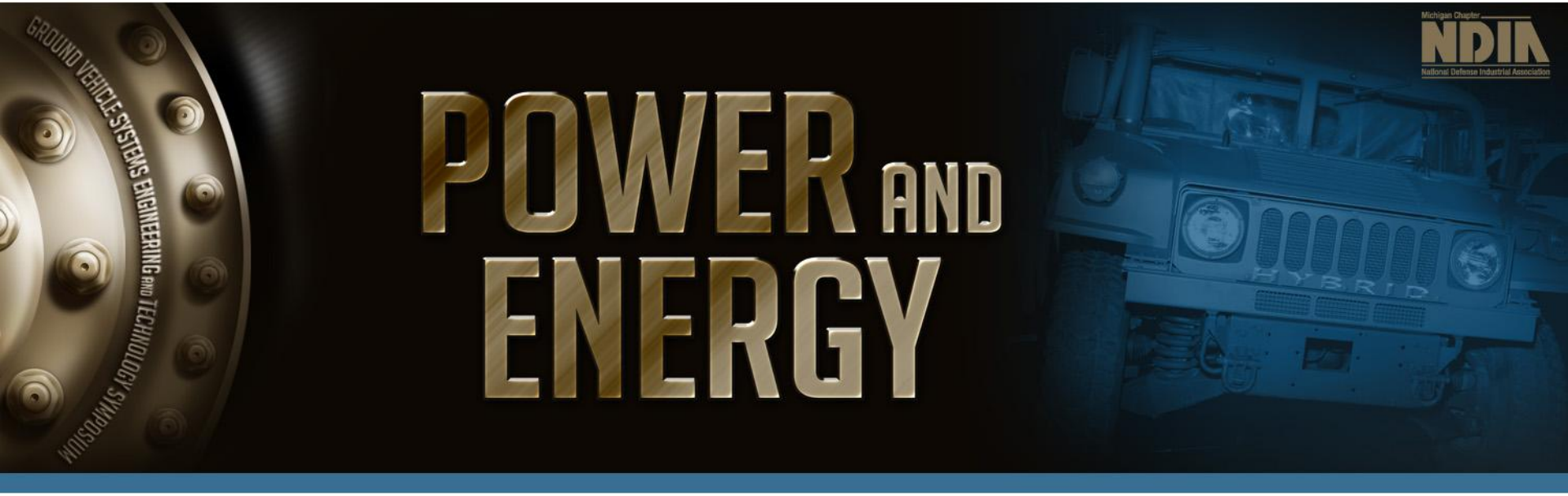

P & E Innovation Workshop Outbrief

Peter Schihl

GVSETS

Report Documentation Page

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The Innovation Workshop

- NDIA sponsored Power and Energy Innovation Workshop (July 7-9, 2009)
  - Attended by Government, industry and academic experts
  - Hosted by TARDEC in collaboration with TRADOC and Office of the Deputy Chief of Staff of the Army
- **Provide possible future power and energy solutions** for Army soldier, ground vehicle, aerial vehicle and installation needs

Background and Motivation

- Successful execution of the United States Army mission requires effective deployment and management of:

Ground Vehicles

Aerial Vehicles

Installations

Soldier

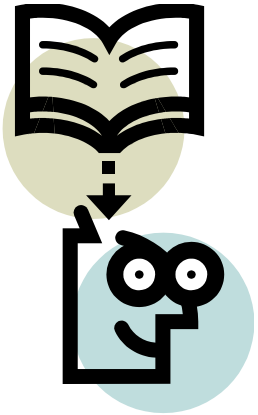
- Unique requirements and challenges
- Articulate power and energy requirements
- Outline efficient technologies
- Reduce energy use to optimize future force effectiveness

Global Problem Statement

- Power and Energy are greatest enabler of warfighter capability

No Silver Bullet

Integrated Suite of Technologies



Education, Training and Awareness

- Key Themes:
  - **Demand** needs to be understood and reduced
  - **Electricity** is the medium for power distribution near to med-term
  - Long term: **multi-fuel sources** (incl. solar, solids, liquids, etc…)
  - **Optimize** the system, not the individual components
- Requirements:
  - **Use** of a globally available fuel source
  - **Increased** power density/higher energy conversion efficiency
  - **Reduce** parasitic loads
- Constraints:
  - **Fuel** requirements (variability, specification)
  - **Nuclear** (shielding, cooling)
  - **Waste Energy Recovery** (temp, materials)
  - **Propulsion** (ability to use commercial equip is declining)

Ground Vehicle Session (continued)

POWER AND ENERGY

- Key Take Away
  - Tightening or modification of JP8 specifications is needed
  - Propulsion systems need certification on broader range of fuels
  - Start exploring the application of WER
  - Grid integration could be phased in as technology advances
  - Nuclear is not feasible for today's GV applications
  - Fuel cells are feasible for APUs and applications under 1kW

Aerial Vehicle Session

POWER AND ENERGY

- Key Themes:
  - **Engines** are key, but rotors/airframe/trans need to be addressed
  - Continue system/component investment for **optimized design**
  - **Mission based profiles** for evaluation of systems/components
- Requirements:
  - **Increase** power capability and fuel efficiency
  - **Reduce** operating and sustainment costs
  - **Explore** alternative fuels
  - **Reduce** air vehicle noise and signature
- Constraints:
  - **Fuels** (lubricity effects on seals, varnishing of injector nozzles)
  - **Hybrid** (Operating voltage, waste heat management)
  - **"More Electric"** (Power to weight ratio, EMI, reliability)
  - Increasing **Payload** (weapon, fuel, sensors, equipment)

Aerial Vehicle Session (continued)

POWER AND ENERGY

- Key Take Away
  - Hybrids* are promising technology for future applications
  - "More Electric" tech promises reduced parasitic engine losses
    - i.e. Nutating, bonner, diesel rotary engines
  - No major roadblocks with alternative fuel use
  - Promising new engine technologies for small aircraft
  - No foreseeable engine technology likely to surpass Brayton cycle (turbine) for large (500+hp) applications

* Hybrid in aerial context means: turbine with any form of electrical, chemical or mechanical power augmentation

Installation Session

POWER AND ENERGY

- Key Themes:
  - **Single Joint Solution** needed for all services in theater camps
  - Must first address how each **soldier views and values** energy
  - **Smart grid technology** is solution that could be utilized today
- Requirements:
  - **Reduce/replace** generators (30%<fuel by 2015, replace by 2030)
  - New energy sources to **minimize/replace** hydrocarbon sources
  - **Use** expeditionary power grids for recharging batteries/fuel cells
  - **Achieve** NetZero installations by 2030
- Constraints:
  - **No one agency** is lead for power/energy for installation/theater
  - **Metrics** must be used to ensure improvements are saving energy
  - 5 year waiting period: **MILCON**
  - There is no **standardization** of theater camps

Installation Session (continued)

POWER AND ENERGY

- Key Take Away
  - Efficient HVAC/ECU's for installations/theater camps by 2014
  - Modeling/simulation is a key tool for infrastructure design
  - New systems must not drastically effect end-user processes and procedures
  - Improved biofuel process needed to be competitive replacement
  - Nuclear use in-camp limited by security and logistics, possible wide-spread use in fixed installations

Soldier Session

POWER AND ENERGY

- Key Themes:
  - Use **high energy density** choices available today
  - All future equipment needs **smart energy management** tech
  - **Power/energy profiles** must be matched with mission profile
  - **System level design** needed to achieve max effectiveness
- Requirements:
  - **Base** equipment strategies on human requirements
- Constraints:
  - **Energy Storage Stds** (connectors, form, voltage, high/low temp)
  - **Energy Harvesting** (random pulses into energy, low watt gain)
  - **Fueled Systems** (efficiencies, power and energy densities)
  - **Nuclear** (low conversion efficiency and power production, Soldier and public safety perception issues)

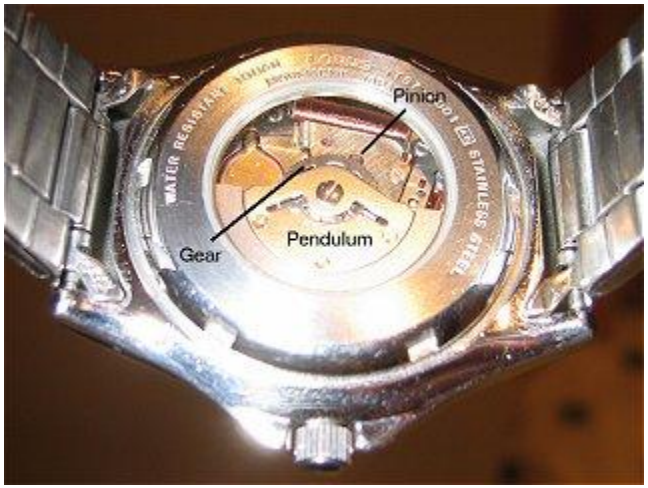
Soldier Session (continued)

POWER AND ENERGY

- Key Take-Away
  - Movement toward rechargeable energy storage solutions
  - Energy harvesting will require technological breakthroughs and major cost reductions before use feasible
  - Fuel cells are likely answer to the high-value mission soldier-worn equipment and applications
  - Nuclear power generation (beta decay) is relevant for long-term, low power applications such as sensors and sleep mode operations

Soldier Session (continued)

POWER AND ENERGY



kinetic watch movement

Robot
340 lbs payload
(Not representative of load capacity)

Personal Fuel Cell

Workshop Next Steps

POWER AND ENERGY

- Future workshops needed for deep-dive look into technology timeline/solutions
- Work with Air Force and Generals Stevenson and Vane to influence industry fuel specifications (*now is the time)*
- Create innovation priority list aligned with “War Fighter Outcomes”
- Develop mission-based energy consumption profiles for developing and testing of new technologies