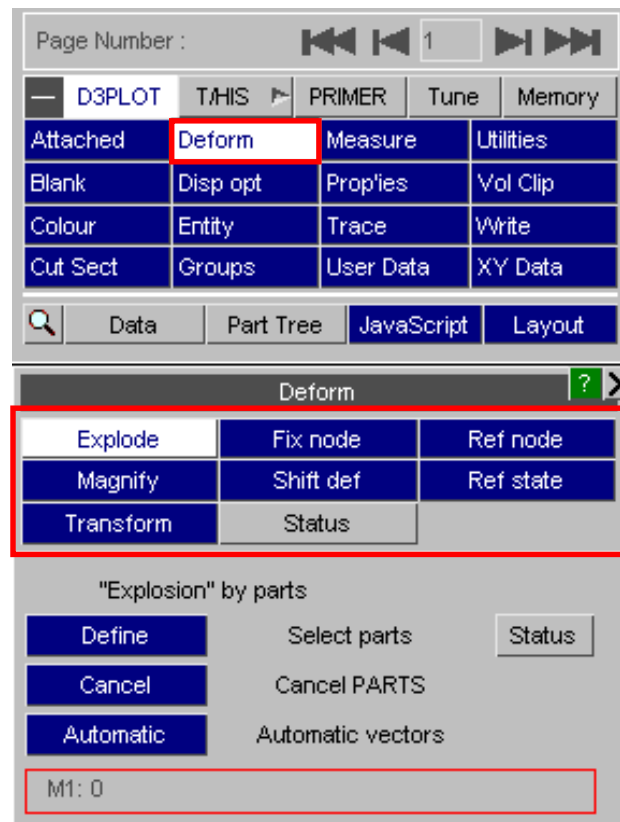


Deform

Deform options

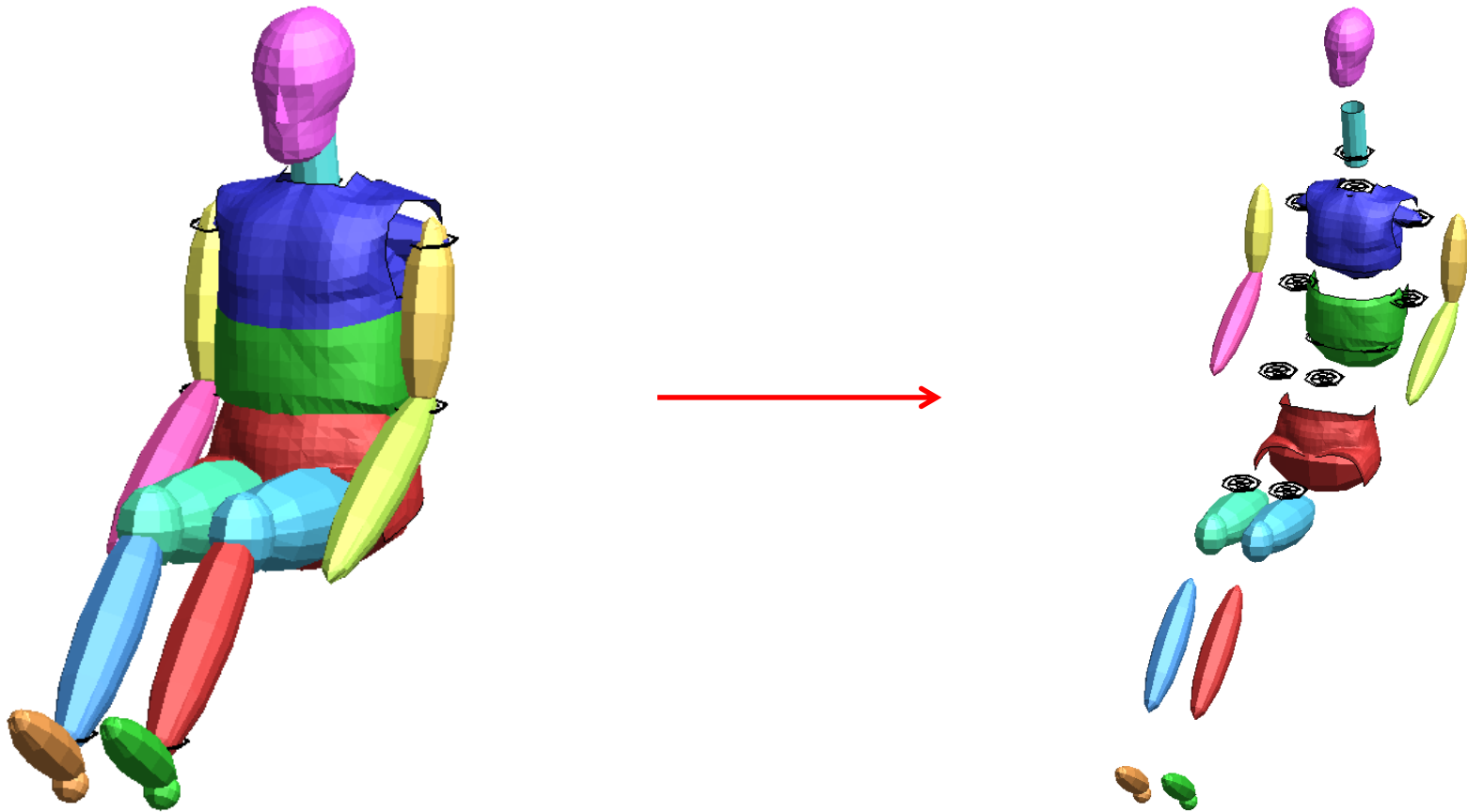
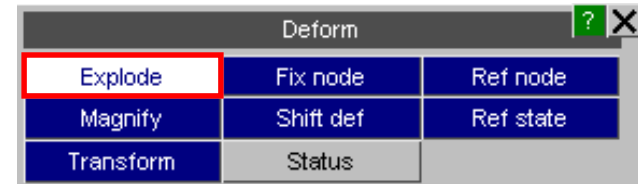
There are various different ways to deform the model geometry to better visualise the results and interrogate models.

These are described in the following tutorial with an example use.



Explode

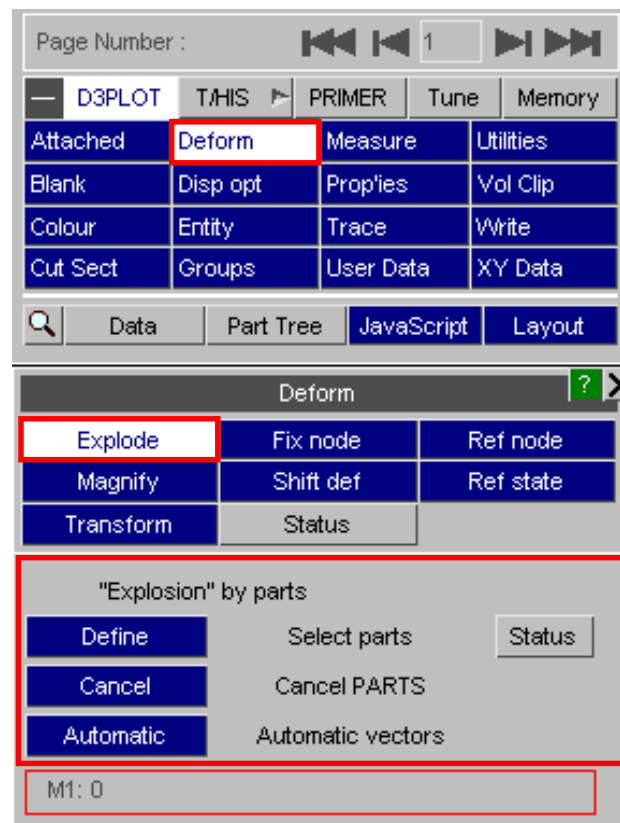
Sometimes it is useful to have an “exploded” view of a model, or part of a model.



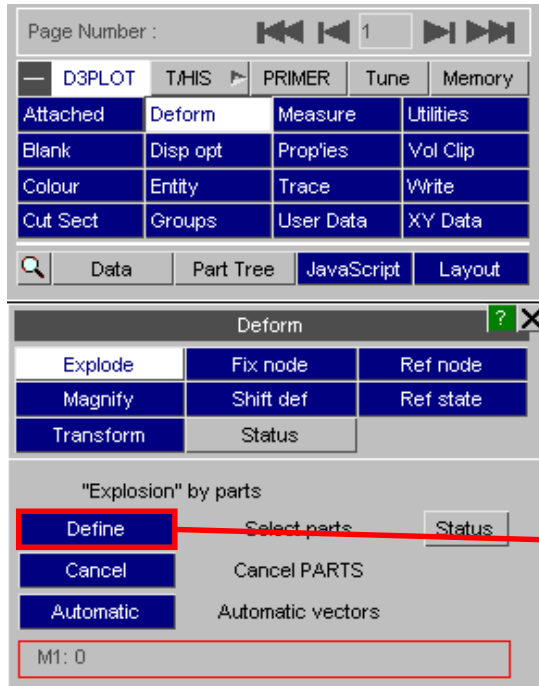
Explode

The 'Explode' function artificially separates parts by applying explosion vectors to them. There are two options to choose from when applying the 'Explode' function:

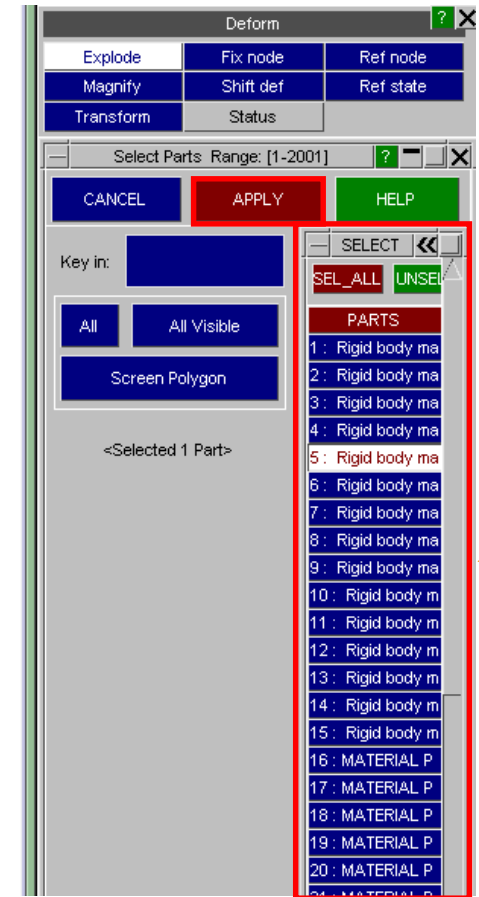
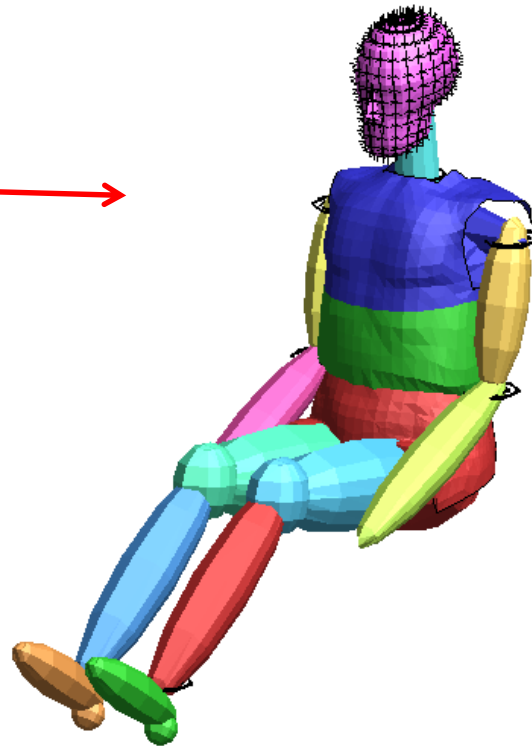
- **Define** – define the parts to apply the explosion and explosion vector to.
- **Automatic** – explosion vectors are automatically generated by D3PLOT.



Explode – using Define



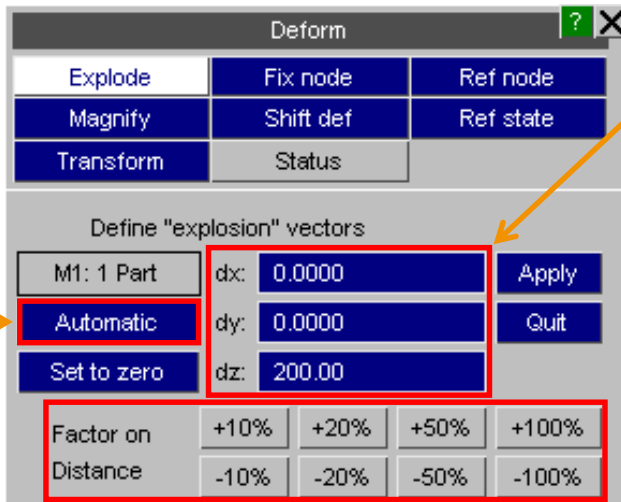
When selecting the 'Define' function within the 'Explode' menu, the part(s) to apply the explosion to can either be selected from the 'PARTS' menu or by clicking onto the part(s) directly.



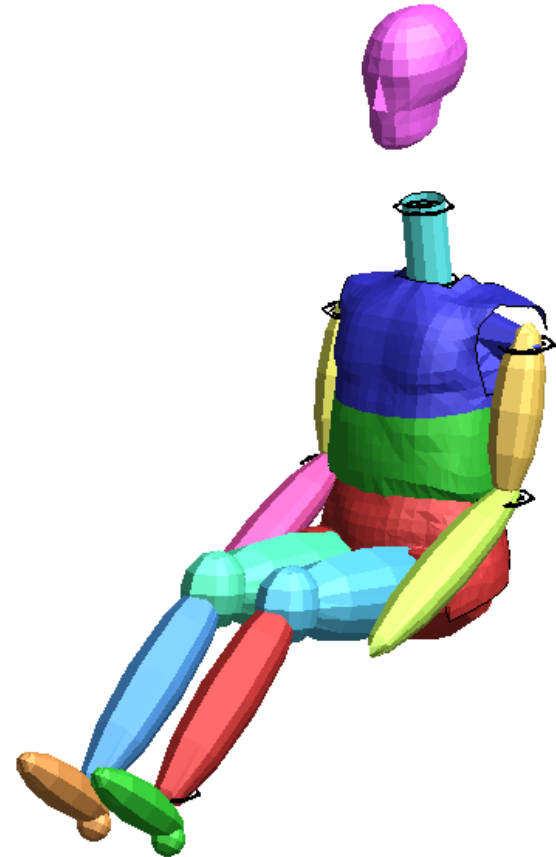
Explode – using Define

Either choose 'Automatic' and D3PLOT automatically calculates the explosion vector.

Or, define the magnitude of the three explosion vectors.



Factor the currently defined explosion vector(s) by a pre-defined amount.



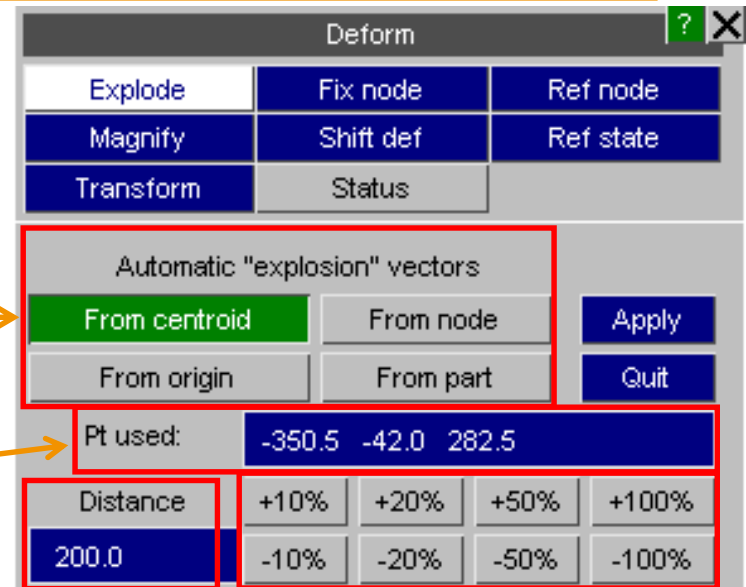
The selected part(s) should then explode.

Explode – using Automatic



When using the 'Automatic' function within the 'Explode' menu. Use the following pre-defined positions for the centre of the explosion:

- **From centroid** – Model centre of gravity.
- **From node** – Nodal coordinate.
- **From origin** – Coordinate [0, 0, 0].
- **From part** – Centre of gravity of a part.



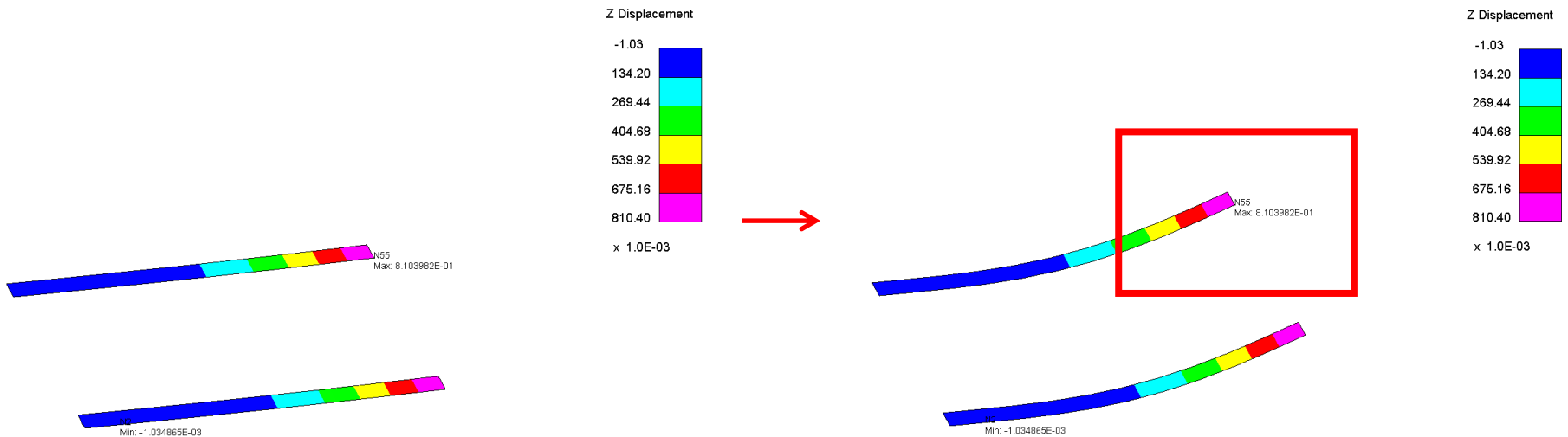
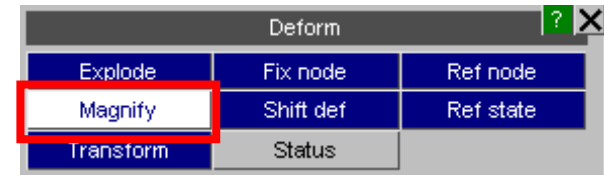
Coordinates for the centre of the automatic explosion.

Define a distance/magnitude for the explosion vector(s).

Factor the currently defined explosion vector(s) by a pre-defined amount.

Magnify

The magnify function can be useful when analysing models with small displacements. Sometimes it may not be obvious that models have displaced. Therefore the magnify function is a useful way of magnifying these small displacements which could go unnoticed.



Magnify

Magnify - applies a user defined scale factor to displacements.

Note: the scaling factors magnify the linear displacements, therefore any rotations in the model will appear grotesquely stretched.

Tip: use magnify in combination with Shift def.

X, Y and Z magnifications can be controlled individually.

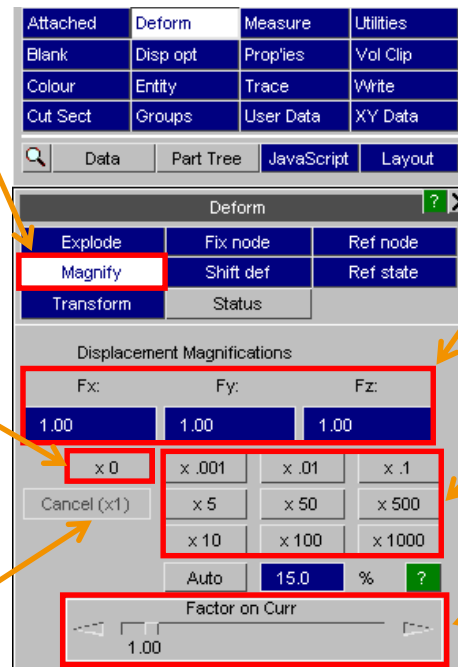
Pre-set buttons will set uniform magnification in X, Y, Z by the specified value.

'x 0' (times 0) magnification will plot the undeformed geometry.

Useful for showing results where bits of the model have collapsed or crushed.

'x 1' (times 1) cancels the magnification.

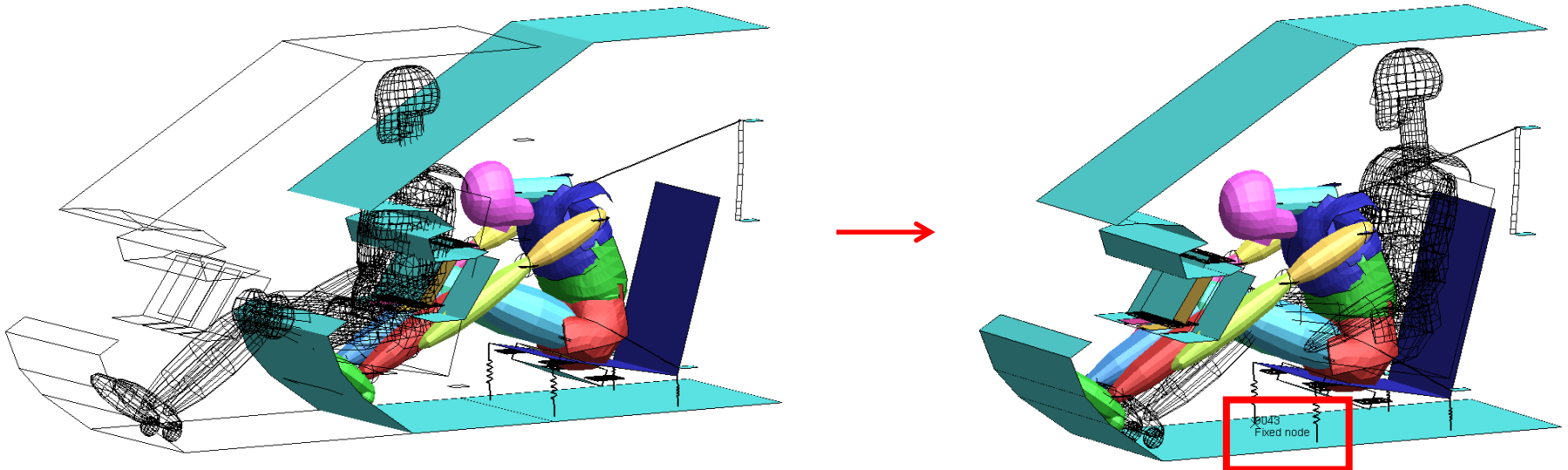
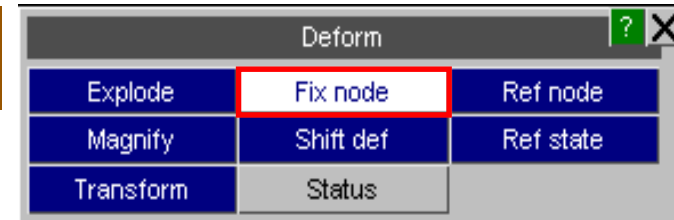
The given factor can be applied to the current values using the 'Factor on Curr' slider.



Fix node

Some models undergo large amounts of movement, which can cause the model to disappear from the viewing window. For example, this sled model.

The 'Fix node' function can be used to "fix" the sled and have it in its undeformed position for the entirety of the animation, so the effect on the occupant can be seen without the sled model disappearing from the viewing window.



Fix node

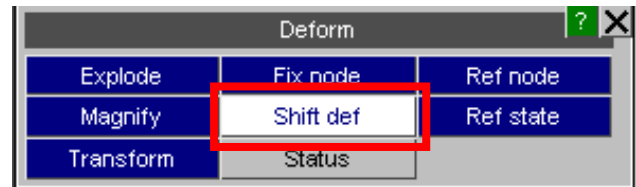
Fix node - fixes a node in space so that all displacements appear on the screen relative to that node.

If 'Ref node off' then this does not affect results on data plots.

See later 'Ref Node' slides for information.

The screenshot shows the D3PLOT software interface. At the top, there is a 'Page Number' field set to 1. Below it is a menu bar with options: D3PLOT, T/HIS, PRIMER, Tune, and Memory. A grid of menu items is visible, including Attached, Deform, Measure, Utilities, Blank, Disp opt, Prop'ies, Vol Clip, Colour, Entity, Trace, Write, Cut Sect, Groups, User Data, and XY Data. Below the menu bar are buttons for Data, Part Tree, JavaScript, and Layout. The 'Deform' menu is open, showing options: Explode, Fix node, Ref node, Magnify, Shift def, Ref state, and Transform. The 'Fix node' option is highlighted with a red box. Below the 'Deform' menu is a dialog box titled 'Definition of fix node'. This dialog has a green 'On' button, a 'Pick ...' button, a dropdown menu set to 'Any', and a field containing 'N6043'. At the bottom of the dialog are 'Ref node Off' and 'Show node' buttons. Two orange arrows point from the text box on the left to the 'Fix node' menu item and the 'Definition of fix node' dialog box.

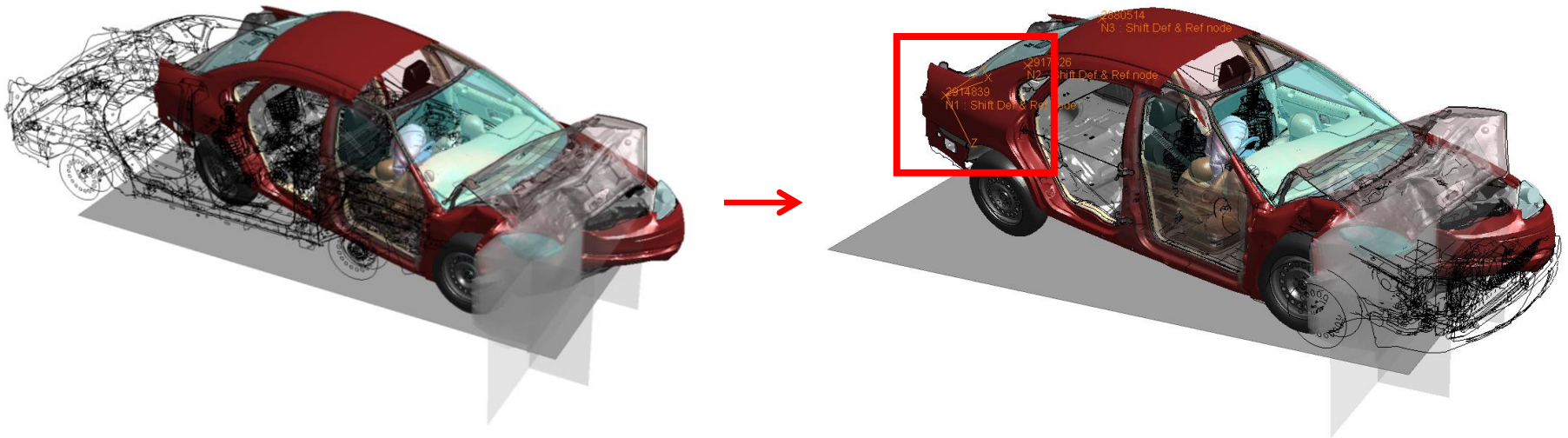
Shift Def



With models that undergo large quantities of displacement and rotation sometimes it may be necessary to prevent a model from displacing and rotating, in order to analyse the deformation of a structure.

For example, when analysing the deformation of a vehicle in a barrier test. As the vehicle collides with the barrier, the large amounts of displacement and rotation make it difficult to analyse the behaviour of the dummy models within the vehicle.

By using the 'Shift def' function, a local co-ordinate system can be defined, and used so that the model moves relative to it. In this example, the local co-ordinate system is at the rear of the vehicle, so the rear of the vehicle is "fixed", thus making it easier to analyse the behaviour of the dummy models inside the vehicle.



Shift Def

Shift def - fixes a plane defined by 3 nodes in space. This forms a local co-ordinate system and all nodes appear on the screen relative to this co-ordinate system.

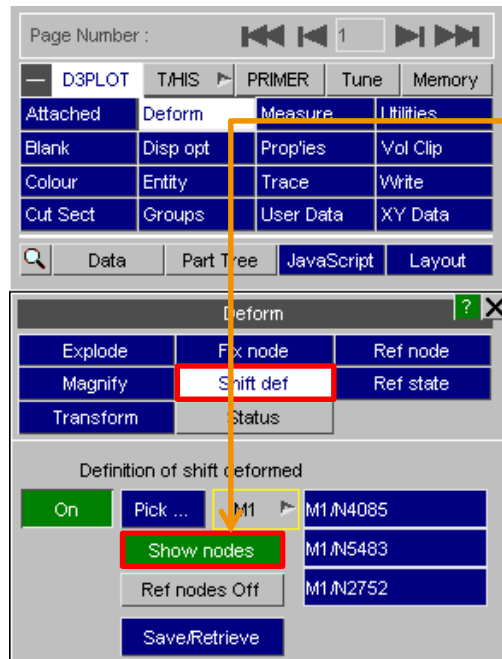
If 'Ref node off' then this does not affect results on data plots.

See later 'Ref Node' slides for information.

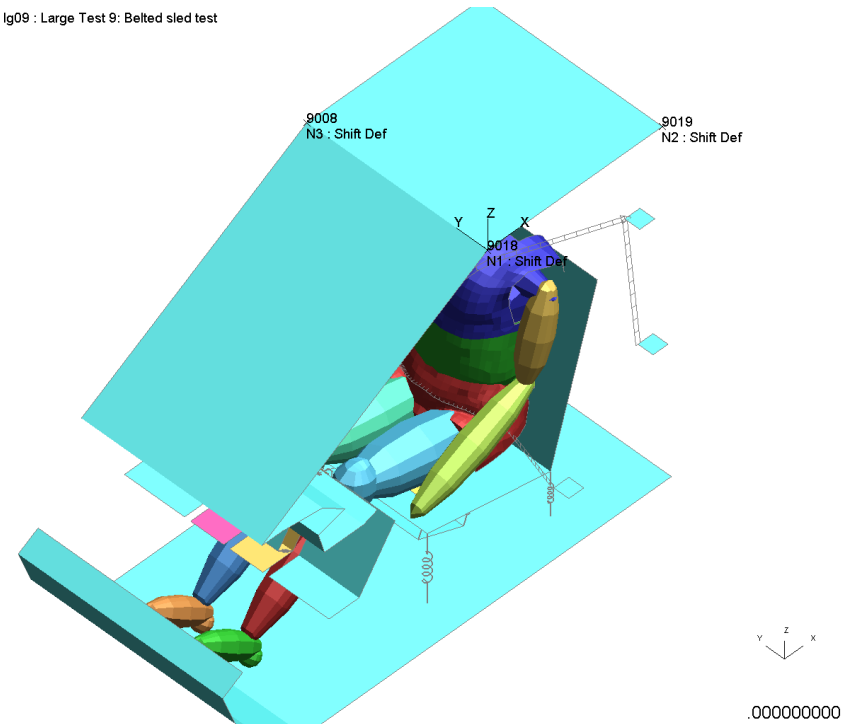
The screenshot shows the D3PLOT software interface. The main menu bar includes D3PLOT, T/HIS, PRIMER, Tune, and Memory. Below this is a grid of menu items: Attached, Deform, Measure, Utilities; Blank, Disp opt, Prop'ies, Vol Clip; Colour, Entity, Trace, Write; Cut Sect, Groups, User Data, XY Data. A secondary bar contains Data, Part Tree, JavaScript, and Layout. The 'Deform' menu is open, showing options: Explode, Fix node, Ref node, Magnify, Shift def, Ref state, and Transform, Status. The 'Shift def' option is highlighted with a red box. Below the menu is a dialog box titled 'Definition of shift deformed' with a red border. It contains a green 'On' button, a 'Pick ...' button, a dropdown menu set to 'M1', and a list of nodes: M1.N4085, M1.N5483, and M1.N2752. There are also buttons for 'Show nodes', 'Ref nodes Off', and 'Save/Retrieve'.

Shift Def Coordinate System

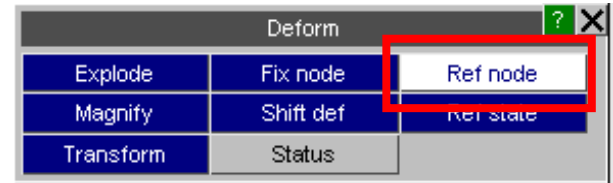
The three nodes selected for Shift Deformed and the local coordinate system can be displayed.



D3PLOT: Ig09 : Large Test 9: Belted sled test

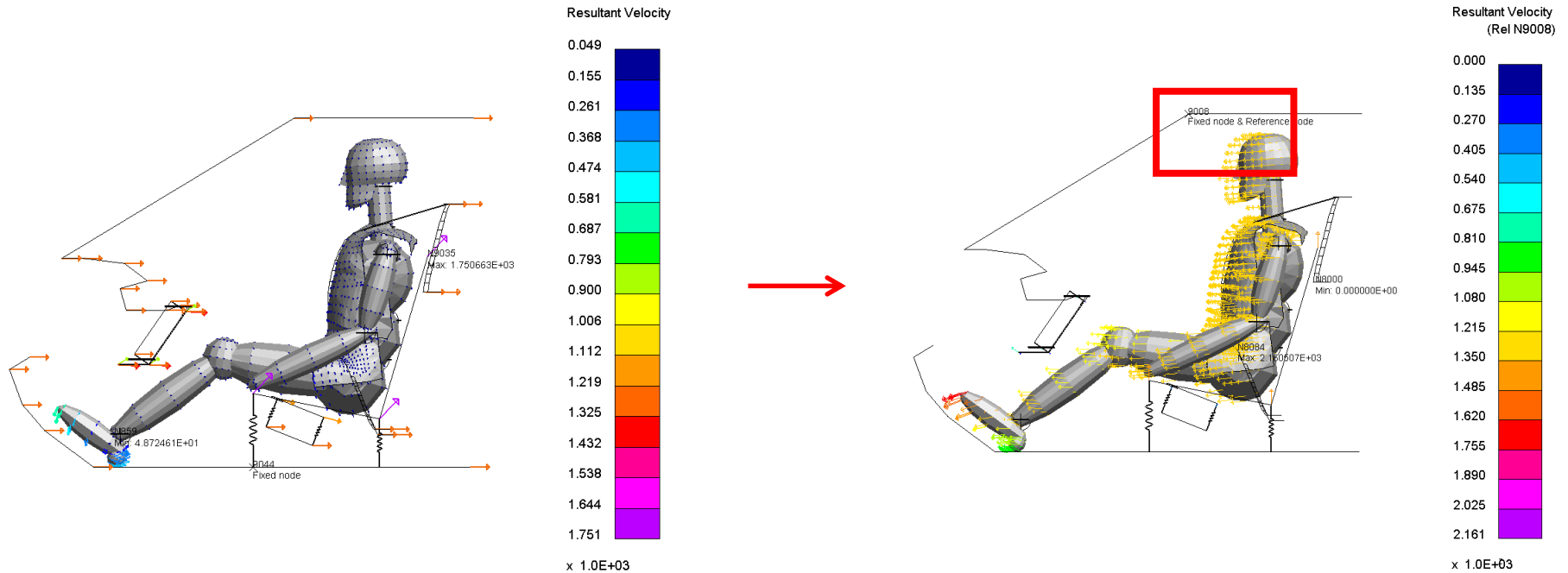


Ref node



In the situation of analysing a sled model with a dummy, users may wish to find the velocity of the dummy relative to the sled since in reality, in a crash the car/sled would be more or less stationary as the dummy travels forward.

Using the 'Ref node' function allows a node to be selected on the sled, and reports all velocities to be relative to the sled (selected node on the sled).

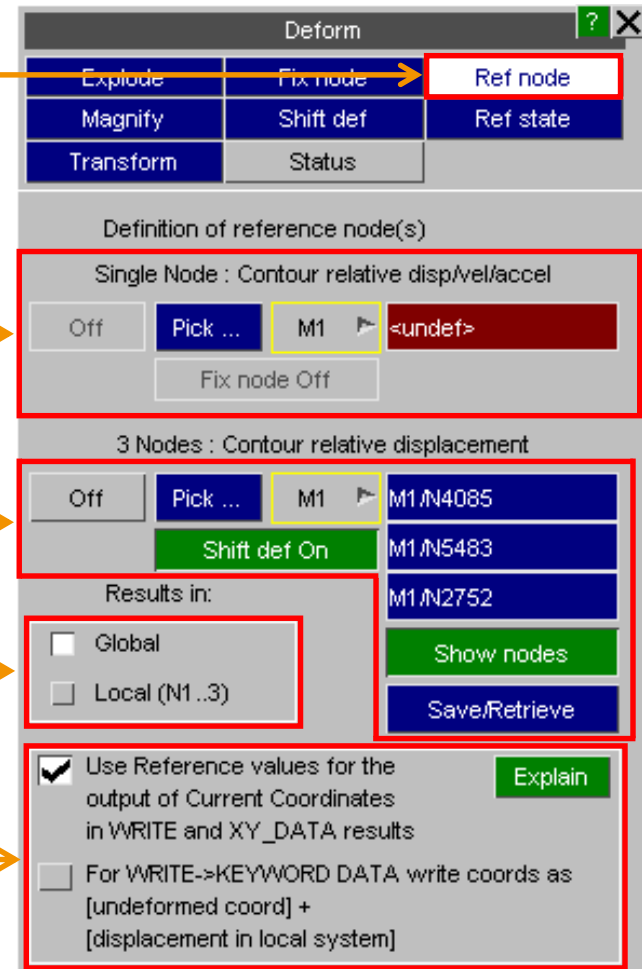


Ref node

Ref node - user can select either a single node or 3 nodes (a plane). All displacement results will be plotted relative to the reference node(s).

When using 'Shift def' reference system, D3PLOT can contour and output displacements relative to the 'Local' coordinate system.

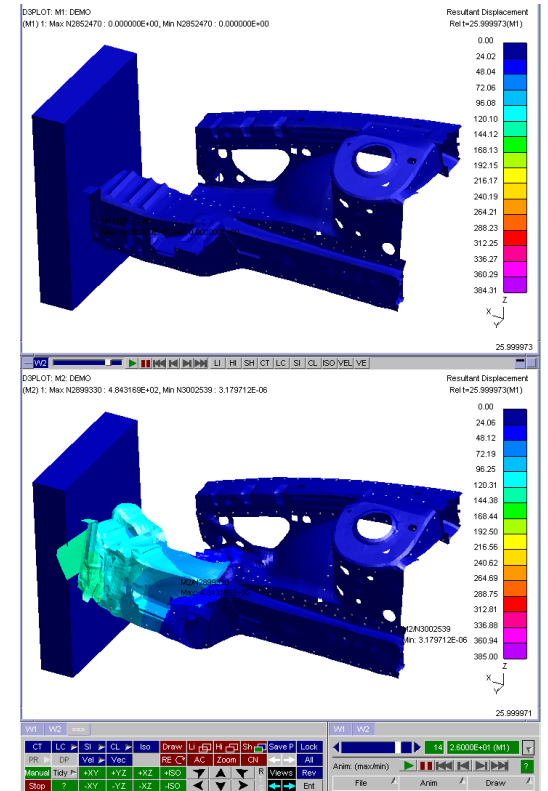
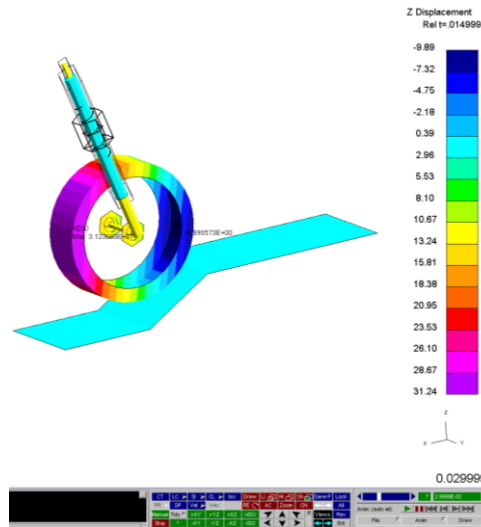
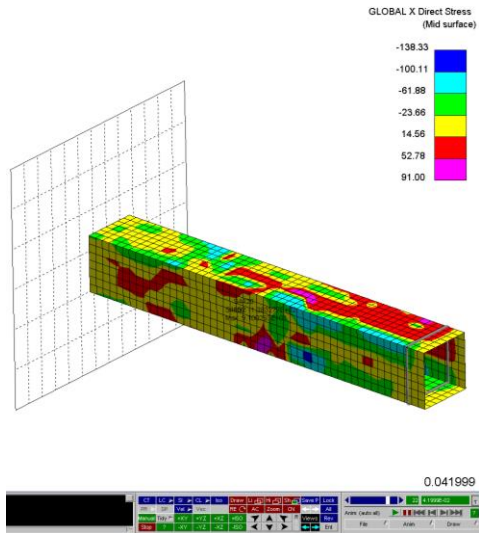
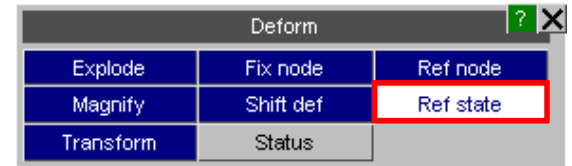
D3PLOT can also output current coordinates (using WRITE, XY_DATA) in the local coordinate system and write coordinates as undeformed + displacement in local system.



Ref state

This can be used to deform the shape of the model to that at a different state, or to compute the data values relative to a different state. Moreover, this may also be done relative to a different state in a different model to allow comparisons to be made between alike models.

Detailed examples are give in this section for plotting the data on the undeformed shape, relative data values and comparison between models.



Ref state

Ref state - Makes results relative to a "reference" state in the current or another model. Choosing a reference state displays the difference between states and models.

Toggle the reference state on/off. Can be toggled on/off for each window separately.

Choose the reference state. The current or a fixed reference state can be selected. If model(s) have been envelope plotted, then a envelope reference state can be defined.

The screenshot shows the 'Deform' software interface with the 'Reference state and/or model' panel highlighted in red. The panel contains the following elements:

- A grid of buttons: Explode, Fix node, Ref node, Magnify, Shift def, Ref state (highlighted with a red box), Transform, and Status.
- Window tabs: W1, W2, and a double arrow button.
- A section titled 'Reference state and/or model' containing a toggle switch set to 'On' and the text 'Current model: State 14 (6.49988E-02)'. The 'Ref state' button is also highlighted with a red box.
- A 'Reference model:' dropdown menu set to '<Current model>'.
- A 'Reference state:' section with a slider from 0 to 54, currently set to 14.
- Fields for 'State: 14' and 'Time: 6.49988E-02 (M0)'. The '14' and '6.49988E-02' are highlighted with green boxes.
- Buttons: 'Use undef (#0)', 'Use current', and 'Use envelope'.
- An 'Apply reference data to:' section with three checkboxes: 'Current coordinates (shape)' (unchecked), 'Data values (contours, etc)' (checked with a green box), and 'Undeformed geometry (when on)' (unchecked).

Select whether to plot relative to the current model or another model.

Control the data that applies to plotted geometry and contoured or written data.

Ref state – Example 1: Deformed Geometry

Models may deform to the point where it can become difficult to view the stresses. For example, when analysing the stresses on a crush tube.

To view the results on the undeformed geometry, set the 'Ref state' to the current state (state 22 in the example below) and apply reference data to the **current coordinates (shape)**.

Reference state and/or model
On Current model: State 22 (4.19992E-02)
Reference model: <Current model>
Reference state:
0 State number 27
22
State: 22 Time: 4.19992E-02 (M0)
Use undef (#0) Use current
Use envelope
Apply reference data to:
 Current coordinates (shape)
 Data values (contours, etc.)
 Undeformed geometry (when on)

GLOBAL X Direct Stress (Mid surface)
-138.33
-100.11
-61.88
-23.66
14.56
52.78
91.00

GLOBAL X Direct Stress (Mid surface)
-138.33
-100.11
-61.88
-23.66
14.56
52.78
91.00

0.041999

0.041999

Tip: to set the current state as the reference state press the 'Use current' button.

22 4.1999E-02
Anim: (auto all)
File Anim Draw

Ref state – Example 2: Relative Data Values

Sometimes it may be required to compare data values at different states.

For example, when a wheel hits a road bump the suspension damper deflects. The user may want to know how much the damper has displaced after the impact. To do this, set the 'Ref state' to the state where the wheel comes into contact with the road bump (state 4 in the example below) and apply reference data to **data values (contours, etc.)**.

Reference state and/or model

On Current model: State 4 (1.49990E-02)

Reference model: <Current model>

Reference state:

State number: 0 21

4

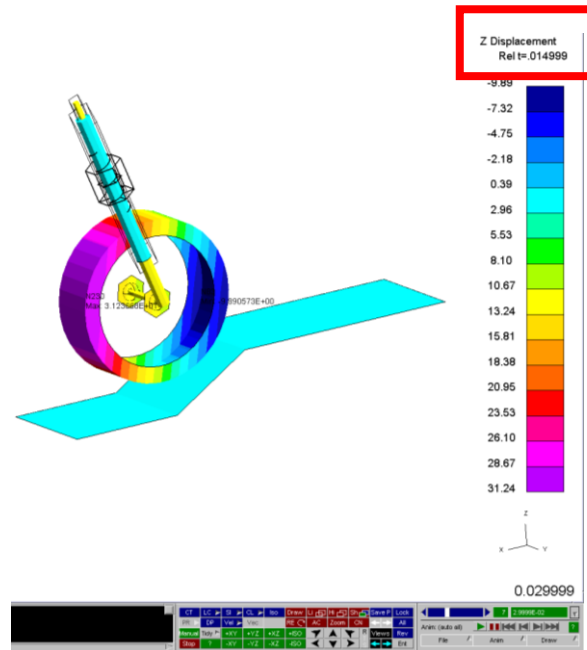
State: 4 Time: 1.49990E-02 (MO)

Apply reference data to:

Current coordinates (shape)

Data values (contours, etc.)

Undeformed geometry (when on)

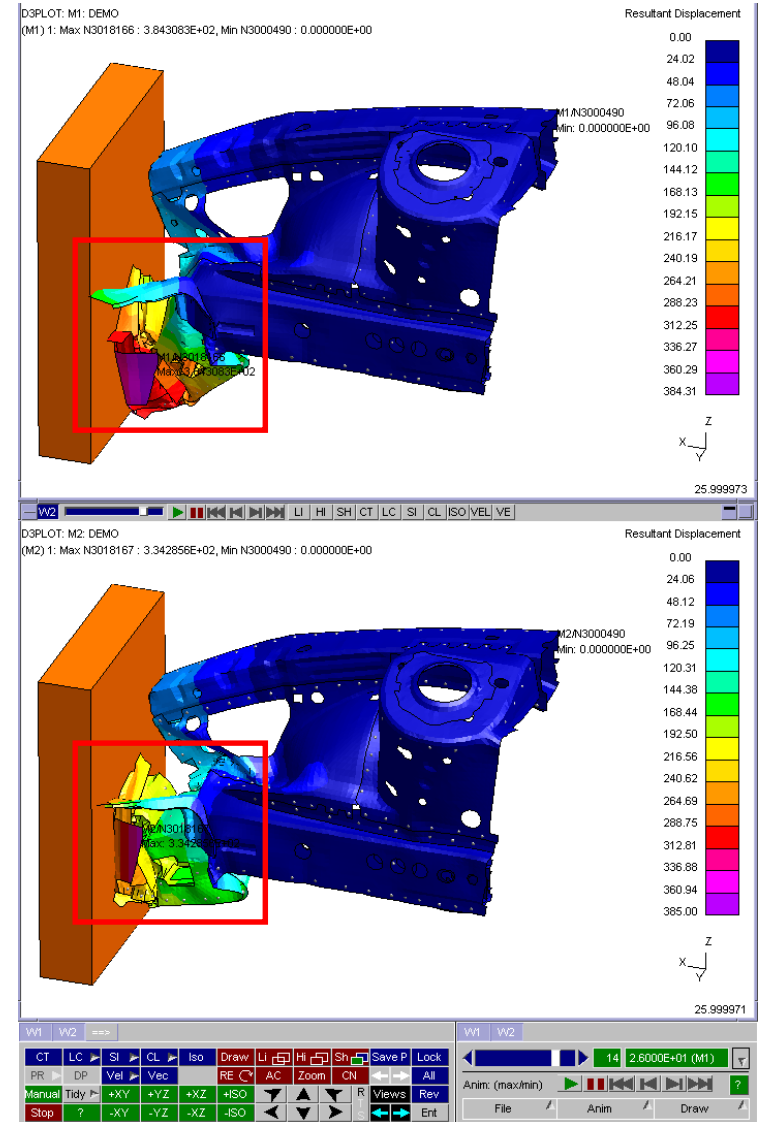


Ref state – Example 3: Model Comparison

When analysing two models simultaneously, it may be necessary to compare results between the models.

For example, when comparing the displacement for two identical models where one is made from aluminium (M1) and the other steel (M2).

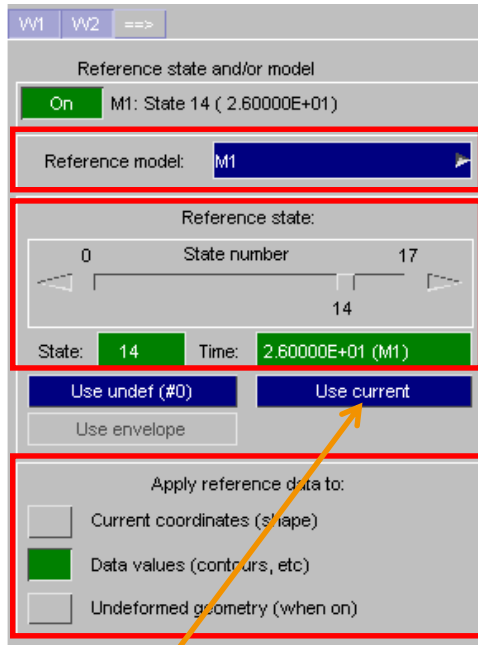
This can be done by contouring the displacement on both models, however 'Ref State' can be used to better display the difference, as shown on the following slides.



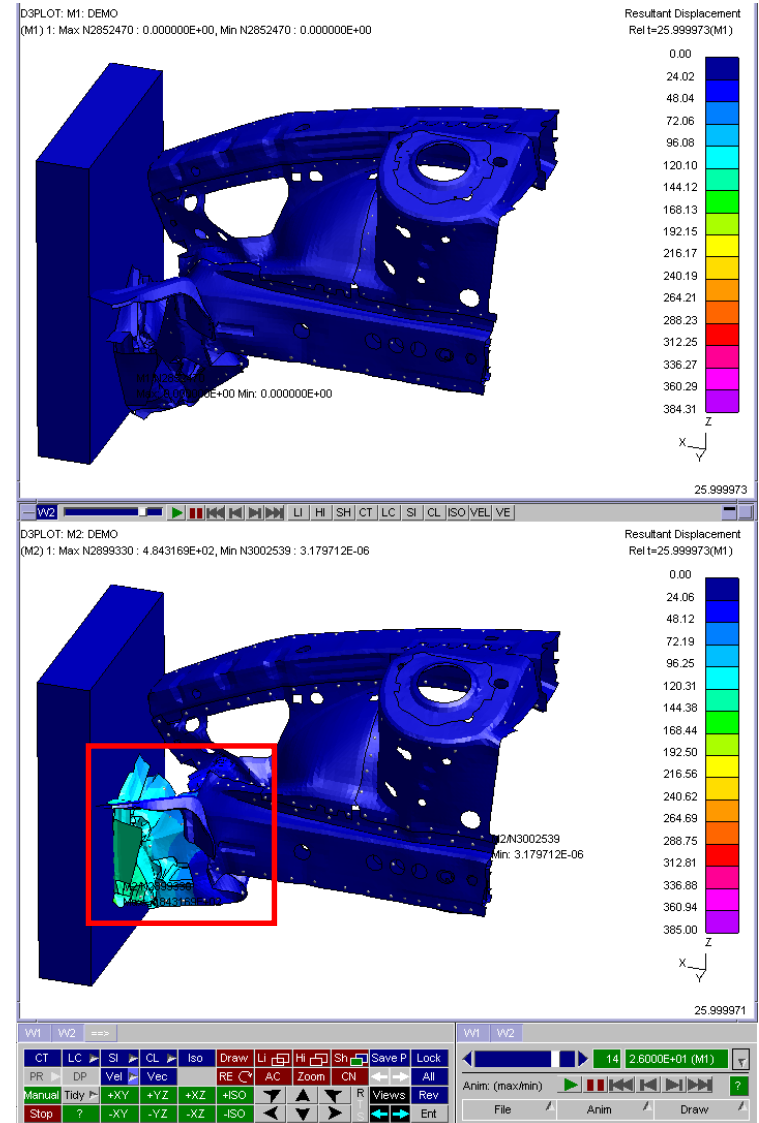
Ref state – Example 3: Model Comparison

To plot the difference in displacement on the steel model (M2) relative to the aluminium model (M1):

Set the 'Ref state' to use 'Reference model' M1 at the current state (state 14 in the example below) and apply reference data to the **data values (contours, etc.)**.



Tip: to set the current state as the reference state press the 'Use current' button.



Ref state – Example 3: Model Comparison

Even better, the outline of M1 can be shown on M2 to allow for a direct visual comparison of the displacements.

To do this, in 'Ref state' also apply reference data to **undeformed geometry (when on)**.

See the display options tutorial for how to turn on undeformed geometry.

Reference state and/or model

On M1: State 14 (2.60000E+01)

Reference model: M1

Reference state:

0 State number 17

14

State: 14 Time: 2.60000E+01 (M1)

Use undef (#0) Use current

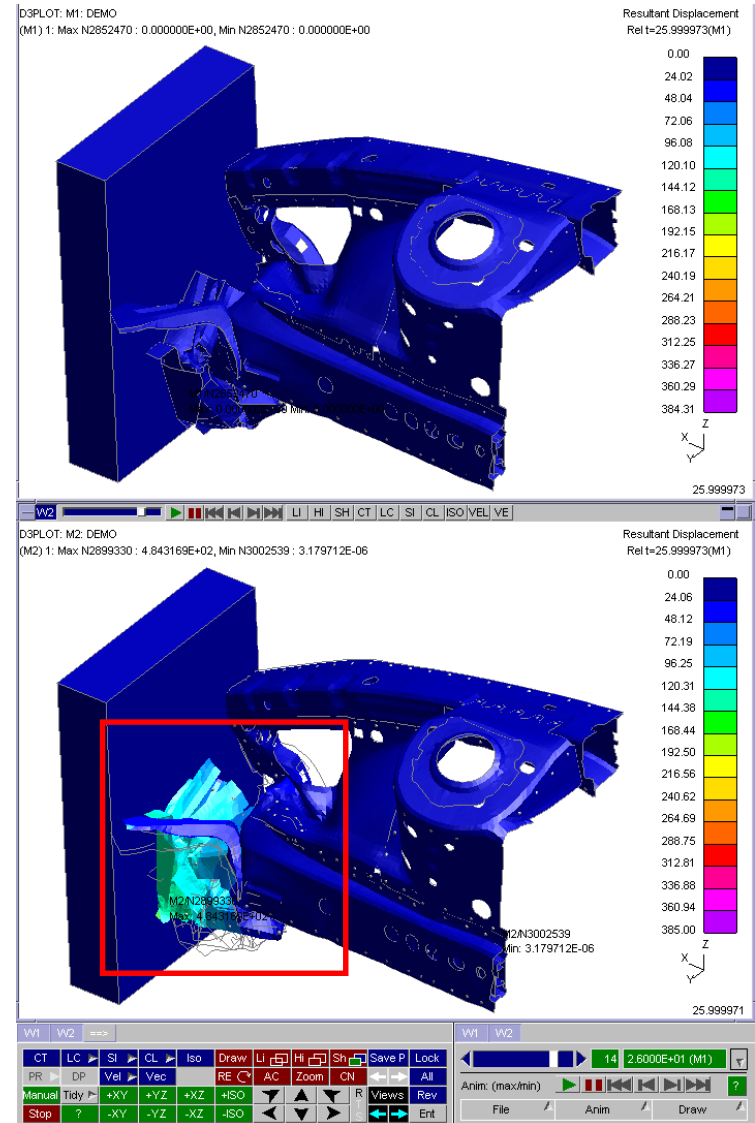
Use envelope

Apply reference data to:

Current coordinates (shape)

Data values (contours, etc)

Undeformed geometry (when on)

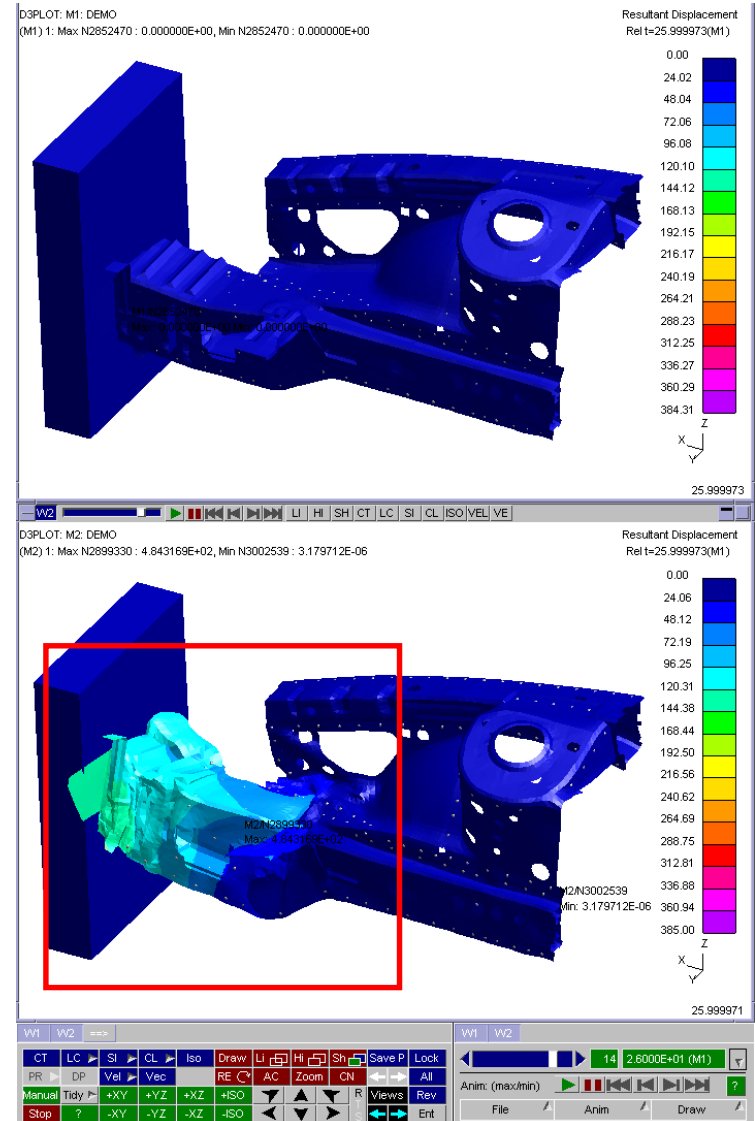
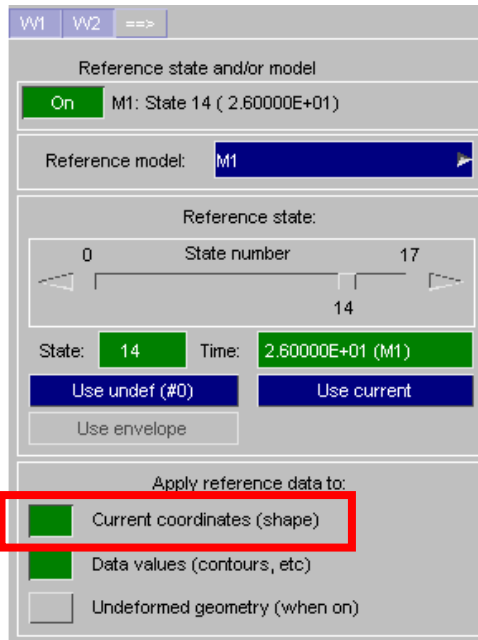


Ref state – Example 3: Model Comparison

Finally, similarly to example 1 the model can be shown in the “undeformed” state to better see the data.

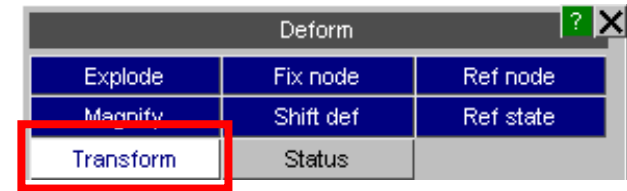
To do this, in ‘Ref state’ also apply reference data to **data values (contours, etc.)**.

In the example, the new geometry displayed in M2 is the difference in displacement between M1 and M2 at the current state (state 14).



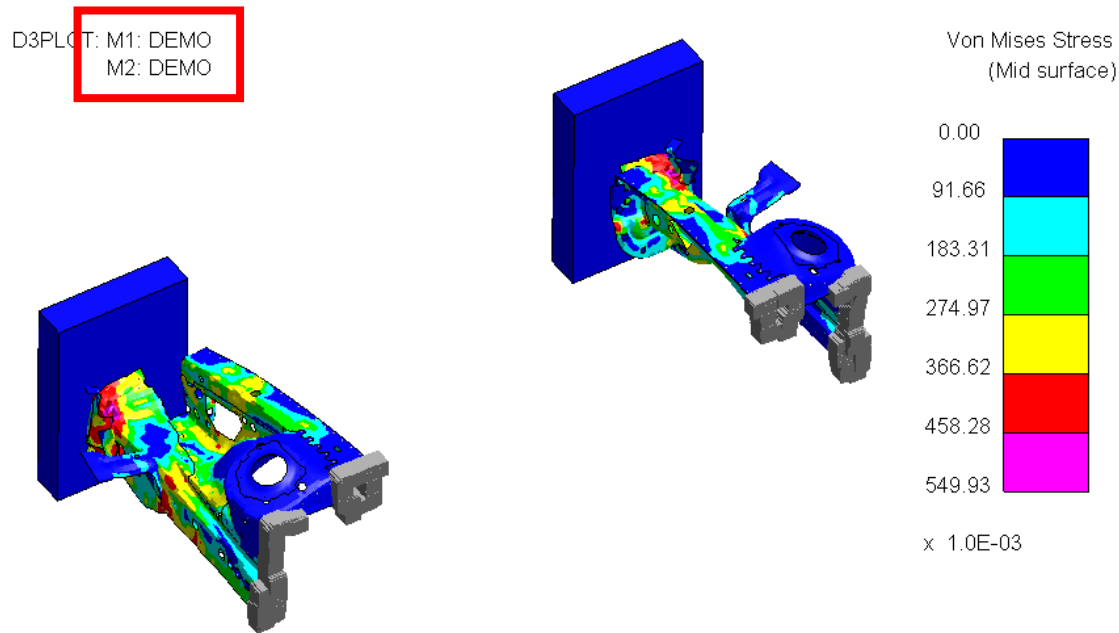
Transform

There are various “Transform” options in D3PLOT, these may be used in various ways, an example is given below.



With models that have symmetry, it is often cheaper to make and run models at the point of symmetry. For example, when running an analysis on a vehicle structure only half of the model might be made and run.

In D3PLOT users may wish to visualise both sides of the model for context. This can be achieved by opening the same model twice, in the same window within D3PLOT, then using the ‘Transform’ tool to ‘Reflect’ the model.



Transform

Transform - Apply translation, reflection, rotation and scale to each model.

Select which models to apply the 'Transform' functions to.

Translate a model by applying a vector in global model space.
Applies to coordinates.

Rotate a models by angles about a centre of rotation.
Applies to coordinates, velocities, accelerations, and stress and strain tensors.

Deform		
Explode	Fix node	Ref node
Magnify	Shift def	Ref state
Transform	Status	

M1 M2

Definition of transformation

Apply Explain this

TRANSLATE Translate by <dx, dy, dz>
Distance: 0.0 0.0 0.0

REFLECT Reflect about global axis
Axis: X Y Z
Distance: 0.0

ROTATE Rotate about global axes
Angles: 0.0 0.0 0.0
Centre: 0.0 0.0 0.0

SCALE Scale along global axes
Factors: 1.00 1.00 1.00

Reflect a model about a point on the X, Y or Z global axes.

Applies to coordinates, velocities, accelerations, and stress and strain tensors.

Scale a model by a factor in the X, Y and Z global axes.

Applies to coordinates.

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