Taking Advantage of BIM for CFD Modeling

MP3397-P

Aryn Bergman
Energy Analyst, TL Circle; BIM Manager, Facebook
arynbergman@tlcircle.com  aryn@fb.com

Jun Ortega
Applications Engineer - Simulation, Autodesk
jun.ortega@autodesk.com
Class Summary

For high performance HVAC systems such as radiant heating and cooling, UFAD, natural ventilation and hybrid systems utilizing both natural and mechanical conditioning of a building, it is critical to understand how the air flows and the surrounding environment impacts the occupants comfort while still being able to balance energy savings. Computational Fluid Dynamics (CFD) models are key to understanding this balance. This class will teach you how to prepare an Autodesk Revit 2013 model and import into Autodesk Simulation CFD to quickly create wind driven models of the airflow around the exterior of a building as well as buoyancy driven transient models to understand the impacts of the building thermal mass and temperature. You will leave the presentation with skills to use your CFD model to optimize your building and achieve energy savings for your high performance HVAC system.
Learning Objectives

- Create the correct BIM geometry and properly import BIM to Simulation CFD 360.
- Quickly perform wind driven analysis.
- Create buoyancy driven models to understand thermal mass and temperature.
- Understand CFD model results to optimize your building and energy savings.
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Autodesk University 2012 Power Track

- Energy Optimization for Retrofits
  - MP3397-P - Taking Advantage of BIM for CFD Modeling
  - MP3565-P - Using a Retro-BIM Workflow: Case Studies in Energy-Driven Retrofit Projects
  - MP3765-P - Using BIM to Streamline Your Energy Modeling Workflows
  - MP3784-P - Calibrating an Existing Building Energy Model
Workflow

Model in Revit
- Create or geometry in Revit
  - Create Revit Mass
  - Transfer model from Revit to Simulation CFD

Model in Simulation CFD
- Define building materials
- Define Air Box
- Assign Boundary Conditions

Simulate and Visualize
- Run Analysis
  - View Velocity Magnitudes, Iso Surfaces and Particle Traces

Analyze
- How do the different building shapes or orientations affect the airflow?
- What are the best locations for air intakes and exhaust?
- How much air can be utilized for space conditioning?

Decide
- Next Step: Look at Natural Ventilation and Transient Studies
- Design option is satisfactory

YES
NO
Creating a Model in Revit

Create a Template File:
- Typical Interior/exterior walls
- Roofs/Metal Roofs
- Floors
- Shading Devices
- Ceilings
- Windows/Skylights
- Doors/Openings
- Fans
- Vents
Views

- Architectural Floorplans
- 3D Views
- True North View

Orientation
Creating Revit Geometry

- Anything hidden in active 3D view will not be included in Simulation CFD.
- Avoid small offsets between geometry. Use the join and align commands to eliminate small gaps.
- Columns and beams are generally not needed.
- Fine features on furniture should be removed.
- All models will need a surrounding mass volume to represent the air surrounding a building.
- Be sure to use the “Metal Roof” ceiling family to represent the geometry of metal roofs and apply the shell thickness in Sim CFD 360.
Wind Driven Models
Buoyancy Driven Models
Revit to Simulation CFD

1. Launch Active Model

2. Change Units
   - Check Change units (Example: 1 m -> 1000 mm)
   - Uncheck to resize geometry (Example: 1 m -> 1 mm)

3. Right Click
   - Geometry (meter)
   - Edges to be merged: 0
   - Display objects to be removed
   - Object smaller than minimum

4. Length units
   - meter
   - cm
   - mm
   - foot
   - inch-BTU/s
   - inch-Watt
Apply Materials

Wind Driven Models with No Temperature
- Air material is the only one of importance
- Any solid will work for the building geometry or can suppress any complicated geometry to reduce runtimes

Wind Driven with Temperatures or Buoyancy Driven Models
- Define materials as accurately as possible
- Use groups to combine similar materials
- Pay attention to emissivity!
Boundary Conditions – Wind Driven Models
Boundary Conditions – Buoyancy Driven Models
Boundary Conditions – Buoyancy Driven Models
Apply the Mesh
Solving – Wind Driven with No Temperature
Buoyancy Driven or Wind Driven w/ Temperatures
Boundary Conditions – Buoyancy Driven Models
Viewing the Results
Useful Resources

- CFDesign Advanced Training.  

- Autodesk Simulation CFD Learning Resources.  
  http://www.cfdesign.com/OnlineHelp/2013/Examples/Learning.htm

- Natural Ventilation Example. CFDesign Learning Resources.  
  http://www.cfdesign.com/OnlineHelp/2013/Training/AEC/Natural-ventilation.htm

- Geometry Modeling Techniques for AEC Applications. CFDesign Learning Resources.  
  http://www.cfdesign.com/OnlineHelp/2013/Training/AEC/geometry-prep-techniques.htm
Appendix
Viewing the Results
Adding Velocity Vectors
Adding Velocity Vectors
Adding Iso-Surfaces
Adding Trace Particles
Manually Adding Trace Points

Creating a Grid of Trace Points
Animating Flow Paths
Animating Flow Paths
Decision Center: Comparing results