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the simplest way to convert 3D images to CAD, RP and FE models

CASE STUDY

Total Hip Replacement (THR)

stryker Europe

Notable Features of Model

- ***Based on in vivo patient data***
- ***Six structures meshed simultaneously***
- ***Inhomogeneous material properties assigned***
- ***Contact surfaces between stem-cement and head-cup***

CT Scan (Siemens Somatom 16)

- 42 year old male patient with THR
- Exeter Hip 44 offset size 1: head 26 mm, cup 52 x 26 mm
- In-plane Resolution: 0.77 mm x 0.77 mm
- Slice-to-slice separation: 1 mm
- Metal artefacts generated from implant

Image Processing in ScanIP

- Resampled: 2 mm x 2 mm x 2 mm
- MAR (Metal Artefact Reduction) filter applied
- Six masks segmented

Mesh Generation in +ScanFE

- Multi-part mesh - 6 structures meshed simultaneously
- Contact surfaces between stem-cement and head-cup
- Material properties based on parent Hounsfield numbers for bone (NB different expression applied for bone in cancellous and cortical range)
- Smooth mesh of segmented structures
- RP model generated based on FE surfaces

FE Analysis in both Ansys and ABAQUS

- Low density mesh with boundary conditions and loads - includes muscle forces
- Node sets of top of pelvis and distal part of femur defined in +ScanFE
- Response under static loading conditions
- Sliding interface between cup-implant and implant-cement
- Number of degrees of freedom: 76,243

Processing Time

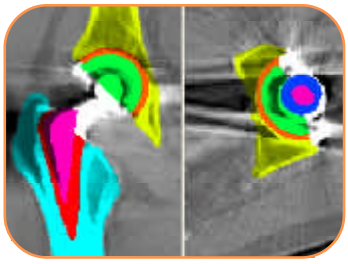
- Segmentation: 5 days
- Meshing: 10 minutes
- FE Analysis: 20 minutes
- **Total time: < 1 week***

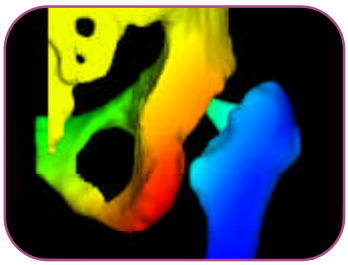
** 32-bit Intel Xeon 2.8GHz 2GB RAM*

Segmentation

Six masks segmented:

- Pelvis
- Cement
- Cup
- Stem
- Cement Mantle
- Proximal Femur





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CASE STUDY

Air Flow in Patient with Tracheotomy

UNIVERSITY OF EXETER

Notable Features of Model

- ***Based on in vivo patient data***
- ***Multi-part model***
- ***CFD analysis***

What is a Tracheotomy?

A tracheotomy operation is a procedure whereby a hole is cut in the patient's trachea to provide an alternative route for air to enter and leave the lungs. After the patient's trachea has been opened a plastic or metal tube (a tracheotomy tube) is inserted and secured. This tube acts like a windpipe and allows the patient to breathe more easily.

Hood Stoma Stent

The Hood Stoma Stent is a self-retaining device used to maintain the patency of a tracheotomy. Made of biocompatible medical-grade silicone, stoma stents are smooth, flexible, and non-irritating to the skin and tracheal mucosa.

Mesh Generation in ScanIP +ScanFE

An *in vivo* CT scan of a female patient was imported into ScanIP and segmented into five different structures (masks). The airways and implant were meshed within +ScanFE and exported in Fluent format. +ScanFE generated a cell deformation index based on a comparison between enclosed and enclosing spheres for each cell. All cells generated by this technique are of good shape with low index values.

CFD Analysis in Fluent

Computations were performed based on gentle exhalation at a flow rate of 30 cm^3/s with the implant initailly closed and then open. Results shown in image present the velocity magnitude and total pressure on this plane for the 'closed-implant' case.

Processing Time

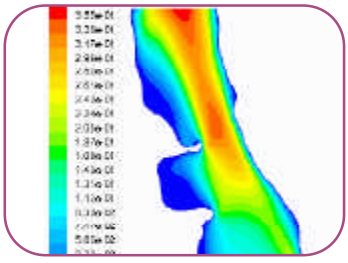
- Segmentation: 5 hours
- Meshing: 7 minutes
- CFD Analysis: 20 minutes
- **Total time: < 6 hours***

** 32-bit Intel Xeon 2.8GHz 2GB RAM*

Segmentation

Five masks segmented:

- Bone
- Soft Tissue
- Tracheal Wall
- Stoma Stent
- Airways



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CASE STUDY

Micro-CT Scan of Auxetic Foam

Notable Features of Model

- ***Based on in vitro scan***
- ***Contact surface automatically generated on structure***
- ***Coupled fluid-structure mesh***
- ***Image to model in less than 20 minutes***
- ***CFD & solid FE analysis***

What is Auxetic Foam?

The term "auxetic" derives from the Greek auxeos to mean "that can expand". Auxetic materials have a Negative Poisson's Ratio, which means in contrast to most materials, they expand in all directions when stretched.

MicroCT Scan

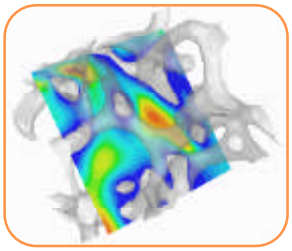
High-resolution 3D scan data of auxetic foam was obtained from synchrotron facilities in Chicago (courtesy Prof Gerry Seidler, University of Washington).

Mesh Generation in ScanIP +ScanFE

The data was straightforwardly segmented using a thresholded flood-fill and a 3D smooth volumetric mesh was generated within +ScanFE. A contact surface was created on the surface of the foam to simulate compression in the compaction regime. The total combined image processing and meshing time, including user interaction time, was less than 20 minutes.

FE Analysis in ABAQUS

- Large deformation compression
- High element qualities
- Dual convergence



CFD Analysis in Fluent

- Flow through dual of mesh
- Fluid-structure interaction
- Exact RP model produced for physical tests

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Processing Time

- Segmentation: 10 minutes
- Meshing: 5 minutes
- FE Analysis: 40 minutes
- CFD Analysis: 40 minutes
- **Total time: < 2 hours***

** 32-bit Intel Xeon 2.8GHz 2GB RAM*