Thermal Management

Smart Thermal Control — Engineered For Motion.

We make ideas happen.

For almost 60 years **ARRK Engineering** has supported renowned customers as a globally active partner for the automotive and mobility industry in the development of their products. Our customers can count on innovation, dependability, and sustainability for smooth development of their products by our competences.
The foundation for our success is the interdisciplinary expertise of our 1,800 employees at locations in Germany, Romania, Spain, the Netherlands, Malaysia, the USA, Japan, and China, as well as the cooperation within the international ARRK Group.

Together with other companies in the ARRK Group, ARRK Engineering supplies parts and components in small series and supports its customers from a single source. As a subsidiary of Mitsui Chemicals, the ARRK Group is part of a shareholder that also significantly expands the Group's options for action with its international setup as a supplier of plastics for the automotive and mobility industry.

Thermal Management and the direct drive train are the basis for an efficient, dynamic driving experience.

Whether for gasoline, diesel, hybrid or BEV propulsion, we work with you at all levels and in all areas to develop the thermal management system that is right for your particular application. With our interdisciplinary skills, we can develop cooling, heating and air conditioning subsystems as well as an efficient complete system, and adapt them to your specific case.

Modules


Car Body


High Voltage Battery


Powertrain

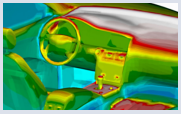

Chassis


Interior & Exterior


Optical Systems

Interdisciplinary Topics


Electronics & Software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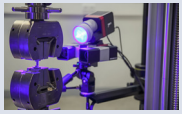

Material


Acoustics


Composite


Digitalization & Software

Entire Vehicle Systems


Automated Driving

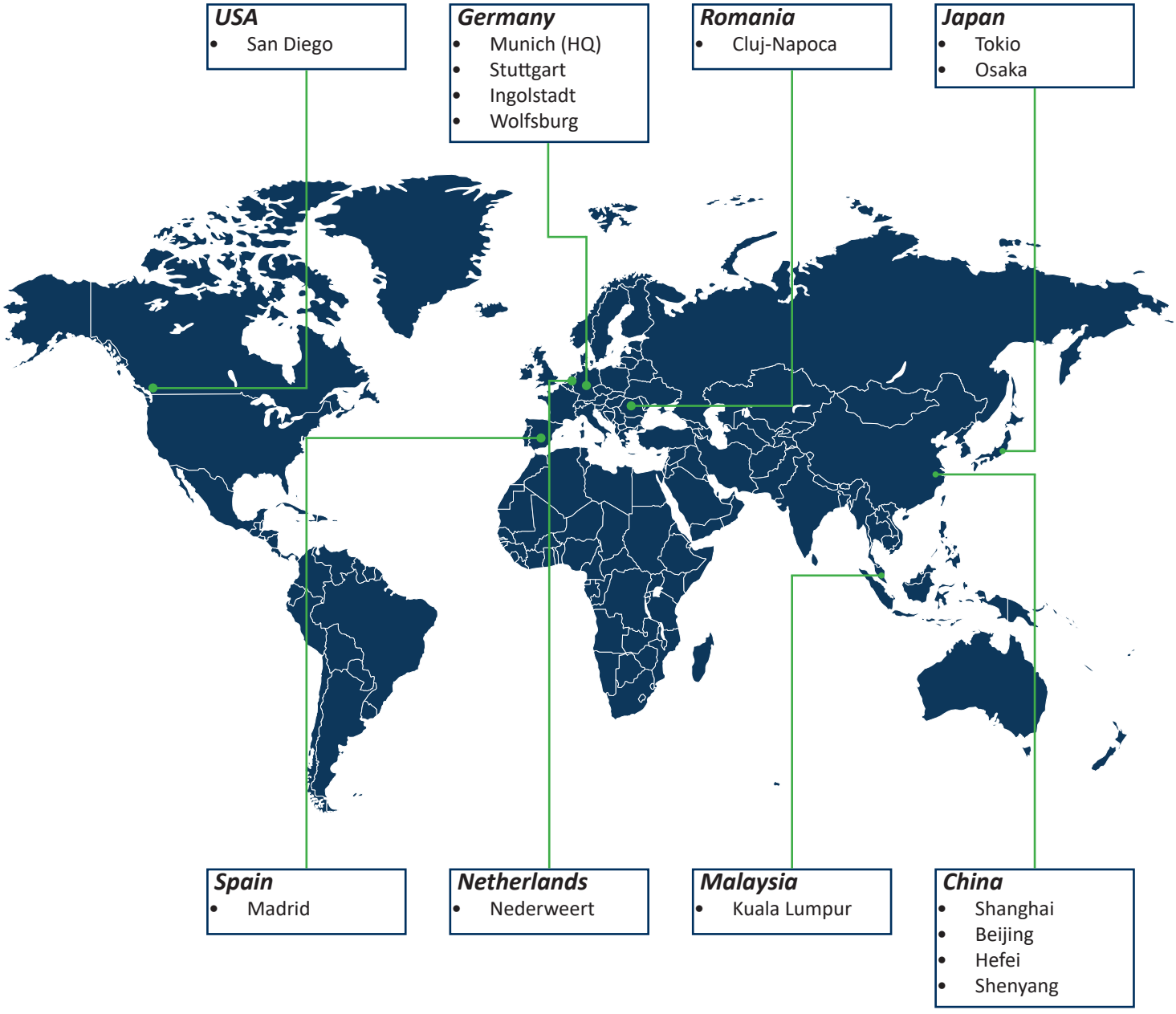

Passive Safety


Thermal Management

Sustainable Transformation


Sustainability Management

ARRK Engineering Locations



Development Process

Circuits

- ✓ Cooling Circuit
- ✓ Heating Circuit
- ✓ Refrigeration Circuit

Control & Regulation

- ✓ TME and Climate Control
- ✓ Functional Description
- ✓ Software Architecture
- ✓ Software & Control Unit

Refrigerant, Cooling and Heating Circuit

- Component Development & System Development
  - *Thermal management modules*
  - *Multifunction valves*
  - *Acoustic measures*
- Geometric Vehicle Integration
  - *System Design*
  - *Positioning & Fix Components*
  - *Piping & Tubing*
- Validation
  - *1D & 3D Simulation*
  - *System Test Bench & Vehicle Testing*

Function Development & Control Strategy

- System Requirement Analysis
- System Architecture
- Functional Concept
- Software
- SW Integration
- Testing
- Application

Interior Comfort

- ✓ Conditioning of the Cells
- ✓ Cooling of the Control Unit
- ✓ Cooling of the Connectors

Battery Conditioning

- ✓ Air Flow & Air Distribution
- ✓ Comfort Evaluation & Optimization
- ✓ Validation (Defrost, Defog ...)

Interior Comfort

- Design of the air ducting system incl. performance of air-conditioning compressor and HVAC incl. ventilation and extraction
- 1D & 3D Simulation
- Component Testing
- Geometric Vehicle Integration
  - *Integration of the air ducts in the passenger compartment*
  - *Integration of Ventilation & Deaeration*
  - *Introduction of Mechanisms for Air Properties (ionisation, scenting, sterilisation...)*
- Validation

Battery Conditioning

- Thermal design & optimization of the active battery heating & cooling systems
- Thermal assessment of cell interconnection & contact interfaces
- Identification & evaluation of thermally critical regions (thermal runaway initiation & propagation behavior)
- Evaluation of thermal insulation materials & processes (e.g., foam encapsulation)
- Analysis & assessment of filling & degassing procedures within the high-voltage storage (HVS) system

Simulate. Analyze. Optimize.

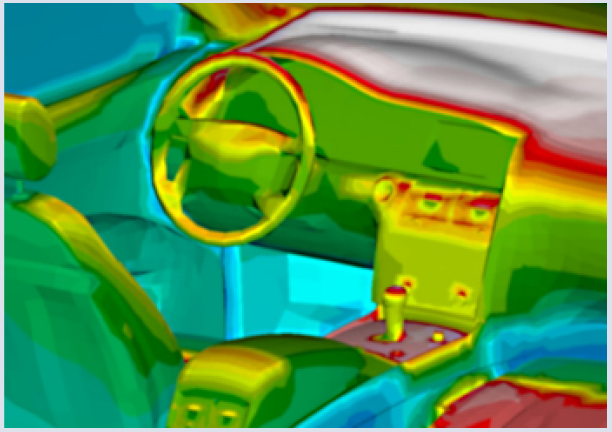
Multi-Air-Zone Comfort Evaluation – Real-Time Vehicle Climate Assessment

ARRK Engineering has developed an advanced Reduced Order Model (ROM) method, now integrated into the comfort solver Theseus-FE, called **Multi-Air-Zone Comfort Evaluation.**

This innovative approach enables real-time comfort assessment for various load cases inside the vehicle cabin. The method couples a 1D system model of the refrigeration circuit with the detailed cabin model in Theseus-FE, enhanced by a precomputed CFD simulation.

To ensure accuracy, the results were validated on a test bench and further confirmed using ARRK Engineering's in-house developed **HVAC measurement dummy.**

Looking ahead, the next milestone is the integration of the climate control algorithm, enabling a detailed virtual HVAC system as part of the digital vehicle. This will allow the entire climate control system to be simulated and applied virtually in real time.



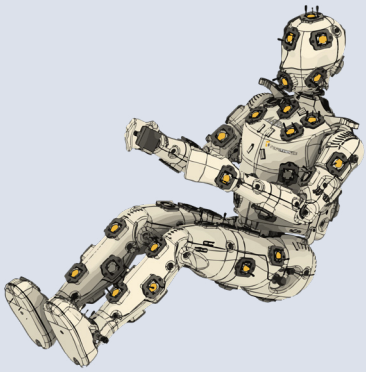
– For True Passenger Comfort

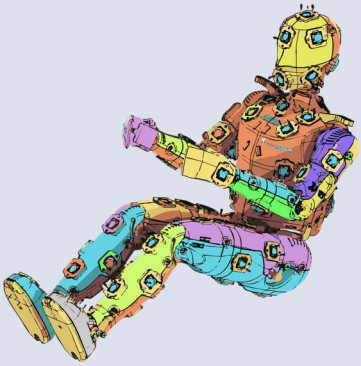
Theseus and Perithous – A Legendary Friendship

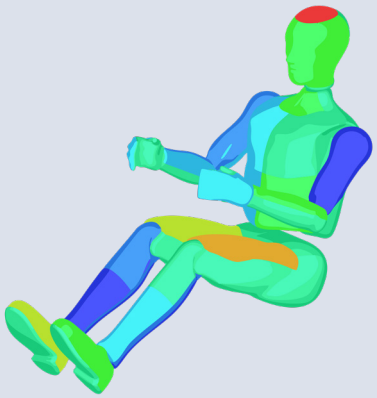
In Greek mythology, **Theseus**, hero of Athens, and **Perithous**, king of the Lapiths, are often portrayed as close companions. Their bond was forged through mutual respect for each other's strength and courage. According to legend, after an initial confrontation, the two became inseparable allies, embarking together on daring adventures.

Their friendship is frequently cited as an example of loyalty and solidarity, even in the face of great challenges.

Technical Parameters	**Number of sensors: up to 73**
Measuring range:	-20°C to +70°C *(Air temperature)*
	0.1-5.0 m/s, Bidirectional *(Wind speed)*
	close to 0 – up to 2000 W/m² *(Radiation)*
	0 to 95% RH, non-condensing *(Relative humidity)*







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