A Practical Method to Model Complex 3D Geometries with Non-Uniform Material Properties Using Image-based Design and COMSOL

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October 10, 2013 | jcepeda@huskers.unl.edu

COMSOL CONFERENCE BOSTON 2013

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OUTLINE

1. Introduction

2. A Practical Method to Model Complex Multipart Geometries

3. Case Study
   – Modeling Air-Cooling of a Chicken Carcass

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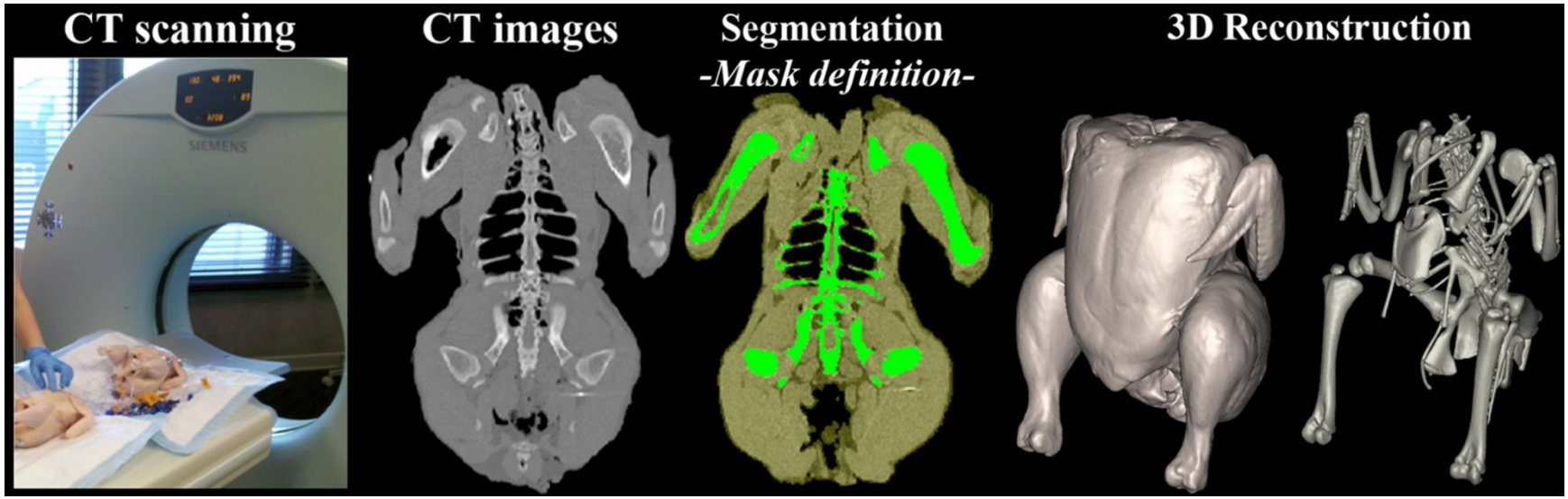
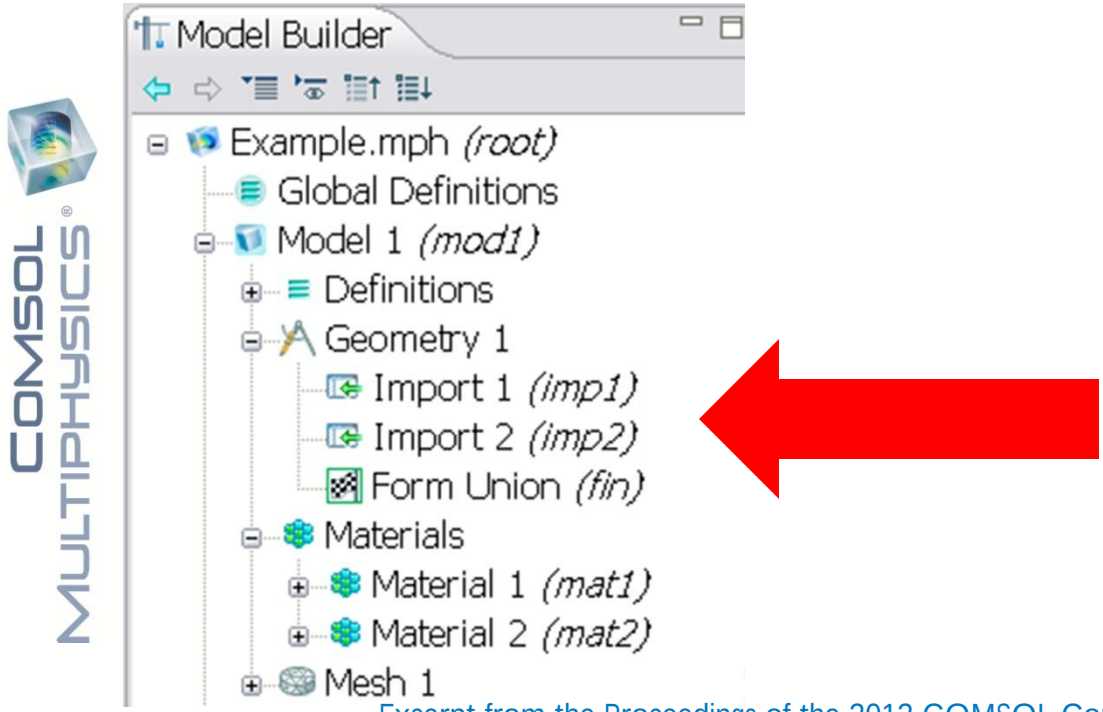
Modeling Complex Multipart Geometries can be a Challenge

- Image-based 3D reconstruction



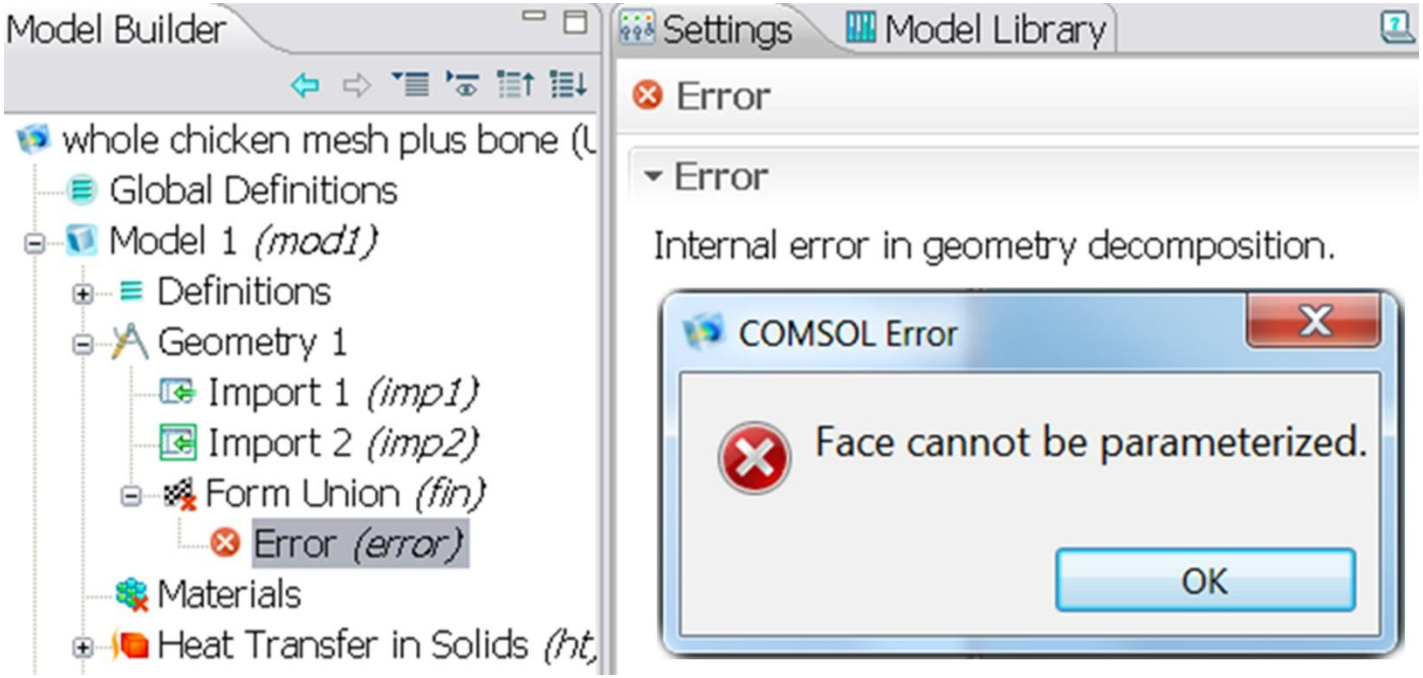
Modeling Complex Multipart Geometries can be a Challenge

- Image-based 3D reconstruction
- Form Union/Assembly



Modeling Complex Multipart Geometries can be a Challenge

- Image-based 3D reconstruction
- **Form Union/Assembly**



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A Practical Method to Model Complex Multipart Geometries

1. 3D Reconstruction
2. Meshing
3. Material Labeling
4. Material Definition in COMSOL

Excerpt from the Proceedings of the 2013 COMSOL Conference in Boston

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1. **3D Reconstruction**
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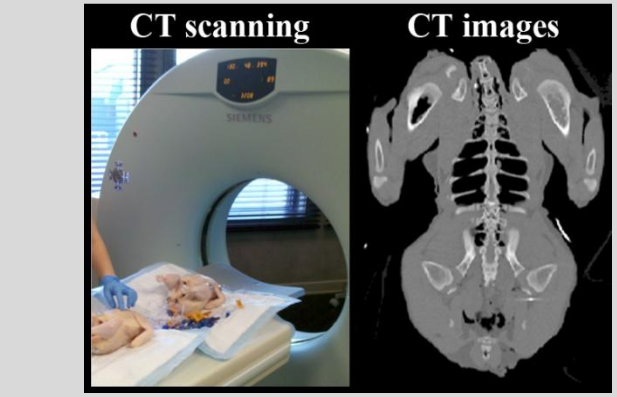

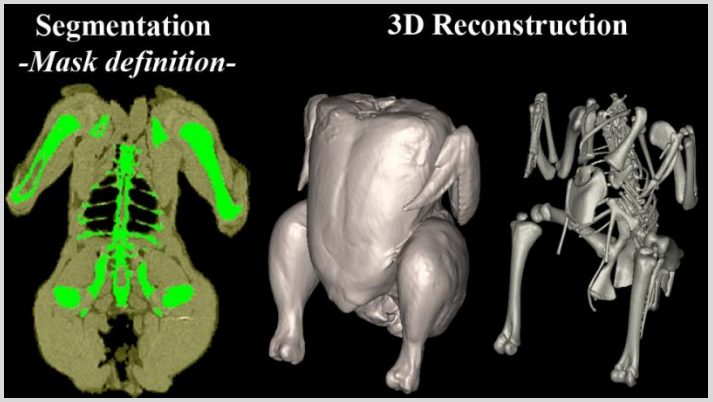

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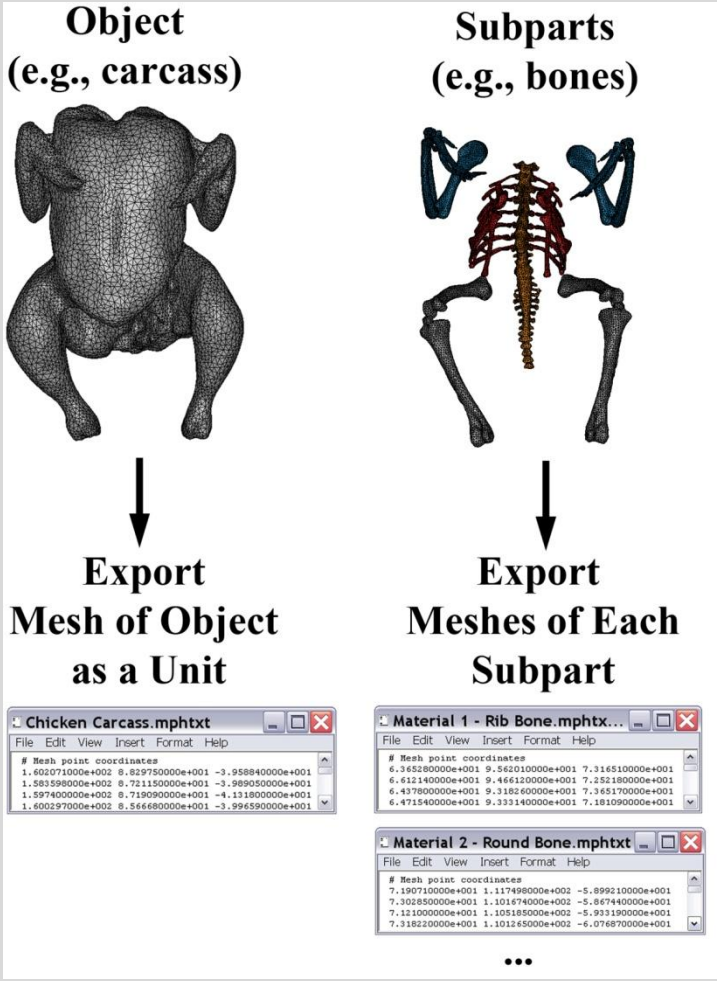

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```
Read Mesh of Object
Read Meshes of Subparts

For Each Subpart
    For Each Node in Subpart
        *Find Nearest Neighbor
          Node in Object Mesh
        *Label the Node in
          Object Mesh with
          Corresponding
          Material
    Next Node in Subpart
Next Subpart
```

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1. 3D Reconstruction
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3. **Material Labeling**

Output:

Labeled Nodes.txt

x [m]	y [m]	z [m]	Material	k [W / m K]	Cp [J / kg K]	ρ [kg / m³]
1.30E-01	1.14E-01	2.78E-02	Meat	0.265	2,021	1,040
1.33E-01	1.15E-01	2.98E-02	Meat	0.265	2,021	1,040
1.77E-01	5.69E-02	5.48E-02	Round Bone	0.265	2,021	1,040
1.05E-01	7.71E-02	7.06E-02	Air	0.026	1,005	1.2
7.16E-02	6.97E-02	-1.98E-02	Rib Bone	0.265	2,021	1,040
7.26E-02	6.55E-02	-1.73E-02	Rib Bone	0.265	2,021	1,040

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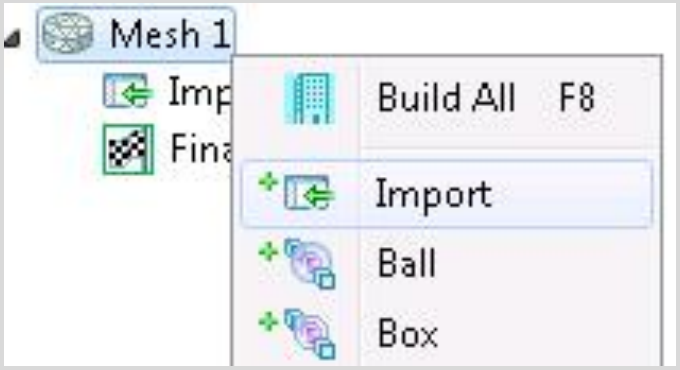
4. **Material Definition in COMSOL**

a. Import Mesh of Object



A Practical Method to Model Complex Multipart Geometries

1. 3D Reconstruction
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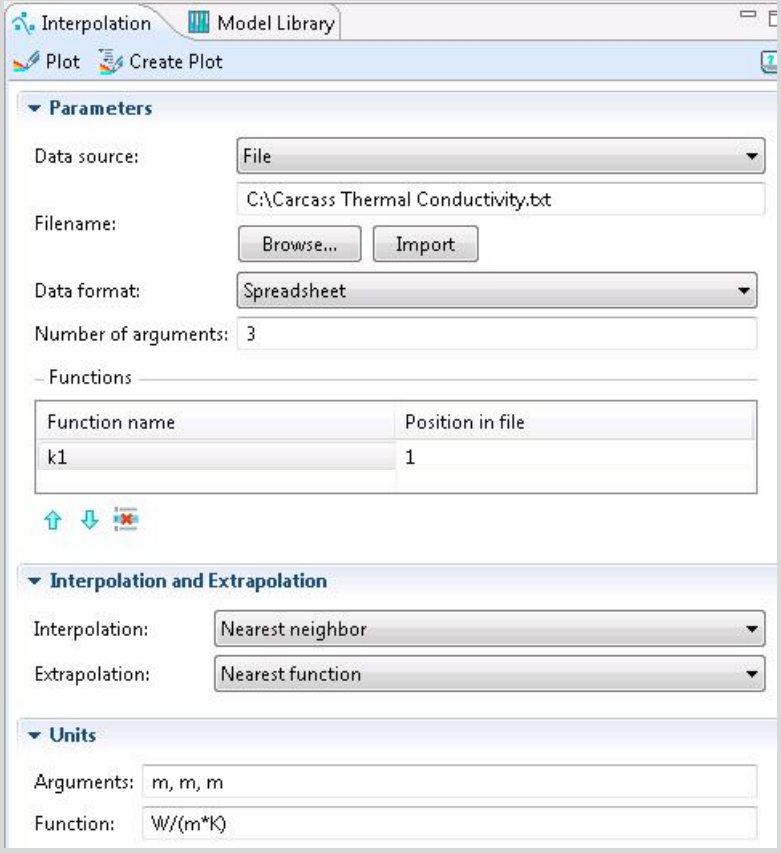
4. **Material Definition in COMSOL**

a. Import Mesh of Object

b. Define interpolation functions



A Practical Method to Model Complex Multipart Geometries

1. 3D Reconstruction
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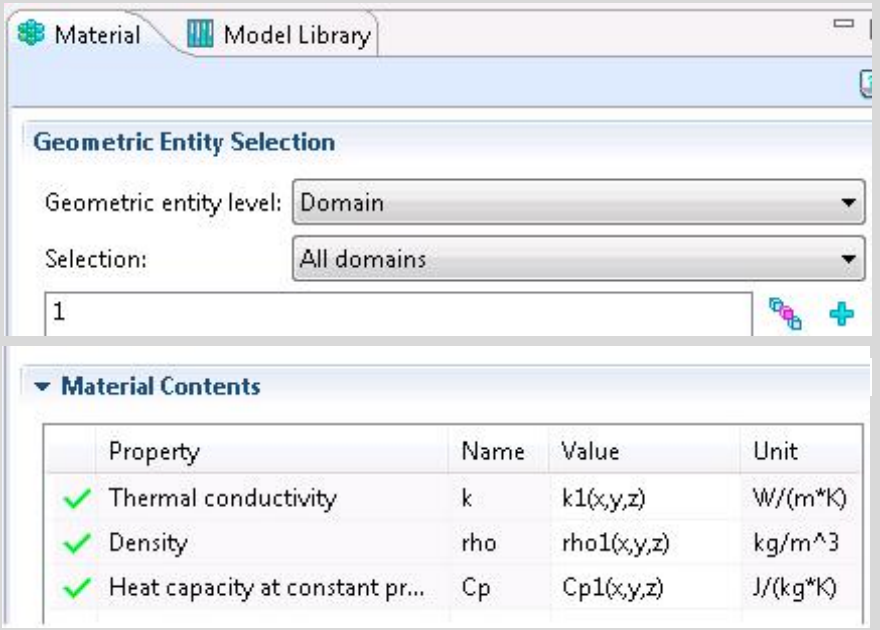
4. **Material Definition in COMSOL**

a. Import Mesh of Object
b. Define interpolation functions
c. **Define material properties as functions of X, Y, Z coordinates**



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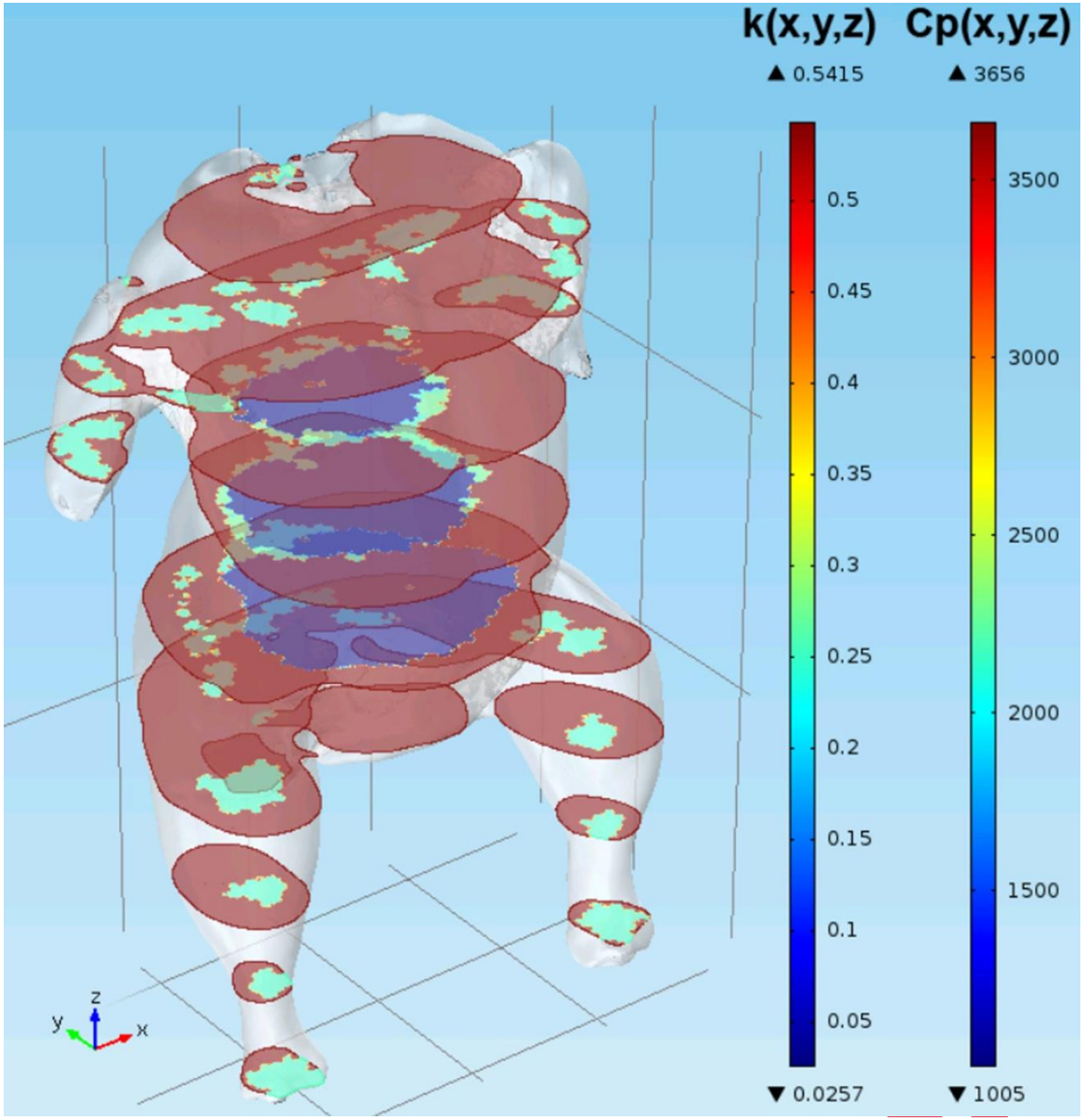
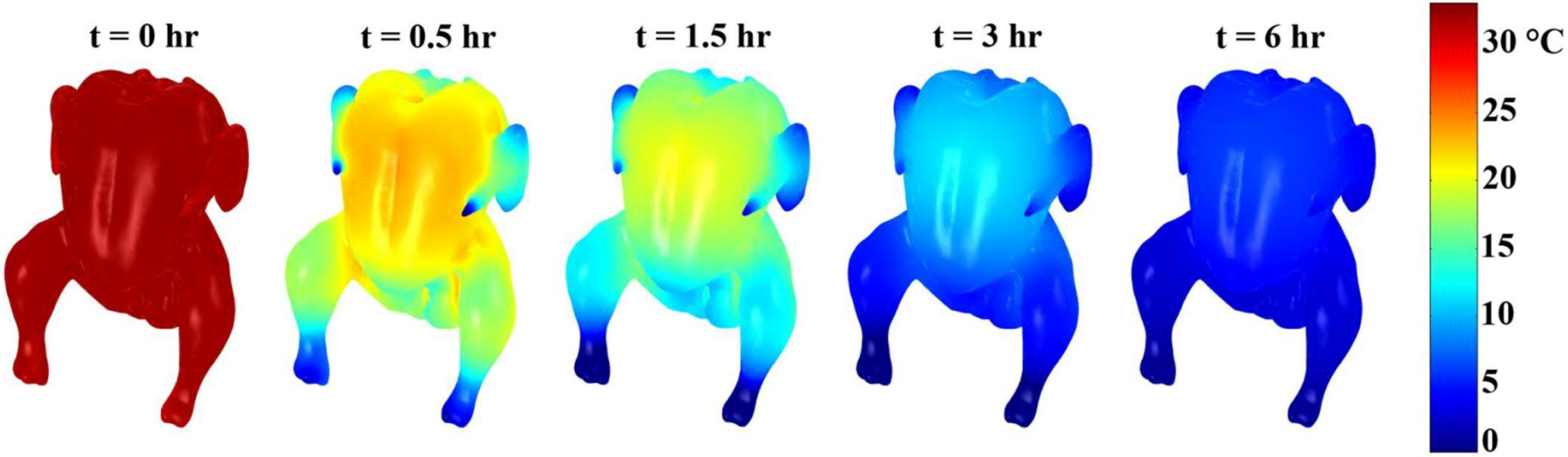


Case Study

Modeling Air-Cooling of a Chicken Carcass

COMSOL MULTIPHYSICS®

- ✓ Heat Transfer in Solids
- ✓ Transport of Diluted Species
- ✓ LiveLink for MATLAB



CONCLUSION

- Image-based mesh generation, a custom algorithm, and interpolation features of COMSOL Multiphysics can be used to define heterogeneous material properties of complex geometries without the difficulties associated with assembling multiple parts.

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