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Handheld Technologies for Urban Forestry - Inventories, GIS, & More

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Abstract: Personal Digital Assistants (PDAs) and computerized tree management software are valuable tools for urban forest management. PDA technology, software and a case study for Washington, D.C. are outlined here.

Utilizing Computer Technology

Various strategies for the collection of field data for inclusion in an urban forest management program can be employed, based on the ultimate intent of use. Broad strategic planning decisions on items such as land-use, regional planning and forest types can be obtained using tools such as satellite imagery, air photos and other remote sensing methods. Finer scale collection methods are needed for developing specific operational planning strategies related to urban forest management. A wide range of methods have been developed for this scale of information collection and analysis, including Global Positioning Systems (GPS), Personal Digital Assistants (PDAs), bar code readers, electronic telemetry and advanced surveying instruments. The tools that are useful in a community, in order to gather information on for managing their urban forest resources are variable and can include a cadre of methods and types.

Street and park tree inventories can include the collection of data on a large scale such as canopy cover, forest type and condition, or examine the specific condition of individual trees, based on field inspection and assessment. This wide range of scale presents problems and opportunities related to the level of management that is being employed in a particular community. Long term strategic planning may utilize a more broad scale analysis of the forest, while short-term operational planning often used a finer scale of analysis, based on day-to-day management of individual trees. Many tools are available for use in assisting these management strategies, but often the most difficult decision is which one will provide the most flexible and robust opportunity for usefulness in a community.

Commercial software packages are available for the management of individual trees growing in a community. ACRT, Natural Path and Davey Tree are three of the most popular firms, which have produced tree management software programs. Additionally the USDA Forest Service has developed several useful tree inventory and management programs. All of the programs noted provide the ability to manage individual trees, based on regular work routines, customized for individual communities. These programs should be considered as one useful component to be used in addressing the operational planning needs of a community's urban forest.

The Forest Service has developed the Mobile Community Tree Inventory (MCTI) software that allows the user to incorporate a PDA for field data collection, and desktop

software for analysis and data management. Additionally, the Street Tree Electronic Management System (STEMS), an add-on component of the MCTI software, allows for the development of maintenance and management work orders and records that can be linked into the MCTI inventory software. All of the software noted has the ability to include data collection using a Personal Digital Assistant (PDA).

Additionally, custom software packages are often prepared for an individual community by consulting arborists and urban foresters. Often these are databases that are incorporated into a Geographic Information System (GIS), and provide the flexibility of providing a range of functionality that can be expanded as a community's urban forest needs grow, or change. The ability to build a management tool from the ground up, based on the specific needs of an individual community, makes this method attractive to many municipalities.

A (GIS) provides a logical foundation for any data collection, analysis and planning initiative related to a community's urban and community forest. GIS programs such as ArcInfo®, ArcView® and ArcPad® are powerful and important tools to consider, whether looking at the overall urban forest, or managing individual trees growing along streets or in parks. Whether looking at the urban forest from a broad scale, or more closely examining individual trees, a GIS provides a strong backbone to any useable system. The ability to geo-reference, display, print and archive database and mapping information makes a GIS an invaluable tool for urban forest management.

American Forest's CityGreen® analysis program provides an opportunity to look at the overall benefits of a community's urban forest, including water analysis, cooling benefits and growth projections. The Forest Service's Urban Forests Effects (UFORE) model examines similar characteristics of the urban forest and more closely calculates air pollution mitigation provided by urban forests. Both of these are useful analysis tools that examine the urban forest on a broad scale, providing useful information for strategic and long-term planning.

Data Collection Using Personal Digital Assistants

Today, a variety of data collection tools, for collecting information on individual street and park trees are available, making the work of an inventory specialist faster, easier and less prone to input error. Proper training of survey personnel is the only way to reduce inaccuracy during the collection process, but the newest electronic PDAs eliminate many of the common problems of data entry and lost records.

Palm OS® and Pocket PC® operating systems provide the mechanism to collect data on a PDA and incorporate the information into a computer database, GIS database, or any other tree management software that is available. Several data collection programs for the Palm OS are available, and the ability to link to a GIS provides even more applicability to these tools. Palm OS® and Pocket PC® PDAs provide very simple, inexpensive and useful methods for data collection in the field. Commercial firms, the Forest Service and many state agencies have developed data collection programs based on the Palm OS® and the Pocket PC®. Davey Tree’s Tree Keeper and the USDA Forest Service’s MCTI are

two of the most widely used inventory programs that incorporate the PDAs in the data collection phase. Commercial development software, requiring minimal computer expertise, is also available for both platforms, providing the opportunity to write custom applications at a low cost.

Global Positioning Systems (GIS) are a component of the arsenal of tools that are available to the tree manager, and their cost, functionality and accuracy is specific to individual application. Low cost units range are available for under $500, while more precise units range up to $5000. Many PDAs are capable of incorporating a GIS in their operation. A careful analysis of how data on individual trees will be incorporated into a management system will dictate the applicability of a GPS to a community forest inventory program, and other methods may be used in conjunction with this tool.

A Case Study: Washington, D.C.

In the Summer of 2002, the Casey Trees Endowment Fund, located in Washington, D.C., led over 500 citizen volunteers and 35 university interns to conduct a comprehensive GIS inventory of 106,000 street trees and 25,000 planting locations throughout Washington for the City's Urban Forestry Administration to use in its planning and decision-making processes and day-to-day operations.

Washington, DC had been known as the "City of Trees" since 1872 when Alexander Shepherd, then governor of the District of Columbia, planted 60,000 street trees to improve its quality of life. One hundred years later, trees are even more important to the image and quality of life in Washington.

The nation's capital is home to 572,000 people and attracts 25 million visitors per year. District of Columbia Mayor Anthony Williams aims to attract 100,000 new residents to Washington. Quality of life issues and beauty rate high on people's list when considering a move to the city from the suburbs and other areas. Trees provide solutions to other issues facing DC which affect its quality of life including:

- Air Quality
- Storm Water Management and Combined Sewer Overflows
- Heat Island Effects
- Crime
- Health and Well-Being

Washington, however, has lost a significant number of its trees. On November 19, 1999 the Washington Post published satellite photographs by American Forests showing a 64% decrease in Washington, DC's heavy tree cover from 1973 to 1997. That same month, the Committee of 100 on the Federal City reported Washington had lost 25-30% of its street trees due to years of neglect, budget shortfalls, and tree-unfriendly design, development, and construction practices. An outdated inventory created both a liability and missed opportunity for the city to plant and care for its street trees.

The first task toward re-greening the city with street trees was to develop a state-of-the-art inventory of all the street trees. The inventory would form the baseline for setting objectives and developing and implementing programs to reach those objectives and the goal to re-green DC's streets. The inventory included the information needed by both Casey Trees and UFA as well as information system needed to manage it.

Casey Trees chose a citizen-based approach for data collection. The benefit of a citizen-based inventory was community participation, increased awareness of the benefits of trees, and commitment to their care and support after the inventory. A participatory process was also consistent with the Casey Trees' mission.

In the summer of 2002, Casey Trees Endowment Fund led an unprecedented citizen-based inventory of every street tree in the District of Columbia for the city's Urban Forestry Administration (UFA) to use and maintain in its planning, decision-making, and day-to-day operations. Recent enhancements in computer technology and software development made a citizen-based inventory of this size and quality possible within the short data collection timeframe. The key innovation was the Geographic Information Systems (GIS)-enabled handheld computers that allowed field teams to enter data directly rather than recording onto paper forms. Compaq iPaq®'s were programmed with ArcPad® 6.0 to provide the data collection interface.

Thirty-five university student interns led teams of community volunteers (Figure 5) to locate and collect information about existing street trees and potential tree spaces. Student interns received an intensive two-week training to prepare for their role as team leaders. Over half the interns were landscape architecture students. Over 500 people including DC high school students partner organizations, and local volunteers participated in the inventory. In addition, Casey Trees launched a DC Citizen Forester Program to train volunteers for the inventory and future planting, pruning, care, and environmental stewardship in the District. For the inventory, each participant attended eight hours of training and offered five days of field service.

All inventory objectives were met: Data quality was >95%, the inventory was completed by August 15th, participants were satisfied with their experience and rated it highly, and everyone was safe except for a few scrapes, blisters, and bee stings. Field teams worked Monday through Saturday from June 3rd to August 13th collecting data and talking to 1,000's of people about the benefits of trees and the inventory. Professional support services were critical to the success. Landscape architects, arborists, and GIS consultants supported the project from concept through design and implementation and were contracted to provide assistance with programming, training, quality assurance, and monitoring. An end-of-Inventory program and celebration was hosted by the National Building Museum with over 400 people in attendance.

Inventory findings show the District has 131,000 street tree sites, with 106,000 existing trees, 23,000 empty street tree spaces, and 2,000 dead trees. Of the existing trees inventoried, nearly one-third were in fair or poor condition. Two-thirds of the existing

trees required routine pruning. Maples comprised 38% of the street trees, oaks 31%, and elms 10%. Four percent of the 8,626 American Elm trees showed signs of Dutch Elm Disease. Of the approximately 1,000 street trees with tree grates, 38% have openings less than 2 inches from the trunk. Eighty-three percent of the trees had no mulching. An additional four percent were mulched improperly.

Conclusion

The use of computerized technologies has provided a number of new tools for urban foresters to utilize in the management of trees in a community. Recently, the introduction of low-cost, easy to use Personal Digital Assistants (PDAs) have made it possible to increase the speed and accuracy of data collection in the field, and have provided new opportunities for strategic and operational management. Commercial consultants, as well as public agencies, including the USDA Forest Service, have led the way in bringing these tools to communities across the country. The use of PDAs, Geographic Information Systems (GIS) and community involvement has been successfully completed in many locations, and the Casey Trees Endowment Fund provides a good example of a working model.