Introduction

- 3D image data acquired from sources such as industrial CT and micro-CT scan be used to visualise and inspect parts, and to characterise material samples.
- Processed data can be exported as computational models for Finite Element Analysis (FEA) and Computational Fluid Dynamics (CFD), as files for Additive Manufacturing (AM), and as NURBS.
- Models created from 3D image data enable comprehensive qualitative and quantitative analysis, including non-destructive evaluation of defects and simulation of material properties.
- Image-based meshing techniques developed by Simpleware Ltd. enable rapid conversion of scan data to models for design and simulation applications.

Benefits of Image-Based Meshing

- Traditional meshing approaches require a CAD geometry to be generated before meshing. By comparison, image-based meshing can generate models directly from 3D image data.
- Meshes can be generated for topologies of arbitrary complexity with any number of constituent materials (multi-part modelling).
- Accuracy of meshes created directly from voxels only limited by the quality of image acquisition and segmentation of materials.
- Image-based meshing technique developed by Simpleware based on an adaptation of the ‘marching cubes’ algorithm to support multiple segmented domains.
- Techniques also developed for multi-part surface remeshing; this enables voxel-based meshes to be effectively decimated according to the size/complexity of local features.

FE-based Homogenisation

- Techniques can be extended to calculating effective material properties using finite-element-based homogenisation.
- Complex heterogeneous material approximated with a homogeneous material whose response to external loading resembles as closely as possible that of the original material.
- Approach simplifies analysis of complex systems.
- Built-in FE solver in Simpleware software calculates response of a cuboidal sample of a material to a sequence of boundary conditions (BCs) associated with certain physics to obtain effective properties.
- Homogenisation workflow supports calculation of elasticity (+SOLID module), thermal and electrical conductivity (+LAPLACE module) and absolute permeability (+FLOW).
- Use of smoothed FE-based meshes and solver in Simpleware software offers advantages over grid or voxel-based approaches with stepped surfaces – FE mesh surfaces are more accurate and converge with increasing resolution to actual surface area.

Conclusions and Applications

- Use of a single integrated software environment enables complete workflow from scan to design and simulation.
- Tools for calculating effective material properties enable comprehensive data to be retrieved from scanned samples.
- Techniques suitable for applications such as non-destructive evaluation of scanned parts, characterisation of material samples, analysis of transport properties of porous media.
- Image-based techniques also enable lattice structures to be easily added to CAD and image data to reduce weight of parts.