

Design Study Environment

CFdesign provides a flexible, intuitive environment for setting up single- and multi-Scenario flow and thermal design studies.

These are the key components of the Design Study Environment:

1. Design Study Automation
2. Critical Value Decision Center
3. Multi-Scenario Design Review Center
4. Model-Centric Interface
5. Customizable material databases

I. Design Study Automation

The Design Study Automation suite of tools streamlines the CFdesign process and improves efficiency and analysis throughput. Several elements make up Design Study Automation. Each serves a different purpose, but all work together to provide a faster, more efficient work flow process.

Design Study Manager

The Design Study Manager coordinates the active CAD model and Design Studies in real-time.

- Use the Design Study Manager to transfer the active CAD model to the CFdesign design study.
- After applying settings in CFdesign, clone the design, and return to CAD to make design changes.
- To update each design, simply launch the Design Study Manager.

CAD Entity Groups

CAD Entity groups are collections of parts or surfaces created on the CAD model.

- Assign model settings directly to the model in the CAD system.

- CAD Entity Groups are saved in the CAD system, so they can be reused for multiple design studies.
- Used in conjunction with the Design Study Builder and Rules, CAD Entity Groups make it easy to set up related design studies from the same CAD assembly by eliminating repeated steps.

Design Study Builder

The Design Study Builder is a powerful automation tool for defining a complete design study in the CAD system.

- Manage multiple designs using the configuration management system specific to the CAD tool.
- Use the Design Study Builder to define all aspects of the Design Study--designs, Scenarios, and settings.
- Add to existing design studies by importing into the Design Study Builder, and configuring additional designs and Scenarios.

Templates

Templates are “thin” files that contain model settings for one or more Scenarios of a Design. They provide consistency for Design Studies that contain similar settings. To quickly assign a collection of model settings, simply apply a template to a Design.

- Templates eliminate the need to repeatedly define the same settings.
- They provide a convenient starting point when setting up models within the CFdesign User Interface.
- Ensure consistency by pre-defining known settings that will be used for multiple Design Studies.

Rules

A Rule automates the assignment of a CFdesign setting to a CAD entity.

- Use Rules to automatically assign settings such as boundary conditions and materials to CAD parts that are often used.
- Rules are applied automatically when transferring the CAD model to the CFdesign Design Study.
- Rule creation is easy and flexible--create them from existing settings or use the convenient Rule Editor.

Solver Manager

Use the Solver Manager to schedule and run multiple Scenarios from a single, concise environment.

- Save time by managing all Scenarios with the Solver Manager instead of manually activating and launching each one individually.
- Use the Solver Manager to assign each Scenario to a computer, the order to run, and the start time.
- Enable e-mail notifications to tell you when certain milestones have been achieved for each analysis. (Example--CFdesign will send you an e-mail when each Scenario is finished running!)

Solution Monitor

The CFdesign Solution Monitor is a stand-alone tool that reports the status of your CFdesign analyses and the solver machines you typically use.

For each computer on your CFdesign network, the Solution Monitor provides the following:

- Where CFdesign analyses are running, and the owner of each analysis
- The current iteration or time step of each running analysis
- The CPU resource load of each machine

The Solution Monitor is available from the Windows Start menu (outside of the CFdesign user interface). Our own engineers at Blue Ridge Numerics use the Solution Monitor all the time to keep track of their models!

2. Critical Value Decision Center

The Decision Center is a simple yet powerful environment for comparing design alternatives. Use it to compare results across a Design study to help make quality design decisions:

- Compare results from multiple Scenarios.
- Extract specific results values.
- Quickly determine pass/fail: identify the designs that satisfy your design objectives and those that do not.

Functionality

Compare results by creating summary entities on a single scenario and seamlessly extracting the corresponding summary data from all Scenarios of the Design Study.

- Compare results from Summary Parts, Summary Planes, and Summary Points with the Critical Values table, a sort of “Engineer’s Spreadsheet.”
- Plot summary values to quickly assess the relative performance of each Scenario against a prescribed reference value (such as a design constraint or known limit).

There are four types of Critical Value Entities:

1. Summary Parts
 - Assess results on Fluid parts, Solid parts, Internal Fans, and Compact Thermal devices.
 - Use Summary Parts to answer questions like: "What is the maximum temperature on these chips?" and "What is the operating condition of this fan?"
2. Summary Planes
 - Summary Planes are planar cutting surfaces at critical locations in the model.
 - Use Summary Planes to answer questions like: "Which Design produced the lowest pressure drop?" and "Which leg of the manifold has the highest flow rate?"
3. Summary Points
 - Summary Points are locations within a model on which specific result quantities are monitored.
 - Use Summary Points to answer questions like: "Which Design produces the most uniform velocity or temperature distribution across a set of points?" and "Does the pressure at a point near a critical component exceed a Design limit?"
4. Summary XY Plots
 - Compare results by overlaying XY Plot data from multiple Scenarios on a single plot.

- Use Summary Plots to answer questions like: "How does the pressure vary across the flow channel as the design is changed?" and "How does the temperature gradient respond as the design is modified?"

3. Multi-scenario Design Review Center

In traditional CAE tools, comparing results from multiple analyses can be daunting. The complexity of manually setting up the exact same view in each analysis and then comparing them side-by-side is a challenging process.

Fortunately, CFdesign has pioneered a better way: the Multi-scenario Design Review Center, an engineering review on your desktop.

It is the ultimate visual design exploration experience built to simplify and sharpen the decision-making process. This is where you will get the money shots – views and knowledge not available from the lab.

- Prepare by creating interesting and insightful results images on one of the Scenarios in your Design Study.
- Issue the command to propagate the view across all scenarios, and compare your results for the entire Design Study, quickly and easily. The results from every Scenario are shown in a consistent manner.
- The Design Review Center empowers understanding of the performance of each Scenario, and simplifies the process of selecting the design that satisfies your decision criteria.

The Design Review Center is structured to allow simultaneous comparison of many Scenarios. This means that it is easy to compare results from dozens of Scenarios at a time:

- Flip between multiple images in a single view-port using the “VCR” controls.
- Review images side-by-side by dragging a view from each Scenario into a separate view-port. Optionally, enable Synchronous Navigation so that all view-ports navigate in the same manner.

4. Model-Centric Interface

At the heart of the CFdesign workflow is the model-centric interface. Working close to the model throughout the design study lifecycle provides numerous benefits:

1. Provides a workflow that is both easy to learn and to live with
2. Maximizes screen space for easier interaction and a better view of the model
3. Eliminates interruptions and excessive mouse movements to enable greater modeling focus

Simulation Setup: Functionality

The model-centric interface provides several ways of interacting with the model at any given time. Simply use the method that is most comfortable and suitable for the situation.

- Work directly on the model using the Smart toolbar and Quick edit dialog.
- Work close to, but slightly off the model using the Selection and List dialogs with the docked Quick edit dialog.
- Define settings, and drag from the Design Study bar to the desired model entity.
- Change the model appearance, selection mode, and manage groups with the right-click context menu.

Results Visualization: Functionality

Provide the same level of flexibility for both results extraction and visualization.

- Extract quantitative results such as part temperatures, point locations, and forces on walls directly from the model with the Results Parts, Points, and Wall tasks.
- Visualize results directly on the model with the Results Planes and Iso Surface tasks.
- Move and rotate results planes by dragging the Plane Locator Triad.
- Change the appearance and displayed result quantity with the Smart toolbar and model right-click context menus.
- Control the model appearance and results quantity with the Global right-click context menus.

5. Customizable Material Databases

CFdesign provides a powerful system for managing collections of materials with customizable material databases. This flexibility is essential for multi-Scenario design studies which form the basis of important design decisions.

Material Libraries: Functionality

The CFdesign Material system is designed for managing materials with a high degree of flexibility.

- Create custom material databases, and organize materials by project, customer, design stage, etc.
- Use the Database management tools to create new libraries, copy existing databases, and import databases from other users.
- Share material databases across multiple CFdesign users in your organization, while maintaining your own local databases.

Material Management: Functionality

Use the Material Editor List tool to efficiently manage materials from as many or as few libraries as you want.

- Sort materials by type and/or database.
- Quickly find needed materials with the Search tool. Mark often-used materials as “Favorites” for even quicker selection anytime.
- Create, copy, and delete materials with simple drag-and-drop mouse actions and context menu commands.

The Installed Material Database

To complement the flexibility of customizable material databases, CFdesign is shipped with a richly-populated material database.

- The installed material database contains an extensive collection of fluids, solids, and manufacturer-supplied device properties.
- With most CFdesign version updates, new materials are added. Custom material databases are not affected by version updates.

The following lists provide an overview of the flexibility and breadth of the Material Databases in CFdesign:

Materials and Device Types

Materials are physical substances, and are the foundation of the CFdesign analysis. Two distinct material types are available--fluids and solids. Material devices are representations of actual physical devices. They provide a convenient way to simulate complicated physical phenomena with simple geometry.

These are the material and device types in the CFdesign Base configuration:

- Fluid materials (including multiple fluid capability)
- Solid materials (volume and thin-shell)
- Contact Resistance material device
- Distributed Resistance material devices to simulate baffles, screens, and other obstructions (volume and thin-shell)
- Internal Fan/Pump material device (with rotational speed and slip factor)
- Centrifugal Pump/Blower material device
- Check valve material device
- Printed Circuit Board material device
- Compact thermal (two-resistor) material device
- Printed Circuit Board material device
- LED material device
- Thermoelectric Cooler material device

Material Properties

Properties are the set of physical characteristics that define every material in a CFdesign analysis. A comprehensive set of materials and their properties are supplied with the CFdesign installation, and a powerful Material Management system enables customized materials to be created quickly and easily.

These are the properties that are available for defining CFdesign materials. (Note that not all properties apply to every material type):

- Density
- Viscosity
- Thermal conductivity
- Solid material orthotropic thermal conductivity
- Specific heat
- Wall roughness for fluids and solids
- Resistance values in Cartesian or Cylindrical directions
- Flow rate, rotational speed, and slip factor for internal fans
- Flow rate, rotational speed, for centrifugal blowers
- Theta JB and Theta JC for Compact Thermal Models
- Total PCB thickness, Trace metal percentage, and Dielectric material selection for PCB devices
- Theta JB for LED material devices

Property Variation Methods

Because of the diversity of liquids and gases, a “one size-fits-all” approach to defining properties is not suitable for industrial-level fluid flow and heat transfer simulation. CFdesign provides a diverse assortment of material property variation methods to help you model the physical situation as accurately as possible:

- Environment-driven variations
- Constant
- Equation of State
- Piecewise linear (user-defined look-up tables)
- Power law

- Polynomial and Inverse Polynomial
- Arrhenius
- Sutherland
- Non-Newtonian Power Law, Hershel-Buckley, and Carreau non-Newtonian variations
- First Order Polymer viscosity variation
- Second Order Polymer viscosity variation to simulate bivariant non-Newtonian fluids
- General direction distributed resistance variation
- Free-area ratio distributed resistance variation
- Friction factor distributed resistance variation
- Head Capacity curve distributed resistance variation with independent variable selection
- Permeability distributed resistance variation
- Head Capacity curve flow rate specification for internal fans and blowers
- User-specified resistance directions: axial and cylindrical
- User-defined axial velocity profile for internal fans
- Thermostatically controlled axial fan and centrifugal blower devices
- Solidification-like properties