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2006 Army Environmental Cleanup Conference

Innovative Technology Update

31 January 2006



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CEHNC MMRP IT Mission

Identify, validate, and implement innovative materials, equipment, and approaches supporting the Corps of Engineers Military Munitions Response Program.

Facilitate tech-transfer between RDT&E, industry and MMRP projects.



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Six-Ds of MMRP Technology

- ◆ Delineate
- ◆ Detect
- ◆ Discriminate
- ◆ Dig
- ◆ Destroy
- ◆ Data Management



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SERDP/ESTCP & EQT Partnerships

- ◆ *Wide Area Assessment*
- ◆ *Statistical Site Characterization*
- ◆ *Geophysical Analysis Software*
- ◆ *Dual-Sensor Towed Array Geophysics*
- ◆ *Next-Generation Geophysical Sensors*
- ◆ *Airborne Geophysics*
- ◆ *Marine Geophysics*
- ◆ *Precision Navigation*
- ◆ *Mechanized OE Removal*



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Delineation

- ◆ Statistical Characterization
 - ESTCP working with National Labs, DoD organizations, and regulators to develop statistical approaches to site characterization
- ◆ Wide Area Assessment
 - ESTCP received FY05 & 06 funding to evaluate & demonstrate WAA technologies



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Statistical Characterization Visual Sample Plan (VSP) Toolkit

- ◆ Technical Basis for
Transect Spacing
- ◆ Follows DQO philosophy
- ◆ Flags potential target
areas – high anomaly
densities
- ◆ UXO VSP Module
Developments supported
by ESTCP

VSP Sponsored by DOE,
EPA, DHS, DoD



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Initial Bomb Target Detection Transect Design

For Bombing Target Area Detection:

- ◆ From historical photos, Aiming circles of 1000 ft diameter observed.
- ◆ Practice and live bombs may have been used
- ◆ ASR suggests multiple heavily used target areas
- ◆ Sparse Transect Spacing Design and Tighter Transect Spacing Design developed
- ◆ Used Visual Sample Plan (VSP) Software

<http://dgo.pnl.gov/vsp>



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Design for Bomb Target Detection

- ◆ With practice bombs, target areas could be smaller than 1000 ft diameter circle
- ◆ Required 99% probability of traversing a 500 ft circular target area.
- ◆ North/South 2m wide parallel transects.
- ◆ Also explored 90%, 95%, 99% desired probability of traversing.
- ◆ ~155m Spacing
- ◆ 1.30% Area Coverage



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WAA

What is Orthophotography?

Orthophotography corrects for distortion caused by the curvature of the earth and terrain.

Orthophotos are spatially accurate, so they can be used with survey and GIS data.

Digital images are collected during the LiDAR flights, then mosaiced and spatially rectified using the LiDAR digital terrain data.

LiDAR-derived contour lines with orthophoto.

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WAA- What is LiDAR?

Light Detection and Ranging (LiDAR) uses the known speed of light and time of return to determine the distance of an object from the sensor.



What is Airborne Geophysics?

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- Magnetometer Array
-
- 200 - 300 acres per day
 - Near earth 1-3 meters



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Equipment

AMTADS

Equipment and Operation

Operational Objectives

- Bell 206L3 Long Ranger
- Kevlar Sensor Boom (5 sections)
- 7 – Geometrics 822 Cesium Vapor Magnetometers
- 2 Trimble MS750 GPS Receivers
- 1 Optech Laser Altimeter
- 4 Acoustic Altimeters
- 1 Cross Bow Tilt Meter
- Pilot Guidance
- 2 Man operation
(Pilot/Sensor Operator)
- Robust DAQ Computer
- Geo-reference position accuracy 0.25m
- Noise level (combined sensor/platform sources, post-filtering) <1 nT
- Data density/Point spacing 0.5 m along-track 1.5m X-track
- Operating parameters (altitude, speed, overlap, production level) 1-2m, 40 kts, 10%, 300 acres/day
- Modeling parameter definition (X, Y, location, size)
XY Location : 90% within 1m
- Depth: 90% within 0.5 m Size: 90% in correct Small Medium / Lager classification
- Modeling parameter definition (X, Y, location, size)
XY Location : 90% within 1m
- Depth: 90% within 0.5 m Size: 90% in correct Small Medium / Lager classification
- Detection of individual target areas w/metal $>90\%$



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Towed Array Ground Transects

- ◆ Use the Vehicular Simultaneous EMI and Magnetometer System (VSEMS) as Part of the Wide Area Assessment Pilot Project to Perform a Mix of Transect Surveys and Total Coverage Surveys.



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Web GIS

Features

- Immediate secure access to all historic and new project data
- ESRI platform, Oracle-ArcSDE spatial database, with several custom and standard analysis algorithms to access / analyze LiDAR and Ortho data.
- Connection to GIS database via HTML / Java website interfaces; local, thin and thick client support.
- Streamlined reporting, oversight and QA/QC. Direct VPN for team members.
- Internet-based interactive maps



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Detection & Discrimination

- ◆ SERDP/ESTCP & Army EQT have a broad range of RDT&E efforts underway to improve existing sensors and develop new sensors:
 - *Ground based*
 - *Airborne*
 - *Marine*



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ArcSecond Laser Positioning

- ◆ Sub-cm accuracy and 40Hz update rate
- ◆ Accuracy of 0.01- 0.18 m demonstrated
- ◆ Average accuracy 0.01m interrogations,
0.04m area navigation & 0.11m picked
from geophysics



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ArcSecond Laser Positioning

- ◆ Laser transmitters at known locations in local or projected coordinates
- ◆ Triangulates on receiver and calculates position
- ◆ Currently using four transmitters, but expandable for complex areas with poor line of sight



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ArcSecond Laser Positioning

- ◆ Single receiver \Rightarrow 3D position at receiver
- ◆ Dual receiver “vector bar” \Rightarrow 3D position anywhere along the axis of the receivers
- ◆ Four receiver “triad” \Rightarrow 3D position anywhere on rigid frame, plus attitude (roll, pitch, azimuth)



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Waterborne Surveys

- ◆ **Site Preparations –Sub bottom profiling, background surveys, item seeding**
- ◆ **Marine Magnetometer Surveys – What can we detect?**
- ◆ **Side Scan Sonar Surveys – What do the sea floor features look like, can we “see” the metal targets?**
- ◆ **Marine EM Evaluation – is this a viable option?**



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Background Surveys

Sub Bottom Profiling at all three sites:

- Soldado: 1 meter typical sand thickness
- Mosquito: 2 meter typical sand thickness
- Manglar: 6 meter typical sand thickness

Background magnetometer surveys at
Soldado and Mosquito only



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Dig

- ◆ ESTCP funding development of Rangemaster
- ◆ CEHNC working with Air Force Robotics Lab to develop magnetic scrap retrieval system



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Destruction

- ◆ Relatively little work on alternate destruction technologies:
 - *Laser*
 - *Perforators*
 - *Enhanced Steam Decontamination*
 - *Multiple Rounds Container*
 - *Water Containment System*



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Features of ESD Unit

- ◆ Transportable and non-incinerating.
- ◆ Electric induction heating to achieve 5X level of decontamination in inert atmosphere.
- ◆ Superheated Steam and Nitrogen as Carrier Gas.
- ◆ Robust off-gas treatment.



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MRC Test Results

- ◆ Fragmentation penetration calculations are conservative
- ◆ 75mm Mk II fragment perforates but doesn't penetrate MRC
- ◆ 4.2-inch M2/M2A1 fragments do not perforate MRC
- ◆ 105mm M60 fragments do not perforate MRC
- ◆ Pressure from 105mm M60 may cause MRC rupture
- ◆ No fragment or pressure threat outside IHF



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Water Mitigation Tests

- ☞ Tested Commercial Off-the-Shelf water containment system
 - Stopped all fragments from 81mm
 - OE Innovative Technology is testing several of these containment systems to get economic data
 - Use on MMR site(s) that has appropriate MEC size(s)
 - Also use sandbags on same site/same size MEC
 - Compare economic data for two mitigation systems



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Data Management

- ◆ GeoSoft- (UX-Process)
- ◆ UXO- Lab
- ◆ UX Analyze
- ◆ Life-Cycle Data Management
- ◆ *PDA for Field Applications*



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UX-Process: Introduction

- ◆ CEHNC & Geosoft partnered in support of ESTCP to create geophysical software tools to run under Geosoft's Oasis montaj™ program.
- ◆ Have been working ~5 years developing tools converted from field UXO QC/QA methodology and feedback from UXO community. Also, provides a standard platform for algorithm sharing.
- ◆ These standard tests and tools enable DGM contractors to be more effective in meeting government data quality standards, and help streamline government QA review.



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UX-Process: Menu

Around 70 menu items in the QC/QA toolset to assist the user in the following:

- ◆ Planning surveys,
- ◆ Importing/Exporting data,
- ◆ Correcting errors in datasets,
- ◆ Testing data quality and completeness,
- ◆ Project status maps, Audit trails
- ◆ Target analysis, including Mag and EM batch fitting



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UXOLab

-
- ◆ Developed by the University of British Columbia's Geophysical Inversion Facility (UBC-GIF).
 - ◆ Software for detection, discrimination and characterization of UXO. Processing steps include:
 - Standard initial processing tools (filtering data, removing duplicate data, gridding data)
 - Define targets (import list or use automatic picking routines)
 - Extract data (create masks for target anomalies)
 - Perform inversion of targets (for TDEM or magnetic data)
 - Analyze results (view modeled parameters and residual fields for inverted targets)
 - Discriminate (for magnetic data only, compares modeled parameters to user defined likely UXO types using remanence)
 - Generate report of results



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UXOLab

Recovered parameters X,Y,Z,
Orientation (azimuth, dip),
Dipole Moment, and
Correlation Coefficient



EM parameters include k_1 , k_2 ,
Beta1, Beta2, which can be
used to determine shape and
material properties of the
target items



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UX-Analyze

- ◆ Software developed by AETC and Geosoft for use with Oasis montaj as a target selection, fitting and classification tool for UXO.
- ◆ Menu for the following:
 - Importing target data
 - Batch fitting a list of targets
 - Adding and/or reviewing individual selected targets
 - Classifying targets
 - Producing a progress report
 - Creating Anomaly Maps of your data
 - Prioritizing your result



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Life Cycle Data Management (LCDM)

- ◆ Deliverables from this effort include:
 - LCDM database archive with a Data Management Standard. This data flow into diagram also includes Quality Control guidance.
 - Tools to facilitate the reduction of footprint of areas to be investigated or cleared of ordnance, based upon historical information.
 - Handheld methods to facilitate data acquisition and transition into GIS ready database.
 - Data checker to facilitate database compliance with current Spatial Data Standard for Facilities, Infrastructure, and Environment (SDSFIE).



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OE GIS Layer Compliance Tool

Validates and ensures data meets Spatial Data Standard (SDSFIE) for the Ordnance Entity Set, Entity Classes and Feature Classes, and any corresponding attributes or domains.

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Handheld Tools

- Palm Zire with Pendragon Forms, Digital Camera, Bluetooth, and other features.
- Blue Logger Bluetooth GPS
- Complete package for data collection with no wires.
- Reduces the data manipulation requirements from field to office.



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Summary

- ◆ DoD has significant investment in MMRP RDT&E
- ◆ New technologies and approaches are emerging, but no “silver bullets”
- ◆ Tech transfer will not happen on its own... need a team approach