Paper Number: 232
Title: ArcGIS Grows a Tree Model for the City of Trees
Author: Peter Godfrey Jr., RLA, AICP

Abstract
The ability of GIS to assist governments in displaying and analyzing assets has grown from a utility-based application to include many other features, including street and park trees. This paper and presentation will describe a case study in the design and implementation of an Arc8 tree geodatabase model for use in Washington, DC, once known as the City of Trees. The model is used for general analysis as well as in inventory, service requests, work order management, and modeling applications.

Paper
The following paper documents the process, findings and recommendations regarding the functional requirements resulting in the creation of a Street Tree Object for the GIS-centric Tree Information System for Washington DC's the District Department of Transportation's (DDOT) Urban Forestry Administration. Also included will be a section generally discussing the resultant geodatabase object and associated graphics representing the business process and data integration mapping diagram.

1.1 INTRODUCTION

The mission of the District Division of Transportation's Urban Forestry Administration (UFA) is *to attain and maintain, in a healthy and safe condition, no less than a 30% overall tree canopy coverage within the District*. This translates into canopy coverage of approximately 10,000 acres.

An implied objective of this mission is to maintain the District's "public space" street tree population (trees between the curb and sidewalk) as well as along unimproved alleys to assure safe passage along District streets (1,500 miles of streets and alleys) and pedestrian walkways (1,600 miles of sidewalks). An important component of this objective is to enhance the quality of life for both District residents and visitors through an attractive urban environment.

Azteca Cityworks software (a GIS-centric asset management system) has been selected to assist the UFA in tracking transitional service requests (6,000 received on an annual basis) and work assignments (FY 2001 saw 20,750 plant, prune and remove work assignments completed), and maintain an inventory of the District's 135,000 tree box spaces. These spaces currently contain 110,000 street trees in varying condition. The Cityworks system will also assist in the management of tree related contracted services (approximately 80% of tree work is done by contractors) and manage internal and external costs.

This section is intended to document the functional requirements of the Cityworks system in the context of the UFA work process. The requirements have been documented with an understanding that Cityworks is a custom off-the-shelf software package (COTS) that already includes numerous functions as part of its core product. As a result, the requirements are presented in a high-level manner for both UFA and vendor review. The requirements should be used as a checklist during system configuration and implementation.

Prior to documenting the functional requirements, an understanding of the existing work process (validated by UFA) was required. This was accomplished through interviews and existing documentation reviews. This does not appear to be a new idea within the UFA and the following documents were reviewed and interviews took place:

- AS-IS PROCESS MODEL FOR TREE AND LANDSCAPE DIVISION
  - OAO Corporation, October 16, 2000
- TO-BE PROCESS MODEL FOR TREE AND LANDSCAPE DIVISION
  - OAO Corporation, October 16, 2000
- MISTRE Database User Manual
  - Version 1.1, March 2001
- UFA Request for Quotation for Tree Management Software
  - Solicitation No. 224661, July 8, 2002
- Plangraphics Interview work process flow diagrams
  - Reviewed October 16, 2002
- Work flow diagramming workshop and verification
  - October 17 and October 28, 2002

As a result, this memorandum will most likely contain some functional requirement definitions that have been previously identified. The focus of this effort was to identify key requirements of the new system for UFA and identify them within the context of the Cityworks implementation. Not all UFA requirements that have been identified will be available within the core Citywork's functionality. As a result, some functional requirements (an example would be batch editing of records) will need to take place post-implementation.

As the functional requirement task was being completed, it became apparent that there should be a few additional high-level sections included for the benefit of UFA, its consultants, and Cityworks. These additional sections should be used for reference purposes and are not intended to represent final recommendations.

This memorandum will contain the following sections:

1.2 Review of tree related existing work processes
1.3 Functional requirements for tree information system
1.4 UFA technical and organizational considerations
1.5 Schematic re-engineered work processes post-implementation

1.2 UFA EXISTING WORK PROCESSES

In order to determine the functional requirements of any information system (be it custom or COTS), it is important to understand the processes that it will support as well as the intended users (AKA actors) that will be impacted. This section will provide an overview of the UFA existing work processes as well as a graphic portrayal of the process in Diagram #1.

1.2.1 Urban Street Trees

On average, an urban street tree will have a life expectancy of approximately of 8-15 years. During this time, the tree will grow (and its "attributes" such as its caliper and crown radius will change), need maintenance (this may consist of pruning, pest control, female ginko treatment, and watering for instance), and eventually the tree will either die from natural causes, diseases or pests (dutch elm disease, bacterial leaf scorch, asian long horn beetle), or due to causes related to its context (vandalism, automobile incidents). The selection of appropriate street tree species, coupled with cyclical inspections and maintenance, can increase life expectancy as well as crown coverage of the street tree population. But this comes at a cost that needs to be burdened by the overseeing entity (maintenance tasks) and requires full support from overseeing and funding agencies.

There are also external conditions that need to be considered when selecting a tree to reduce necessary maintenance. These would include over-head wires (impacting expected tree height), distance to adjacent structures (impacting expected tree canopy radius as well as potential pruning cycle), and underground infrastructure (impacting root growth or tree pit design due to surface vents, manholes, etc.). Street trees will also be impacted by activities such as cyclical road reconstruction and capital improvements such as infrastructure/utility work. Most urban infrastructure assets (water pipes, sewer pipes, gas lines, etc.) are located underneath the street and any excavation and work done to these facilities can potentially impact the health of a street tree.

Maintaining an inventory of urban street trees will consistently be a dynamic process. While there will be trees that are part of an inventory due to validation through censuses, inspections, and construction/economic development, there will also be trees that have been added to the inventory without notice such as un-monitored neighborhood planting or individual planting. There are also street trees located within the "public space" but not the responsibility of UFA. These would trees in areas administered by the Federal Highway Administration, VMS asset management, and others. The UFA may not know of this tree until a service request is initiated and once the request is inspected it will be determined that this should be forward to another agency. Also, while the inventory may consist of street trees as defined by UFA, there will also be trees that may be planted contiguous to the "public space" on private property, but due to their growth habit will impact the public space if limbs are broken and hanging or if the tree falls onto the sidewalk or street. In most cases, if the tree fails, it will become UFA responsibility.

1.2.2 Tree Related Work

As a general rule, street tree work can be broken down into the following categories: plant, inspect, treat, prune, or remove. These categories form the lifecycle of the urban street tree and all work related activities take place during these stages. Prior to reviewing the tree related work processes, it is important to understand the definition of where trees are located or grow within the "public space".

Trees are either planted in a designated "tree box space" which is defined as a rectangular cut-out in the sidewalk measuring approximately 4' x 9' or larger or in a "continuous space" which would indicate a space such as a grass strip where multiple trees could be planted. Sidewalk tree box spaces can contain a decorative tree grate (which can girdle a tree if sized too small) and/or

can be impacted by utilities that run through the sub-surface area or day light within the space (such as manholes and vents). These tree box spaces are tracked by UFA and define the true UFA inventory. The trees and all subsequent tree-related activity are tracked by the space (location). It must be remembered that while the space can be dynamic (it can be removed through construction activities and paved over), it is much less dynamic than the tree that has a defined life expectancy and is replaced by a new tree within the same tree box space.

Tree Planting (4,000 – 5,000 per year)

Street trees (typically 2"-2.5" caliper) are planted each year between the months of October through April. On an annual basis, UFA will aggregate planting work assignments by resident request as well as assignments that result from a tree removal. These requests and work assignments are aggregated until calender date July 15 each year. The cumulative planting list will then be put out to bid (all plantings are done by contractors) and the low bid contractor(s) will begin planting in October. There are 130 trees that are listed on the approved UFA District planting list. Trees can also be planted by non-UFA contractors in association with development such as building renovations or new construction.

Tree Inspections (multiple inspections per tree box space)

Street tree inspections are done year-round by UFA staff and can be associated with a service request response, monitoring of planting-pruning-removal activities, street reconstruction work, pest/disease treatment and post-treatment monitoring, new development, utility cuts (e.g. WASA, Washington Gas), and newly planted trees during the guarantee period (one year). UFA staff is also responsible for inspection and tagging of potential street trees at the growing grounds prior to contractor acquisition.

Tree Treatment

Street tree treatment activities would include spraying female ginko trees to prevent fruiting, elm bark beetle treatments after pruning, various insect, bacterial, or fungal outbreak mitigation, or watering during droughts. This activity is done by UFA staff as well as contractors and also includes consultant activities for disease verification.

Tree Pruning (14,000 - 17,000 per year).

Street trees, by nature are dynamic in their habit and most species will require some pruning to encourage proper branch structure and overall vitality. In an urban setting, tree pruning will also be done to provide unencumbered pedestrian passage as well as maintaining a safe distance from structures. Pruning is often required for safety purposes such as clear visibility to traffic control devises, street furniture such as signs, and overhead utility wires. In the District, PEPCO prunes the trees around electric wires and often UFA staff or contractors will need to follow this activity to properly shape the tree through additional pruning. UFA defines pruning as either "crown clearing" for activities related to clearing branches around buildings, traffic devises, or wires and "crown raising" to increase the height of the lower branches from the ground plane. Tree pruning is done by contractors for street trees that are larger than 12" in caliper or for "block trims" that involves pruning all trees within a discrete street block. UFA staff will prune individual trees that are less than 12" in caliper. Tree pruning can also be a result of emergency activities such as storm damage or basic tree failure.

Tree Removal (2,000 per year)
Street tree removals are undertaken when a tree dies as well as when a tree fails and falls within the "public space" or street during a storm or due to natural causes. When trees are removed, they are "topped" or the portion of the tree containing branches are removed, "trunked" when the portion of the tree down to the stump containing the roots is removed, and finally "stumped" when the roots are removed and the planting box space is prepared for a new planting. Once a tree has been "stumped" it can be considered removed.

UFA staff removes trees 12" in caliper and under and clear downed trees due to emergencies/storms. Contractors remove all other trees above 12" in caliper and emergency contractors remove trees 18" and under during storm events but leave the stump for future UFA removal.

1.2.3 Existing UFA Tree Related Work Process (refer to Diagram #1 during review)

Simply stated, the existing business processes for the UFA consists of service request scouting, scheduled and ad hoc inspections (including permits), issuing and monitoring work orders, street tree pruning and removal activities, emergency and storm tree activities, and monitoring contracted tree related work (plant, prune, remove). While the work processes may not seem particularly complicated, in reality the workings behind each one of these tasks has many decision points and general guidelines as opposed to set rules. For instance, while it is generally assumed that UFA staff only undertake work on trees 12" in caliper and under, in reality, depending upon the situation, UFA staff can and will work on trees between the 6" through 42" and above caliper.

UFA currently uses the Management Information System for Street Trees (MISTRE) for street tree maintenance information and management of the tree box space inventory. The MISTRE system runs a SQL Server backend and a Visual Basic front end. MISTRE was developed as a sub-system of the Department of Public Works (DPW) street information system (SIS) which was designed to provide a working inventory of all District streets and related infrastructure. Both MISTRE and SIS use a common location schema (in MISTRE this schema is contained in a portion of the 19 digit UFA "soul" number). UFA staff has become dependent on this number that is defined as follows:

SOUL # 38138-090-3001-0089-000

3 = Quadrant (1-NW, 2-NE, 3-SE, 4-SW, 5-Distict Boundaries)
8138 = Street inventory code (8138 = South Carolina Avenue)
090 = 100 block (090 = 900 block)
300 = Roadway condition (300 = paved)
1 = Street side (1 = even, 5 = odd, 3 = center median, 2 = east median, 4 = west median)
0089 = Distance from point of entry in feet (89' from intersection with 9th Street)
000 = Offset from curb (000' means tree is on the curb)

While the MISTRE system is used for UFA management of service requests, work assignments, contractor work, and the tree space inventory (also known as the tree census), all service request work as well as work order dispositions are also tracked in the DPW SERVES 2000 system as

well as the Mayor's One-Call Hanson system. The SERVES system was developed over ten years ago to manage citizen calls regarding all street related complaints and has a SQL Server backend. The Hanson system (also SQL Server backend) is the District's answer to a municipal one-call system and a majority of the tree related service requests are initiated here.

The result of having to use the SERVES, Hanson, and MISTRE system has been:

- The Hanson and SERVES system are the provider of a vast majority of service requests
- All service requests that come from SERVES and Hanson need to be manually entered into MISTRE
- The MISTRE system is used not for management of service requests, but rather work orders
- All service request dispositions (what needs to be done) have to be manual entered into the Hanson, SERVES, and MISTRE system
- All work order status and dispositions have to be manually entered into the Hanson, SERVES and MISTRE system
- All Hanson, SERVES, and MISTRE records for a service request will contain different key ID numbers for internal tracking

Service Request

Typically all work is initiated by a service request. A resident, UFA staff or other operational District entity due to field observation, or political entity can initiate a service requests. The political requests will often increase the requests priority (this type of request is referred to as "hot"). Requests are typically identified as external (not directly initiated by UFA) and internal (initiated by UFA).

Hardcopy service requests are printed out by UFA administrative staff and sorted according to type (plant, trim, remove). The UFA arborist or inspector responsible for *these types* will collect the forms and "scout" each request in the field. An arborist is the only staff who inspects remove requests.

During the "scouting", the request type will be verified (e.g. a trim may need to be a remove) and a work assignment will be indicated on the service request form. In most cases, the UFA will also leave a form letter with the resident who initiated the call during the service request scouting. These completed request forms are turned in at the end of the day to the UFA administrative staff. The staff then enters the data back into Hanson and SERVES to dispose of the service request (the service request information is ephemerally entered into MISTRE) and into MISTRE to create a work assignment

Work Assignments

Most service requests will result in a work assignment (work order). Work assignments can be either completed by UFA staff or by contractors that have been awarded the work (plant, prune, block prune, remove, emergency remove). There can be multiple contractors per work type. All contractor work assignments will be inspected by UFA staff for verification of the work and quality on a daily basis. The work assignment ID is the 19-digit tree ID number (soul number).

Work assignments are manually tracked on hardcopy Log Report and Assignment sheets for each work type. Emergencies are manually tracked on a hardcopy Tree Tracking Form and contractors

are also tracked on the Contractor Location form. Work assignment forms are used to verify work, track progress, and update the tree census after both UFA as well as contractor work assignments have been completed. This is all done manually on hardcopy forms and UFA administrative staff manually updates the tree inventory (in MISTRE) from the completed work assignment forms. Once a work assignment has been completed, MISTRE as well as the Hanson and SERVES system also need to be manually updated in order to close out the work assignment as well as update the Hansen or SERVES initial request.

Inspections

UFA staff will inspect contractor work on a daily basis throughout the lifecycle of the assignment. UFA also inspect "permit" related work prior to and during new construction/renovation, utility cuts, street renovations, and private home construction. Any work that will potentially have an impact on the health of a street tree needs to be inspected. During the contractor work inspection the tree inventory (census) is updated based upon the final and completed type of work.

The stages of work that are inspected are as follows:

- Plant: Tree space excavated, tree planted by date
- Trim: Tree trimmed by date
- Remove: Tree topped, tree trunked, tree stump removed by date
- Emergencies: As needed
- Disease/Pest Treatments: As needed
- Permit work: Initial, pre-construction, during construction, post construction

Emergencies

Street tree related emergencies could be caused by tree failure as well as storms. During tree-related emergencies, the goal is to keep the street and sidewalk safe and passable.

Tree emergencies can be considered work assignments that in many cases are initiated prior to a service request. Daytime emergencies can be either external or internally initiated, and if the emergency is after 7:00PM it will be initiated by the 24- hour Mayors Command Center (6161).

The 6161 calls are initially routed to the District Neighborhood Infrastructure Maintenanence Officer (NIMO) who will inspect the incident and notify the UFA on-call staff member (UFA maintains a 24 on-call staff which rotates on a weekly basis). The UFA on-call staff will then also inspect the incident and coordinate necessary work. Trees that are 12" will be disposed of by UFA staff, trees 18" and under will be disposed by the emergency contractor (the stump will be left), and trees above 18" will be disposed of by the regular removal contractor(s). Emergency work is tracked on the manual Tree Tracking Form and will eventually be used to update MISTRE and Hanson post activity.

Once an understanding of the various work processes that are undertaken by UFA staff are verified, it is possible to define the information system functional requirements.

1.3 UFA Tree Information System Functional Requirements

The following software requirements are being specified for the DDOT UFA Cityworks implementation. Cityworks is intended to recreate portions of the functionality currently available to users of MISTRE as well as introduce new and desired functionality beyond that currently available. The implementation of Cityworks will introduce accountability and performance measurement tools as well as integrate geographic information system (GIS) capabilities into the daily work process. Cityworks will also address many tasks that are currently managed manually or ephemerally due to the current system constraints.

Due to the fact that Cityworks is a custom off-the-shelf software package (COTS) containing existing core functions, the functional requirements identified in this section will not follow standard Software Requirements Specification (SRS) documentation. The requirements will be documented in statement form followed by a brief description. The satisfaction of the identified requirements will rely on either core system functionality or future enhancements.

The functional requirements are intended to define UFA user requirements in a manner that will assist Cityworks in their implementation. The requirements can also be used to indicate system enhancements that may be desired post-implementation.

Prior to defining the UFA tree system functional requirements, the definition of a requirement should be addressed. There are three levels of software requirements:

- Business requirements: These are typically captured in a vision statement and represent the high-level requirements of the organization and the client.

- User requirements: These describe the tasks users must be able to accomplish.

- Functional requirements: These requirements define the functionality that the software product must provide so the *users* can do their tasks and satisfy the *business* requirements. This type of requirement will be defined in this document.

In the case of the UFA, the first two types of requirements may be defined as:

- Business requirements (UFA as an administrative unit of the DDOT)
    - The District of Columbia government's Division of Transportation's (DDOT) mission is *to enhance the quality of life* for District residents and visitors by ensuring that people, goods, and information *move efficiently and safely*, with minimal adverse impacts on residents and the environment.
    - The UFA's mission is *attain and maintain, in healthy and safe condition*, no less than 30% overall tree canopy coverage within the District of Columbia.

- User requirements (specific to UFA)
    - Efficiently, effectively, and proactively manage all street tree related work processes and information
    - Manage and maintain an up to date and accurate street tree and tree box space inventory

- Respond to service requests and dispose of work assignments within pre-determined timeframes to measure performance
- Accurately measure internal and external costs by activity
- Incorporate spatial analysis into the everyday work process
- Seamlessly integrate with external information systems
- Provide typical cyclical and ad-hoc reporting
- Retain data for a period of seven-years for potential legal claims

The functional requirements in this section should not be confused with nonfunctional requirements. Nonfunctional requirements address issues such as standards, external interfaces, performance requirements, design and implementation constraints, and attribute quality.

The functional requirements presented below are not listed according to priority and are a result of the following activities or document reviews:

- Review of OAO As-Is and To-Be Process Models dated October 16, 2000
- Review of DDOT Tree Inventory and Service Request Application needs assessment dated December 2001
- Notes taken during UFA (then known as TLD) meeting on January 10, 2002
- Review of UFA Request for Quotation for Tree Management Software RFP dated July 8, 2002
- Informal interviews at UFA site (October 7-9, 2002)
- Informal interviews and work flow modeling at UFA site (October 16-18, 2002)
- Informal interviews and work flow modeling and verification at UFA site (October 28-29, 2002)

1.3.1 UFA Information System Functional Requirements

The forty-five (45) functional requirements presented below have been categorized as follows: general, service request related, and work assignment related. These requirements represent the identified functionality as defined by the potential users and it must be stressed that not every requirement will be met by the initially implemented Cityworks system. The list represents a "long-term" approach to functionality and some of the requirements can and should be classified as system enhancements. This classification will need to be done by Citywork's staff.

General

FR #1. Apply status transition rules
The system shall apply and enforce process rules to work assignment activities (e.g. cannot close a removal Work Assignment until the stump is removed).

FR #2. Multiple look-up value capability
The system shall provide querying capability for more than one attribute (e.g. type of tree planted between certain dates).

FR #3. Minimize keystroke required fields
The system shall rely primarily on field population through pull down menus as opposed to keystrokes.

FR #4. Sort and display geographic data on multiple fields
The system shall sort data on multiple fields and display the result on a map (e.g. display trees worked on by a specific tree contractor between certain dates).

FR #5. Automatically generate form letters
The system shall maintain assorted form letter templates and automatically assign the recipients mailing address.

FR #6. Generate reports
The system shall generate reports based upon standard daily, weekly, monthly and yearly criteria and provide acceptable ad-hoc report functions.

FR #7. Maintain tree inventory
The system shall be used to update the tree inventory attribute data based upon a completed work assignment or inspection.

FR #8. Track permit work
All permit work shall be tracked in the system as well as its associated costs.

FR #9. Assign image data
The system shall allow the association of scanned documents and images to a service request, work assignment, or permit.

FR #10.Alert users when status changes
The system shall automatically alert identified UFA staff when the status of predetermined request or work assignment types change (e.g. if a politically hot tree removal is completed, the UFA Chief Forester should automatically be sent an email).

FR #11.Update data through daily field data gathering downloads
The system shall provide integration with mobile data gathering efforts for automatic end of day data download and synchronization (e.g. if the use of mobile technology solutions are integrated into the existing work process, the data gathered in the field should automatically update data maintained on a stationary server or PC at the end of the day – note this differs from FR #12 below).

FR #12.Update data through wireless technology
The system shall provide integration with mobile wireless technology for real-time data downloads, access, and uploads.

FR #13.Assign security edit protection
The system shall provide data security measures and administrative clearances for editing and maintenance (e.g. only select staff should be allowed administrative access).

FR #14.Automatically validate request
The system shall automatically validate the service request address as the responsibility of UFA (e.g. if the service request is for an address known to be that of VMS, the system shall identify this, not initiate a UFA request activity, and forward the request to the responsible entity).

FR #15.Assign constraints by location
The system shall automatically assign tree species constraints by location and condition (e.g. if a tree box space is located under a wire, only certain trees should be displayed on the drop down list).

FR #16.Display legacy data
The system shall display, but not sort or query, on certain MISTRE legacy attributes (e.g. the "soul" number should be visible to UFA staff on all forms and the interface, but only in a static state).

FR #17.Batch edits
The system shall provide batch-editing capabilities (e.g. if numerous planting assignments are completed by one contractor in one day, the closing of all these assignments should be done through one action as opposed to closing each assignment individually).

FR #18.Notes and comments
The system shall provide a free-form text field for notes.

FR #19.The system shall be user intuitive
The system shall be easy to use and intuitive for all end users regardless of computer literacy.

FR #20.System tables shall be editable by UFA staff
The system shall provide the users with editing capabilities for value tables (e.g. some users should have administrative privileges to edit tables and values within the system as opposed to relying on vendor support).

FR #21.Link Service Requests, Work Assignments, Inspections, and Permits to a tree box space
The system shall automatically associate all activities to a discrete location as well as a GIS feature.

FR #22. The system shall display and track street and development activities
The system, through the GIS interface, shall provide the ability to enter and track locations for District work that falls outside UFA responsibility, but may impact the tree inventory (e.g. if there is an identified tree on private property that is leaning towards the public space, a record should be proactively created).

FR #23. Integrate District-wide spatial data
The system shall integrate and display relevant District GIS base data for reference by UFA staff (e.g. aside from tree points, also display street names, buildings, alleys, wards, etc.).

FR #24.Automatically receive and update external system records
The system shall automatically receive as well as update relevant fields and records from the Hanson and SERVES systems.

FR #25.Automatically time stamp all process tasks and sub-tasks during transitional state from initiation to final disposition

The system shall automatically timestamp service request, work assignment, inspection, and permit activity during the discrete process stages.

FR #26. Intelligent street name recognition

When entering a caller or locational address, the system shall require minimal keystrokes before prompting the user with a full street name or choice box (e.g. the user enters MAR and a choice box appears displaying a choice between MARKET and MARLEY).

FR #27. Verify street address range

The system shall validate caller addresses based upon street address ranges associated with street segments to minimize errant assignments (e.g. a caller says their location is West Street, but there are two in the District and they are unique based upon their address ranges West Street #1 has a range of 0-299 and West Street #2 has a range of 300-599).

FR #28. Sort activities by geopolitical area

All service request, inspections, and work orders shall be automatically associated with District geopolitical areas (e.g Wards, Quadrants, Region, Zip Codes, UFA responsibility)

FR #29. Default to populated field

There shall be no default "blank" fields and all fields shall contain an intuitive default.

Service Requests

FR #30. Query on all Service Request numbers

The system shall allow the user to query on Cityworks, Hanson, and SERVES service request numbers. The implication of this requirement is that these core systems interface seamlessly with each other.

FR #31. Geocode and display Service Request location(s)

The location of any service request shall be automatically geocoded and displayed on a map as well as hardcopy form.

FR #32. Automatic display of prior Service Request calls

Any new service request shall automatically be associated with legacy service requests from the same caller or address (e.g. old service requests from the caller or location should be accessible prior to entering a new service request).

FR #33. Display status of Service Request

The status of the service request shall be automatically displayed in both text and graphic format.

FR #34. Assign Service Request number automatically

The system shall automatically assign a "non-intelligent" unique service request number upon initiation.

FR #35. Assign staff cost to Service Request

UFA staff costs shall be automatically assigned and calculated to a service request.

FR #36.Assign equipment cost to Service Request
Equipment costs shall calculated and assigned to a service request.

FR #37.Assign Service Requests to specific UFA staff
Service requests, where appropriate, shall be automatically assigned to specific UFA staff.

Work Assignments

FR #38.Assign Work Assignment number automatically
The system shall automatically assign a "non-intelligent" unique work assignment number upon initiation.

FR #39. Display Work Order location(s)
The location of any work assignment and its related "feature" shall be automatically displayed on a map as well as hardcopy form.

FR #40.Display status of Work Assignment
The status of the work assignment system shall display in both text and graphic format.

FR #41.Assign Work Assignments to specific staff
Work assignments, where appropriate, shall be automatically assigned to specific UFA staff (e.g. all permit work should be assigned to the Deputy Chief Forester).

FR #42.Assign staff cost to Work Assignment
UFA staff costs shall be automatically assigned and calculated to a work assignment, including overtime and emergency costs when applicable.

FR #43.Assign equipment cost to Work Assignment
Equipment costs shall calculated and assigned to a work assignment.

FR #44.Track contractor(s) work and cost
Contractor work and associated costs shall be assigned and tracked by work assignment. as well as contractor(s) costs to date shall be calculated and contract funds remaining shall be automatically displayed.

FR #45.Track contractor(s) contract status
Contractor costs to date shall be calculated and contract funds remaining shall be automatically displayed.

FR #46.Automatic alert to staff for cyclical activities
The system shall automatically alert UFA staff for cyclical maintenance or inspections (e.g. tree inspections during first year after planting)

FR #47.Track material costs and quantities
The system shall track UFA materials by type, cost and quantity per service request and work assignment.

This list represents the identified UFA tree information system functional requirements. This list should not be considered static, but should be used during Cityworks implementation and future system enhancement.

1.4 UFA Technical/Organizational Recommendations

Described below are some overall issues that should be monitored as the information system (IS) environment is being configured and Cityworks is being rolled-out and integrated into the daily workings of UFA. Many of these issues have already been identified by other UFA consultants and are potentially completed. They are solely offered as a checklist to assure verification of necessary pre- and post-implementation activities.

1.4.1 UFA Technical/Organizational Recommendations

Technical Recommendations

Prior to the Citywork's implementation and rollout, there are some tasks that need to be clearly defined and completed in order to create and stabilize Citywork's distributed IS environment. If these tasks are not completed or are delayed, the value of the new tool and its impact on UFA efficiency will be postponed.

IT Environment

- Design, piloting, and implementation of seamless two-way Hanson/SERVES-Cityworks interface
- Installation, configuration and stabilization of Citrix Server
- Installation, configuration of Oracle DBMS
- Determination of necessary ESRI modules and licenses (ArcView 8.x and ArcEditor)
- Installation and configuration of ESRI Arc8 modules including SDE
- Determine timeframe, methodology, and platform for daily/wireless field data collection and update

Data

- Identify, integrate, pilot, and refine tree pint attribute data fields (CASEY and MISTRE)
- Integrate CASEY and MISTRE spatial GIS data
- Migrate tree point ESRI shapefile into geodatabase format
- Determine procedures for periodic update of CASEY data
- Determine format of unique tree point ID as well as unique tree ID
- Determine, configure and pilot District GIS base layers for use in support of Cityworks GIS interface:
    - Digital orthophotography
    - Tax parcels with address annotation
    - Impervious surfaces
        - Building footprints
        - Sidewalks
        - Curbline
        - Streets
    - Street centerline
    - Parks and other open spaces
    - Geopolitical boundaries

- Wards, Quadrants, Regions

While the above recommendations are presented in a high-level manner, they are included solely for assistance during big picture implementation efforts.

Organizational Recommendations

Based upon statistics presented in the OAO reports and the Tree Management Software RFP:

- There are approximately 135,000 tree box spaces within the District (tree planting points)
- There are approximately 110,000 existing trees within these planting points in varying degrees of health
- UFA is responsible for processing approximately 6,000 requests on an annual basis
- There are the following backlogs (which represent a four year effort to resolve):
  - 15,000 trees to be removed
  - 50,000 trees to be pruned
  - 20,000 trees to be planted
  - 1,000 unresolved service requests
- In FY 2001:
  - 16,000 trees were pruned
  - 3,300 tree were removed
  - 4,000 trees were planted
- Based upon FY 2001:
  - Median tree prune cost = $96
  - Median tree removal cost = $856
  - Median tree planting cost = $285
- UFA typically contracts out:
  - 65% of pruning
  - 80% of removals
  - 100% of plantings
- The FY 2001 overall budget allocated for tree work was $4.8 million
- UFA staff (at the time of the OAO report UFA was part of the Tree and Landscape Division) numbered:
  - 16 field tree workers (arborists, inspectors, laborers)
  - 7 administrative staff
- FY 2002 DDOT UFA related scorecard goals
  - Plant 4,000 new trees to enhance the District's green spaces and neighborhoods
  - Maintain 70% of the District's trees to a level that will rank good or excellent under the DDOT Infrastructure Quality Index
  - By FY 2006 70% of individuals polled will rate the division's services as good or better

The above statistics are presented to gain a brief understanding of the workload and responsibilities of the UFA. By generally looking at the above statistics, the following can be inferred from matching the statistics with the existing workflow as presented in Section 1.2:

- 6,000 service requests translate into 18,000 records currently manually maintained (Hanson, SERVES, MISTRE)

- Based upon the current fact that initial service request "scouting" is assigned by type to the designated plant, prune, remove staff, daily scouting can be widely dispersed and result in expanded travel time and increased gas use
- The 3,300 trees removed resulted in a minimum of four (4) UFA inspections (verify tree, top, trunk, and stump) for a total of 13,200 individual inspections
- 102,300 street trees should currently have a condition of at least "good"

Again, these inferred statistics are included to gain an understanding of some of the nuances of the existing workflow within UFA.

Based upon these facts, the following recommendations are suggested for UFA with the implied assumption that staff will be increased and the pending Tree Bill will be adopted:

- Assign crews (arborist, inspector, foreman laborers) by Ward or a combination of adjacent Wards assuring that the cumulative tree space population per area is comparable
- Assign scouting by geopolitical area (e.g. Ward) as opposed to request type
- Track trees on private space that could fall into the public space
- Create a contract administration and field crew for contractor and permit related inspections
- Provide networked computers running Cityworks for the field crews so they can update service requests and work assignments
- Consider implementing portable field data gathering and record editing capabilities through either daily downloads and uploads or wireless technology
- Consider implementing a crew routing application
- Consider implementing an ESRI spatial analyst module for storm tracking
- Actively participate in capital planning meetings and scheduling for street renovation and utility cuts

2.1 GEODATABASE

The UFA spatial data (GIS) will be designed and implemented in the Environmental Systems Research Institute's (ESRI) geo-object model commonly known as the geodatabase. This data model represents the shift from the geo-relational model where the spatial and attribute information was partitioned (spatial information such as X, Y coordinates were represented as binary files and attribute information such as tree size were represented in a separate table) to a model where all information is shared in one central database and can be administered centrally.

The geodatabase format is a critical aspect of the new ArcGIS GIS data paradigm for ESRI and represents the future of its spatial data format.

Some other benefits of the geodatabase that would apply to UFA would be:

- Implementation of automatic behavior rules (for instance a tall tree could not be planted in a tree box space under wires)
- Efficient data entry and editing

The high-level representation of a spatial object in the geodatabase is based upon the object's geometry (point, line, polygon) and is called a "feature". For UFA purposes, the "***point feature***" has been chosen to spatially represent the tree space box and will be called the "***tree point***" during the remainder of this section. The point feature is the logical choice for spatial data modeling based upon the fact it is uniquely located (X, Y), is not part of an interconnected network (like sewer pipe lines), or accurately represented by a polygon (like a tax parcel).

2.1.1 UFA Geodatabase Structure

UFA staff, Cityworks staff, and UFA consultants undertook a two-day effort to define the point feature and were faced with two distinct choices:

- Create a tree point feature to represent the tree box space and also create a related "object" to the tree point feature that would represent a tree
- Create a single tree point containing both tree box space and specific tree data

In real world terms, the former model would more accurately represent reality. Tree box spaces are more permanent than the trees that inhabit these spaces. In other words, there can be many individual trees that are planted, pruned, and removed in one static tree box space. At the same time, one UFA defined "continuous" tree box space can contain numerous trees. This situation creates redundant data due to the fact that the tree box space attributes (type, width, length) will need to be redundantly recorded for each of the individual trees within a continuous space.

After much discussion, centered on the pros and cons of these two approaches, it was determined that the latter model would be implemented.

2.1.2 Geodatabase Diagram (see Diagram #2 and #3)

The model represented in associated diagram is simple in nature and represents the final conceptual design as defined through the two-day effort (October 28 & 29, 2002). This should not be considered the final model and it will need to be piloted and refined by UFA staff and its consultants as well as Cityworks prior to final implementation.

The model represents the spatial attributes of the GIS feature that will be used in the Cityworks application. This feature provides the true asset "inventory" that is available for display, query, and analysis purposes. The Cityworks service request and work order information is managed in a separate portion of the database and "linked" to this GIS feature.

In order to develop the conceptual design and final design, the following activities took place:

- Analysis and field mapping of the MISTRE and CASEY GIS attributes (this is represented in the diagram)
- Determination of required fields within the geo-object model (shown as the "point feature class" in the diagram). Many of the attributes shown in this diagram contain either notes or preliminary values within their individual boxes.

Also included in the diagram are the fields that are currently listed on the variety of hardcopy service requests and work assignments that are used by UFA staff to track internal and contractor

work. These are included for UFA staff and consultant analysis as well as Cityworks for use during the design of the service request and work assignment database.

2.1.3 Conclusion

As mentioned above, the geodatabase model will most likely need to go through a few more cycles of refinement. Included in this report is a digital copy of this model for use by UFA staff and consultants as well as Cityworks.

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David Keller, Plangraphics
Sheila Hogan, Casey Tree Foundation

Author Information

Peter Godfrey Jr., RLA, AICP
Senior GIS Project Manager
CDM
1500 JFK Boulevard, Suite 624
Philadelphia, PA 19102
215.636.0600 ext. 254
215.636.9811 fax
godfreyp@cdm.com