

The Key to the Present is the Past.

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Abstract

History is incredibly important to local government, but how do you view time in tabular and spatial data? The Ortho Viewer is an Intranet web application that Pierce County designed to view temporal changes in imagery. The viewer allows users to explore multiple years of imagery for locations throughout the County. The Ortho Viewer is used for code enforcement to see where structures were built without permits, for planning to see how floodplains evolve, and for other concerns such as public safety and emergency response. This paper will focus on designing and implementing a user interface that easily allows the average County employee to see how the landscape has changed over time. The Ortho Viewer uses ArcIMS, ArcSDE, SQL Server, and Cold Fusion MX.

Introduction

Pierce County GIS has multiple sets of imagery spanning several years. County employees from many departments use these data sets to view how time has changed the landscape. The current methods of viewing the same geographic extent with multiple image layers are slow and cumbersome. Based on user demand Pierce County GIS undertook a project to allow County employees to easily view multiple images from multiple years of the same area. The Ortho Viewer web application helps casual GIS users view history in geographic data. The project included several challenges from user interface design and system architecture to application programming. This paper will discuss how Pierce County GIS used ArcIMS, ArcSDE, SQL Server, and Cold Fusion MX to cleverly make viewing history in geography easy.

The Problem

Pierce County GIS has over 700 geographic datasets. Among the most useful are the image layers (Table 1). Currently, Pierce County has 10 image layers that include orthophotography and color infrared that span 5 years from 1998 to 2003.

Each layer was flown during different seasons, with various focal lengths and flight heights resulting in a range of pixel sizes and positional accuracy. The orthophotography layers use several terrain models ranging from LiDAR to 30m USGS DEM. The image layers are wildly popular among county GIS users because of the detailed contextual information they add to mapping. Using Pierce County's CountyView enterprise GIS system based on ArcView 3.x, County GIS users currently view multiple images from different years using the flip book approach. They add two or more image layers to the view and then turn them on and off to view the change. The other method currently in vogue is to open multiple views and add one image layer to each view and then manually tile the views so you can see each. The first option suffers from slow redrawing time. The second option is really only viable for someone who is both patient and knowledgeable.

Name	Date Flown
Orthophotography 1998/1999	June & July/1998 & 1999
Orthophotography 2001	March, July, & August/2001
Orthophotography Alder Lake 2001	February/2001
Orthophotography 2002	April & May/2002
Orthophotography USGS 2002	Summer/2002
Color Infrared 2002	April & July/2002
Aerials Express 2003	September/2003
Color Infrared Basins 2003	April & June/2003
Orthophotography Lake Tapps 2003	March/2003
Orthophotography Most Recent	Varies/1998-2003

Table 1: Image layers and date flow.

Design

How do you view history in geographic datasets? Initial work focused on designing a user interface that would make viewing multiple sets of imagery simple and intuitive. To allow for easy deployment and rapid development we decided to build the Ortho Viewer as an Intranet web application.

The first design element this project utilized was Tufte's small multiples. According to Tufte (Tufte, 42), "Small multiples are economical: once viewers understand the design of one slice, they have immediate access to the data in all the other slices." The Ortho Viewer uses small multiples to represent sets of imagery

from different years side by side (Figure 1). Viewing maps in this form allows for easy comparison.



Figure 1: The use of small multiples and a timeline makes comparing images and viewing history intuitive.

The second design element was a time line. We wanted to stress the importance of time. The images being compared would be ordered by date to stress this temporal aspect. The earliest image layer is always first and ends with the latest (Figure 1).

The third design element focused on a set of intuitive controls to locate the viewer. We wanted people to be able to efficiently find their location of interest. Initially we provided address, parcel, and place name searches.

The fourth design element called for filtering image layers by geography. If an image layer doesn't exist at the user's current geographic extent it should not be selectable. This makes it easy for the users to decide which layers they want to turn on because they are always dealing with a subset of the total number.

The next design element called for providing preset selections of image layers. Ortho Viewer provides most recent, oldest, and spread categories that make it easy to select a group of images quickly.

The sixth design element stressed the need to simplify map navigation. While geographic information systems are becoming more common, we wanted Ortho Viewer to be accessible for everyone so we provided only zoom in, zoom out, pan, and full extent buttons.

Using any geographic data effectively demands an understanding of its associated metadata. Where did this data come from? What is its accuracy? Imagery layers have their own set metadata. The Ortho Viewer needed to provide concise metadata that would be easy to understand. We selected the date flown,

flight height, focal length of the camera, pixel size, terrain model, and positional accuracy

Finally, while it is great to look at the images online, the current generation also likes to print and save the images. We needed to provide print and save options to common file formats such as pdf, jpeg, and png that printed and saved good looking cartographic products.

Prototypes

After coming up with the design elements we decided to create three prototype user interfaces that would vary the size of the small multiples and the size of the enlarged view (Figures 2). These prototypes were then presented to representatives from several County departments to gather feedback. The idea was well received the resulted in several new design elements including preset categories. They provided excellent ideas and gave GIS a feedback on which departments and divisions would use this targeted tool. In the end they selected prototype 2 (Figure 2 upper right).



Figure 2: Prototypes 1, 2, and 3.

Ortho Viewer Development

The Ortho Viewer application, which was designed from proto type 2, consists of four map windows (Figure 3). The map windows are ordered along a time line starting at the top left with the earliest image and continuing to the bottom right with the latest. Each map window allows interactive zooming and panning. Zooming in an out can either use the click method to zoom in or out a set distance or a rubber band method that allows the user to draw a rectangle. Panning uses an intuitive drag and drop method. Development was jump started by using an ESRI site starter for Cold Fusion MX. From a system point of view, Ortho Viewer consists of an ArcIMS mapping server, an ArcSDE geodatabase, and a Cold Fusion MX application server. All of the image layers were loaded into an ArcSDE geodatabase which runs on SQL Server. The ArcIMS map service runs on an IBM blade server running ArcIMS 9.0 and exclusively uses SDE layers for performance. The map service is set

with a complicated suite of group renderers with scale-dependent thresholds. The web application itself runs on a Cold Fusion MX application and uses the MachII framework for a clean and maintainable software architecture. The business logic is coded in reusable Cold Fusion Components. The ESRI Java Connector is used by the Cold Fusion MX application server to communicate with the ArcIMS mapping server. Cold Fusion MX runs as a Java server so integration between the ESRI Java Connector and Cold Fusion has proven to be easy and rewarding. From a development point of view, the Ortho Viewer web application uses the following languages: Cold Fusion, Java, JavaScript, HTML, CSS, ArcXML, XML, XSLT, and SQL.

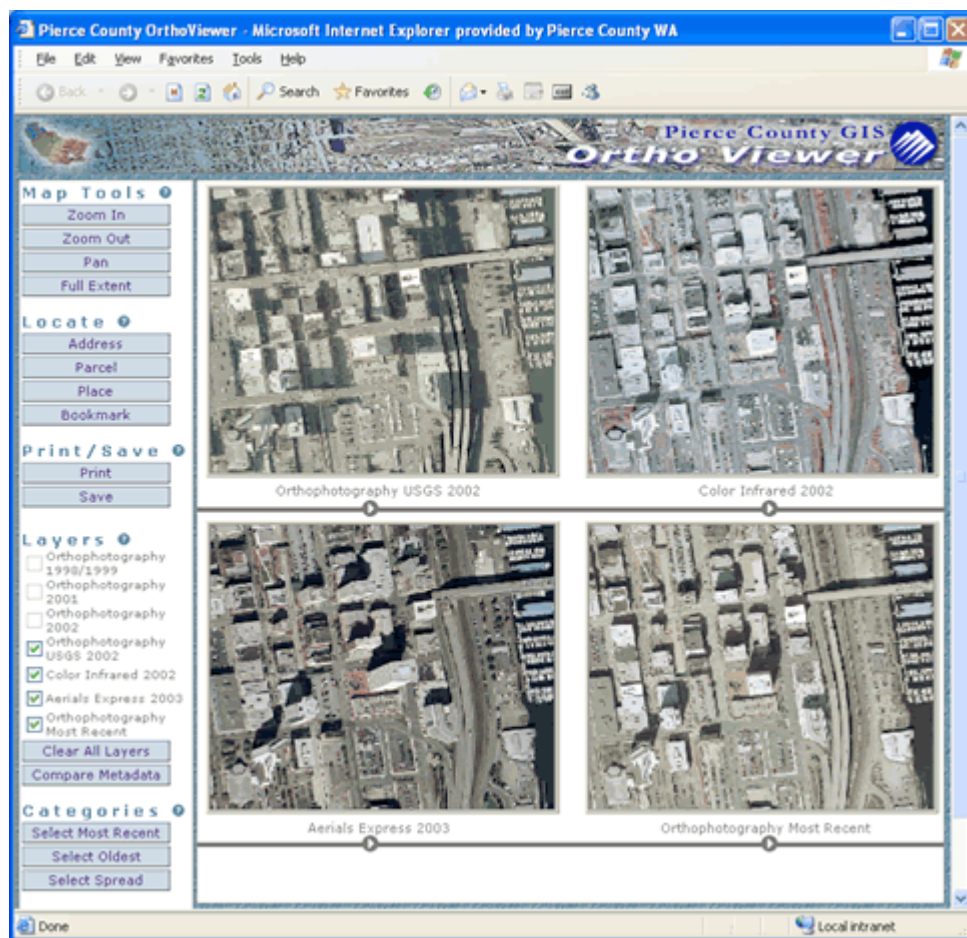


Figure 3: The finished Ortho View web application.

Ortho Viewer contains four ways for a user to quickly and easily find their location (Figure 3). The address dialog uses the ArcIMS Java Connector to geocode addresses and intersections on the fly (Figure 4 top left). The parcel dialog provides

a quick search by parcel number (Figure 4 top right). The places of interest dialog uses the USGS place name dataset to give users a quick search by keyword (Figure 4 bottom left). Finally, the bookmarks dialog gives frequent users a way to store their favorite locations to their computer using cookies (Figure 4 bottom right).

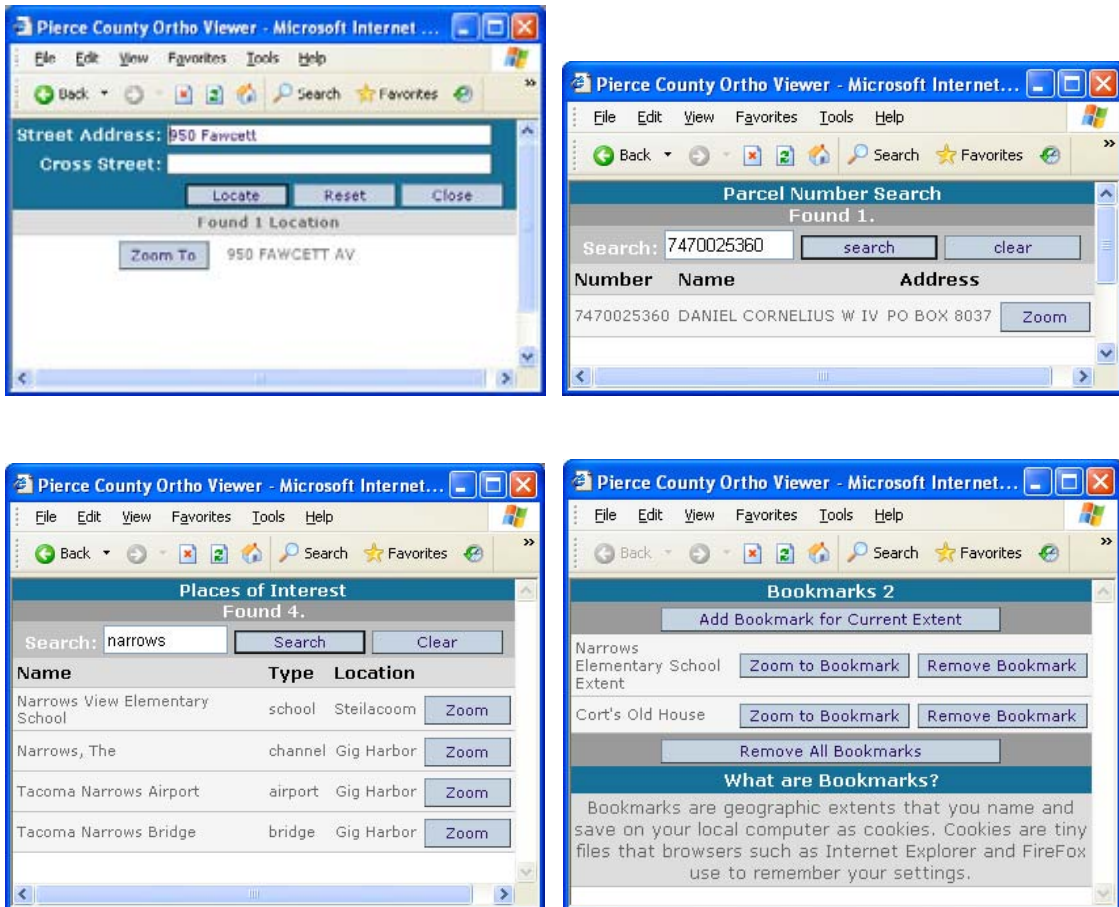


Figure 4: Location dialogs allow the user to find their area of interest quickly and easily.

Ortho Viewer makes it easy to turn layers on and off but for performance reasons only four layers can be checked on at a time (Figure 5). Preset categories make it easy to select layers quickly.

Layers ?

- Orthophotography 1998/1999
- Orthophotography 2001
- Orthophotography 2002
- Orthophotography USGS 2002
- Color Infrared 2002
- Aerials Express 2003
- Orthophotography Most Recent

Categories ?

Figure 5: Layers selection is filtered by geographic extent and preset categories make it easy to select layers.

Metadata is very important to using GIS data effectively. Ortho Viewer provides links to the metadata of a single layer by clicking on a layer's name (Figure 8 left). Users can also compare the metadata of every layer shown by clicking on the "Compare Metadata" button below the layer list (Figure 6 right).

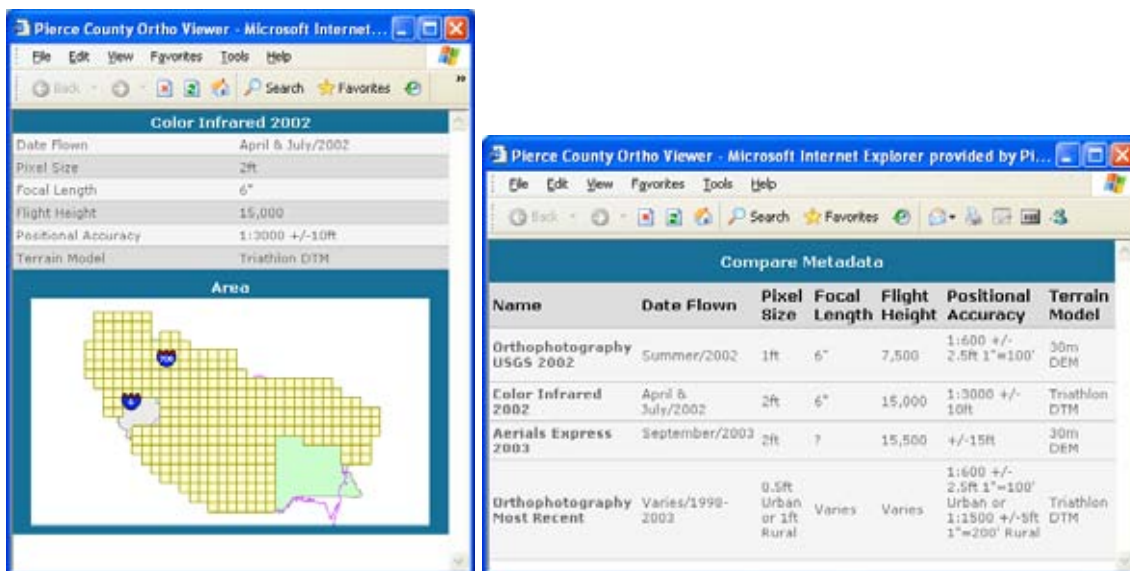


Figure 6: Targeted metadata makes it easy to understand the differences between the various imagery layers.

Ortho Viewer can save PDF files for printing and archiving by using the open source Apache FOP Java library. Apache FOP takes an XML file and transforms it into a PDF file using a XSLT style sheet (Figure 7 left). Ortho Viewer can also save to a JPEG and PNG by using Java2D technology which allows the application server to dynamically generate images in memory (Figure 7 right).

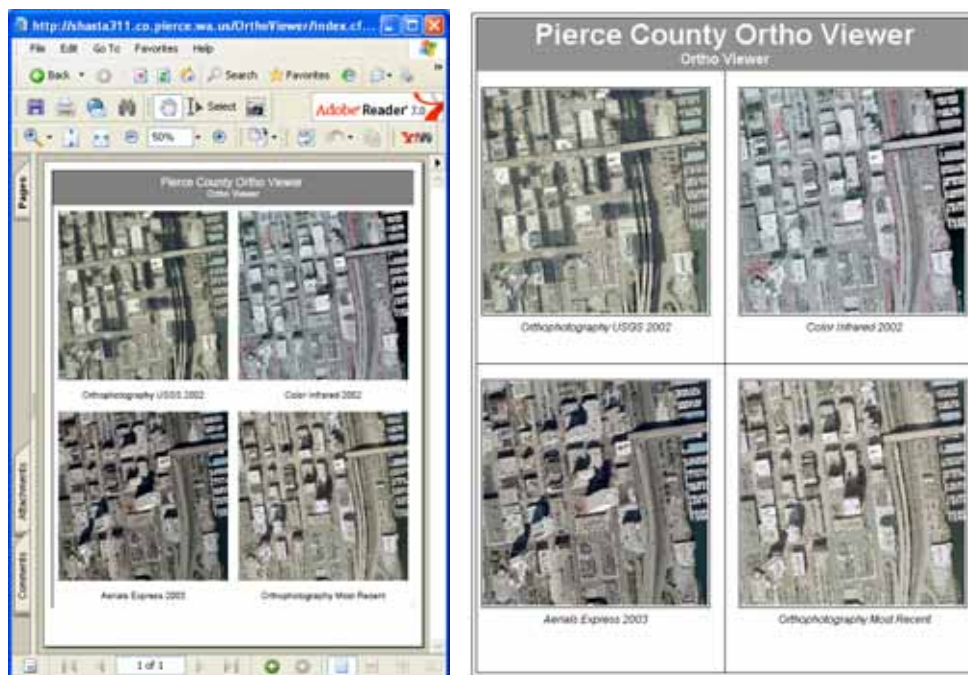


Figure 7: Ortho Viewer can save PDF files using the open source Apache FOP Java library and PNG or JPEG files using Java2D.

Conclusion

The Ortho Viewer is an Intranet web application that Pierce County designed to view temporal changes in imagery. The viewer allows users to explore multiple years of imagery for locations throughout the County. This paper discussed how important it is to start a project with a specific problem, how design elements make

an application more intuitive and user friendly, and how many different servers and languages it takes to implement a geographic information system on the web.

Citations

Tufte, Edward R. *The Visual Display of Quantitative Information*. Cheshire, Conn.: Graphics Press, 2001.