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CAD geometry based pre-processing for CFD using abstract modeling techniques

CastNet: CAD-based Pre-Processor for OpenFOAM®

Attributes: Concept of CAD associated mesh and solution set-up

Abstract modeling

CastNet CAD input and meshing

- Modeling and meshing environment for CFD and FEA

- CAD-Model based (reads Parasolid -xt, Acis –sat or Granite Pro-E parts) or discrete mesh data (e.g. stl)

- Builds internally non-manifold model based on CAD assemblies with conformal mesh transition between parts

- Generates hybrid meshes

- CFD specific features (boundary-layer-meshing, curvature controlled meshing,…)

- CastNet is based on commercial meshing, CAD import and abstract modeling technology (not open source)

Major goals:

• Providing access to reliable, robust and high quality CFD-meshing based on CAD geometry

• Establishing complete GUI based environment: Access to strong OpenFOAM® -solution capabilities without editing text files or detail knowledge of keyword-structure (e.g. "turbulentMixingLengthFrequencyInlet")

• Reducing the time from CAD model to OpenFOAM® run-ready case

Fully compatible: User can switch anytime from GUIs to text-based model setup

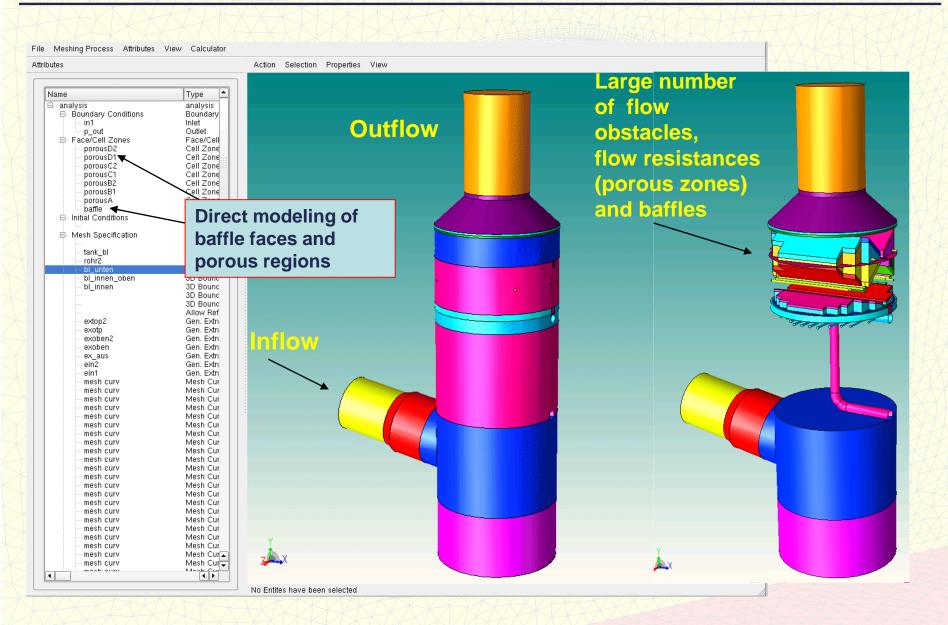**User can extend the CastNet model output for specific needs**

CastNet for OpenFOAM®

Major features:

• Support of OpenFOAM® 1.5 and OpenFOAM® 1.6.(x)

• Direct generation of complete models (variables, controlDict, solver settings, materials etc.) for more than 15 solvers in 1.6

• Convenient definition of boundary conditions using derived OpenFOAM® patches

• Definition of local, initial conditions e.g. specification of volume fractions in particular regions

• Face and cell zones (e.g. baffle or fan faces, porous or MRF-zones)

• User support by "defaults" e.g. walls with zero-gradient or wall function selection

• SnappyHexMesh in case hex-dominant meshes are required

• Additional GUI for job-control during the run: Switching solvers, changing schemes, modifying underrelaxtion factors, plotting residuals,…
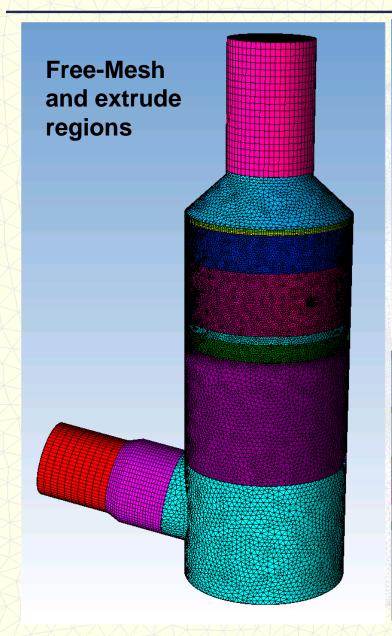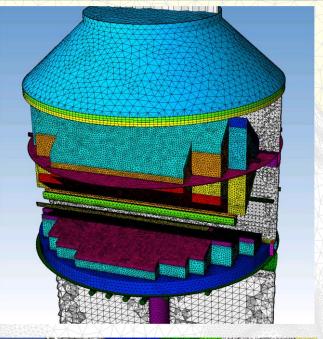
Example

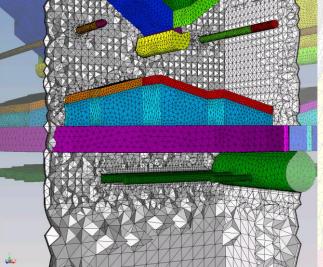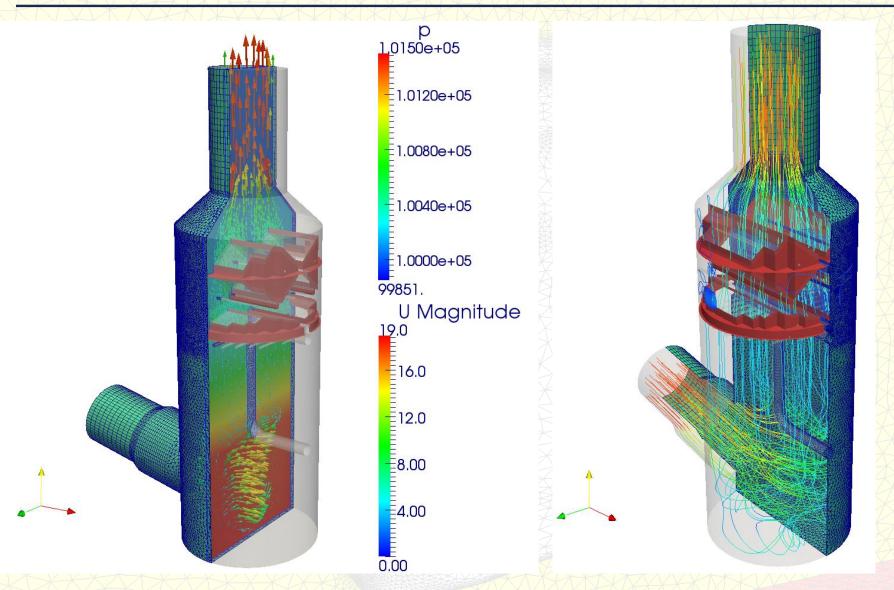**Free-Mesh and extrude regions**

Boundary-Layer

Note: More complex meshing examples of customer cases presented in Gothenburg

Visualized with Paraview
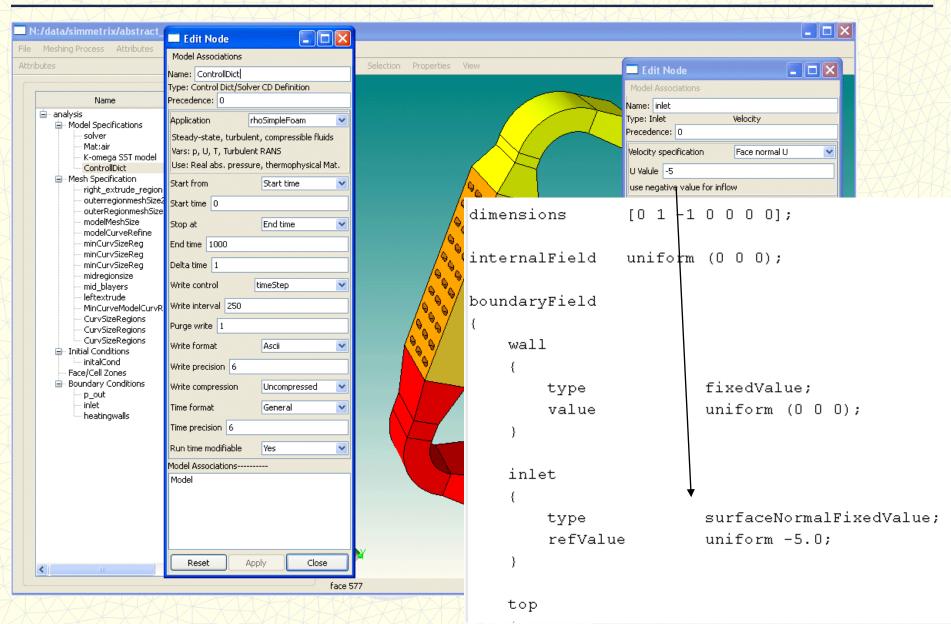
OpenFOAM® Interface
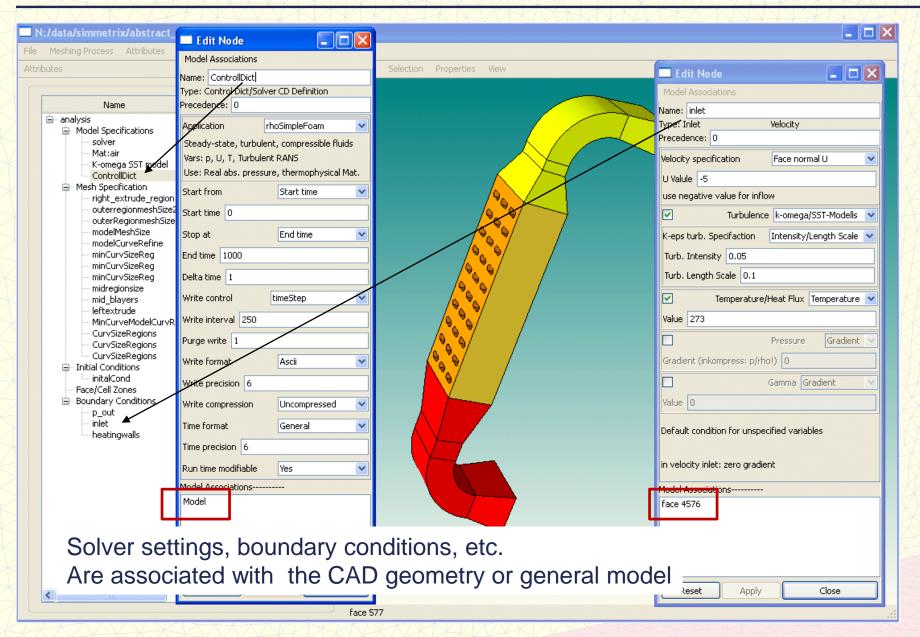
OpenFOAM® Interface

Solver settings, boundary conditions, etc.
Are associated with the CAD geometry or general model

Advantages of CAD associated modeling

• Allows changes easily, e.g. boundary-layer, mesh refinement zones boundary conditions
• Mesh can be defined and successively improved in a step by step approach
• Meshing process can be optimized dynamically considering all attributes (e.g. adapted surface mesh if volume mesh would cause bad elements)
• Simplifies data-management: Attribute file and CAD geometry store all meshing and simulation model data (solver settings, material…)
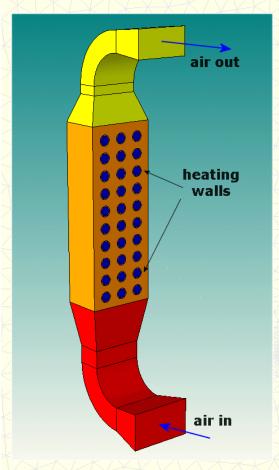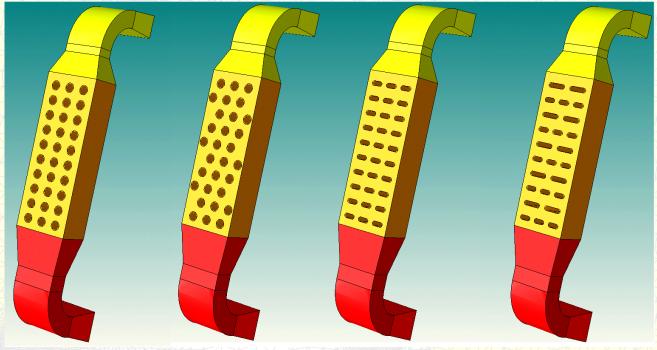
Establish and undo associations

Abstract modeling:
Abstract modeling is a technique that allows to define the components of a numerical analysis problem independent of a specific geometric.

Concept- or design study

air out

heating walls
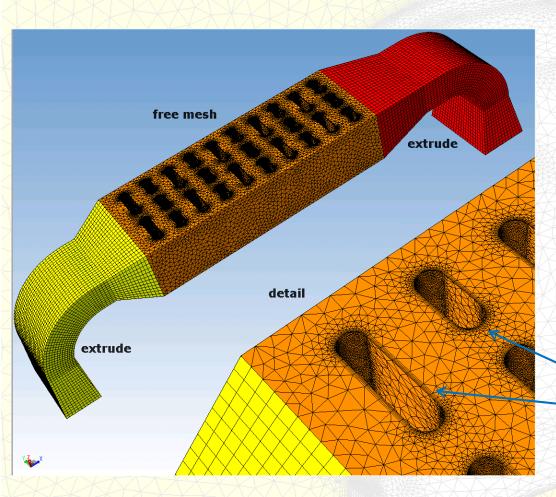
air in

Basic question:

How can CAD entities (faces, regions, edges…)

be addressed in very different designs?

Several options in CastNet:

1. **Identification tags in CAD system**

2. **Geometrical compare**

3. **Relative relations and search algorithms**

Example: Relative relations and search algorithms

1. Step:
Definition of abstract components

General model:
Used for controlDict, solver setting, fluid properties,…
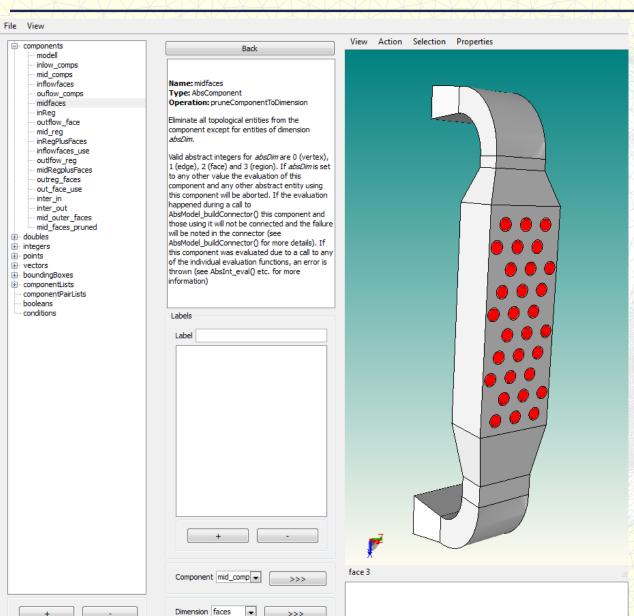
CAD-model related entities (e.g. faces):
Used for:
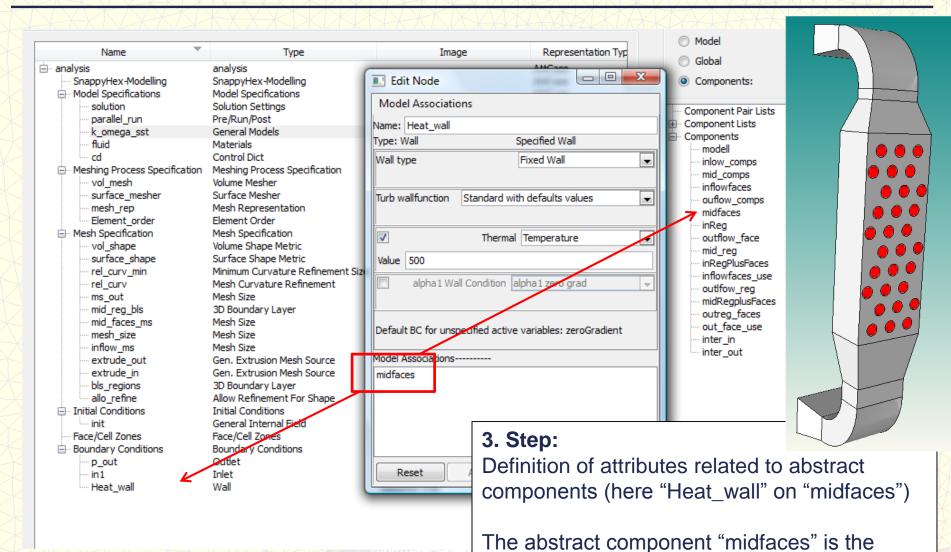Meshing, boundary conditions

Example:
Identify middle faces for
1. Meshing: boundary layer
2. Boundary condition: Heating walls

Abstract Modeling: Example

2. Step: Modeling GUI: Simplifies the abstract component definitions and visualizes the component in target models.
Typical operations are:

• Find nearest entity (e.g. face) of a given point

• Bounding boxes: E.g. pick all entities in a specified bounding box (used here to identify the midfaces).

• Loops over geometrical objects.

• Boolean operation (e.g. compare regions to identify common faces)

3. Step:
Definition of attributes related to abstract components (here "Heat_wall" on "midfaces")

The abstract component "midfaces" is the placeholder for the real CAD entities
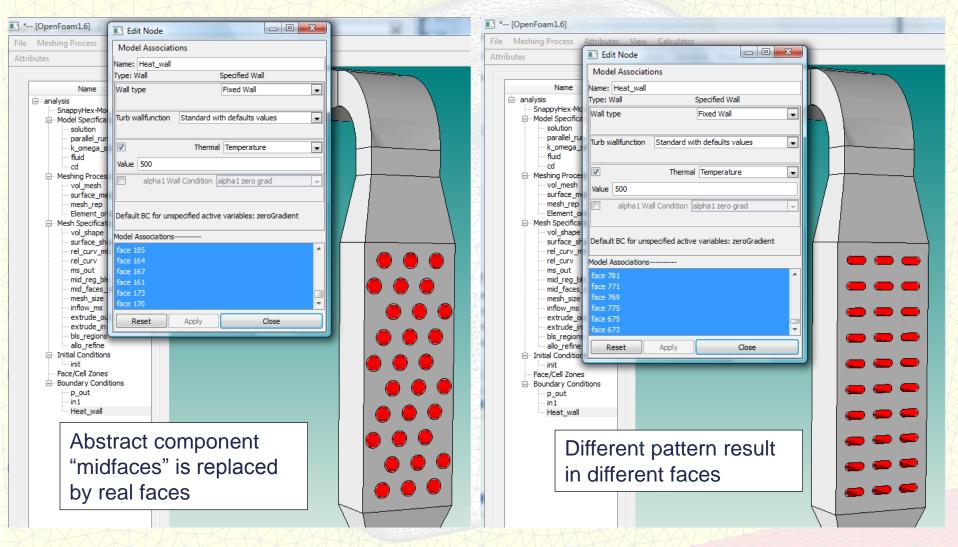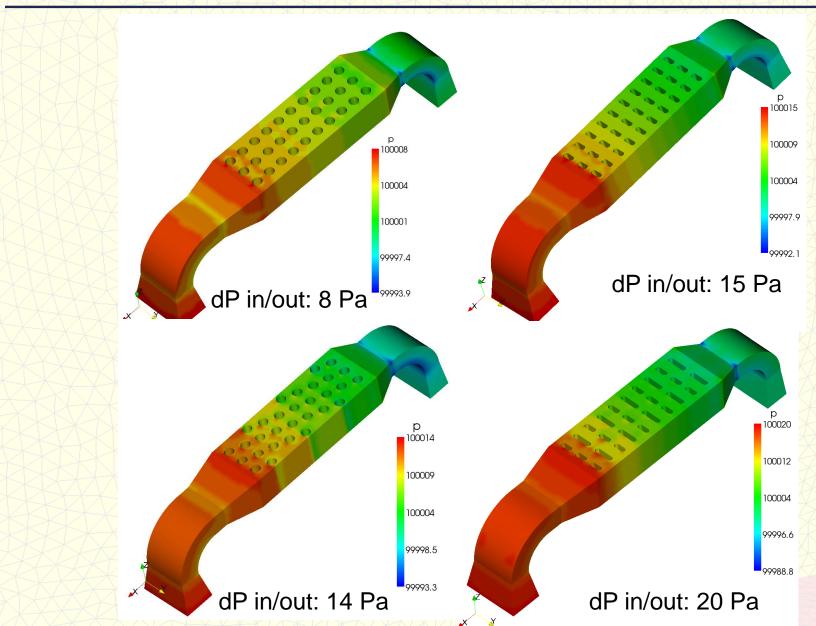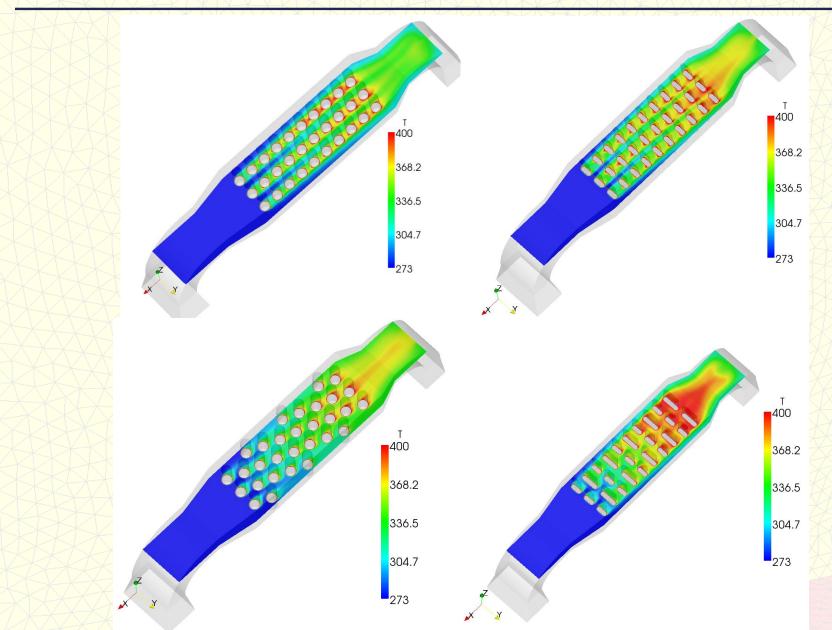
4. Step: Finally: Applying the abstract model to different CAD geometry

Abstract component "midfaces" is replaced by real faces

Different pattern result in different faces

Abstract Modeling: Example

dP in/out: 8 Pa

dP in/out: 15 Pa

dP in/out: 14 Pa

dP in/out: 20 Pa

Benefits of abstract modeling

- Allows defining components of OpenFOAM® cases independent of a specific geometry.

- Fast and reliable model generation for geometry case studies including meshing, boundary conditions and solver settings.

- The abstract model condenses all CFD- and OpenFOAM® expert knowledge (meshing, solution settings) resulting in run-ready cases after applying the abstract model to various CAD-geometry cases.

- The risk of biasing the design study by mesh dependency or different solution setting is reduced.

DHCAE Tools

CastNet for OpenFOAM®

• Further support of CastNet features: Easy identification of cell and faces zones for multi-region applications (e.g. chtMultiRegion, FSI…)

• Extending the runGui: Allowing a detail job control and manipulation (e.g. plotting probes, switching more schemes….)

• Support further features for 1.6-extended as soon as this version is available
  • GGI
  • Sliding meshes
  • Windows Version
  • more schemes, patches and solver

Thank you for your attention !

For more information (e.g. movies „CastNet for OpenFOAM®") please visit:

http://www.dhcae-tools.com/OpenFOAM.htm