Overview

This is the 9th and final year of MM-0131: Integration of UXO Software Suite, performed by Geosoft Inc. and the US Army Engineering & Support Center Huntsville (CEHNC). The software developed under this project, known as UX-Process, has been expanded over its lifetime to provide a comprehensive software system, free of charge, to US government agencies and their contractors. The increasing number of active licenses is a testimony to the effectiveness of this platform. In 2009 the UX-Process license count is 284, and it is used to some degree on most DGM MMRP projects.

Software Program Usage 2006-2009

![License User Count Graph]

The current workflow has been tailored and refined to provide an easy to use one-stop shop for the UXO community. It consists of 3 menus with over 90 GXs, providing:

- A standard platform for geophysical data corrections and processing
- Tools to standardize the QC/QA process
- Tools for target analysis and management
- Tools for survey planning and progress reporting
- A standard platform for algorithm sharing

This poster summarizes developments in 2009.

New Features

Depth/Response Curves

The recent report NRL/MR/6110—08-9155, entitled "EM61-MK2 Response of Standard Munitions Items" tabulates the peak EM61 responses of various munitions items at different depths. The curves representing this data are an excellent tool for sharing information with stakeholders, and will likely be used on MMRP projects for planning purposes, instrument testing and be included in project reports. The new DepthResponseCurves GX produces graphs delimiting the band within which the EM61-MK2 response for different munitions are expected to reside. All UX-Process users will have easy access to the latest version of this data. This GX includes the following options:

- Batch produce systematic response graphs at a desired scale for selected munitions and EM61-MK2 gates.
- Plot targets on the graph, indicate the deviation from the expected range, and report relevant statistics.
- Allow the user to interactively input single target responses to be displayed on the map.
- Allow the user to specify a response value and report the acceptable depth range.
- Alternatively, allow the user to specify a depth range and indicate the expected response range on the graph. These alternatives can be used in the preparation stage of a survey.
- Allow the user to specify and/or calculate background noise levels to display on the graph to assist in determining expected detection depth.

Current UX-Process menus

<table>
<thead>
<tr>
<th>UX-DataPreparation</th>
<th>UX-ParameterDetermination</th>
<th>UX-TargetManagement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Setup Parameters...</td>
<td>Total Field Magnetic Data</td>
<td>Target List Management</td>
</tr>
<tr>
<td>Survey Layout</td>
<td>1VD Magnetic Data</td>
<td>Target Utilities</td>
</tr>
<tr>
<td>Import</td>
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<td>USACE Instrument Tests</td>
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<td>Dig Sheet Utilities</td>
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<tr>
<td>Data Corrections</td>
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<tr>
<td>Utilities</td>
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<td>QC QA Tools</td>
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<td>Progress Reporting</td>
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<tr>
<td>Other DoD Tools</td>
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</tbody>
</table>

Figure 1: Number of current licenses of the UX-Process system.

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Mean (µ) and standard deviation (σ) can be interactively calculated from survey data or entered manually. R is an arbitrary multiplier allowing the user to view various noise levels in determining target selection thresholds and estimating site-specific detection depths.

Figure 2: UX-Process is subdivided into 3 menus, which are integrated with Geosoft’s licensed UXO product, UX-Detect, into a single workflow. Each menu cascades into submenus. At each development phase these menus have been expanded with additional functionality and revisited to ensure a natural workflow.

Figure 3: User dialogue screen for generation of Depth/Response Curves. Munition type and responses are read real-time from a lookup table produced from NRL reports for standard munitions and surrogate items. Plots for the munition types can be generated and used for planning, documenting instrument functionality and determining expected site-specific detection depths.

Figure 4: User dialogue screen for generation of Depth/Response Curves. Optionally targets from a target database could be displayed on the depth/response graph.

Figure 5: User dialogue screen for noise level definition. Horizontal dash lines will be plotted in the output map at µ+Rσ. Mean (µ) and standard deviation (σ) can be interactively calculated from survey data or entered manually. It is an arbitrary multiplier allowing the user to view various noise levels in determining target selection thresholds and estimating site-specific detection depths.
Figure 6: Depth response curve for 4.2" mortar. The blue and red curves show the best and worst orientation peak response over the target. The lighter shadow curve depicts the optional user specified permissible deviation, to account for sensor offset from the item. The crosses indicate project-specific responses of known seeds or recovered munitions.

Merge Target Databases

Targets resulting from calculations with different methods and/or sensor data must at times be consolidated into a master list. Historically this has been a tedious manual operation, prone to error.

The Merge Targets GX consolidates target lists and optionally produces a cluster list. Furthermore this GX creates additional channels that report the number of items merges for the merged list and the number of items in a clusters as well as the cluster dispersion for the cluster list.

Additional statistical calculations can draw on this information to establish a relative level of confidence for each target in the master target list.

Figure 7: Interface merging up to 4 target databases. Each target database must have X, Y, ID, and Mask channels. User defines the channels to be ported to the output database. Merged data can be clustered within a specified dispersion distance.

The output of the merging process produces a merged list and a cluster list as illustrated below.

Figure 8: Output merged list. For reference this list carries the position and target IDs of the input list. Additional channels can be moved over to the output merged list.

Figure 9: In addition, once the targets from different lists are merged, they can be clustered within a user defined dispersion range.

In the illustrations below, EM61-MK2 targets picked from Gate 2, as well as magnetic monopoles and dipoles of the same area are shown on separate maps. Some targets have responses in both data sets while others are present in only one or the other.

To optimize the remediation process, targets which have overlapping signals or are closer together than the reacquisition search radius are often grouped together into clusters and investigated as polygons instead of single points.

In this GX, after the initial step of merging the two target lists, the merged list can be evaluated for clusters using a separate clustering search radius. The user must then determine the appropriate polygon extents to provide to the intrusive team for each cluster.

Figure 10: Targets from EM61-MK2 Gate 216 data. The mag targets have also been indicated with light + for reference.

Figure 11: Targets from Geometrics 858 magnetic data. For reference the EM targets have been indicated with x.
Below, the colour map of the merged targets shows the Mag and superimposed EM both in 50% transparency. The merged targets are shown as circles in solid colors while a trace of the input targets is displayed for reference. Two separate lists are created, one for the merged data and another for the clusters.

Figure 12: The merged targets are indicated with circles. The final target list is an inclusive list of all the targets.

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Figure 13: The indicated window is zoomed to show that targets from EM only, mag only and merged from both list appear in the final list.

VSP Compatibility

Visual Sample Plan (VSP) is a software system from Pacific Northwest National Laboratory (PNNL) that generates sampling plans based on statistical sample analysis. VSP, and is gaining momentum in the UXO community for use in site characterizations. In collaboration with PNNL, Geosoft has produced Import/Export tools for VSP, eliminating the need for manual reformatting by the user. A self-contained VSP menu allows the import/export between the VSP transect and Oasis montaj line data formats. The import prompts only for the file. All other parameters are identified automatically on import, and all workspace parameters are carried over.

Figure 14: Simple VSP Import. All parameters are identified on the fly.

Figure 15: The VSP transect/ course over ground are imported into a GeoSoft database and displayed on a map for verification.

Figure 16: All the parameters are carried through by Oasis montaj and can be exported at any time back to VSP.

Technology Transfer

CEHNC will host their annual free workshop with Geosoft trainers in early 2010. The timing will be dictated by the release date of Geosoft's Oasis montaj version 7.2, and will be announced over the UXOnet online user forum. You can subscribe to this forum at: http://www.geosoft.com/support/forums/index.asp

Users and interested parties are encouraged to use the UXOnet online user forum as a venue to discuss software issues, post announcements and ask questions of colleagues.

US government scientists and contractors as well as existing Geosoft users may request a free copy of the UX-Process software at: http://www.geosoft.com/pinfo/industry/uxo/uxprocess.asp

Future Availability

The UX-Process software is a complex system of tools that requires yearly maintenance to remain viable. The maintenance has so far been funded by ESTCP and in-kind contributions from Geosoft, but upon the release of the final Phase 9 version, another source of funding must be identified. After evaluating maintenance options, the recommended solution is for a centralized DoD agreement in which the services each contribute. The main benefits of this solution are:

- Significant reduction in overall cost.
- DoD retains control over UX-Process QA/QC capabilities.
- Critical tools for contractors remain free and supported to authorized users.
- Supports other new development in future.

The Corps of Engineers through the Environmental and Munitions Center of Expertise is working to develop a Memorandum of Agreement for this support and execute the contract with Geosoft. Discussions are ongoing with the services and agreements for a majority of the required FY10 funding have been obtained.

Please contact us with any questions.