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Advanced Planning Briefing for Academia

APBA

Ground Vehicle Power & Mobility (GVPM)

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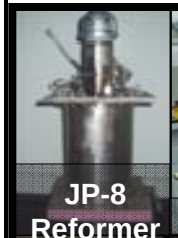
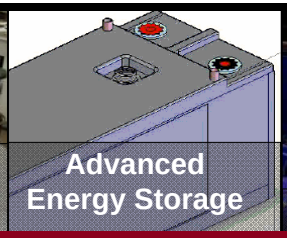
GVPM - Mission and Vision

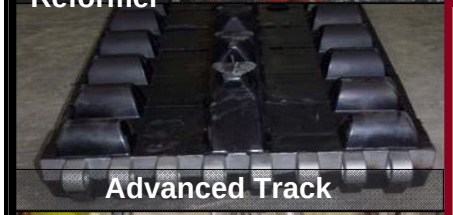

JP-8 Reformer


Engine Testing


Air Cleaner Testing


Advanced Energy Storage


Power and Energy SIL


Advanced Track


Transmission Testing


Air Conditioning Test

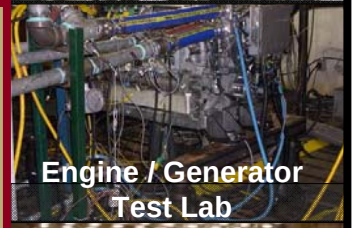

Auxiliary Power Units


Engine Research


Integrated Power and Thermal Systems

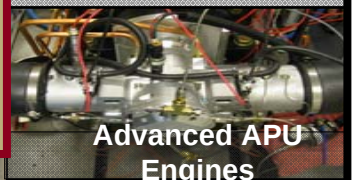

APU Testing & Analysis


Elastomer Research


Engine / Generator Test Lab


Full Load Cooling Test


Advanced Power Electronics


Advanced APU Engines


Energy Storage

MISSION:

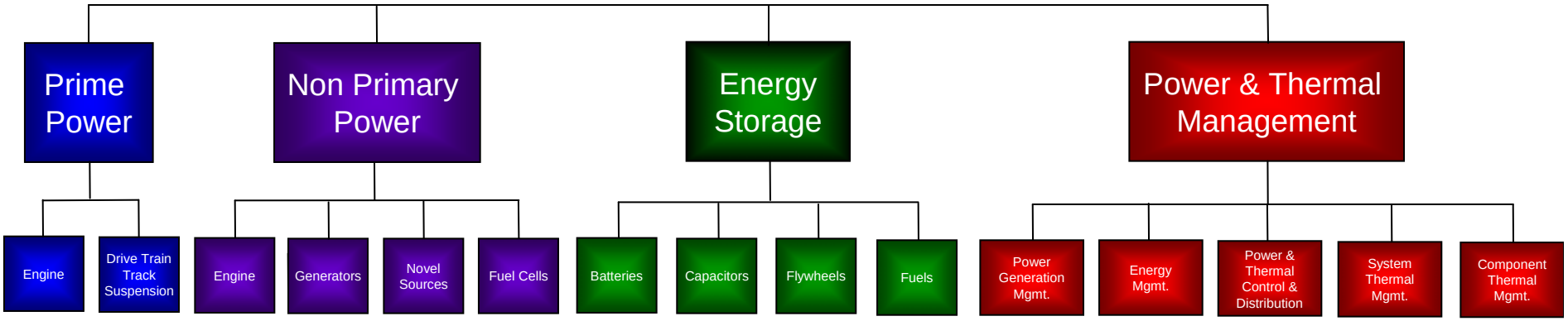
Provide technically sound and timely responses to the soldiers' current and future needs for technology and engineering expertise in ground vehicle power and mobility technologies.

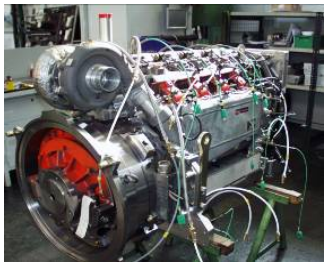
VISION:

Be the Army's "Center of Excellence" for technology and engineering expertise for research, development, testing and engineering of ground vehicle power and mobility technologies – today and tomorrow.

UNCLAS: Dist A. Approved for public release

GVPM – Organizational Thrust Areas

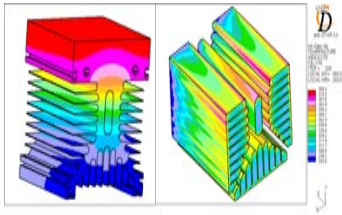




Prime Power

Non Primary Power

Energy Storage



Power & Thermal Management

Prime Power (Engine) Technology

Problem:

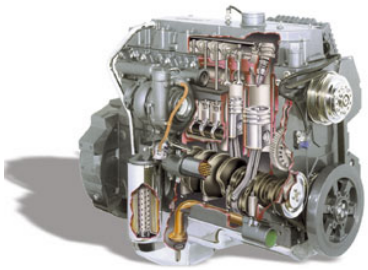
Current high power commercial engines are not compact enough for future manned ground combat platforms.

Future ground combat vehicles will require lighter and more efficient engines that occupy less space.

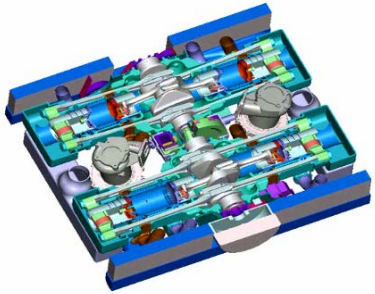
Current state of the art engines require significant development operate on one fuel and meet future vehicle power and mobility needs.

Research Challenges:

- Diesel combustion research to increase physical burn time.
- Propulsion system research to increase power density.
- Engine thermal management research.
- Research combustion optimization strategy for JP-8 military version of an emission compliant commercial engine.



Diesel Engine Research



Advanced Engine Research

Advanced Combustion System Research

Hybrid Electric Technology

Problem:

Hybrid electric systems for combat and tactical vehicles challenged to meet mobility requirements within the specified space and weight constraints.

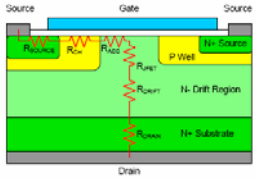
The State Of the Art power electronics operate at low temperatures resulting in large cooling system which also requires a significant amount of power from the prime mover.

These challenges result in over sizing the engine/generator to gain power lost to the cooling system.

Research Challenges:

- Research high temperature / high frequency compact power electronics.
- Research high power / high torque density motor / generators.
- Research advanced power electronics and component thermal management.

Traction motor



SiC MOSFET

Power & Energy SIL

Track Technology

Problem:

Future combat vehicles desire lightweight track with no degradation in robustness or field supportability.

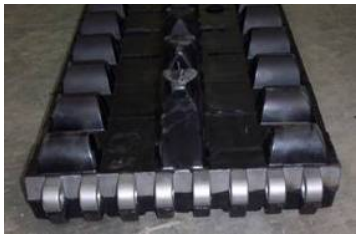
Current lightweight track durability challenged at higher GVW vehicles.

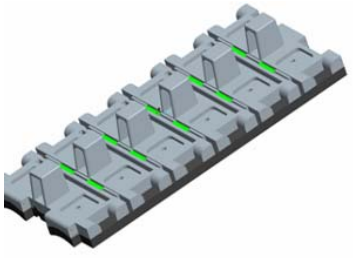
Current lightweight track prone to anti personnel mine blast damage.

Elastomer components are track system life limiter of legacy track fleet.

Research Challenges:

- Research new lightweight metallic materials for track system application.
- Research understanding of mine blast event to improve track survivability.
- Research elastomers for improved life spans under high stress / high temperature conditions





Suspension Technology

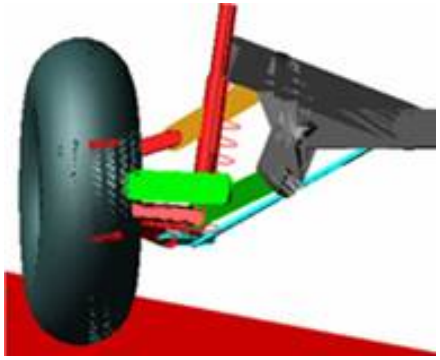
Problem:

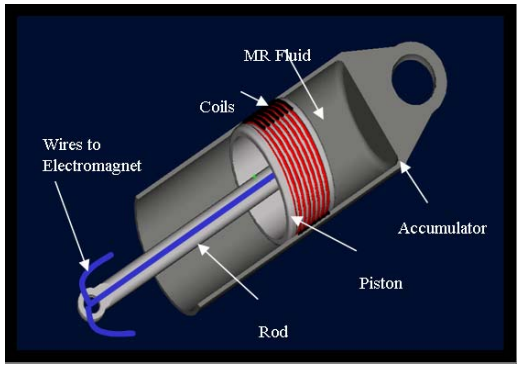
Army Tactical and Combat vehicles require superior performance for battlefield dominance.

Up-Armoring of existing vehicle fleet challenging stock suspension components.

Research Challenges:

- Research novel suspension components with adaptive control.
- Research suspension components with adjustable weight carrying capacity.
- Develop suspension components for robust, passive default, outside armor application.





Non-primary Power System Technology

Problem:

Current non-primary power approach inadequate.

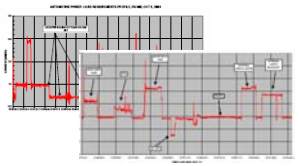
Lead-acid batteries store insufficient energy to meet War Fighter requirements for vehicle silent watch (main engine off). Silent watch requirements vary from several hours to 24 hours. Current approach requires restarting of main engines during silent watch to recharge batteries, causing excessive fuel use, acoustic and thermal signatures.

Research Challenges:

- Research engine-generator technologies with high power densities and low acoustic signatures.
- Research fuel cell challenges:
  - Hydrogen fuel currently not logistically practical.
  - JP-8 fuel reforming is developmental.
  - Fuel cell power units need maturation for the battlefield.

Rotary Engine APU

OPOC APU



Non-propulsion Load Analysis

SOFC APU

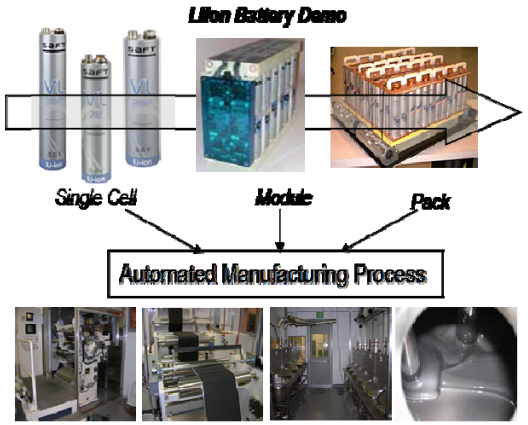
Energy Storage Technology

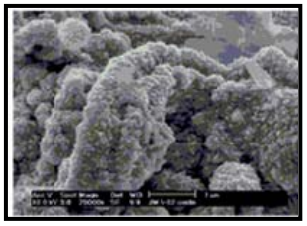
Problem:

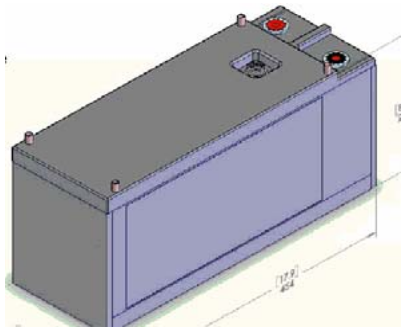
High power Li-Ion battery pack sized for combat hybrid electric vehicles is extremely costly.
High power Li-Ion batteries for combat hybrid vehicle application must be safer and more reliable.

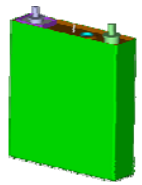
Research Challenges:

- Research thermal runaway process and its control.
- Research power vs. energy trade-off design optimization.
- Research manufacturing process development and cost control.
- Research thermal management.
- Research cell & system, safety & reliability.
- Research system control & cell and battery management systems.
- Research alternative electrochemical improvements.









Power Management Technology

Problem:

Current and future force electrical power demands exceed power generation and energy storage capabilities.

Advanced power generation systems depend on sophisticated control methodologies for safe operation.

Limited fuel availability in the field.

Increasing number and size of electrical loads on a vehicular platform increases the heat generation.

Presently, no automated way to recover from faults and induced faults (i.e. Sympathetic tripping, chain tripping of loads).

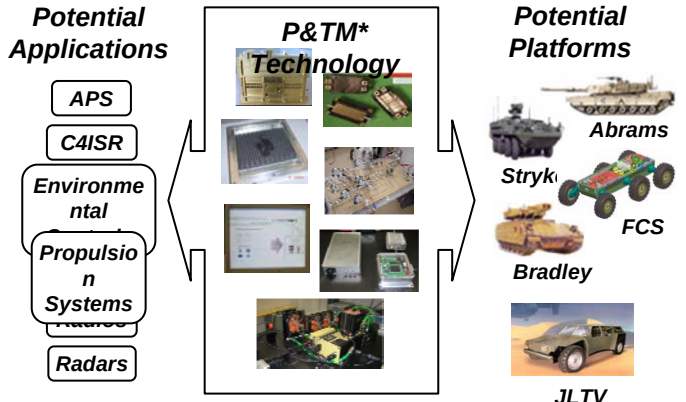
Current vehicular electrical architectures contain vehicle-unique electrical components which increase the logistics burden.

Research Challenges:

- Research ability to accurately monitor and control the power distribution to react to fluctuating loads and sources in real time.
- Research open architecture for electrical power architecture.
- Research power requirements of military equipment and load management strategy.

Software Standard

Flex cable/PCU integration



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Thermal Management Technology

Problem:

Cooling systems for hybrid electric combat vehicles challenged for projected requirements.

Increases in electrical power demand proportionately increase cooling system volume and weight requirements.

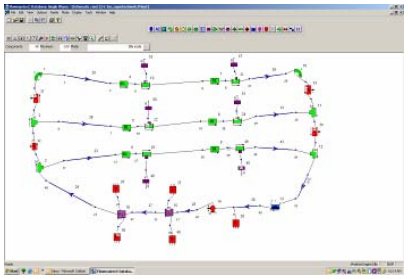
Thermal degradation inevitably results in reductions of component life and reliability.

Lack of intelligent control strategies for military ground vehicle thermal management systems.

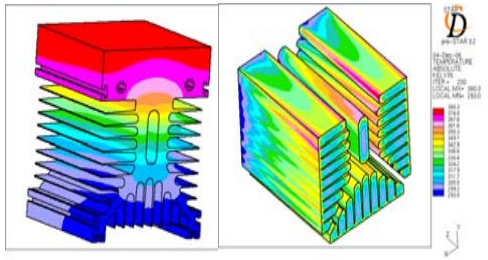
Debris and contamination cause damage to vehicle power train components.

Research Challenges:

- Research heat rejection techniques for the military vehicle application.
- Research improvements in capabilities for filtration (liquid and air) without increasing the system physical size.
- Research the efficiency benefits of emerging technologies into ground vehicle power electronics.



Analogous flow network model



Computational fluid Dynamics (CFD) model

GVPM – Projects with Academia

• **Lawrence Technological University:**	Fuel cell performance in environmental extremes, hybridization with ultracapacitors, and develop fuel cell lab setup procedures for TARDEC.
• **University of Michigan:**	Solid oxide fuel cell (SOFC) materials design, using Density Functional Theory, a reduced quantum chemistry approach.
• **University of Michigan:**	Control theory analysis of an integrated SOFC and JP-8 reformer system, to establish strategies to optimize controllability of the system.
• **Auburn University:**	High contact area, low flow resistance systems for very compact chemical reactors and sorbers, applied to integrated JP-8 reformer/fuel cell systems.
• **University of Michigan - Dearborn:**	Cognitive power management system development for hybrid electric vehicles, enabling vehicles to optimize power usage based driver behavior and terrain.
• **University of Michigan - Dearborn:**	Machine Learning Approaches to Vehicular Power Management to identify or predict the drive cycle and perform optimization. This is a joint project with TARDEC, Univ. of Michigan-Dearborn and Ford Research Labs through the Michigan 21st Century Job Fund Project.
• **Michigan Technological University / KRC:**	Design/Develop and Build " State of the Art" R&D Bushing Tester for Military Tracked Vehicles.
• **Wayne State University:**	Low Temperature Diesel Engine Research.

System Test and Evaluation