Overview – Features and Applications
About us...
Our Company

Magna International

SEATING  EXTERIORS  CLOSURES VISION SYSTEMS  ROOF SYSTEMS  BODY & CHASSIS  POWERTRAIN ELECTRONICS  VEHICLE ENG CONTRACT MFG  FUEL SYSTEMS

Engineering Center in St. Valentin

- Complete Vehicle Engineering
- Technology & Software Development
- Vehicle Testing
The KULI Team

Energy & Fluid Simulation
Christian Rathberger

Sales
Rolf Salomon

Services
Christian Rathberger

Software Development
Thomas Naderhirn

Software Methods
Christoph Stroh

Software Developers and Software Users exist under one umbrella!
What is KULI?
Powertrain Cooling

Air Conditioning

Consideration of all Thermodynamic Key Values

- Temperatures
- Pressures
- Mass flow
- Heat flow
- Other Energy flows

Windows Desktop Software for the 1D-Simulation of the Vehicle Thermal Energy Management
Thermal Management Software

1-dimensional Fluid Network Analysis – Quasi 1-dimensional Air Flow Network Analysis
Energy Management Software
Typical Applications
Typical Applications – Top Tank Temperature

Input

- KULI data for fans and coolers
- Volume flow data for all participating fluids
- Ambient temperature
- Driving velocity
- Rejected heat by the condenser
- Amount of glycol in the coolant

Results

- Top tank temperature
- Air to boil
- Analysis of the operating points of the fans/coolers
  Additional results:
  - Parameter variation (fan speeds, volume flows,...) on the above mentioned measurable variables
• Compare direct and indirect charge air cooling

low temperature radiator

conventional CAC

water-cooled CAC
Typical Applications – Minimize Package Size

- Reduce heat exchanger sizes according to performance limits
Typical Application – Transient Simulation

- Warm up and cool down investigations

Thermal capacities considered

KULI Engine Model
Typical Application – Cool Down Simulation

- Find evaporator heat load such that passenger Cabin cool down requirements are met
Applications – A/C system use for battery conditioning

Complete vehicle thermal management

- A/C system use for battery conditioning
- Heat pump
- Air Condition (electric driven)
- Latent Heat Storage System
- …
Typical Application – Energy Management

Energy Management Simulation for a Hybrid Truck

Driving Cycle (HUDDS)
Heavy-Duty Urban Dynamometer Driving Schedule

Fuel Saving Potentials

Parallel Hybrid Vehicle

Battery, Coolant Temperature
Application – Cell Temperature Optimization

- Battery type (Li-ion, NiMh, …)
- Internal resistance
  = f(current, temperature, SOC)
- Open circuit voltage characteristic
  = f(temperature, SOC)
- Heat source
  = f(current, internal resistance)
- Cell cooling
- Thermal network
Why KULI?
Why Thermal Energy Management?

- Engine power increasing
- Inlet area decreasing (design)
- New technologies (e.g. hybrid)
- More components / auxiliaries
- Legislative Standards

Emissions
Fuel Consumption
Costs

Comfort
Durability
## Why use Computer Simulation?

<table>
<thead>
<tr>
<th>System Comprehension</th>
<th>Concept Studies</th>
<th>Support Test Bench</th>
<th>System Optimization</th>
<th>Minor Model Update</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Understand complex component interactions easily</td>
<td>• Fast analysis and solutions: “Rapid Prototyping”</td>
<td>• Improve test quality through plausibility checks</td>
<td>• Quickly find measures for improvement</td>
<td>• Easy handling of engine upgrades</td>
</tr>
<tr>
<td>• Effects of single measures can be within measurement accuracy</td>
<td>• Save time and cost (test bench, prototypes)</td>
<td>• Reduce hardware test loops</td>
<td>• Find control strategies for auxiliaries</td>
<td>• Component replacements: compare different suppliers</td>
</tr>
</tbody>
</table>
Why use KULI? – Low Hardware Demands

- Works on any laptop
- Steady state results within seconds
Why to use KULI? – Realistic Results at Low Effort

Learn to use within 2 days of Training

- Component & Function Toolbars
- Project Organization
- Analysis Progress Info
- 2D Fluid Network View
- 3D Air Network View
Why use KULI? – Tailored to Customer Needs

From Engineers for Engineers

Specialized: Automotive Industry

Flexible Software: simple & complex

Modular Structure
Passenger Cars – Trucks – Construction/Farm Machines – Trains… | OEMs – Suppliers – Researchers
Why to use KULI? – Multitude of Features

- **Postprocessor**
  - Output Analysis
  - Presentation Material for Management

- **Uniform Component Library**

- **Extendable Media Library**
  - Water/Glycol, Oil, Exhaust, Refrigerant

- **Unit Converter**

- **Optimization Package**
  - Optimization, Parameter Variation

- **Software Interfaces**
  - Excel, Matlab, CFD codes,…
Why use KULI? – Best Software Support

Support is given by all members of the KULI Team
- Expertise through product overview
- Expertise through product insight
- Expertise through product practice

Friendly and personal
- Working to YOUR advantage

Quick response
- Usually within 24 hours

Facility to “enhanced” support
- Paid services for quick and reliable solutions

Sales

Services

Software Development

Software Methods

KULI Team

kuli.support.mpt@magna.com

07.08.2017
R. Salomon
Who should use KULI?
Who should use KULI?

Engineers concerned with Thermal Management
(not restricted to Automotive Industry)

<table>
<thead>
<tr>
<th>OEMs</th>
<th>Suppliers</th>
<th>Researchers</th>
<th>Engineering Service Companies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design-Engineers</td>
<td>CAE-Engineers</td>
<td>Test-Engineers</td>
<td></td>
</tr>
</tbody>
</table>

R. Salomon 07.08.2017
How to get started?
When to use KULI - Product Development Process

Key Milestones:

- Product Specification
- Concept Development
- Virtual Model
- Product Design
- Simulation / DMU / Validation
- 1. Prototypes / Mules
- 2. Prototypes / Pre-Production
- Product Validation

Program Management:

- Functional / Fatigue / Vehicle Testing
- Program Management

Product Definition:

- Concept
- Simulation
- Prototyping
- Funct. Testing
- Vehicle Testing

When to use KULI:

- Product Development Process

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How to use KULI – Data Structure

Vehicle Data
- Design
- Engine

Simulation Conditions
- Ambient
- Operating Status

Component Data
- Dimensions
- Characteristics

Boundaries & Targets
- Max. Dimensions
- Max. Top Hose Temperatures

OEM

SUPPLIER
How to use KULI – Workflow

**Component Setup**
- Input data (Geometry, Characteristic)
- Save in Component Library

**System Setup**
- Load components (from Library)
- Define Media Properties
- Position and Connect Components
- Input Simulation Parameters

**Simulation**
- Run Analysis
- Optimize, Vary Parameters

**Results**
- Get Output from Postprocessor, Excel Sheet,…
- Compare with System Measurement Data
- Interpret Results, Reporting
How to use KULI – KULI lab Output

Temperature levels and Pressure Drops

Heat Turn-over and Efficiency of Package

Detailed Conditions and amounts of Cooling Air

Optimized Parameters depending on Targets

User-defined Units

Data Filter

Various Graphics

Variant Comparison
Where to buy KULI?
### Global Contact

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