

## Highlights:

Easy-to-use parametric finite element cylinder structure

Cylinder structure transfers heat with combustion gas, coolant and oil circuits

Liquid circuits and thermal masses built semi-automatically from 3D CAD data

Flow solution is based on Navier-Stokes equations (robust and stable)

Always solves energy equation (thermo-hydraulics)

Stable even with zero flow and thus "standing water" presents no difficulty

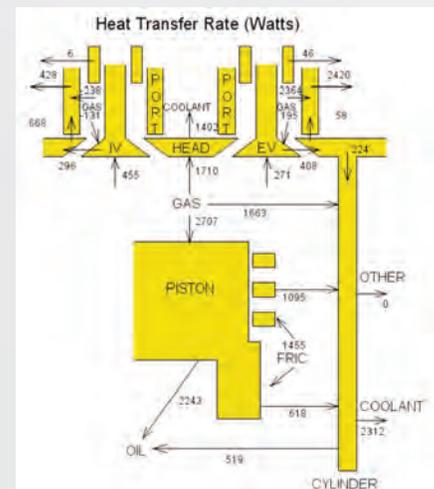
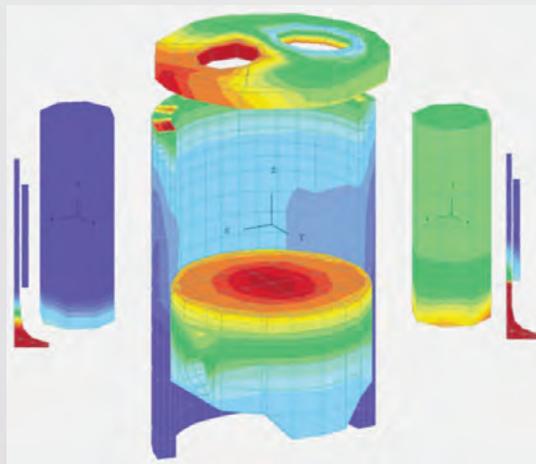
Heat distribution model easy to integrate with full vehicle models for transient drive-cycle analysis

## Engine Cooling

### Heat Distribution through the Engine Structure

GT-SUITE offers the leading solution for modeling the distribution of heat through the engine structure from the combustion chamber to the coolant, oil and ambient. It has the unique capability to **predict heat rejection to water and oil**, both at steady state and in transient events. To predict the heat distribution within the engine requires accurate handling of the "inner" cylinder structure, the sources of heat (combustion and friction), the coolant and oil passages, and the "outer" block structure. GT-SUITE offers unparalleled functionality within each of these areas.

To model the inner structure, GT-SUITE offers an easy to use **parametric FE cylinder model, unique within the industry**. The GT-SUITE solver automatically generates the FE model based on parametric geometry inputs. The piston may optionally be defined with a custom mesh based on 3D CAD data. The resulting model includes the cylinder liner, piston and rings, head fire deck face, ports, and valves. The boundary conditions from the combustion gases, coolant, and oil are automatically applied to the FE structure, along with the friction-generated heat that is applied to the piston skirt and rings. A rapid FE solver produces a solution in a **small fraction of a second**, enabling the FE model to be useful within large system models over long transients.



## Advanced Features and Applications:

Accurately account for interactions between engine cooling system, thermal structure, and combustion chamber

Built-in FE solver predicts engine structure temperatures, steady state and transient

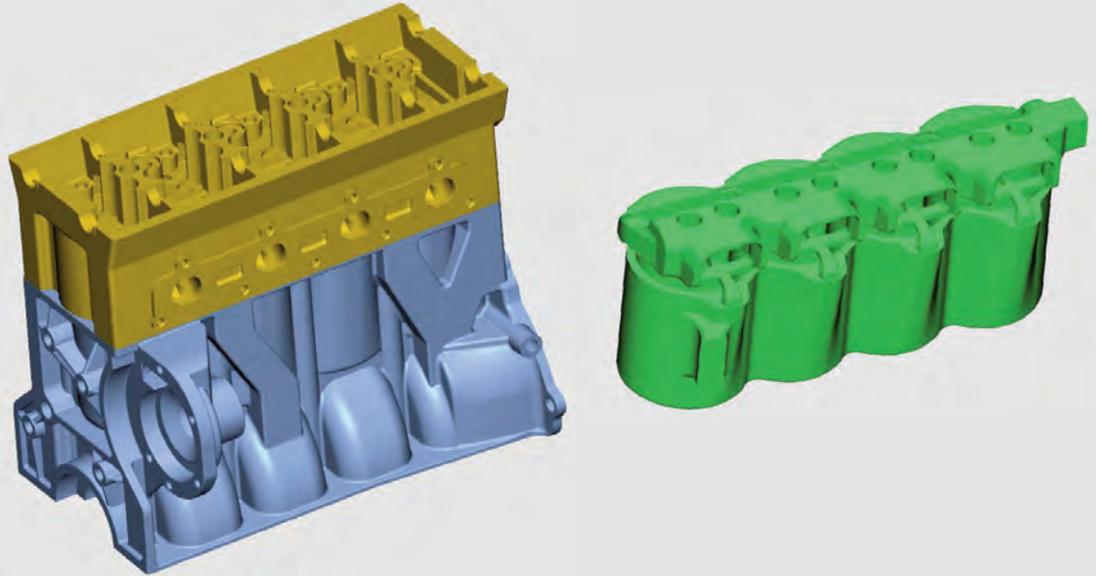
Predicts engine thermal balance by detailed modeling of conduction paths between all heat sources and sinks

Predicts heat rejection to coolant, oil and ambient

Study the potential fuel savings associated with concepts for more efficient warmup of engine fluids and structure

These capabilities are included in every GT-SUITE license

The engine heat is transferred from the FE model to the coolant and oil circuits as well as the “external” structure of the block and head. These flow circuits and thermal masses can be easily generated from CAD data using GT-SUITE’s 3D pre-processing tools.



Within the fluid volumes, GT-SUITE uses an advanced solution methodology for compressible 1-D flow, based on the **Navier-Stokes** equations. This solution is more accurate than all other hydraulic simulation tools, especially under transient or unsteady flow situations. The solution is inherently stable and therefore has no problem maintaining a stable, fast solution with zero flow.

This predictive approach to modeling the heat distribution within the engine inherently accounts for the interactions between the various sub-systems, and enables the prediction of steady-state heat rejection rates to coolant and oil. In addition, an engine heat distribution model can be prepared so that it is ready to plug in to transient vehicle system models to enable the study of advanced concepts for fuel consumption reduction

