

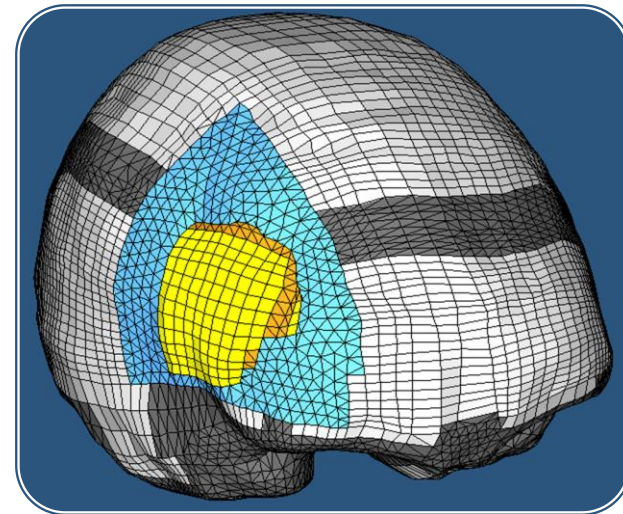
Tutorial for using HyperMesh

This presentation sums up how to create a
brain model with HyperMesh

The work is based on the results obtain after the work on Slicer3D and IA-FEMesh

Contents

- ▶ Import your model from IA-FEMesh
- ▶ Remesh the ventricles
- ▶ Remesh the elements from brain and tumour with a low jacobian number (< 0.3)
- ▶ Integrate the tumour and ventricles in the brain mesh
- ▶ Create the skull
- ▶ Create the nodes sets

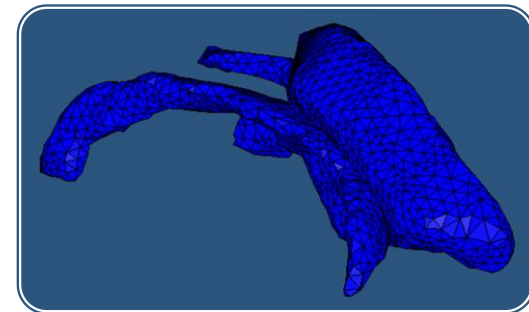
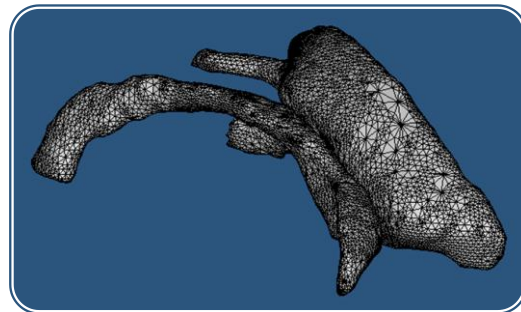


Import your model

- ▶ Use the exported Abaqus file from IA-FEMesh for the brain and the tumour
- ▶ Import just the surface for the ventricles as .stl file
- ▶ Brain and tumour are 3D meshes and ventricles is considered as a surface mesh with very high density

Remesh the ventricles

- ▶ Create a surface based on FE (Geometry > Surfaces)
- ▶ Clean the surface generated (Geometry > Autocleanup)
 - Target element size parameter : 5mm
- ▶ Mesh this surface in another component (2D > Automesh)
- ▶ Check the length of the new mesh (Tools > Check elems)
 - No elements should be smaller than 1 mm
- ▶ Remesh manually the small elements by replacing the nodes (2D > Replace). If too many left to do so, redo the previous steps

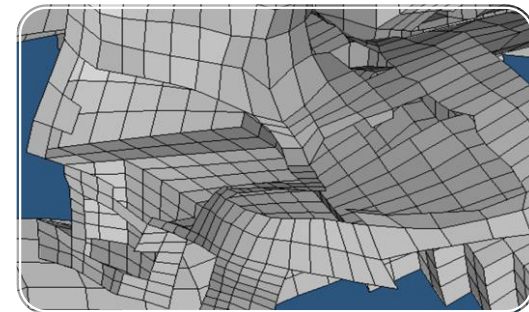
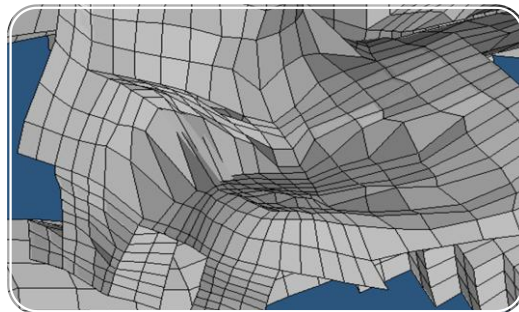


Remesh the “bad elements”

- ▶ The model shouldn't contain any element with a jacobian smaller than 0.3
- ▶ Check the elements of your brain (and tumour in a second time) and save the failed ones
- ▶ Put them in a new component (Tool > Organize > Elems > Retrieve)
- ▶ You can select the adjacent elements too (Elem > By adjacent)
 - No element should be isolated and the final volume has to be quite thick for a proper tetras mesh
- ▶ Extract the faces from this new component (Tool > Faces) and place them in a new component
- ▶ This new component contains 2D elements which need to be cleaned up

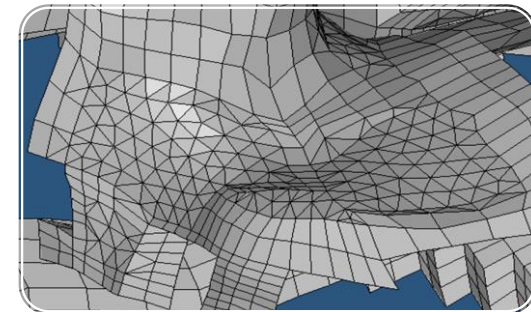
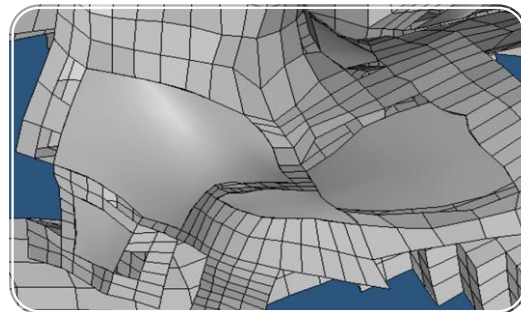
Remesh the “bad elements”

- ▶ Check the connectivity, duplicates and bad jacobian (<0.3) elements in this 2D mesh
- ▶ Delete them (adjacent elements too if necessary), we'll have to remesh these parts
- ▶ You can find the edges with: Tool > Edges
- ▶ Create surfaces to fill the holes
 - Based on node list often works
 - If the spline fails, create a smoothed line first and create the surface based on the lines



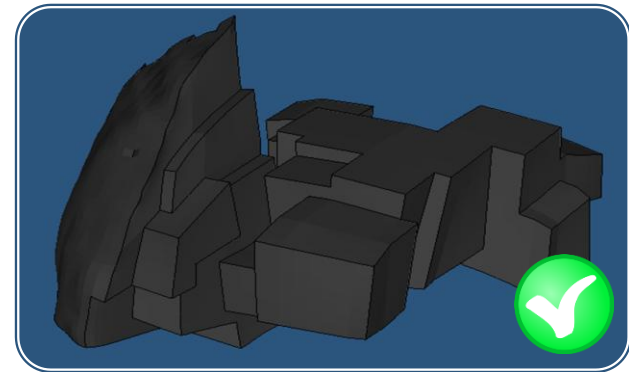
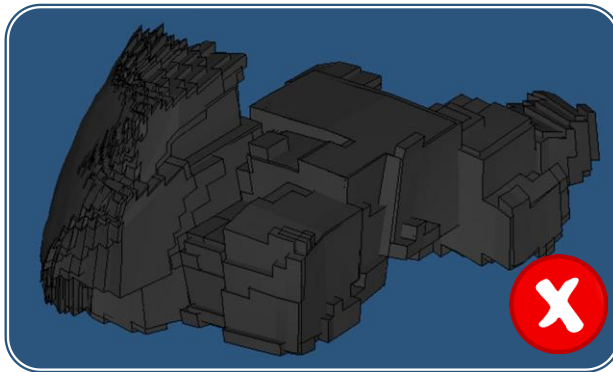
Remesh the “bad elements”

- ▶ Remesh the surfaces with triangles
 - Use the same element size than the parts around
- ▶ Merge all the nodes to obtain an enclosed volume
 - Automatic replace by equivalence (Edges > Equivalence)
 - Manual (2D > Replace, 2D > Split, 2D > Edit Element)
- ▶ Check that the volume is enclosed with Edges
- ▶ Mesh this volume with tetras and place them in a new component (3D > Tetramesh > Tetra Mesh)



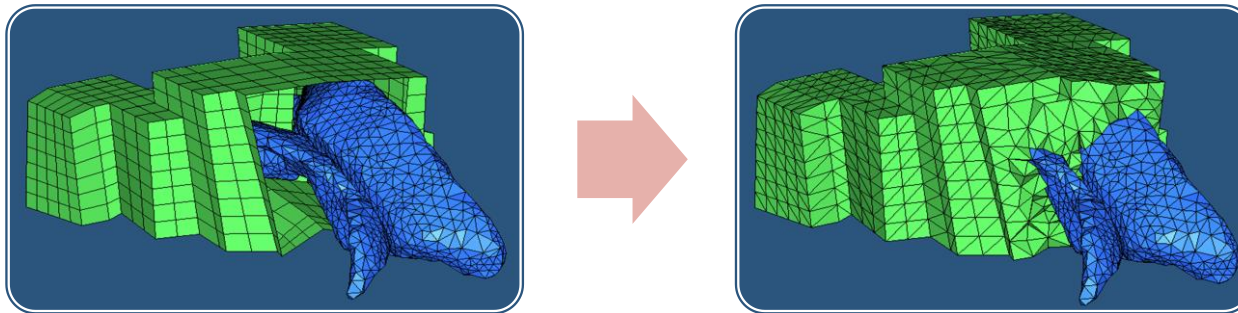
Integration of the tumour and ventricles

- ▶ Create a few blocks around the tumour and ventricles which will be used to select brain elements (Analysis > Blocks)
- ▶ Put the brain elements inside the blocks in a new component
 - This component will be the part remeshed with tetras
 - Make the parts as simple as possible (else the mesh could fail)
- ▶ Extract the faces of that component



Integration of the tumour and ventricles

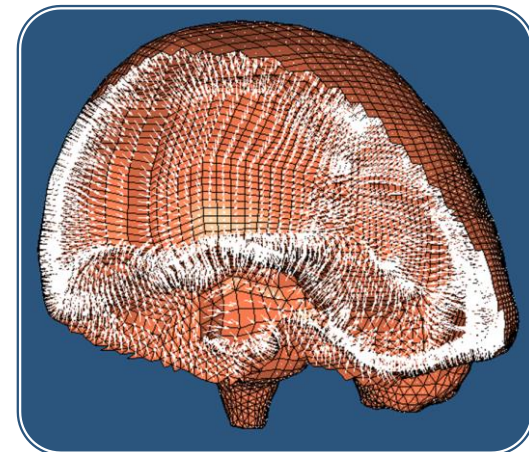
- ▶ Extract external faces from the tumour (cf. Creation skull)
- ▶ Mesh the hole with tetras
 - Select the two components you want for boundaries
 - The mesh will stop at the inner component



- ▶ Check if the nodes of all the useful component are merged
 - Tool > Edges > Preview Equiv with a low tolerance (0.01)

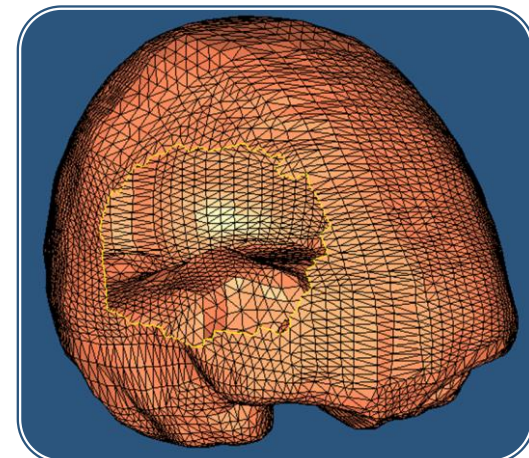
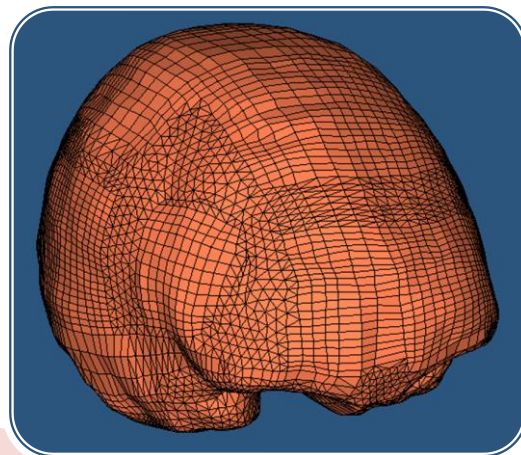
Creation of the skull

- ▶ Extract faces from all the components visible from the outside of the brain and **COPY** them in a new component
- ▶ Check the connectivity of these faces and delete all failed elements
 - These are the faces between each component
- ▶ Make sure you only have the external faces by looking inside
- ▶ Check the normals from these faces (Tool > Normals)
 - Normal should point at inside
 - Select one element in Orientation and Adjust Normals



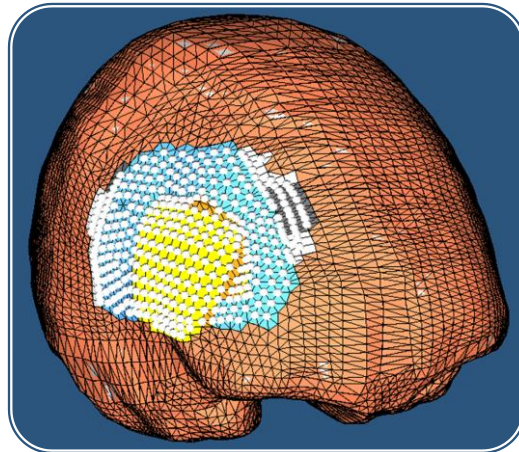
Creation of the skull

- ▶ Offset these faces (2D > Elem Offset)
 - Shell offset: squared corners
 - Distance: 0.1 mm
 - Offset-
- ▶ Import the segmented skull which shows the craniotomy
- ▶ Delete the 2D elements which are visible through the hole
- ▶ Convert all quads into triangles (2D > Split)
 - Plate Elements: divide quads

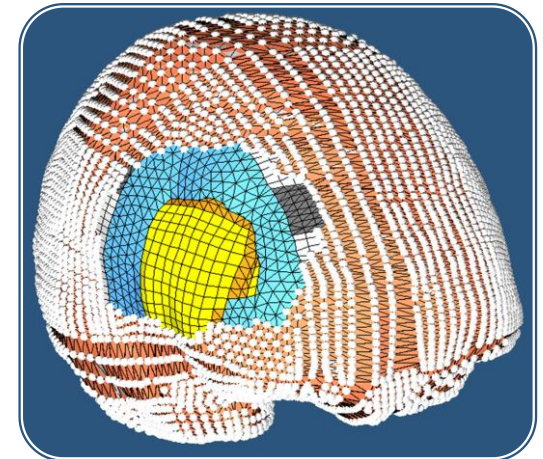


Creation of the nodes sets

- ▶ Nodes sets are used during the simulation
 - Load-Nodes: surface nodes from brain visible through the hole in the skull
 - Contact-Nodes: all other surface nodes from the brain
- ▶ Create the sets (Analysis > Entity Sets) and select the nodes based on the faces you used for the skull
 - The nodes have to belong to the brain



Load-Nodes



Contact-Nodes