Saving Time and Money Using a Customized ArcPad Application

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Introduction

Traditional field data collection methodologies involve many repetitive steps, adding a lot of time to the process and a lot of room for error. A field scientist will usually go out into the field and spend days and often weeks logging observations and hand digitizing features on paper maps all while juggling a cumbersome GPS unit. Once this phase of the project is finished, the scientist must return to the office and either type up the observations and digitize the drawings themselves or instruct someone else to do so. This step allows for error for example, illegible handwriting or misinterpretation of field notes and drawings. At this point, an iterative process between the person who collected the information and the person who entered the information electronically will begin, often several weeks passing since the original data was collected, increasing the chance for data entry error, lost papers and labor-intensive post processing and time-consuming QA\QC iterations. All of this work needs to be complete before the analysis, reporting, mapping and report writing can even begin.

With the development of ESRI's ArcPad 6.03, mobile devices and hand held GPS units, field technicians now have a streamlined, more efficient and cost-effective method for collecting data. Custom ArcPad applications can be developed allowing the user to collect and manage their data, thus eliminating many of the traditional field data collection problems.

Project

VHB was tasked with developing an inventory of wetlands and streams along a 325 mile interstate corridor and 100 miles of existing railway corridors for an Environmental Impact Statement (EIS).

The users needed the ability to:

- Add, Modify and Delete streams and wetlands;
- Edit the characteristics (attributes) of these features in the field; and,
- Make use of a GPS unit for either adding features or for way finding purposes.

Various methods for collecting the data were assessed from the traditional paper method to using ArcGIS or through a wireless connection. It was finally decided that ArcPad would be the software of choice for the following reasons:

- Connectivity with GPS;
- Simple to use editing tools;
- Customizable forms;

- User friendly interface; and,
- Cost.

Aside from finding the appropriate software for the project, there were many initial challenges at hand, including:

- A short timeline;
- A large study area;
- Massive amounts of base data;
- Multiple data collection teams;
- Selecting the most appropriate hardware to run the application on; and,
- Complex relationships between the features and their attributes.

Client Interactions

Before the development could begin it was absolutely necessary for all parties involved to:

- Understand the technology;
- Be aware of the kind of data that was going to be collected; and,
- Know what information was going to be assigned to the features.

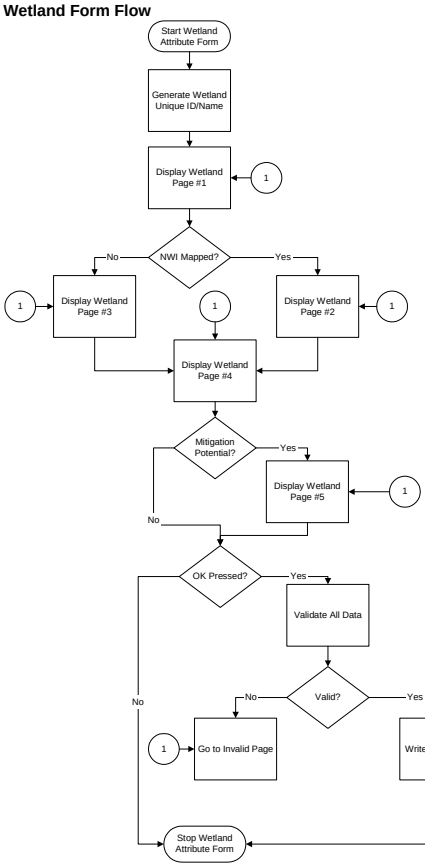
To accomplish this, the first part of the development phase included several meetings, conference calls and email conversations with the clients to finalize the details of the application.

A similar application had previously been built for another in-house project and was demonstrated through the invaluable resource of Microsoft NetMeeting to the client. This step gave the client an idea of what the application was capable of and what could be customized to fit their specific data collection needs. The client came back with a series of attributes that they required of the application along with some conditions and assumptions to characterize the wetlands and streams that needed to be worked into the overall functionality.

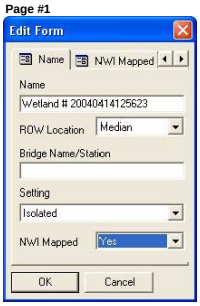
Functional Specification

A Functional Specification was written to outline every single detail of the application to insure accuracy and understanding before moving into the development phase of the project. The Functional Specification involved using ArcPad Application Builder and Visio to create some “mock up” diagrams of the application to figure out the overall design and flow for every page.

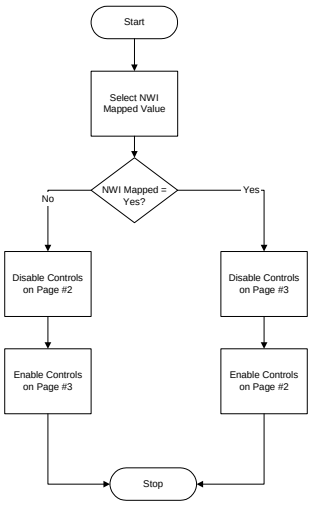
Wetland Form Flow



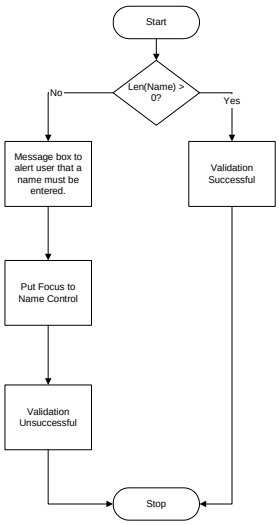
Page #1



OnSelectionChanged Event for NWI Mapped Control



OnValidate Event for Name Control



- In addition to the diagrams, the specification included an Attribute Table for each feature to be collected.

Attribute	Method	Comments	Required?	Lookup Table	Default Value	Validation
PAGE 1 – NAME						
Name	Textbox		Yes	None	"Wetland # 20040414115005"	Validation to ensure this textbox is not blank
ROW Location	Combobox		Yes	ROW Location		
Bridge Name/Station	Textbox		No	None		
Setting	Combobox		Yes	Setting		
NWI-Mapped?	Combobox	If Yes, Go to Page 2, If No, go to Page 3	Yes	Boolean		

The appendix of the Functional Specification included every lookup table used in the application and listed the values of each lookup table.

The development team required the end users to thoroughly review and approve the Functional Specification before the development of the application began.

Data

The client wanted to use existing GIS data as base data so they had a place to start when collecting the streams and wetlands. National Wetland Inventory (NWI) wetlands and streams were acquired for the study area as well as mile markers along the corridor and a corridor centerline. The attributes from the NWI data that the users wanted to maintain were imported into the format of the wetland and stream shapefiles that were being used by the application. A buffer to simulate the study area boundary was created so the users had a guide when collecting the data. Also, the use of aerial photography was requested.

Another challenge of the project was that the base digital orthophotography was in two different projection systems. Due to the massive quantity of orthophotography, a short timeline and the risk of sacrificing the data quality, it was decided that the study area would be split into two projection systems. This required the application to be setup twice – one for each projection. When the users crossed projection systems during the data collection, they had to close the application and open the one specific for the projection system they were currently working in.

Hardware

Initially, it was thought that Pocket PCs would be used to collect the wetland and stream data. It quickly became evident that it would not be possible due to the large amount of data and the lack of storage space on Pocket PCs - the orthophotography alone totaled over 6 Gigabytes (Gb) in size. Hence, the search for a suitable field collection device became necessary.

It was finally decided that a Fujitsu Tablet PC would be the most appropriate device for the project and the issue of storing all of the base data was now no longer a concern.

The users also requested the ability to use GPS for way finding along the study area. It was not a requirement to use GPS to actually collect the data so using a GPS with 3-5 meter accuracy was suitable for the job.

A Pharos GPS unit was selected as it could be used as a Bluetooth device or it could be used through a Compact Flash Card slot in the Fujitsu Tablet.

Due to the remote location of the study area and the lack of high speed internet connections the field technicians were not able to connect to VHB's FTP site to upload and backup their data on a nightly basis. Instead, each tablet was equipped with a DVD-RW drive to which the data could be copied as a backup in case of unforeseen circumstances.

Application Development

Since it was decided that ArcPad would be used to collect the wetland and stream data, it was an obvious choice to use ArcPad Application Builder to develop the application.

The conditions for each feature attribute were quite complex and required a lot of enabling and disabling of the controls based on specific characteristics. In conjunction with the control properties, it was necessary to implement validation not only on the controls, but on the pages and on the forms in order to insure accurate attribution of the features.

Since there were over 1000 digital ortho photos that covered the study area, it was necessary to devise a way to display only those images within the view extent, otherwise, the draw time would be extensive and it would be too cumbersome for the user to manually turn the images on/off individually. An Image Catalog function was developed for ArcPad so as the user navigated around the study area, the images within the view would turn on to aid the user in collecting the data while at the same time, conserving hardware memory and processing. The image catalog also included a scale threshold so the images would only draw when the user had zoomed in to a specific scale.

Post Processing

The field data collection took a total of 2 ½ months at which point it was necessary for the data to be processed so it could be used for analysis and reporting. Again, due to the short timeline of the project all of this had to be done in the most efficient manor. Since the data was collected by two different teams on two Tablet PCs, the data from each computer needed to be imported back into the centralized database. Obviously, this post-processing step took considerably less time than the traditional method of collecting and processing data. All of the information was already in electronic format so it was quite easy to import the data and prepare it for the next phase of reporting, analysis and mapping. However, it would have been easier if the data was all in one projection system.

Reporting, Analysis and Mapping

Some of the deliverables of the final project included:

- Reports;
- Spatial analysis; and,
- Maps.

This phase of the project was simplified due to the fact that the data was in a format ready for use by those performing the analysis and mapping. Also, the data was imported into a Microsoft Access Database which made it very easy to produce any necessary reports required for the project.

Reports were produced with the purpose of using the results directly in the written report and were generated using the reporting capabilities of Access. Reporting in Access made querying, filtering and grouping the data effortless, satisfying the client with their requests and deliverables.

The mapping and spatial analysis of the data was performed using ArcGIS 9.0. Since the data was already in shapefile format the files could easily be brought into ArcGIS 9.0 to perform various spatial analyses and produce the required maps for the report.

Conclusion

The project was a success and many milestones were achieved. Some of the highlights and improvement areas realized at the end of the project:

- The Functional Specification was an invaluable resource in the implementation of the application development;
- Despite the initial costs in the preliminary phase of the development of this customized ArcPad application, the data was collected in half the amount of time budgeted and the total cost was still lower than the traditional method of field data collection;
- Collecting the data in electronic format proved useful in generating the deliverables post-data collection in a timely and efficient manor;
- The client was very satisfied with the entire process and products;
- The data collection and post-processing could have been streamlined if all of the original data was in the same projection; and,
- The Fujitsu Tablet PC was the best choice at the time for the price, portability, use with GPS and hardware specifications, but the only drawback was that it was not ruggedized which made it difficult during inclement weather to collect the data.

As a testament to the entire application development process, one of the field scientists said after the project was completed:

> "The entire I-81 corridor was covered in roughly half the budgeted time, a testament to the quality of the application and the dedication of the staff who developed it under such a demanding timeframe."