AEC Applications

Inside the CFdesign Advanced Module

Upfront CFD is all about using simulation to drive design decisions. The CFdesign Base Module contains an extensive collection of functionality, and is capable of solving a wide breadth of applications. Some situations, however, are a little more complex, and require physical models that are beyond the scope of the Base System. The best solution for these situations is the CFdesign Advanced Module.

License Requirements: The CFdesign Base System is a requisite for the Advanced Module.

Advanced Simulation Scope

The CFdesign Advanced Module provides additional flow and thermal simulation functionality to further expand the solution scope.

Advanced Fluid Flow

- Supersonic compressible
- Transient (time varying)
- Two-phase flows
  (humidity and steam mixtures)
- Height of fluid formulation
- Two-fluid scalar mixture model
- Compressible liquid (water hammer)
- Cavitation

Advanced Heat Transfer

- Internal radiation heat transfer
- Radiation through transparent media
- Solar Loading
- Temperature dependent emissivity
- Joule heating with temperature dependent resistivity

Advanced Conditions

- Relative humidity
- Steam quality
- Fill level
- Time varying boundary conditions
- Current
- Voltage

It's important, however, to understand how these models solve real-world problems. Let's explore the following questions for the Advanced functional items that are most commonly used for AEC applications:

1. *What is it?*
2. *Why would you need it?*
3. *What can you do with it?*

Copyright© Blue Ridge Numerics, Inc. 2011. All rights reserved.

There are several primary classifications of Architectural, Engineering, and Construction (AEC) analyses: Ventilation, Air Quality, Occupant Comfort, Datacenters, Solar Loading, and External flow (wind loading). All contain numerous challenges, and understanding the flow and temperature is essential for occupant comfort, reducing operating costs, and ensuring that design requirements are met.

Transient

What is Transient?

A process that is "transient" varies with time. Unlike a steady state process, the flow distribution and temperature change from one moment to the next. CFdesign uses an implicit time stepping method to compute the time-dependent solution.

Why would you need Transient?

Understanding the effects of time-dependent variations such as oscillatory flow is essential to making informed design decisions. If the amount of flow varies with time, the transient module provides valuable insight into how the flow develops and how the system adapts to changing inputs. If the amount of heat added or removed from the device is controlled with a transient boundary condition, predicting this is even harder with hand calculations or experimental methods.

What can you do with Transient?

The Transient physical model provides value through in many ways:

- Vary the amount of flow or heat entering or leaving the structure with transient boundary conditions. Many systems are subject to cyclical inputs, and the Transient module simulates this input variation.
- Model structural diurnal heating due to sun exposure, and track the time history of the resultant solar heat flux and building temperatures.
- Simulate failure scenarios within datacenters. Because redundancy levels are dropping, failure margins are growing tighter. It is critical to understand the physical conditions that drive the flow and thermal gradients during failure events.
- Track smoke visibility and contaminant/pollutant levels. Understanding the propagation rate in any inhabited structure that is subject to fire, spills, or re-entrainment is vital to occupant safety.

Copyright© Blue Ridge Numerics, Inc. 2011. All rights reserved.

- Review the time history by animating results. Share your results using several formats: Dynamic Images for viewing in the CFdesign 3D Viewer, AVI, and MPEG.

Radiation

What is Radiation?

Radiation is a surface-to-surface heat transfer mode that relies on a direct line of sight between surfaces. Unlike conduction or convection, radiation does not need a medium such as a solid or carrier gas. Heat radiates through empty space with electromagnetic waves.

Why would you need Radiation?

Incorporating radiation often leads to greater solution accuracy for high temperature applications. Radiation is an essential element for simulating solar heating, and plays a role in the calculation of occupant Thermal Comfort as well.

What can you do with Radiation?

The CFdesign Radiation Model is a physically rigorous model that provides a high level of solution accuracy. Using an optical view factor calculation, the Radiation model produces an accurate energy balance and enforces reciprocity between solid objects.

- Achieve accurate temperature predictions in applications with very high temperature regions for smoke visibility and other safety-related simulations.
- Use the radiation model to include the effects of temperature-dependent emissivity to simulate the effects of spectral radiation.
- Compute radiative heat transfer through transparent media such as windows and clear plastic. Simulate real-world objects by specifying the emissivity and transmissivity properties of solid objects.
- Simulate the effect of radiant panels for managing zone-specific thermal management.

Copyright© Blue Ridge Numerics, Inc. 2011. All rights reserved.

Solar Heating

What is Solar Heating?

A sub-set of radiation heat transfer, solar heating is radiative heat from the sun. Unlike conduction or convection, solar radiation does not rely on a medium such as a solid or carrier gas. Heat radiates through empty space with electromagnetic waves.

Why would you need Solar Heating?

The Solar Heating model is essential for optimizing the thermal performance of devices that operate out-of-doors, especially in environments exposed to harsh sunlight with little shade.

Many buildings, atria, and other structures are subjected to harsh conditions imposed by the sun. Depending on the location, the building design should either protect from or incorporate solar heating to ensure optimal occupant comfort and regulate HVAC costs.

What can you do with Solar Heating?

CFdesign provides a comprehensive set of tools for specifying the exact location, time, date, and physical orientation, to ensure accuracy.

- Asses the thermal performance due to solar heat loading to make design decisions that will affect product durability and life-span.
- Simulate the effects of shadowing. The relative location of objects significantly influences how solar energy affects other objects or devices.
- Study the long-term effects of diurnal heating. Vary the sky temperature and emissivity to simulate thermal cycling from day to night and back to day.
- Accurately account for the amount of cloud cover and ambient light by specifying the albedo (the amount of radiant energy that is reflected off the sky and back to earth).

Copyright© Blue Ridge Numerics, Inc. 2011. All rights reserved.

Humidity

What is Humidity?
Humidity is the amount of water vapor contained within air.

Why would you need Humidity?
It is crucial to regulate the relative humidity and to safeguard against condensation in situations that contain sensitive components such as clean rooms and data centers. In addition, curtainwalls and facades must be simulated, especially in non-traditional ventilation applications. An early understanding of where condensation can occur is valuable for designers. Educated design decisions can lead to significant cost savings in terms of equipment life-span and process efficiency.

What can you do with Humidity?
- Study the relative humidity in and around sensitive components. Ensure that air handling equipment and methods effectively manage the relative humidity early in the design cycle, decreasing the risk of costly redesigns and (worse) equipment malfunctions and failures.
- Visualize where condensation occurs and the amount of liquid condensed.
- Calculate the condensed liquid as a mixture fraction: the mass of the condensed liquid divided by the total mass of the liquid, vapor and carrier gas.

Copyright© Blue Ridge Numerics, Inc. 2011. All rights reserved.