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THE MANAGEMENT OF URBAN STREET TREES USING COMPUTERIZED INVENTORY SYSTEMS[1]

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Abstract. The microcomputer has made possible the storage, access and analysis of large quantities of data at high speed and low cost. it is the objective of this paper to describe the contribution the microcomputer can make towards the management of street trees in urban areas. Benefits and problems associated with urban trees are outlined and the work of the Arborist and workforce is described. Existing systems of recording, filing, and retrieving information, are compared with those incorporating the use of a computer. The paper focuses on the application of recent developments in computer technology towards data management for the Arborist. Some of the difficulties associated with the transition from a manual filing system to one that is computer based, are discussed. Further areas of research and development in this field are explored.

Résumé. *Le micro-ordinateur a permis* l'emmagasinage et l'analyse de grandes quantités de données rapidement et à peu de coût. Le but de cet article est de décrire la contribution que les micro-ordinateurs peuvent faire à la gestion des arbres de rues en milieu urbain. Les bénéfices et les problèmes associés aux arbres sont présentés ainsi que la description du travail de l'arboriculteur et des équipes de terrain. Les systèmes actuels d'enregistrement, de classement et d'analyse sont comparés à ceux utilisant les ordinateurs. Cet article met l'accent sur l'application des progrès récents dans la technologie informatique pour la gestion des arbres par les arboriculteurs. Quelques difficultés associées à la transition d'un système d'inventaire manuel à un système informatisé sont discutées. Des secteurs futurs de recherches et de progrès dans ce secteur sont explorés.

A complete survey of the public tree population in the greater Hobart area was seen as providing a prerequisite information base from which to operate in developing a Computerized Tree Inventory System (CTIS) for some 80 to 100,000 trees under Council control.

Tree Survey

Objective. The survey results assisted in developing a computerized data base to supply technical and field staff with improved access to information on all trees that are the responsibility of the Corporation.

Preliminary research. The reference systems chosen for this exercise were 'Dialogue' (based in California and covering all relevant journals published world-wide), and 'Aussinet' (a wholly Australian based system). Various professionals working in related fields were approached including the Department of Forestry, CSIRO, Division of Forest Research, Department of Information Science (University of Tasmania), and State Computer Centre. All offered suggestions and criticisms on the design and implementation of the survey.

Species identification. Initially time was allocated to species identification. Apart from the assistance given by technical staff in the Department of Parks and Recreation, the co-operation of the Royal Tasmanian Botanic Garden and the State Herbarium is acknowledged.

Survey sheet design. Identical survey sheets were used for street, park and trees on reserve as the same attributes applied in all cases though management requirements differed. All data were collected in coded form suitable for direct transfer to the computer. Private trees of significant value (eg. historic or landmarks) were included in anticipation of future changes to tree preservation ordinances in Hobart and the creation of a Significant Trees register.

Data collection. Individual assessments were made of all public trees, and a tree number

1. Presented at the annual conference of the International Society of Arboriculture in Vancouver, B.C. in August 1988.

allocated as a primary and unique identifier of each tree in the data base. As no previous inventory had been undertaken on public trees, it was difficult to estimate how long the recording process would take. On the basis of street trees surveyed, one person working alone could record on average 150-200 trees per day.

Problems encountered were: i) the identification of commercial cultivars and Australian native species planted by the public on Council land. ii) Determining whether trees on nature strips were privately or publicly owned.

Development of mapping system. One of the most difficult areas in the implementation of computer inventories is acknowledged to be that of pinpointing the precise location of a tree, eg. house numbers will be applicable as a reference in some, but not in all cases, while trees in parks, reserves and on median strips bear no relation to houses at all. Therefore, some visual presentation of the tree population was required. As a solution, a series of 1:2000 scale maps of the City were prepared and all street trees were individually marked "in situ". This method avoided the problem of devising a single geographical identifier and provided the arborist with the added bonus of assessing the distribution of trees in an area *pictorially* as well as *statistically* by computation.

Objectives of the CTIS

The Computerised Tree Inventory System (CTIS) was developed to serve the following functions:

To provide an inventory of all trees in the Greater Hobart area for which the council was responsible, with respect to location, species, size, year planted, condition, site details, maintenance details, and inspection details.

To provide a management system which enabled the efficient scheduling of tree maintenance.

To provide the means of quickly preparing detailed reports in response to aldermanic requests and public enquiries.

To establish a data base following an extensive survey of all trees growing on public land in Greater Hobart.

To develop management systems to allow programs to be written for the analysis of the CTIS database and the subsequent preparation of reports, such programs to include maintenance reports, monthly inspection reports, tree reports with respect to location, and various statistical combinations as reports.

Computer Programming

The computer system and program had to satisfy the following conditions:

- Financial constraints.
- Flexibility—capacity to tailor the software to meet projected needs, with some provision for future expansion.
- Back up support—technical assistance with programme 'bugs' either from the manufacturer or a local consultant.
- Information requirements of the department as a whole, so a wide application was important.

The *microcomputer purchased was a ITT ATW/286* with the following specifications:

Clock speed	10 mhz
RAM	1MB
Hard disk	30MB
Tape drive	20MB
Cost	A $9,000

In comparison with four other models the *ITT ATW/286* provided a considerably faster processing speed, a larger hard disk, a larger floppy disk, and software that enhanced the performance of the machine at a very competitive price. A floating mathematics co-processor was purchased to improve the machines performance in statistical analysis, a facility desirable with regard to the processing of data for statistical reports.

The program selected is suitable for use by people quite unfamiliar with computers and has the capacity to create new files at a later stage if modifications need to be made to the database. Hence there is scope for experimentation by new and additional users whose perceptions of information needs are likely to change in the future.

The mechanics of developing the software package according to the Arborist's specifications was undertaken by a post graduate student who undertook the project as part fulfillment towards a Graduate Diploma in Computer Studies at the University of Tasmania. The student liaised with the Arborist to ascertain the specifics of data

storage and access.

The design of the system commenced in June 1985 with completion date being March 1986, followed by a major revision and update during the period mid to late 1987.

Staff training. Prior to the computer system being operational, all employees dealing with trees were trained in those aspects of computerization affecting their duties. In the case of work crews this has included relaying information on plantings, removals, diseased or dangerous trees. The system in use does not require the operator to be familiar with computers, but some instructions as to commands and techniques was necessary.

Application for Tree Management

Manual filing systems are considered to be unsuitable for handling records on individual trees because the data volume is so large that storage, organization and retrieval is unwieldy and time consuming. Morever, it is not always possible for the Arborist or tree manager to tap the considerable analytical potential of the information stored because of the labor costs involved. In contrast, computer based files can provide rapid and accurate information in response to a variety of management needs. As suggested by Grainger and Thompson (4), the concrete benefits of computerized data bases can be best understood in terms of the various functions such systems can perform.

Visual Display Units

One of the current problem areas of tree management in Hobart is in relation to public requests concerning individual trees. These are generally telephone requests that cannot be resolved immediately because the Arborist had no previous ready access to information in order that claims can be validated and an appropriate course of action implemented. Time consuming inspections were consequently necessary to satisfy the query. With computerized tree records, detailed information such as species and site

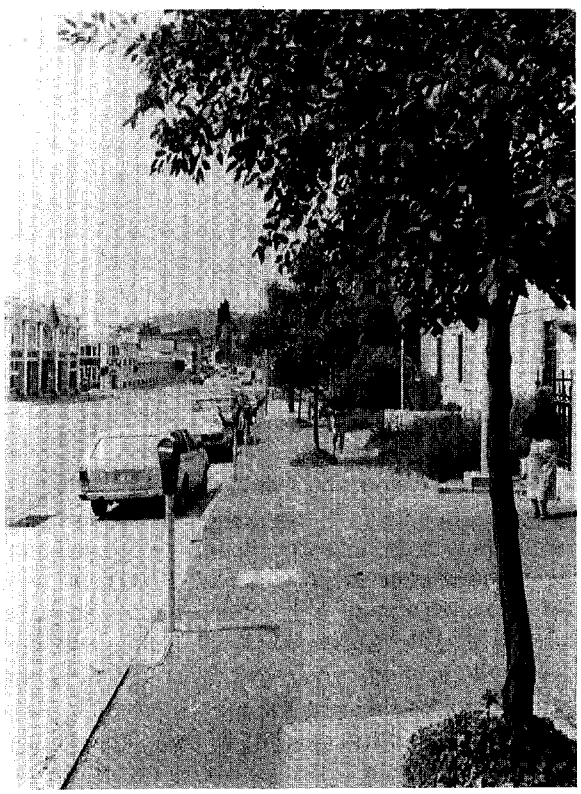

Fig. 1. *Alnus incana* and *A. glutinosa* along Macquaire Street in Hobart. Photo credit: T. Kingston, H.C.C.

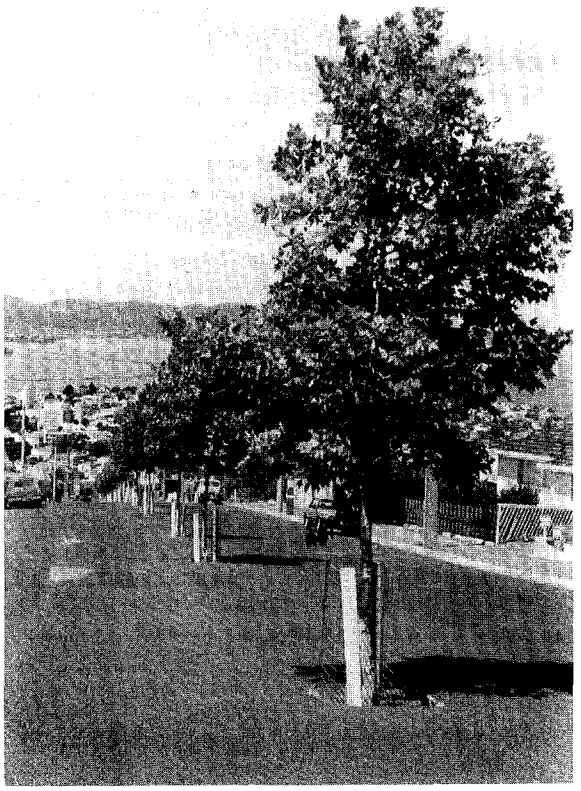

Fig. 2. London planes along Forest Road in West Hobart. Photo credit: T. Kingston, H.C.C.

characteristics, maintenance and past history for public requests are available for immediate viewing on the visual display unit (Table 1).

Screen viewing has a number of advantages: 1) The enquirer is given a positive impression of Council's approach to tree management hence the arborist is seen to be well informed and in a position to discuss an appropriate course of action. 2) Data available from the tree's record may eliminate the need for a personal inspection which may be time consuming, unnecessary and costly.

Individual tree records have application in cases of *public liability for damage caused by a Council tree.* The computer allows ample storage and access to public request and inspection files for each tree. This information may be used to provide evidence that the local Authority Council, etc. *has not* been negligent in so far as the tree's maintenance is concerned should the suggestion of legal action arise, it has been the experience elsewhere that municipalities which are shown to exercise reasonable care are in a favorable position regarding liability for damages (3).

Work Programming

Regular maintenance tasks are stored against each tree's record where appropriate, according to the time of year. If for example a particular task such as watering of recently planted trees is carried out for the entire population, a search can be made of all trees requiring watering according to their suburb. This precedure ensures that trees are not neglected and that watering can follow an efficient geographical pattern. In the long term, regular maintenance scheduling such as watering will lead to a healthier tree resource which is aesthetically pleasing to the public and less costly in terms of removals and replantings.

Other work generated by the computer includes remedial or removal programs for declining trees that are diseased or have been indiscriminately pruned in the past. These are recorded at the time of surveying and a logical works program devised on the basis of their location, size and site characteristics (eg. presence/absence of obstructions, removal difficulty etc).

Finally as part of a newly developed program, time is available for the Arborist to inspect the entire tree population on a regular basis (annually) in order that an update can be made and tree records checked.

Table 1. Character and sample data

Character.	*Sample data (coded for storage).*
Suburb	Sandy Bay
Street	Lord Street
Cross Streets	Regent and Grosvenor
Street Classified	Res; low volume traffic
House Number	56
Tree Number	1001
Species	Betula pendula
Size/Age	Juvenile
Initial Inspection	10:3:83
Inspection Interval	12 months
Date Last Inspected	15:4:84
Nature of Planting	*Individual*
Condition	None
Aspect	Slope
Removal Difficulty	Easy
Thin Out	Autumn
Remove epicormic buds and suckers	Autumn
Council Maintained	Yes.

Annual Reports

Descriptive information on the tree population as a whole for the purpose of annual reports can be quickly compiled using computerization. The total size of population, the numbers of dead or dying trees, public requests, etc. are typical examples of questions that can be answered in a routine manner. Over a period of years, changes in such factors can be used to evaluate the impact of the management program.

Forward Planning and Policy Making

Descriptive data can be used to determine present needs and future directions in which management should proceed together with the resources, eg. the isolation of a number of trees in each suburb to give an overview of distribution and areas of planting requirements or referring the problem further to ascertain the number of trees in say each suburb according to age, the arborist can then forecast future plantings based on the numbers, location of senescent and mature individuals.

Many other cross tabulations of tree characteristics can be constructed when such a programme has been finalized, including the number of individual trees according to species, age, land use, removal difficulty, cause of death or ground conditions.

One factor which may be useful in future computer tree management policy is the *amenity values* of trees. This concept, which suggests that a tree has a quantifiable value in dollars has received attention in papers dealing with urban forestry over recent years in Australia and elsewhere (2, 5, 6). The value or rating is based on such criteria as replacement costs, crown size (for shade value), historical significance, and condition and location. There are a number of situations in which this information may be helpful, eg. the posting of bonds for trees on land which is being developed, or assessing the worth of a tree against the cost of remedial work to preserve it, or engineering activities.

Budget Forecasting

In the past, there has been no objective method of accounting for funds expended on the management of trees in Hobart. Utilizing stored computerized data, the annual costs of maintaining the tree population (eg. inspections, maintenance, plantings and removals) can be itemized, calculated and justified, as a consequence the Arborist, Manager or Parks Director can account for the expenditure of funds and provide a sound basis for budget projections. Further justification is the organization of the inspection schedule. If the last inspection date and a given interval are recorded for each street, the computer can calculate the next inspection date. Streets can then be listed with others for inspection at the appropriate time. To ensure the inspection is carried out, records of non-inspected streets will keep appearing on listings until these streets are visited and the last inspection date changed in the data base.

Fig. 3. *Platanus occidentalis* along Salamanca Place in Hobart. Photo credit: T. Kingston, H.C.C.

Print outs. In addition to the search, viewing and computational facilities all information is presented in the form of a print out. Apart from the advantages of having physical records of information on request, print outs can be used as checklists for maintenance work (Fig. 1).

Updating. The success of any computerized system is based upon updating. During 1987 the Computerized Tree Inventory System (CTIS) was updated primarily to enable the scheduling of tree maintenance programs, to accomplish this the

PARKS AND RECREATION DEPARTMENT
TREE INVENTORY UPDATE FORM

TREE NO. _____
DATE _____

TYPE OF WORK PERFORMED:

☐ Planting ☐ Removal ☐ Other Maintenance _____
☐ Access Cut ☐ Wire cut
☐ Lifting ☐ Structural Development

LOCATION:

Park Trees

Park _____

Diagram to show tree's location

Street Trees

Street _____
1st x street _____
2nd x street _____
Closest House No. _____
Position in Street -
☐ odd ☐ even ☐ middle ☐ other

SPECIES: _____
(use common name if botanical name unkown)

AGE: ☐ juvenile (staked) ☐ established (unstaked) ☐ mature ☐ senescent

GROUND CONDITIONS: (choose one)

☐ bark mulch ☐ bluestone mulch ☐ bitumen at base
☐ planter in road ☐ embankment ☐ ground cover
☐ grass verge ☐ wire grating ☐ footpath

OBSTRUCTIONS: _____
(likely in next 5 years - give details, eg. wires, pedestrian access, etc)

TYPE OF PLANTING: (choose one)

☐ *individual tree* ☐ screen ☐ windbreak/hedge
clump avenue of trees ☐

CONDITION: (choose as many as necessary)

☐ *healthy* ☐ poor health, lacks vigour ☐ diseased ☐ damaged trunk
☐ *lopped* ☐ clipped/pruned to shape ☐ physical damage, vandalised

following procedures were implemented.

- All existing tree information was updated.
- Computer programs were designed for the production of reports including a wide range of tree maintenance programs to be scheduled. As a consequence a report system was produced (either statistically or as tree lists) which utilize combinations of the numerous characteristics for each tree.

In updating the existing information: All trees under Council control were examined, each for approximately 36 identifying characters. Some 2,500 new trees identified and characterized. Some 400 trees were found to have been removed, the tree data were removed from the computer, printed and archived. Information on *Tree species* was updated and 37 new species added to the inventory—totalling 366 species. Approximately 3000 previously recorded trees required editing for characteristics. New and edited information was entered into the microcomputer, printed copies of all data and changes were dated and archived. All maps were edited and duplicate copies archived.

The computer program designs evolved through noting the practical requirements of the system and its users at all levels eg. field workers, supervisors, technical staff, and keyboard operators/programmers. This information was integrated and expanded upon to produce a superior product with great flexibility. From this the "Main Menu for CTIS functions" was produced to outline the systems capabilities.

Summary

This paper has outlined the capabilities of utilizing computerization in processing the data collected during the Hobart tree survey. Although the advantages of such systems over manual files is evident there remain numerous pitfalls associated with the setting up of computerized data bases. Two main problems appear to be: 1) The collection of unnecessary information that is found later to have no real practical value. 2) The failure to ensure that tree records are regularly updated from the field to provide accurate information. Both these factors have been taken into account in the overall design and updating of the Hobart Computerized Tree Inventory System.

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