City of Boulder, Colorado, Transportation Information System: Customized ArcIMS Website

Abstract

This paper will outline the processes, work tasks and results obtained in creating an interactive **ArcIMS** website application for the City of Boulder, Colorado Transportation Department.

This **ArcIMS** application went online November 19th, 2003 and displays both existing and proposed transportation geographic features and attributes (bike, pedestrian, transit, and auto). The website serves the dual role of providing accessible transportation information to the public and also functioning as a desktop geographic work tool for engineers, planners and developers, to help them better understand the city's transportation system, policy plans and infrastructure needs.

A portion of the paper will discuss the key roles **ArcGIS** and **ArcSDE** played in the GIS data development component of this project. The presentation will also address how web programming code (FlashMX, JavaScript, jsp, XML & HTML) was utilized to customize the functionality and enhance the interface of this application.

URL weblink to this site is:

http://gisweb.ci.boulder.co.us/website/pds/Transportation_gisweb

---

Project Background

The city of Boulder's Transportation Master Plan (TMP) provides the policy basis for how transportation funding is spent, and what projects or programs the city focuses on to provide transportation services for its citizens through the year 2025. The TMP is updated every five years.

The 2003 TMP update project began in earnest in October, 2001 and the process culminated with the posting of a city web site that provided an accessible, user friendly, cost-effective and informative presentation of the community's transportation vision. This marked the first time that an interactive master plan for the city of Boulder had been created and posted on the World Wide Web. A unique feature of the website is an interactive Geographic Information System (GIS) mapping application (called "Map It") that allows the user to display information on both existing transportation facilities and planned future improvements.

This website displays geographic mapping features of the city of Boulder's existing and proposed transportation system. This mapping information has been grouped by the following different modes of travel:

- **bicycle / pedestrian** (bike paths, sidewalks, multi-use paths, underpasses, bridges)
- **transit / bus** (local and regional bus routes, bus stops)
- **street / automobile** (street labels, street classification types)

Definition of the Problem

Most departments in the city of Boulder have master plans that implement the policies of the Boulder Valley Comprehensive Plan. Master plans refine the policy direction and establish the spending priorities of the department, and have been updated every five years. These documents tend to be a "challenge" to sift thru, remaining static and not reflecting changes until the next update process. This approach contrasts with citizen and staff demands for easily accessible, up to date information. The previous TMP embodied these problems, consisting of four volumes of documents with the main document being at least 200 pages, along with supporting volumes of about 220 pages in length. Supporting data sources depicting project information were not standardized and in varying degrees of usability which included numerous spreadsheets, graphic representations, hard copy documents and single purpose maps. No centralized database or GIS functionality existed. Because of the sheer size of the existing document and the scattered locations of mapping and attribute data, an organizational "disconnect" existed when it came to tracking and monitoring the policies and projects of this plan. With over 90% of Boulder citizens having Web access, the idea of a "virtual" plan offered the potential to make the plan more accessible and current to both residents and staff. The 2003 TMP was developed as a prototype for a Web based presentation of future city master plans.

Project Description

Objectives of the TMP update included converting all transportation planning and project information into a standardized database and GIS mapping format. Concurrent with the policy development, city GIS staff converted hardcopy mapping, document and spreadsheet data into ArcMap GIS data sets. This included converting more that 800 existing street, bike and pedestrian projects from the 1996 TMP and the inclusion of projects from four Transportation Network Plans that had been prepared since the 1996 TMP. This year long effort culminated with the creation of a complete inventory of existing and proposed transportation projects, presented interactively through the Web based TMP.

The final 2003 TMP consists of a relatively short, policy-level document (33 pages) that was submitted and approved by City Council on Sept. 16, 2003. The Web site contains all the material from the document that was adopted by City Council as well as additional information that provides significant background on the policies and investment program presented in the actual document, including the products from each phase of the update process (over a two year period). A unique feature on the Web site is an interactive mapping application (called "Map It") that allows the user to display information on both existing transportation facilities and planned future improvements. The "Map It" site is accessible to anyone with a standard PC / Mac web browser, making the geographic information easily accessible to the general public and staff. For example, a citizen can look up their address and identify which transit routes or bike paths go from their house to their place of business. Another option is that a citizen can look up their address and see what transportation improvements are planned for the future, such as a new multi-use path. This application and data development is now being used by other city departments. For example, city planning staff can now more easily track the progress and location of proposed TMP infrastructure projects as they relate to new development within the city. The TMP Web site is able to reflect the most current information as well as the document that was approved at a given point in time. For example, when a new project is built, the map can be changed from the designation of "proposed" project to "existing" facility. In this way, the TMP can become a virtual, "living" plan, with the TMP Web site reflecting ongoing changes in programs and projects.

The TMP Web site utilized existing resources and did not require the city to purchase additional hardware or software. Previous TMP's had been printed documents consisting of many volumes of information. For instance, the 1996 TMP document had four volumes with about 440 pages. Reproducing the 1996 TMP document cost the city approximately $22,000 for about 650 copies which would then cost the citizen at least $10 to $20 to obtain a copy. This does not include staff time for handling and distributing the plan, or the cost of mailing the document. In the past, reprints have been ordered as staff runs out of copies of the TMP. The cost of producing the digital TMP Web site was $28,000. At least half of the cost is attributed to creating and building the interactive mapping application (Map It!). The Web site makes the plan more accessible and convenient for Boulder residents to use and is expected to provide significant cost savings in the future as we move to an entirely digital presentation for all city master plans.

DATA, DESIGN, DELIVERY CONCEPT

In undertaking a project of this magnitude, City GIS staff found it useful to categorize the work tasks into 3 principal areas. Those component areas being: **Data**, **Design** and **Delivery**. The following is a synopsis of the main issues of each work component:

DATA

Creating GIS data for the application

A major aspect of this project was the creation of both existing and proposed enterprise Transportation GIS data (bike, street, and transit) to make it compatible with the ArcIMS web based application. This was accomplished in ArcGIS by creating a series of SDE Oracle feature data sets and feature classes that were based on a data schema of unique ID numbers which were dependent on modal travel type (i.e. auto, bike, pedestrian and transit). Oracle-based ArcSDE was used to store GIS transportation data that was digitized and registered to the city's aerial photography basemap. Normalized data tables were created to store attribute information that pertain to proposed and existing transportation features (i.e. type, location, year built, cost). By linking this attribute information table to a transportation GIS feature, TMP Web site visitors are able to query and display information with ArcIMS software's query server.

The task of creating the GIS data for this web application was accomplished by partnering with the City transportation staff and their consultant. City GIS staff created a series of hard copy aerial base maps, which the transportation staff was able to mark up with proposed and existing transportation features. These hard copy “mark up” maps were resubmitted to city GIS staff, which then created in ArcMAP, point, line and polygon features that were stored in an ArcGIS SDE repository. Staff estimates that there were over 70 maps of “mark up” data that were converted to GIS data using this methodology. In retrospect, it worked well, because it enabled the data to be created and converted into GIS format within a fairly short timeline.

DESIGN

Application Programming Languages and Code Design

The principal code languages used for this ArcIMS application were: XML, JavaScript, HTML, and jsp.

Custom JavaScript was used to send XML requests to ArcIMS software's query server and then parse the responses to generate attractive Web pages that displayed maps, PDF documents and photographs of proposed and existing transportation features.

Crucial to the development of this application was a GIS layer controller function that was built in Flash MX which interfaces with the ArcIMS website. The following is a sampling of how some of this code functionality works within the Flash controller.

Changing View Layers

Each time a layer checkbox is chosen, an element or elements on the array called: ‘*gLayersValues*’ is modified by the function: ‘*onChangeLayer*’. The value Y makes this layer visible, the value N removes it from the screen. When the update map button is clicked a function called*: ‘sendValues’* is triggered which displays the selected GIS feature(s) on the web page.

The *‘sendValues’* function concatenates the array into a single string consisting of a Y or N for each layer of the map service. The string is sent, via a JavaScript function call, to the host document, layers.htm, then to a JavaScript function called *‘flash_layers_DoFSCommand’* along with two arguments, *‘command’* and *‘args’*. Command is the action for the javascript function to instantiate and args is the concatenated string representing the layers of the map service.

If the command is "layers" the function *‘updateLayers’* is called and is sent ‘*args*’ as the argument. The ‘*updateLayers*’ function then modifies the *‘LayerVisible’* array in the map service and calls the *‘sendMapXML’* to update the map service.

If the command sent to *‘flash_layers_DoFSCommand’* is *‘zoomout’* or *‘zoomextents’* the extents of the map service is modified and then the layers are updated.

Activate pop up windows

The controller also uses JavaScript function calls to open HTML popup windows. The following functions *openpopup()* and *openpopupHop()* were utilized to accomplish this task.

Communication between the Map Service and Controller

Communication between the map service and controller is done by the ‘*updateFlashController*’ in layers.htm. The *‘updateFlashController’* sends the layer string along with a the frame number to jump the controller to a specified frame of the controller, which then sets the array *‘gLayersValues’* to match the layer string and sets the frame to the frame number sent. For example the following URL code statement was written to display a specific transit route on the website:

http://gisweb.ci.boulder.co.us/website/pds/Transportation_gisweb/viewer.htm?frame=3&
layers=00001

This URL code could be hyper linked to a control on the HTML side of the website, that when activated would take the user directly to the ArcIMS site with the desired transportation data displayed in the view window.

Symbology

Another design technique that was used by City GIS staff was the development of a .gif library of transportation symbol images. This enhanced the look of the point features displayed in the site. Instead of pointing to a simple circle, square or triangle feature, the source code would connect to a more stylized symbol depending on the data layer selected.

Interface design

Some of the design concepts of the ArcIMS interface were:

- Maximize the size of the mapping window and let the “picture tell the story”.
- Look for ways to display tool buttons in a way that won’t infringe upon the map view window of the site.
- Rather than trying to display all the data selection options in one view, use folders or pick lists that maximize the use of “precious” view space.
- Try and create an uncluttered, user friendly interface.

DELIVERY

System viewing recommendations for this site:

- Monitor: 1024x768 screen resolution and 16-bit or better color
- Connection: Minimum of 56k modem, for optimal results a DSL, T1, or other Internet High Speed Internet connection is recommended.
- Supported browsers:
  Windows users: Netscape 6.2 or IE 5.0 or newer
  Macintosh users: OS X or newer with Safari 1.0.1 or Netscape 7.1

Enterprise Application Delivery

Just as the TMP illustrates the Enterprise-wide approach to transportation planning, the technologies used to publish this unique plan are also enterprise-wide. For example, the web mapping module is ESRI’s ArcIMS – Internet Map Server, and the data that supports the maps is located in the enterprise GIS Repository, again an ESRI environment known as SDE or Spatial Database Engine. This Oracle database provides one stop shopping for the Enterprise’s geographic information. It provides both a development and production environment so applications like the TMP can be prototyped, modified, and finally published to either the internal web or the world wide web.

Web based mapping can be prototyped in the City’s “staging” or development web site. This site is easily accessed by any City department needing to develop web based maps. Web pages can be designed and tested thoroughly by the individual project team members. When the page design and function is finalized, the web pages can be easily moved to the more secure internal and www web servers. The City’s web mapping architecture consists of three Dell Poweredge 2650 servers, each with dual processors, 4 GB of RAM and 36 GB of disk. These servers run the Windows 2000 server operating system with the included IIS web server. Mapping software is ArcIMS version 4.0.1. Each server is dedicated to a single environment – staging, internal web, and world wide web.

A significant advantage to the enterprise GIS (geographic information system) user community that came out of the TMP was a single table, or feature class in GIS parlance, containing all transportation routes such as alleys, streets, main roads, trails, bikeways and greenways. This single source of transportation information gives the Enterprise several advantages. First, there is now one best, up-to-date and "official" source for street names, address ranges, and road classifications. Redundant data entry and duplicated data sets are eliminated. Kindred systems that draw heavily on transportation routes, such as pavement management, sign and signal maintenance, and routing are drawn back to the enterprise data repository instead of evolving as isolated desktop applications. Finally, various views of the same table are created in SDE, for example, a layer named Alleys is really a view of the master transportation feature class with only the features classified as "ALLEY" selected. Thus 3 layers (main roads, streets, and geostreets) in the old system, were replaced with many views (alleys, main roads, streets, geostreets, trails, etc) of the same master layer each displaying only the attributes relevant to the particular layer.

Acknolwdgements:

Robin Woodsong, City of Boulder, P&DS Information Resources
Kip White, City of Boulder, Information Technology GIS
Joanna Crean, City of Boulder, Public Administration

References:

Environmental Systems Research Institute, Inc. 2002, *Using ArcIMS 4.01*
ESRI, 92373Redlands, CA

Author Information:

Laurence Ferguson
Senior GIS Specialist, P&DS Information Resources GIS
City of Boulder, Colorado

1739 Broadway, Boulder, Colorado 80302
303.441.3213
303.443.8196 FAX
fergusonl@ci.boulder.co.us