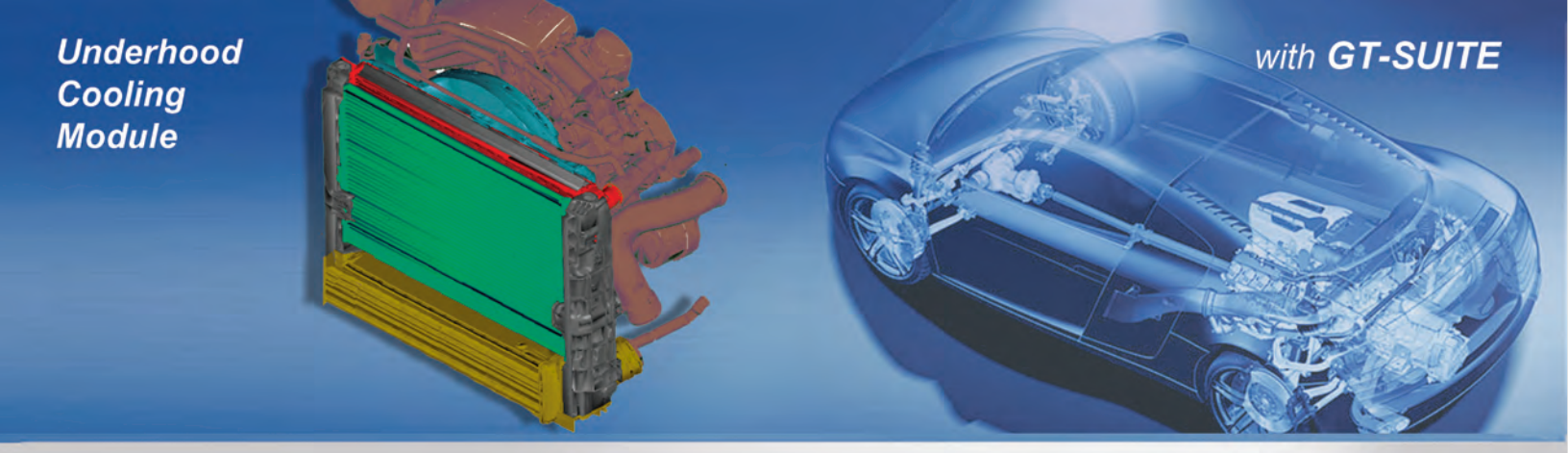
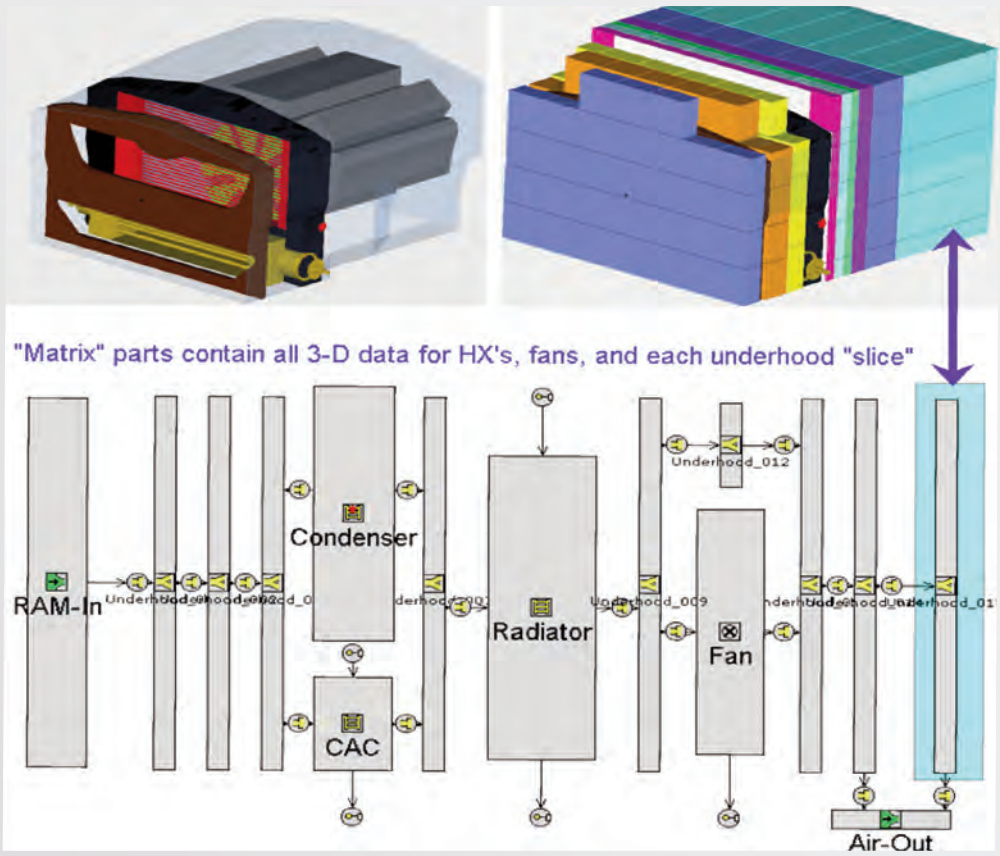


Underhood Cooling Modules

Unique 3D Flow Solution for Underhood Modules

GT-SUITE is quickly becoming the industry standard tool for **predicting the air flow rate and flow distribution in the vehicle underhood compartment, and the heat exchange with various heat exchangers** (radiator, A/C condenser, charge air cooler, oil cooler). The strength of GT-SUITE lies in the true physics-based solution, state of the art model building tools, and the ability to integrate the underhood model with any other vehicle sub-system.

GT-SUITE includes a state of the art **pre-processing tool for efficiently building models** of the underhood cooling module. This tool, called COOL3D, provides a 3-D graphical environment in which the complete underhood compartment may be built, including grill, heat exchangers, fans, fan shrouds, and various objects that block flow (i.e. engine or structural elements). This tool then discretizes the underhood into a coarse 3-D mesh of volumes, and automatically generates a GT-SUITE underhood model.



Highlights:

Models flow through complex underhood cooling packages

Represents air flow passing through a set of heat exchangers and fans

Coarse 3D CFD solution based on Navier-Stokes equations

This solution is predictive in nature, and thus is far superior to 1-D streamtube models

Rapid calculation of underhood flow under steady state and transient flow conditions

Flow discretization by a unique automatic CAD-based preprocessor COOL3D

GT Gamma Technologies

Contact us at: www.gtisoft.com

Advanced Features and Applications:

Contains models of all components of underhood module, including entry grille, radiator, CAC, EGR, and other coolers fan, shroud and few blockages

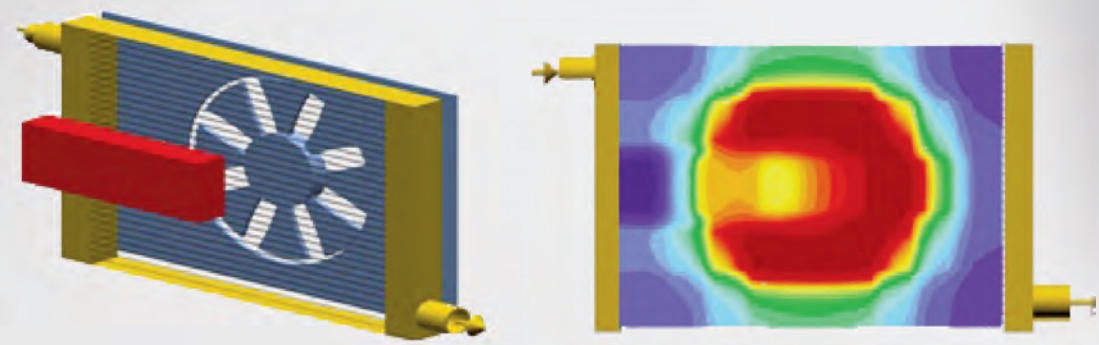
Calculates 3D flow distribution produced by the various components

Models heat exchanger heat transfer as a function of Reynolds number through the laminar, transition and turbulent regime

Accurate modeling of scaled heat exchangers due to fundamental physics

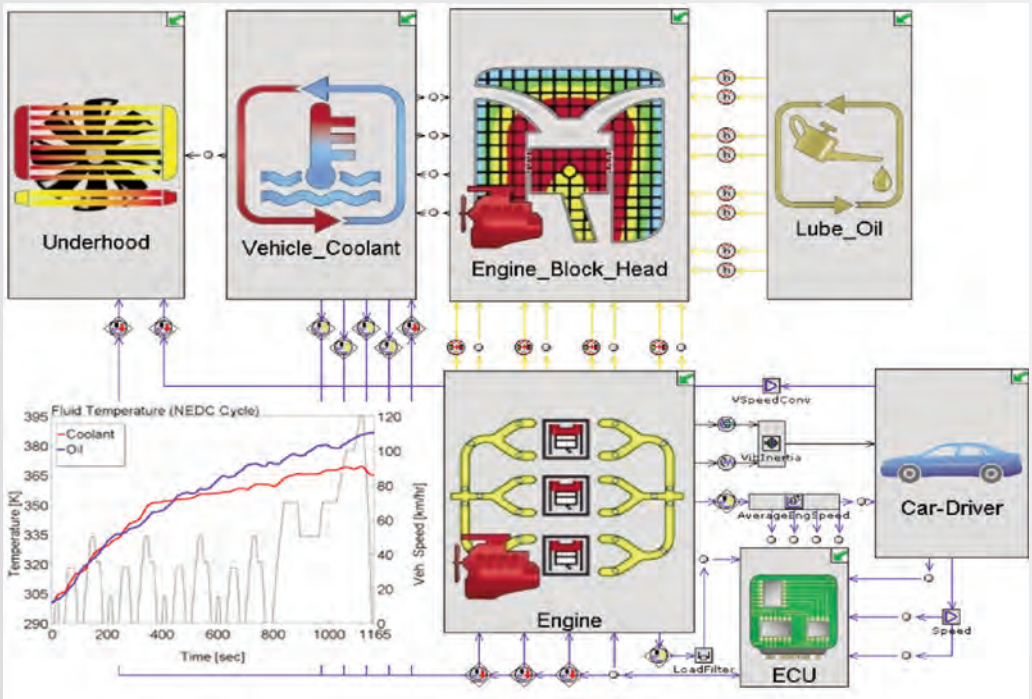
Models produced by COOL3D are exported into GT-SUITE graphical interface where they are easily connected to the complete vehicle/engine model for a system simulation of a complete system

The COOL3D tool divides the underhood air space into a **coarse 3-D mesh**, where each element of the mesh is a rectangular prism. In this way, the GT-SUITE solver predicts flow into or out of each volume through any of the 6 faces. In a similar way, heat exchangers and fans are divided into smaller connected elements, so that the airflow and heat exchange are predicted locally for each discretized element. Like all other fluid flow applications of GT-SUITE, the solution of flow through an underhood cooling module involves the simultaneous solution of the **Navier-Stokes** equations. The solution of heat exchange is performed using a 3-regime Nusselt correlation that is automatically determined to best fit measured performance data.



This approach provides a **highly accurate, predictive, and spatially resolved solution that does not require extensive calibration of "resistances" to match measured data or CFD results** (needed in all other commercial underhood tools). It also allows 3-dimensional flow phenomena such as flow around blockages or recirculation to be accurately predicted. This enables underhood module optimization early in a program **before CFD data may be available**, and also can minimize the configurations for which full CFD analysis is required.

Due to the **inherently transient solution** and the flexible GT-SUITE architecture, a GT-SUITE underhood model may be integrated with other sub-systems (engine, coolant, A/C) to include a predictive underhood model within a larger **system model**. This approach accounts for interactions between the various sub-systems, and enables accurate predictions of the impact of underhood design changes on overall engine or vehicle performance over transient vehicle drive cycles.



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