Morph Boxes with High Order

High order morph boxes

PRIMER

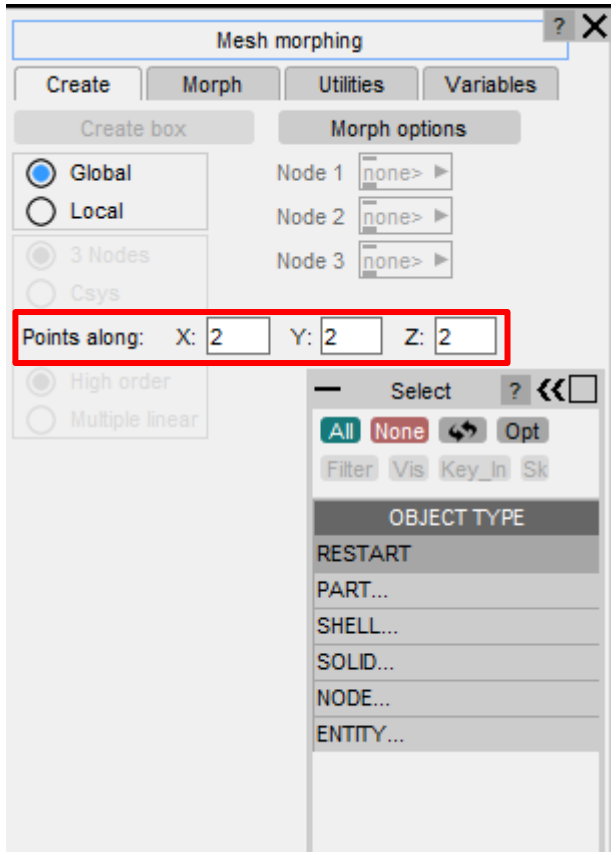
- This tutorial highlights differences between basic order morph boxes and high order morph boxes.

- Knowledge of the basic morphing functionality is assumed. It is described in the Morphing tutorial.

- Here we will see how high order morph boxes give more control over smoothness when morphing a mesh.

Creating high order morph boxes

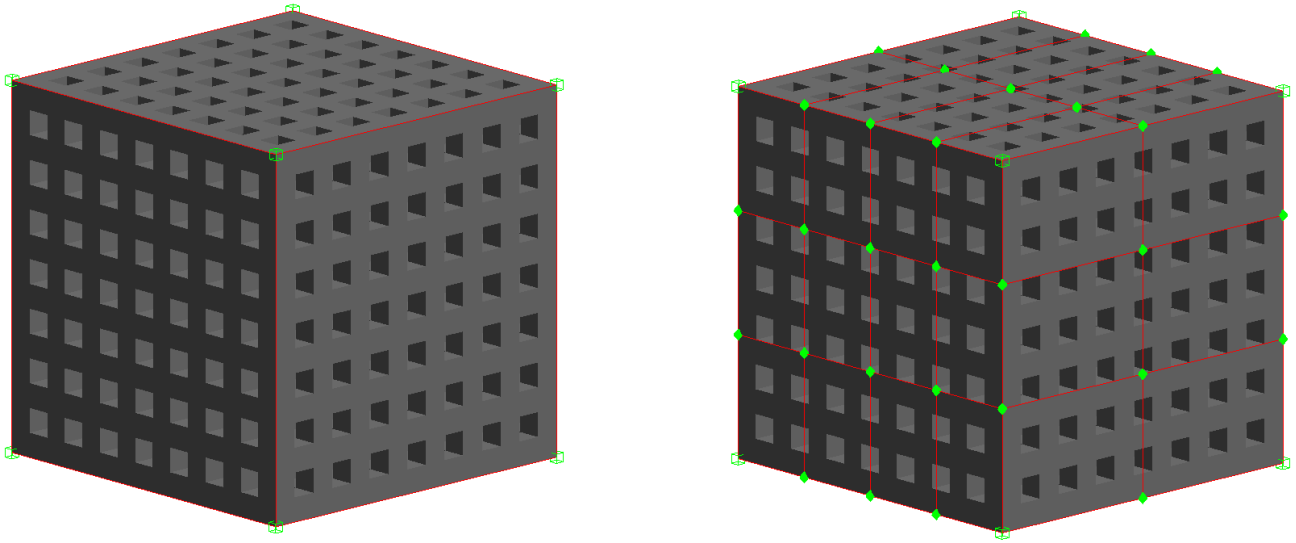
- On the Create tab of the Morph panel the numbers of morph points for new boxes can be specified along each coordinate direction.
- By default these numbers of points are 2 in each coordinate direction. In that case the morph box will have 8 morph points in the corners, and nodal coordinates will be calculated linearly from morph point coordinates in each coordinate direction.
- If the numbers of points are increased, nodal coordinates are calculated as Bernstein polynomial of higher order in each coordinate direction. The geometric meaning of this is explained on the following slides.



Morph boxes without midpoint handles

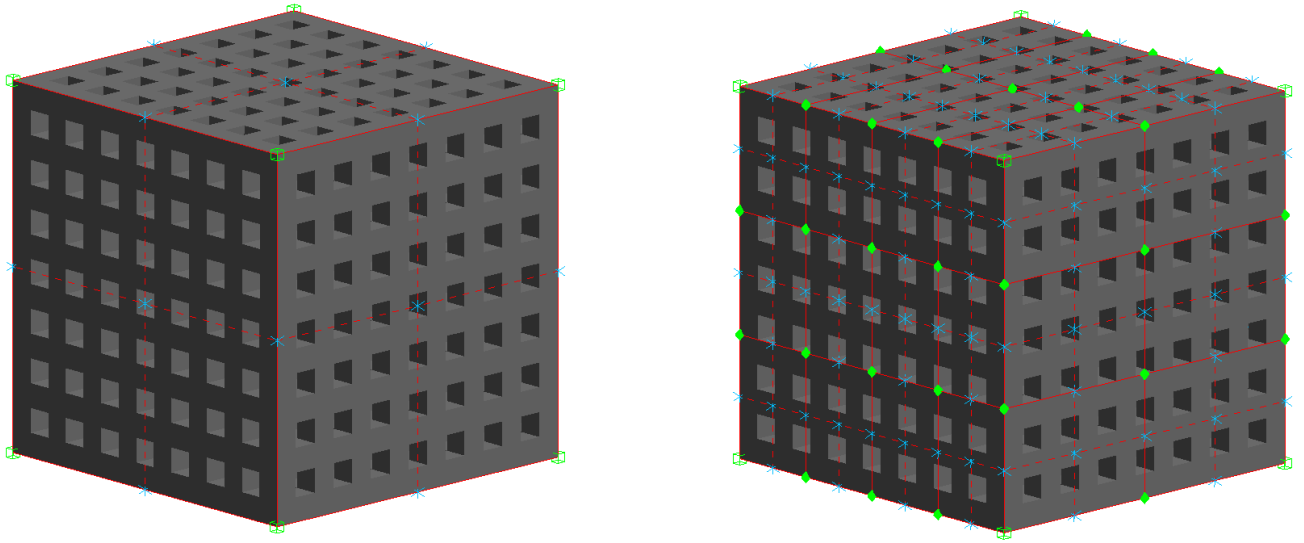
PRIMER

This picture shows a basic order morph box with 2 by 2 by 2 morph points on the left and a high order morph box with 3 by 4 by 5 morph points on the right. The drag handles at edge and face midpoints are turned off.



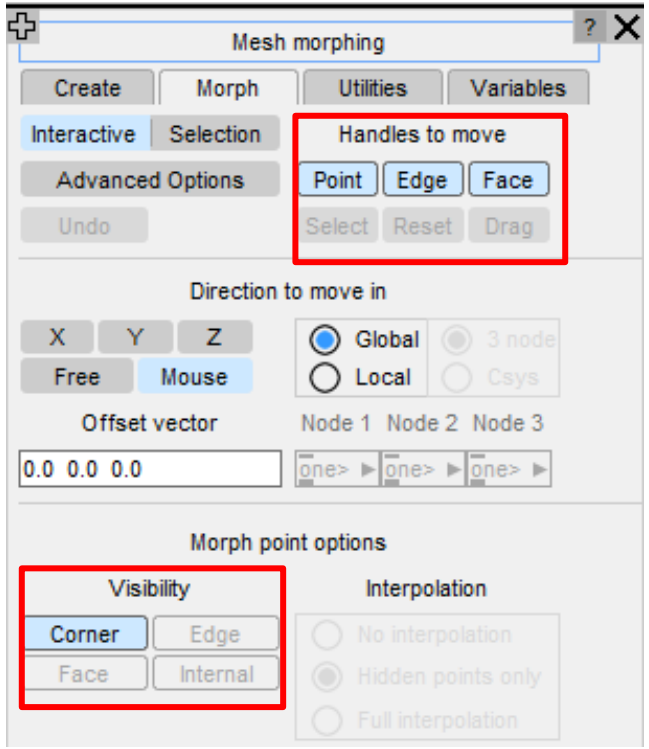
Morph boxes with midpoint handles

This picture shows the same morph boxes as one the previous slide, where the drag handles at edge and face midpoints are turned on. They are on by default if only basic order boxes are in the current PRIMER session.

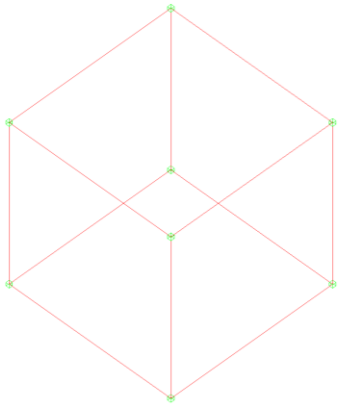


Visibility switches

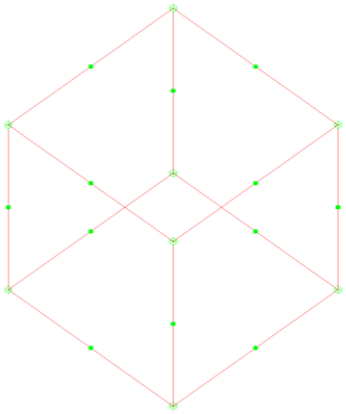
- The visibility of edge and face midpoint handles can be controlled by the switches “Handles to move”. The Point handle switch does not affect visibility, but filters the morph points while dragging.
- Basic order boxes only have got their 8 morph points at the corners, whereas high order boxes will have edge, face and internal morph points. Their visibility can be switched with the buttons underneath “Morph point types to show”.
- Edge and face morph points should not be confused with the midpoint handles on basic order boxes. The latter are a convenient way of moving several morph points by the same vector, whereas edge, face and internal points are morph points themselves morphing the mesh.



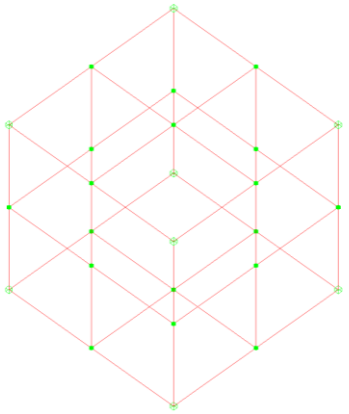
A box with different visibility switches



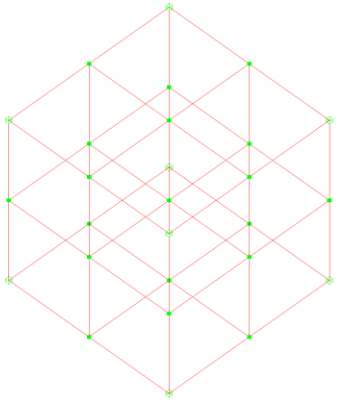
Corner points only



Corner and edge points visible

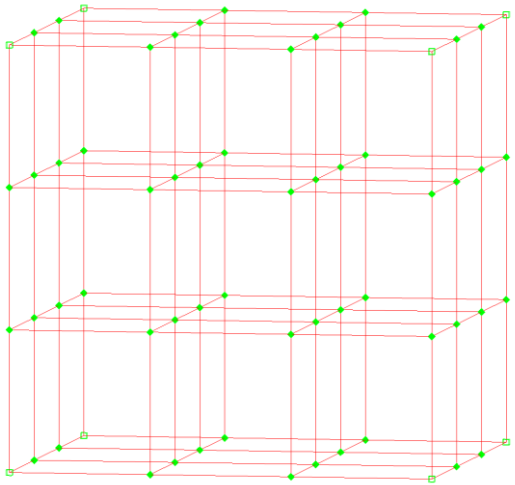


Corner, edge and face points visible

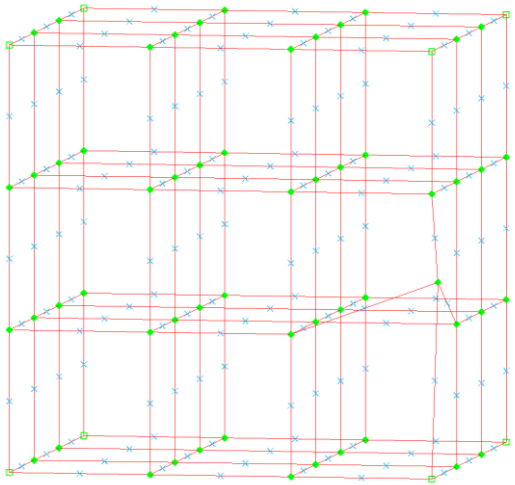


All morph points visible

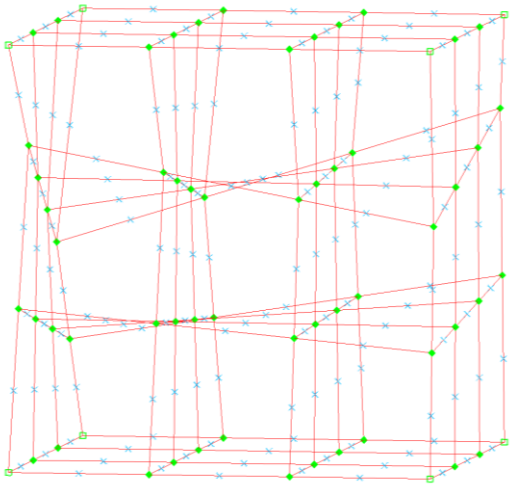
Morph point interpolation



Original position

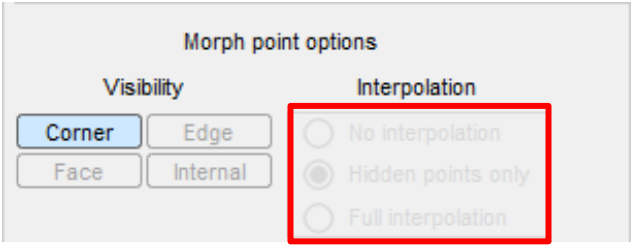


No interpolation

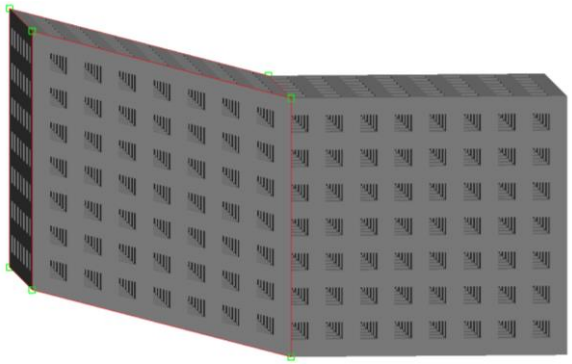


Full interpolation

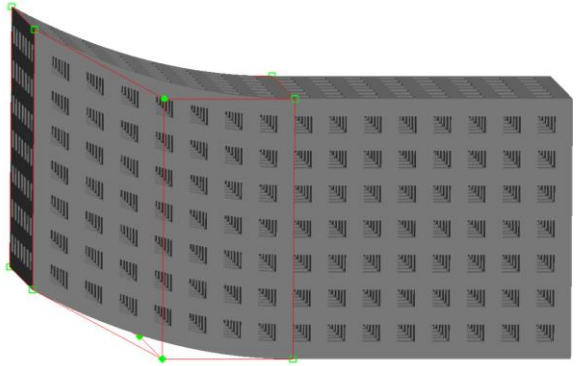
Morph point movements can be interpolated. Without interpolation only the explicitly selected morph points move, whereas with interpolation others move as well by a fraction of the vector. This is illustrated in the pictures where only one edge point is explicitly selected. The option “Hidden points only” only interpolates those whose visibility is turned off.



Tangent directions

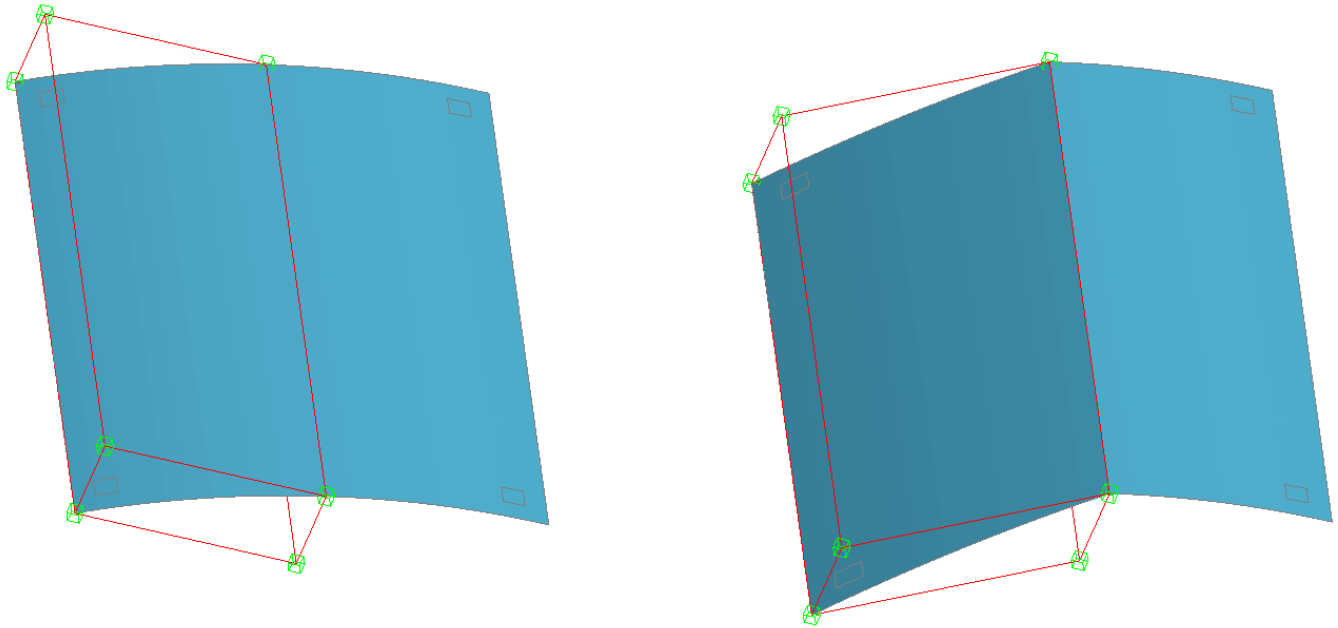


For morph boxes with 2 by 2 by 2 points nodal coordinates are calculated linearly when morphing. The mesh does not remain smooth at the right of the box because there is no continuity in tangent directions.



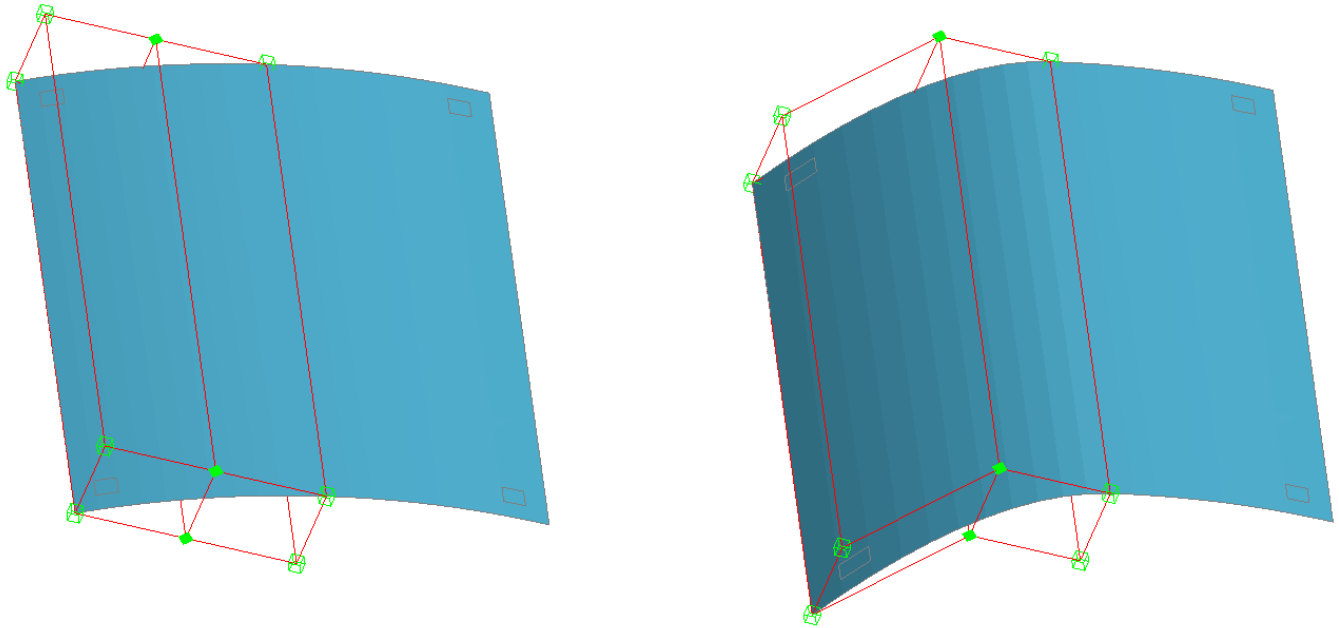
With morph boxes of higher order you can control the tangent directions. To preserve them on the right hand face of the box for a smoother mesh, the last two layers of morph points at the right need to remain unchanged, but the box has got more morph points to give you flexibility about mesh deformation.

Tangent directions



This shows the deformation of a part with shells by a linear morph box. Note the sharp bending on the right where the morph box ends.

Tangent directions



•This shows the same part as on the previous slide, but with a morph box with 3 by 2 by 2 points. As only points on one face move, the transition from inside to outside of the box at the opposite face has got continuous tangent directions, so the mesh remains smoother.

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