

GT-TAITHerm Solutions for Cabin Simulation

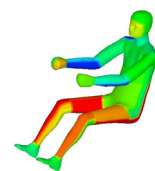
Balancing Vehicle Efficiency & Cabin Comfort in your Driving Experience

Using Simulation to Improve Energy Efficiency & Cabin Comfort

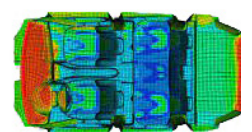
Thermal comfort, range and air quality have become standard requirements for customers today. OEMs and suppliers are also incentivized to achieve best in class efficiency when designing their systems, indeed in very hot or cold conditions energy required for driving safety and comfort may exceed the energy required for the actual city drive. As a result, vehicle range may decrease by 50% or more for extremely cold trips.

Optimizing HVAC and cabin systems is important not only for the end consumer, but also to respect upcoming EV regulatory testing procedures that include cold ambient temperature testing with cabin heating in operation. Heating needs to be achieved or spot quickly with requirements flexible enough to accommodate both resistive heating and heat pump systems.

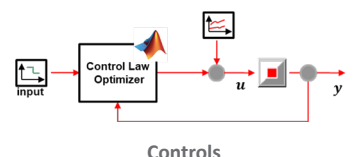
Gamma Technologies, the industry-leading Model-Based Systems Engineering (MBSE) solution provider, offers a holistic multiphysics solution that is fully integrated with ThermoAnalytics solution TAITHerm. The combined GT-TAITHerm solution helps to fulfill the needs of the industry and upcoming EV challenges. The solutions are already helping in digitizing the engineering work guiding the transformation expected for the market. This covers areas of predictive digital twins and physics-driven smart components.



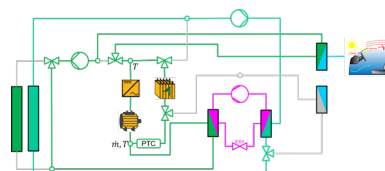
Thermal Comfort



Cabin Thermal Management



Controls

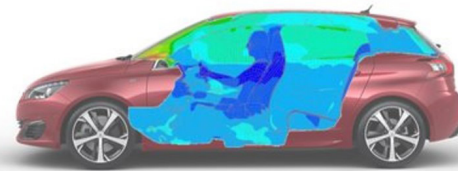


HVAC System

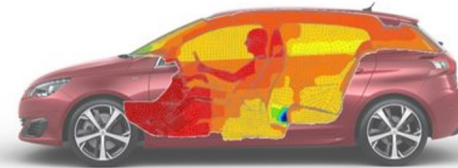
Physics Based Modeling as a Backbone for Cabin Comfort

Properly accounting for cabin heating is crucial:

- to ensure that consumers are provided with realistic estimates of electric vehicle range
- to have efficient HVAC systems that can prove their effectiveness and justify any potential cost differential between them and more conventional resistive heating systems
- to understand and document the degradation in attainable range and vehicle energy efficiency (and hence CO2 emissions) over the operating lifecycle of the vehicle
- to accurately capture the impact of cabin design on human thermal comfort



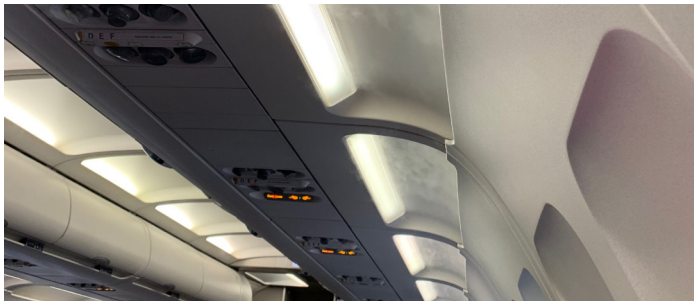
Cool-Down Analysis



Heat Up Analysis

GT-SUITE and TAItherm synergetic simulation solution:

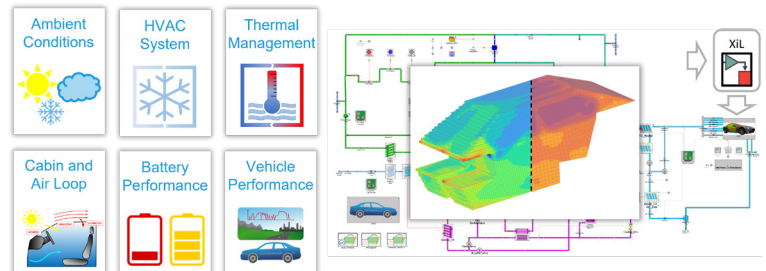
- 3D resolved cabin temperature with fully transient solution, connected to cooling and 2-phase systems seamlessly and offers a holistic multi-fidelity resolution of the problem statement
- Accurate and fast (several degrees of magnitude faster than traditional 3D-CFD) capable of close to Real-Time prediction of cabin thermal comfort
- Run drive cycles (i.e. WLTP, RDEs) and optimize through virtual calibration controls control strategies based on zonal temperatures
- Optimize thermal comfort strategies such as thermal pads size and location, seats cooling and heating, steering wheel heating and cooling...
- Optimize glass coating and isolation materials to reduce solar load into cabin
- Fully utilize TAItherm's built-in thermal manikin model to predict sensation and comfort of the occupants



Virtual Calibration and Controls:

Setting up control algorithms for a cabin systems can be a daunting task especially for system integrators that have to rely on supplier hardware and data. Many hours spent in the test lab running system cycles in specific climatic chambers are often needed to fine-tune the system.

For this reason, GT-SUITE and TAItherm Solutions are an excellent ally to hardware testing: the digital twin is easily connected to hardware and software algorithms, enabling virtual testing and controls calibration. Transient, predictive, 2-phase, real-time capable digital twins are key in achieving a successful Software/Hardware-in-the-Loop (SiL/HiL) and will be a key enabler for a faster



How GT-SUITE & TAItherm Simulation can help:

- Classify cabin technology bricks with respect to thermal comfort, cost, EV range and controls optimizations
- Pre-map controls algorithms prior to climatic chamber or hot/cold testing
- Multi-physics solution to investigate a complete system design and performance including novel refrigerants and accurate charge prediction
- Real time, predictive models that can run SiL/HiL (Software and Hardware –in-the-loop) as well as on the cloud for live

Key Takeaways:

- Model-based Digital Twin for Component and System optimization
- Virtual controls optimization for minimal operating costs

Democratizing Simulations with GT-PLAY : A cloud-based Solution



Scan the QR code to learn more about GT's simulation software to design and optimize HVAC Engineering

