

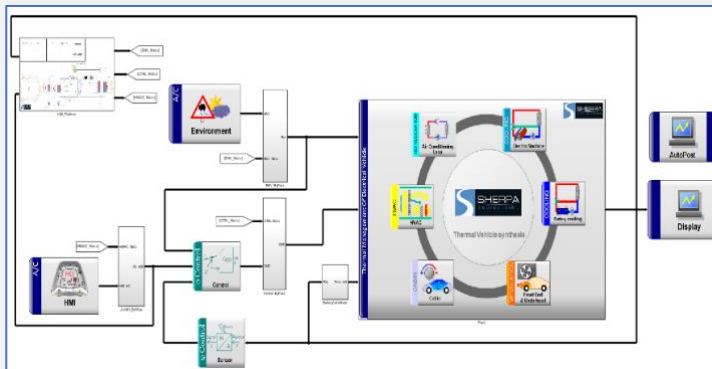
# E-Vehicle Thermal-Management Simulation Platform

**Sherpa Engineering** has developed expertise in automotive air conditioning and engine cooling systems for over 20 years.

Through multiple R&D projects with European OEMs, we have developed state-of-the-art multi-disciplinary modeling and controls system design tools.

## Description of the Simulation Platform

The **Thermal Management Platform** extends MATLAB - Simulink modeling and simulation.



Simulink Model of the Thermal Management Platform

The technical perimeter covers the last innovating cooling systems architectures, including a Heat Pump with two evaporation branches, one for the HVAC unit to cool the cabin and one for a Chiller that cools the EV battery through a secondary fluid loop. A water condenser is connected to the HVAC to warm the cabin during winter, while Electrical devices (motor and electronics) are cooled by a dedicated water loop. The platform integrates a large database of refrigerant and fluids, allowing you to expand the scope of your studies.

## Purpose of the platform

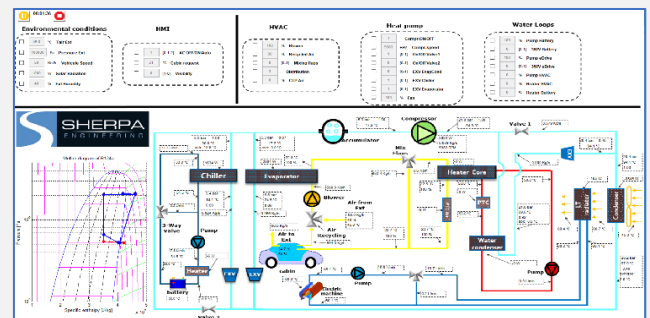
### Plant architecture studies:

- **Quickly and efficiently design** your thermal system architecture and test it according to standard protocols or your own ones.
- **Size the architecture components** of your plant. Your sizing studies are easy and fast because your design is directly related to vehicle results (cabin comfort, battery temperature, energy use).
- **Compare several architectures** according to different criteria (Maximum Power, Cost, Overall Energy Efficiency, Complexity, Range of Use etc.)
- **Easily calibrate** your existing components or develop your database of components.

The acquisition of know-how in this field through many research and industrial projects with European OEMs has enabled us to develop powerful tools for multi-physics modeling and control system design. Our product is a performant Thermal Management Simulation Platform that offers many possibilities to design and test your thermal system and its control logics, with a high accuracy and in a fast way.

A moist air circuit is also modeled and represents aeraulic chain including the HVAC unit and a cabin comfort module. One main advantage of this platform is that it **combines control algorithms with the plant model**. This allows you to design closed- loop control logics to optimize comfort and energy consumption. By default, a standard control module comes with the platform.

Our platform **allows you to simulate dynamically all your scenarios, standard ones coming from regulation (NEDC, WLTP...)** or your own ones, with a wide range of inputs values.



An attractive control HMI allows you to visualize in real time many variables from control and plant model. The HMI makes it possible to manually change actuators controls or to modify environment inputs in order to study specific cases.

### Control design studies :

- **Design or integer your own control** algorithms from MATLAB/Simulink. Being in a closed loop, the control design is robust and fast.
- **Run calibration studies on your control SW**. You win time and reduce the expensive physical tests during the validation phase.
- **Reproduce problems** measured during vehicle or bench tests, by injecting experimental data into the platform.
- **Generate industrial code** with auto-coding tools compatible with MATLAB/Simulink.

## The strengths of our Simulation Platform

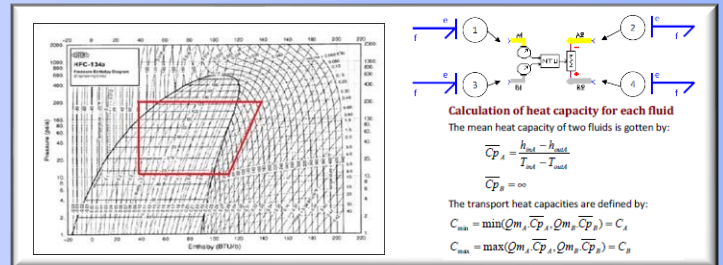
### Combining multi-physics modeling and control design

The Thermal-Management Simulation Platform is the only tool on the market that allows you to run accurate multi-physics modeling activities and powerful control design in the same environment.



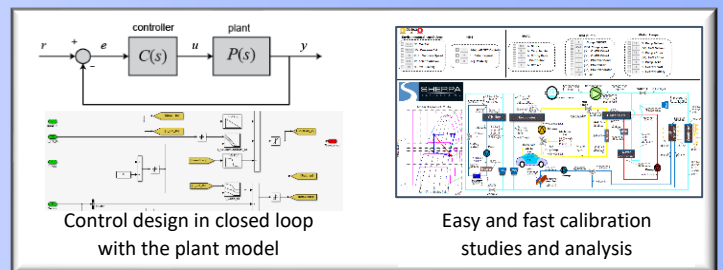
### The best in 0d/1d thermo-fluid modeling

The platform is based on a strong knowledge in diphasic heat exchange phenomena. Thermo-Fluid modeling is complex, notably in diphasic area. Sherpa developed during time a very robust way to calculate in 0d/1d the exchangers surface ratio and build refrigerant loop models with a high level of precision.



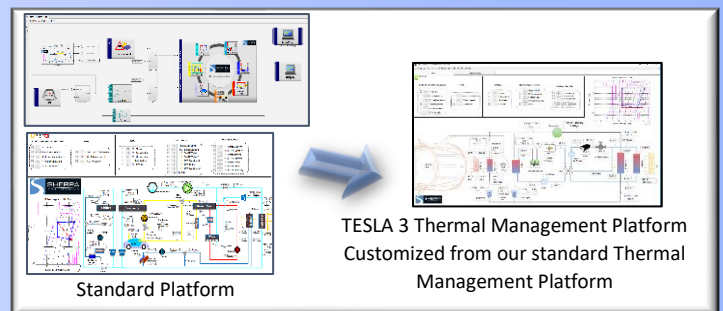
### Fully suitable for control design

The Platform extends MATLAB/Simulink, which is one of the best tools to design robust control software. You can use the platform to design your own control logics or to connect your existing ones directly in it. Using adequate auto-coding tools, you can run MIL, SIL or even PIL studies directly with the platform.



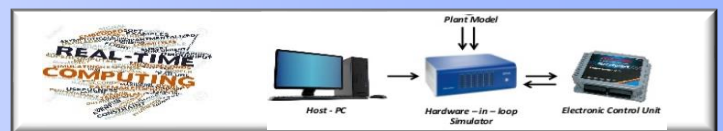
### Easy to customize!

The platform is open. This means that you can change the plant model architecture and adapt it to your own needs. It is also possible to load your own control software and connect it to the plant multi-physics model directly in the platform. Sherpa is able to help you in these kinds of tasks. We can also deliver to you completely custom-made platforms.



### Real-Time Compliant

The platform subsystems are real time compliant. You can use the multi-physics models for any HIL application.



### Bond-Graph based

The modeling methodology is based on the Bond-Graph theory. Only a couple of tools in the world are using this approach to design multi-physics models. The Bond-Graph methodology enhances the visual understanding of physical systems through the explicit indication of the cause and effect relationships of energy transfer between subsystems. The management of the causality (mandatory in a non-causal tool like Simulink) guarantees a high level of robustness to the simulations of our applications.

