

# Using GIS to Manage Trees in Pittsburgh

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## (ABSTRACT)

Trees are an important asset to any region. They are even more important in urban areas where they provide aesthetic, environmental, recreational, and other benefits. This paper describes a project to produce an integrated information system to help the City of Pittsburgh manage its more than 50,000 trees. The system relies on MapObjects to provide a GIS interface embedded within a general forms-based program utilizing an Oracle database. This allows tree information to be accessed by location as well as by tree characteristic. The system allows multiple departments to access and update those parts of the tree information within their purview. While the major rationale for the system is the life cycle management of trees, other benefits to be attained from the Trees project for the city include improved budget planning, forecasting, improved response time, and cost effectiveness.

## Introduction

This paper describes an initiative called the Trees Project undertaken by the City of Pittsburgh and the Visual Information Systems Center (VISC) at the School of Information Sciences at the University of Pittsburgh to create a GIS-based system to help the City manage its trees. In particular, the major goals of the system are to:

- Provide accurate and comprehensive tree information to all City departments through the City's GIS system.
- Develop a GIS-based facility to manage trees that is compatible with other City Asset management systems and follows a well-codified tree management process.
- Assist in an inventory of all city-managed trees.

## Background

Pittsburgh is a medium-sized eastern city encompassing 55.5 square miles with a population of approximately 320,000 (1). Pittsburgh is one of the most highly forested urban areas in the United States. The city manages an estimated 50,000 trees along streets, in parks and along rivers and waterways. The city employs a full-time forester and has a small division specifically dedicated to tree maintenance. Pittsburgh has had a long and active tree planting program.

Recognizing the importance of trees to the quality of life and the revitalization of the community, the mayor and city council have established the Pittsburgh Shade Tree Commission as the lead organization in advocating and promoting trees in Pittsburgh. The Commission is charged with: establishing policies related to the community tree program, educating the public with respect to the value of trees and proper tree care, and obtaining funding to support the community tree program.

The Shade Tree Commission (2) and others (2)(3) have identified a wide variety of environmental, economic and social benefits of urban trees. Examples of these include:

1. Aesthetics
2. Recreation
3. Wildlife
4. Carbon Sinks
5. Air Quality Improvement
6. Soil Stabilization
7. Increase Property Value
8. Household Heating & Cooling, Via Shade & Shelter
9. Wind Breaks
10. Moderators of Temperature
11. Stabilizers of the Water Table
12. Ecological Maintenance
13. Food, i.e., Fruit & Nut Trees
14. Social Benefits
15. Tourism
16. Public Opinion
17. Employment
18. Privacy

More and more urban planners and officials are coming to recognize trees as important assets to the community. It is estimated that the annual economic value to Pittsburgh of tree-related benefits is over \$6.5 million. It follows logically from this that the systematic management and cultivation of trees as assets are important activities.

Prior to the Trees Project, Pittsburgh had no formal inventory of its trees. While the most credible tree estimates put the number of trees at about 50,000, other estimates have ranged from 30,000 to 100,000 trees. Trees information was recorded more on an

ad hoc as encountered basis. . Some issues with the existing tree information systems were:

1. Lack of "centralized" database
2. Lack of citywide data compilation capabilities
3. Inconvenient, error-prone user interface
4. Poor input screen organization
5. Lack of an archival data function (e.g., only the last action is retained in database)
6. Inflexible reporting capabilities that do not meet user needs
7. Lack of a method for accurately locating trees within parks.

A well-planned tree information system should be flexible, have an open architecture, and maintain an intuitive manner of data entry, maintenance, and editing. State-of-the-art tree management package should allow for entry of tree information, tracking of work requests and work histories, speedy identification and maintenance during storms or other disasters, and facilitating the creation of custom reports for urban forest resource management purposes. Advances in GIS are allowing city authorities to take inventories one step further by using a Geographic Information System (GIS) to map trees. This information is important because it will have a profound affect on how tree location data can be handled.

There are many advantages to utilizing a GIS program:

1. Mapping trees allows quick visual surveys.
2. It is often easier to locate a tree in the field when a map is provided to indicate its location.
3. Maps are powerful tools to illustrate needs and situations.

## **The Trees Project**

The Trees Project officiated by the City of Pittsburgh and the Visual Information Systems Center (VISIC) at the School of Information Sciences at the University of Pittsburgh addresses the issue of keeping track of all the trees located within the city limits – i.e. streets and parks. Reasons for keeping track of the cities trees consist of the need for planting, pruning, maintenance and/or removal of trees. These needs are manifested by various circumstances such as regular maintenance, unexpected damage from storms, insects, disease, accidents, vandalism, or new development. During a typical winter in Pittsburgh, the city often experiences huge snow deposits, heavy rains and freezing ground-level conditions. The weight of the ice and extreme rain can often bring down trees, power lines, telephone poles and transmission towers, closing roads and knocking out power for weeks. Trees—depending on their species, general health and location—sustained the greatest injury and are in immediate need of attention and help.

The true cost associated with maintaining the health of street and park trees can be estimated in terms of staff time and material costs. These include:

1. Site preparation
2. Planting
3. Staking, mulching, watering
4. Feeding
5. Inspection in response to a request
6. Pest/disease control
7. Pruning (cyclical)
8. Removal

The time spent on tree care does not take into consideration the numerous fields of data that need to be managed, edited, and reported on per tree in an information system.

While the benefits of maintaining healthy street and park trees cannot be measured solely in fiscal terms, the actual costs can and should be, to assure efficient expenditure and accountability. Benefits to be attained from the Trees Project for the City will include improved budget planning, forecasting, improved response time and cost effectiveness. The inventory could be used to keep a work history on each tree as well as being able to call for service needs. The city can use the inventory to find specific information or to analyze the urban forest -- What are the species? What sizes are the trees? What are the future maintenance costs going to be?

## **Proposed Trees Information System**

City of Pittsburgh aims to create a good maintenance program, in its endeavor to address the need for successful management of the city trees and urban forest. The primary functional requirements of the proposed system include:

1. Customer call intake
2. Generation of service requests
3. Tracking of inspections
4. Generation and tracking of work orders
5. Flexible reporting capabilities
6. Cost tracking (internal and external work)
7. Inventory
8. Work history
9. Maintenance and access through a central relational database management system platform (RDBMS)
10. Integration with geographic information system (GIS) platforms
11. Capability for field data collection and download (real time and/or end of day)
12. Distributed access and maintenance
13. Intuitive interfaces

Using these requirements as a guide, the City of Pittsburgh intends to create tree management software dedicated to produce relevant and accurate information on the trees in the city; integrate GIS technology a geographic information system (GIS) and use

satellite imagery, to show the exact location of every tree in every neighborhood in a city; make the information available in an appropriate format for analysis in terms of species breakdown, size, age class, condition; study notable trends relating to weather damage, disease or defects.

## **The Project**

The Trees Project itself is fairly broad in scope. This paper will focus on the interface that will be used to enter tree inventory and tree maintenance information. We will not deal with issues relating to data analysis or the integration of information into the City's GIS system. The listing below gives the major technologies used in the Trees Project and their application.

### **Technologies Used**

- Oracle 9i (v2) database for application creation, proposed to convert to a Geo Database.
- ArcGIS for the creation of maps to show the particular location of the tree(s) within the city.
- ArcPad used for capturing tree location which can be downloaded into hand held computers for accessing/capturing information on site.
- Visual Basic 6 for the user interface and integration of components.
- MapObjects for embedding maps within the system interface.
- Digital Photo's of the different tree species within the city.

All the information obtained about the city trees will be stored in an Oracle Geo Database. The use of a standardized format for collecting information pertaining to the city's trees as well as a centralized place for the stored information (Oracle database) provides an efficient and cost effective measure for the City of Pittsburgh. Many of the City's other systems use Oracle as their database engine, allowing for easy integration of information and processes.

## **The Tree Application**

The Tree Application is the central interface for managing trees. In essence, tree management involves two major processes: tree database creation and updating and tree maintenance. Tree database creation is closely allied with the tree inventory. The tree inventory initially "fills-in" the tree database. As time goes by, the number, condition and status of the trees change. One of the functions of the Tree Application is to help keep the tree information current. The Tree Application was purposely designed and built before the tree inventory was taken. This was done to assure that the appropriate elements were defined for collection during the inventory. In addition the mapping capability of the Trees Application could provide assistance in locating and identifying trees.

The tree maintenance process involves four broad steps:

- A problem with a tree(s) is identified, usually by an inspection or through an incident report.
- An inspector is dispatched to assess the condition of the tree(s).
- A decision on the actions to take with regard to the tree(s) is made and a work order is issued.
- The actual work is done.

The Tree Application is a network-based application which allows access by several types of diversely located city personnel. An appropriately authenticated network user can access the application and is immediately presented with the main menu screen as shown below.

### Main Menu Screen:



The main menu screen provides two levels of access.

**Level 1**, which is accessible to all employees, includes the following forms:

- Call Form
- Tree Form (read-only)

**Level 2**, accessible to the Inspector(s) and Forester, includes the following additional forms:

- Tree Form
- The Inspector Form
- Work Order Form

**Call Form:** The Call Form provides standardization for how tree information is gathered from the public and then reported to the city's Inspectors and Forester. Reports of tree problems can come from many sources, including regular inspections by city Forestry personnel, phone calls to the Mayor's Action Center, Police reports, etc. The reporting

source is coded for 36 different sources. In addition to collecting data about the tree problem, the form provides a map facility for locating the tree. Call takers can drill into the map and get a more precise identification of the tree. This is particularly important when the caller is a citizen unfamiliar with the neighborhood. The form collects specific information on the type of problem with the tree. A pull-down list is provided with the type of tree problems pre-classified as:

- Dead/Dying
- Interfering W/Structure
- Interfering W/Wires
- Storm Damage
- Tree Down in a Row
- Tree Leaning
- Branches Down in a Row
- Structural Damage to Tree
- Sidewalk Damage
- Sidewalk Damage W/Citation
- Sewer/Gas/Water Line
- Insect/Disease
- Nuisance Debris/Fruit
- View Clearance
- Insect Infestation
- Street Light
- Traffic Signal/Signs
- Row Clearance
- City Steps
- Routine
- Root Prune Routine
- Root Prune W/Citation
- Banner
- Flag
- Holiday Tree
- Other

The form allows the call taker to assess the severity of the call and assign a priority to the call:

- Routine
- Moderate
- High
- Immediate

The screenshot shows a web-based 'Call Interface' for tree management. At the top left is a city crest logo. The main title is 'Call Interface'. The form is divided into several sections:

- Caller Address:** Includes fields for Source Of Call (dropdown menu), MSC Number, First Name, Last Name, Address Number, Street Name (dropdown), Phone, Alt Phone, and Email.
- Time of Call:** A text field showing '3/16/2009 2:37:13 PM'.
- Record Number:** A text field with the value '1'.
- Entered By:** A text field with the value '14305'.
- Problem Address:** Includes Problem Address Number, Problem Street Name (dropdown), Number Of Trees, and Park (dropdown).
- Caller Request:** A dropdown menu set to 'NONE'.
- Description of Problem:** A dropdown menu set to 'NONE'.
- Postal Code:** A dropdown menu set to 'NONE OR N/A'.
- Citation Code:** A dropdown menu set to 'NONE OR N/A'.
- Action To Be Taken:** Includes radio buttons for 'Information Only', 'Refer to Outside Agency', and 'Clear Selection'. A 'Call Priority' dropdown menu is set to 'ROUTINE'.
- Comments:** A large text area for entering notes.
- Map:** An embedded map of the city showing streets and tree locations.
- Buttons:** 'Clear Form', 'Submit', and 'Main Menu' buttons are located at the bottom.

**Tree Form:** The Tree Form is used by the city Inspectors and Forester to add/update information pertaining to each of the tree's within the city. This is the main mechanism that is used to update the tree database. Specific information about the tree (e.g. species), the tree site and the regular maintenance needs of the tree are recorded in the tree record.

Call takers have access to this form to check on information about a specific tree. Quite often information on this form can help resolve identification issues that might arise on the Call Form.

The Tree Form also has an embedded map facility that helps the user locate the tree relative to streets, landmarks and other trees.

### Tree Form

**Tree Identification**

Tree ID:  Survey Date:  Owner:  DEC Contract #:

Sheet ID:  Surveyor:  Contacts:



**Tree Information**

Number:  Street Name:

Tree Address Grid:

Part:  Species:

Root Width:  DBH:

Condition:  Location of Tree in Lot:

**Maintenance Needs**

**Site/Planting Information**

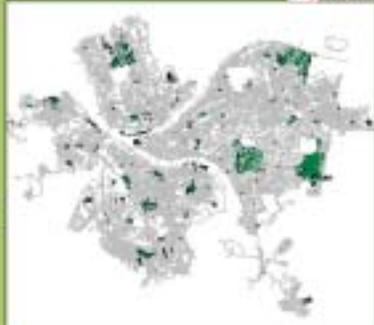
Sidewalk Type:  Pavement Width:  Length DI Sidewalk:  Utility Type 1:

No Parking Date:  Hazard:  Width DI Sidewalk:  Utility Type 2:

Date Planted:  Caliper Size:  Root Collar:  Utility Type 3:

ADA Compliance Root Collar Size:  Utility Type 4:

Comments:



**Inspector Interface:** The Inspector Interface provides the city Inspector(s) and Forester with the detailed information for each call received and submitted for inspection. From here the Inspector can choose to add the particular tree for inspection (Add to Inspection) or s/he can place a work order (Work Order Builder) for immediate work without further inspection.

MSC Number

## Inspector Interface

**Request Information**

Number

Date

Data Entry

Inspection Priority

Citation  Permit

Problem

Description

Comments



**Caller Information**

Name

Contact Phone

Alternate Phone

**Problem Address**

Number  Street Name

Park

No Work Necessary

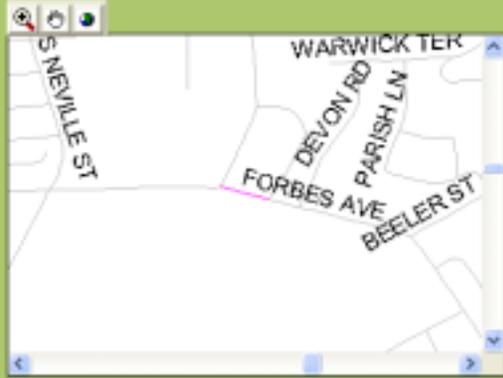
<<      >>

Update Record

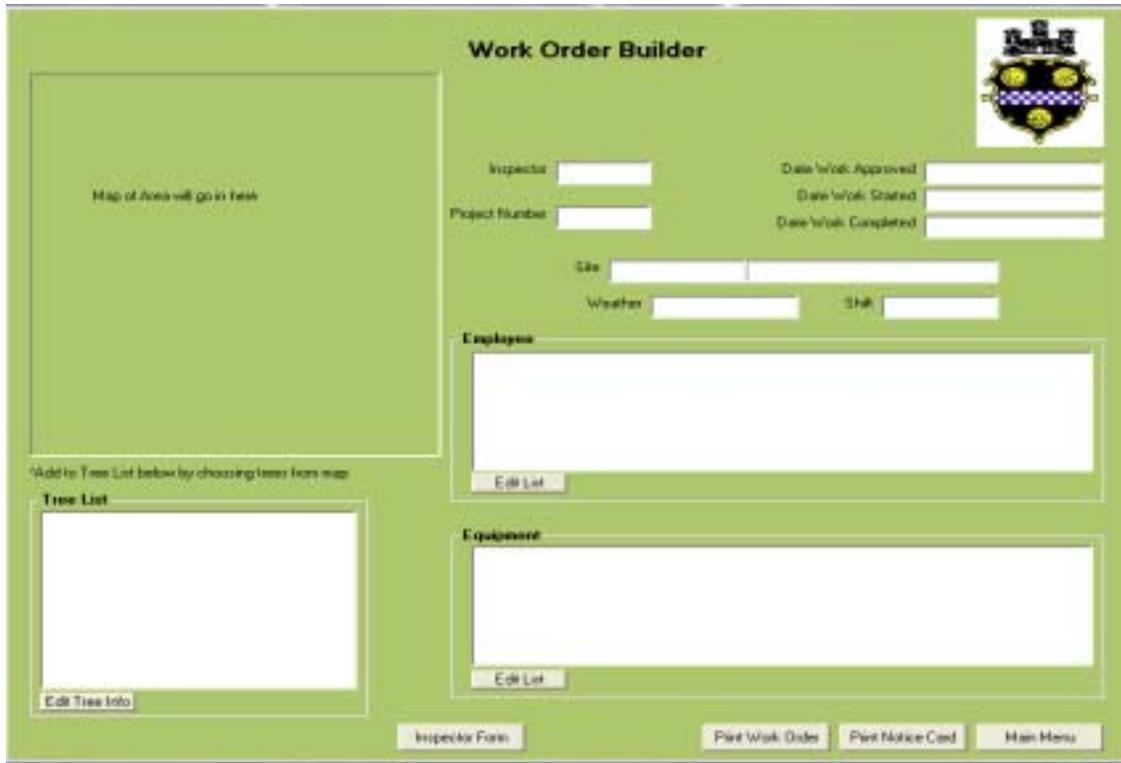
Add to Inspection

Work Order Builder

Main Menu



**Work Order Builder:** The Work Order Form is used by a city tree Inspector if s/he decides that work needs to be done on a particular tree(s). This form has specific information about the work to be done. Free form fields are used to allow the Inspector or Forester to give detailed instructions to those who are going to perform the maintenance on the tree(s). The form also contains fields that allow the work order, inspector, employee, etc. to be identified for later retrieval or archiving. Facilities are also provided for printing work orders to take into the field.



## Conclusions

The Pittsburgh Trees Project provides an example of how GIS can be integrated into an asset management business process. The Trees system provides for tree information to be accessed from a spatial perspective as well as a traditional database perspective. The application is designed to mirror the actual business processes that the city forester and his staff perform.

The Trees Project also took a different approach to the definition of the tree inventory. In many similar settings, an inventory would be completed before the construction of the management system. In the Trees Project the design and construction of the system was used as a specification and testing mechanism for the inventory. Only those elements that would be used were collected.

## References

1. Kidd, Charlotte M. Trees: Pittsburgh's Tallest Natural Resource, Sylvan Communities, Winter 1999.
2. Pittsburgh Shade Tree Commission Brochure, 1999.
3. Regional Ecosystem Analysis for the Willamette/Lower Columbia Region of Northwestern Oregon and Southwestern Washington State, American Forests, Washington, DC, 2001.