**Computer Modelling**
# FROM REALITY TO MODEL IN MINUTES OR ON THE AERODYNAMICS OF A THANKSGIVING TURKEY

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## INTRODUCTION

Novel techniques have been developed to convert 3D image data as obtained from a range of imaging modalities (MRI, CT, Ultrasound) into numerical meshes suitable for finite element or computational fluid dynamics analyses. These new meshing techniques provide a significant qualitative and quantitative improvement compared to currently available methods.

A number of example cases will be shown to illustrate the use of these techniques in a wide range of fields including Finite Element models of a hip implant and CFD models of cooling of a thanksgiving turkey in a light breeze.

## METHODS

The steps involved in the generation and processing of finite element models based on medical imaging data are listed below.

(1) Scan and Image Processing

ScanIP is Simpleware's Image processing software tool. It offers a user friendly environment and a wide range of image processing tools to assist the user in visualizing and segmenting regions of interest from 3D data.

(2) Finite Element Model Generation

ScanFE, Simpleware's meshing software tool automatically generates the mesh from the parts (masks) generated by ScanIP. The proposed automated mesh generation from scan data simplifies has several important advantages:

1)   finite element mesh sub-voxel geometry accuracy;
2)   automatic multiple part structures meshing;
3)   variations in material properties throughout the medium can be reflected in the finite element model
4)   interfacial contacts can be modelled;
5)   both scan and experiments can be performed simultaneously within the imaging modality.

(3) Export to FE mesher

Nodes, elements, material properties, contact surfaces for any or all meshed parts may be exported to input-format files for a variety of FE and CFD packages.

(4) Export to RP facility

Mesh surfaces for any or all parts may also be exported in STL file format. It allows the generation of an exact physical replica of any part for which a volumetric mesh has been generated and can, for example, be used to provide experimental corroboration of FE simulations.

## RESULTS AND DISCUSSION

(1) Hip Implant

A male patient with a Total Hip Replacement (THR) was CT scanned (cf. Figure 1-a). The data was then segmented in 6 different parts and meshed. RP models were generated and an FE analysis was conducted with different mesh density models, taking into account material properties derived from the original grayscales, boundary conditions and loads were applied. Excellent qualitative and quantitative agreement was obtained for predicted stresses using both low and high element density models.

(2) Thanksgiving Turkey

A frozen turkey was scanned in an MRI scanner (cf. Figure 1-b). The segmentation was carried out based on grayscale intensities and the mesh was created in minutes. Airflow past the turkey was modelled to obtain effective lift and drag coefficients. The lift /drag ratio = 0.09 - frankly, it won't fly!
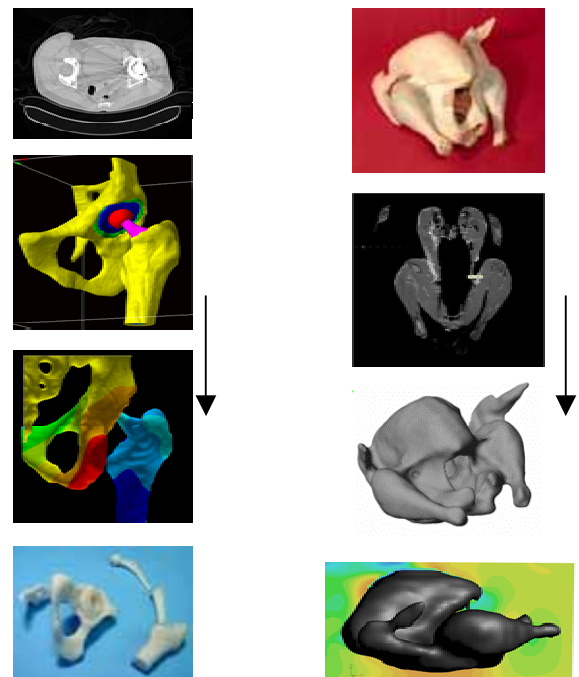


**Figure 1**:  a) Total Hip replacement: from CT scan to FE analysis and RP model. b) Turkey: from actual turkey to CFD analysis.

## CONCLUSIONS

These studies have clear implications for the future of Biomechanical modelling. Models of unmatched sophistication can now be generated with ease which opens up a wide range of previously difficult or intractable problems to numerical analysis.