US Army Corps of Engineers ®
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HDR

IWR-GeoFIT Design Document

For Refinement and Corps-wide Deployment of the USACE New Orleans District's Automated Mobile GIS for Use with the Structure Inventory Collection and Valuation Process Related to HEC-FDA Study Guidelines

March 13, 2007
Contract # W912P8-05-D-0012-0006
Task Order # 15

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The project management plan goal is to evaluate an existing software application developed by The New Orleans District Corps of Engineers (CE-MVN) which automates the structure inventory and valuation process of the economic analysis portion of flood control feasibility studies. Based on the evaluation, guidelines for refinement of the tool into a version that can be used Corps-wide by all districts performing this type of economic analysis will be created. The plan outlines the following:

- Structure and data flow of the existing tool
- Assessment of other district needs
- Discussion of different refinement possibilities for creating a Corps-wide tool
- Select ion of a recommended initial deployment and outline costs schedule and scope of the selected refinement

MVN's Existing Software Tool

Introduction

MVN created a structure inventory collection tool in the spring of 2004 in order to help automate the economic portion of the Alexandria to the Gulf of Mexico Feasibility Study. The original tool was developed specifically for the Alexandria to The Gulf of Mexico Study, but the New Orleans District realized the tool could be used to automate this function for all structure inventory collection and valuation processes regardless of project or location.

The MVN found a need to automate and streamline business processes into one application. Technology, such as spreadsheets, Global Positioning Systems (GPS), and Geographic Information Systems (GIS,) were used to perform tasks by different offices and contractors.

In large studies where perhaps tens of thousands of structures may need to be inventoried, a single comprehensive method of data collection is vital in order to avoid hours of repetitive manual tasks and a high instance of human error.

Structure

The tool is designed to run on a laptop PC and facilitate "windshield surveys" from a vehicle. The tool was written as a Windows executable, and was authored and compiled in *Microsoft Visual Basic .Net*. The tool uses a mapping/GIS component that currently requires a license of *ESRI ArcGIS 9.1* installed on the laptop or PC. The required database that contains the geospatial data used in the inventory and valuation process is stored in a Microsoft Access ESRI Personal Geodatabase. A workflow diagram illustrating MVN's Structure Inventory process is shown in Figure One. The corresponding steps in the process are described below.

Work Flow

(Corresponding diagram follows)

1. **Define Survey Areas:** The first step in utilizing the Structure Inventory GIS application is to define the survey areas where the field survey will be conducted. The combined geographic survey areas define the entire project area. Usually this is accomplished by first defining where the overall feasibility study area will be located by digitizing a single polygon feature from photography or quad maps. This "project area" will then be divided into survey areas based on logical subdivisions for field collection or study analysis. Rules defining survey areas are project specific and only one survey area is required for each project; however these areas are usually divided at major roads crossings, waterways or reach areas.

Work Flow ***(continued)***

2. **Digitize Survey Area and Structure Point Features:** Once the Survey areas are defined, the data must be digitized and stored in an ESRI Geodatabase format according to a provided database template. Once the survey areas must be digitized and each survey will need to be given unique "survey name" and "survey description" attributes for identification purposes. After survey areas are digitized and attributed, point features are to be digitized representing each structure within the study area (survey areas) by creating a point in the center of each structure from aerial photography or other base data. It is important to note that this is an optional step as structures may also be created in the field. It is suggested, however, that it may be easier to digitize structures up front so that a running total of how many structures remain to be inventoried.

   Digitization may be accomplished using several possible methods including using CADD or GIS technologies, automatic centroid creation from existing building footprints or even using the "create in field" tool inside of the Structure Inventory GIS application. The only requirements are that the final structure point features exist in the predefined Geodatabase format and that the "STRUCTURECAT" and "STRUCTURESUBCAT" fields are attributed properly. These fields define the type of structure and corresponding estimator that will be used. Because assigned structure type may just be an estimate and aerial photography may be unclear or out of date, the exact location and type of structure can be added to or changed in the field.

   Acceptable values for the user-defined structure category attributes are as follows:

   - *STRUCTURECAT (Determines Estimator/Form Used)*
     - *STRUCTURESUBCAT (Determines Specific Category of Building)*

   - R (Residential)
     - G (General)
     - M (Mobile Home)
   - C (Commercial)
     - G (General)
     - A (Agricultural)
     - I (Industrial)

3. **Apply Sampling Rules:** When conducting an inventory of structures, random sampling may be applied to the structures as defined by the project. If sampling will be provided, an update in the structures table must be made where the "UPDATEABLE" field is set true for the structures in the sample. Sampling may also be applied with an automated process within the Structure Inventory GIS application with the options to apply sampling as a percentage of each survey area or as a specific number of structures sampled per survey area.

Work Flow ***(continued)***

4. **Conduct Field Survey:** The Geodatabase, base data, aerial imagery, ESRI map document and address locator for the project will be loaded onto laptop computers to be taken into the field. Once loaded onto the laptop, the structure inventory tool is then configured to work with project-specific data for the study area being inventoried. A zip code layer specifying zip code locations and city names may be specified as an optional data layer for use in attributing new structures with zip codes and city names based on geographic location. These field values are optional during the field collection process but are required by the Marshall & Swift / Boeckh (MS/B) ® Residential and Commercial Estimator desktop software applications when value estimation is performed. If a zip code layer is not provided to the Structure Inventory GIS application, a zip code and city/town name must be populated manually for any structures without these two values assigned after the field collection is completed. Once the Laptop computers are configured, windshield surveys are done by driving in front of a structure to be surveyed and clicking on the corresponding structure point. An electronic commercial or residential form will appear which must be completed and saved. Once a structure is saved, a black check mark will appear on top of the structure showing that it has been edited. If a structure is placed in the wrong location or the structure is not to be inventoried for whatever reason, the structure can be marked as deleted and a red "x" will be placed on top of the structure. A structure marked for deletion may be "undeleted" at any time during the field survey process. When all structures are marked as updated, the field survey should be complete. A running total will show the number of structures to be completed in each survey area and the "show structures left" tool will zoom into and flash the structures remaining to be inventoried on the field map. Upon completion of field data collection, the master Geodatabase should be referenced by a Federal Geographic Data Committee (FGDC) standard metadata records associated with each spatial data layer. The metadata records should be project specific.

5. **Export Sampled Structures to MS/B Import Export Files:** After the field survey is completed, the structures are ready to be exported to MS/B to be valued. Prior to this action, MS/B Estimators require that all structures be assigned a zip code and city name for the import to be successful. This may require a manual GIS step if the zip code layer was not specified for the project and additional structures were added in the field. If more than one team was conducting field surveys, the databases may need to be merged into one database before running the export as well.

   After these preliminary steps are taken, the values can be exported by simply selecting the **File→Export→MS/B Residential** and **MS/B Commercial** options from the main menu bar. The files will be saved to a text file with a specified filename and path.

   Once exported, the files now contain all of the data needed to import the structure inventory information collected in the field into the MS/B Estimators. This can be done by simply selecting **File→Import→Option** from the Estimator's main menu bar. It is a good idea to create and specify the category under which all estimates will be imported. If any error occurs, the import program will either crash or give a running total of the errors depending on the estimator. After the import is completed, all records will appear in the estimator under the assigned category.

Work Flow ***(continued)***

6. **Run Batch Value Calculations:** The structures and corresponding field attributes now reside in MS/B's Estimator programs and are ready to be valued. The most efficient way to perform the valuation process is to run the batch valuation command within the estimators. This can be accessed from the main menu under **File→Calculate Values.** The user must first search and select the values to be calculated. In most cases all structures will need to be valued, so running the **Find** command on blank criteria under the projects category will select all structures imported. Now simply press the **Run** command to begin the batch calculations and all values will be assigned to the structures.

7. **Export Structures with Values to MS/B Estimator Export Files:** After values are assigned, the data are simply exported out to the MS/B Import/Export format. This file format is the same used to import the structures with the exception being that values are now assigned to each structure.

8. **Import Values from MS/B Export Files:** The values contained in the exported MS/B files will now be imported back into the Structure Inventory GIS application using the **File→Import Values** commands on the Structure Inventory GIS application's main menu bar.

   A successful import can be verified by identifying an existing structure after the value import has occurred. If the value for that particular structure was assigned, it will appear in the forms title bar caption.

9. **Assign Hydrologic Engineering Center's Flood Damage Analysis (HEC-FDA) Computer Program's Hydrologic Frequency Curve Station Numbers to Structures:** At this stage in the workflow, inventory data with computed structure values are almost ready to be sent to HEC-FDA, but the required step of assigning hydrologic station numbers to each structure corresponding to hydrologic stream and station in HEC-FDA must be performed. The MVN Structure Inventory GIS does not have an automated utility or set methodology for performing this step and therefore must be done according to the project's specific requirements. In most cases, a GIS professional or a professional with intermediate level GIS experience will use ArcGIS to assign this value spatially, either by reach location or relative position, to Hydrologic Engineering Center's Geographic River Analysis System (HEC- GeoRAS) or other model cross-sections.

10. **Export Sampled Structures to HEC-FDA ASCII File:** The final step in the work flow is to simply export the data to HEC-FDA ASCII file format. This can be performed by simply running the **File→Export→To HEC-FDA** command from the Structure Inventory GIS main menu bar. During the export, the number of structures a valued structure represents is automatically calculated based on the number of total structures assigned to the same HEC-FDA station number. The HEC-FDA export file is formatted as a tab-delimited file and ready to be imported into HEC-FDA. It may be previewed in Microsoft Excel.

Data Flow Diagram

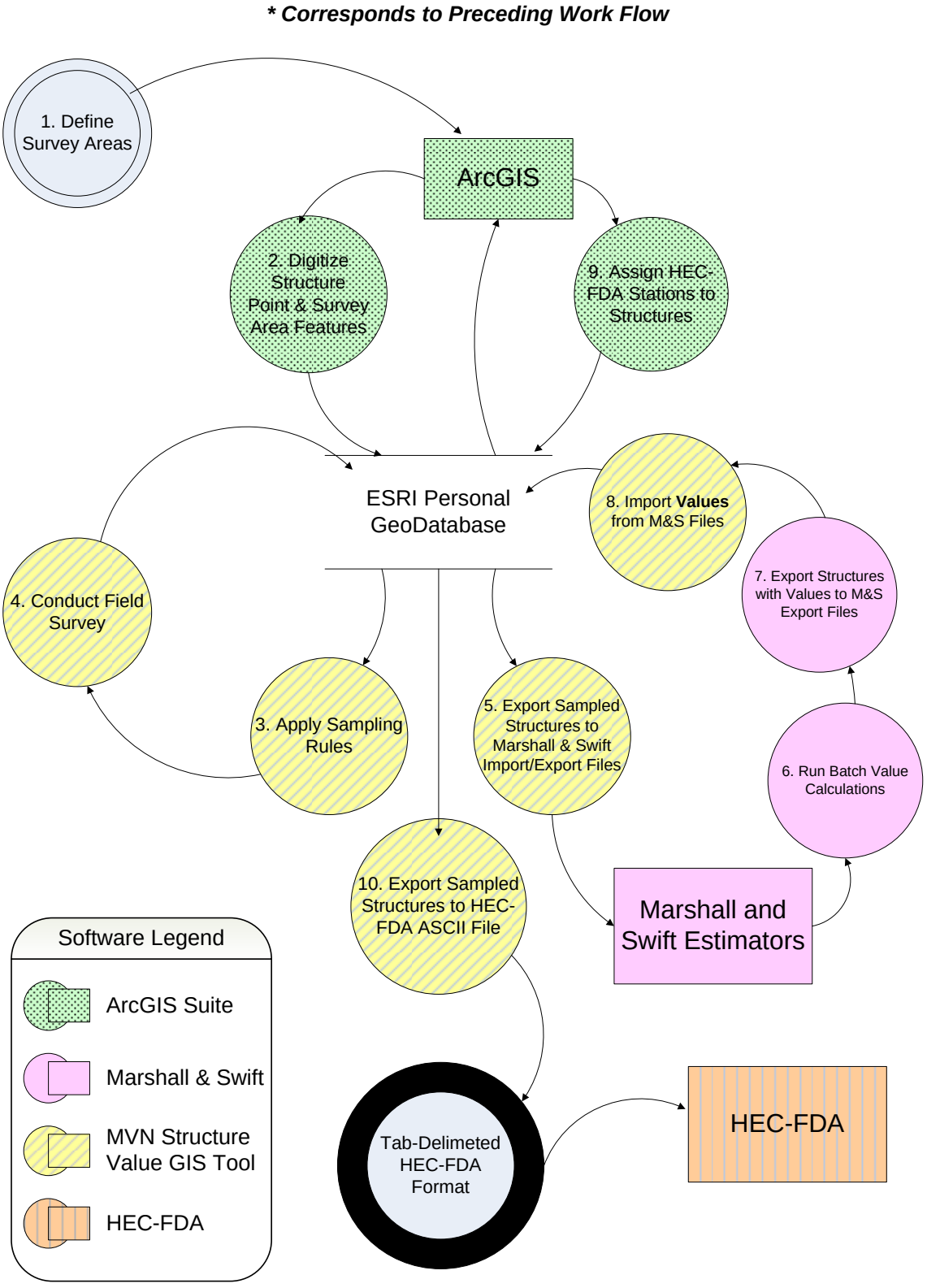

Figure 1: Data Flow of MVN's Structure Inventory and Valuation Process

Logistics

The current version of MVN's structure inventory tool is a modification of an early version originally designed to automate the structure inventory process for one feasibility study (Alexandria to the Gulf of Mexico). The original tool was shortsighted in scope because of time constraints and immediate need for this project. Although the original tool was a vast improvement over the former business process of structure inventory collection, the original tool did not have other feasibility study projects in mind within the New Orleans District much less the need Corps-wide. It is important to evaluate the process of structure valuation on a Corps-wide scale when evaluating the usefulness of the tool.

The current version of the tool used in the evaluation allows for more customizations from the original such as multiple project support, MS/B import & export, and HEC-FDA export. The overall advantages of the tool include improved efficiency in labor hours required to effectively value buildings within a study area and the accuracy of collected data.

Benefits

Structure inventory tools save time by allowing inventory crews to collect data in the field without the hassle of using numerous paper location maps and manually filling out and transporting thousands of paper inventory forms. The completed electronic forms include drop downs lists and auto complete fields for many of the values that are collected which save time typing or hand writing field values. The GIS interface allows several different location tools to help locate a desired sample structure without the burden of large-scale maps and manual location methods. Tools include the following features:

- Locate by street or address
- Locate by latitude/longitude
- Locate by structure name/id

In addition to these tools, scale and map extent are not hindrances to the GIS interface as it is with paper maps because of the ability to zoom in, out, and pan the interactive map.

The automated conversion tools which transfer data between data collected in the field to valuation software and on to the Corps of Engineers HEC-FDA computer program save a tremendous amount of time compared to manual data entry and conversion.

Because data entry is required only once during the field collection, and conversion is accomplished through batch processes, operational costs are dramatically reduced regardless of the number of structures inventoried.

Human errors can occur easily when entering data manually into a system. Although errors can never be completely eliminated, they can be reduced drastically by limiting the number of times the same data is entered into different systems. The automation tool improves accuracy of collected data in the field and entered in valuation software by limiting mistakes and reducing the number of times data is reentered. The tool only allows acceptable data to be entered into each required field by type or domain. For example, only numeric values can be entered for numeric fields, such as square footage, and only valid domain values, such as occupancy codes, may be entered. The tool also automates the conversion process between different software packages used in the economic evaluation process. A set of rules are defined in code, enabling the conversion between systems, and these rules are followed by computer logic regardless of the number of structures collected.

Needs Assessment

Workshop

IWR, along with assistance from MVN and HDR, conducted an online workshop with

representatives from several Corps districts in order to get a better understanding of the economic development community Corps-wide as it relates to the process of structure inventory collection and valuation. A list of workshop participants who attended the workshop is listed in Appendix A.

MVN presented the existing tool used at the New Orleans District highlighting the method involved in automating their business processes, the benefit of using the tool and the cost savings realized from using the automation tool. In addition the MVN representatives gave a live demonstration of a "typical" workflow in which structures would be inventoried in the field, exported to MS/B Estimators for valuation, and then converted into a HEC-FDA import file. The final portion of the workshop consisted of a formal and informal discussion focused on how the MVN tool may be used to assist other districts with similar structure inventory and valuation business processes.

During the workshop, participants were given an overview of MVN's automation tool and a live demonstration showing a typical workflow using the tool from the field collection process, the export and valuation using MS/B and finally the export to the HEC-FDA ASCII format. After the demonstration, a question and answer session took place.

The following is a of list questions and brief summary of typical responses:

1. *Which component of the structure inventory & valuation tool would be most useful to your organization?*

   For this question, the majority of responses were focused on the GIS field collection, the HEC-FDA conversion and all other components in equal portion. The majority of detailed responses were that, although the MVN business processes were not exactly like what other districts have in place, there are portions of the automation tool that would help tremendously in the areas of time-saving and data accuracy. The majority stated that entering the collection data for thousands of structures only once would save an enormous amount of time in the valuing process.

2. *Which portion of the structure inventory application would be least useful or irrelevant to automating your organizations structure inventory and valuation process?*

   The majority of attendees stated that the MS/B Estimator export/import portions were the least useful. After further discussion, it became apparent that this had mostly to do with the differences in the valuation process among the districts. First, some districts stated that they used local or regional tax-assessor data to some degree and were unsure of how this would fit into the MS/B export and batch valuation process. Secondly, some districts did not have software versions of the estimators or did not pay subscriptions to keep their versions up to date. Thirdly, districts had their own methodologies, sometimes based on MS/B publications and formulas, but using their own customized spreadsheets or manual calculations customized spreadsheets or manual calculations. Finally, some districts used the MS/B software but were concerned with the accuracy of the batch calculation process due to the lack of information provided to the Estimators from the MVN tool.

Workshop
(continued)

3. *Where do the main differences between your organization's structure valuation process and the New Orleans' District's process exist?*

   Question number 3's response mainly focused on multiple, varying differences. It was also stated that this does not necessarily make the tool useless but has more to do with the current overall process. Many districts do not use an automated tool for

the entire process but there are those districts that use some GIS and tools like CEFIT to automate at least a portion of their process. Other districts that use GIS to assist with field collection mentioned other technologies such as ESRI ArcPad and handheld GPS devices. As mentioned in response to question number 2, many districts had differences with their valuation process that needed to be addressed.

4. *How can the structure inventory application be improved to best meet your organizations needs?*

   The majority of responses focused on automating the hydrologic data integration. During the live demonstration, a discussion began with the question of how to automate the assignment of hydrologic data to structures before the data is sent to HEC-FDA. Attendees from the Chicago District, and a few others, mentioned that there was a methodology in place by which this may be accomplished; however further investigation into this method would be needed. The current MVN tool does not automate this particular process but does allow the data to be easily updated because the structure data is contained within a standard GIS data format.

5. *What limitations, if any, would your organization run into with implementation of an application like the Structure Inventory GIS tool?*

   The overwhelming response was “Lack of GIS/Database Support”. It is true that there is still a manual GIS setup process involved with each project before the application can be used for a feasibility study. GIS setup and data creation are present with each individual study project. Many district economists expressed the fact that either they do not have enough individual GIS experience or do not have access to those that do on a regular basis in order to support this type of business process.

Phone Interviews

HDR conducted phone interviews with a few district representatives, as a follow-up to the workshop. The phone interviews helped acquire more detail about concerns individual districts may have about implementing an automation tool. The following are short excerpts of feedback issues, questions and concerns mentioned during from some of those interviews:

9/12/06 Corps of Engineers - Chicago District (LRC) Interview: David Bucaro and Gary Wickboldt

- LRC representatives stated that the data input forms used to collect information on commercial and residential structures need to allow for additional values such as heating/cooled air and roof type. They also suggested that perhaps the forms could be customized to allow different values to appear on each form depending on the project. In this way, roof type may appear on the entry form for one project and not on another.
- The software should support any spatial coordinate system
- LRC currently uses a handheld PDA with integrated GPS to collect field data. LRC would like to see support for technology such as ArcPad and at least GPS capabilities for the laptop. (See Appendix A)
- LRC has used CEFIT to aide them with structure valuation in the past and are concerned with immediate support of this application. LRC was questioning if the tool would integrate with CEFIT or replace it. LRC is also concerned about cost requirements for purchasing MS/B software.
- ***HDR mentioned discussions with MS/B representatives during the research and suggested different options for valuation. Those suggestions include a web-based upload for valuation, pricing by structure assessment, and implementing an integrated MS/B software development kit so that valuation could be merged with the data collected in the GIS format. LRC responded that separate billing may be a good solution because they would only pay for what they need and costs for hosting a centralized "valuation" server could be shared by division or region. Tracking costs by individual project would also be easier.***
- ***HDR mentioned the possibility of separating the field collection and GIS tools from the valuation and export/import tools as a way of reducing required costs and ease of installation. The current application does not require that MS/B is installed on the same PC as the tool, but the export format is designed for stand alone installs of MS/B Residential and Commercial Estimators.* LRC responded that they liked the idea of keeping components separate.**

9/19/06 Corps of Engineers - Seattle District (NWS) Interview: Mike Green and Don Bisbee

- NWS economists are currently entering thousands of structure records by hand into spreadsheets. An automation tool similar to MVN's would help NWS economists] in the structure inventory process by reducing the time and human error involved.
- How compatible would a solution be with the HEC-FDA 2.0 version which has integrated GIS capabilities? ***HDR understands from conversations with Bob Carl of the Hydrologic Engineering Center that HEC-FDA 2.0 is still in design phase and not undergoing active development and, therefore, should not be a conflict at this time.***

Phone Interviews *(continued)*

- How compatible would the hydraulic information be to the new Flo-2D format? ***In the current MVN tool, hydraulics are handled separately from the structure inventory and valuation process. The only time hydraulics comes into play is***

when hydrologic stations are assigned to each structure before being exported to HEC-FDA. This methodology is not defined by the tool.

- Can the application be used to only do structure inventory and not use HEC-FDA or MS/B? ***Yes, the current MVN tool can be used as needed. In some cases where only 10 ten structures are in question, NWS may only need some basic information about these structures and MS/B may be applied manually. It does not force the user to use the typical workflow and all phases, GIS map creation, field data collection, valuation, HEC-FDA conversion and import, are all separate processes. There is no reason why a district-wide tool would change this ability to customize its use.***
- NWS's main concern is the level of GIS expertise and support available to the economists in order to properly use the application. Getting basic GIS training for some of the economists was suggested.
- NWS representatives were also concerned with the cost of software and hardware needed to support the application.
- NWS economists are currently entering thousands of structure records by hand into spreadsheets. An automation tool similar to MVN's would help NWS economists most in the structure inventory process by reducing the time and human error involved.

9/20/06 Corps of Engineers - Los Angeles District (SPL) Interview: Mike Hallisy and Mark Beirman

- SPL uses GIS heavily and have adequate support and/or training required to use GIS automation tools similar to the MVN tool.
- SPL does not use the MS/B Estimators but instead uses a customized Excel spreadsheet with formulas derived from the Marshall & Swift Assessment books and methodologies.
- SPL stated that, usually, their district has geographic parcel data available before going into the field. This means much of the structure information such as geographic locations, street addresses, and square footages do not need to be collected in the field. Instead only a smaller set of data is collected related to building condition. ***HDR responded that because the database is open-ended and in a standard ESRI GIS format, that it would be simple to load the data upfront into the structure inventory tools Geodatabase with some standard GIS/Database work. Centroids based on zoning information could be generated from the parcels layer and a simple SQL query or programming script could be written to "copy" over attribution information. The results would be a data layer with most attributes already completed on the inventory forms.***

Phone Interviews ***(continued/ SPL)***

- Structure inventory is not inputted directly into HEC-FDA but instead uses a Flo-2D model***. HDR's response was that not all aspects of the application have to be used. Only the custom field collection GIS portion could be used if desired.***

ArcGIS Engine and Version Compatibility

Technical and Automation Issues

After assessing the needs of the USACE community and what will be required in order to provide a viable solution, a few technical issues need to be addressed before deciding how to move forward with making the existing application available to all districts. These issues are broken down into the following: ArcEngine compatibility, required assessment software, coastal study compatibility, inventory, and non-GIS user needs.

As mentioned in the "Structure" section of the PMP document, one of the requirements of the existing structure inventory application used by the New Orleans district is that any computer running the application must also have a fully functional version of *ESRI ArcGIS 9.1* .[1] While investigating costs associated with using the application, it became apparent that this application would be a good candidate to use the more affordable *ArcEngine* license but that some testing for compatibility would be needed in order to see what changes to the existing application, if any, would be necessary.

Because this issue deals primarily with cost versus functionality, licensing of *ESRI's ArcGIS* family of products had to be investigated. According to investigators, the main focus is the stand-alone license that must be purchased in order to bring a laptop into the field. Additional "manual" GIS work will be required by GIS professionals before and after the field collection takes place, according to investigators. This task will most likely require full licensing on a desktop PC in the office in addition to any *ArcEngine* licenses purchased. Most districts currently using *ESRI* products in an environment where more than a handful of GIS users exist usually use a concurrent licensing pool on a district-wide license server in order to address these needs. The investigation and testing of the compatibility issue, therefore, focuses on the licensing required for the field work alone.

Typical retail pricing for a stand-alone *ArcView 9.1* license is around $1500 USD as compared to *ArcEngine* where pricing for the run-time engine is around $400 USD. The main difference between the *ArcGIS Engine* and *ArcGIS* family of licenses, of which *ArcView* is the most "standard" version, is that *ArcEngine* does not include the standard graphical user interfaces associated with a typical installation of GIS software. Instead, *ArcGIS Engine* allows developers to distribute custom GIS applications, similar to the structure inventory application and not require that a full-blown *ArcGIS* interface also be installed on the end-users PC.

ArcGIS Engine and Version Compatibility *(continued)*

ArcGIS Engine Testing Results:

In order to test for *ArcEngine* compatibility, HDR employees deployed the latest version of MVN's structure inventory application along with a sample feasibility study project onto a laptop PC. In addition to the structure inventory application, the laptop had the following software packages pre-installed: *Microsoft .Net Framework version 1.1*, *ArcGIS Engine for .Net*.

The application ran well, at first indicating that the same *ArcObject libraries* used to develop the application were compatible with the libraries distributed with *ArcEngine*. Once the sample project was selected inside the application and the map form began to load, an irrecoverable error occurred indicating the following: *".Net Assembly not found: ESRI.ArcObjects.ArcCatalog."* The debug information also indicated the program error occurred during an attempt to load the geocoding service from the project-specific address locator file. Upon close inspection of the source code, it was apparent the program attempted to use an *ArcCatalog* function to access the file based geocoding service in memory. With the error message indicating that the *ArcCatalog library* was not available on the laptop, an investigation into the availability of this library began.

After checking the *ESRI Developer Network* along with the computer registry of the test laptop, it was apparent that the *ArcCatlog library* is not available with a purchase of the *ArcGIS Engine library*. HDR also checked registered components for compatibility with all other *ESRI.ArcGIS libraries*, of which all appeared to be present at the time.

HDR has found the existing application needs to be changed in order to be compliant with the *ArcGIS Engine Runtime* if it is to be used. The change should be relatively minor because the incompatibility only affects the loading of the project files and not the overall functionality of the GIS interface and file conversion functions, however the project administrator interface will need to be rewritten.

Coastal Study Compatibility

Coastal properties that are studied for flood risk analysis have significant differences that need to be addressed in order to see if the MVN tool or a similar version can be used to help automate the structure inventory and valuation portion of flood feasibility studies in coastal areas. With the help of Linda Lent, visiting scholar with IWR, HDR was able to identify two major areas of concern that would make the current MVN tool incompatible with coastal studies. The following areas of concern include:

1. Not enough data or the wrong type of data is collected by the structure inventory input forms in order to evaluate coastal structures in the *MS/B Estimators* accurately.

2. Differences in the input format and data fields exist which will prevent structure inventory information from being evaluated by *Beach FX*, the model used in estimating depreciated replacement values in coastal regions.

The *MS/B* estimators fall short in a few areas. According to Lent, the *MS/B Estimator* programs are based on "typical" or "average" structures for an area. The first problem with this assumption is that coastal property is typically the most valuable real estate in the region. "Average" structures are not built on real estate which can cost up to 50 times the average property in the region. The second issue relates to the relatively unique aspects of coastal construction. Additional/different supporting members are required to effect construction in sand. Costs increase when structures are built to withstand winds common in coastal areas, and construction costs are always higher in the vicinity of resort property. Further, resort properties are often located in more remote areas, which have a finite labor supply that cannot increase to accommodate the surge in demand following a hurricane. Material shortages are likely as well. In riverine flooding, most houses suffer a degree of damage rather than full destruction, and the valuing technique used by MS/B states that "typical repair work will cost 10%-20% more than new construction." Even if the structures are destroyed, the cost to clear the debris and foundation components remaining on the site is an added cost to new construction not included in MS/B estimates. These are all adjustments that are suggested by MS/B Estimators but not easily applied and/or are virtually impossible (adjusting for high end construction) in the standard estimator programs. It should also be noted that MS/B offers online versions of the estimator applications that are known by IWR economist to be better at valuating high-end properties which are more common in coastal areas. More information about the online estimators can be found at http://www.swiftestimator.com.

Coastal Study Compatibility *(continued)*

The second area of concern has to do with the values required for input by *Beach FX* compared to that by *HEC-FDA*. The following chart shows the differences in the data entities required to input damage entities or structures:

Structure Inventory Input Value Comparison

Beach FX	**HEC-FDA**
LotNumber	Struc_Name
DamageElementTypeCode	Cat_Name
FoundationTypeCode	Occ_Name
ConstructionTypeCode	Station
ArmorTypeCode	Year
DEDescription	1F_Stage
Group	Struc_Val
StructureValueP1	Num_Struct
StructureValueP2	Stream_Name
StructureValueP3	Street
ContentsValueP1	City
ContentsValueP2	State
ContentsValueP3	Zip
DepreciationFactor	North
AppraisalDate	East
RepresentativePointNorthing	Zone
RepresentativePointEasting	Notes
RepresentativePointLocationType	
AzimuthAngle	
DistanceFromReferenceLine	
DEWidth	
DELength	
DEFirstFloorElevationP1	
DEFirstFloorElevationP2	
DEFirstFloorElevationP3	
DEGroundElevation	
DEGroundElevationReferenceNorthing	
DEGroundElevationReferenceEasting	
ConditionIndicator	*(no additional values)*
DENumberOfFloors	
TimeToRebuildP1	
TimeToRebuildP2	
TimeToRebuildP3	
NumberOfTimesRebuildingAllowed	

Although the inputs are similar, issues still exist which require consideration before coastal properties can be assessed with MVN's tool. Changes to the inventory form would have to occur to allow additional input values to be collected such as *DistanceFromReferenceLine* and *ContentsValueP1,* as well as an added functionality to allow export to *BeachFX* format.

Form Changes

During the user needs assessment, HDR determined, in addition to the data collection forms used by the New Orleans District, necessary changes and additions needed by other districts are required in order to match the field collection business processes required for valuation. These needs were identified as the ability to collect quality, condition, effective age, heat and cooling systems, roof covering, exterior wall covering, porches and decks, basements, and garage type information for each structure. In addition, the effective age formula used by MVN was determined to be an unacceptable method of assigning an effective age to each structure surveyed. Other districts would require field collectors enter the effective age manually.

In order for these needs to be addressed, changes to the database, user entry form and *MS/B* export feature would have to be made. The *MS/B* acceptable domain values for each additional data item would have to be incorporated into the *Geodatabase*. Additional fields would also have to be added to the *Geodatabase* in order to store the additional data values. Lastly, the *MS/B* export feature would have to be updated to include the values that would be transferred from the field collection database to *MS/B Estimators* for valuation.

Non-GIS Users

Needs assessment indicated there may be a need to create a version of the software that does not require GIS capabilities. This may occur in cases where field collection does not take place by the Corps of Engineers, but instead, another external source provides the data. In these cases some data entry, and the export/import to MS/B and HEC-FDA, is still required. In other cases where tax assessor data may even provide structure values, only an export of the data to HEC-FDA may be required. In these cases, GIS capabilities would not need outside support and the subsequent cost of buying GIS software avoided. It is therefore recommended that if non-GIS users are to be supported in the tool refinement process, one of two versions of the tool will have to be developed.

Non-GIS Version 1:

Version 1 of the non-GIS tool would consist of a tool that allows for data form entry, export to *MS/B Residential and Commercial Estimator* import/export format for valuation, import *of MS/B* values into the tools internal access database and export of structure data with values and hydrology to *HEC-FDA*. This version of the tool is possible but would require a complete rewrite of the tool removing all GIS dependant components from the source code. This solution would require that both a GIS and non-GIS version of the tool be supported simultaneously.

Non-GIS Version 2:

Version 2 of the tool is more of a universal solution in which different functionality of the tool is broken into separate components. In this solution, the GIS field collection would be one application, and the Import/Export or valuation features would be a second component. Version 2 would therefore allow each district to pick and choose the level of support they wanted. This would be a more open-ended solution where several different interfaces could be created on a district or Corps-wide level in the future. This solution would include an "engine" or "software development kit" that would allow for the conversion of data between the Access database, *MS/B Estimators* and *HEC-FDA*, but not force a district to use a standard interface if they choose not to implement a particular module such as GIS.

Alternative Refinement Versions

HDR has defined several suggested refined versions of the MVN tool that can be used as a Corps-wide tool, based on needs assessment, schedule, and technical issues. This section

describes the details of various alternatives for refinement.

Version A

The first suggestion for refinement is viewed as a "minimal change" version. This version of refinement would allow the tool to be released, at least as a Beta version, to other districts as quickly as possible. The overall functionality would not change significantly from the MVN version, but it would still be universal and function regardless of geographic region.

Any significant changes in this version of the tool would involve the ability to function in different spatial coordinate systems and required inventory form changes. Documentation would need to be created in order for users to setup projects and properly use the application

Required Refinements:

- Update structure inventory forms to allow for roof covering, exterior wall covering, porches and decks, basements, and garages.
- Remove the effective age formula from the existing form and allow the effective age to be manually entered.
- Update *MS/B* export to account for additional form changes.
- Update *MS/B* export to be compatible with the latest copy of the estimators. These updates would be focused primarily on the fact that any component or occupancy lists may change at any time according to MS/B's specifications. In addition, some lists are dependent on others, such as components that belong to certain systems and building classes that are acceptable only for certain occupancies. These relationships may change as new rules are updated in the estimators. The last change would focus on the ASCII file format itself. The Export/Import format may change at MS/B's discretion. Version A would have to adapt its export file format as these changes occur within the estimators.
- Ensure that the GIS portion is compatible with data stored in any spatial reference/coordinate system.
- Perform a test of the tool and fix any discovered bugs. This should include testing a comprehensive data selection, testing of what happens with incomplete and invalid selections, testing of import and export features, and testing of formatting and reliability of calculation and reporting features. Ensure the application does not lock up or that the application does not cease operation unless the user has logged out. Create an error logging facility.
- Make the application compatible with both ArcEngine and ArcGIS.
- Create an application installer and distribute the tool through online or physical media.
- Create a metadata template for any GIS layers created to be used with the application.
- Enable a GPS integration option.
- Create user documentation.
- Create a GIS setup guide.

Version B

Version B includes a handheld/integrated PDA version of the field collection tool along with a Windows desktop version of the file conversion tools. This version addresses the needs of districts that may require use of existing handheld devices where walk-up access to buildings is necessary. The recommended technology, *ArcPad* is more light-weight than *ArcGIS*, can be run on either a laptop or palmtop computer and the price is roughly $1100 less expensive than a stand-alone version of *ArcView*. GPS capabilities are already integrated into the system.

Required Refinements:

- Perform complete rewrite of the field collection tools as an *ArcPad* application.
- Setup methodologies or software tools to convert between *Shapefile*, the supported geospatial data format used by *ArcPad* and *Geodatabase* formats, when transporting data back and forth from the field.
- Create a standalone tool to run on the desktop that will convert data from *Geodatabase* or *Shapefile* to *Marshall & Swift Estimators* format, import values back into the *Geodatabase*, and finally, export data to *HEC-FDA* format. This functionality will be similar to the *MVN* tool but without the GIS and electronic form interfaces.
- Distribute the tool through online or physical media.
- Create a metadata template for any GIS layers created to be used with the application.
- Create user documentation.
- Create a GIS setup guide.

Version C

Version C addresses issues that were discussed during the need assessment and would be the most complete and universal version of the tool. It will also take the longest time to develop and involves some areas that still have questionable implementations at the time of this PMP creation. Similar to version B, this version will separate the functionality of field collection and data valuation but will include more overall functionality for both applications. Version C also considers the needs of non-GIS users mentioned in the *Technical and Automation Issues* section by separating the GIS from the valuation and reporting tool. Coastal study needs are additionally addressed in this version.

Required Refinements:

- Create an application installer and distribute the tool through online or physical media.
- Create a metadata template for any GIS layers created to be used with the application.
- Create user documentation.
- Create a GIS setup guide.

Field GIS tool:

- Remove the effective age formula from the existing form and allow the effective age to be manually entered.
- Ensure the GIS portion is compatible with data stored in any spatial reference/coordinate system.

Version C *(continued))*

- Perform a test of the tool and fix any bugs that are currently known and any previously known bugs. This should include testing a comprehensive data selection, testing of what happens with incomplete and invalid selections, testing of import and export features, and testing of formatting and reliability of calculation and reporting features. Ensure the application does not lock up or that it does not cease operation unless the user has logged out. Create an error logging facility.
- Make the application compatible with both *ArcEngine* and *ArcGIS*.
- Add the ability to include all available *MS/B Estimator* fields for both residential and commercial structures.
- Add optional agricultural and mobile home custom forms.

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- The forms will include organizational “tabs” that can be turned off and on by a project administrator. These will depend on each projects or each districts required level of detail for field collection.
- Include a tab or optional field forms for additional “coastal values.”
- Remove all import/export functionality from the GIS field collection application.
- Add integrated GPS support.
- Add more location devices including:
- Locate by Township-Range Section
- Locate by River Mile Custom layer query
- Integrate field photos with structures on the project level as a one-to-many relationship. For each project, each structure can have many photos associated with the structure.

Desktop Reporting and Valuation tool:

- Add the ability to create and save aggregate queries about structures in a project database. These queries may include number of structures grouped by type for each hydraulic reach area or values with calculated statistics for different areas.
- Add structure & query printable report functionality with integrated field photos. The reports can be saved out to various formats such as *Microsoft Word* and *Adobe PDF* format. The reports should also be able to be sent directly to the printer.
- Include the ability to apply values for the structures within the application using built-in technology without requiring import and export of data to *MS/B Estimators*
- Include optional import and export of different estimator formats that may be used such as excel spreadsheet formats and assessor data.
- Include export to *HEC-FDA* and possible direct integration with *HEC-FDA 2.0.*
- Include an export of structure data to *Beach FX*.

Recommended Refinement Version

HDR recommends that **Version A** be selected as the preferred refinement version at this time. It should also be noted, however, that versions B & C, along with future adaptations of both, should be considered for future development.

It is also recommended that Version A of the tool be given a formal name at the Corps' choosing and be referred to as the Beta 1.0 version because of subsequent field testing that will be performed. It is also recommended that the Corps sets up its own method for reporting bugs and recommended improvements during the beta testing period.

Version A was selected based on the fact that it would be the quickest to implement and get into the hands of real users Corps-wide. This would have the two-fold benefit of allowing users to perform necessary beta testing of the application and quickly automate portions of economic feasibility studies throughout the Corps. More complete versions would take longer to develop and may require an even longer modification time after beta testing is completed.

Scope And Schedule

The U.S. Army Corps of Engineers New Orleans District developed an automated, GIS-based computer tool to expedite data acquisition on residential and commercial structures; these data are subsequently used for flood damage assessments.

The Institute for Water Resources (IWR) has explored the feasibility of refining this data acquisition tool and adopting it for use in other districts. As a result, IWR has identified a number of tasks that are required to make this tool functional and accessible to Corps users.

Scope

Task 1. Updating the Acquisition Tool: The Contractor will update the tool so that it is compatible with the latest version of the MS/B Estimator software. The Contractor will ensure that occupancy codes are current, and building classes are correctly associated with the occupancy codes. Structure features should include a complete range of choices for quality, condition, effective age, heat and cooling systems, roof covering, exterior wall covering, porches and decks, basements, and garages.

Task 2. Testing and Bug Repair: The Contractor will perform a test of the tool and fix any bugs that are currently known and any previously known bugs. This should include testing a comprehensive data selection, testing of what happens with incomplete and invalid selections, testing of import and export features, and testing of formatting and reliability of calculation and reporting features. The Contractor will ensure that the application does not lock up or that it does not cease operation unless the user has logged out. The Contractor will create an error logging facility so that bugs can be identified, tabulated, and corrected more easily.

Task 3. Ensuring GIS Compatibility: The Contractor will ensure that the application is compatible with both ArcEngine and ArcGIS so that data will be accepted without problems from either of these applications.

Scope ***(continued))***

Task 4. Constructing User Interface: The Contractor will create a self-loading installation program that can be downloaded from a Corps website. Ensure that all data entry screens give clear directions on how to proceed. Write and enable context-based error messages for users. There should be clear menus for importing, exporting, saving data, and generating reports. Create a data entry template.

Task 5. Testing and Preliminary Delivery: Following completion of the user interface, the Contractor will test the application and ensure the application and the interface are properly working. The application will then be sent to the Government for further testing.

Task 6. One-Day Meeting to Review Testing and Documentation Content: The Contractor will participate in a one-day meeting in the Washington, D.C. area to demonstrate the software and discuss the results of testing and the content of the user documentation.

Task 7: Documentation and Delivery of Working Application: The Contractor will produce a 10-20 page user manual with screen captures on the application's purpose, software and hardware requirements, limitations, installation, and operational procedures. The Contractor will provide source code, a data dictionary, and a metadata template. The final working application will be directly exportable to the Hydrologic Engineering Center's Flood Damage Analysis Program. Following completion of the documentation, the Contractor will deliver the documentation in Microsoft Word and a self-installing web-based version of the software application for unlimited distribution.

Schedule

TASKS	***MILESTONES***
Task 1. Updating the Acquisition Tool	Within 21 days of Notice to Proceed
Task 2. Testing and Bug Repair	Within 35 days of Notice to Proceed
Task 3. Ensuring GIS/GPS Compatibility	Within 50 days of Notice to Proceed
Task 4. Constructing User Interface	Within 70 days of Notice to Proceed
Task 5. Testing and Preliminary Delivery	Within 90 days of Notice to Proceed
Task 6. One-Day Meeting to Review Testing and Documentation Content	Within 100 days of Notice to Proceed
Task 7. Documentation and Delivery of Working Application	Within 120 days of Notice to Proceed