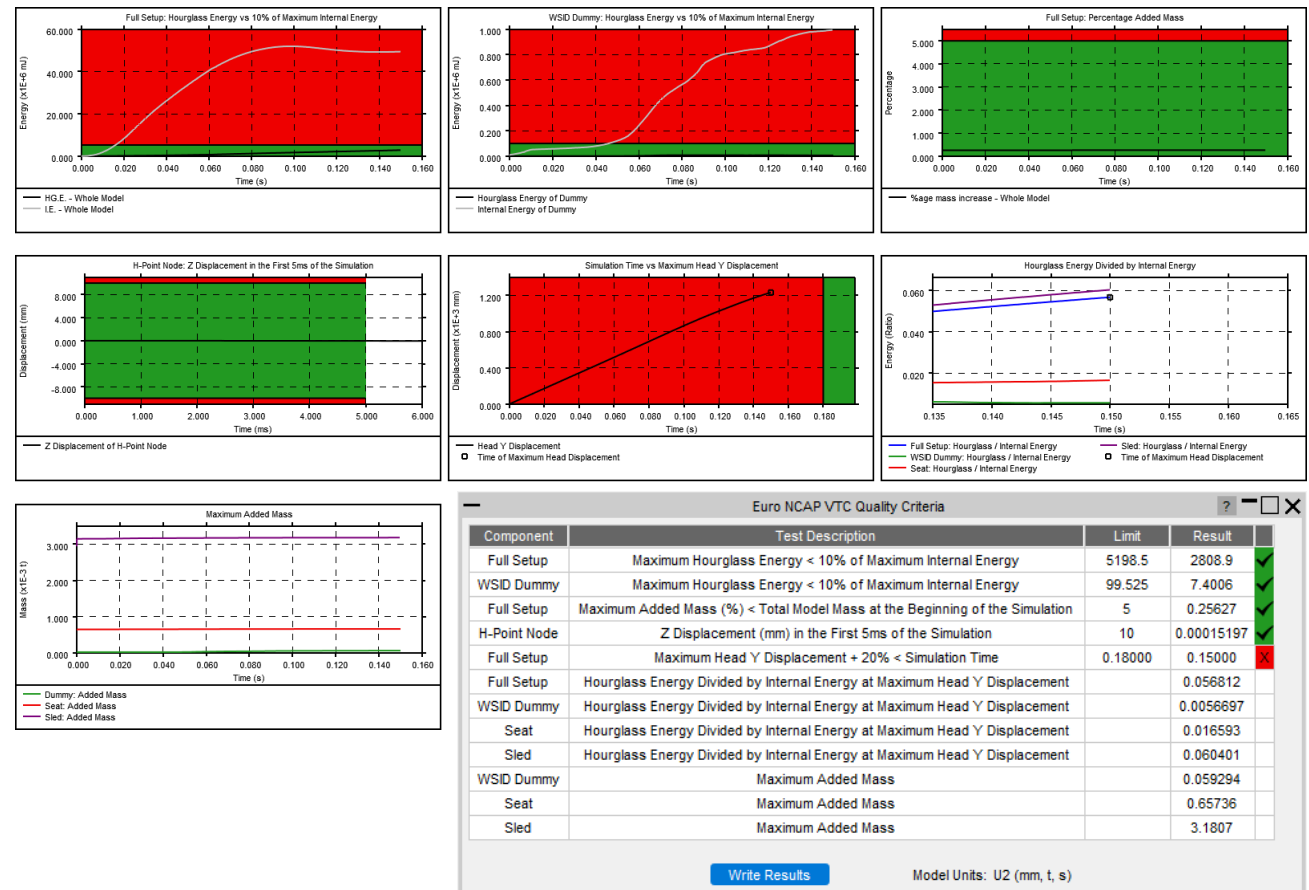
# Euro NCAP VTC Quality Criteria

- The Euro NCAP VTC Quality Criteria Workflow tool can be automated using the REPORTER template provided.

# C-NCAP VTC Quality Criteria

- The C-NCAP VTC Quality Criteria Workflow tool follows the same principals as the Euro NCAP version but assesses the quality criteria specified in section H.1.1(f) of the C-NCAP Far Side Simulation & Assessment Protocol.

- The tool can be automated using the REPORTER template provided.

# Euro NCAP VTC Videos

- The **Euro NCAP VTC Videos** Workflow tool helps you calculate the views and export the videos specified in section 5.2.1 of the Euro NCAP Virtual Far Side protocol.

- The tool attempts to calculate the camera positions automatically based on model entities you define in **PRIMER**. You can then adjust and save the views in **D3PLOT** to be reused to capture the videos for future LS-DYNA runs. The whole process can be automated using the **REPORTER** template provided.



PRIMER

Oasys

# C-NCAP VTC Videos

- The **C-NCAP VTC Videos** Workflow tool follows the same principles as the Euro NCAP version but helps you calculate the views and export the videos specified in section H.2.8 of the C-NCAP Far Side Occupant Protection Protocol (2024 Edition).

- Use the standard Workflow method in **PRIMER** and **D3PLOT** or the whole process can be automated using the **REPORTER** template provided.
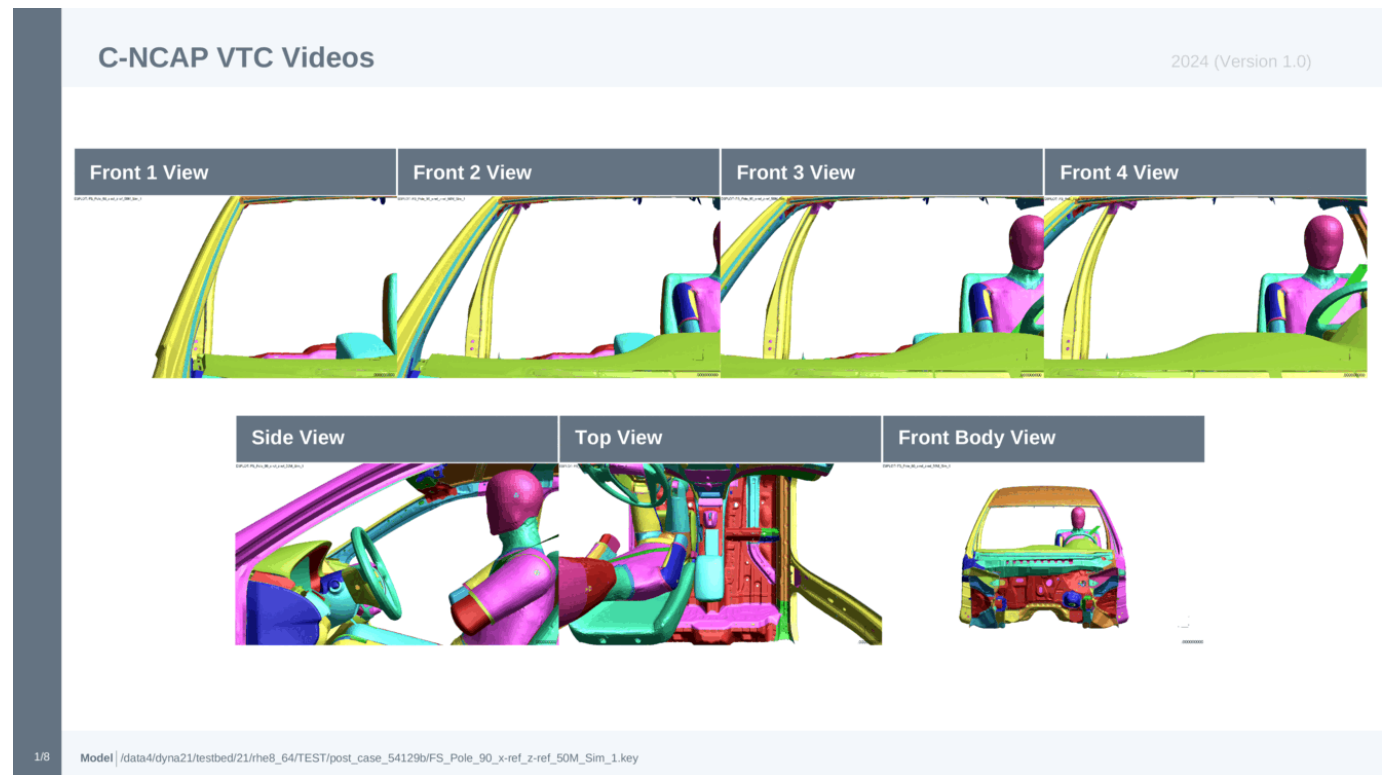
# Miscellaneous

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# Selection Options for Clipboard
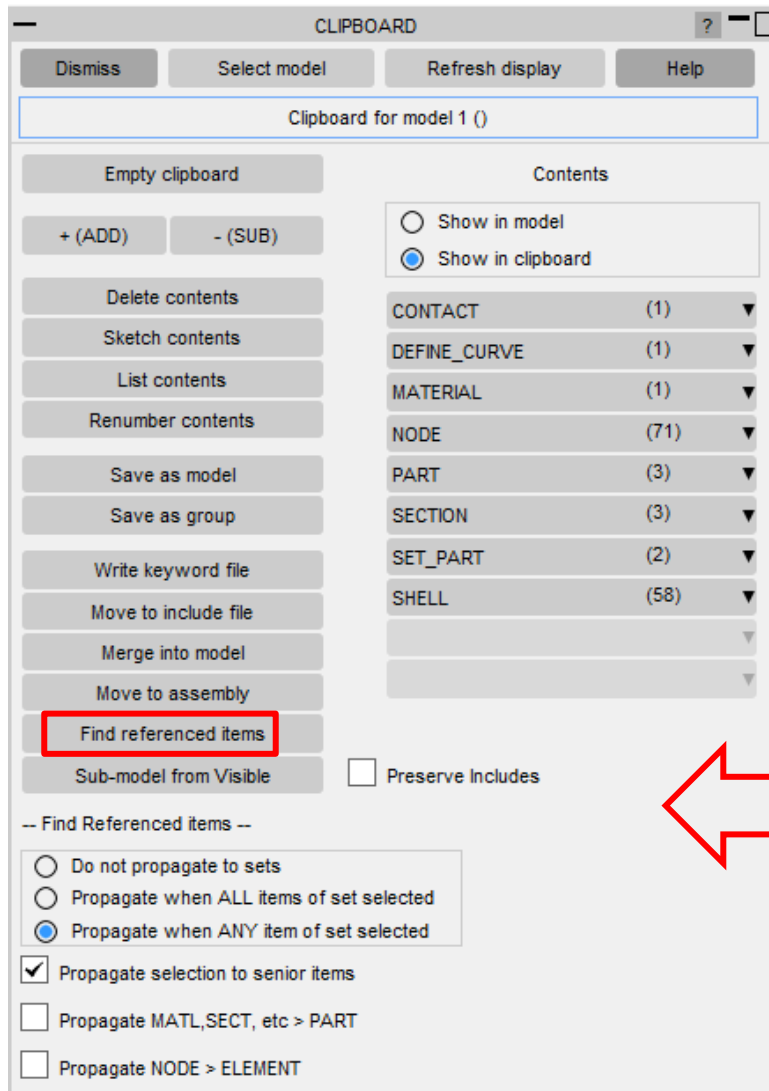


- By default, Find referenced items:

  - propagates to junior items e.g. parts > elements;

  - finds any latent entities e.g. part > mid;

  - finds attached mass.

- New options:

  - Propagate to set if item in set (or all items) selected;

  - Propagate to senior item to which selected item xrefs

With these options Initial selection of Part, selects Set Part which in turn selects Contact.

Default selection only gives what "belongs" to Part

# High order elements – Check and adjust

- Higher order elements are Parabolic and cubic elements, shells and solids with interpolation nodes.

- A model check gives a warning if an interpolation node is not on the straight line joining the 2 corner nodes.

- This is not necessarily wrong (e.g. curved surfaces), but if desired, the nodes can be adjusted to the mid point position.

- This can be done using the new Interp. Nodes button available in shell and solid panels:
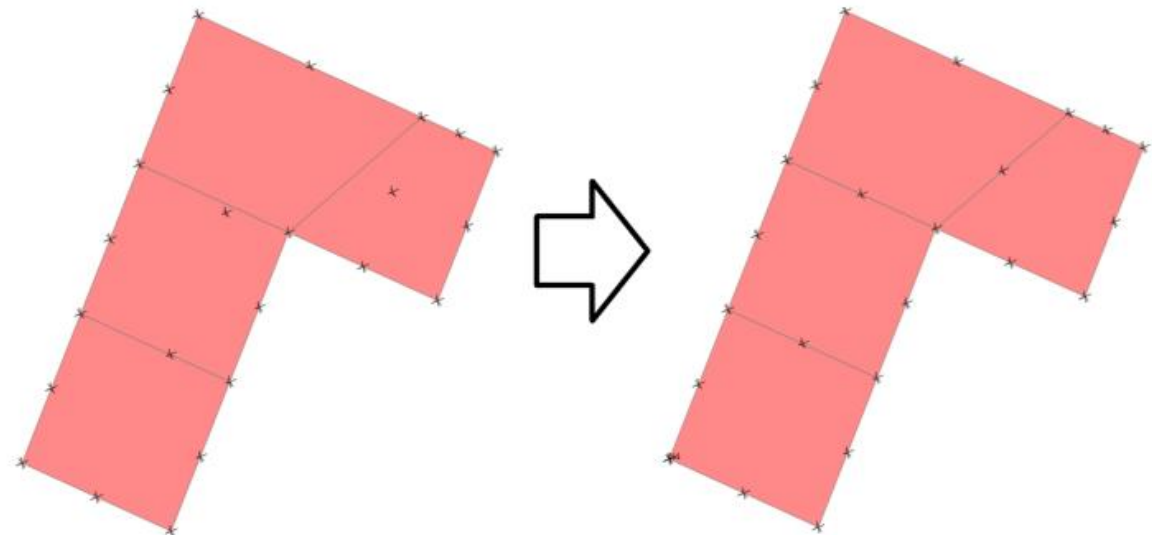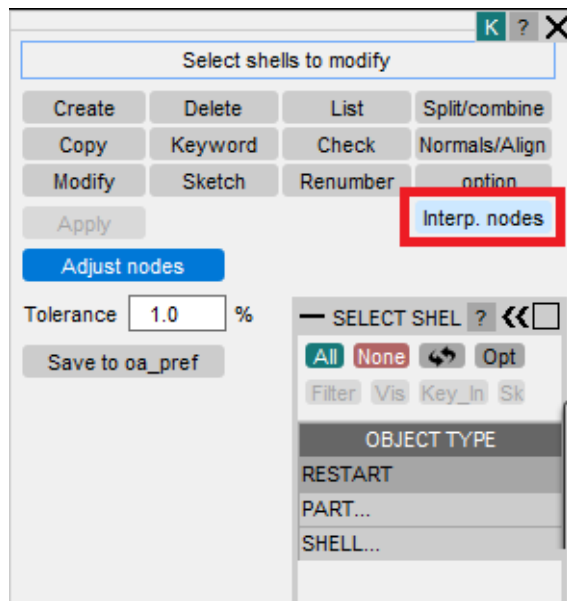
# Support for *CONSTRAINED HyperMesh components

- Added support for processing HyperMesh Components formed of **\*CONSTRAINED**s when reading in a LS-DYNA .key file containing HyperMesh comments (previously PRIMER only supported Components formed of **\*PART**s).

- Now all $HMNAME COMPS, $HWCOLOR COMPS, and $HMCOLOR COMPS comments get preserved when read into PRIMER, and all **\*CONSTRAINED** instances get added to their corresponding PRIMER groups and assemblies as listed in the $HMASSEM comments.

*Oasys*

# Lock Connections in Mechanism Positioning panel

- You can now Lock or Unlock Multiple

  connections in the list with a single click, via

  the "Lock Connections" popup menu that

  has been added to Lock button:

  - All: Locks all the Connections;

  - None: Unlocks all the Connections;

  - Reverse: Reverses the current Lock/Unlock

    selection for all the Connections.
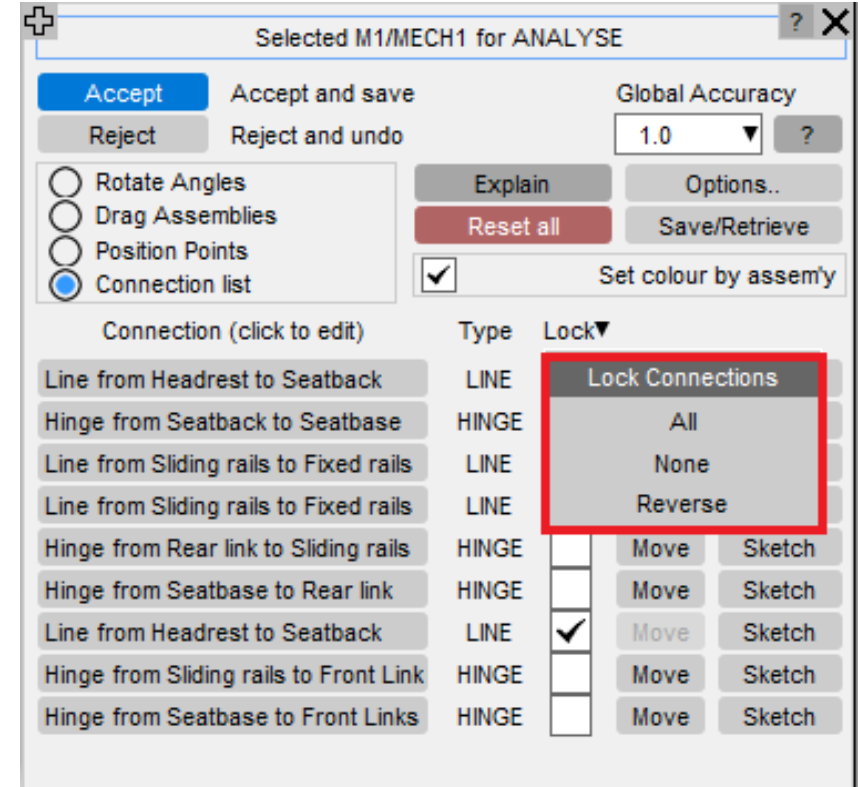
# Parameters

- Parameter edit panel can now be opened from the part tree.
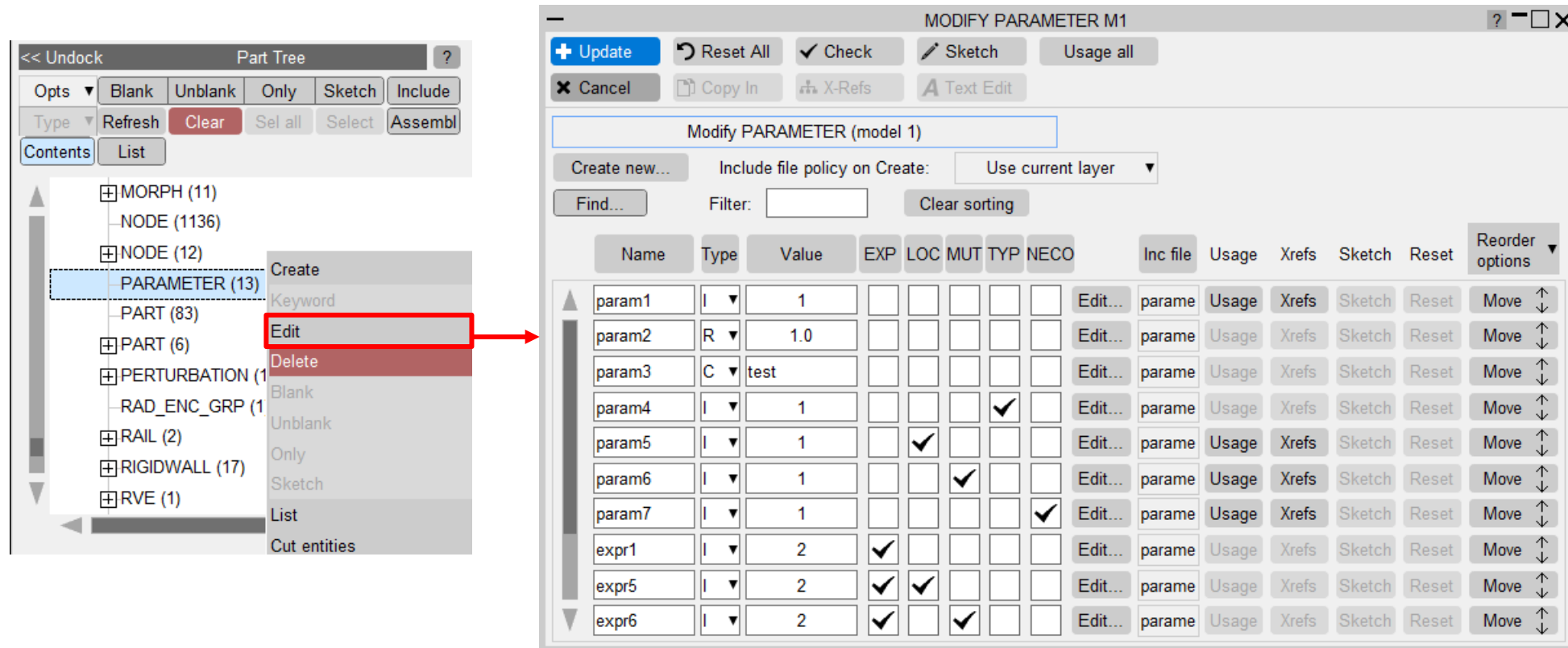


- Parameter names starting with an underscore are now permitted.

# Preferences

# New Preferences

| Preference | Description |
|---|---|
| **primer\*initial_view_orientation**<br>**oasys\*initial_view_orientation** | Sets the initial view of the graphics window in which PRIMER opens (Individual program preference takes precedence) |
| **oasys\*workflow_only_use_specified_directory** | Only scan location set by preference oasys*workflow_definitions_directory for Workflow definitions (if it is set) |
| **oasys\*workflow_user_data_directory** | Name of a folder to search in for workflow user data |
| **oasys\*workflow_max_upward_folder_search_depth** | Maximum number of folders to search up to look for workflow user data |
| **primer\*beam_orient_vector_min_angle** | Minimum angle (radians) between beam axis and orientation vector below which it should be flagged as error |
| **primer\*allow_bolt_at_hole_convert_to_hexa_weld** | Allows conversion of bolts on holes to single solid weld |
| **primer\*contour_ramp** | Contour ramp colour option |
| **primer\*geometry_highlight_failed_surface_boundaries** | When TRUE, trim curves of geometry surfaces that failed to render are copied to a new model and drawn |
| **primer\*geometry_write_tessellation_error_log** | When TRUE, error messages related to geometry surface tessellation are written to a log file in the same directory as the parent model |

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# New Preferences

| Preference | Description |
|---|---|
| primer*geometry_add_failed_surfaces_to_clipboard | When TRUE, surfaces that have failed to render will be added to the clipboard |
| primer*geometry_curve_max_edge_length_factor | Max edge length, as a factor of the model diagonal, for segments used to draw geometry surface trim curves |
| primer*geometry_curve_min_edge_length_factor | Min edge length, as a factor of the model diagonal, for segments used to draw geometry surface trim curves |
| primer*geometry_surface_max_edge_length_factor | Max edge length, as a factor of the model diagonal, of trias used to draw geometry surfaces |
| primer*geometry_surface_min_edge_length_factor | Min edge length, as a factor of the model diagonal, of trias used to draw geometry surfaces |
| primer*geometry_element_max_separation_factor | Max separation, as a factor of the model diagonal, between the centres/edges of trias, used to draw geometry surfaces, and a surface |
| primer*graticule_mode | Graticule mode - 2D/3D |
| primer*label_background | Label background display |
| primer*include_file_exceeds_80_char_warning | Message handling when include file exceeding 80 char is read |

# New Preferences

| Preference | Description |
|---|---|
| primer*read_set_collect_include_trans | If **\*SET_COLLECT** in **\*INCLUDE_TRANSFORM** with IDSOFF is unreferenced remap references |
| primer*warn_set_collect_include_trans | Warn if **\*SET_COLLECT** in **\*INCLUDE_TRANSFORM** with IDSOFF non-zero may have errors |
| primer*permit_duplicate_edit | Whether or not to allow a 2nd and subsequent editing panel on the same entity |
| primer*mat_68_write_all_cards | As of version 21, MAT_68 optional cards are no longer written, set to 'TRUE' for reading MAT_68 into older versions of PRIMER |
| primer*nastran_read_retain_parabolic_nodes | Retain mid-side nodes for parabolic solids and shells |
| primer*nastran_read_convert_2_noded_RBE2_to_weld | ON (def) to convert 2-noded RBE2 to Constrained_Spotweld, others to Constrained_NRB.<br>OFF to convert all RBE2 to Constrained_NRB |
| primer*nastran_write_continuation_strings | Write continuation strings |
| primer*nastran_write_merge_overlapping_nrbs | Merge overlapping Nodal Rigid Bodies before Nastran write |
| primer*nastran_write_process_mat169_into_new_parts_by_thickness | Split adhesive parts into different parts containing solids of similar thickness |

# New Preferences

| Preference | Description |
|---|---|
| primer*nastran_write_convert_tied_contact_to_RBE3 | Convert DYNA tied contact to RBE3 |
| primer*nastran_write_contact_rbe3_placement | RBE3s created from tied contact written to same include as element of dependent node, element of independent node, or of Dyna contact |
| primer*nastran_enable_rotational_dof_on_RBE3_shell_nodes | Consider rotational d.o.f on RBE3 nodes attached to shells (default is translational only) |
| primer*nastran_write_suppress_rigid_elements | Do not write elements when rendering rigid part into Nastran use CONM2 instead (unconditional for Part_inertia) |
| primer*nastran_write_rigid_element_limit | If n.gt.0 rigid parts with numel.gt.n will be written using reduced RBE2, otherwise all (external) nodes are included |
| primer*nastran_write_translate_matl_with_uncalc_poisson_ratio | apply user value for Poisson ratio if it cannot be calculated |
| primer*nastran_write_poissons_ratio | Value of Poisson ratio that will be used for materials with undefined Poisson ratio |
| primer*nastran_write_mat67_with_cbush_stiffness_values | MAT67 written using 6 stiffness values as defined on Nastran writeout properties panel |
| primer*nastran_write_cbush_prop_tkr/tks/tkt/rkr/rks/rkt | Values of cbush stiffness that will be used while writing MAT_67 |

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# New Preferences

| Preference | Description |
|---|---|
| primer*vis_menu_position | Position of the Vis menu - graphics area or docked to parent |
| primer*orient_constraint_with_node | Orient whole constraint when any node is oriented |
| primer*any_coord_clamp_zero | Any nodal coordinates less than this \|clamp value\| will be set to zero during output |
| primer*trans_coord_clamp_zero | Transformed nodal coordinates less than this \|clamp value\| will be set to zero during output |
| primer*dp_genio_prec_gui | General DP values in GUI data fields: number of significant figures to use |
| primer*dp_genio_prec_10/16/20 | General DP values in 10, 16, and 20 wide fields. It specifies number of significant figures to use |
| primer*dp_ncio_prec_gui | DP coordinate values in GUI button fields: number of significant figures to use |
| primer*dp_ncio_prec_10/16/20 | DP coordinate values in 10, 16, and 20 wide fields. It specifies number of significant figures to use |
| primer*tied_rounding | How tied values exactly between upper and lower bounds will be rounded |

# New Preferences

| Preference | Description |
|---|---|
| primer*script_copy_nonexistent_include_warning | Whether to show a warning if a keyword is copied into a non-existent include |
| primer*belt_xsec_naming_convention | Database Cross-section naming convention |
| primer*belt_xsec_custom_pre_text | Additional pre-text for Database Cross-section e.g. Dummy 1 |
| primer*belt_growth_percent | Permitted %age growth of belt element length during fitting |
| primer*initial_belt_readjust_accept | Readjust initial belt points around sliprings after accepting belt path |
| primer*belt_buckle_rot_iter_per_mode | Number of iterations per buckle rotation mode |
| primer*belt_refit_xsec_rename | Rename Cross section titles when doing a belt auto-refit |
| primer*undo_align_elements | Turn on/off undo of aligning elements |
| primer*undo_parameter_change | Turn on/off undo of changing parameters while renumbering |

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# New Preferences: PRIMER 21.1

| Preference | Description |
|---|---|
| primer*threaded_elem_node_lookup_limit | Threshold test time (ms) for element topology lookup to consider threading |
| primer*threaded_elem_node_lookup_yield | Permit thread to yield its time slice while waiting |
| primer*keyout_mutable_at_top | Which mutable parameters to write out in the PARAMETER block at the top of the file |
| primer*keyout_mutable_post_include | The status of mutable parameters in the parent file after reading child INCLUDE file |
| primer*update_params_on_unused_curves | Following a units change whether to change parameterised data fields on unreferenced loadcurves |
| primer*speedup_set_handling_for_node_set_general | Speeds up edit create ops for models with many SET_GENERAL |

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