

Simple, but Therefore Clever Idea – An Effective Dendrological Inventory Process for Landscape Architecture and Design Projects

Heiki KALBERG, Nele NUTT, Sulev NURME and Mart HIOB

1 Introduction

Good solutions do not necessarily need to be highly complicated or costly. This article introduces a simple way to improve the economic efficiency of the digitalization of dendrological inventory data. The application developed in this study makes it possible to effectively link drawing and database programmes so that data can be utilized in both CAD (computer-aided design) and GIS (geographic information system) systems. Furthermore, no additional investments in training or technology are necessary, as this application uses software already featured in most plan design offices.

In Estonia, more than four hundred parks are protected areas (SINIJÄRV, 2008), but there are many more historical parks (HEIN, 2003). After Estonia regained independence (1991), people grew more passionate in restoring and rebuilding historical parks, which explains why landscape architects deal with compiling restoration projects on a daily basis. Compiling park design projects involves the inventory of park trees (EESTI STANDARD, 2010), and provides a much needed overview of park conditions along with the data needed for choosing the best restoration methods that promote sustainable design (NURME, 2008). Dendrological inventory is a time-consuming process due the extensive fieldwork involved and the detailed data digitalizing and systemizing processes that follow.

2 Application for inventory data integration

2.1 Reasons and causes of application development

There are two kinds of dendrological inventory data: primary data and collected data. *{Primary data involves geodetical base plans that have been compiled during surveys (RTL, 2007) on which locations of tree trunks are marked, together with the area layout that links to the L-EST97 coordinate system.}* For compiling digital base plans, the CAD system software is suitable; in Estonia the most commonly used are vector graphics programmes MicroStation (dgn) and AutoCad (dwg). The geodetical measurements must be taken with professional equipment, usually an automated theodolite operated by one geodesist. GPS measurements are not suitable as they are too inaccurate. Another component of inventory data consists of data collected during fieldwork. In Estonia, no specific methodology has been established for dendrological inventory (KUPPER, 2012). Trees are most commonly taken into inventory as individual items. The species of each tree is determined and certain parameters are measured (trunk diameter, crown projection area,

tree height). Landscaping value (TALLINNA LINNAVALITSUS, 2006) and condition of the tree (NURME, 2008) are also analyzed, with damages described when necessary. Two people are needed for data collection, with one researcher taking measurements as the other records the information.

During fieldwork, this data is recorded by hand into inventory data tables, while geodetical base plans are used to mark tree locations. Data from the tables and trees on the plan are systematically linked to each other with numbers. Data collected during fieldwork is then entered into a spreadsheet table (Microsoft Excel is used primarily) and marked on a plan in a vector graphics programme, but this table and plan are not digitally linked to each other. This process is extremely time-consuming and creates excessive data entry after concluding field research.



Fig. 1: Determining the damage on a tree trunk (Researcher is shown holding a calliper, a device for measuring trunk diameter)

2.2 Methodical basis of the application and description of the work process

The objective was to develop an application that would:

1. be easy to use, save time and resources, work on basic programmes found in offices that deal with compiling plans (MS Excel, MicroStation);
2. combine MS Excel data tables with digital plans into a linked spatial database that would make it possible to automatically read data from the database and mark the information down on the plan, while also adding coordinates from the plan to the database;
3. create the necessary structure of layers on the plan and allow data to be added to these layers;

4. allow adding information derived from the data collected during fieldwork to the database;
5. allow for flexible data interpretation regardless of the inventory methodology used;
6. perform independently if necessary, but could also be combined with GIS programmes (MapInfo Professional or ArcGIS).

In 2012, the landscape architecture office Artes Terrae started looking for ways to optimize the inventory process by utilizing already existing tools. They focused on two objectives: Digitally recording data collected in the field through the use of existing tools such as phones and tablet computers, while also working with licensed programmes already in use to further refine the data analysis process.

First, an Android-based Smartphone (Samsung GALAXY S III) was used to record measurements. As a result, data entry took slightly more time during fieldwork than it had when recording the data onto tables by hand; however, the lengthy process of transferring the data after completing fieldwork into MS Excel tables was avoided. Researchers also utilized tablet computers (Samsung GALAXY tab 2 10.1) for entering plan data. The tablet computer with its larger screen was more practical to use during fieldwork, but had issues with processing the plan information entered due to the low productivity of the CAD software used in tablets, making it impractical for drawing plans. Researchers then started looking for other ways to increase the economic efficiency of the project.

Several existing applications such as Ezytreev Tree Management software, Treeworks, and Tree Tracker offer good options for arborists, dendrologists, and other specialists involved in tree inventory, evaluation, and planning maintenance (RUNNEL, 2012), but they are not suitable for the plan projection process. MicroStation, the CAD system vector graphics programme used by Artes Terrae, allows for entering various types of data in addition to plan information by using tags, like GIS systems. Still, using this during fieldwork can be impractical and time-consuming compared to MS Excel. Furthermore, GIS programmes such as MapInfo Professional are too inaccurate for practical application to the plan projection process. For this reason, to satisfy the needs of plan compilers, a macro working on MicroStation basis that could share data with MS Excel was developed.

During the first stage of the application development process, researchers defined the structure of data used for dendrological inventory (order of fields, data type of entries, abbreviations of entries, etc.) then used these for creating the table structure of the MS Excel programme along with the MicroStation macro. *{During the second stage, a technical solution was developed, but its specifics will not be discussed in this article. However, the usage purposes of the application will be described}.*

To use the application, the plan in the MicroStation programme must be opened; symbols of trees are linked to coordinates and the Excel table containing fieldwork data. When clicking on a symbol representing a tree, the programme automatically transfers its coordinates to the corresponding row in the Excel data table, and therefore links the plan to the table. It is important to make sure that when clicking on tree symbols on the plan, they are chosen according to their numbers.

The programme automatically chooses the parameters of the correct tree from the MS Excel table, and with the next click a circle with the necessary diameter is created on the

plan. In drawing the diameter of the tree, the programme chooses data from the MS Excel table in a certain order. It first chooses measurements of the crown projection area or diameter, or when no data is given, uses the diameter of the trunk. When the necessary data is not supplied (for instance, diameters of shrubberies, individual shrubs, and dense groups of young trees are not measured), the manual drawing programme is activated and the image of the crown is mechanically marked on the plan using fieldwork data. If necessary, the digital drawing can be manually corrected using the fieldwork plan because the fieldwork plan is visible on the desktop as the bottom layer.

Moreover, the application simultaneously organizes database entries by adding related information, such as the full names of tree species in both Estonian and Latin. Abbreviations are converted into text with the help of special support files which have been created for this purpose.

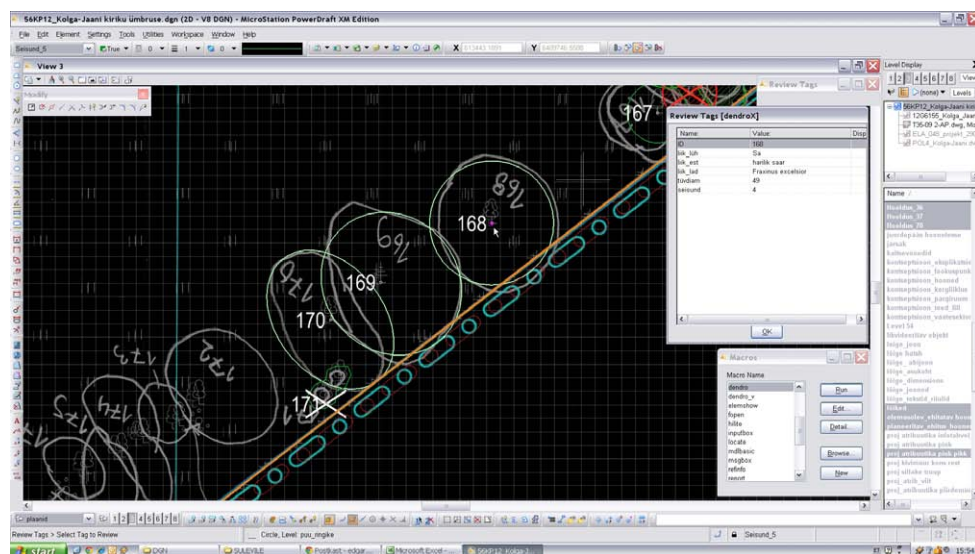


Fig. 2: When clicking on a symbol, the number of the tree and a circle marking the crown diameter automatically appear. The accuracy of the data can be easily verified with the help of the fieldwork plan stored in the bottom layer.

3 Results

The application was first tested in August 2012 with the inventory of Toila Oru grove park, which covers 105 hectares and contains over 6000 individual trees that were inventoried (NURME et al., 2012). The application worked well and no technical problems occurred. Half as much time was spent on data digitalizing, and data conversion into MapInfo went smoothly. Some problems arose when reading the data table, and therefore the format of the data needed alterations (abbreviations were needed, order of letters needed changing,

etc.) Legends for abbreviations were created, which thanks to their universality can also be used in the future.

As expected, developing a technical solution (macro programming) for the application was cheaper in comparison to the cost of the previously mentioned programmes. This application fulfilled the developers' expectations, and with further development its economic efficiency can be maximized.

4 Conclusion

In conclusion, it can be said that the application developed in this study:

- is very easy to use;
- can be used on the basis of existing programmes;
- requires no special knowledge or additional tools
- requires no additional investments in training or software
- makes managing large amounts of data easier;
- saves time previously spent on digitalizing and analyzing data;
- makes for cleaner analysis of various types of data such as volume of tree-felling, species composition and landscape condition by systemizing different types of information (placing on different layers);
- allows for conversion of the spatial database into CAD and GIS system programmes;
- can be used to create a database that compiles information on all parks in Estonia for use in renewing national registers.

Goals for the future:

- making analysis and summarization processes more automated;
- automatically detecting possible errors made during the data entry process by setting size limits;
- calculating total amount of maintenance work, for example, tree-felling;
- automatically converting chosen codes and abbreviations into text and vice versa;
- converting data for different geodetic systems (WGS->L-EST);
- possibly adding a date to the fieldwork data to make it ready for database storage.

In the future, the dendrological data could be recorded during the geodetical survey of the area. This adds to the costs of the survey, for in addition to a geodesist, an arborist or landscape architect must be present to evaluate measures such as health, condition, species or damages, but would further improve efficiency in the compilation of park design plans.

The results – time expenditure in different work phases using different methods and additional characteristics of the methods – are summarised in the following figure.

Traditional method		New method		Possible future method	
Geodetical survey	1	Geodetical survey	1		
Dendrological fieldwork, two specialists using paper-table and paper-plan	2	Dendrological fieldwork, two specialists using tablet	2	Geodetical survey and dendrological fieldwork, two specialists using self-registering tacheometer	2
Spreadsheet data transfer to computer	1				
Map data transfer to computer	1	Map data transfer to computer	0,2	Map data transfer to computer	0,06
Total working days	5	Total working days	3,2	Total working days	2,06
Possibility to put data to different layers depending of condition-class of tree	No	Possibility to put data to different layers depending of condition-class of tree	Yes	Possibility to put data to different layers depending of condition-class of tree	Yes
Coordinates from digital map to MS Excel	Additional work	Coordinates from digital map to MS Excel	Automatic	Coordinates from digital map to MS Excel	Automatic
Names of species to the map	Additional work	Names of species to the map	Automatic	Names of species to the map	Automatic
Transfer of species' abbreviations to full names	Additional work	Transfer of species' abbreviations to full names	Automatic	Transfer of species' abbreviations to full names	Automatic

Fig. 3: An example of work process, a 3 hectares area with 400 trees. The numbers indicate the number of working days per person.

References

- Eesti standard EVS 907:2010, *Rajatise ehitusprojekt. (Facility building project.)* Estonian Centre for Standardisation Tallinn, 9.
- Ehitusgeodeetiliste uurimistöde tegemise kord.* RTL 2007, 71, 1231.
<https://www.riigiteataja.ee/akt/12861144>.
- Ezytreev Tree Management software. <http://www.ezytreev.com/>.
- Hein, A. (2003), *Eesti mõisaarhitektuur historitsismist juugendini (Estonian Manor Architecture from Historicism to Art Nouveau)* Hattorpe, 11).
- Kupper, K. (2012), *Comparison of various research methods of allees according to the example of the avenue on Vanapargi street in Pärnu.* Tallinn University of Technology, Tartu College. Tartu, Estonia, 15-20.
- Nurme, S. (2008), *Ajaloolise haljasala puistu inventeerimine. (Inventory of a Historical Green Grove).* Parkide restaureerimine (Restoration of Parks), Tartu College of Tallinn University of Technology, Tartu, Estonia, 285-306.
- Nurme, S. & Kalberg, H. (2012), *Reconstruction project of Toila Oru park.* Artes Terrae Ltd, Tartu, Estonia.

Puittaimestiku ja haljastuse inventeerimise kord (Requirements for inventories of deciduous plants and urban greenery). Tallinna Linnavalitsus 03.05.2006 määrus number 34.

Runnel, H. (2012), *Comparative study of tree management software*. Project GreenMan (ELRI-177) Kino Ltd, Tartu, Estonia.

Sinijärv, U. (2008), *Pargid kaitsealuste objektidena (Parks as Objects of Protection)*. Parkide restaureerimine, (Restoration of Parks) Tartu College of Tallinn University of Technology, Tartu, Estonia, 179-182.

Treeworks. <http://www.kenersongroup.com/treeworks.aspx>.

Tree Tracker. <http://www.treetrackersoftware.com/>.