



# **Simpleware:**

## **Converting 3D Images into Computational Models**

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(Application Engineer)  
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# Introduction

# Simpleware: The Company

*Developers of industry-leading software solutions for the visualisation and analysis of 3D image data.*

- Founded in the UK in 2000
- Key Pioneers in image-to-mesh techniques to generate simulation ready models of highly complex structures
- Worldwide customer base supported by a global sales channel
- Strong company growth year on year
- Winner of Queen's Award for Enterprise in Innovation 2012

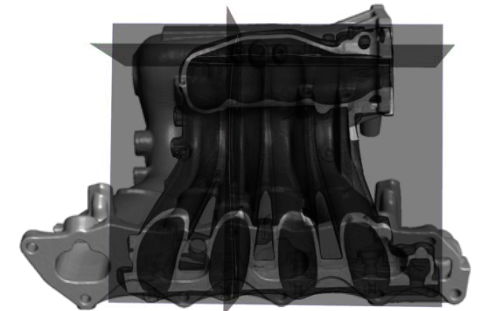
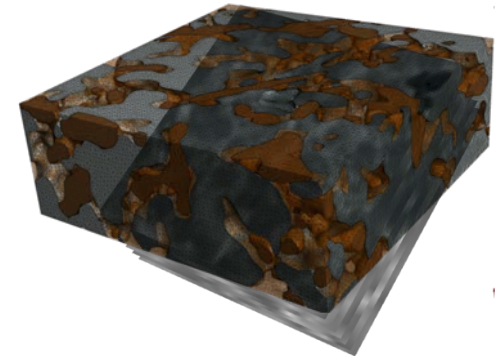
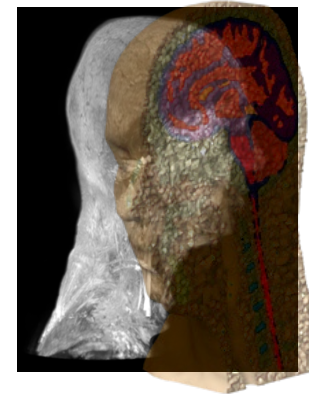




## **Simpleware's Solution**

# Simpleware's Solution

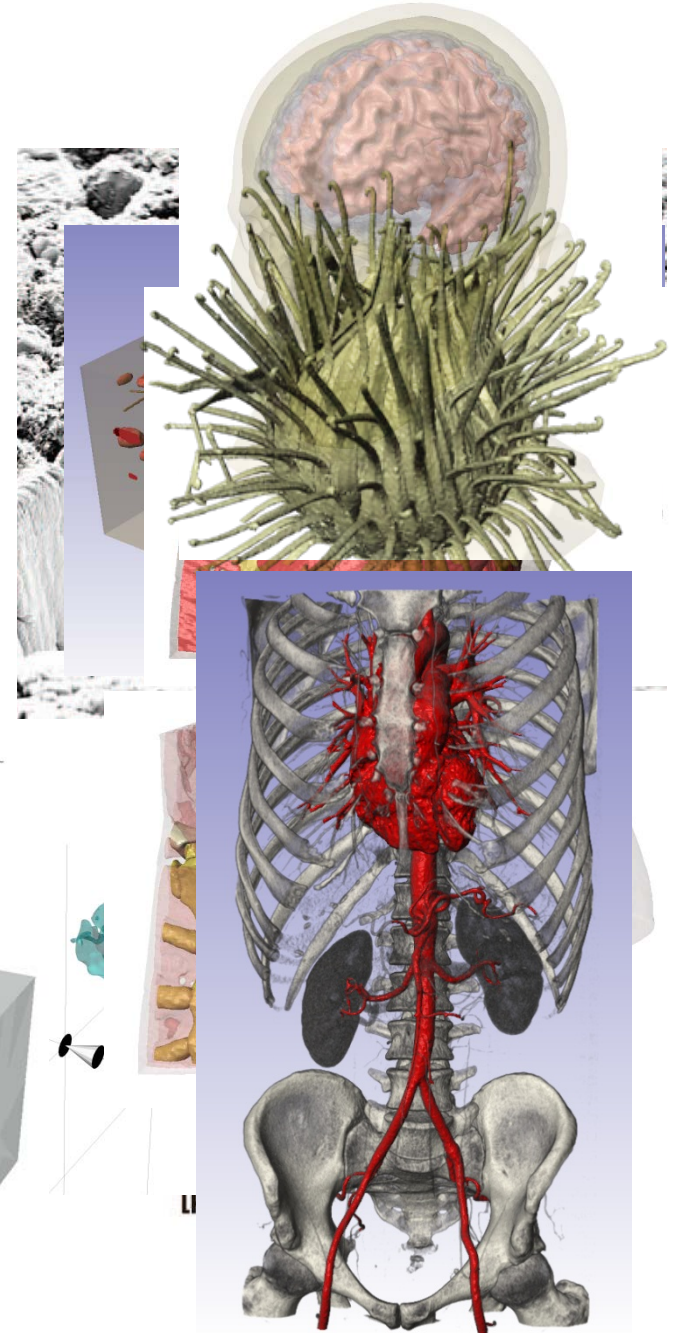
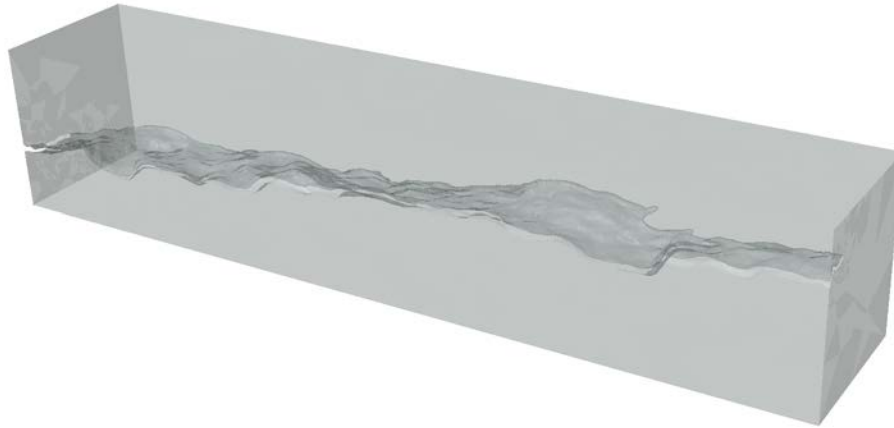
- Software for the conversion of 3D images into analysis ready, multi-part models
- Conversion process is...
  - User friendly
  - Accurate
  - Robust
  - Flexible
  - Reliable





# Convert Data From...

- CT and MRI
- Ultrasound
- microCT and nanoCT
- Confocal Microscopy



## Import

CT, MRI, Micro-CT,  
Microscopy,  
Ultrasound, etc. ....



## Simpleware

### ScanIP

Image processing, segmentation,  
visualisation and measurements

### +FE module

Automated and robust  
multipart FE +CFD meshing

### +NURBS module

Automated NURBS patch CAD  
model generation

### +CAD module

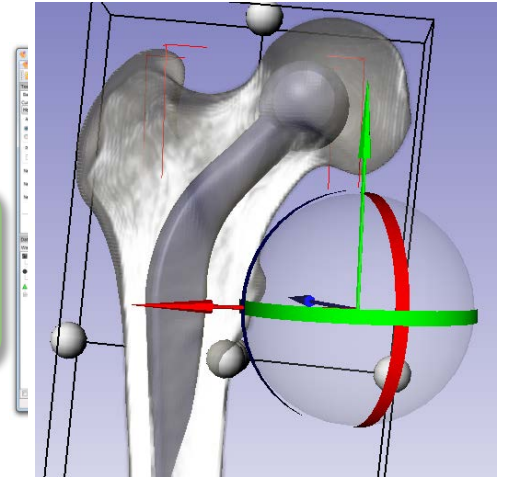
Integrating CAD into image  
for meshing and visualisation

## Export

**Surface meshes**  
e.g. STL

**Volume meshes**  
e.g. FE & CFD

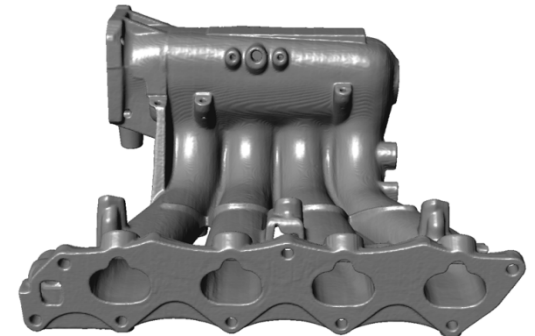
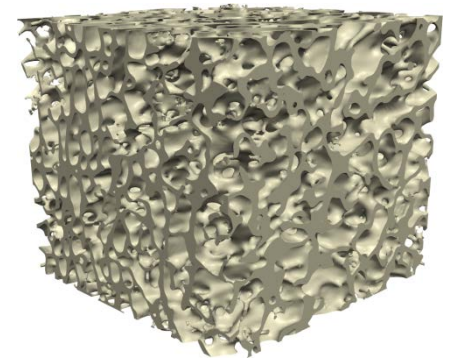
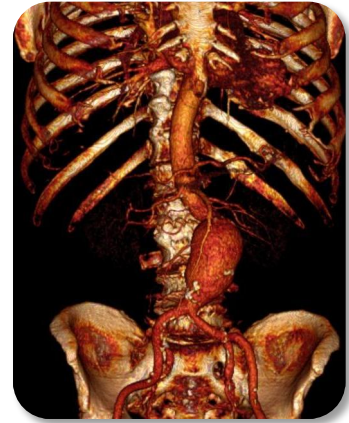
**CAD models**  
e.g. IGES



# Simpleware's Solution

Can be used for...

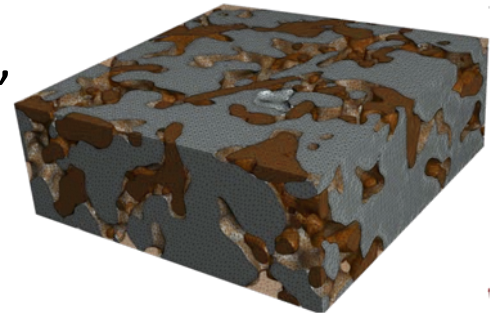
- Any stacked image set
- Arbitrarily complex topologies
- Multi-part models
- Visualisation and Measurement
- 3D printing
- Export to all major CAD/FE/CFD packages, including:
  - Ansys, Abaqus, COMSOL ...
  - Fluent, OpenFOAM ...
  - SolidWorks, SpaceClaim...





# Simplware's Applications

- Biomedical-Biomechanics
  - Implant design – stents,
  - Consumer products – shavers, toothbrush
- Materials, composites used in automotive, defence, aerospace, oil & gas
  - Non-destructive testing
  - Material evaluation
  - Pore Scale Fluid Flow
  - Composite Analysis
- Reverse Engineering, inspection
- Archaeology, Palaeontology
- Anything that can be scanned!!





## **The Benefits of Simpleware**

# Reliable, Robust and Accurate

- Established/tried and tested commercial code
- Efficient, fast, stable – parallelised etc
- Code based on combination of proprietary algorithms and published literature
- Every action is logged and recorded in a history file for tracibility

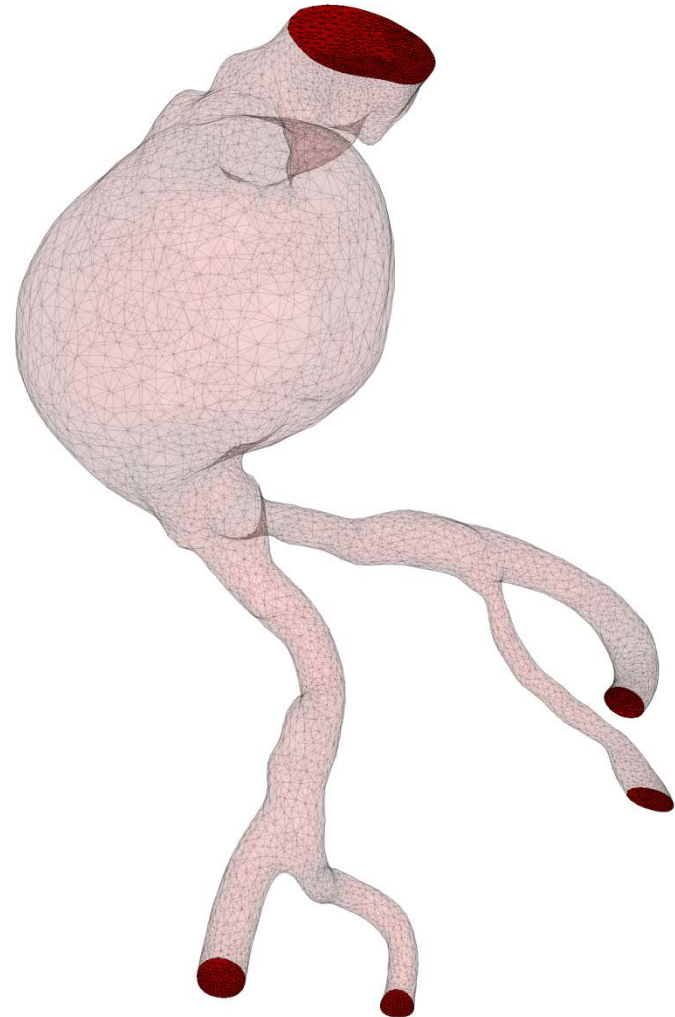
## Software Features



# Software Overview

*Visualisation, quantification and model/mesh generation from 3D images:*

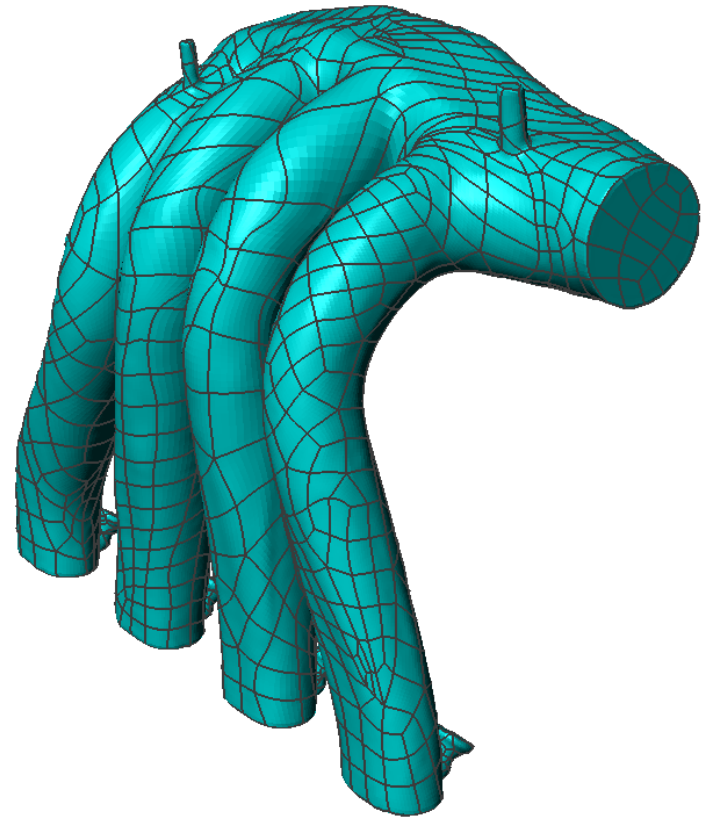
- Visualise 3D image data
- Image processing tools
- Measure/Quantify
- Rapid Prototyping (RP)
- Finite Element Analysis (FEA)
- Computer Aided Design (CAD)
- Computational Fluid Dynamics (CFD)



# Software Overview

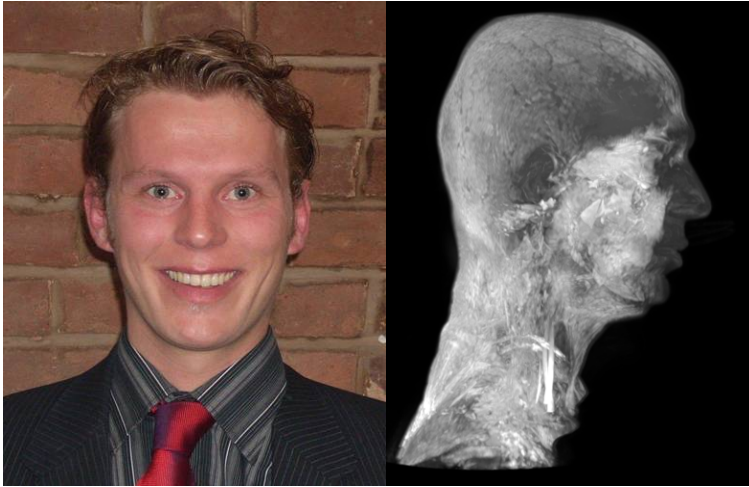
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- Visualise 3D image data
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## Case Studies

# Head Model for Realistic Simulation



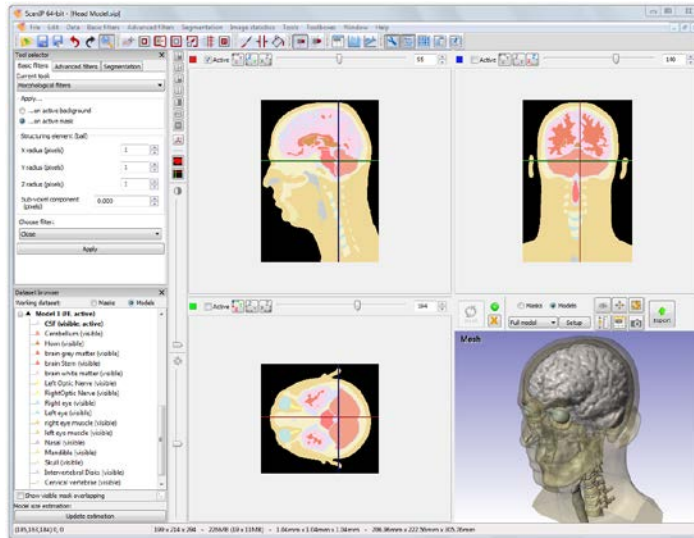
- *In vivo* MRI scan of 26 year old male

*In collaboration with:* ARUP

Young et al, 2008. An efficient approach to converting 3D image data into highly accurate computational models. Philosophical Transactions of the Royal Society A, 366, 3155-3173.



# Head Model for Realistic Simulation

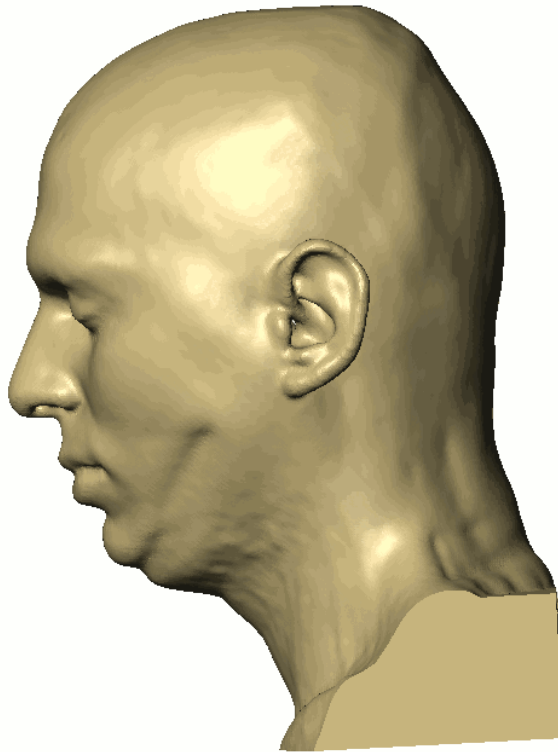


- *In vivo* MRI scan of 26 year old male
- Segmentation
  - Threshold, floodfill and filters
  - Segmentation of 12 structures

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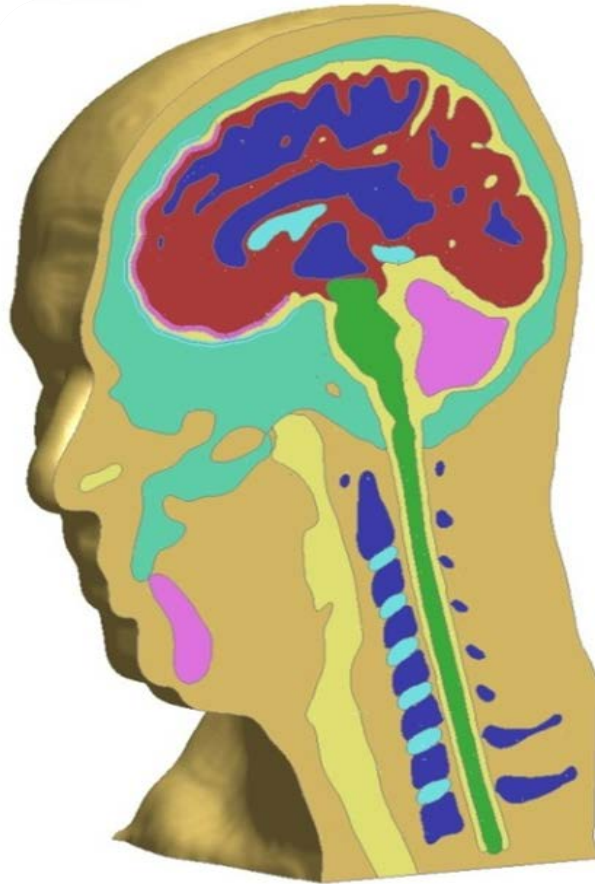


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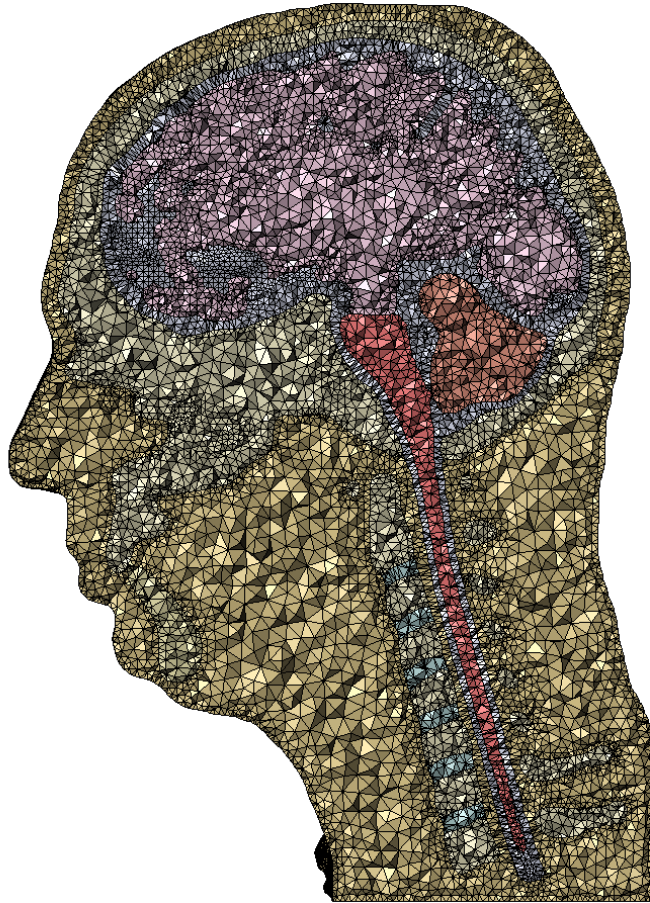


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  - 12 structures meshed simultaneously
  - Multipart smoothing with conforming interfaces

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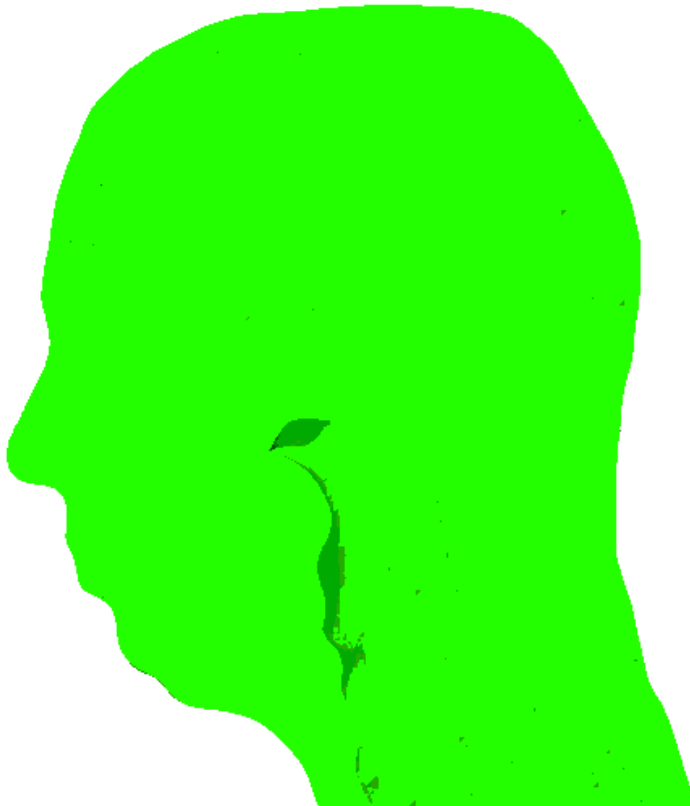
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# Head Model for Realistic Simulation

Step: Step-1 Frame: 0

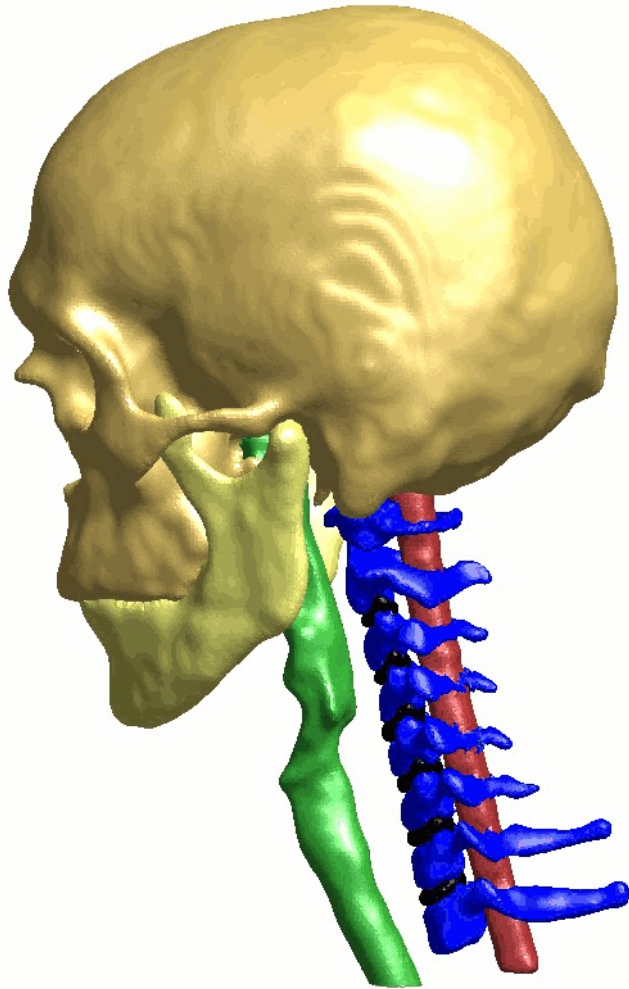


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- FE analysis Abaqus and LS-Dyna
  - Boundary conditions and loads
  - Response to blast wave and to dynamic loading conditions

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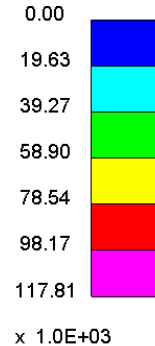
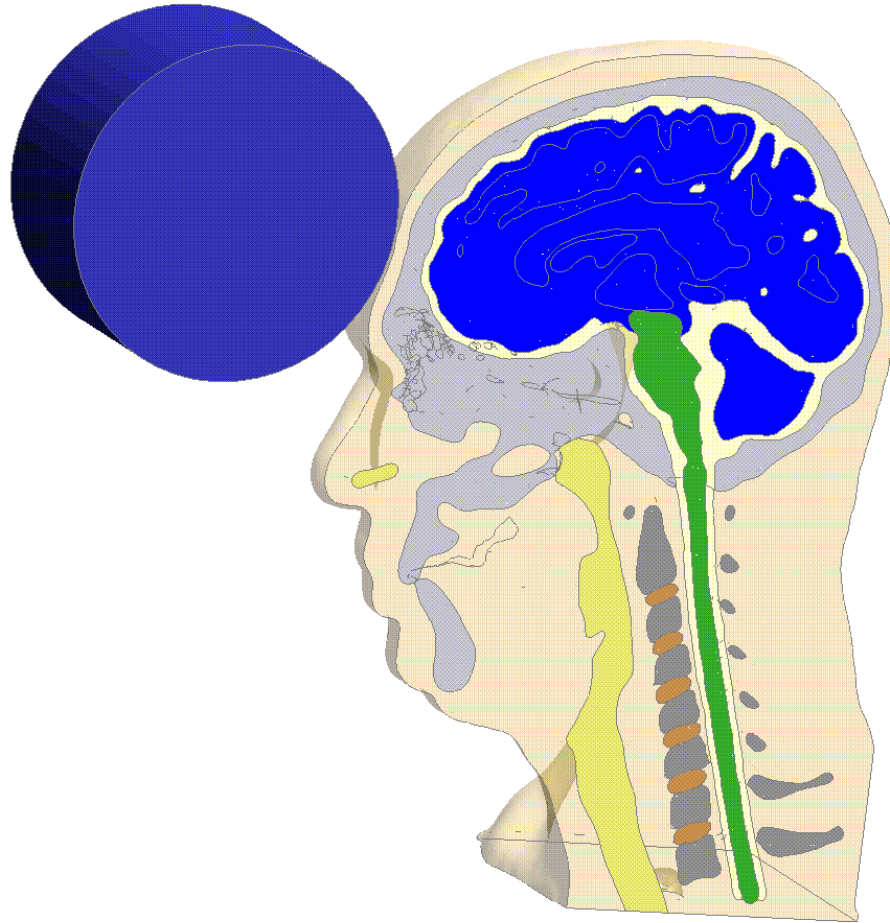
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# Head Model for Realistic Simulation

OASYS D3PLOT: SIMPLEWARE HEAD 28  
 1: Max H6616603 : 0.000000E+00

VON\_MISES\_STRESS  
 (Mid surface)



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In collaboration with: **ARUP**

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# Auxetic Foam



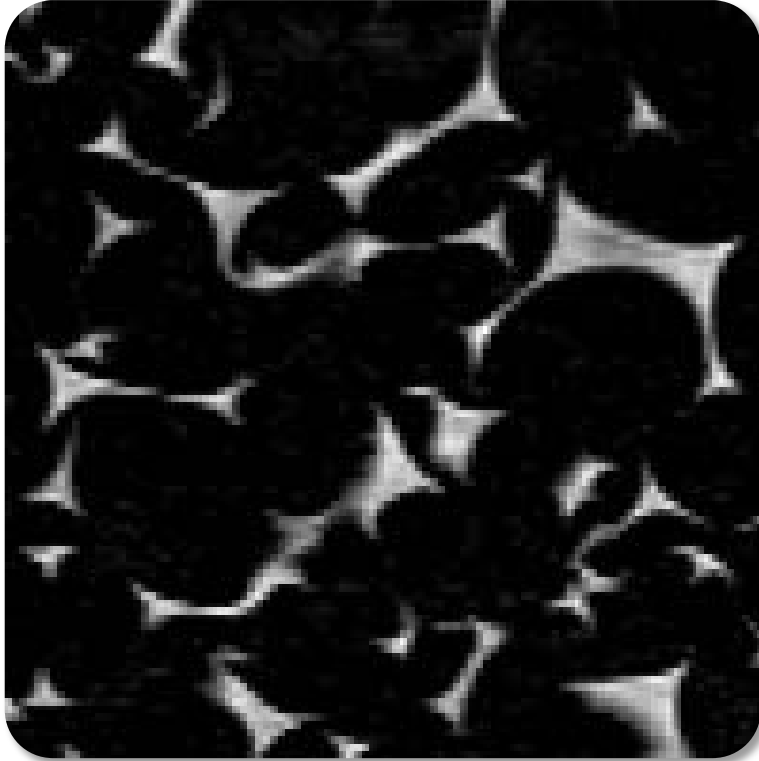
- Auxetic Material
  - Negative Poisson's ratio
  - Contracts
    - compression/expands
    - tension
  - Example application: filters

In collaboration with:  ARUP

Notarberardino et al, 2008. Image Based Simulation of Large Strain Deformation of Open Celled Foams. Materials Evaluation, 66(1), 60-66.



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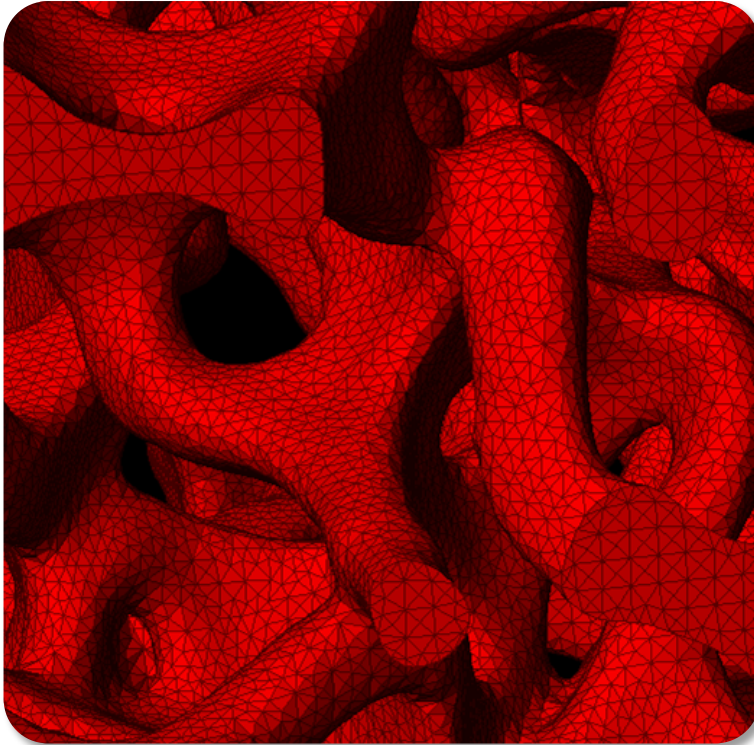


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  - Example application: filters
- Synchrotron XMT
  - 0.003 mm resolution

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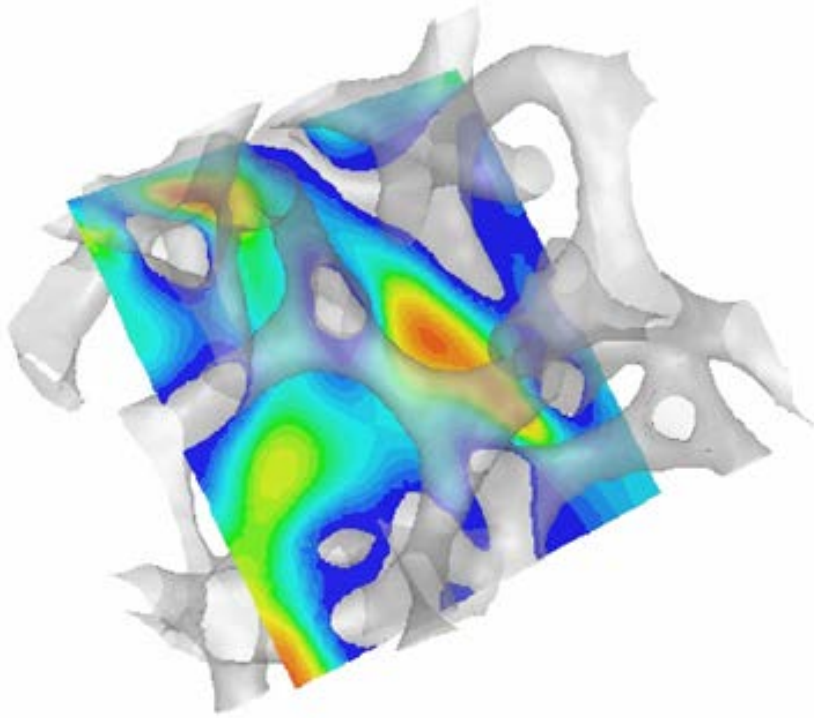


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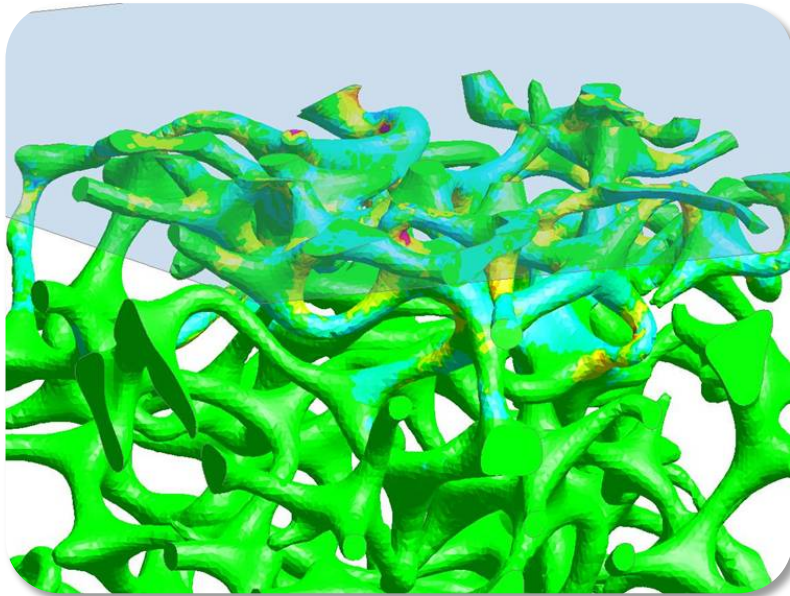


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  - Flow through dual of mesh
  - Fluid-structure interaction

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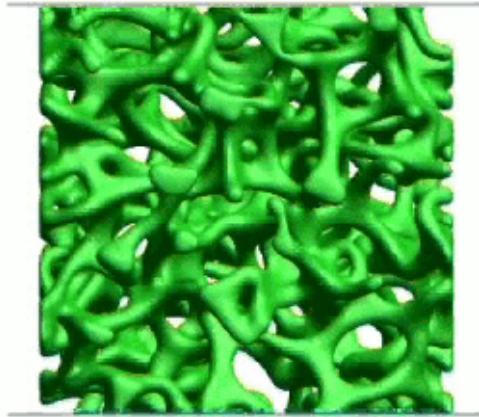
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- Impact simulation in LS-Dyna

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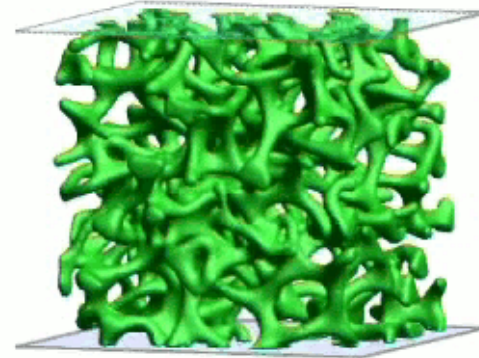


# Impact of Foam Sample in LS-DYNA



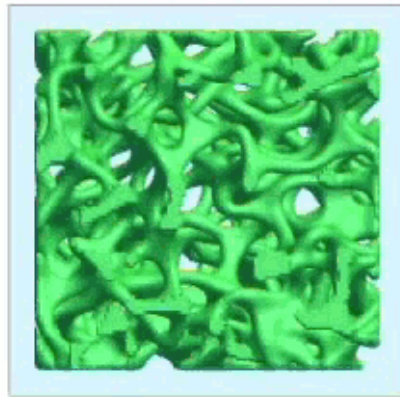
Z  
Y

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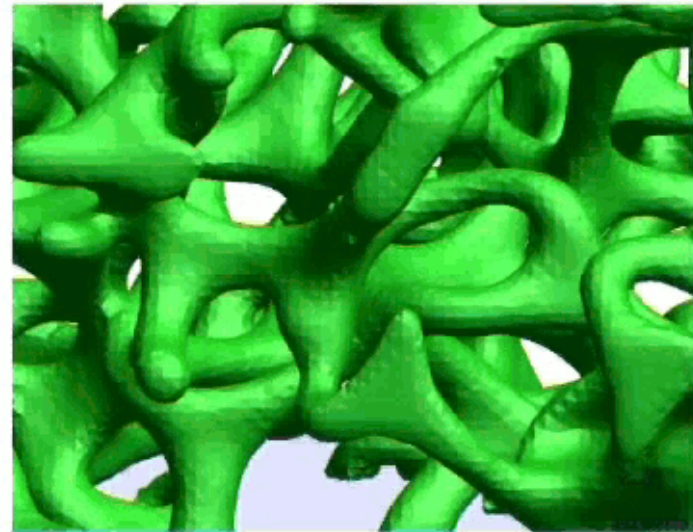
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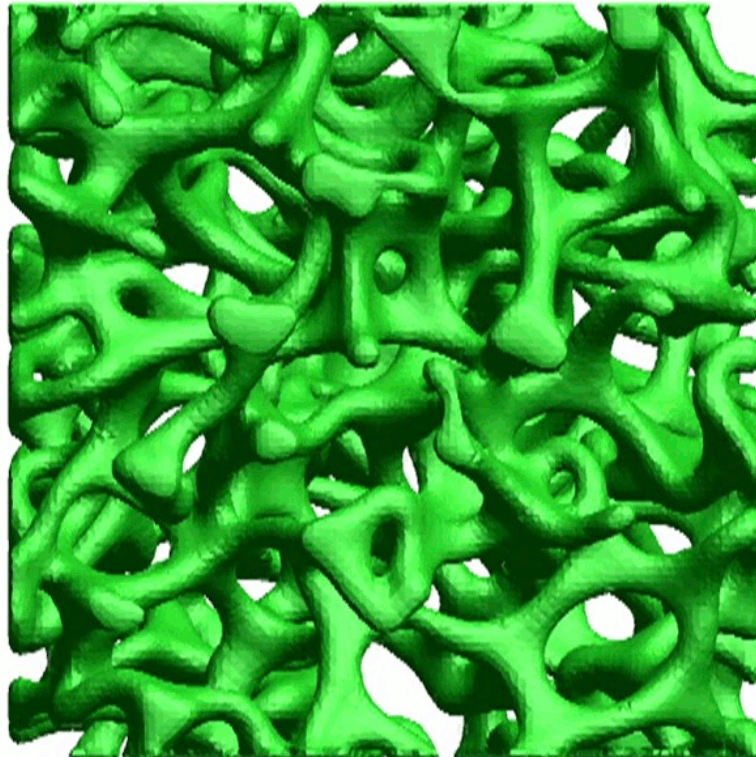


Y  
X

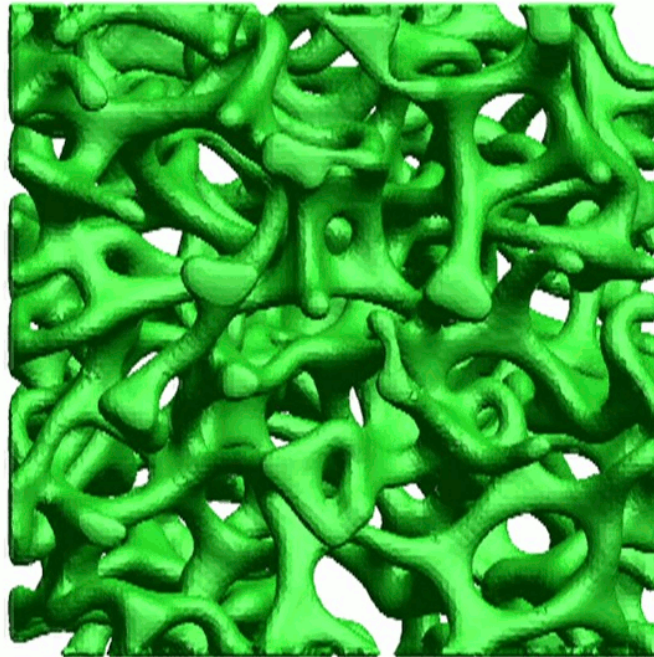
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# Shear on Foam Sample in LS-DYNA



# Stretch on Foam Sample in LS-DYNA





## Summary



# Reliable, Robust and Accurate

- Established/Tried & Tested commercial code
- Efficient, Fast, Stable
- Code based on combination of proprietary algorithms and published literature
- Rapid and Responsive development
- Guaranteed generation of watertight surfaces
- Fully automated surface/volume meshing
- High mesh quality suitable to direct use in FE/CFD
- Fully scriptable in a variety of different languages including; Python, C#, Java,



## **Any Questions?**

**For more information or a demonstration please visit us at our booth.**