



**GVPM Thermal Management Overview**  
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## Report Documentation Page

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14. ABSTRACT <b>Any system that generates or consumes power rejects heat. This heat is typically not considered as a significant design factor when integrating on a platform. Most military engine cooling systems are under-designed as a result negatively impact mobility functions. Internal combustion is the only source of power on all military vehicles. There are no other alternative energy sources on any military vehicles. Soldiers are routinely exposed to elevated in-cabin temperatures (above 85F), consequently their ability to complete the mission is negatively impacted.</b>			
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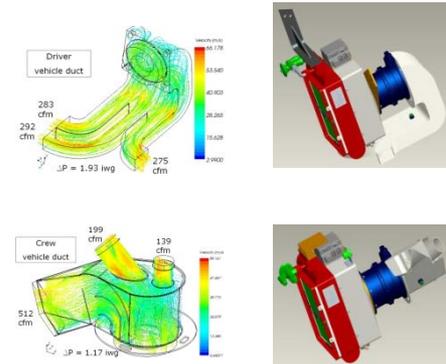
# Thermal Management

## Challenges we have:

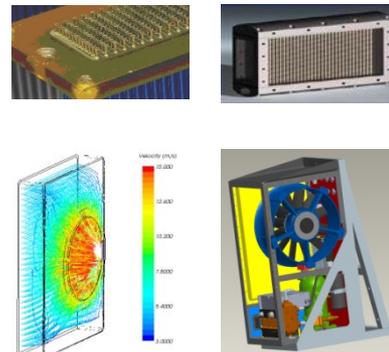
- Any system that generates or consumes power rejects heat. This heat is typically not considered as a significant design factor when integrating on a platform.
- Most military engine cooling systems are under-designed as a result negatively impact mobility functions.
- Internal combustion is the only source of power on all military vehicles. There are no other alternative energy sources on any military vehicles.
- Soldiers are routinely exposed to elevated in-cabin temperatures (above 85F), consequently their ability to complete the mission is negatively impacted.

## Solutions we are investigating:

### Redesigning More Efficient In-Vehicle Air Flow Paths and Air Handling Units (AHU) Using Computational Fluid Dynamics (CFD) and Modeling and Simulation (M&S)



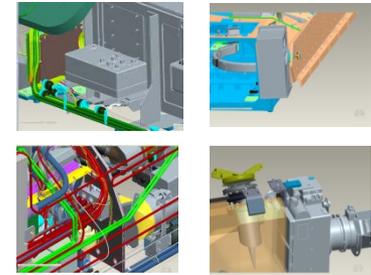
### Advanced Heat Exchanger Design, Development, and Testing in New Vapor Compression System



### Development of High Voltage Electrically Driven Components (Fans, Pumps, Valves and Controllers) that Support Electrification of Thermal Management Systems



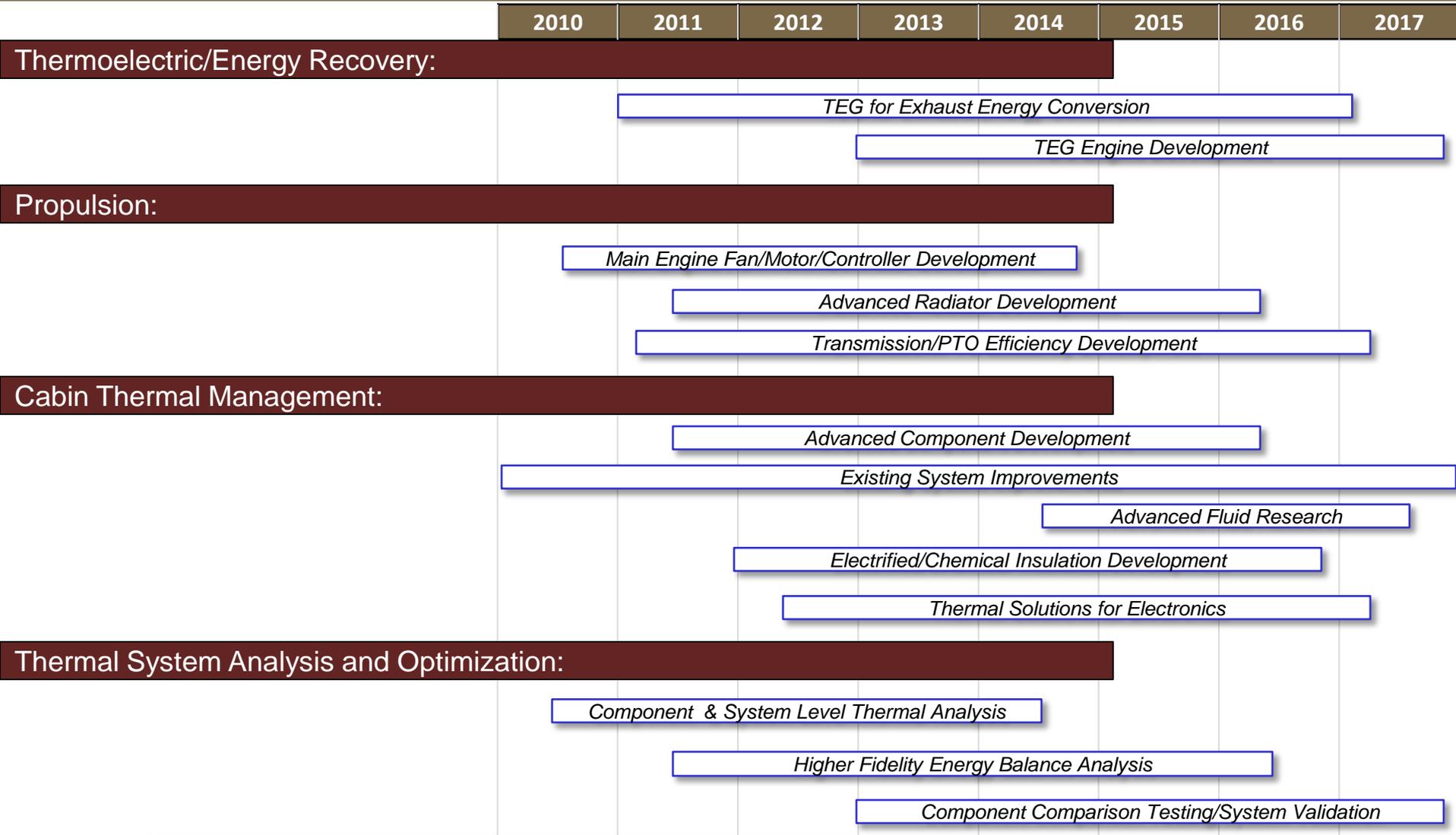
### Thermoelectric modules to be incorporated into exhaust or engine compartment



## Where we need your help:

- Innovations in: Improved system performance, thermal component efficiency, reduce fan power consumption, reduce component size and weight, minimize waste heat, efficient techniques to move and manage heat
- Existing energy balance and thermal optimization tools
- Advanced fluid research for cabin thermal management and/or propulsion cooling

# Projects Current & Future



# Laboratory Capability Current & Future



## Current Capability



- Air Filtration Test Bench
- Vehicle Radiator Evaluation

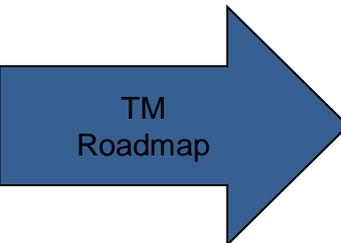
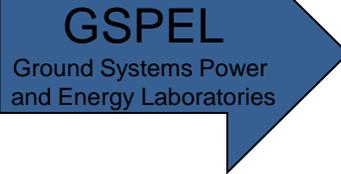


- Thermoelectric Bench Testing

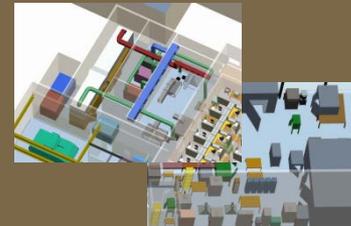


- Full Load Cooling Test
- Cabin Cooling Evaluation

- Labs
  - Building 212 – vehicle level testing
  - Building 7 – limited component testing
- Capability to test components for verify against standards
- Small scale thermoelectrics
- Sub-system HVAC validation



## Future Capability



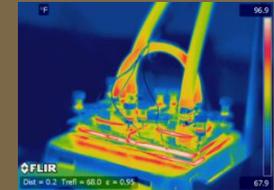
- Air Filtration Test Bench
- Vehicle Radiator Evaluation

- Thermoelectric Validation Testing

- System Level Thermal Management Analysis



- Full Load Cooling
- Cold-start / operation
- Cabin Heating and Cooling Evaluation



- Labs
  - Building 212 – maintain test capabilities
  - GSPPEL – relocated Building 7 testing and increase capability
- Capability to test components at a sub-system level for validation of supplied/modeled data
- Increase operating range and analyze thermal from system level

# Energy Usage

(For average representative platform under one specific steady state point)

# GVSETS

GROUND VEHICLE SYSTEMS ENGINEERING AND TECHNOLOGY SYMPOSIUM

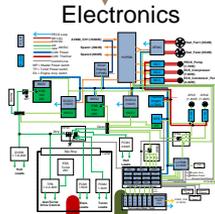
## Energy from Fuel



Exhaust  
30%

Engine Cooling  
30%

Indicated Power  
40%



Sprocket Power

Waste Heat  
30%

Waste Heat  
30%

Waste Heat  
1%

Utilized Power  
8%

Waste Heat  
1%

Waste Heat  
5%

Sprocket Power  
25%