Overview: NPS Multidisciplinary Energy Studies Support for the USMC Expeditionary Energy Office

Start Date: 1 November 2012

"The Marine Corps Expeditionary Energy Office will analyze, develop, and direct the Marine Corps' energy strategy in order to optimize expeditionary capabilities across all Warfighting functions."

By: Andy Hernandez, PhD
Colonel, US Army (Ret.)
Associate Professor, System Eng.
Dep. Dir., SEED Center
Principal Investigator

Agenda

- Background
- Results to Date
- Organization and Processes
- Current Projects
- Way-Ahead

Background

- In 2009 the CMC recognized **energy as an essential combat enabler**, but also a growing vulnerability to the Corps and the US military.
- The **HQMC Expeditionary Energy Office (E2O)** was established and tasked to "**analyze**, develop and direct" the USMC Energy Strategy
- E2O analysis is **requirements driven**:
  - Initial Capabilities Document/Capabilities Based Assessment for USMC Expeditionary Energy, Water, and Waste
  - USMC Expeditionary Energy Strategy
- In **Nov 2012 E2O and NPS established an "umbrella" program**, focusing NPS thesis research on expeditionary energy topics, under one management lead.

Intent and Objectives

- **Intent**: Forge a partnership between NPS and E2O to leverage NPS' students, capabilities and knowledge pool; formalize a portal to new ideas and access to resources for future research.
- **Objectives:**
  - Create focal point for expeditionary energy studies and research, expand community of interest
  - Recruit motivated and passionate students to address E2 issues and unexplored gaps in the body of knowledge.
  - Create a generation of officers who recognize the importance of operational energy and embed them into the Force.
  - Connect academic and research energy pursuits into a coordinated effort.

Results to Date

- NPS-E2O Thesis Research Program is addressing analytical gaps for the Marine Corps and seeding a new generation of officers trained in expeditionary energy issues.
- Funding represents ~30% of E2O FY13 analysis budget
- Since Nov 12:
  - **13** different studies initiated—individual thesis and group projects
  - **8** different disciplines and programs: system engineering, operations research, business, mechanical engineering, applied physics, computer science, applied mathematics, electrical engineering
  - Supported by **12+** professors
  - **25+** military and civilian students – resident and distance learning
  - **4** new studies to begin FY14

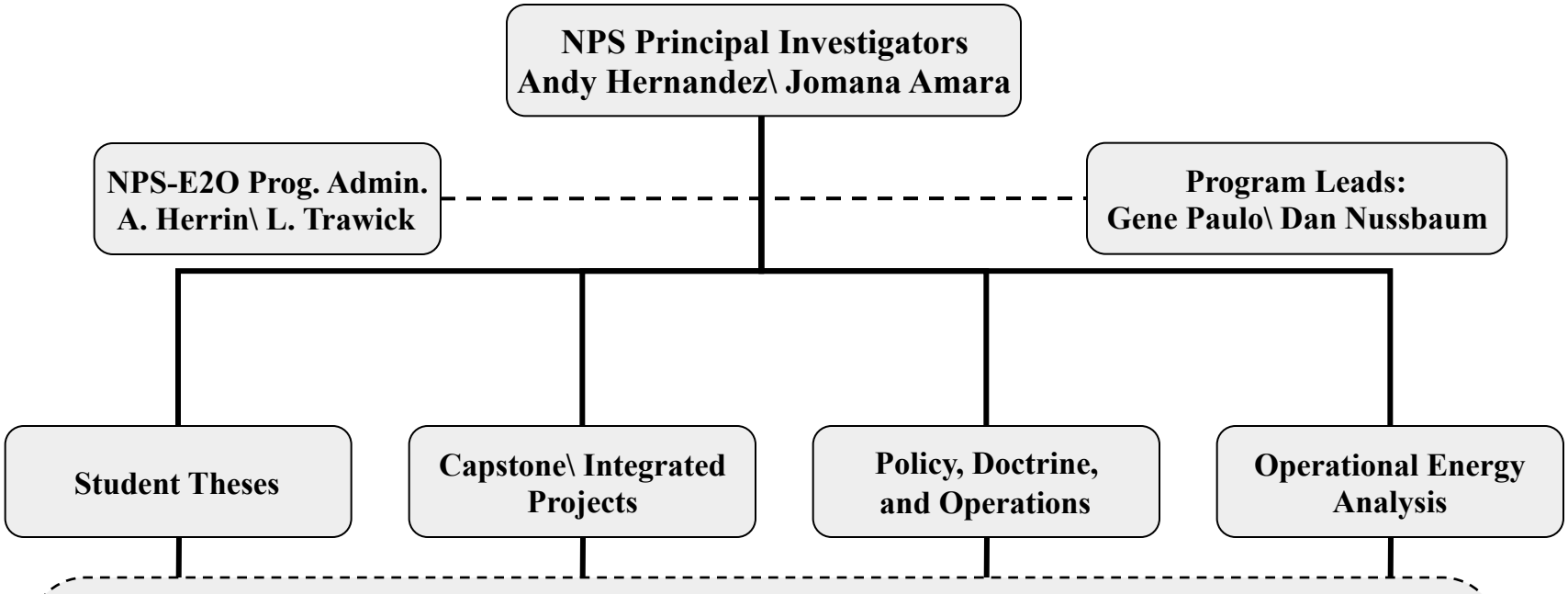
Ingredients for a Successful Partnership

- **Engaged Sponsor**:
  - Funding Commitment
  - Clear, focused priorities
  - Direct engagement/active support
  - Designates study POCs
- **Active NPS Team:**
  - Single belly button – Principal Investigator (PI)
  - Fully understands sponsor mission, intent, and challenges → relevance
  - Engages and recruits faculty, student, and staff
  - Develops a support structure and processes that build, maintain and manage diverse portfolio of studies
- **Reliable and Flexible Resourcing**:
  - Establishes a solid base of sponsor funds
  - Under control of PI at NPS
  - Working relationship between Sponsor and NPS Team to select studies

NPS-E^{2}O Study Organization and Processes

(A Case Study for TRWG)

NPS Study Structure for E2O



Supporting enablers such as:

- Simulation Experiments and Efficient Design Center\ Research Centers
- Academic and Research Laboratories
- Energy Academic Group
- NPS Energy Communities of Interest

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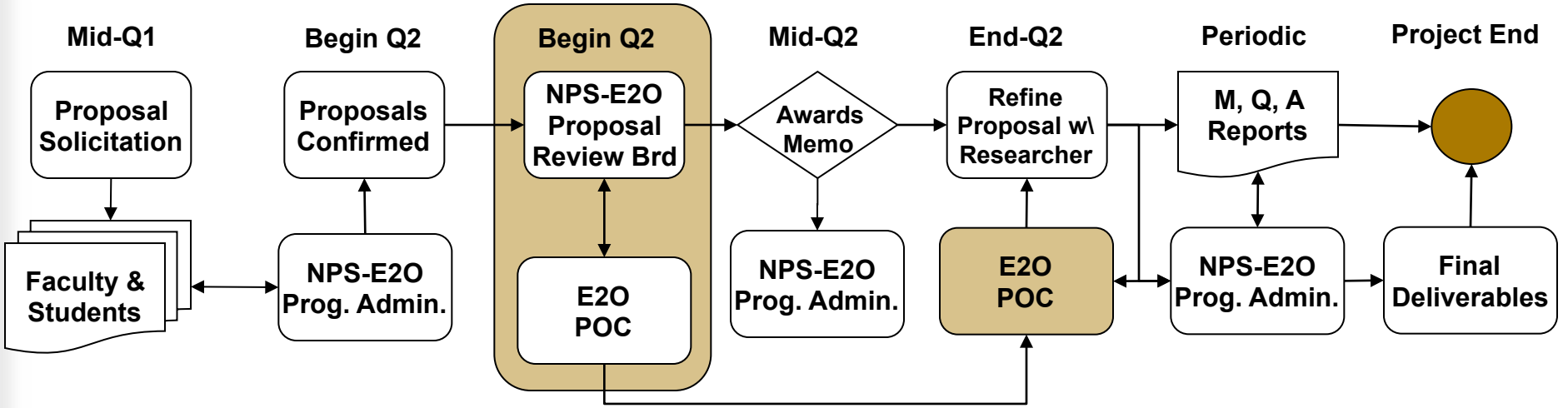
Proposal Review and Selection Process

FY2013 – Illustrates one iteration; Intent to initiate new cycle each quarter



Proposal Requirements:

- Research proposal[1]
- Thesis proposal (if student thesis is involved)[1]
- Faculty and students involved
- Budget[2]: faculty labor (identify each faculty or staff), identify specific travel, materiel, other.
- Quad chart

Steps:

1. Solicit for proposals mid-quarter
2. NPS-E2O program receives proposals beginning next quarter.
3. Confirm complete proposals.
4. NPS-E2O leads and E2O review candidate proposals for approval.
5. Announce approved proposals.
6. NPS-E2O program establishes sub-JON.
7. E2O designates SME lead as POC for study.
8. Researchers refine proposal with E2O SME.
9. Follow report and deliverable requirements.

1. Follow department format.
2. Follow RSPO format.

Deliverables

- **Deliverables:**
  - Thesis; Technical Report (where warranted)
  - Publications and presentations
  - Data → Utility for modeling and simulation (identify if source constrained)
  - Software applets and documentation
  - Reach back\ Request for Information
- **Reviews**
  - Monthly reports or as defined per E2O lead
  - Quarterly IPRs
  - Annual review

Results: NPS-E^{2}O Ongoing Research and Way-Ahead

Currently Supported Studies

- Joint Logistics Over the Shore Application (JLOTS):
  - A systems engineering approach to establish operations of non-fossil fuel dependent bases at JLOTS locations.
  - **Faculty Lead**: Profs Andy Hernandez and Dan Nussbaum
  - **Student**: LT Crystal Miller

- Feasibility of Scaled Geothermal Power:
  - Apply Systems Engineering methods to examine the feasibility of locally-generated renewable energy, primarily from geothermal sources, to power forward operating bases.
  - **Faculty Lead**: Profs Fernand Marquis and Andy Hernandez
  - **Student**: LT Troy McClure

Currently Supported Studies

- Energy Messaging and Behavioral Factors:
  - Identify energy messaging and behavioral factors to support the adoption of sustainable energies on the battlefield.
  - **Faculty Lead**: Prof Kathryn Aten
  - **Students**: Capt Jason Ciarcia, LT Daniel Eddy, LT Jonathan Greenwald, and MAJ Vinh Nguyen

- Feasibility of Cold Spray Technology:
  - Explore the feasibility of using cold spray technology for the deposition of thermoelectric materials for waste heat recovery.
  - **Faculty Lead**: Prof Sebastian Osswald
  - **Student**: Maj Matthew Lavallee

Currently Supported Studies

- Improving Operational Effectiveness of Tactical Long Endurance UAS by Utilizing Solar Power:
  - Examine the use of a combination of solar and thermal energy harvesting algorithms and instrumentation to enable UAS to remain airborne for extended time; for 3-5 days or as needed.
  - **Faculty Lead**: Prof V.N. Dobrokhodov
  - **Student**: LT Nahum Camacho

- Adaptation of HOMER Energy Micropower Optimization Model for Marine Corps Logistics:
  - Through the execution of a design of experiments provide analysis to support validation of HOMER M&S components and will identify potential for future advancements.
  - **Faculty Lead**: Profs Dan Nussbaum and Gene Paulo
  - **Student**: Capt Matthew Morse

Currently Supported Studies

- Feasibility Study for the Use of Radioisotope Therma Generators in USMC Expeditionary Unit Equipment:
  - Determine the feasibility of using radioisotope thermal generators as a stable, reliable power source, while simultaneously attempting to maintain the effectiveness of units employing the technology.
  - **Faculty Lead**: Prof Fernand Marquis
  - **Student**: LT Ryan Langham

- Systems Engineering CAPSTONE Project:
  - Examine materiel and non-materiel means to improve energy efficiency in a Marine Expeditionary Brigade while conducting a humanitarian aid mission.
  - **Faculty Lead**: Prof Gene Paulo
  - **Students**: Team (6 – 8 students)

Currently Supported Studies

- Marine Expeditionary Unit Rifle Platoon Operational E2W2 Burden Alleviation:
  - Consider a fully integrated robot-human MEU rifle platoon that delivers current and enhanced capabilities and functionality while reducing E2W2.
  - **Faculty Lead**: Prof Dick Millar
  - **Students**: Maj Thomas Atkinson and Mr. Tim Lane

- MEMS-Based Waste Vibrational Energy Harvester:
  - Test a vibrational energy harvesting microelectromechanical systems (MEMS) device to convert vibrational waste energy into usable power.
  - **Faculty Lead**: Prof Dragoslav Grbovic
  - **Students**: LT Daniel Hogue and LTJG Sarah Gregory

Currently Supported Studies

- Analysis of Advanced Battery Technology for USMC Expeditionary Tactical Information Systems:
  - Evaluate potential of advanced Li-Ion battery technologies to address power requirements of tactical communication systems.
  - **Faculty Lead**: Prof Sebastian Osswald
  - **Students**: Capt Joshua Kapp

- Graphene Research Roadmap in Support of US Marine Corps Expeditionary Energy:
  - Set the roadmap for future efforts on the use of graphene with the long term goal of developing materials or systems that could enlarge the capabilities or effectiveness of expeditionary operations.
  - **Faculty Lead**: Prof Claudia Luhrs
  - **Students**: TBD

Currently Supported Studies

- Future Energy Resource Needs Simulator (FERNS) Educational Case Study Development:
  - Develop a case study related to resource considerations and energy strategy for OA4333: Simulation Analysis. FERNS uses a framework initially developed to anticipate future needs for the armed forces.
  - **Faculty Lead**: Prof Paul Sanchez
  - **Students**: All course students

- Studies planned for FY14:
  - "Optimal Design of Piezoelectric Materials for Maximal Energy Harvesting"
  - "Applying Systems Engineering to Improve Energy Efficiency in A Marine Expeditionary Brigade while in an Anti-Access, Area-Denial Environment"
  - "The Modification of HOMER Software"
  - "Improving Cost-Benefit Assessment for Energy Initiatives using Robust Design"

Way-Ahead

- IPR with E2O 29, 30 May 2013
- Deliver first set of theses June 2013
- Launch new solicitation in August for award in October 2013
- Actively recruit studies in social sciences for FY14
- Establish processes to transfer mature research

NPS-E²O Team POCs

Dr. Andy Hernandez
Systems Engineering Department
ahernand@nps.edu
831-656-3823

Dr. Jomana Amara
Defense Resource Management Institute
jhamara@nps.edu
831-656-3591

Dr. Dan Nussbaum
Operations Research Department
danussba@nps.edu
831-656-2387

Dr. Gene Paulo
Systems Engineering Department
eppaulo@nps.edu
831-656-3452

General POC: Anjulee Herrin, arherrin@nps.edu, 831-656-2599

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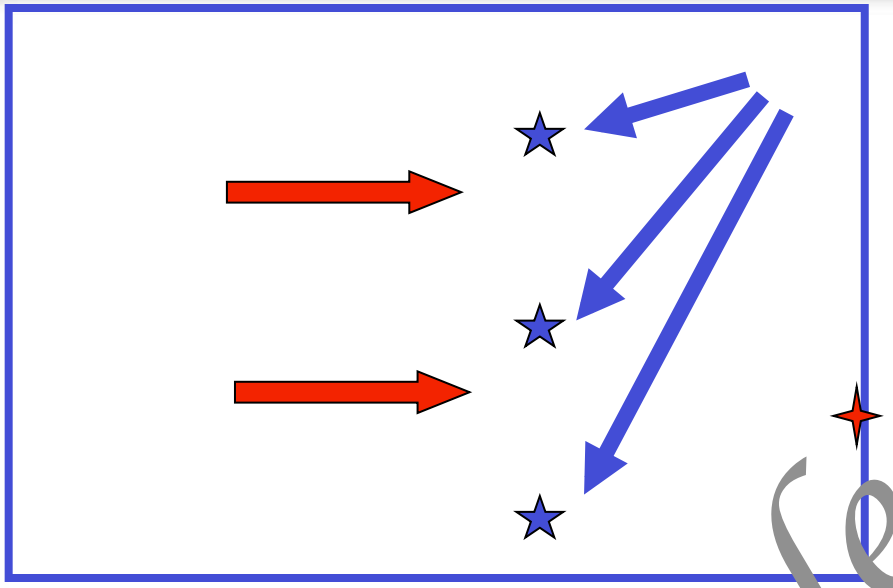
Integration of Tactics, Techniques, and Procedures with Counter-IED Technologies



Objectives:

To identify tactics and capabilities that reduce the effectiveness of the terrorist organizations to target and effectively attack forces conducting distributed operations. Identify likely CONOPS of terrorist forces to mitigate the effects of distributed tactics or fielded counter-IED capabilities. The projects will identify follow-on requirements for analysis. the impact of emerging counter-IED technologies on tactics and training

Description: The US Marine Corps has developed a new tactical approach (distributed operations (DO)) for the employment of forces. The TTPs for DO require integration with rapidly developing technologies to counter the IED threat. Utilizing multi-agent simulation and Nearly Orthogonal Latin Hypercube design of experiments, the research will simulate multiple factors within a data farming environment to gain insights into organizations, tactics, and capabilities that will assist forces operating in the IED environment.

Key Participants:

Dr. Tom Lucas, Dr. Susan Sanchez (OR, SEED Center) PI
Capt William Midgett (OR, Student); RA Steve Upton (SEED)

Milestones to Fielding Capability:

1. Develop Design of Experiments (DOE)
   - Portray distributed operations within a multi-agent simulations
   - Identify procedures to integrate Blue Force Tracker and SIGACTs data within the simulation.
   - Scope research as a proof of concept project for larger follow-on experiments
2. Provide MCCDC/MCSC an analysis and simulation (with data) to explore the impact of emerging counter-IED technologies on tactics and training

Key Deliverables:

- DOE and all scripts to run the experiment.
- Multi-Agent simulation in Pythagoras
- Input and output data from experiments
- Research Thesis with full analysis
- Briefings, VTC's at the end of each major task

Administrative Processes

- Centralized management w/ PIs, but decentralized execution w/ sub-JON PIs
- Funding:
  - Overarching JON
  - New research areas receive sub-JON, along with the sub-JON PI
  - PIs must be qualified under SPPGM-12-12 PI PD, http://intranet.nps.edu/ResAdmin/SPPGM-12-22_PI_PD.pdf
  - PI receives indirect as outlined in, http://intranet.nps.edu/ResAdmin/FY13/FY13_Indirect_Cost_Recovery_Rates-18July2012.pdf