Oasys PRIMER: Seat and Dummy Positioning and Belt Fitting

Training course

Course objective & contents

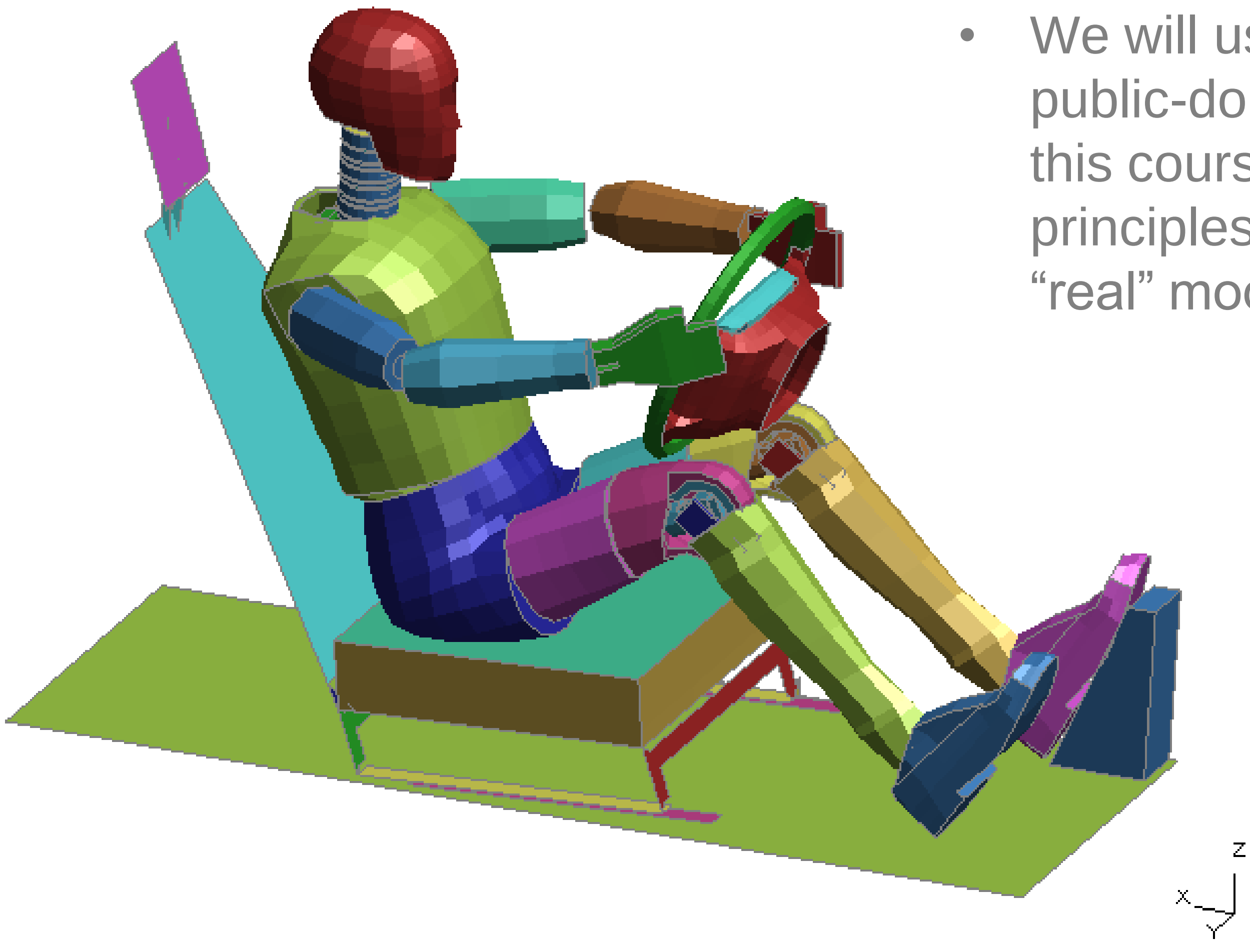
Objective:

- Learn how to use Primer to position seats and dummy models, and fit seatbelts.

Course Contents:

- Seats
  - defining the mechanism data
  - Positioning
- Dummy positioning
- Linking the seat to the dummy for combined positioning
- Belt re-fitting after dummy positioning
- Seat foam compression
  - Primer method
  - LS-DYNA method (pre-simulation)
- Belt fitting
- 2D Seatbelts
- Dummy positioning by LS-DYNA method (pre-simulation)
- Multiple dummy model setup by JavaScript

Model to be used

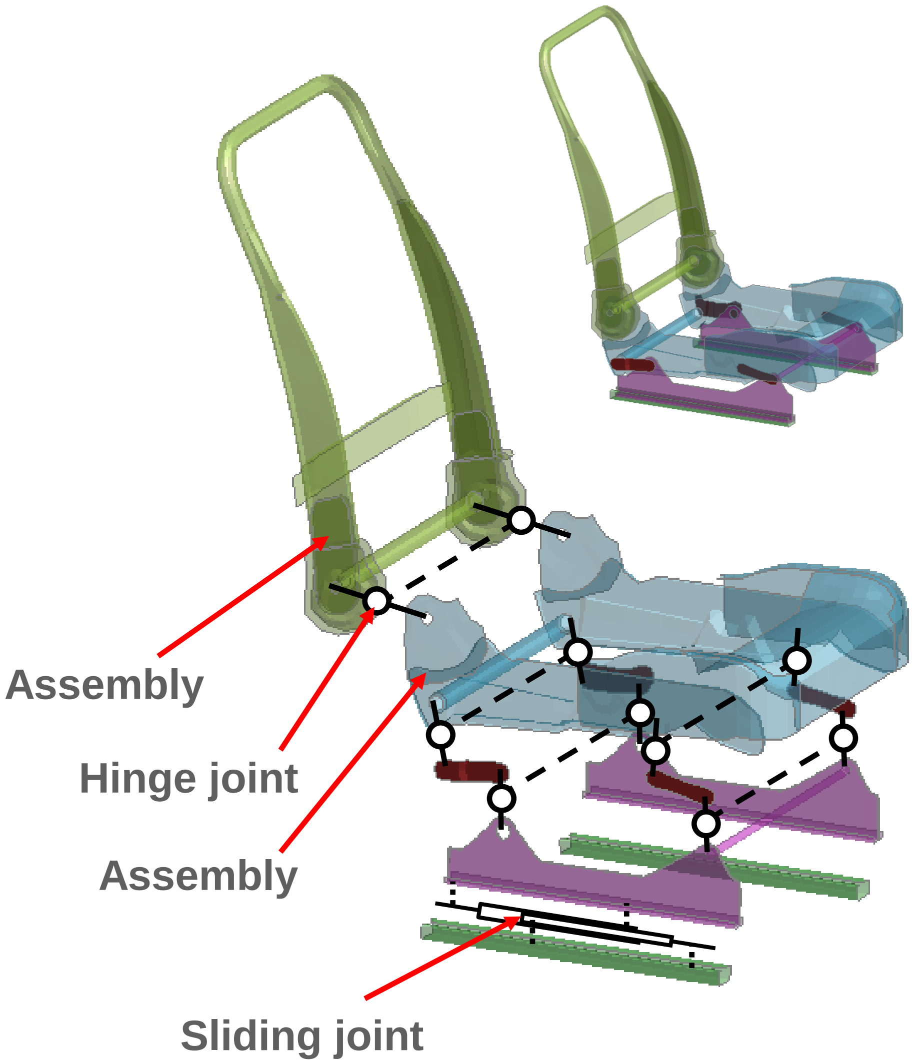


- We will use a very crude public-domain model during this course, but the same principles can be applied to “real” models.

Seat positioning

Mechanism definition

- The seat will be positioned by using Primer to define a mechanism, which we can then articulate into the desired position.
- Assemblies identified by Parts or Part Sets, e.g. back, squab, front links, etc. During positioning, each assembly will behave as if rigid.
- Connections (joints) defined at nodes. These are used purely for positioning the mechanism and are independent of any LS-DYNA joints. Connection types: pin, hinge, sliding.
- Reference Points (e.g. H-Point) – mechanism can be positioned by specifying coordinates of reference points.

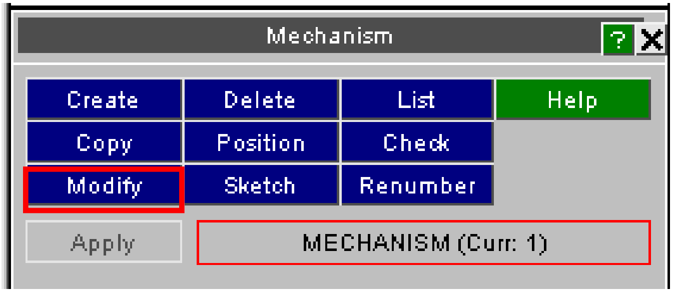


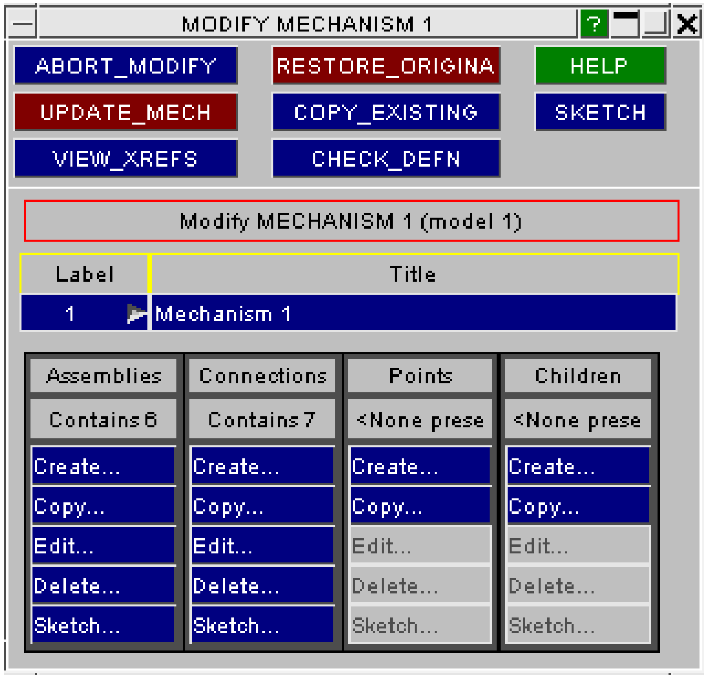
Seat – model requirements

- Requirements for the Seat model:
  - You need to know which parts will be in which assemblies – it is convenient to group these into sets before starting to define the mechanism.
  - Nodes must not be shared between assemblies.
  - Assemblies should not contain parts that have elements bridging across to other assemblies – that would lead to the “shared node” problem.
  - The “joints” in the Primer mechanism are independent of any LS-DYNA connections between the parts. The seat model does not need to contain LS-DYNA joints. Consider instead how you want the model to behave when you run it in LS-DYNA – probably, the mechanism should not articulate, therefore the parts will be fixed rigidly together e.g. using *CONSTRAINED_RIGID_BODIES.

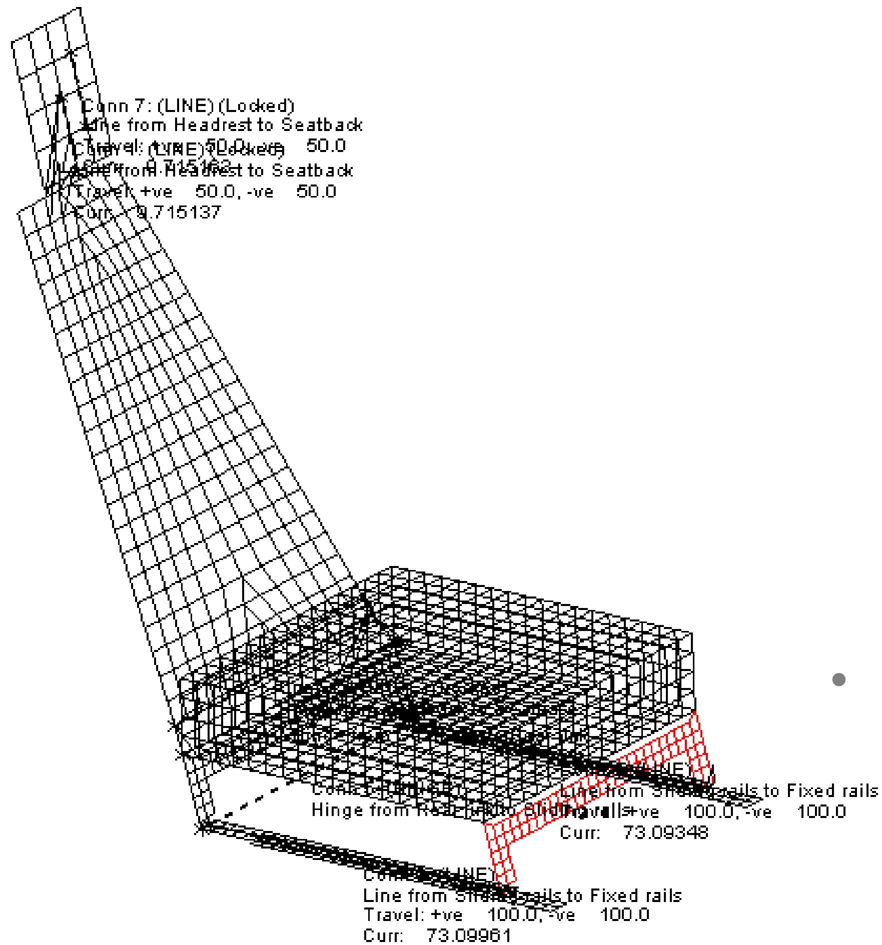
Workshop – defining a mechanism

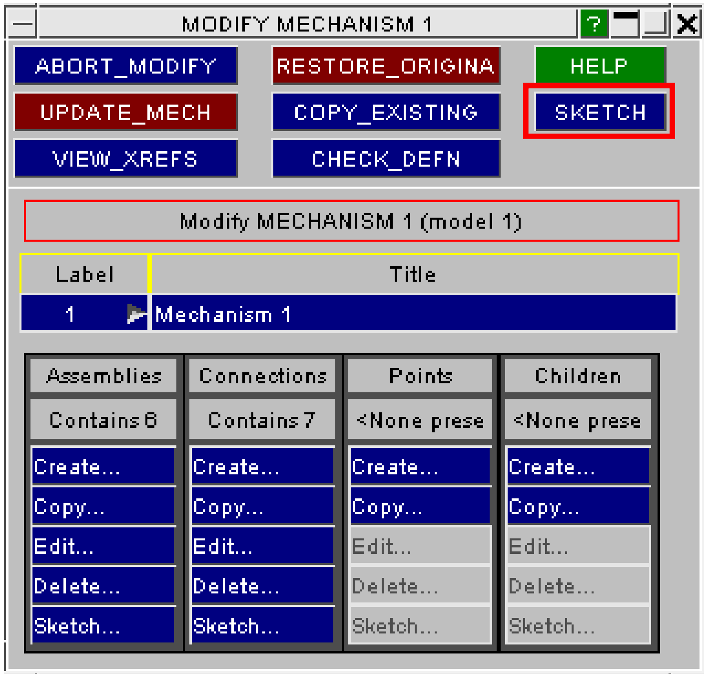
- Read the model seat_incomplete.key, which contains an almost-complete mechanism definition.
- Tools=>Mechanism=>Modify
  - (If the model did not already contain a mechanism definition, you would press Create instead of Modify)
- This menu allows creation, editing and deletion of Assemblies, Connections, and Reference Points





Workshop – defining a mechanism

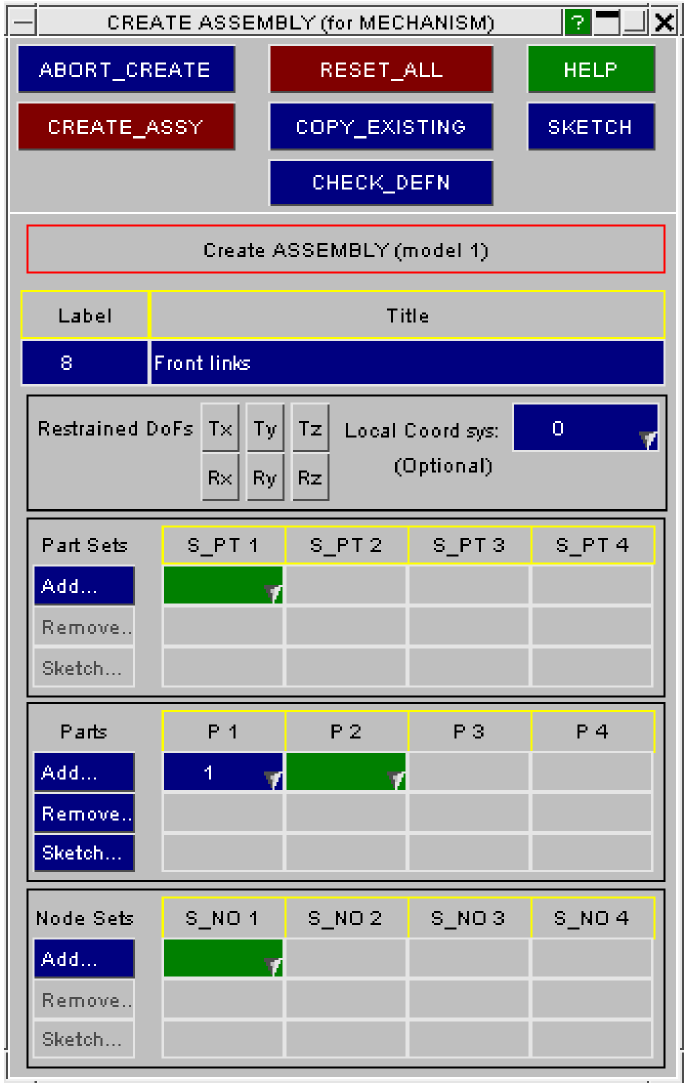




- Sketch the mechanism, rotate the model around. The front links, and their connections to the sliding rails and seat frame, need to be added.

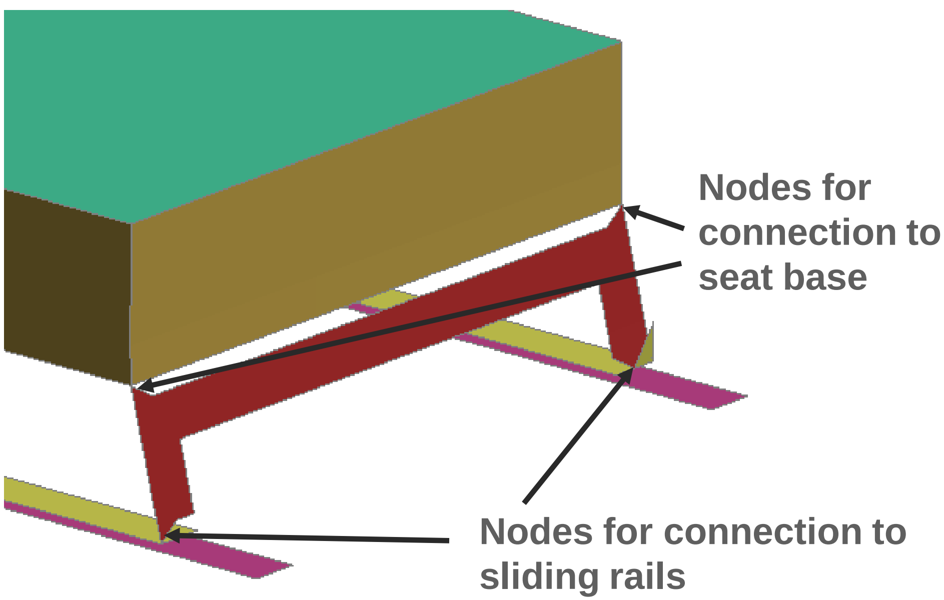
Creating an assembly

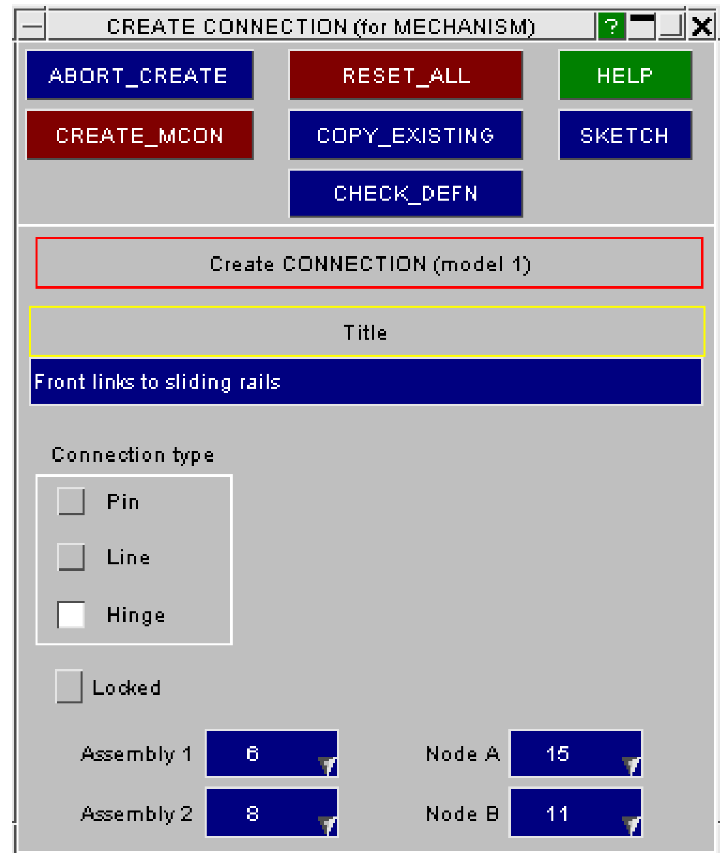
- Assemblies=>Create; give the title "Front links"; under Parts, drop-down to "pick" and pick the red part. Press "Create_Assy"
- In a "real" seat model, there will probably be several parts in each assembly. They can be picked individually, or via a Part Set.
- Node sets are available for adding loose nodes to the assembly. This can also be used for elements such as spotwelds whose Part Ids are used in more than one assembly.



Creating connections

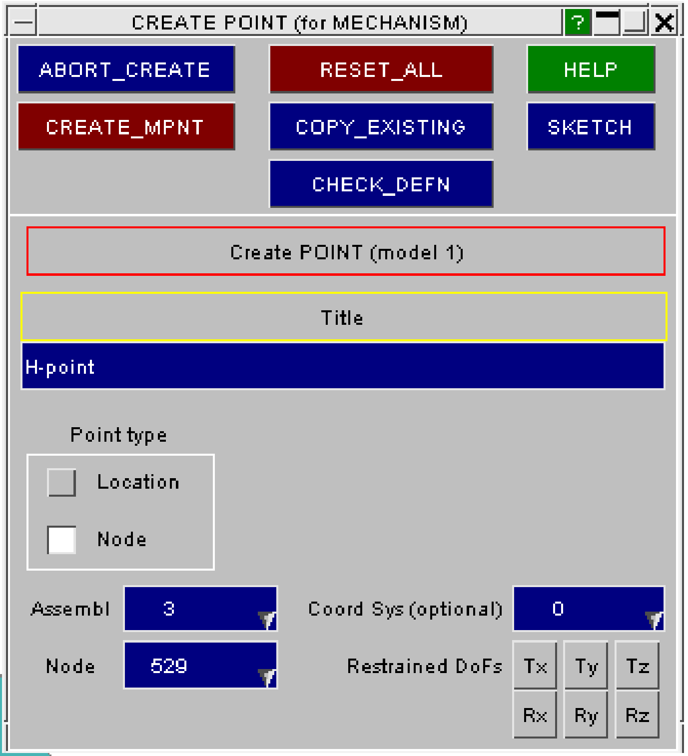
- Connections=>Create; give title “front links to sliding rails”, choose type=Hinge; For Assembly 1, drop-down to Select, choose the assembly named Sliding Rails; for Assembly 2 select Front Links; pick nodes as shown below; Press “CREATE_MCON”
- Create another hinge connection between Front Links and Seat Base

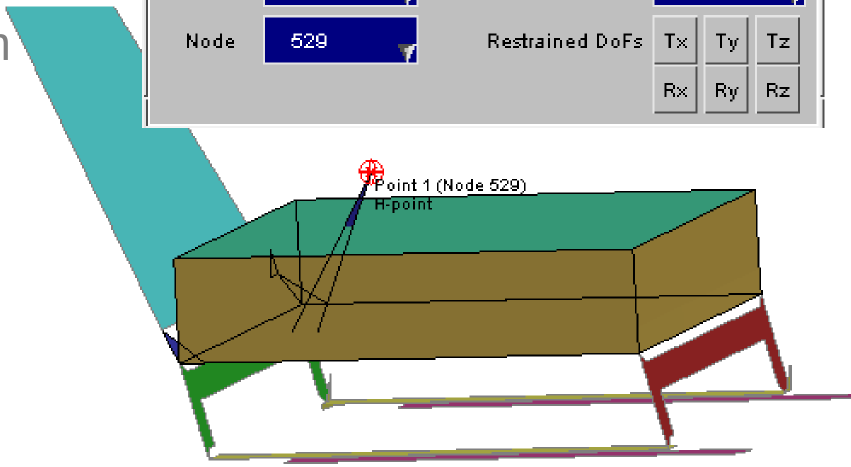


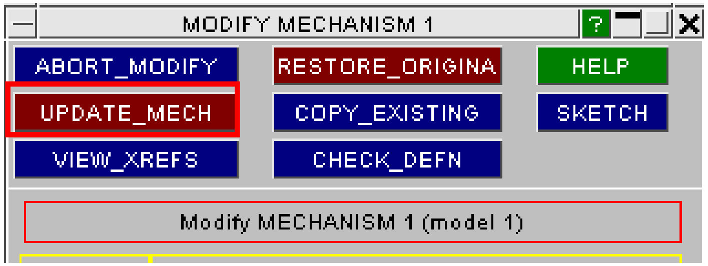


Adding a Reference Point

- Mechanisms can have any number of reference points. Each may be positioned to user-specified coordinates.
- Create a point named “H-point”. Switch the definition method to “node”, and pick the node at the apex of the triangle that sticks out through the seat cushion.
- Attach the reference point to the Seat Base assembly.
- Press CREATE_MPNT
- To save all the changes to the mechanism definition, press “UPDATE_MECH”

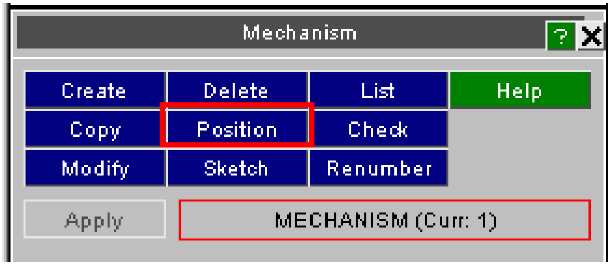


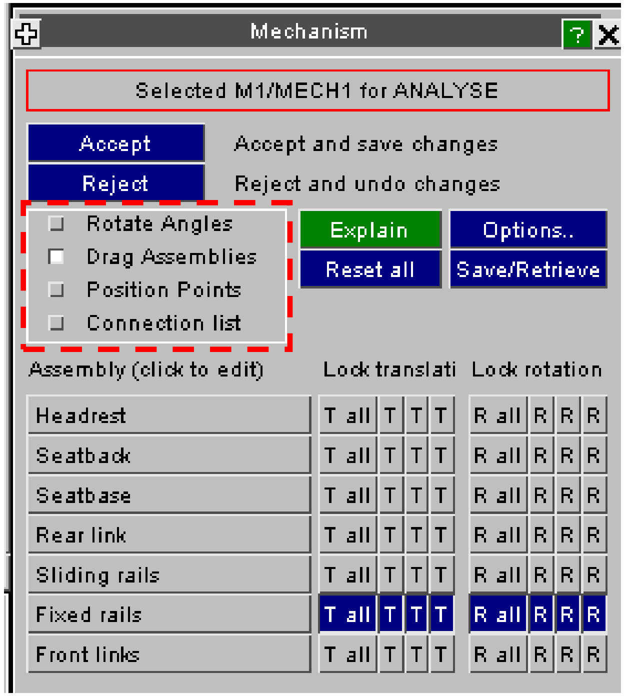




Using the Drag Assemblies menu

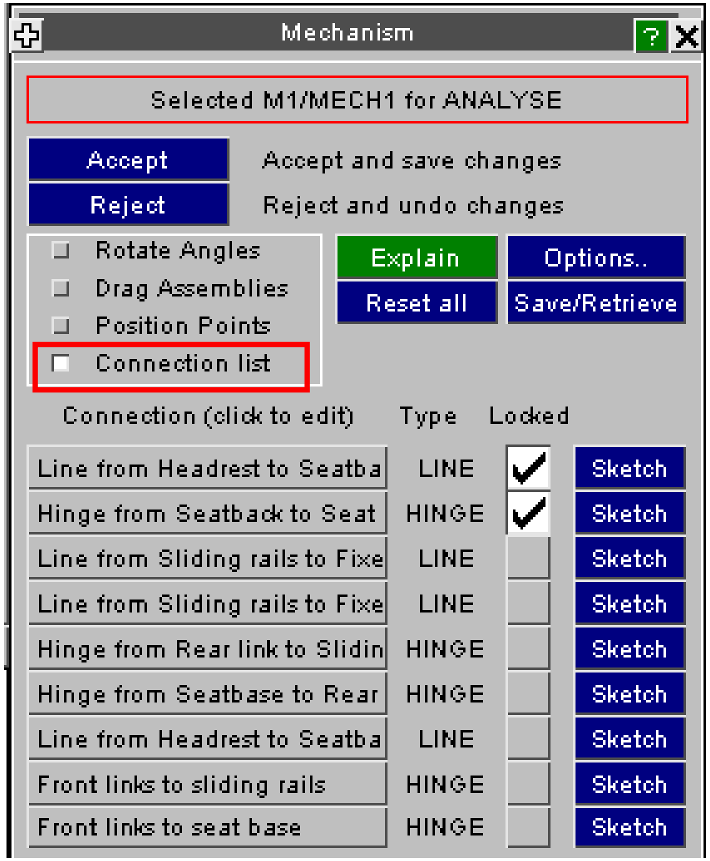
- Press Position. Primer starts in the “drag assemblies” sub-menu: this allows the assemblies to be restrained. (You can still drag the mechanism in any of the four sub-menus within the Position menu).
- In the model provided, the “fixed rails” have been restrained.
- Try dragging the seat cushion – set the view roughly side-on.
- Try removing the restraints from the fixed rails; drag again.
- Press “Reject”. This returns the mechanism to the configuration it was in when you entered the Position menu (or when you last pressed “Accept”).
- Go back into the Position menu, and put back the restraints on the fixed rails. Try restraining the sliding rails, then drag the cushion. Release the sliding rails again.





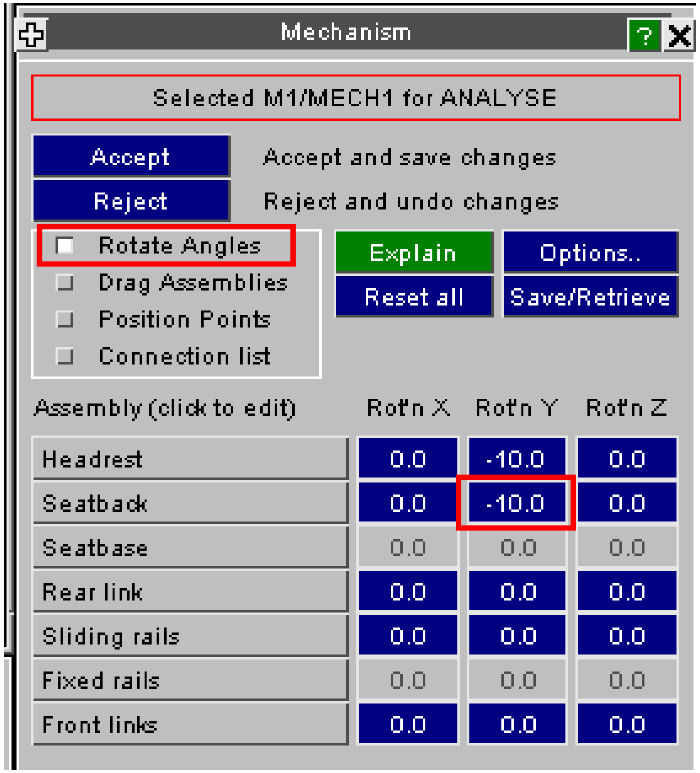
Using the Connection List menu

- Go to the Connection List sub-menu
- In the model provided, the seat back hinge and the headrest slider are locked.
- Experiment with releasing these, then dragging the seat back or headrest.
- Try locking other joints to see the effect.
- Remember, you can always press “Reject” if you don’t like the result.
- The positioning has no permanent effect until you press “Accept”.



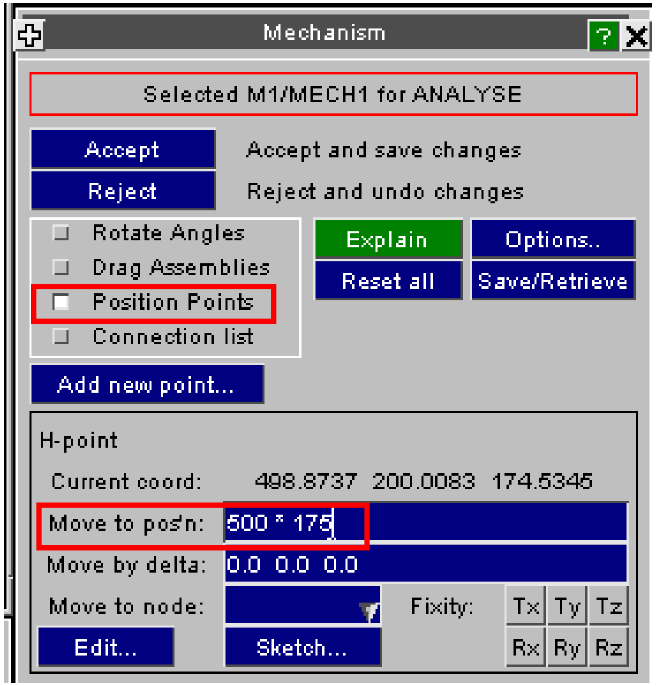
Using the Rotate Angles menu

- In the Connections menu, check that the seat back hinge is released.
- Restrain the seat base (in the Drag Assembly menu)
- Go to the Rotate Angles menu.
- Drag the seat back and note the Y-axis angle changing
- Type an angle into the y-axis angle box for the seat back and see the effect.
- Angles are defined as the orientation of the assembly in the global axis system, relative to its orientation at the time the mechanism was created.
- Reject this position and go back into the Position menu.



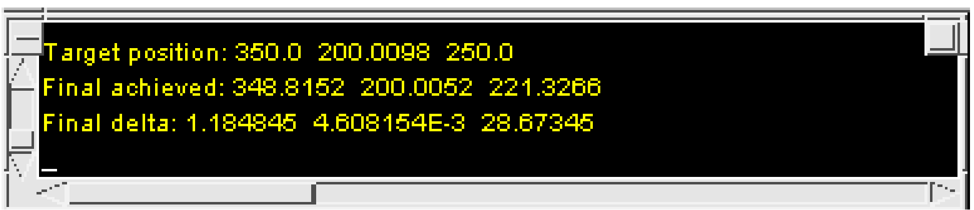
Using the Position Points menu

- Now reset the restraints (in the Drag Assemblies menu) – only the fixed rails should be restrained; and in the Connections menu, only the seat back hinge and headrest slider should be locked.
- Go to the Position Points menu.
- Type in H-point coordinates 500 * 175 (* means “don’t care”)

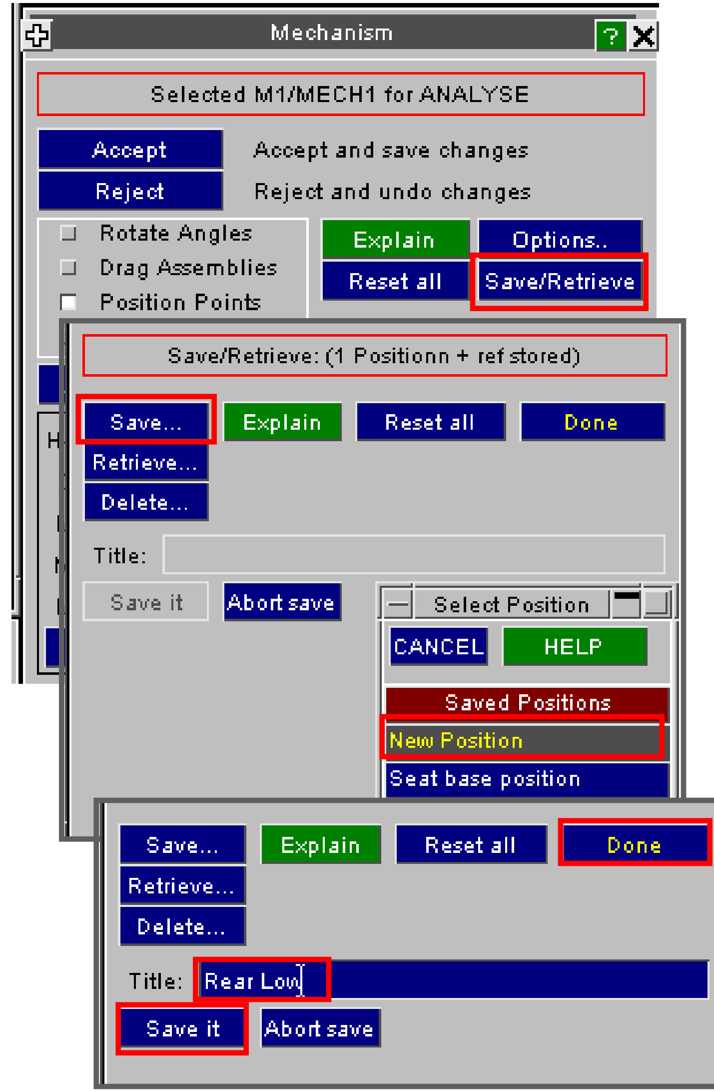


Saving and retrieving positions

- Save this as a New Position, calling it “Rear Low”, then press “Save It” and Done.
- Type in H-point coordinates 350 * 250. The H-point cannot reach this position – it is outside the possible locus with this mechanism. Note the message in the dialog box telling you that there is a “Delta” (difference between what you asked for and what Primer could achieve).



- Save this position, calling it “Front High”.
- Now retrieve the position “Rear Low”, and swap back to “Front High”.



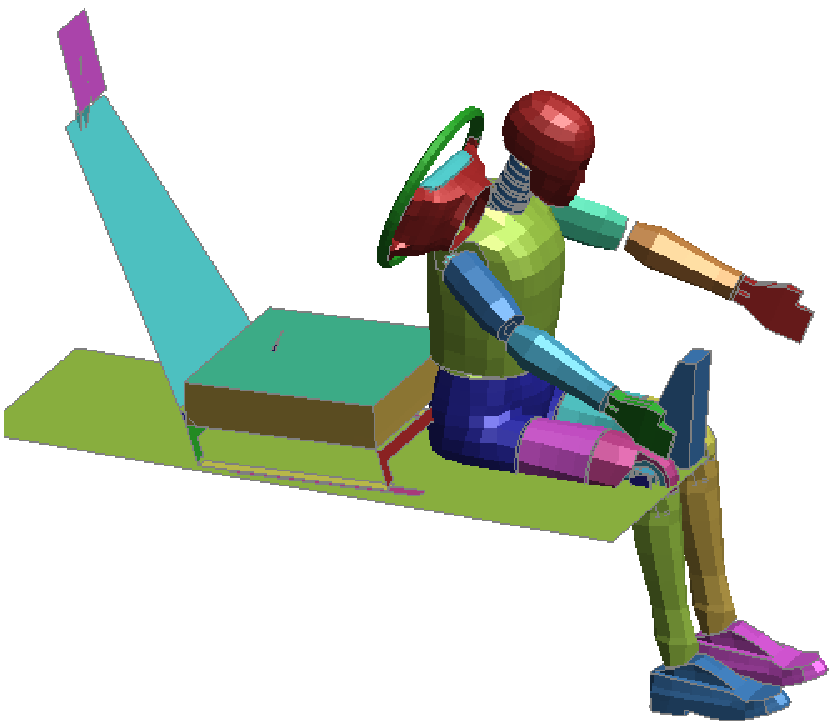
How the mechanism data is stored

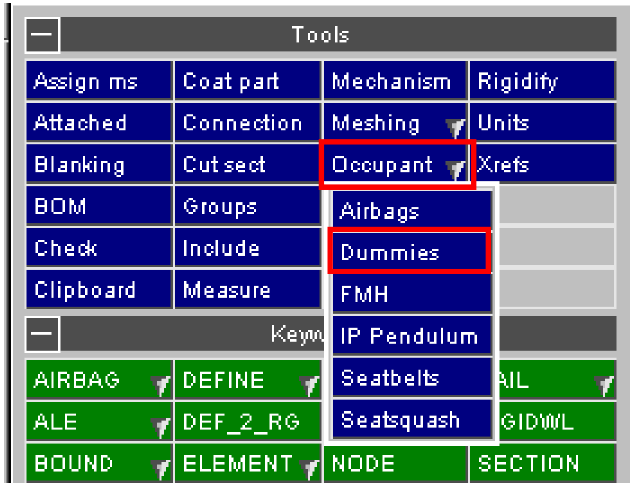
- Finally, return the seat to the base position (the first stored position), and write out as a new keyword file seat_positioned.key.
- Using a text editor, look at the end of the keyword file (after *END). The keywords between *MECHANISM_START and *MECHANISM_END contain the mechanism data and stored positions. These will be available in Primer next time this model is read in.
- Delete the seat model from Primer, ready for the next exercise.

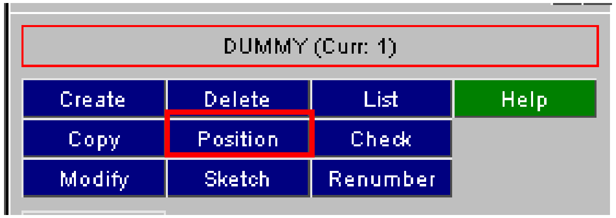
Dummy positioning

Workshop - dummy positioning

- Read dummypos_start3.key.
- The dummy is in its “neutral” position.
- The dummy’s tree file is automatically used by Primer to allow the dummy to be positioned like a mechanism – you do not have to create the mechanism data.
- Go to Occupant=>Dummies=>Position

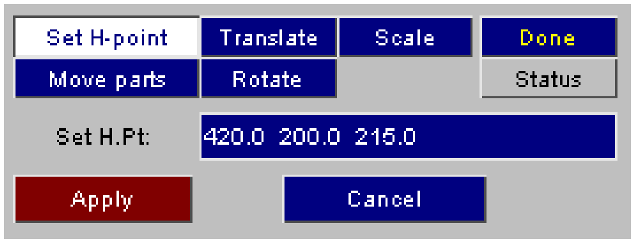




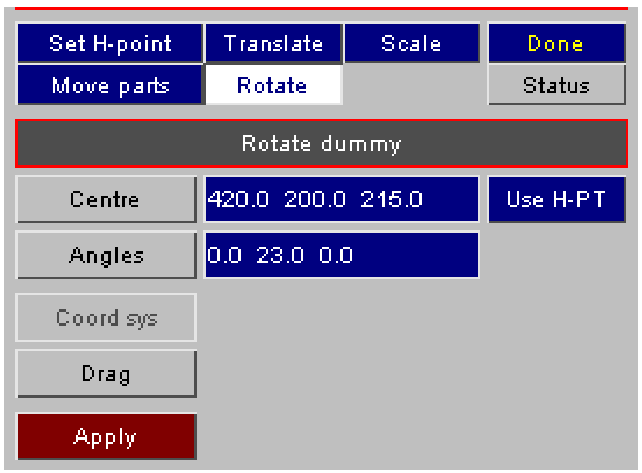


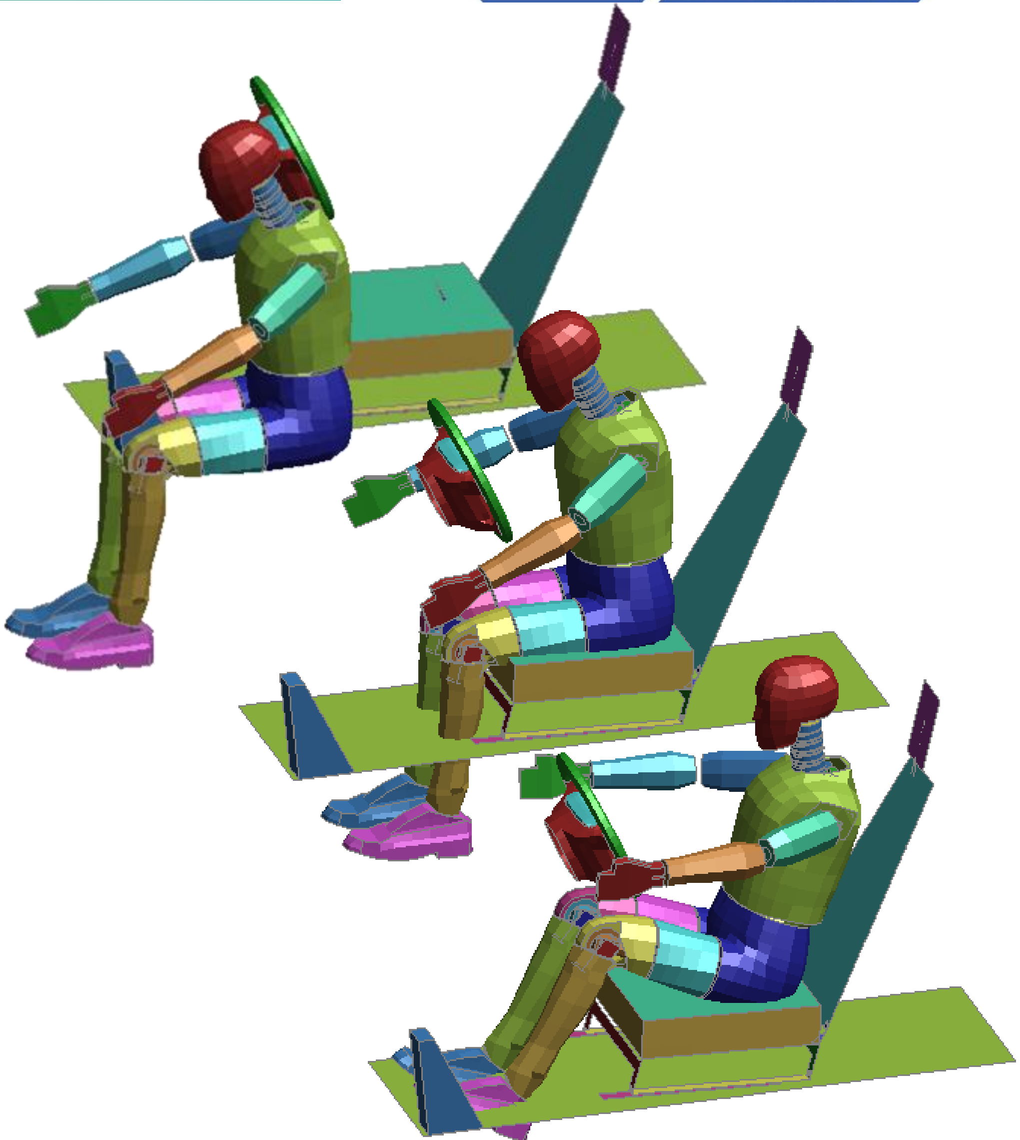
Workshop - dummy positioning

- “Set H-point”, type in the coordinates 420 200 215



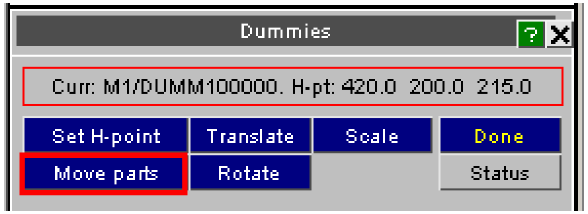
- “Rotate”, for the centre of rotation choose “use H-point”, type in angles 0 23 0, Apply.

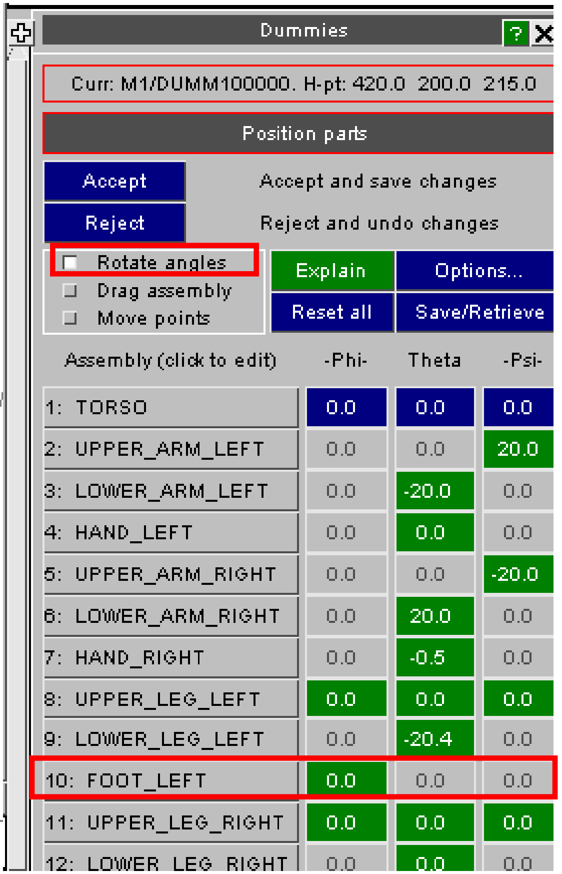




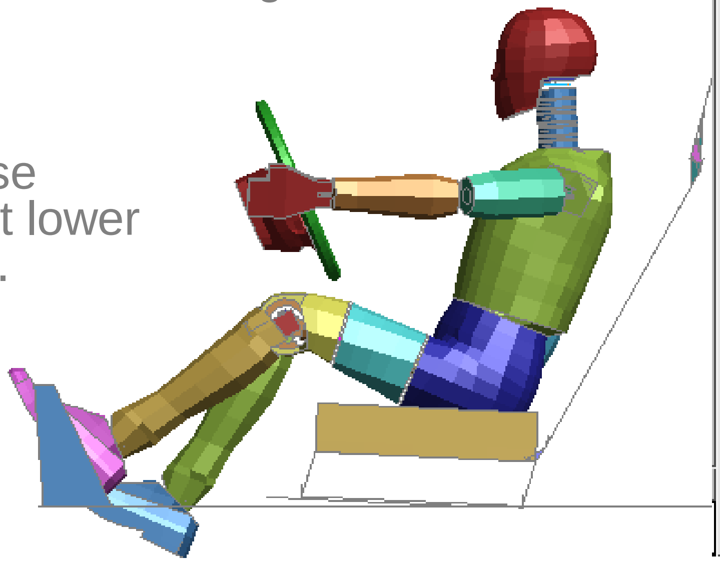
Dummy positioning – Rotate Angles

- “Move Parts” brings up a menu very similar to the Mechanism Positioning menu.
- The initial sub-menu is Rotate Angles, which is the “old style” dummy positioning capability.
- In this menu, dragging is by left, middle and right mouse buttons for rotations about the local X, Y and Z axes (Phi, Theta, Psi in the menu). Green colour indicates a degree of freedom that can be dragged.
- You can also type the desired angles in the menu.



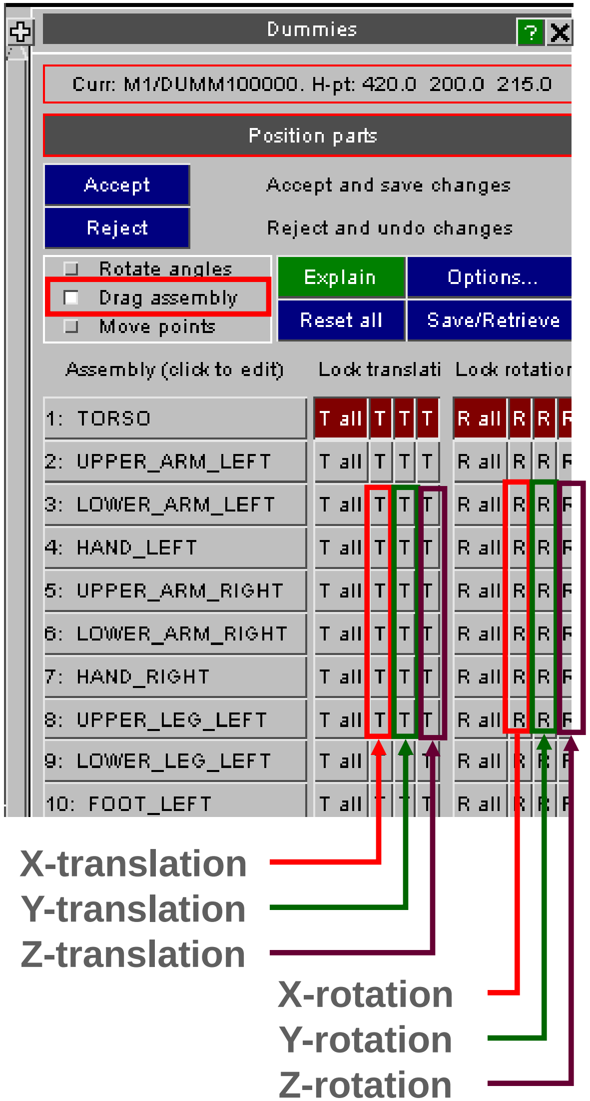


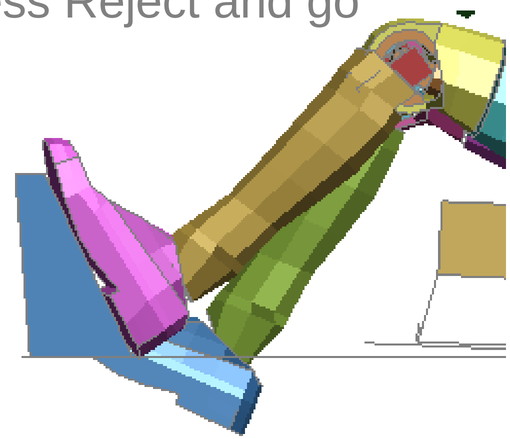
- Use the middle mouse button to drag the left lower leg to a new position.



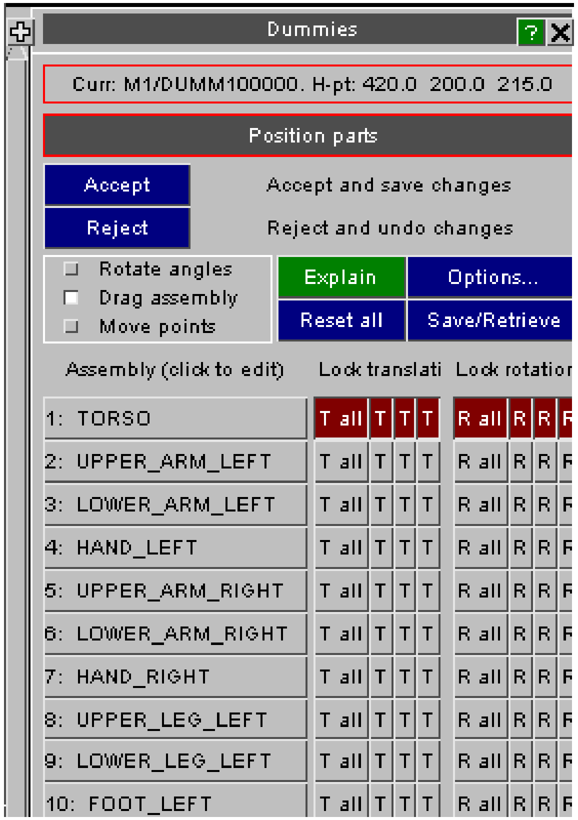
Dummy positioning – Drag Assembly

- Change to the “Drag Assembly” submenu. The Torso, hands and feet have already been restrained.
- Check the restraints on the torso – it should be fully restrained while we position the limbs.
- Cancel the translational restraints from the left foot. Drag the foot onto the footrest.
- Also try restraining the rotations (but not translations) of the foot, then dragging it into position. This technique is useful for putting feet and hands into roughly the correct position.
- If you want to start again, press Reject and go back to the Position menu.

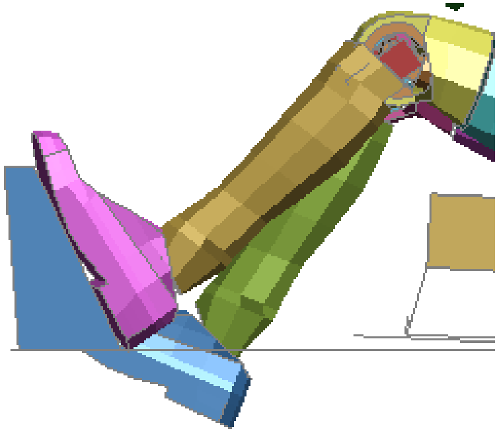




Dummy positioning – Drag Assembly

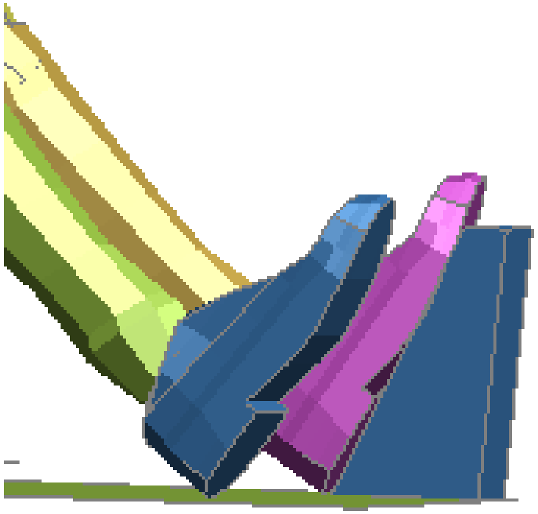


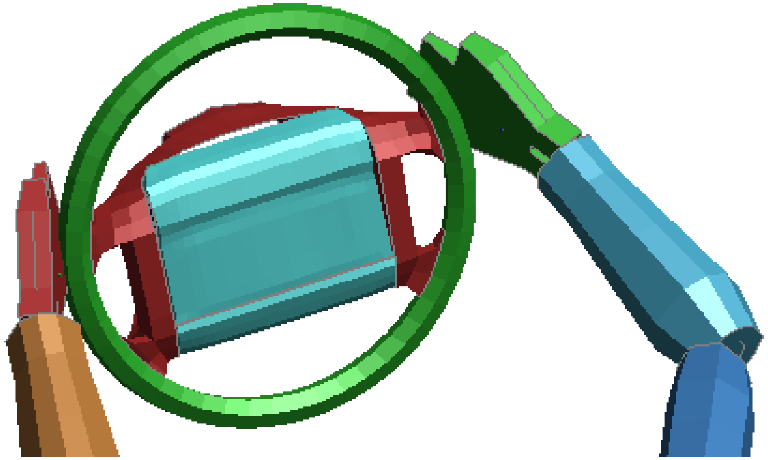
- Explanation of mouse actions in this sub-menu:
  - In this menu, left mouse is normal dragging
  - Middle mouse button is for dragging with the next assembly down the tree temporarily locked (e.g. if you drag the foot like this, the lower leg will be locked).
  - Right mouse allows freedom of the dragged assembly and its immediate neighbour; this is useful with dummy models that have small assemblies in the wrists and elbows.
- Try the effect of dragging the foot with the middle mouse button, then the right mouse button.
- Complete the positioning of left foot onto footrest



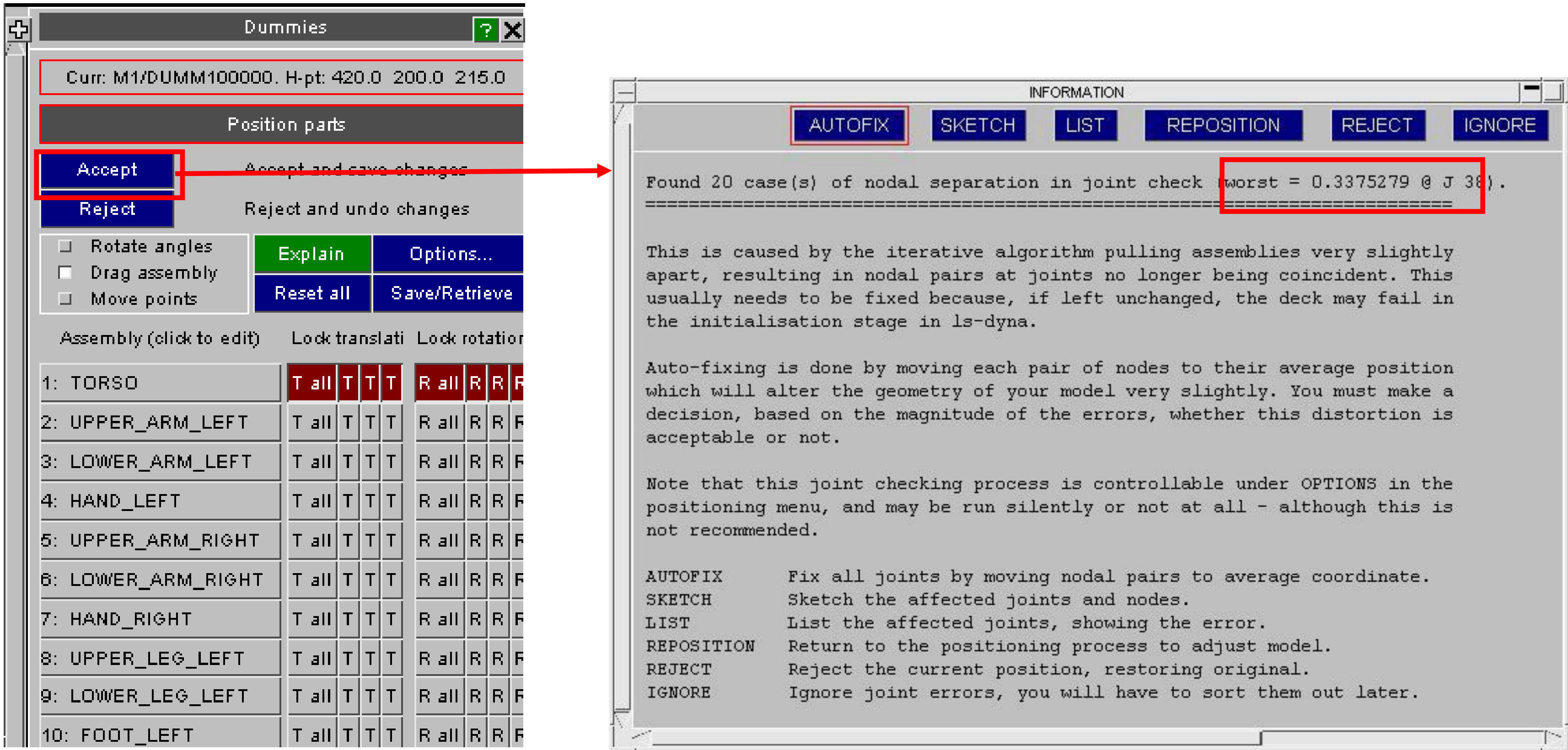
Dummy positioning

- Drag the right foot to rest on the floor
- Drag the left and right hands onto the steering wheel.
- To make the right hand exactly match the left, go to the Rotate Angles submenu, observe the angle of the Left Yoke, and type in the same angle for the right yoke. Depending which way around the joint is defined, the angles for left and right may have opposite signs.
- Make the angles match also for the right upper arm, right lower arm, right hand.





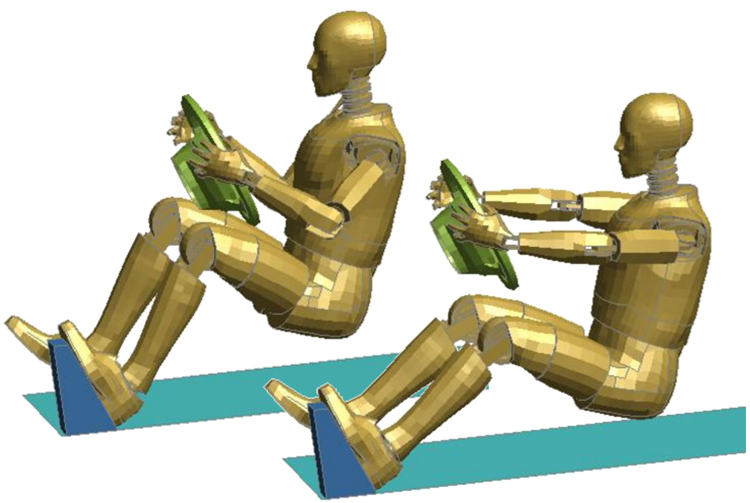
Saving dummy position

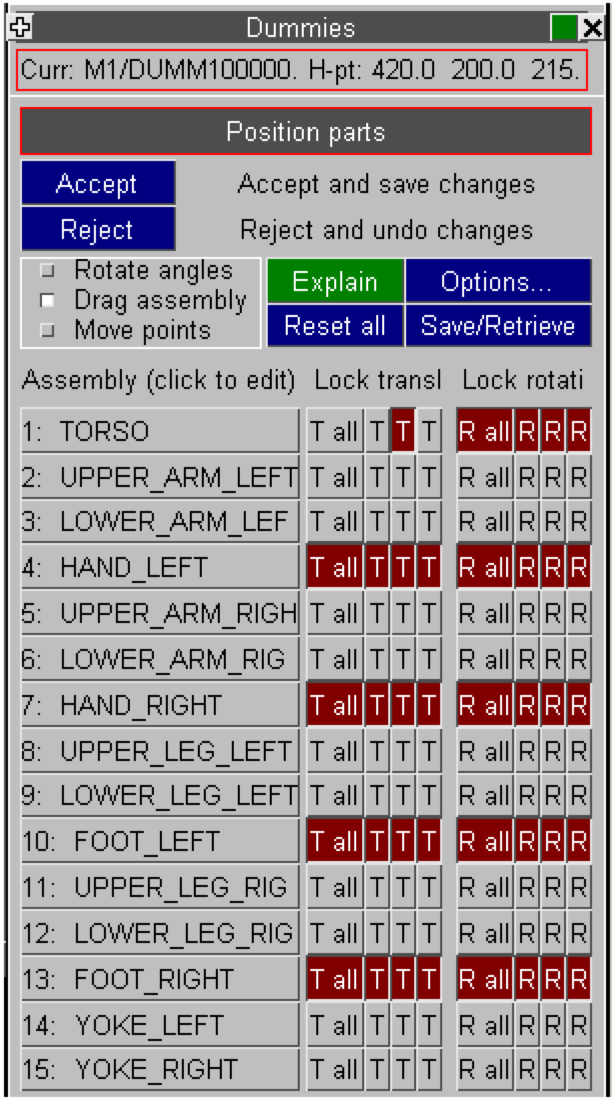


- Press Accept
- Primer will find that some nodal pairs at joints are no longer exactly coincident. Check the nodal separation; if small, select AUTOFIX to make the joint nodes coincident. This results in slight geometry change to the model.

Dummy positioning

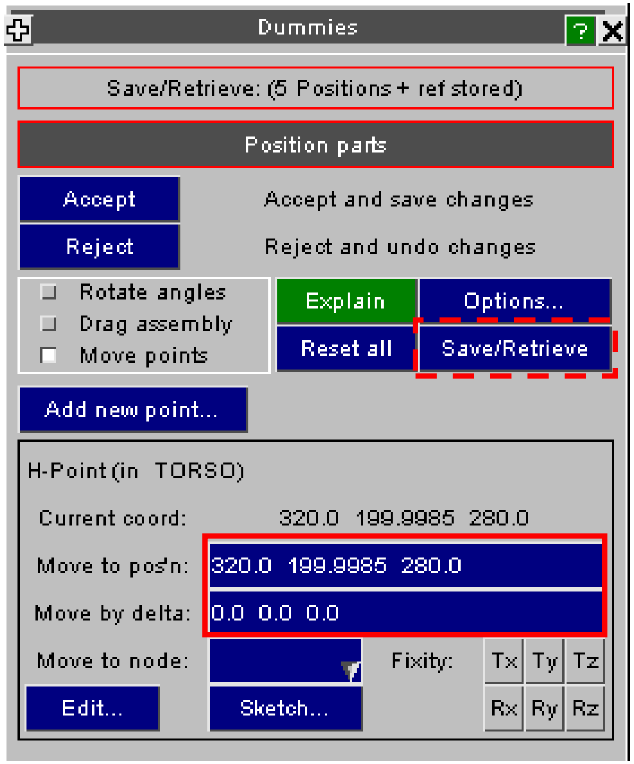
- We will now hold the hands and feet fixed, and move the H-point.
- Apply translational and rotational restraints to the hands and feet.
- Free the X and Z translational restraints on the Torso.
- Try dragging the torso to a new position.

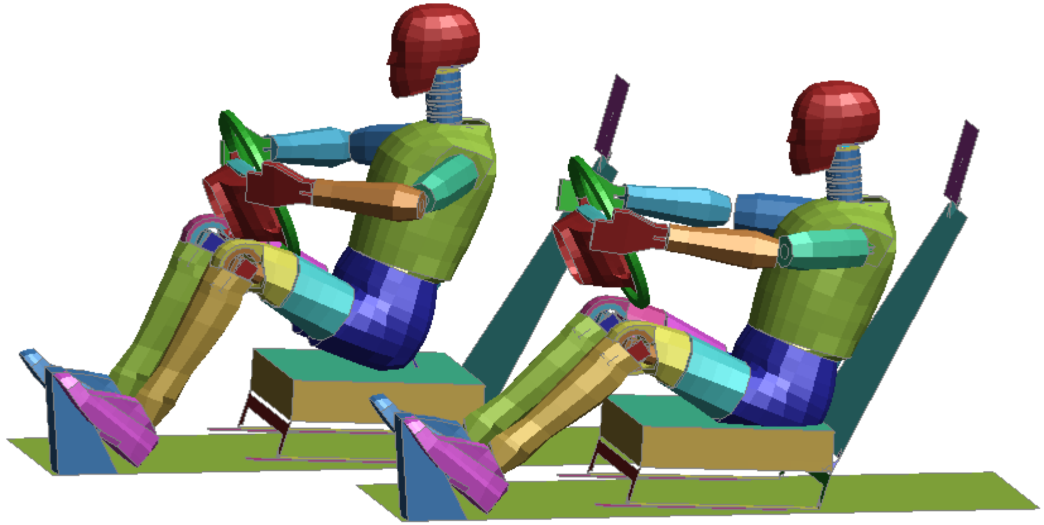




Dummy positioning – Move Points

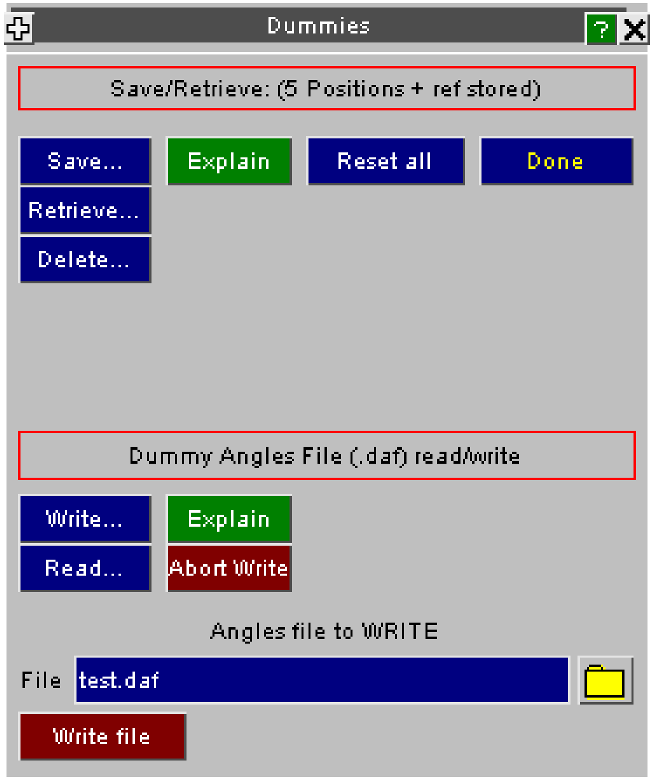
- Go to the Move Points submenu
- This works in the same way as the Mechanism menu
- Type in new coordinates for the H-point: (320 * 280)
- Save this position as “Front High”
- Now type in H-point “delta” (100 * -80)
- Save this position as “Rear Low”
- Retrieve Front High and Rear Low alternately.





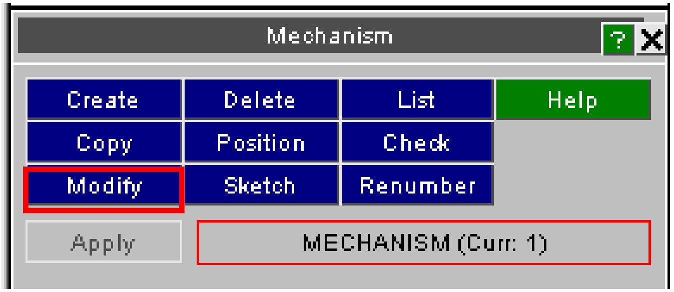
Dummy angles file

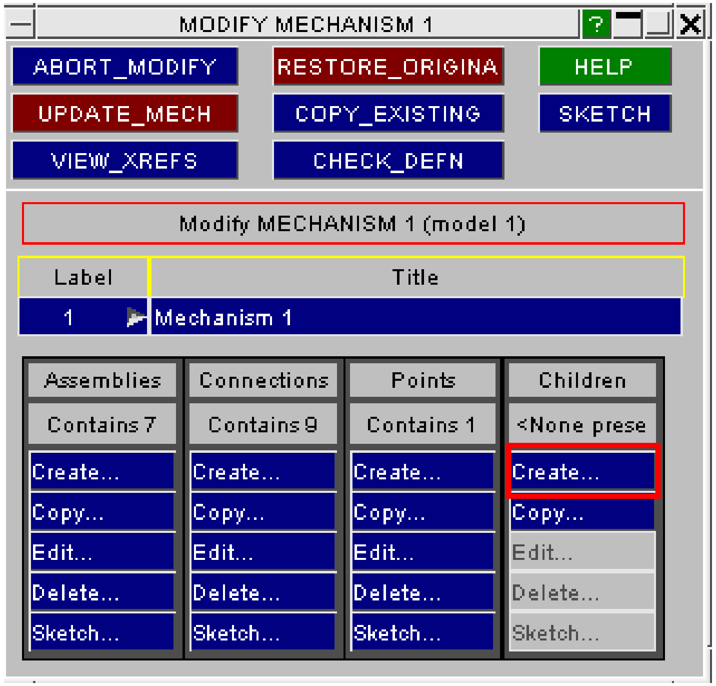
- In the Save/Retrieve menu, write a Dummy Angles file (test.daf)
- Look at the file in a text editor
- The saved positions are intended to be used within the same model. The dummy angles file can be read in to different models, provided that the dummy model has the same assemblies and joints.



Workshop – linked seat/dummy

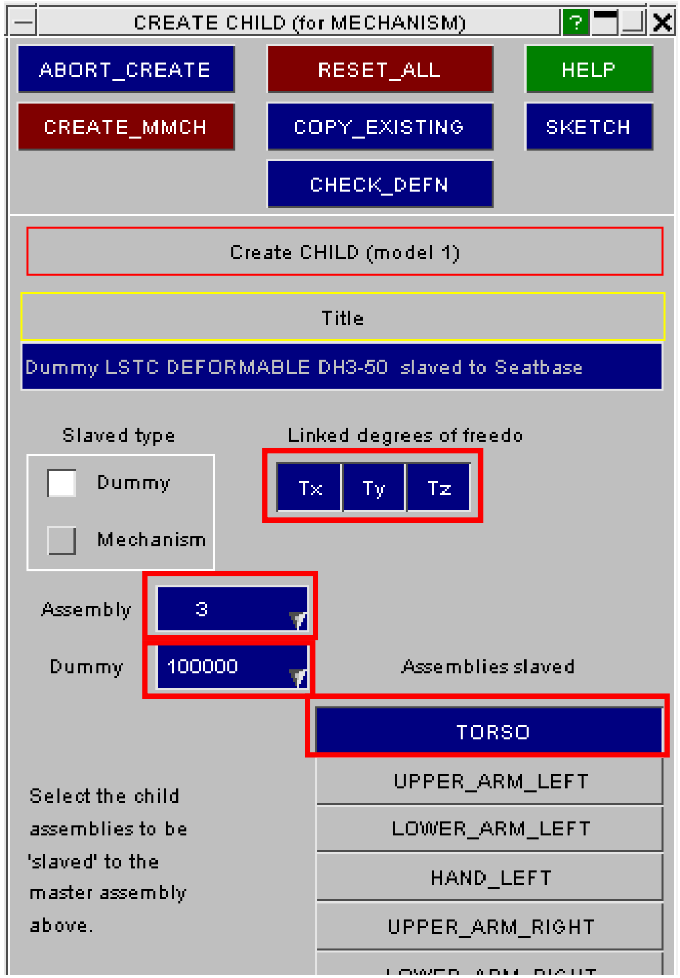
- Delete any existing models from Primer
- Read in dummy_seat_ready_for_linking3.key
- We will link the dummy as a “slave” to the seat. Then, if we move the seat, the dummy will also move, but not vice-versa.
- Go to Tools=>Mechanism=>Modify
- Children=>Create

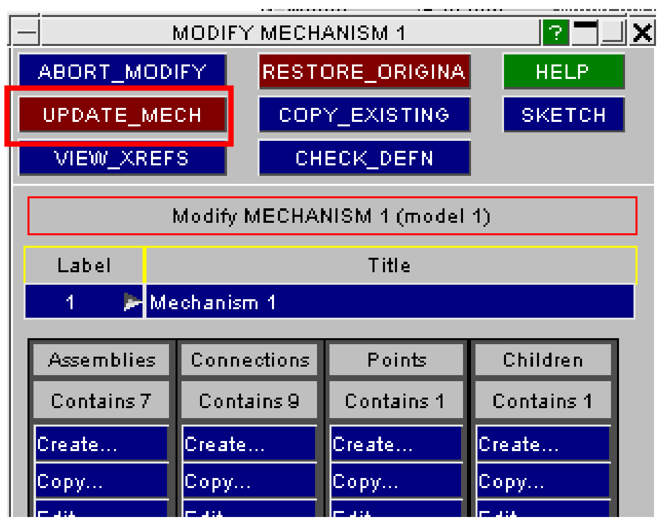




Workshop – linked seat/dummy

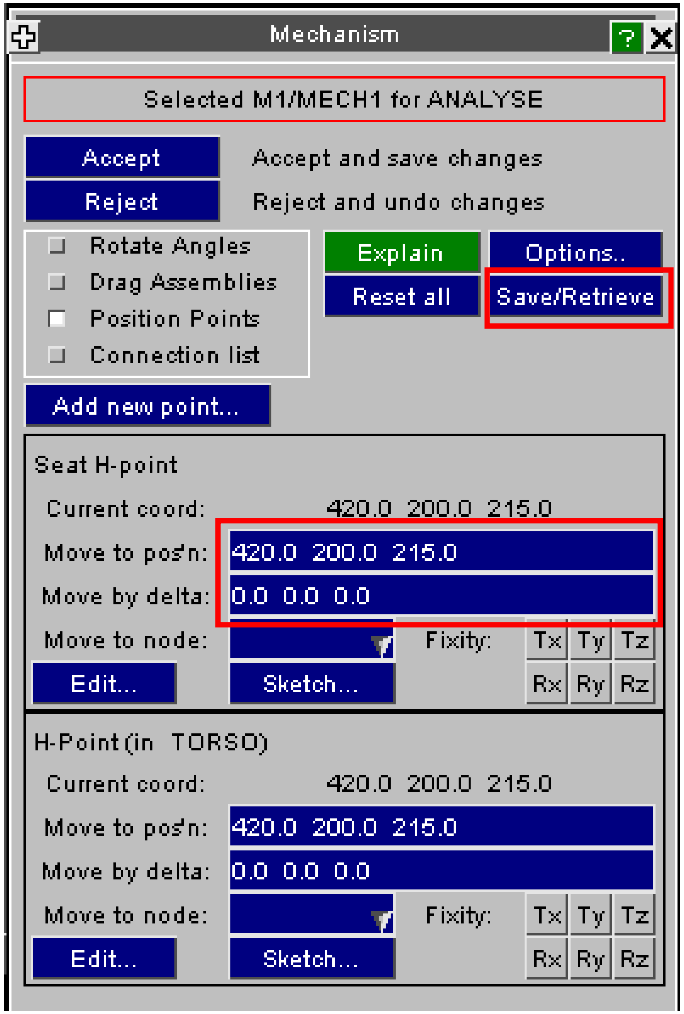
- Under Assembly, select the Seat Base.
- Under Dummy, select the only dummy
- Select the Torso to be linked
- Linked degrees of freedom: select X Y and Z
- Press CREATE_MMCH
- Press UPDATE_MECH to save the changes in the model





Workshop – linked seat/dummy

- Now go to Mechanism=>Position, Drag Assemblies, check that the restraints are correct (hands/feet fixed, torso free in X and Z; fixed rails restrained).
- Try dragging the seat base. Reject.
- Now go to Mechanism=>Position, Position Points sub-menu
- Type in new H-point 320 * 180
- Save position as “seat-dummy front low”
- Type in H-point delta = 100 * 0
- Save position as “seat-dummy rear low”
- Retrieve “seat-dummy front low” ready for the next workshop.



- Mechanisms and dummies may be positioned using command-line (for example, in a command file as part of a batch process). Example:

```
/READ DK seat_model.key
/MECHANISM
ASSEMBLY 6
FIX 123456
DONE
POINT H-Point
POSITION 1250 400 350
DONE
ACCEPT
/WRITE DK new_model1.key
/MECH
POINT H-Point
POSITION 1350 400 380
DONE
ACCEPT
/WRITE DK new_model2.key
```

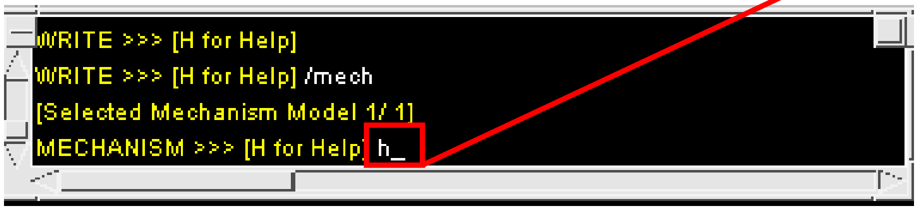
New command MECHANISM

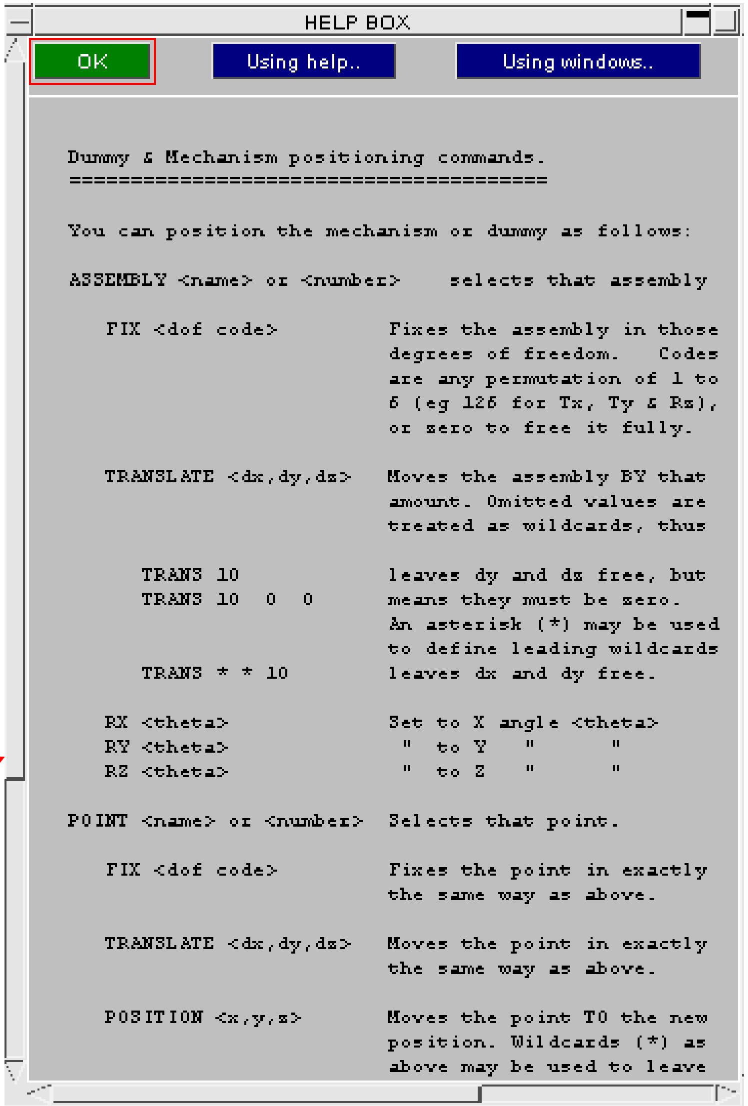
Can restrain, translate or rotate assemblies. If the correct restraints were already saved in the keyword file, there is no need to add commands here to restrain the assemblies.

Can restrain, translate or type new coordinates for ("Position") Reference Points.

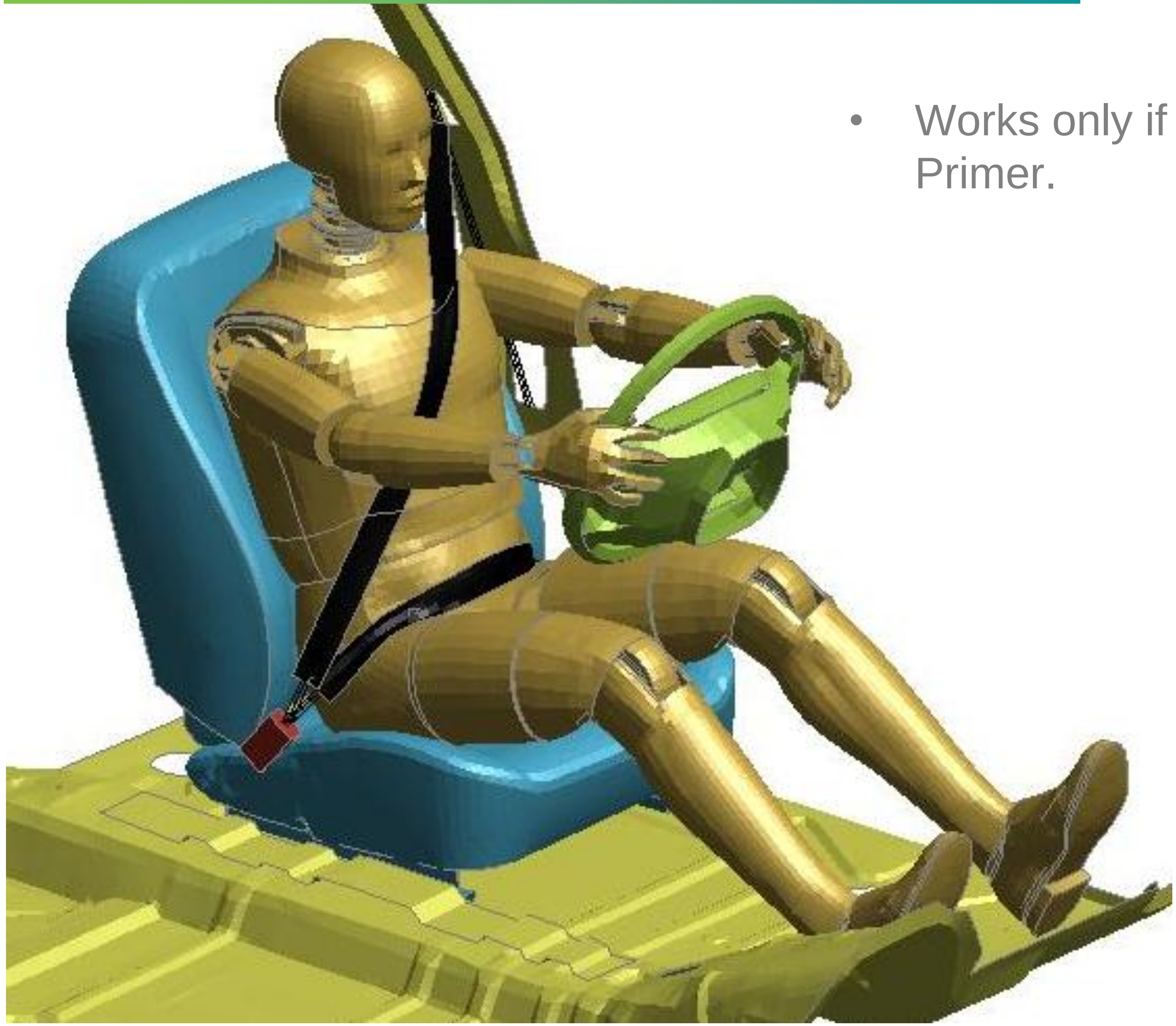
This command file writes two models, each with the H-point in a different position.

- To find the available commands, type "H" (for "Help") in the dialog box. Type one of the options shown in the menu. Type "H" again… etc.
- The same commands that can be typed in the dialog box, will also work when used in a command file.





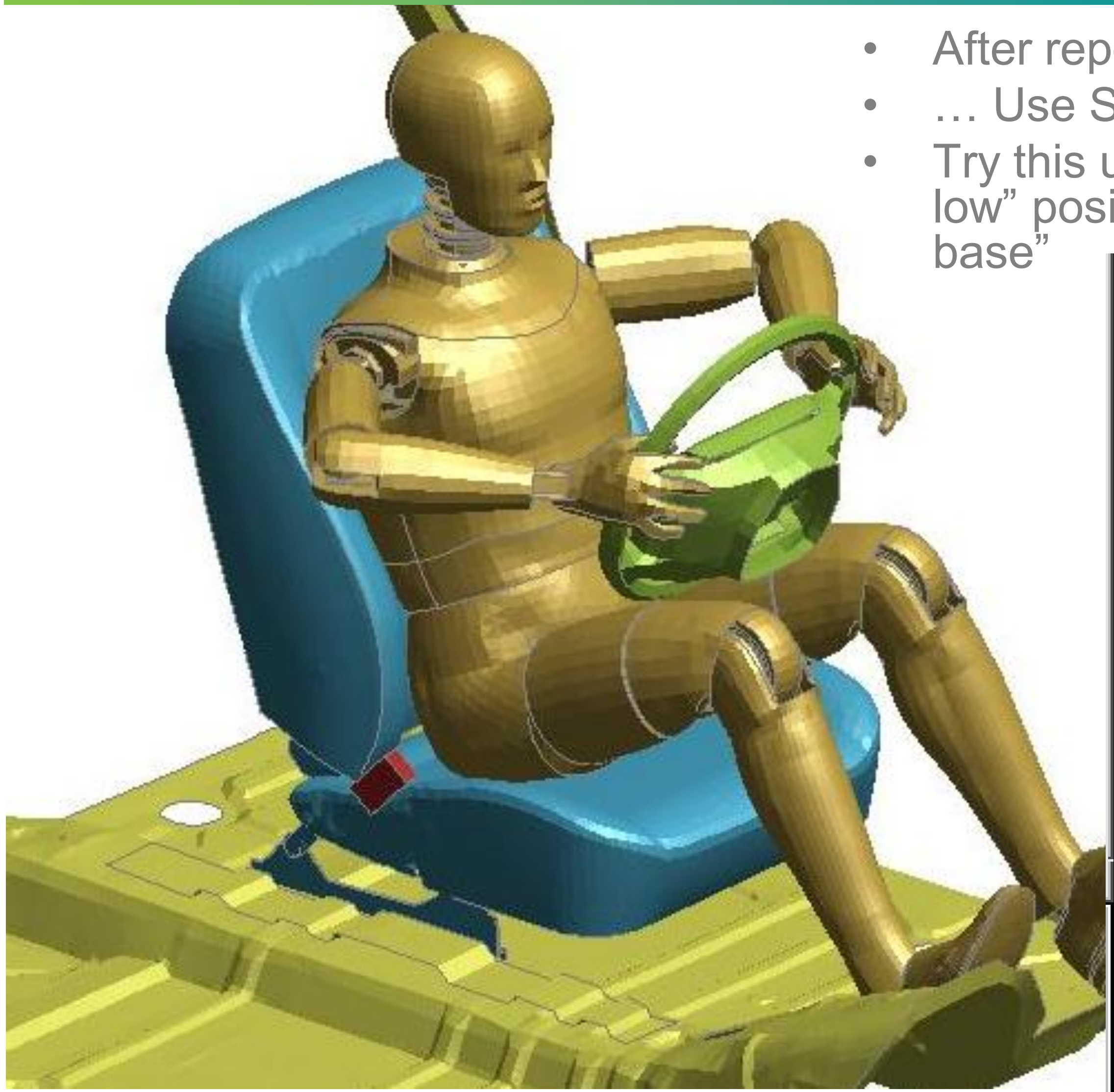
Belt re-fit

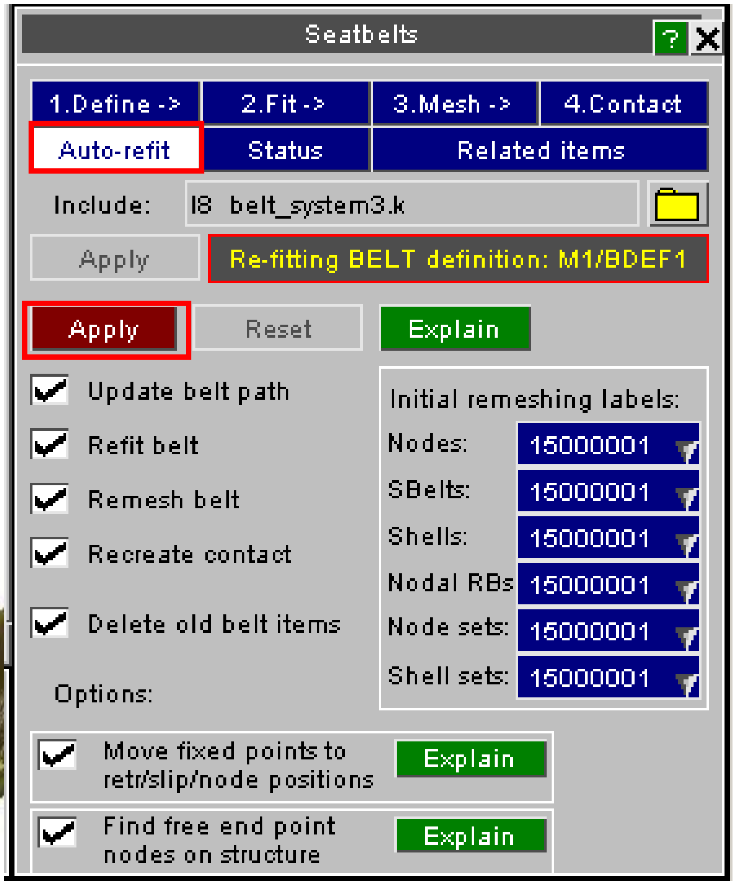


- Works only if belt was initially fitted in Primer.

Belt re-fit

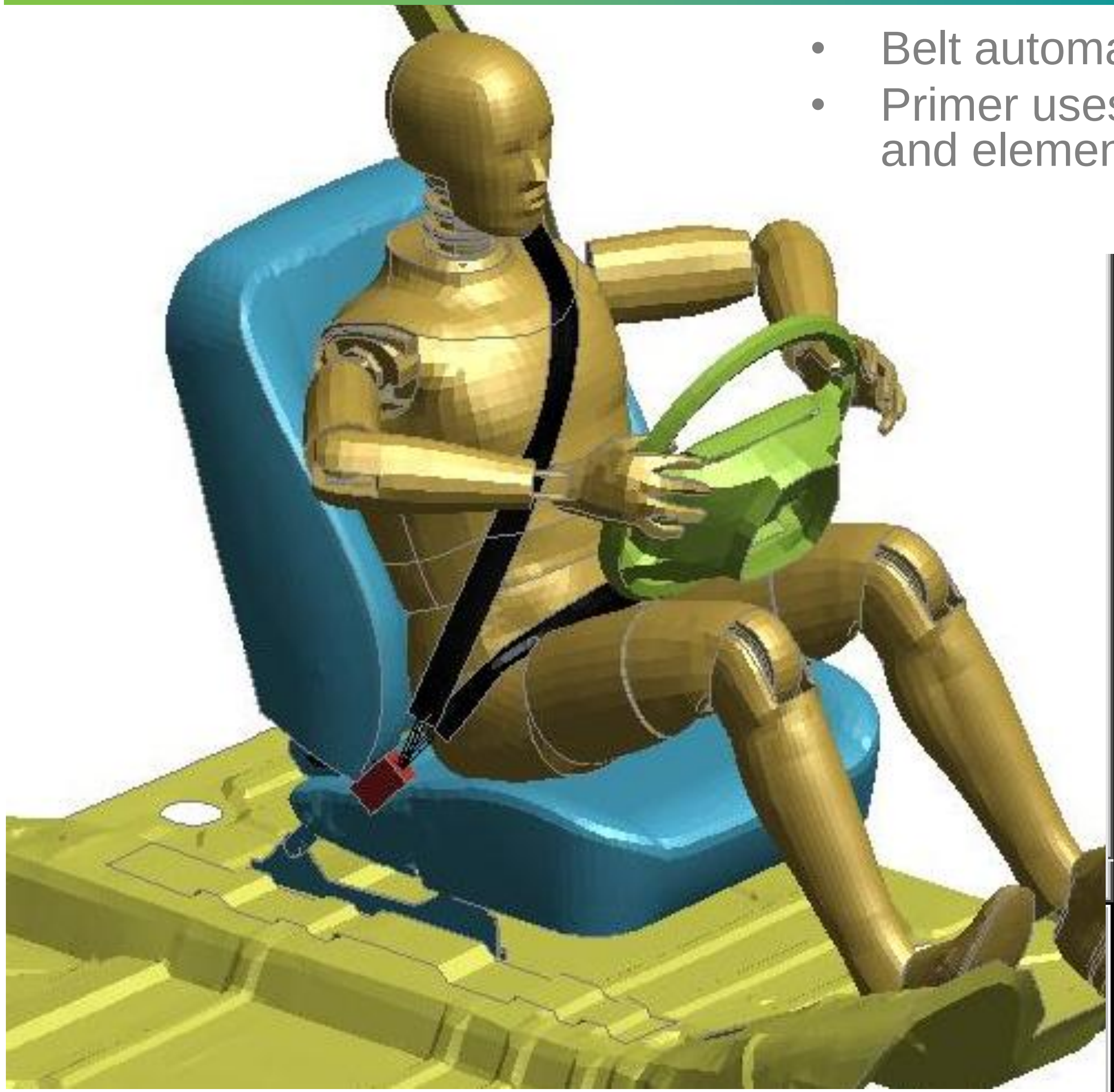
- After repositioning dummy and seat…
- … Use Seatbelt=>Auto-refit
- Try this using your model in “front low” position, then “seat-dummy base”

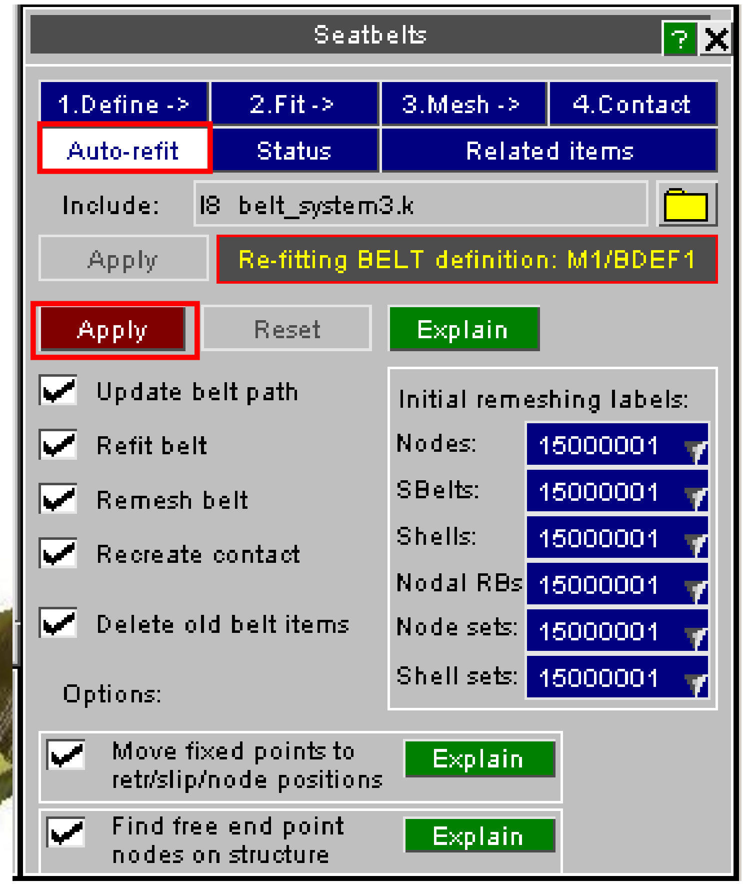




Belt re-fit

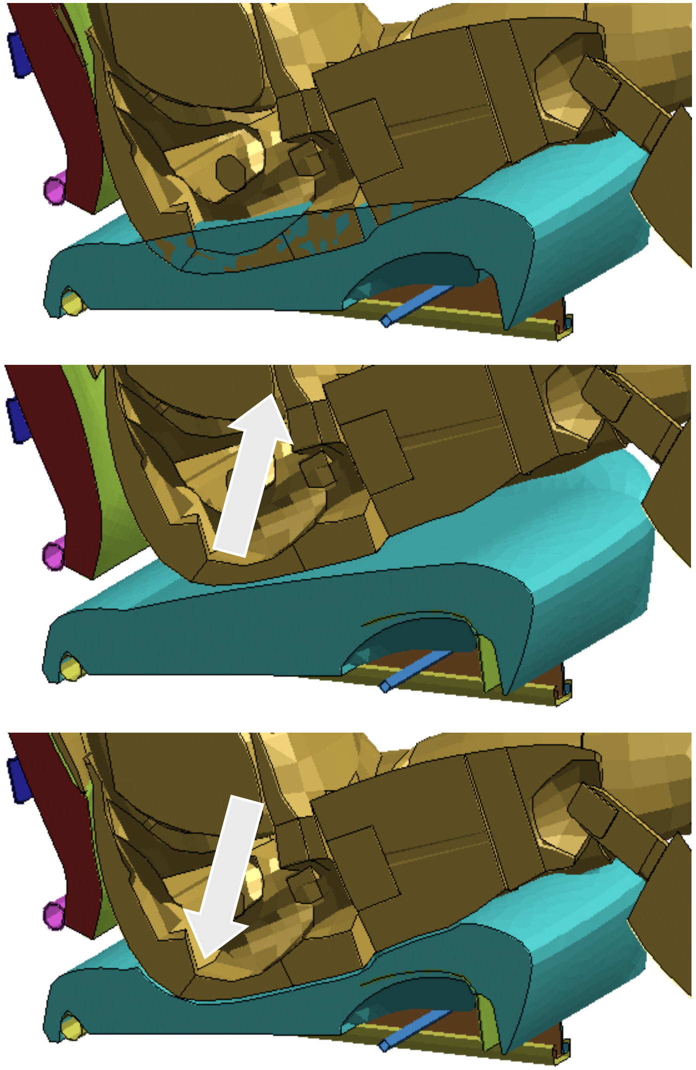
- Belt automatically re-fitted and remeshed
- Primer uses the same meshing parameters and element types as the initial belt mesh





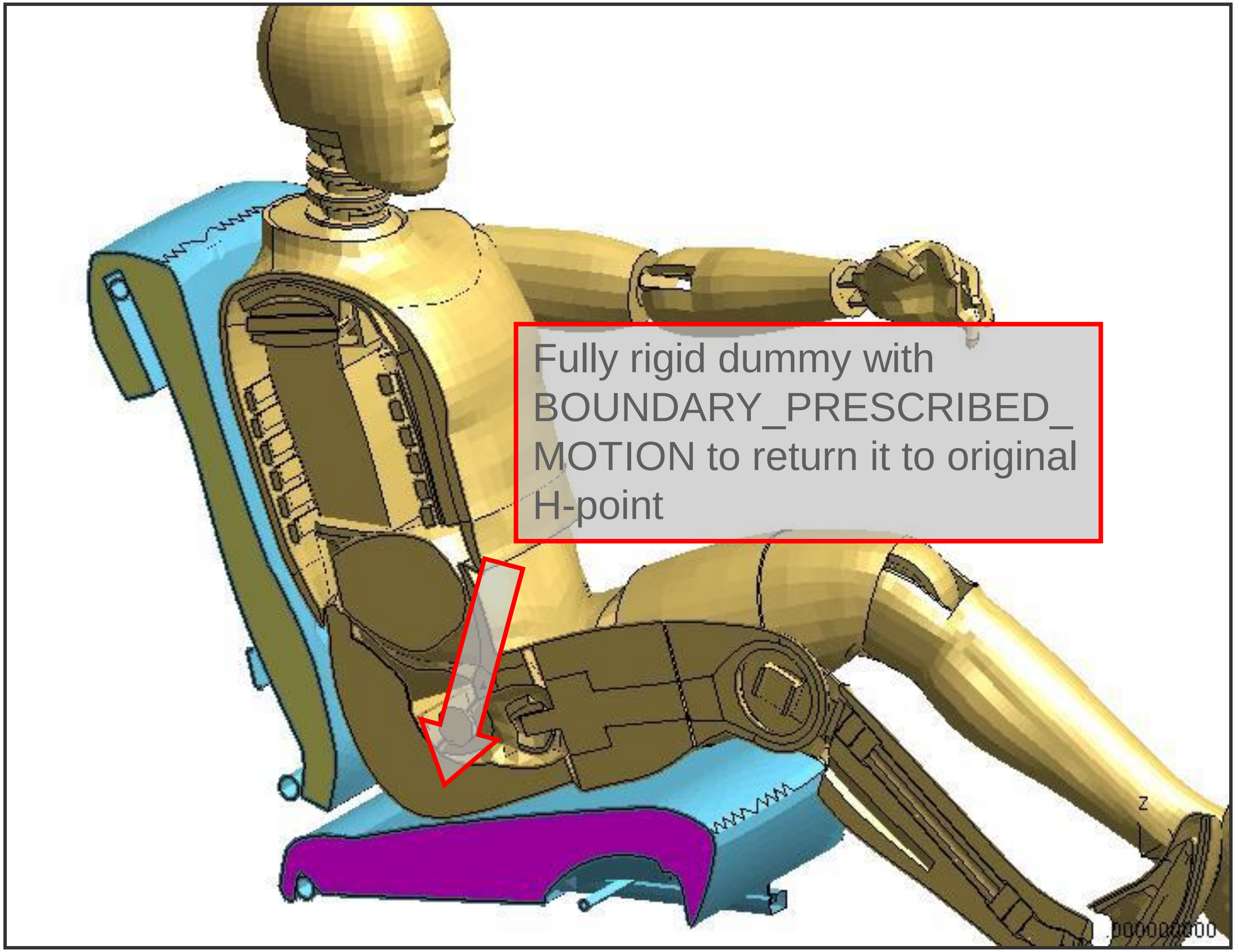
Seat foam compression

Seat foam compression

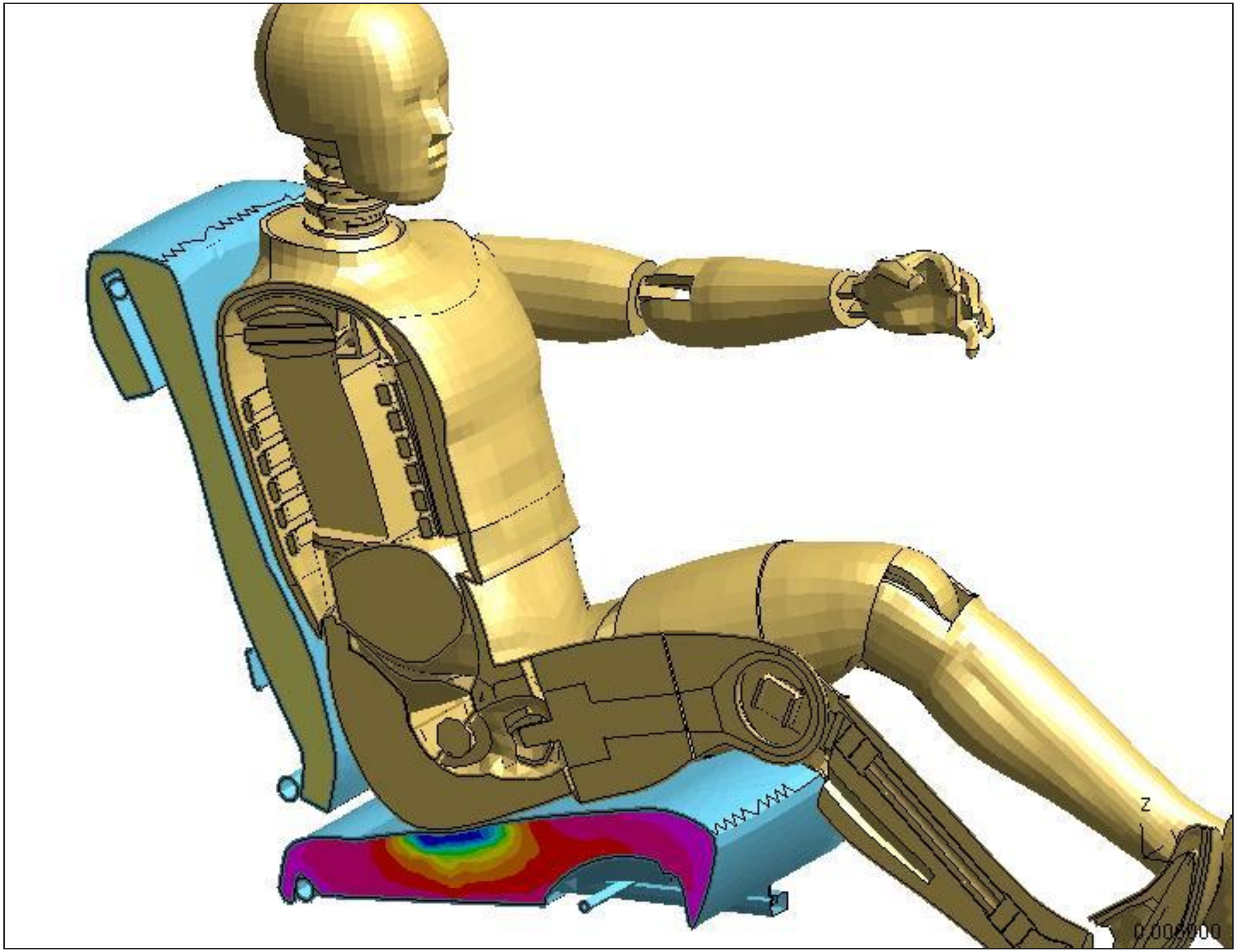


- Dummy has been positioned, penetrating the foam
- User invokes Seat Squash feature, selects the dummy/seat contact and the top and bottom surfaces of the foam.
- Primer raises dummy until there are no penetrations.
- “Primer Method”: Primer pushes the dummy back down, compressing the foam evenly to prevent penetrations.
- “DYNA Method”: Primer helps the user to create an LS-DYNA model in which a rigid dummy will be pushed into the seat, and then import the deformed seat node coordinates into the model.

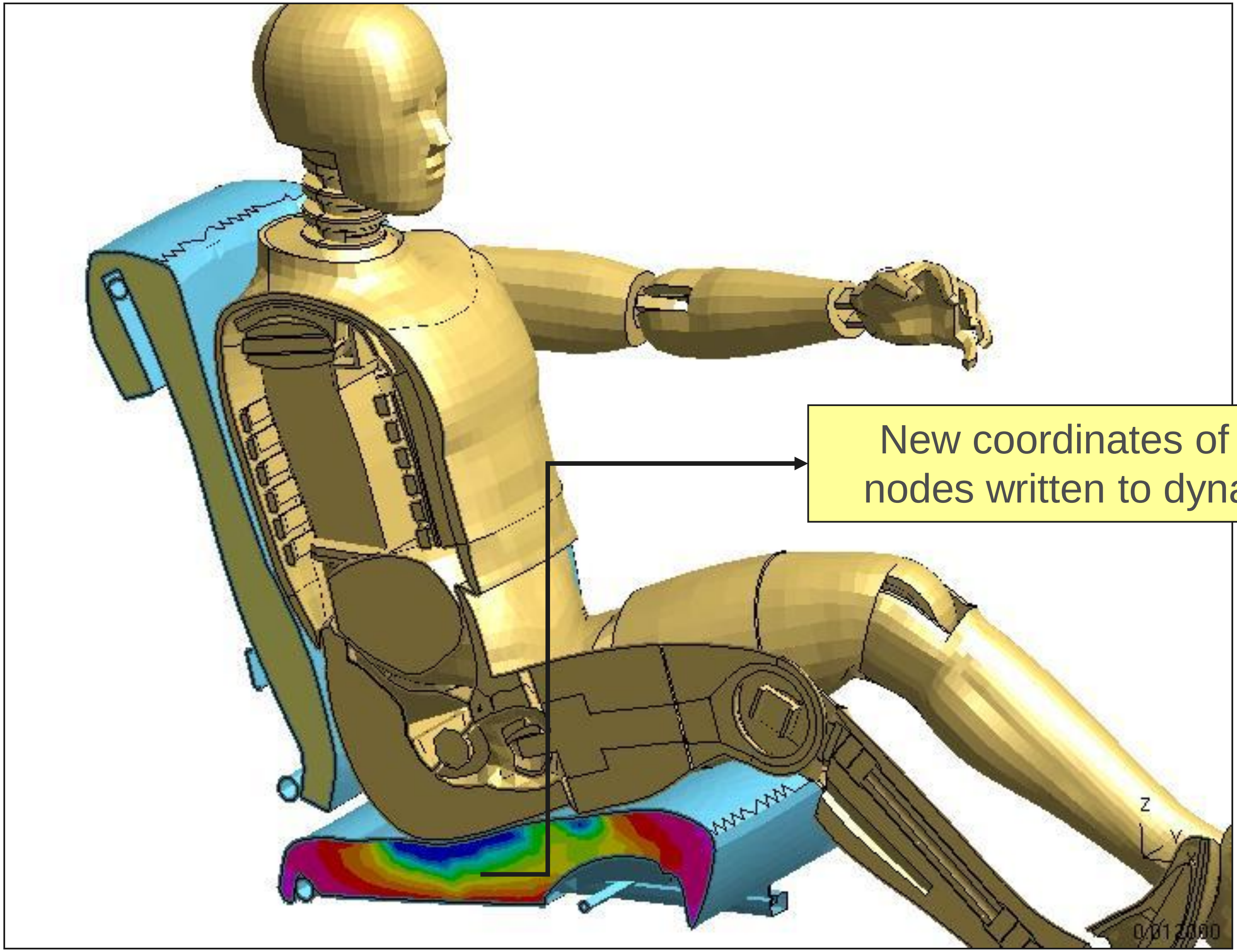
Seat foam compression – LS-DYNA analysis



Seat foam compression – LS-DYNA analysis

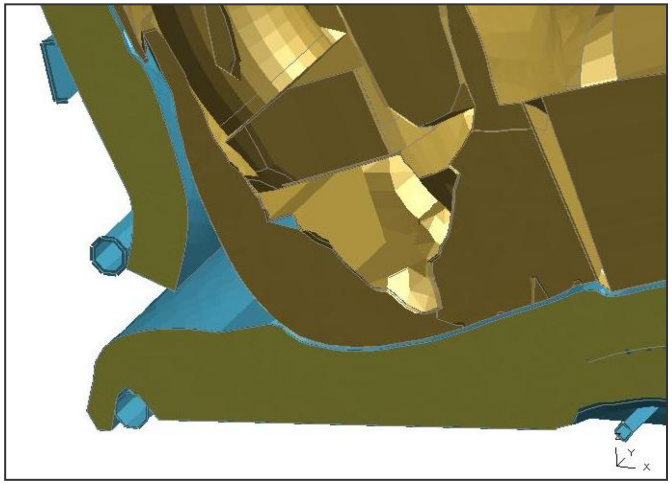


Seat foam compression – LS-DYNA analysis



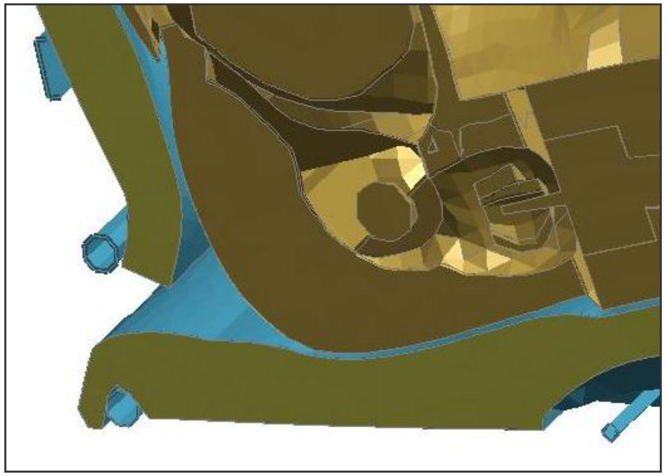
New coordinates of foam nodes written to dynain file

Oasys PRIMER method



- Result is an imprint of the dummy shape into the foam
- Only the foam is deformed
- No initial stresses
- Time taken: 1-5 minutes

LS-DYNA method

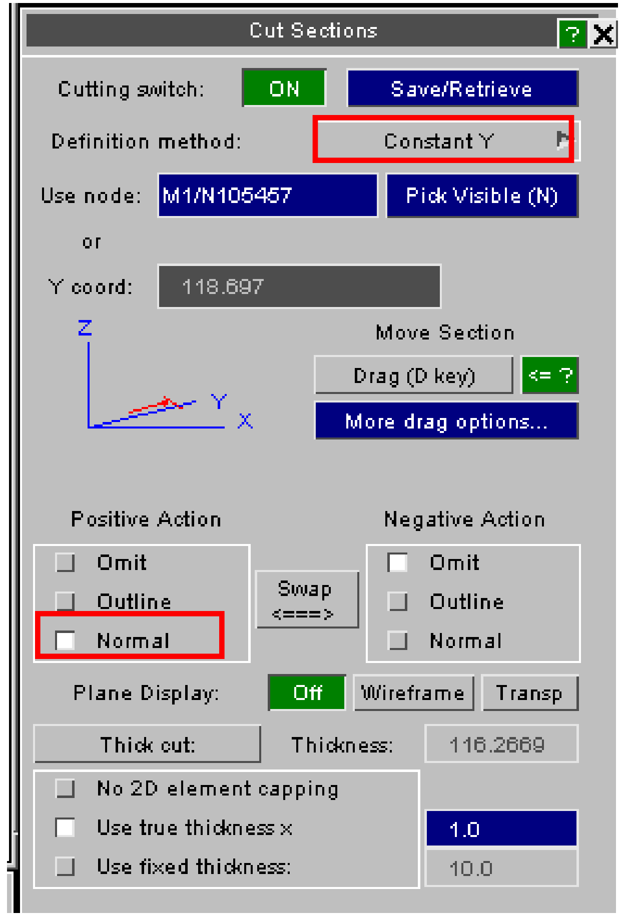


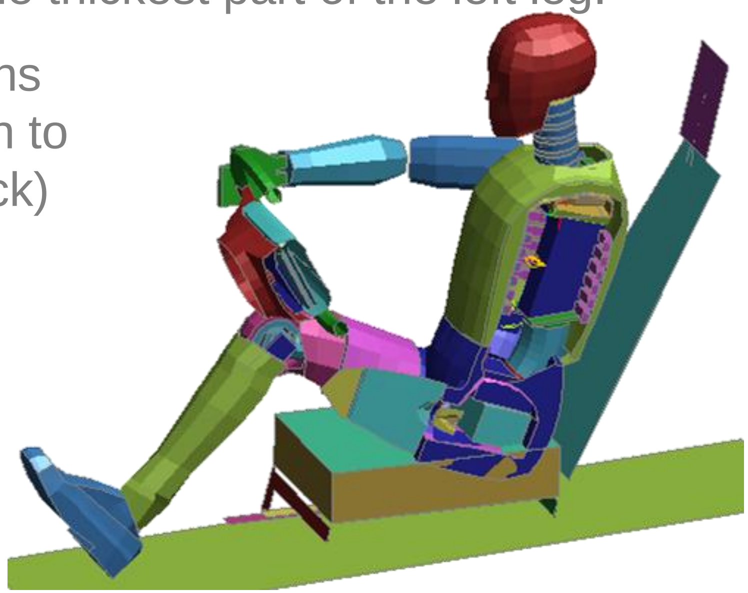
- Result is a more realistic deformation of the seat
- Other parts can deform, not only the foam
- Can include initial stresses if required
- Time taken: 5-30 minutes including LS-DYNA analysis

- If you do not have the seat/dummy model already in Primer, read dummy_seat_ready_for_linking3.key
- The H-point of both dummy and seat should already be at (420, 200, 215)
- The dummy is penetrating the foam. In this workshop we will try both Primer and LS-DYNA methods of seat foam compression.
- First, we will set up a view that shows the interior elements of the foam under the dummy.

Set up a cut section

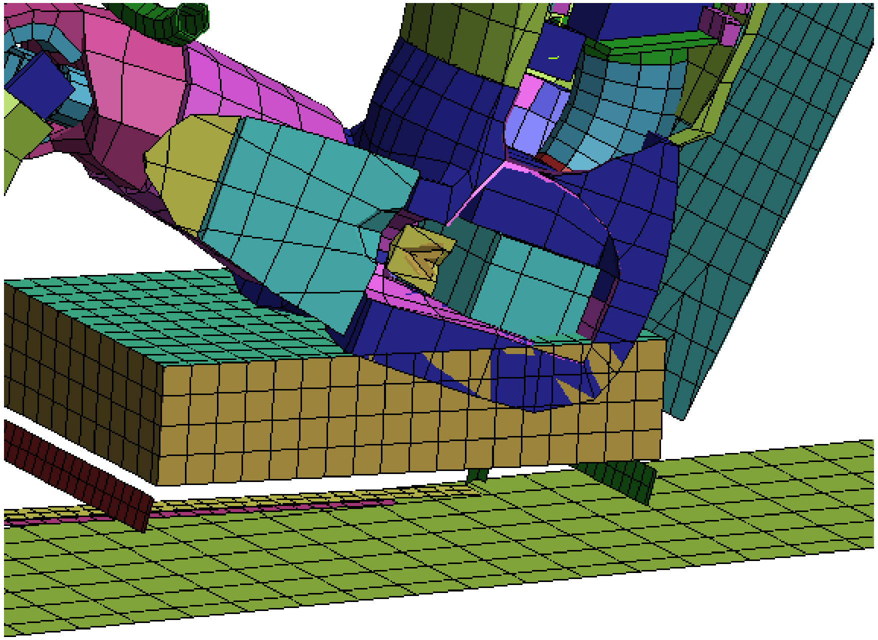
- Shortcut X brings up the cut section menu
- Shortcut N then allows you to pick a node where the section should be cut – pick a node on the dummy's left leg
- Change definition method to "Constant Y"
- Change Positive Action to "normal"
- Shortcut D then drag the section through the model, until at the thickest part of the left leg.
- Shortcut Q returns the mouse action to normal (Quickpick)

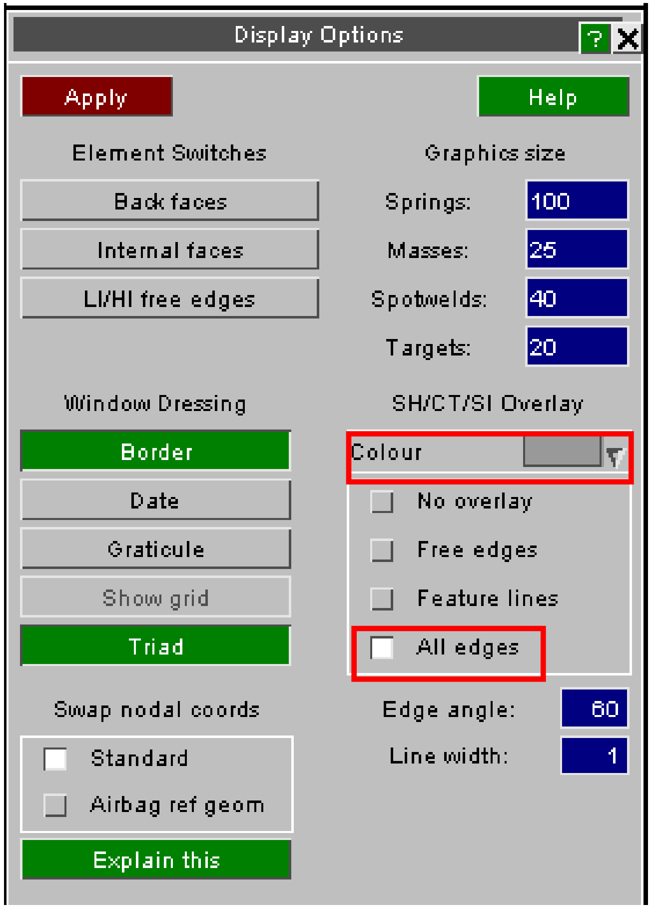




Add mesh overlay

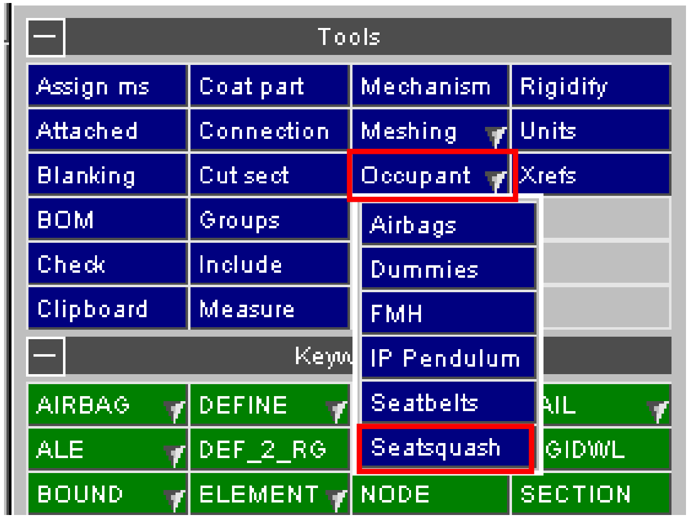
- View the mesh: bring up the Display Options menu (shortcut O)
- Set “All edges” (or use shortcut Y)
- For extra clarity, set the overlay colour to black

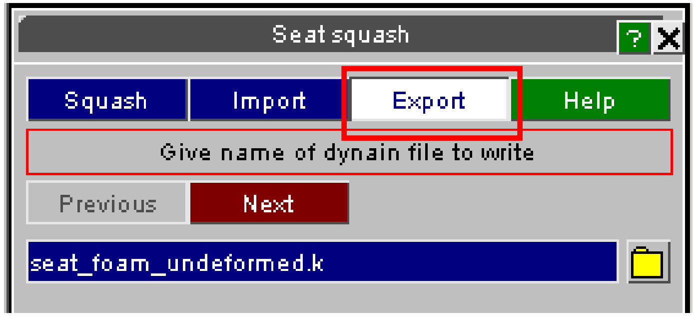




Export the initial foam geometry

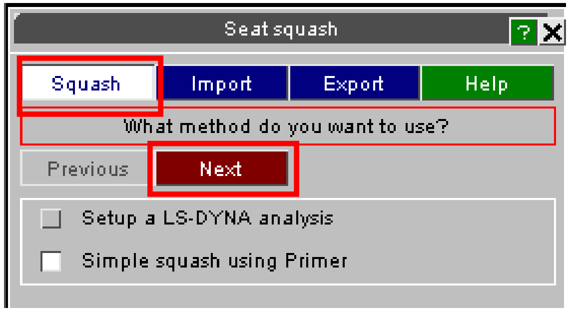
- Go to Tools=>Occupant=>Seatsquash
- It is useful to keep the initial coordinates of the foam nodes – these can be imported into the model later if required.
- Use the Export button, selecting Part 8 (the foam), and giving file name seat_foam_undeformed.k



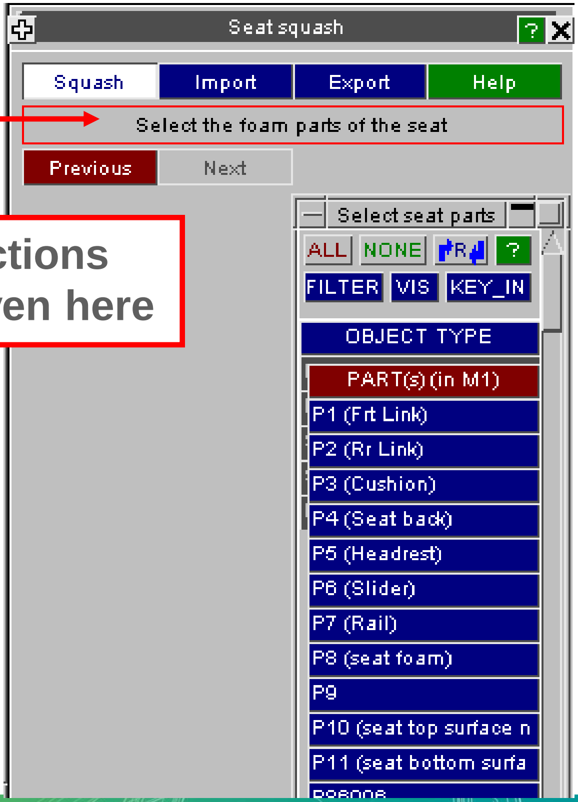


Oasys PRIMER-method foam compression

- Select Squash, then Primer method
- At each step, instructions appear.
- Foam = Part 8
- Top surface of seat = Part 10
  - The nodes belonging to this part will be depenetrated using the contact definition below
- Bottom surface of foam = Part 11
  - The nodes belonging to this part will remain fixed
- Dummy = (select the only dummy)
- Contact = (select the first contact)

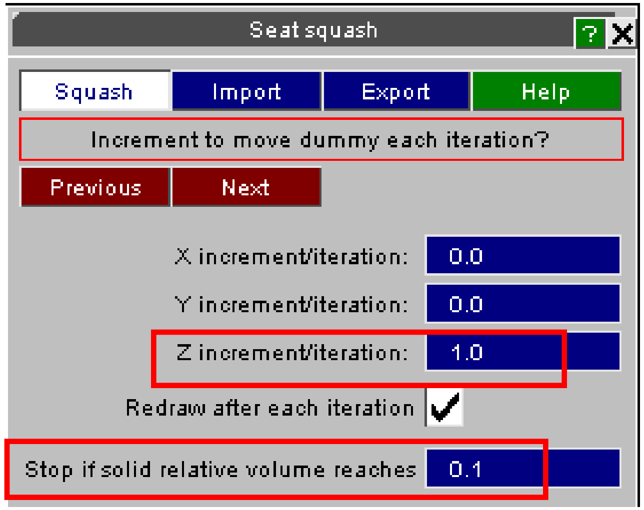


Instructions are given here



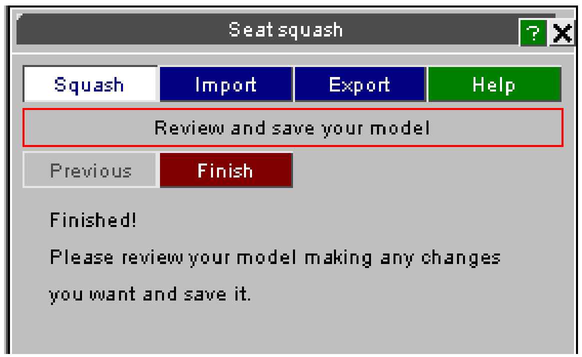
Oasys PRIMER-method foam compression

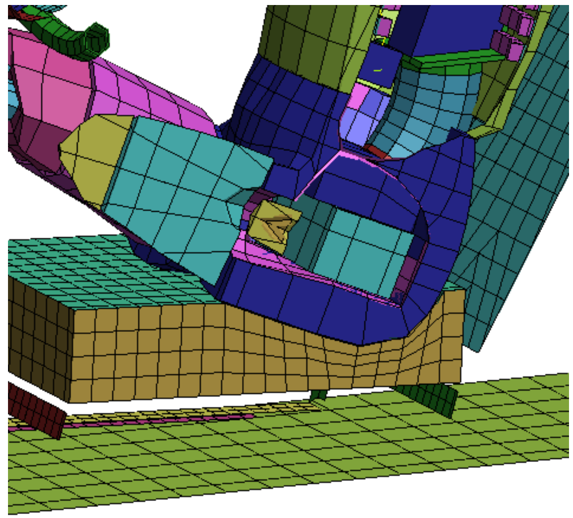
- X, Y and Z increments = displacement of dummy per iteration.
  - Dummy is first moved in positive vector direction until there are no penetrations.
  - Then the dummy is moved in the negative vector direction until either the original H-point is reached, or else the elements become too distorted.
- Enter a Z increment 1.0, leave X and Y zero.
- Reduce the relative volume check to 0.1
  - The elements in this model are large, so a lower limit is OK. With typical real models meshed with tetrahedra, leave the default 0.2.
- Press Next and Apply – Primer moves the dummy up out of the seat, then down compressing the foam.

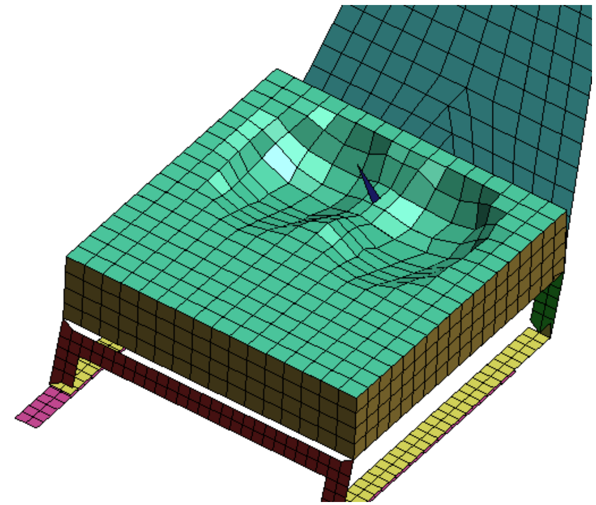


Oasys PRIMER-method foam compression

- The result should be as shown.
- Export the new coordinates (part 8) using filename seat_foam_primer.k.





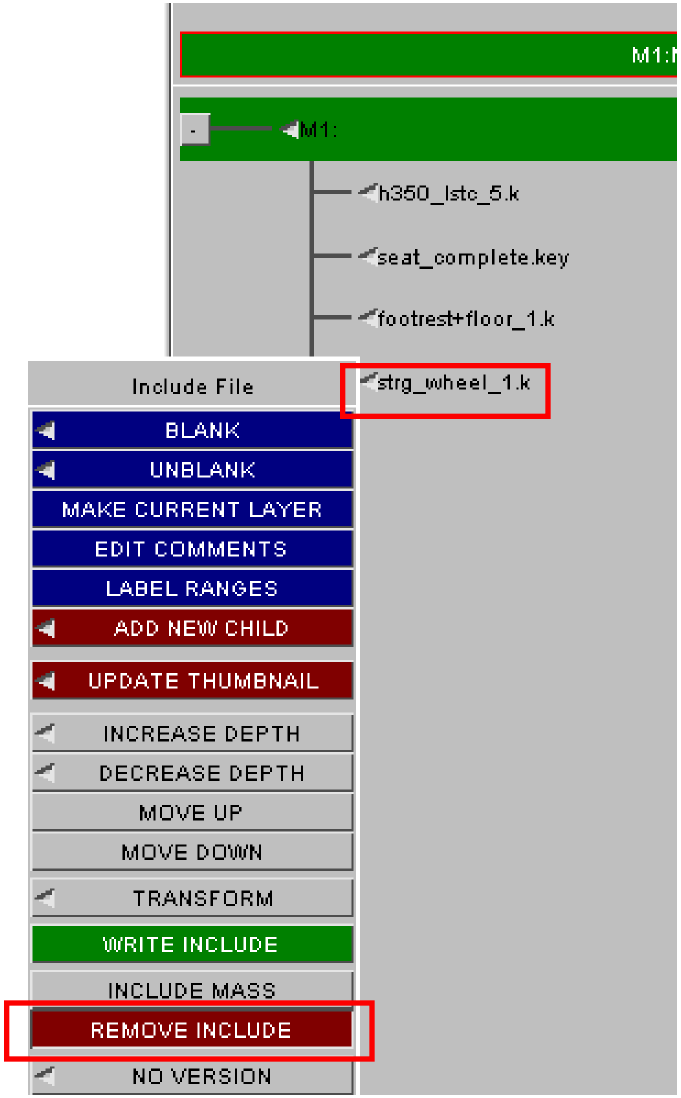


- Depending on the requested dummy position and the degree of deformation imposed on the foam, Primer may fail to achieve the required position. Check the dialog box for any error message.

- Model requirements for Primer method foam compression
  - Foam coated with shells (can be *MAT_NULL or fabric, leather, etc) – to create these elements use Tools=>Coat. This will generate shells on all exterior surfaces of the foam.
  - The shell element coating needs to be split into parts for the “top” and “bottom” surfaces. “Top” surface should cover anywhere that the dummy might contact. See parts 10 and 11 in this example.
  - Contact between dummy and seat. The contact thickness must be at least twice the selected step size. In this example model, the contact thickness was set to 2.0mm, the step size was 1.0mm.
- Foam solid elements can be any type (hexa, tetra, wedge). Failure to compress the foam to the desired H-point may be due to poorly meshed tetrahedron elements, especially where these are initially almost flat. Such elements may also lead to “negative volume” problems in LS-DYNA. Primer includes a mesh-improvement step to help with this (for tetrahedra only).

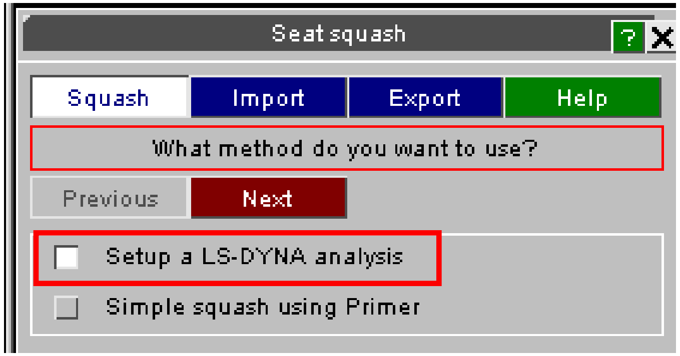
LS-DYNA-method foam compression

- We will now try the DYNA method of foam compression
- Delete the model from Primer and re-read
- For the purpose of creating an LS-DYNA seat foam compression analysis, we do not need the steering wheel or floor. Remove them using Tools=>INCLUDE=>(drop-down from footrest+floor.k to EMPTY INCLUDE), with option DELETE_2 and agree to delete the Include file. Similarly, remove strg_wheel.k.
  – In real models, there may be many other parts to delete, such that you are left with just the seat and dummy.



LS-DYNA-method foam compression

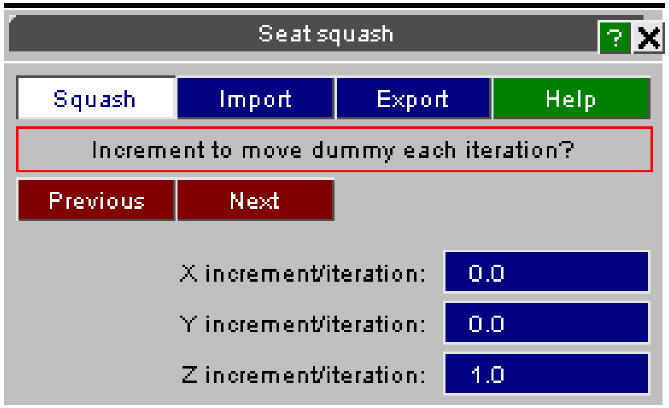
- Go to Seatsquash=>Squash and select DYNA method.
- For the seat, select INCLUDE file seat_complete.key

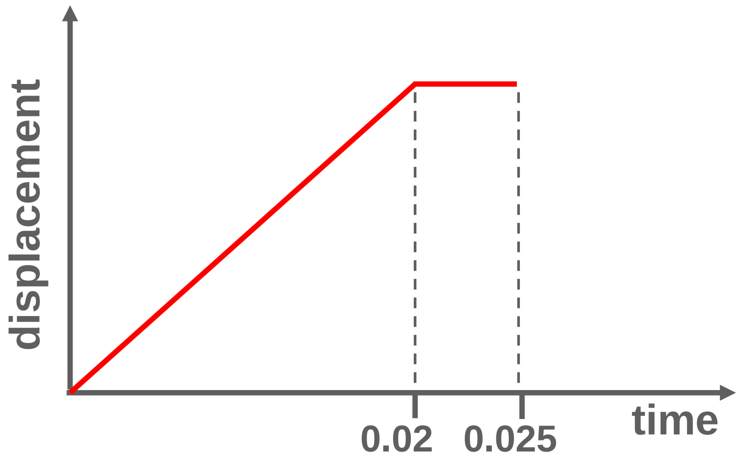


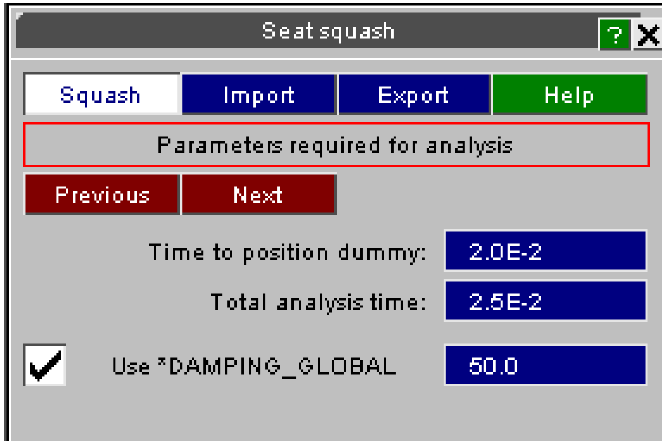
- Deformable parts = Part 8
  - With more complex seat models, we may also wish to leave other parts deformable, e.g. the springs or membrane supporting the foam
- Dummy = select the only dummy
- Do not select any parts of the dummy to remain deformable.
- Contact = select the first contact
- Internal contacts to remove – accept Primer’s suggestion.
  - In some models, internal contacts within the seat may need to be kept to prevent penetration of the deformable parts of the seat

LS-DYNA-method foam compression

- X, Y and Z increments = 0, 0, 1. The step size is less critical with the DYNA method – if too large, there will be more initial gap between dummy and seat.
- Enter 0.02 for “time to position dummy”
- Enter 0.025 for “Total analysis time”
- Leave the damping input as per Primer’s default
- Press Next and Apply



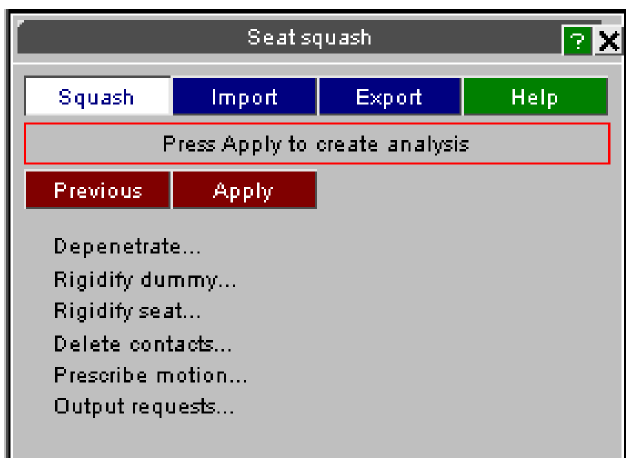


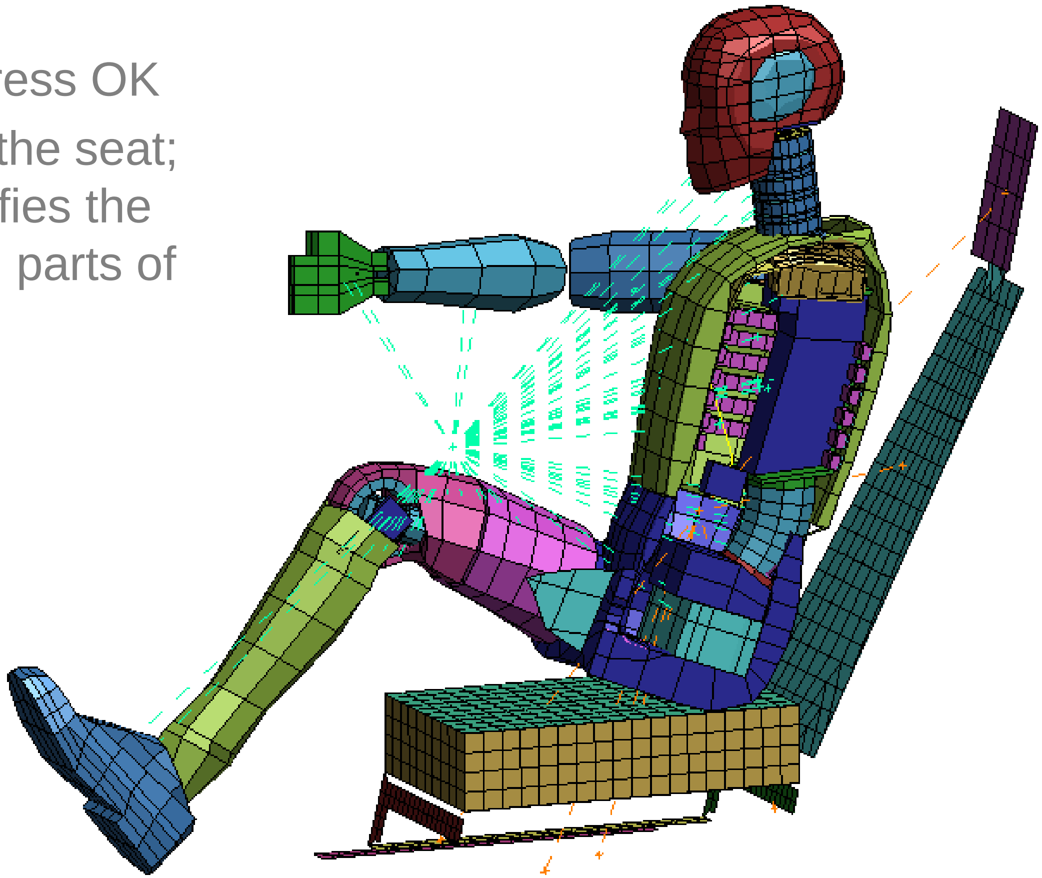


LS-DYNA-method foam compression

Oasys PRIMER

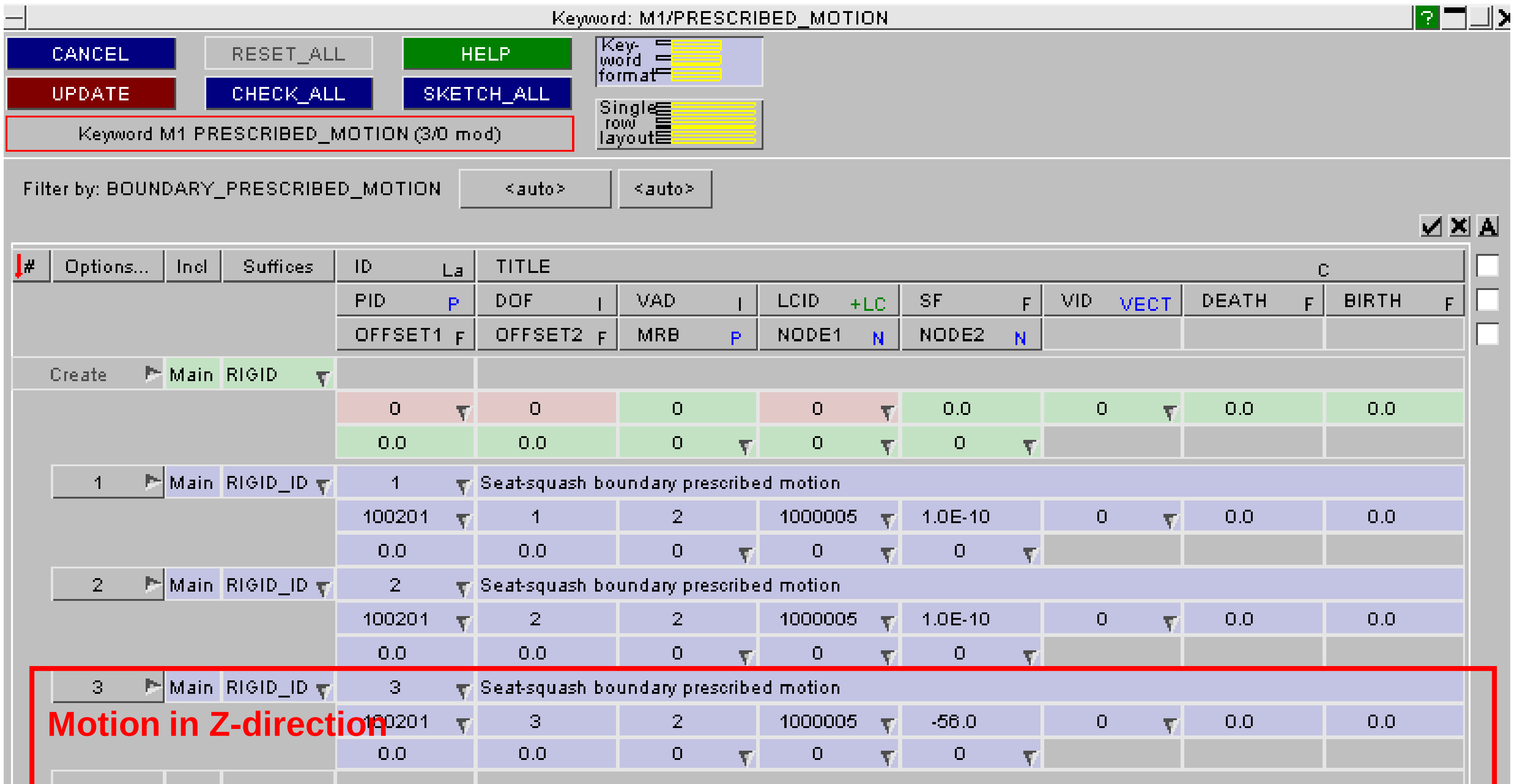
- If warnings appear about PART_INERTIA losing mass, press OK
- The dummy will now rise out of the seat; lines will appear as Primer rigidifies the dummy and the non-deformable parts of the seat.
- The model should look like this:





LS-DYNA-method foam compression

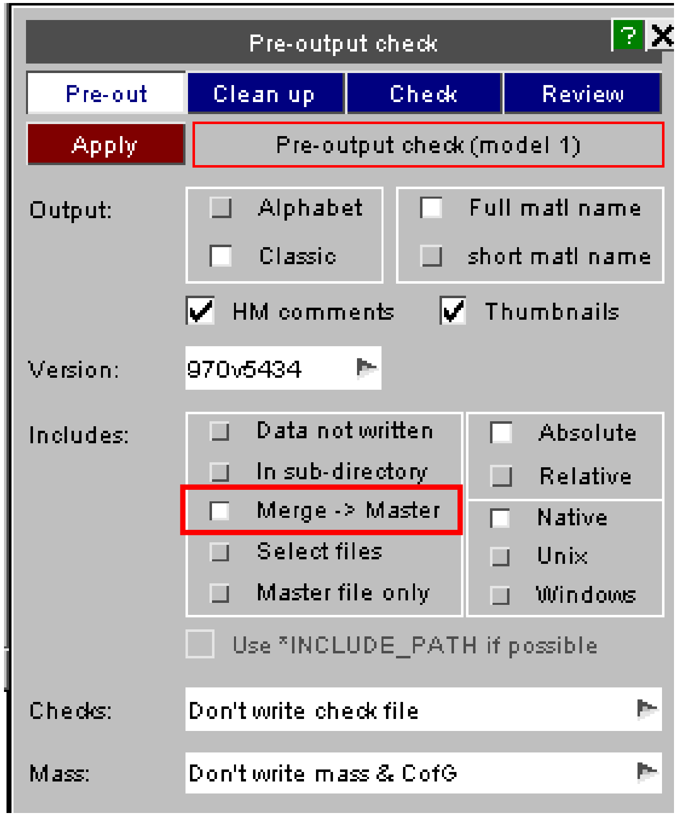
- Go to Keyword=>BOUNDARY=> PRESCRIBED_MOTION =>Keyword. You will see the motion definition that Primer has created, to move the dummy back to its initial position during the LS-DYNA analysis.



LS-DYNA-method foam compression

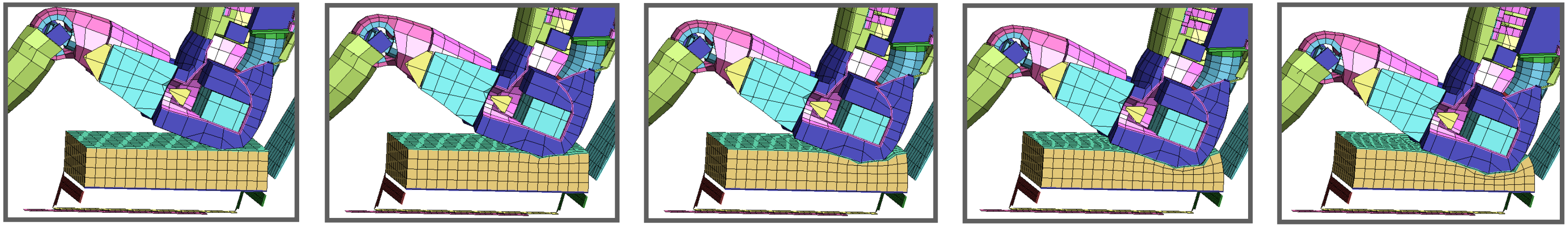
- The model includes *INTERFACE_SPRINGBACK_LSDYNA. Primer has created this card to force LS-DYNA to write a keyword-format file ("dynain") at the end of the analysis, from which the foam coordinates and stresses can be taken.

- Write out the model with filename "foam_compress.key". For simplicity, merge the INCLUDE files into the master model (option during model write-out).



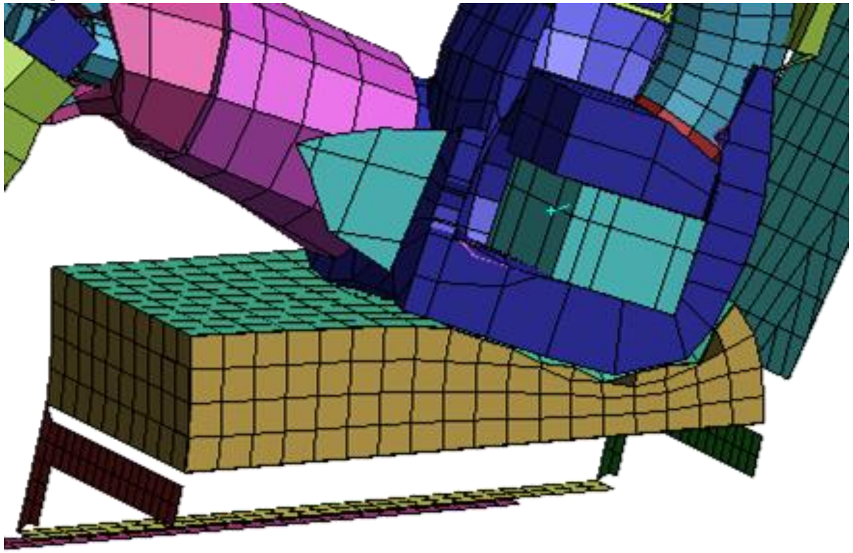
LS-DYNA-method foam compression

- Run the model in LS-DYNA – it should take about 10-30 seconds.
- Check that LS-DYNA has written a file named dynain. Look at its contents with a text editor.
  - *NODE cards will be used to modify the coordinates of the foam nodes
  - *ELEMENT cards will be ignored
  - *INITIAL_STRESS cards can optionally be read in to prestress the foam
- Animate the results in your usual postprocessor. It should look like this:



LS-DYNA-method foam compression

- In Primer, delete all existing models. Read in dummy_seat_ready_for_linking3.key
- Occupant=>Seatsquash=>Import, select the dynain file.
- Import all parts in the file (it will be only the foam).
- Switch off INITIAL_STRESS cards – to use these effectively, the new model would need gravity, so that the weight of the dummy would have to be in equilibrium with the foam stresses. But this introduces complications such as the dummy slumping out of the intended position.
- The model should now look like this:
- Write the model.



Foam compression – other notes

- Sometimes, the Oasys PRIMER-method foam compression algorithm may fail to reach the final end-point. This is usually due to sharp edges on the dummy, e.g. the bottom edge of the jacket, or leg-to-pelvis gap.
- We would generally recommend the LS-DYNA method to obtain the most accurate results when the initial penetration is large.
- For small adjustments to the dummy position, the Primer method is usually adequate.

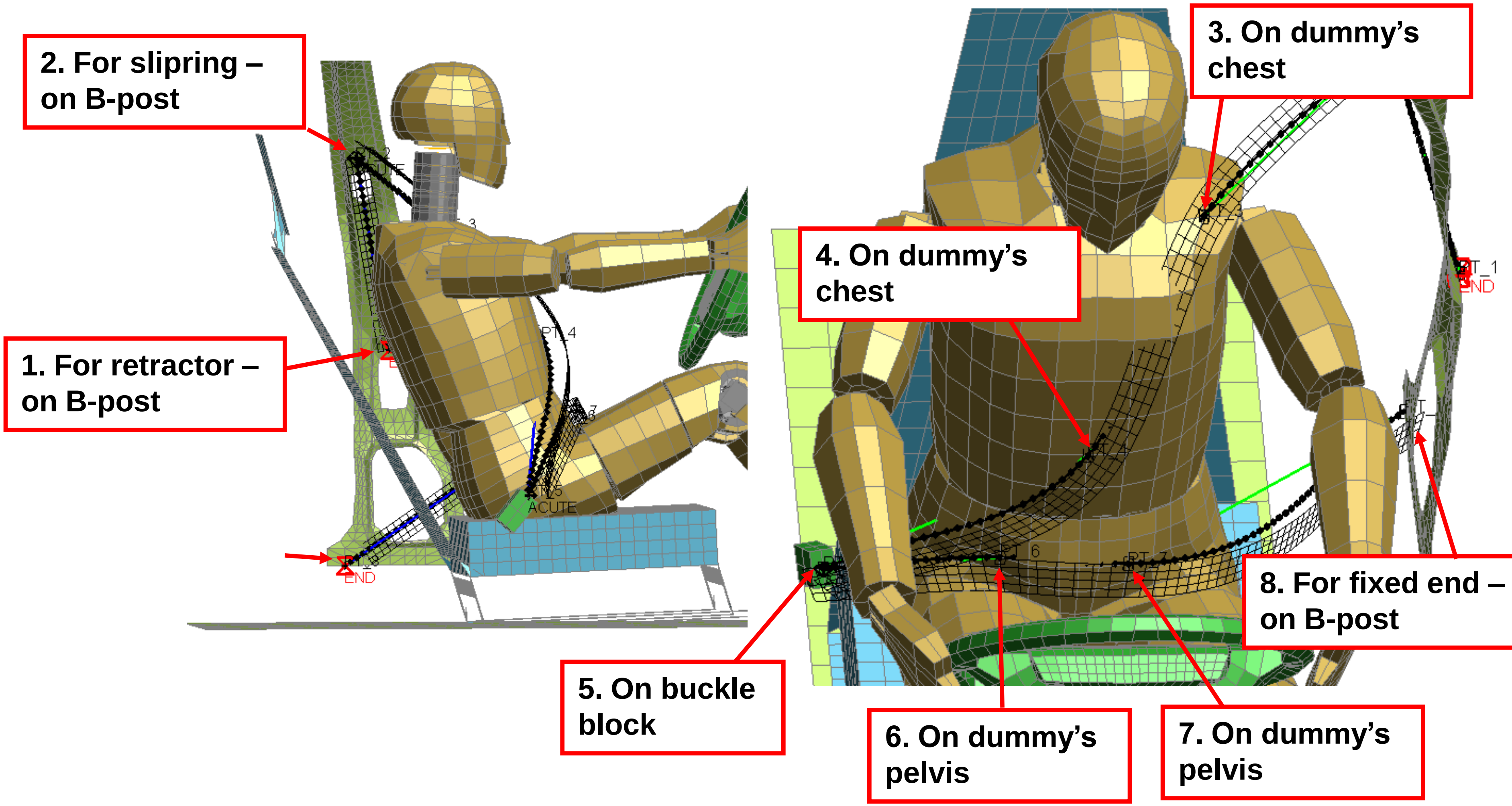
Seatbelt fitting

Seatbelt fitting – first steps

- We have already seen how to re-fit an existing seatbelt. Now we will learn how to create and fit a new seatbelt.
- Delete existing models from Primer.
- Read dummy_seat_for_belt_fit.key.
- Before we start work, consider into which Include File we want the new belt elements to be placed. Set this Include file as the “current layer”.
- Go to Tools=>Occupant=>Seatbelts.
- In the seatbelts menu, press “1. Define”, then “Create”, and “Apply”.
- We now select the parts that can be contacted by the belt during fitting. In the object menu, select the object type “Part”, then click on the chest and pelvis of the dummy. Press “Apply”.

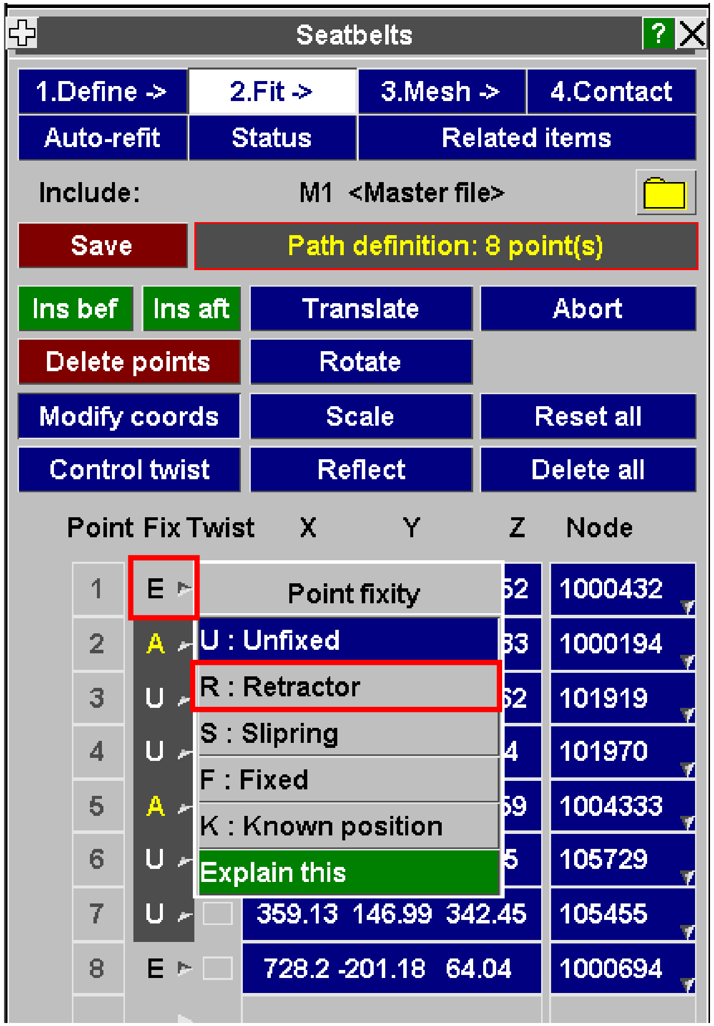
- Press “2. Fit”.
- Press the “Dimens” button and set the length of the belt elements to 15mm, and the #rows to 4 (4 elements across the width of the belt). Press “Done”.
- Press “Define path”.
- We are now going to pick nodes forming the path of the belt, starting at the retractor. To make it easier to see the nodes, use shortcut Y to add the mesh overlay.
- Try to pick nodes approximately as shown on the next slide.

Seatbelt fitting – path definition



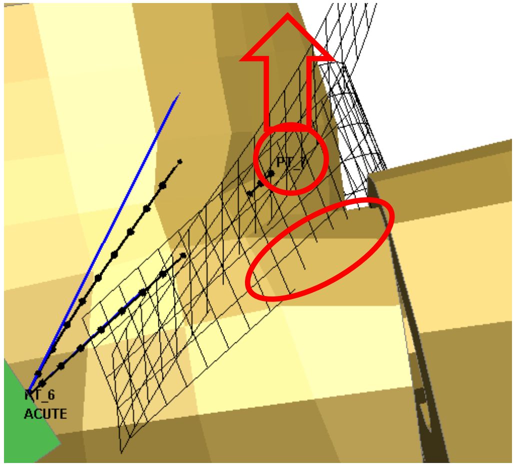
Seatbelt fitting – path definition

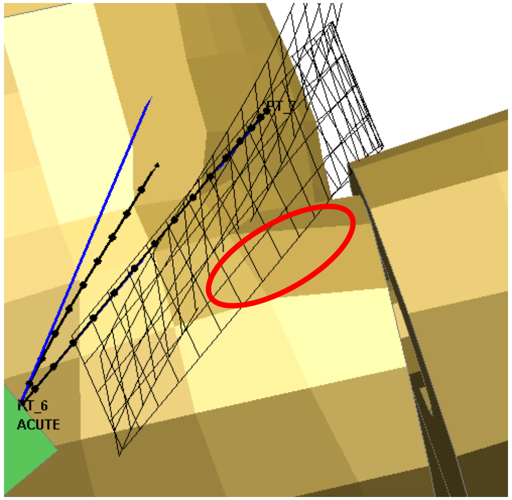
- Change point 1 to be a retractor.
- Change points 2 and 5 to be sliprings.



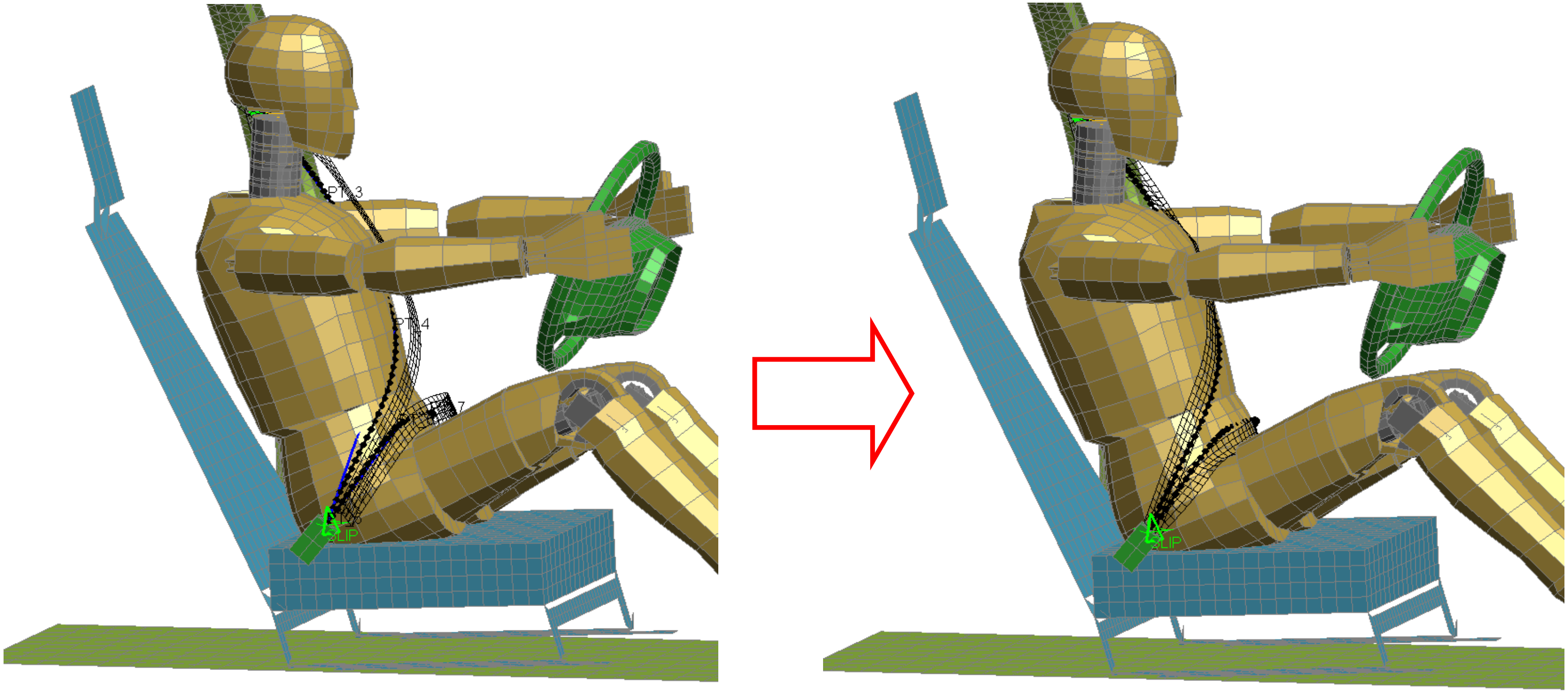
Seatbelt fitting – path definition

- Check that the prototype mesh does not penetrate through the chest or pelvis of the dummy. If it does, move the path points (press "Modify coords", then drag path point with left, middle and right mouse buttons for X, Y and Z directions).
- It is also possible to control the twist of the belt path if you wish ("Control twist", then use the drag handles).



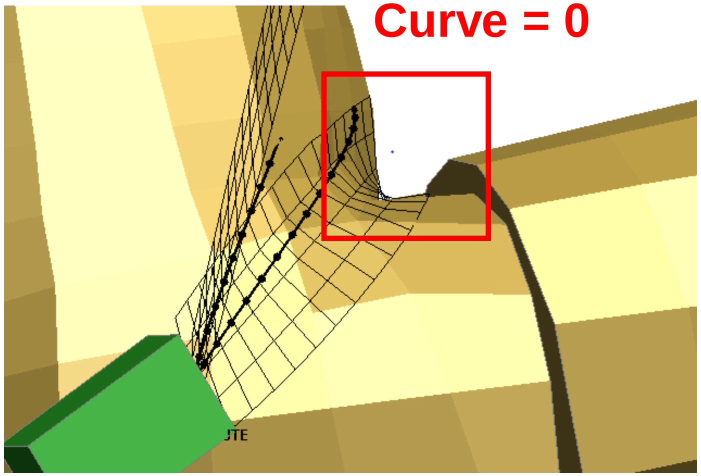


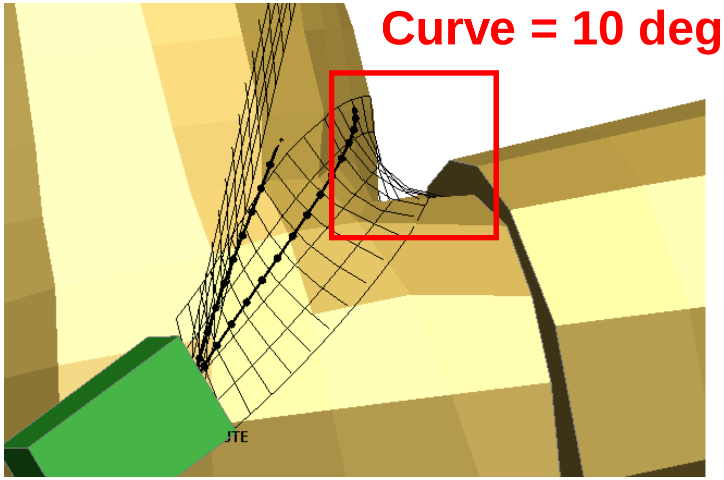
- Press “Fit”. Primer tightens the prototype belt mesh onto the dummy.
- If the result looks reasonable, press “Accept”. If not, go back to “Define path” and modify the initial path, then Fit again.



Seatbelt fitting – path definition

- It is possible to prevent the belt folding tightly into the pelvis/leg area
- If you wish to do this, go to the Params menu, set “Curve” to 10 degrees, and press Fit.
- This function is new in Primer 10.1.





Seatbelt fitting - meshing

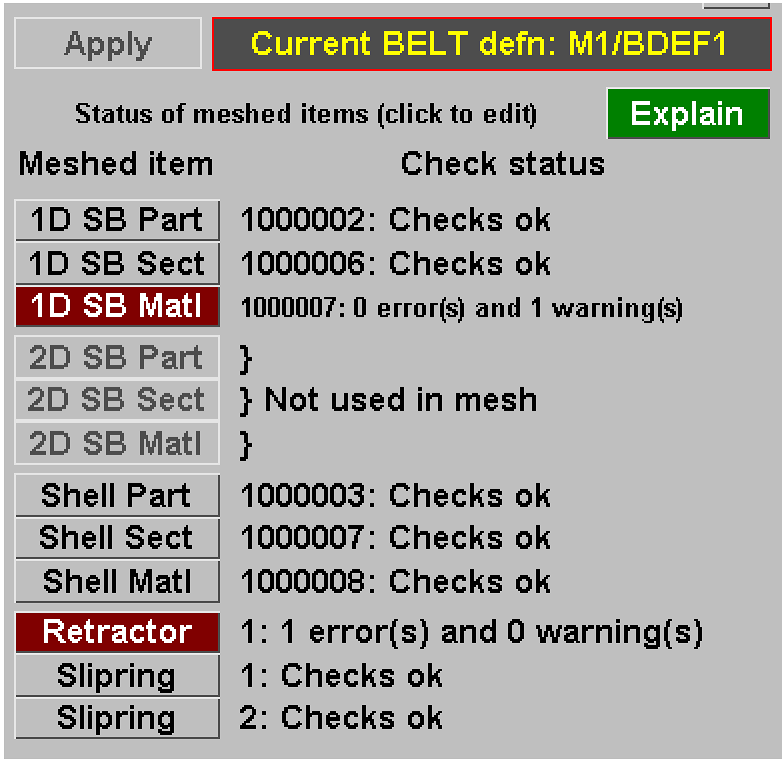
- Next we will mesh the belt. The prototype mesh seen in the previous steps exists only to show where the mesh will be created.
- Press “3. Mesh”.
- Primer now displays the first “segment” of the belt, from retractor to slipring.
- We will choose to use LS-DYNA’s 1-dimensional *ELEMENT_SEATBELT. The “meshing type” radio button is already set to “Sblt 1D only” – this is they type we want.
- To select a part for the new seatbelt elements, press “1D Sblt props” and right-click on the Part ID, Select, scroll the list of parts to the end, select part 1000002. Press “Update property”.

Seatbelt fitting - meshing

- Press the button marked “[>]” to display the next segment of belt (across the chest).
- This time we want a mixed mesh, with 1D elements near the sliprings (so they can pass through the sliprings) and shell elements elsewhere to provide a realistic contact condition to the dummy.
- This is already the default (“Mix Sb1/Shl”). Also, we can leave the default number (4) of 1D elements at each end.
- To select a part for the new shell elements, press “Shell props”, right-click on the Part ID, Select, scroll down the list, pick part 1000003. Press “Update property”.
- Move to the final belt segment using “[>]”. Check that the settings are correct.
- Press “Generate”, press OK.

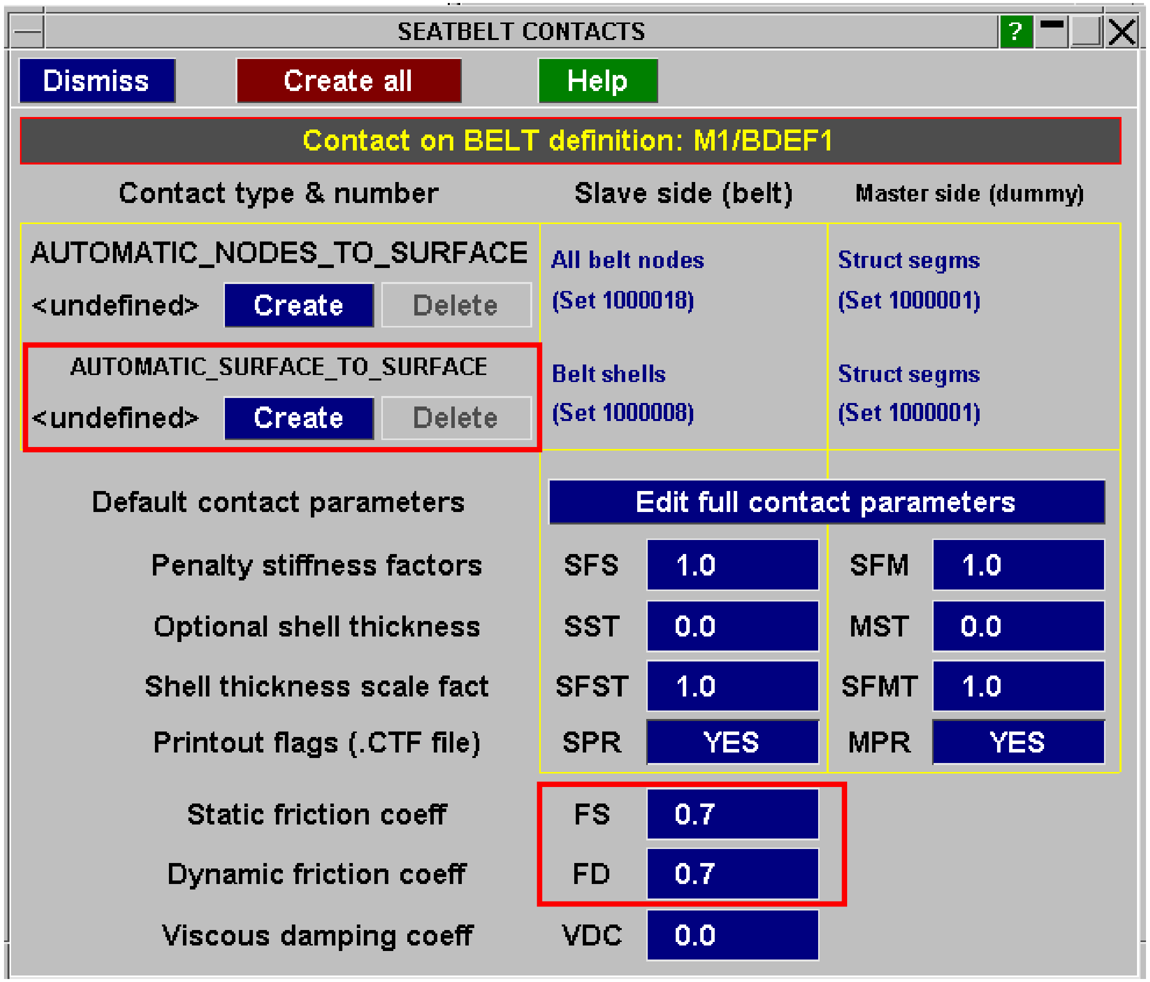
Seatbelt fitting – error check

- The next menu highlights (in red) any error found.
- Click on “1D SB Matl”. Press “Check defn”. Primer will explain the error. Press “Continue”.
  - Change LMIN to 5(mm)
  - Press “Update”.
- Click on the red “Retractor” button, and “check defn”.
  - Select the only sensor for SID1.
  - For LLCID, select curve 1000004
  - For ULCID, select curve 1000005
  - Set LFED = 20mm
  - Update Element.
- Also click on the slipring button. For each slipring, change the friction (FC) to 0.2.



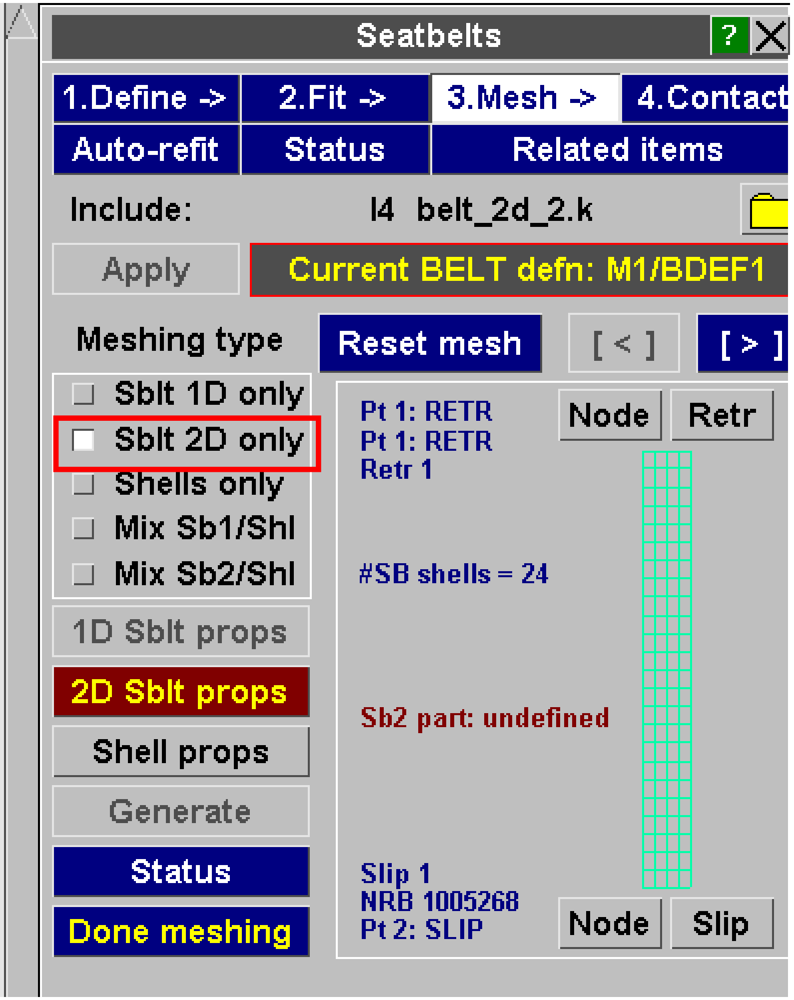
Seatbelt fitting – define contact & save model

- Press “4. Contact”.
- We will create a surface-to-surface contact for the belt to the dummy.
- Change the friction coefficients FS and FD to 0.7.
- Under “AUTOMATIC_SURFACE_TO_SURFACE”, press “Create”, then Dismiss the Contact menu.
- Now write out the model under a new name.



Creating 2D seatbelts

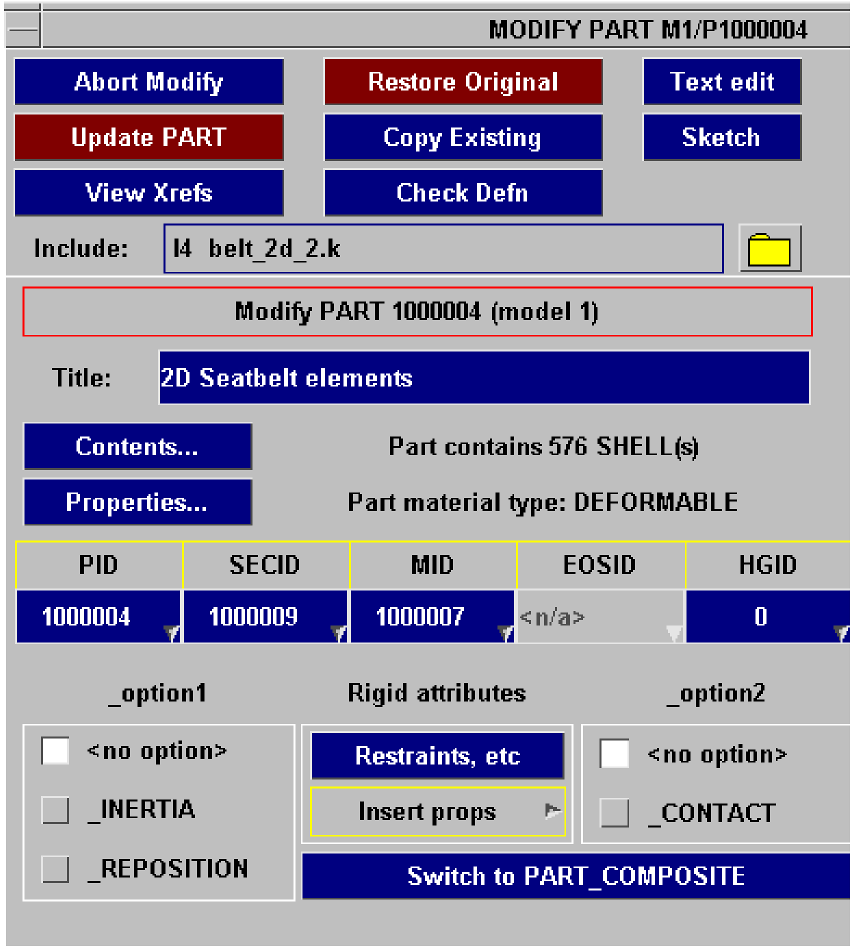
- To create 2D seatbelt elements, the process is the same except for the choice of element type during the Meshing step.
- Alternatively, we can start from a model containing a belt made from 1D seatbelt and shell elements, and change the mesh type. We will use this method.
- Dismiss the main Seatbelt menu, and re-open it.
- Press “3. Mesh” .
- For the first segment of belt, change the meshing type to “Sblt 2D only”



Creating 2D seatbelts

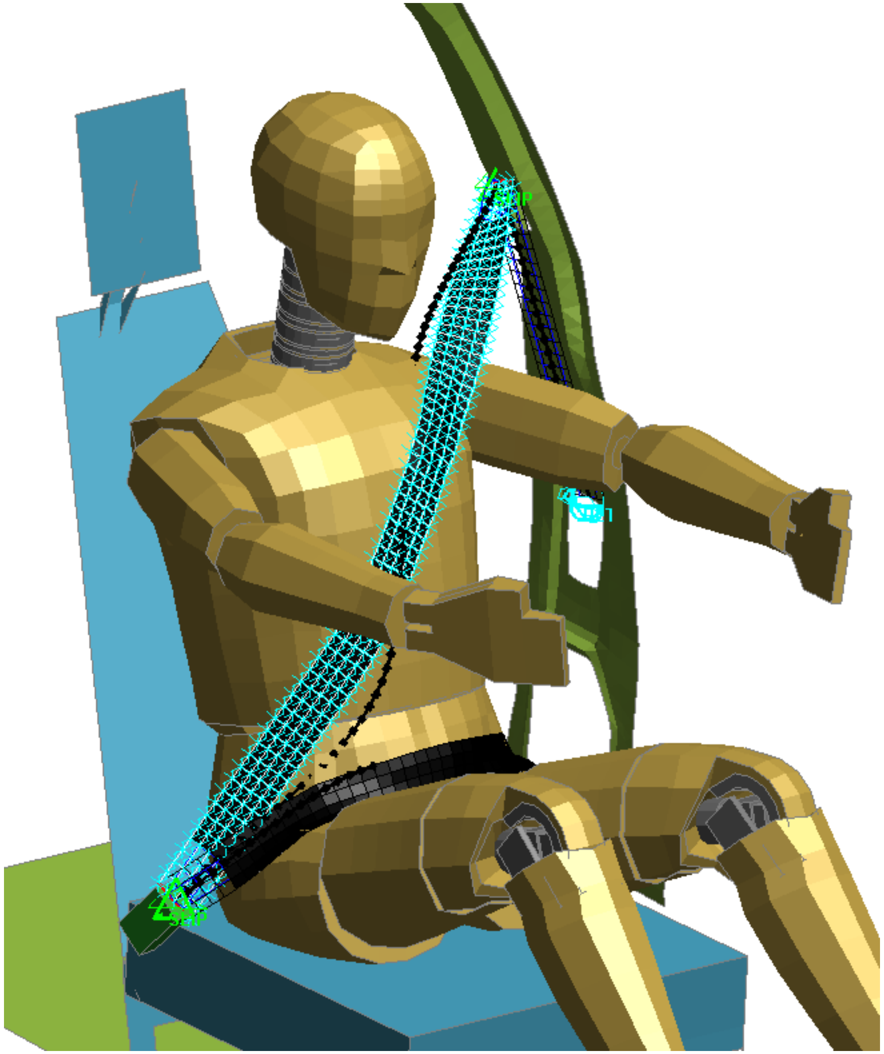
Oasys PRIMER

- We need *PART data for the 2D seatbelt elements. Press the red button “2D Sblt props”
- In the red text-box for the Part ID, use the drop-down menu to create a new Part.
- Give a title, e.g. “2D seatbelt elements”
- For SECID, select existing *SECTION_SHELL 1000009. Note that the Section must not be used by any other Part.
- For MID, select existing *MAT_SEATBELT 1000007.
- Press Update Part.



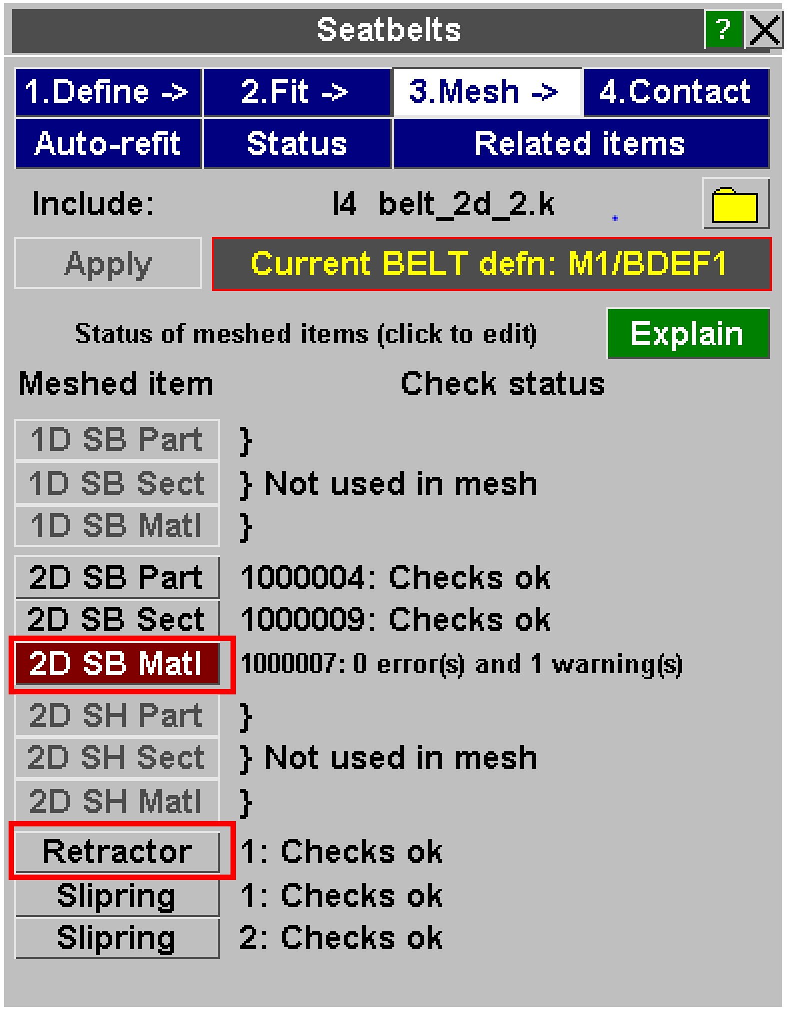
Creating 2D seatbelts

- Press [>] to move to the next belt segment (thorax).
- Change the meshing type to “Sblt 2D only”
- Press [>] to move to the next belt segment (pelvis).
- Change the meshing type to “Sblt 2D only”
- Press “Generate”
- In the text-box that appears, press “Reuse”
- Primer deletes the previous belt mesh – press “Delete sel” and “Continue”
- Primer informs about the new mesh – press “OK”



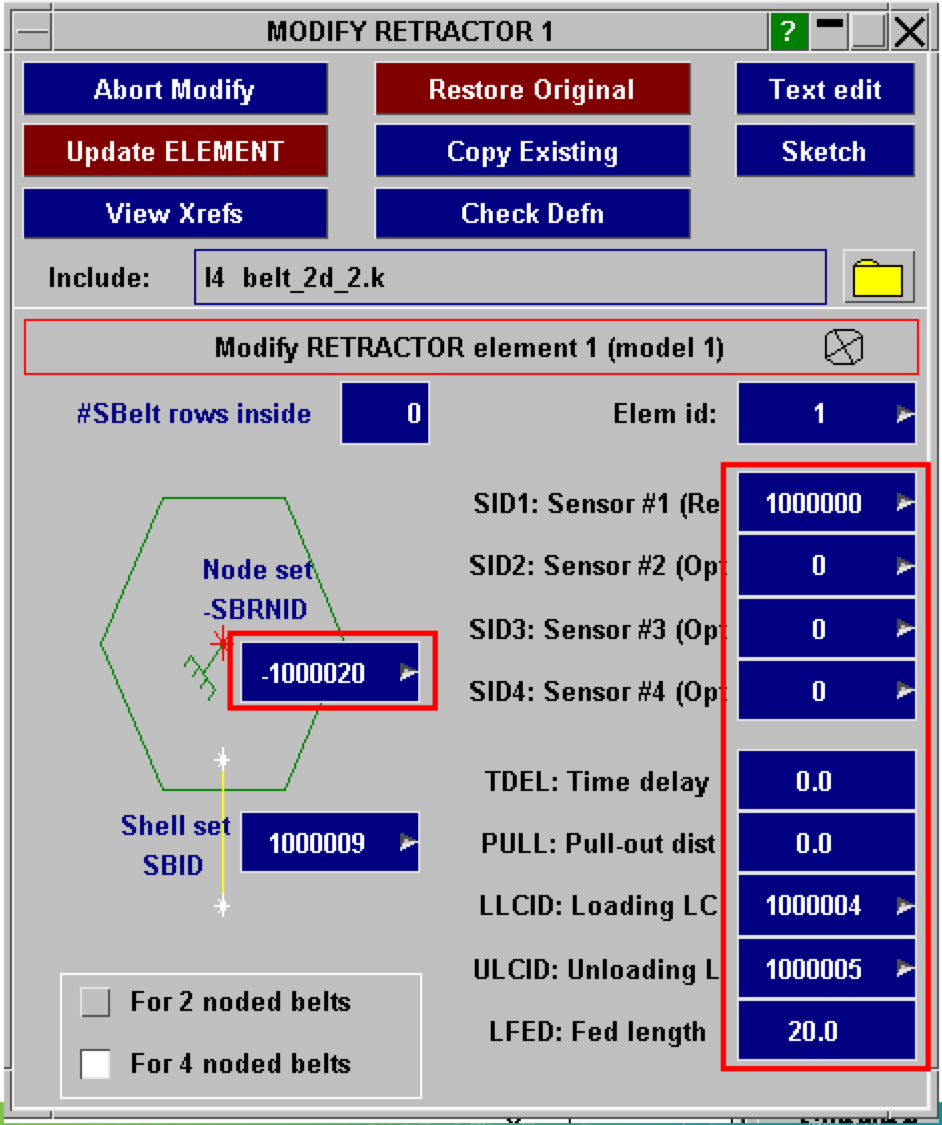
Creating 2D seatbelts

- Primer finds an error with the *MAT_SEATBELT. Use “Check Defn” to find the problem and fix it.
- Press “Retractor” to see the retractor data (see next slide).



Creating 2D seatbelts

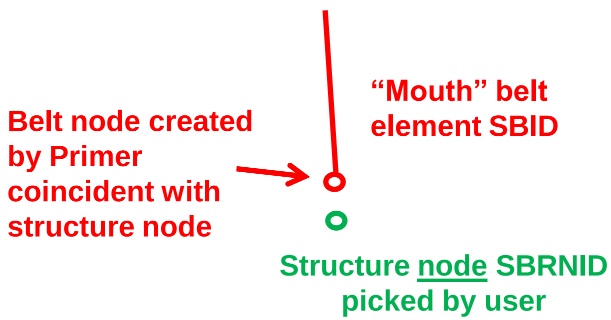
- Confirm that the following data is still set correctly:
  - SID1 = 1000000
  - LLCID = 1000004
  - ULCID = 1000005
  - LFED = 20
- 1D seatbelt retractors have a single structural node; for 2D seatbelts there is a Node Set, created automatically by Primer.
- Sketch the Node set –SBRNID. These “structural” nodes are coincident with the nodes of the seatbelt elements.



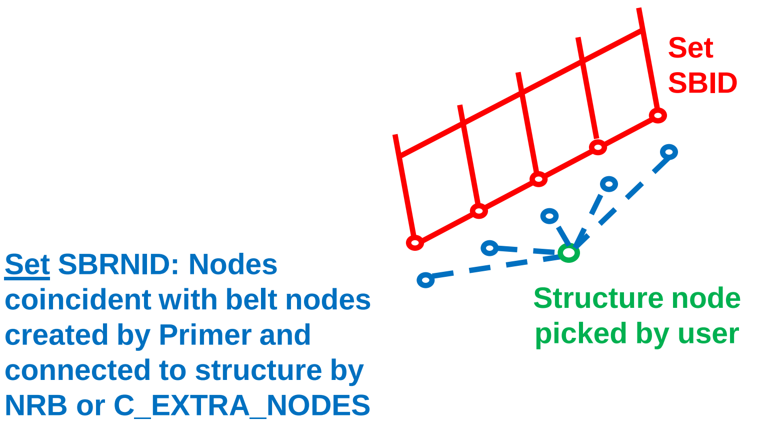
Creating 2D seatbelts

- Use the “J” shortcut to see how the structural nodes are attached to the structure. The green dashed lines show *CONSTRAINED_EXTRA_NODES.
- The “K” shortcut restores the entity visibility to initial settings.
- The 1D seatbelt retractors reference a single “mouth” element. For the 2D seatbelts, Primer automatically creates a Set SBID, as required. Sketch the set.
- For the Sliprings, sketch the Node Set –SBRNID and Shell Sets SBID1 and SBID2.

1D Seatbelt retractor

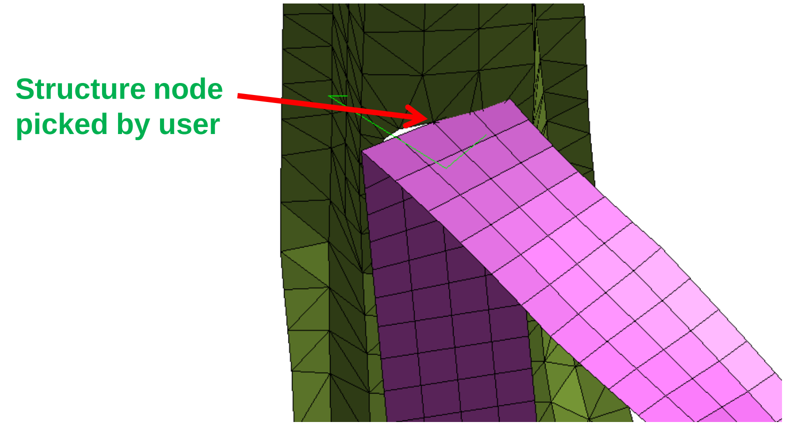


2D Seatbelt retractor

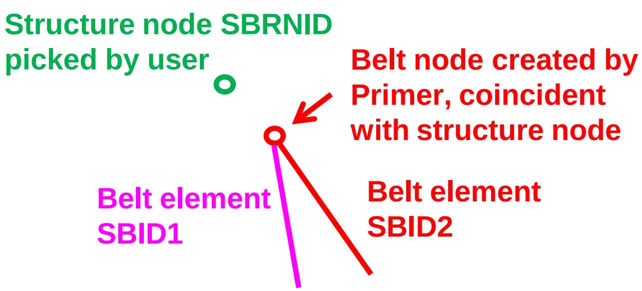


Creating 2D seatbelts

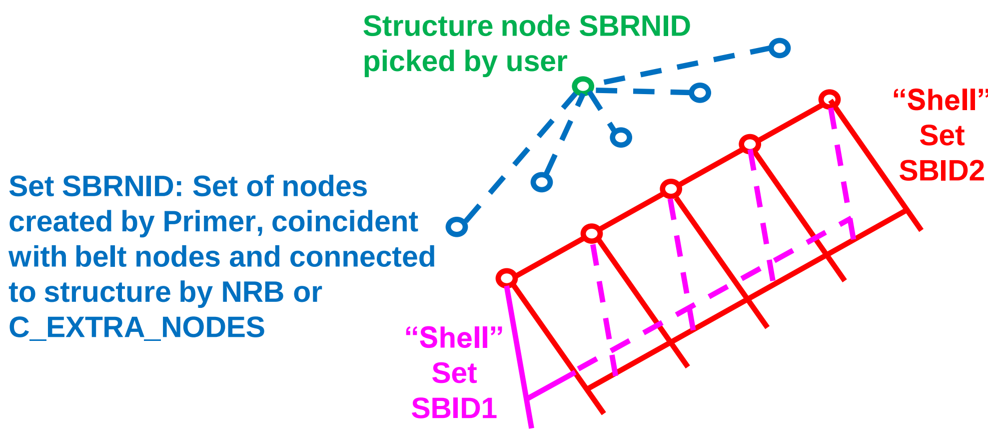
- For the Sliprings, sketch the Node Set –SBRNID and Shell Sets SBID1 and SBID2.
- Check how the structure nodes in the set SBRNID are attached to the vehicle structure, using “J”.



1D Seatbelt slipring

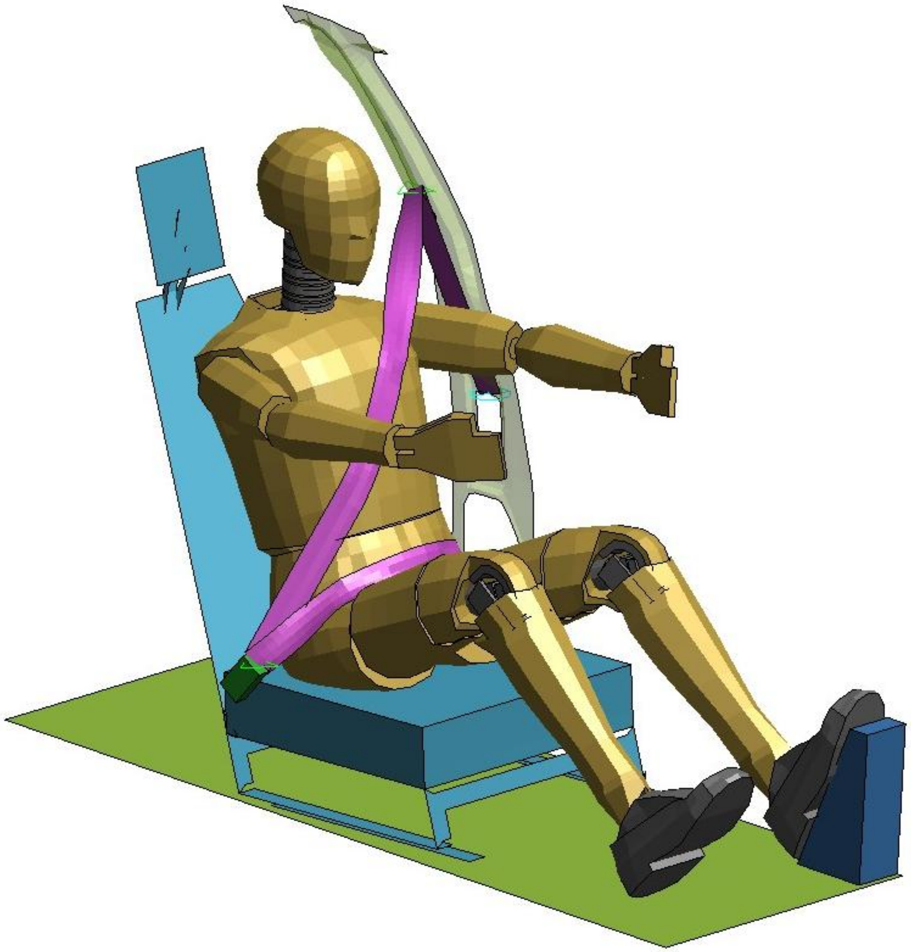


2D Seatbelt slipring

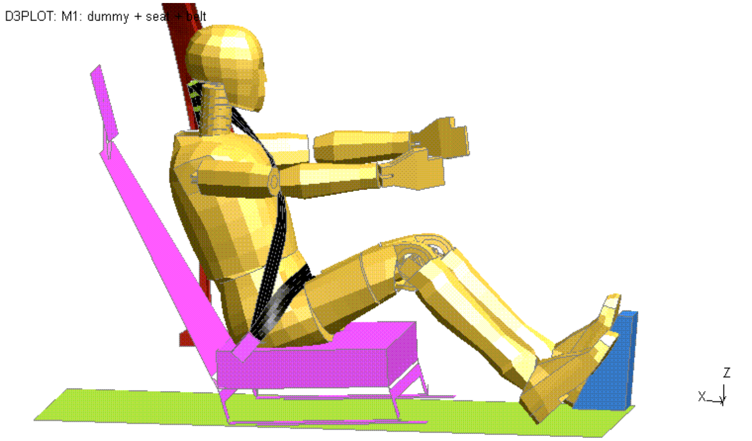


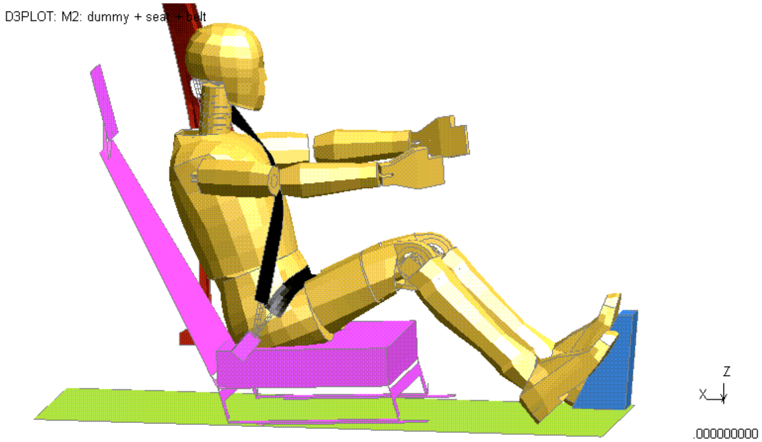
Creating 2D seatbelts

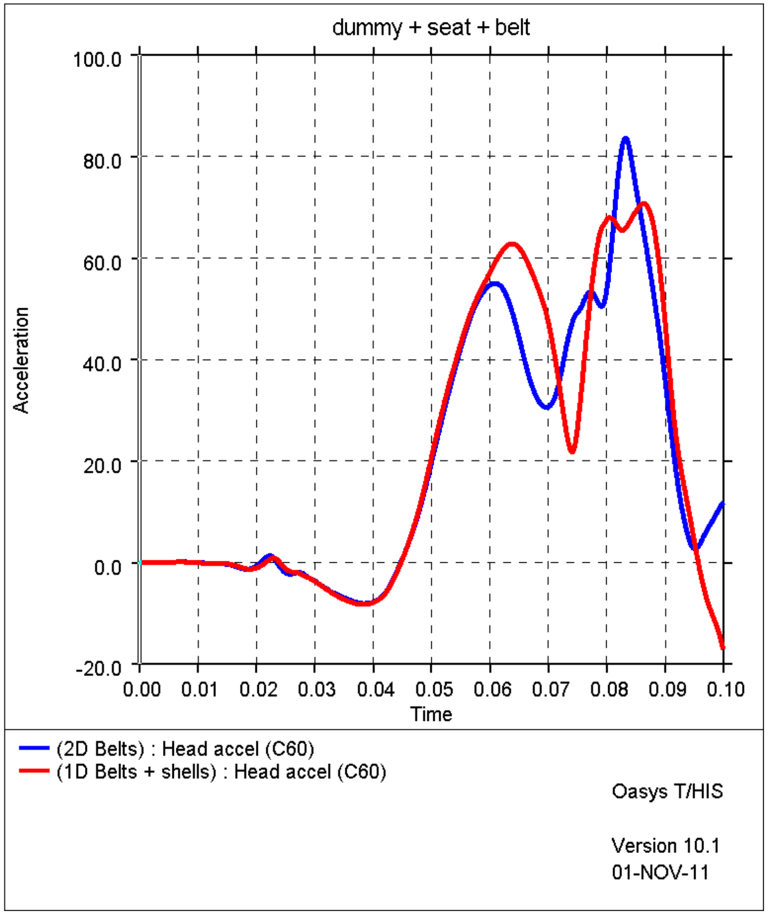
- In the Seatbelts menu, go to "4. Contact", create the contact as before with friction = 0.7.
- Use Remove=>Cleanup Unused. This prevents LS-DYNA errors caused by empty sets.
- Write the model.
- The model can be run in LS-DYNA



- We expect the results from 1D or 2D seatbelt elements to be similar but not identical.



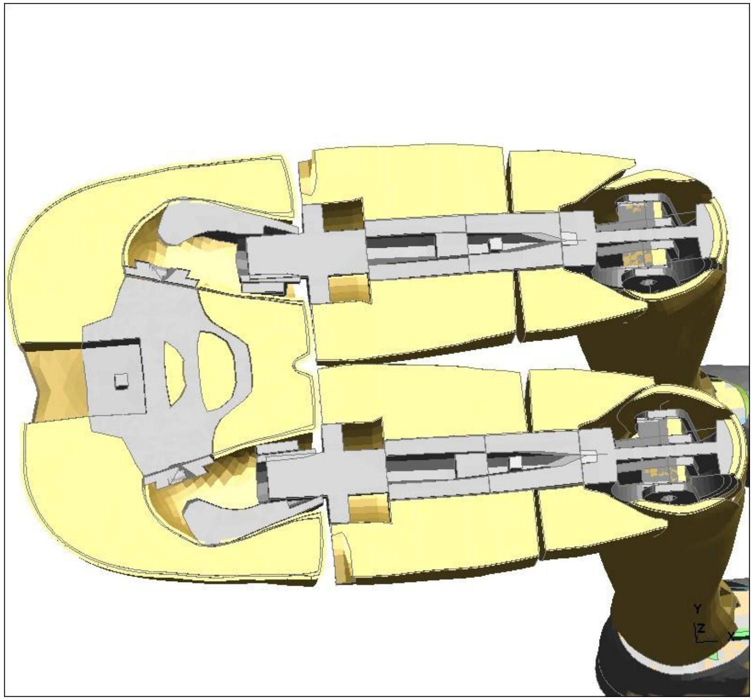


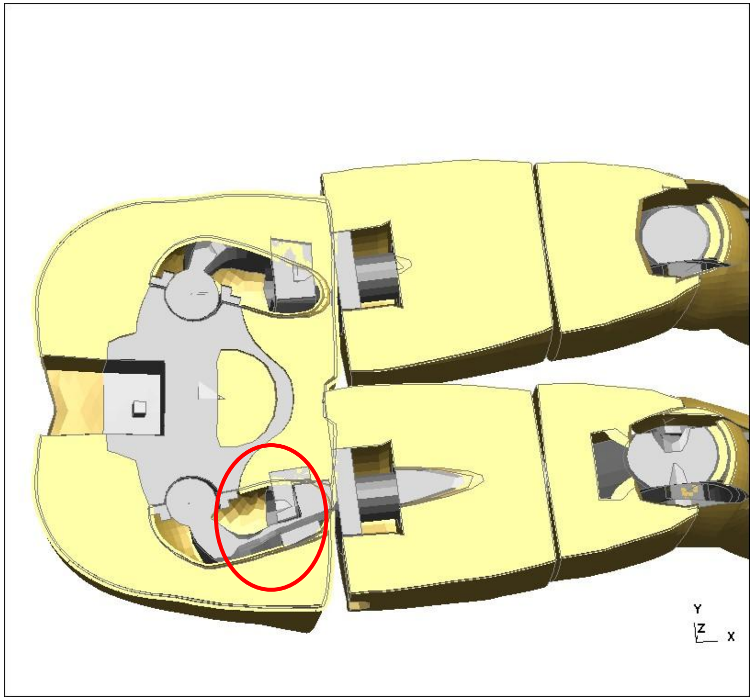


“Dyna Method” dummy positioning (pre-simulation)

Dummy positioning

- Dummy positioning by the normal Primer method can cause penetrations in the dummy

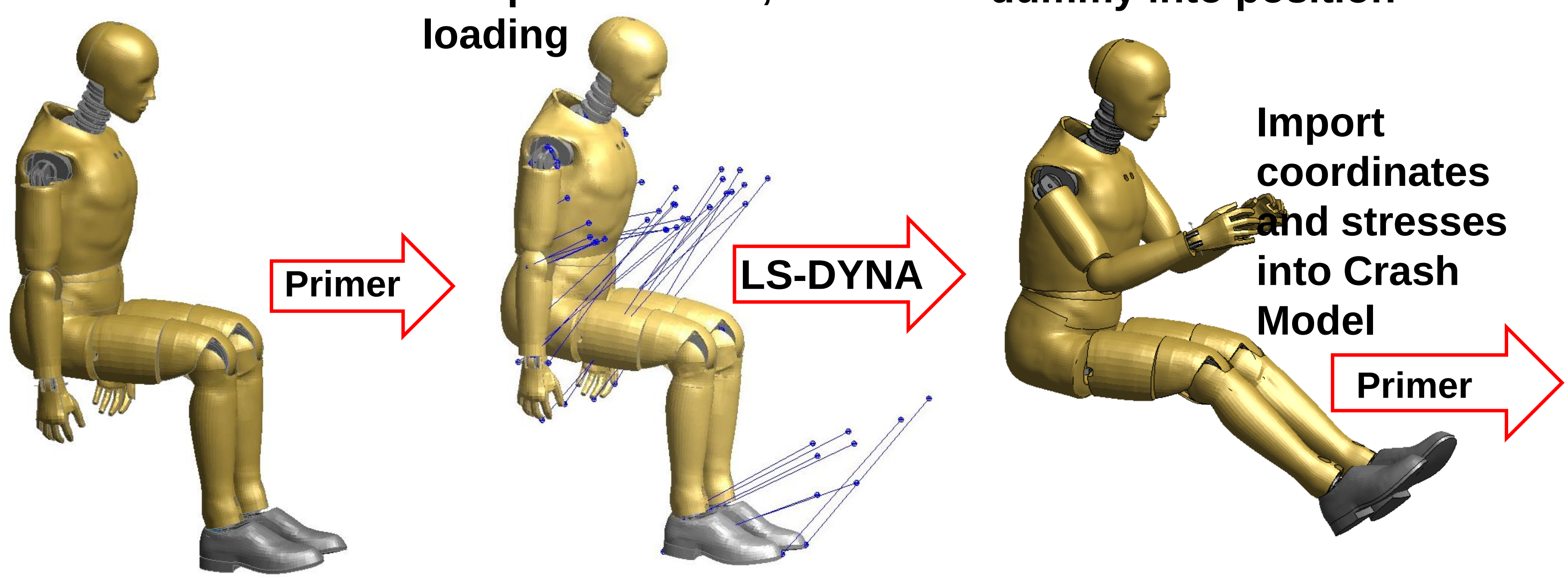




- In real life, the parts would contact and deform
- LS-DYNA can do this – the positioning should be analysed by LS-DYNA

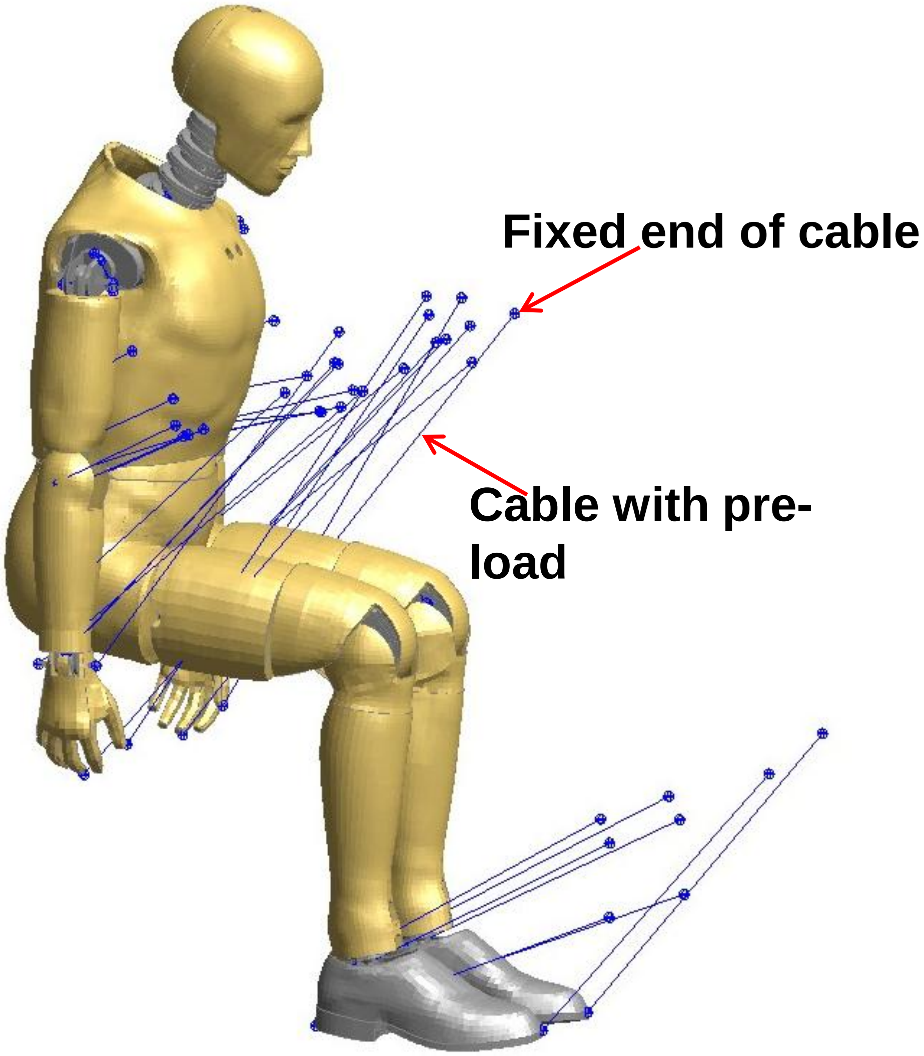
Dummy Positioning – “LS-DYNA Method”

- Primer creates cables and loading to “pull” the dummy into position during an LS-Dyna analysis. The coordinates and initial stresses can then be imported into the original model. This allows internal parts to deform and contacts to remain free from penetrations during positioning.



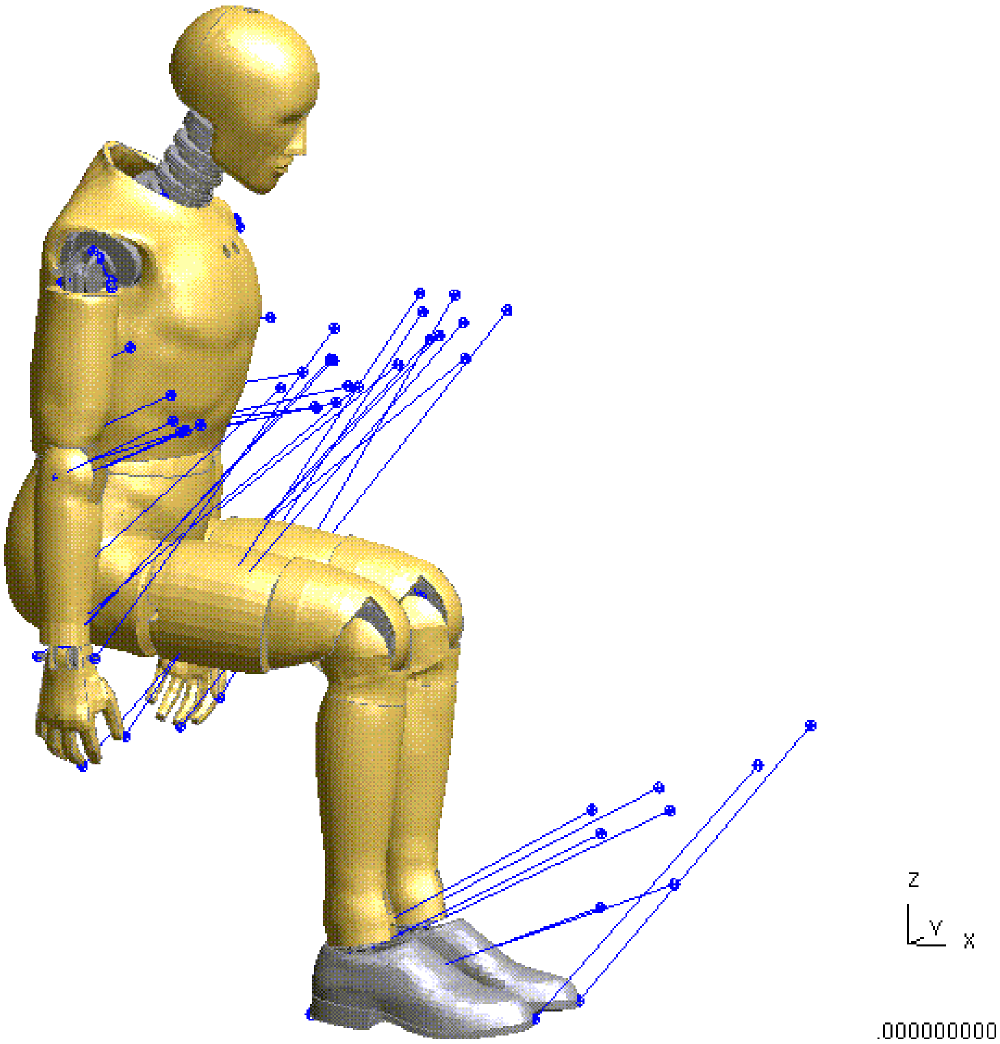
Dummy Positioning – "LS-DYNA Method"

- Each cable has one end fixed to a node on the dummy. The other end is fixed, at the required final position of the node on the dummy.
- The cables have preload, so they will pull the dummy towards the required position.
- **Each cable also has a damper element to reduce dynamic oscillation and limit the velocity during positioning.**



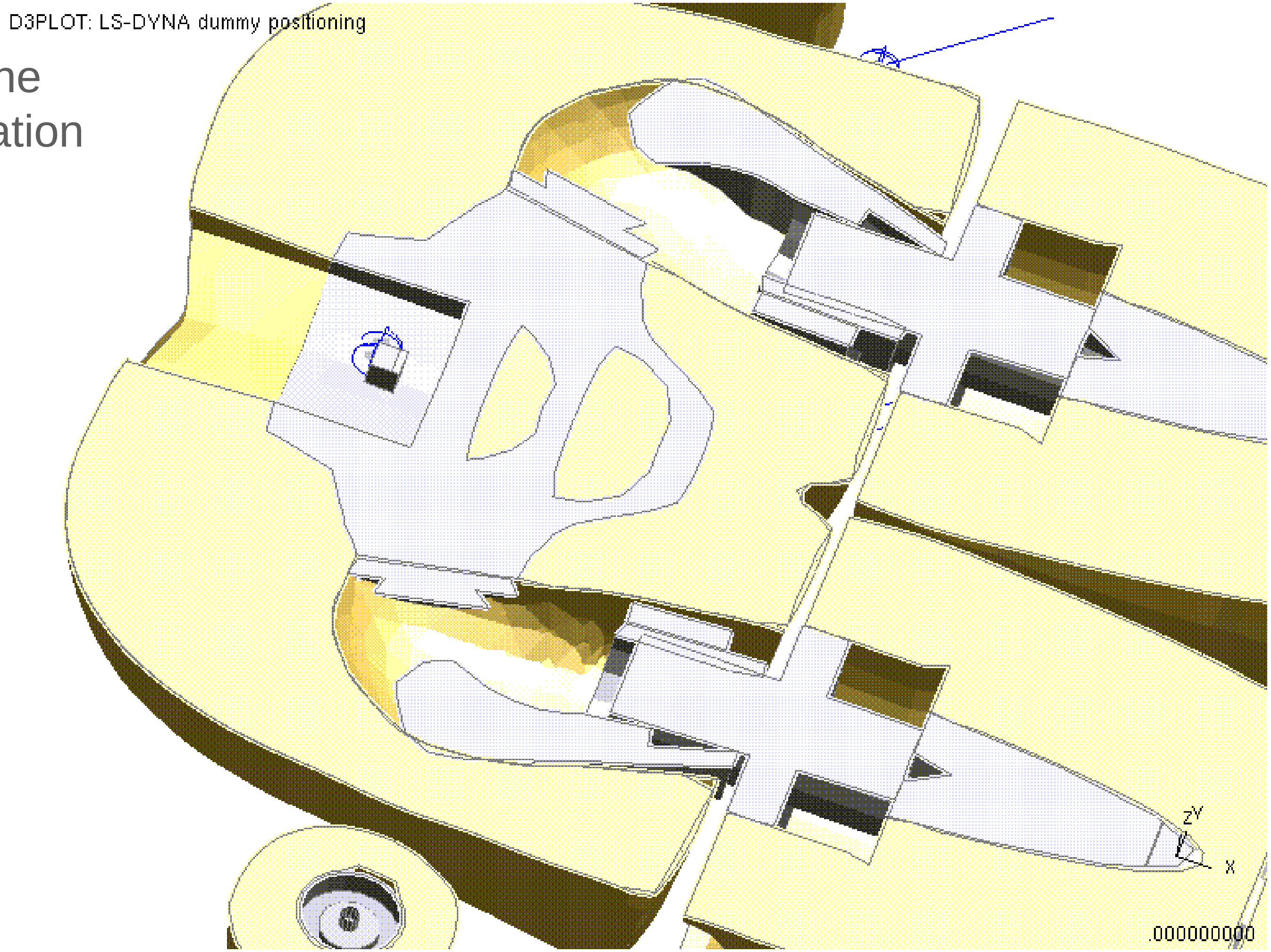
Dummy Positioning – "LS-DYNA Method"

- The cables shorten until they have zero length.
- **The dummy is then in the required position.**



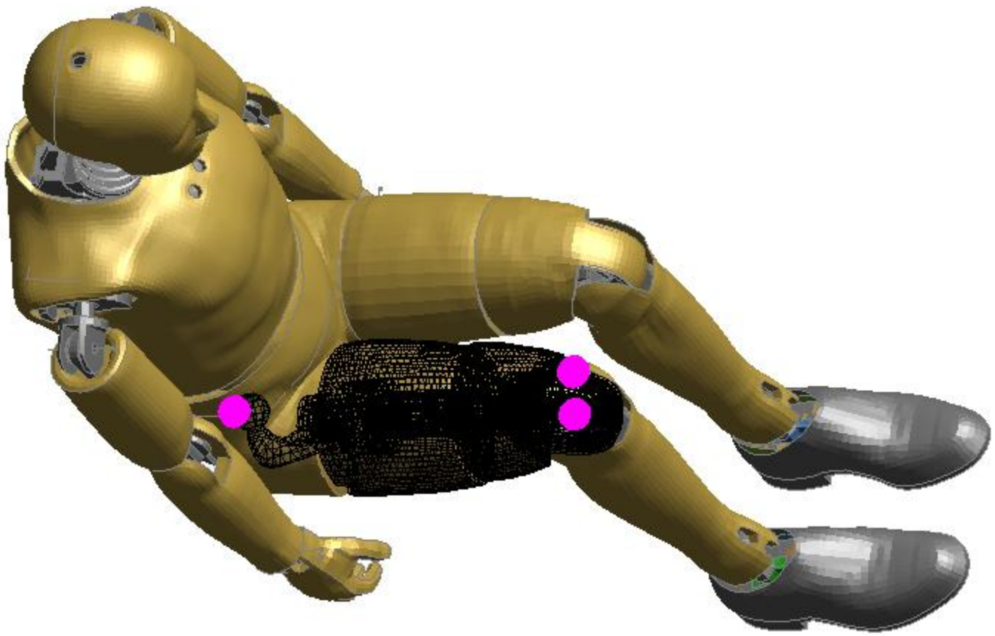
Dummy Positioning – "LS-DYNA Method"

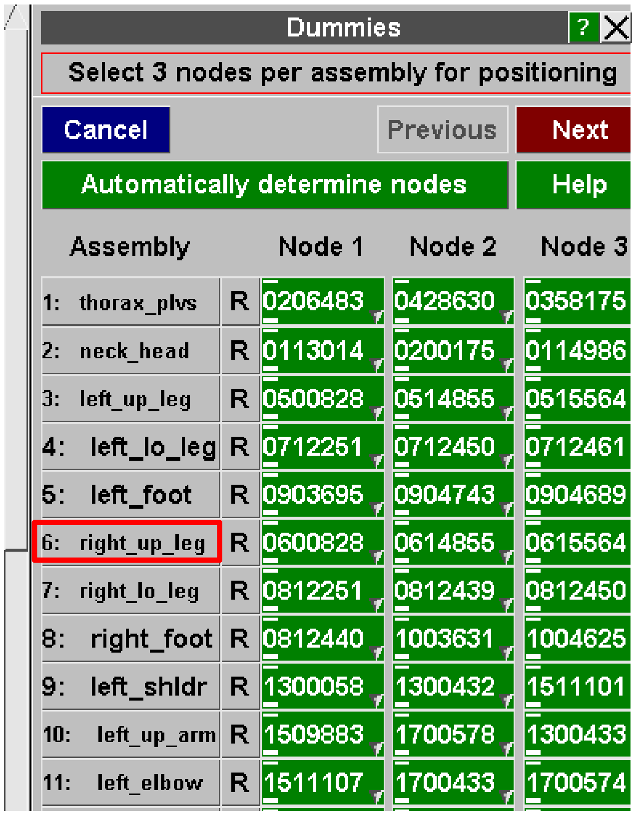
- LS-DYNA handles the contact and deformation of the internal parts.



Dummy Positioning – “LS-DYNA Method”

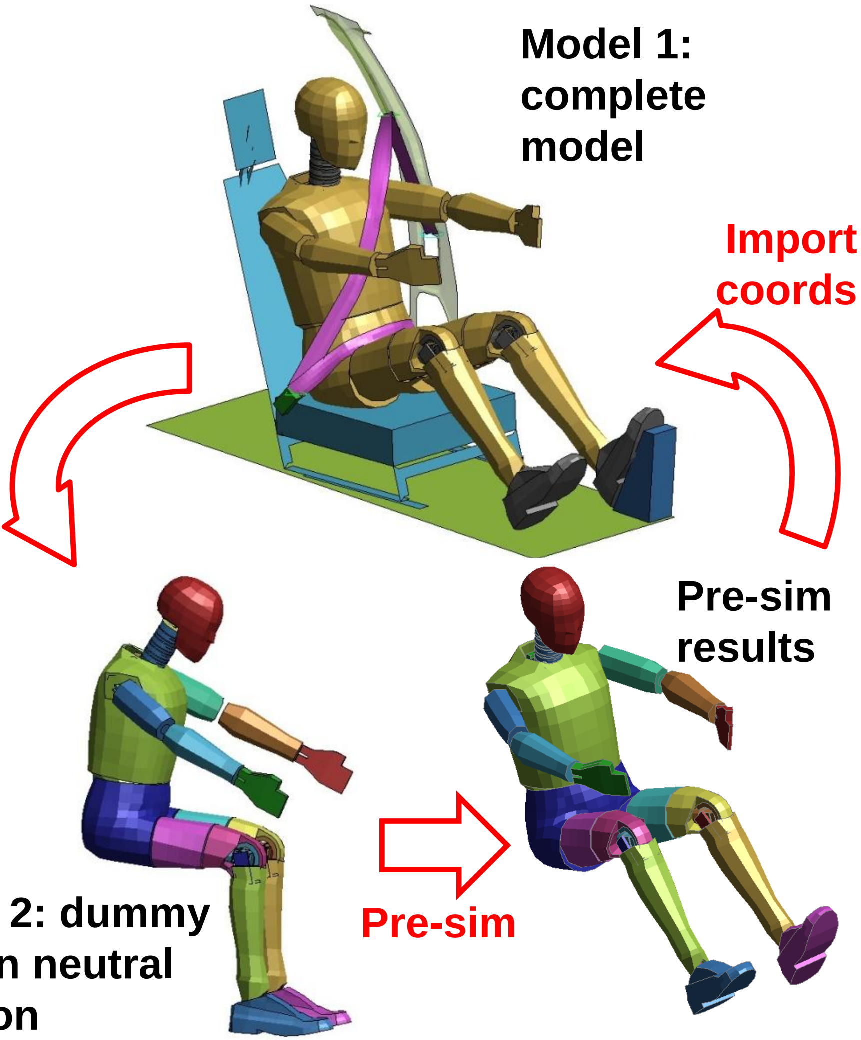
- The three nodes (where the cables will be attached) may be sketched by clicking on the assembly name.





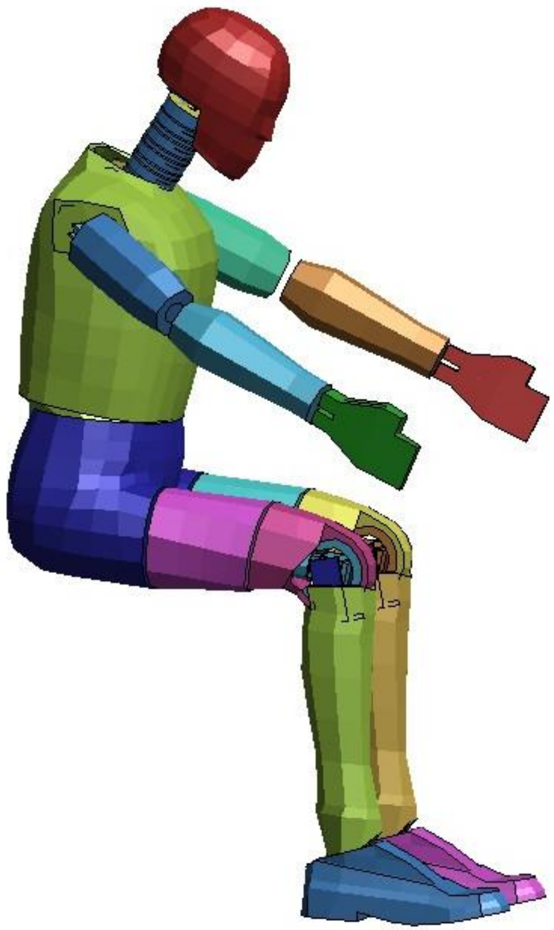
Dummy positioning by LS-DYNA pre-simulation - workshop

- Previously, we positioned the dummy using Primer methods. Next, we will create the same dummy position by LS-DYNA pre-simulation.
- If you don’t have a complete model, use dummy_seat_ready_for_linking3.key
- Make sure you have saved the current position of the dummy: Occupant=>Dummies=>Position=> Move Parts=>Save/Retrieve.
- Check that the dummy also has a saved position called “Neutral position”. Set the dummy in Neutral position, Accept.
- Write the keyword file for the dummy (e.g. using Tools=>Include=>Write). Use filename dummy_for_presim.k.



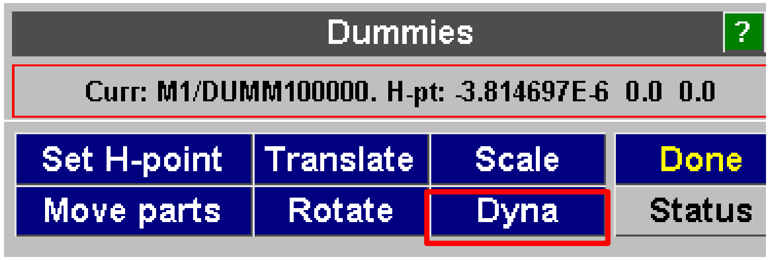
Dummy positioning by LS-DYNA pre-simulation - workshop

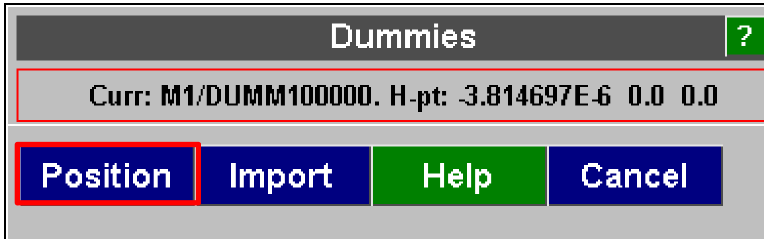
- It is recommended to start from the dummy in a position that does not have any initial penetrations. Usually this means starting from the dummy's neutral position.
- Read dummy_for_presim.k into Primer as a separate model (Model 2) – this one will be used for pre-simulation. (If you don't have this keyword file, h350_lstc_start7.k will be OK).

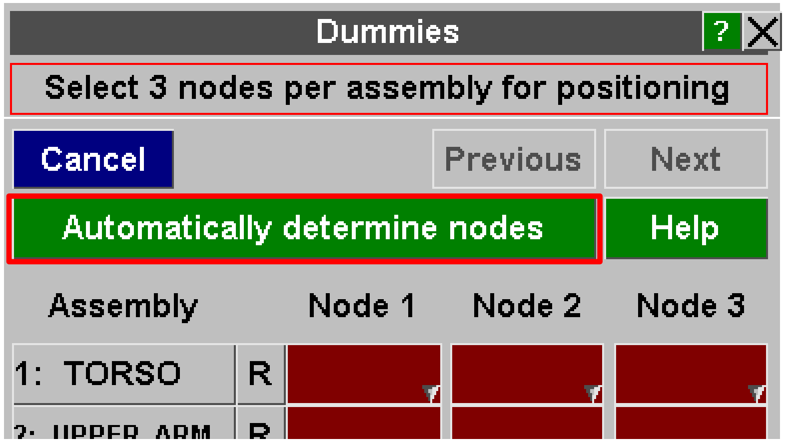


Dummy positioning by LS-DYNA pre-simulation - workshop

- Go to the Dummy Position menu for Model 2, choose the option Dyna.
- Press “Position”
- Request Primer to automatically determine the nodes where the cables will be attached.

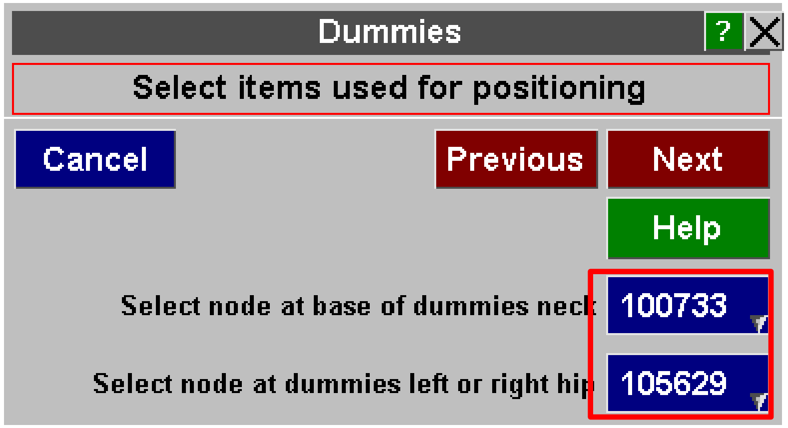


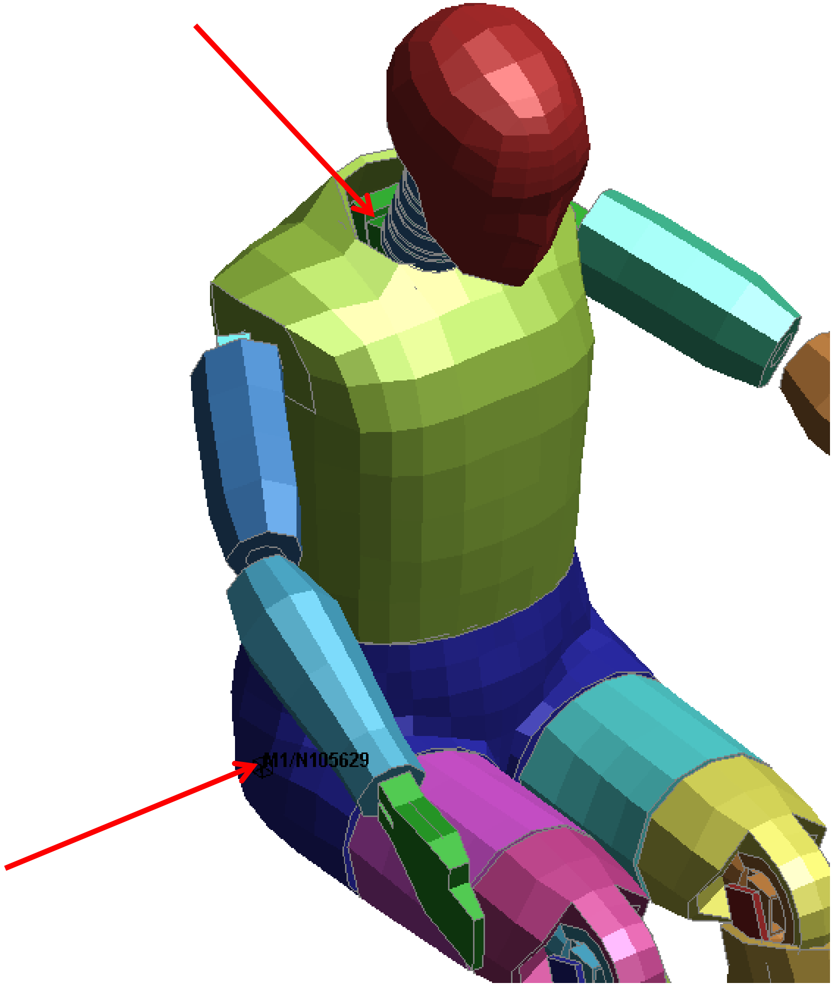




Dummy positioning by LS-DYNA pre-simulation - workshop

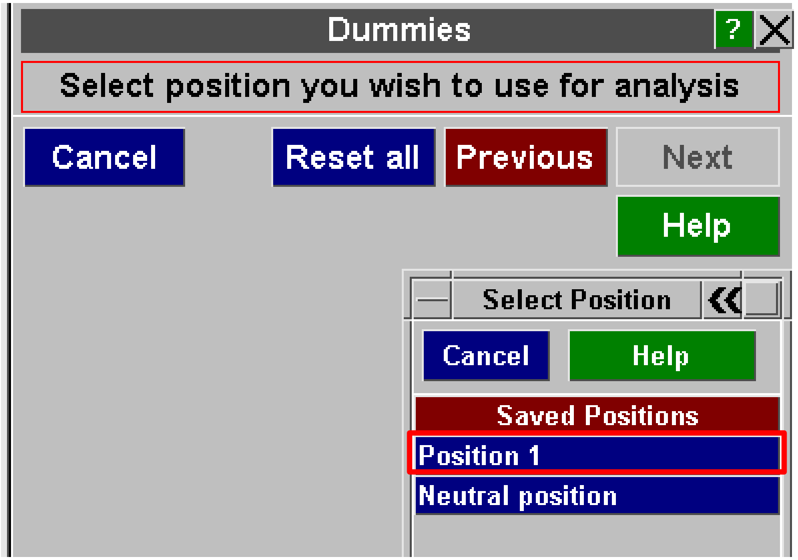
- Select nodes at base of dummy's neck and on the pelvis as shown. It is not important which node is selected.





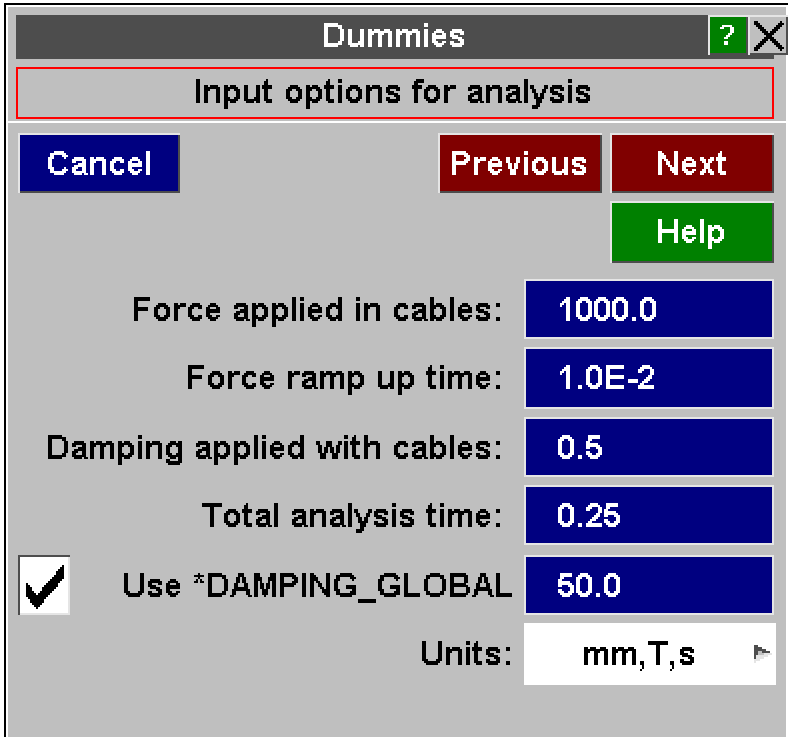
Dummy positioning by LS-DYNA pre-simulation - workshop

- Select previously saved position (this is the required final position after pre-simulation).



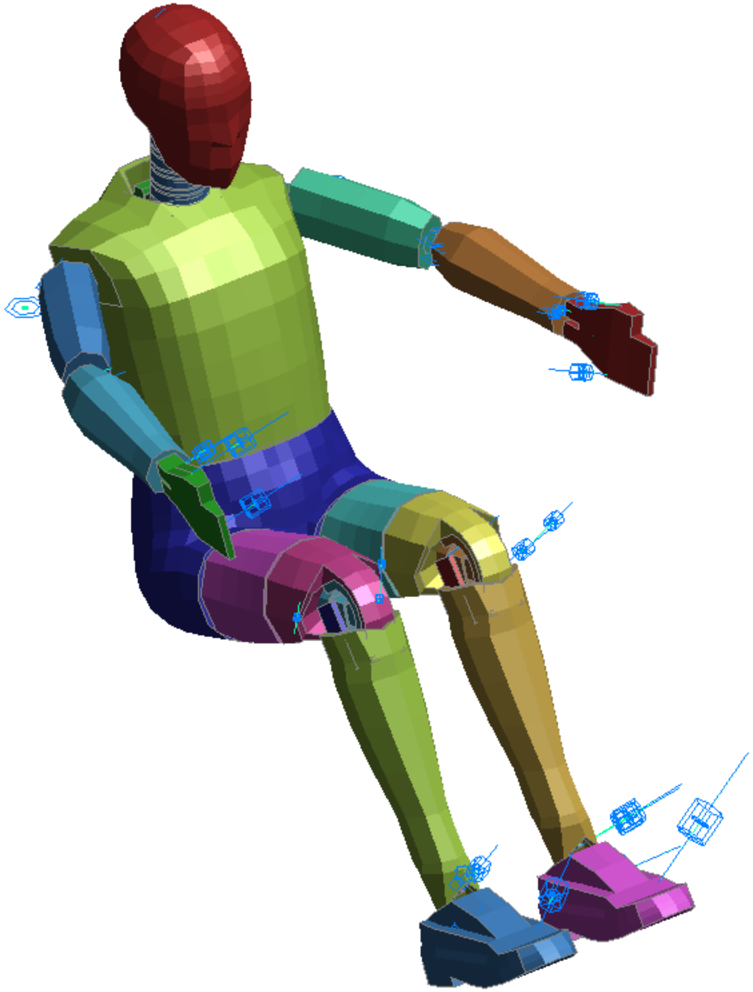
Dummy positioning by LS-DYNA pre-simulation - workshop

- Check that the units are correct – should be mm, T, s (millimetres, tonnes, seconds). These are used to decide the values of the other parameters, such as cable force.
- The default parameter values are OK for this example.
- Press Next and Apply, and Finish.

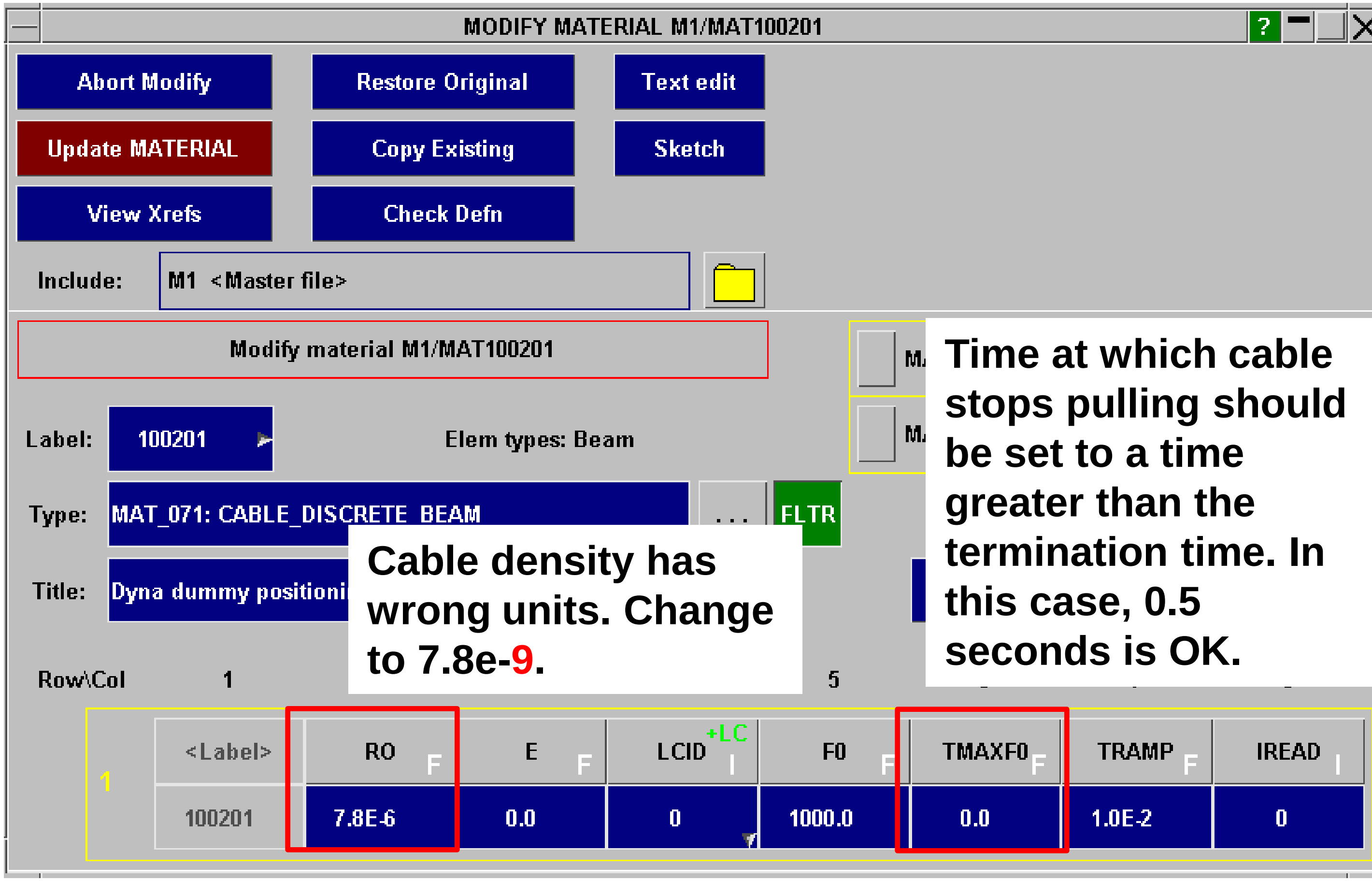


Dummy positioning by LS-DYNA pre-simulation - workshop

- Primer rotates and translates the dummy from the initial neutral position, and creates the cable and damper elements.

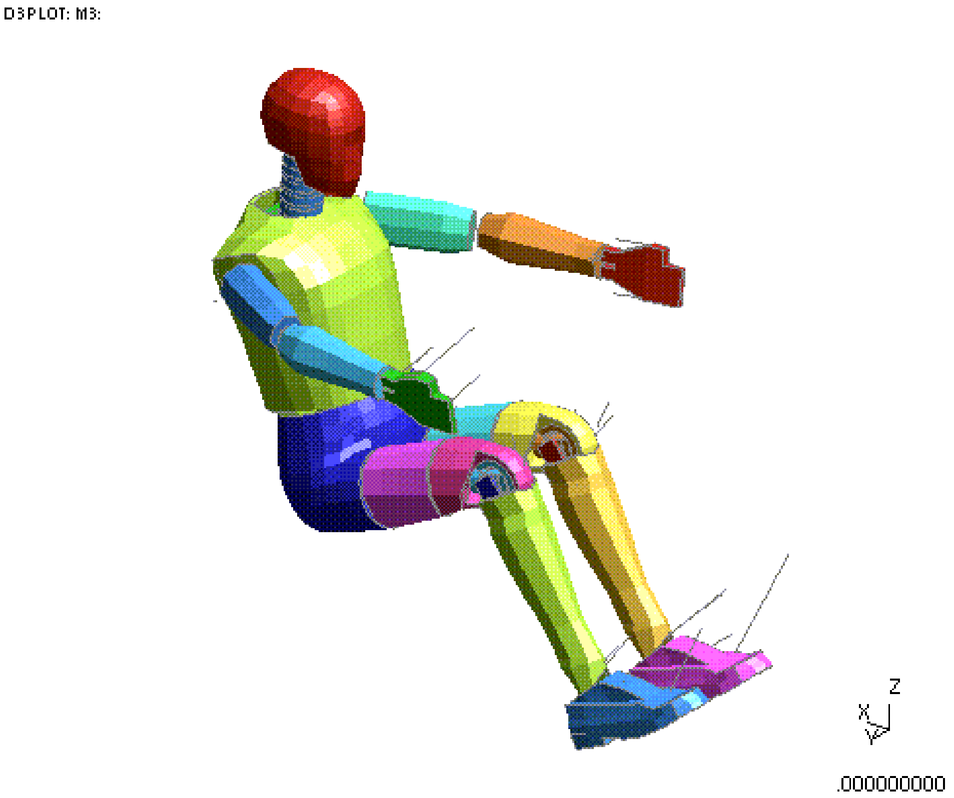


- In version 10 or 10.1 of Primer, we must edit the *MAT_CABLE data. Repeat this for <u>both</u> *MAT_CABLE definitions created by Primer:



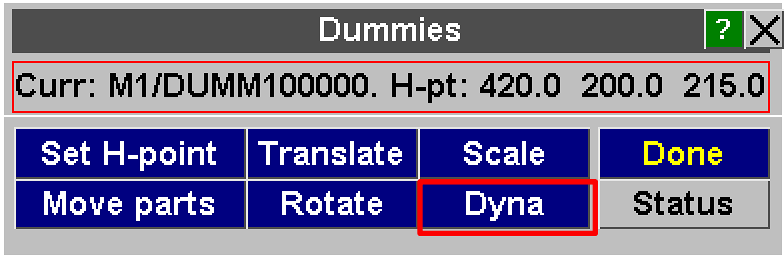
Dummy positioning by LS-DYNA pre-simulation - workshop

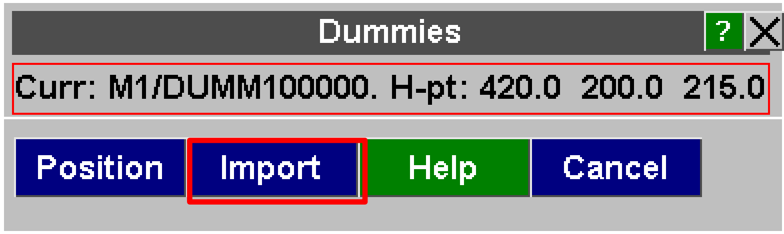
- Write the model.
- Submit to LS-DYNA. In case you cannot do that, result files are provided in the directory DYNA_DUMMYPOS_RESULTS.
- One of the result files is end_stage001_dynain. This is a keyword-format file containing the final node coordinates.
- In Primer, exit from Dummy Positioning. For Model 1 (the complete model with belt etc), go to Dummy Positioning=>Dyna=>Import. Select the dynain file.

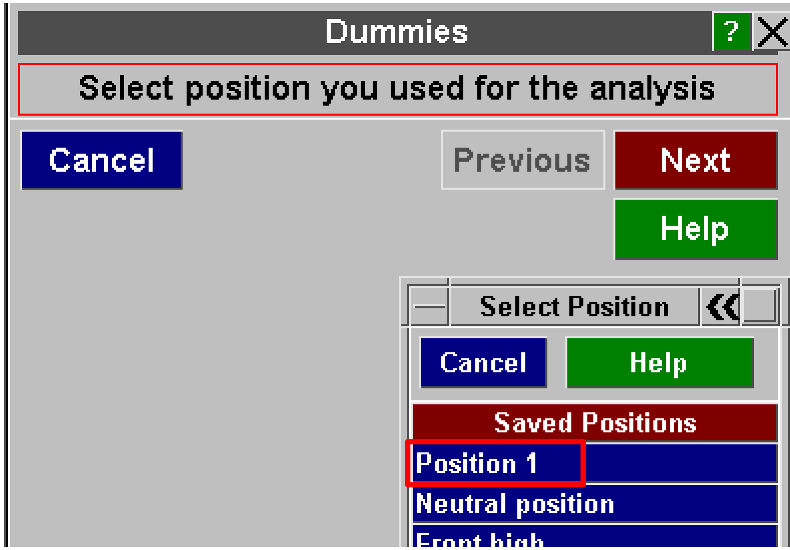


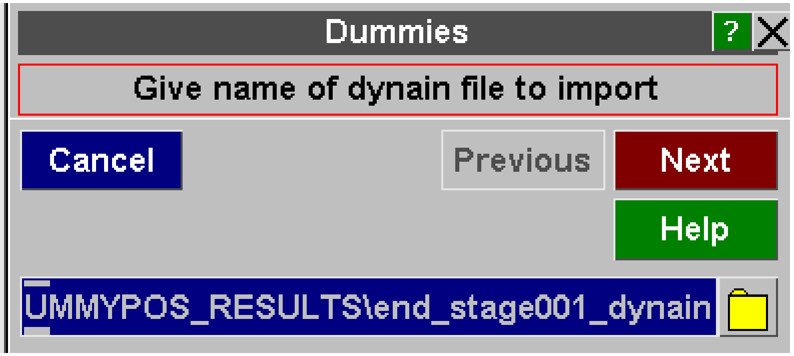
Dummy positioning by LS-DYNA pre-simulation - workshop

- In Primer, exit from Dummy Positioning. For Model 1 (the complete model with belt etc), go to Dummy Positioning=>Dyna=>Import.
- Select the saved position – must be the same position as used in the pre-simulation.
- Select the dynain file.
- Apply. Allow Primer to auto-fix joints if requested. The workshop is complete.









Summary

- We have covered the following subjects using a simplified model:
  - Defining the mechanism data for seats
  - Methods of positioning seats
  - Storing and retrieving seat positions
  - Methods of positioning dummies
  - Storing and retrieving dummy positions
  - Linking the seat to the dummy for combined positioning
  - Batch mode commands
  - Belt re-fitting after dummy positioning
  - Seat foam compression – Primer method, LS-DYNA method
  - Belt fitting – 1D belts, 2D belts
- Have fun with your real seat and dummy models!

Multiple model setup using Javascript

Oasys PRIMER: Seat and Dummy Positioning and Belt Fitting

Training course