An Excel Based Digital Tool for Planting Design, Analysis and Evaluation

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Abstract

With digital technology, a common zonal plant database has been established. Using the universal software – Excel as the technology platform, and incorporating various principles, strategies and methods in the process of planting, this tool creates ability of searchers, filters and analyser. It also accomplishes plant selection based on their attributes and characters. Taking the design in different locations as the research starting point, we gradually explore objective evaluation standards, and establish a complete analysis and evaluation system in order to verify and optimize planting design. In this study, the tool developed delivers not only the digital planting design but also the optimization and evaluation of the design scheme.

1 Introduction

Combined with the basic knowledge of forestry, horticulture and other subjects, the traditional planting design depends on practical experience which accumulates by LA designers. Although restricted by design principles, the result still exists several probabilities. In this study, information storage technology, intelligent data analysis techniques and data-visualization techniques are applied. All these elementary technologies come with Excel, which is a part of the universal software Microsoft Office. According to various principles, strategies and methods of traditional planting, and researching the zonal plant application in China with the subtropical monsoon climate, the tool is able to deliver digital planting design as well as the optimization and evaluation of the design scheme.

2 Background

It is a solid foundation for the study, as there are several achievements which aim at the research about plants digitization. These achievements of the existing study could be categorized as three directions: namely the retrieval of digital information, the digital measuring technique and information management, the modelling of virtual plant.

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2.1 Retrieval of plants digital information

As the basic study, there are certain websites that could provide retrieval of digital plants information. At present three websites are quite well-known. One is The Flora of China, co-founded by the CAS Institute of Botany and the country's key laboratories of botany (http://frps.plantphoto.cn/). Others are RHS' plants column (http://www.rhs.org.uk/Plants/) and BBC's gardening column (http://www.bbc.co.uk/gardening/). The latter two websites provide not only the function of retrieval by plants name, but also the technical guidance to the configuration of garden plants, involving garden design, planting, and selection of species etc.

2.2 Digital measuring technique and plants data management

Companies which specialized in digital measuring technique and information management have existed in quite a few countries. Such as Ezytreev, Tree Tracker, Treeworks etc. The emergence of 3D laser scanner plants is a big promotion in measuring and mapping plants. However, due to varied form of plants and the stability in wind environment, it has certain difficulties in the application of plants measuring and mapping. Yet, point cloud data obtained by the portable 3D laser scanner could be read and processed, by the means of transforming with software, such as AutoCAD and ArcGIS. It could provide assistance to the preliminary investigation in plant design, and has become an important development direction. At DLA 2013 Congress, KALBERG et al. (2013) introduced a method of using portable digital products such as smart phones, Tablet PC to improve the information data acquisition of recording and storage in the process of measuring plants.

2.3 Modelling 3D virtual plant

On the aspect of digital model of virtual plants, there are a few relatively well developed software. For instance, SpeedTree, Tree Storm, EASYnat, Landsim3D, Xfrog, Plant Studio, GOSSYM&Cotton Plus, AMAP, Virtual Plants, etc. Taking individual plant as object, VR technology that could show the plant in 3D visualization, has been accumulating with other related technologies in terms of revealing the physical function, exploring growth regularity, and predicting outcome. Although, these technologies mainly focus in the morphological structures of individual plant, and the application in the area of LA design is restricted to the visual presentation. Therefore, more research on plant growth and variability are required.

3 The Methods for Establishing Zonal Plant Database

Microsoft Office Excel is applied widely with high stability. The zonal plant database, built on Excel, could be used on smartphones, Tablet PC and other portable digital devices. So it is very convenient to make reference, select and analyse during the design process.

To establish the database, first task is to choose and categorize items. The certainty around the scientific name and species of botanic enable the corresponding columns to be set up directly. For example, types of plants are classified as tree, shrub, ground cover, vine, bamboo, herb and aquatic (CHEN 1990). They also could be listed as evergreen or

deciduous. Moreover, aiming at the process of landscape design, several relevant columns are set up specifically to reflect plants' essential feature and functional characteristics. The former includes appearances, habits and physical functions; the latter contains ornamentals and applicabilities. As a result, the plant database is improved.

3.1 Impact of aesthetic factors

The columns are created according to the plant morphological characteristics. Some of them are height, crown diameter, DBH (diameter at breast height) and branch height, which are all related to plant sizes. Others are qualitative indexes, such as foliage colour, flower colour, fruit, the root depth, and the canopy density of an individual plant. On account of the individual differences, the size columns have a certain flexibility.

In general, ornamental features can be classified into three main types: flower, leaf and fruit. For the columns of foliage and flower, the descriptions focus on seasonal change of colour performance and excludes a number of morphological characteristics that have little effect on the landscape space. The foliage colour are divided into: grass green, green, forest green, brown yellow and others colour-leaf, such as crimson, golden yellow, etc (BRICKELL 2010). The flower color could be generally described as white, yellow, orange, red, pink, violet and so on. As the fruit size has minimal impact on the design, the fruit column could be simply defined as “fruited” or “fruitless”.

Using the words “deep” and “shallow” to indicate plants root is adequate. Most of the plant roots are not obvious In terms of appearance. This is an important design consideration as they could influence the design response to particular places. For instance, it is inappropriate to plant deep-rooted trees in the roof garden or the ground over underground parking lots. Although the plants with developed root systems contribute to hold soil in place, they could damage the road surface and cause ground structures uplift and subsidence.

The canopy density of an individual plant is to define the dense degree of branches and leaves, and it could be affected by the branch height. Then, the corresponding column divide into three levels “high”, “middle” and “low”. This item aims to represent the effects on the guidance, obstruction and encirclement of the sight line, and the activity of space under forest.

Taking the function plant landscape as the object of study, the applications of ornamental are described as “parterre”, “carpet bed”, “accent plant”, “background plant”, and so on. These are a further supplement to express the plant morphology.

3.2 Impact of ecological factors

Ecological attributes are included with the focus on plants’ ability to adapt to environment of various light, moisture, temperature conditions. It can be set out in the form of “full sun”, “partial shade” and “shallow” to classify plants demand of sunlight. In terms of shade, drought endurance, water tolerance and frost hardiness, they are in the form of “strong”, “medium” and “weak” to express the degree. Some plants have requirements on soil pH. According to the pH value, are classified into three levels: pH<6.5 is “acid”, pH 6.5-7.5 is “neutral”, and pH>7.5 is “alkaline”.

3.3 Impact of chronological factors

In plant physical function, factors that have influence on design ideas include the speed of growth, blossom, defoliation, aromaticity, planting radius, safety and defensiveness. The corresponding columns are established.

As the plant is a living material, the appearance of completed plant landscape would change over time, presenting unidirectional growth or periodic succession. For example, choosing fast growing trees can achieve the desired results of the design environment faster. And then, the growth rate could be classified as “fast”, “medium”, and “slow”. Besides, the sequence of bloom and defoliation affects space formation as well. Plants that seasonal variation is obvious, can be recorded with the realistic months of florescence and leaf fall period. In addition to the value of visual experience, plant fragrance plays an important role in people's mental and spiritual health. Listing it as “with” or “without” is simple and clear.

In order to enrich the environment that just completed, increasing planting density will negative impact on normal growth. To avoid this situation, the column of “planting radius” is set up to regulate and control the planting spacing and density. “Safety” column can mainly describe the toxic plants and the thorn plants that can hurt children. Secondarily, as there are several exotic species, that will overrun and cause harm to the surroundings, it is necessary to pay more attention to the safety issues associated with plants.

4 Digital Application in the Design Process

4.1 Targeted combinatorial filter and select plants

4.1.1 Diversity and flexibility of filter combinations

Although filter items are all come from columns that have been set up previously, the customised combination of these filters is the embodiment of professionalization. On account of the flexibility, filters can be re-grouped into various combinations to suit the specific needs of different places. Generally, taking the design in different locations as a starting point, according to the needs of plant landscaping to choose columns, is an essential principle of assembling filters.

4.1.2 Method of re-grouping filters

Through the establishment and application of filters, it can gradually narrow the range of plants choice, as well as provide a relatively objective basis for the selection of plants. Filters, which using the excel Slicer and PivotTable smartly, make it simple, visual and efficient to select plants (see figure 1). Users can directly build their own portfolio of filters by ticking on and off a range of pre-setup filter options without engaging sophisticated cell functions.

Illustrated by the example of a relic park which is a water station in Suqian, Jiangsu province, filters are assembled in accordance with the type of site(see figure 2). Forestlands are focused on the aesthetics characteristic. Therefore, columns of ornamental value of plants are necessary. To design the waterfront, water factor indicating the water tolerance of plants has always been a primary consideration. For revetment in garden, the first process is

to set up the root column and select “shallow” item. However, for slopes it is necessary to select plants with the function of resisting wind, protecting water and soil.

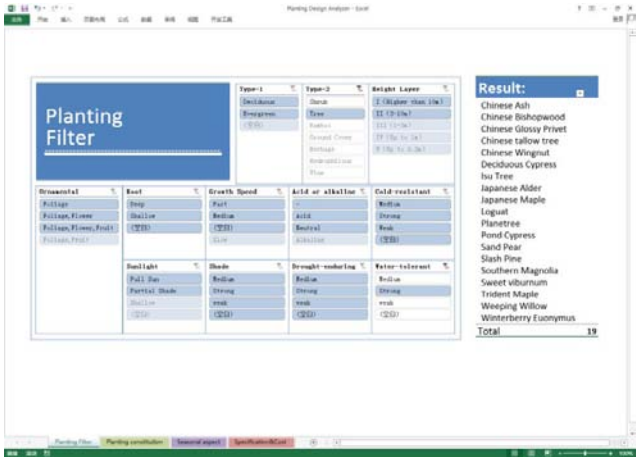

Fig. 1:
Plant Filters

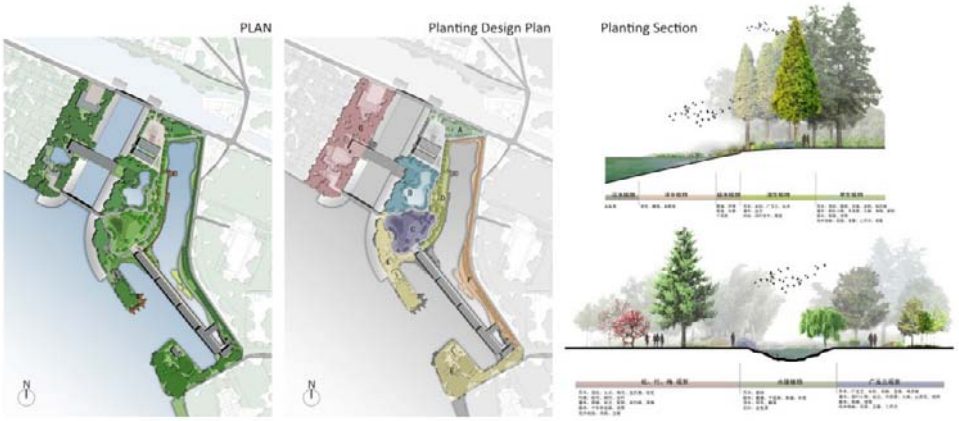

Fig. 2: Planting design of the relic park in Suqian

Specific requirements of filter come from the particular spaces. As there are lots of pines that are more than 30 years old, it is of cultural and ecological significance to preserve them in the relic park. And the philosophy of “three cold-weather friends” – pine, bamboo and plum, derived from Chinese traditional culture, is filled in cultural attributes column to guide the selection of plant collocation. Because of the large quantities of trees, the high canopy density is high. And then, the existence and growth of plants under forest could be disturbed seriously. After investigating the ecological factors involving temperature, water, light and soil, shade-tolerant species of shrubs, vines and ground covers are selected, in order to fit in the environment of this relic park. Adding ornamental item can select the special ornamental plant. In the same way, using florescence and flower color items can select the flowering plants that have the space filled with flowers all the year round.

4.2 Digital analysis and evaluation

4.2.1 Analysis point setting

Compared with the empirical planting design, this study has the ability to analyse the comprehensive index of plants more objectively and rationally. In the project of the water station Relic Park, after surveying the environmental circumstances, the information of selected plants can be retrieved in the database instantly. Editing functional relations, and assigning values with the quantity statistics, the user eventually gets the visual analysis with graphs and charts in Excel.

Analysis Point 1: Proportion of plants type and layer structure

According to the statistics of each type of plants in the relic park, the proportion of "tree, shrub, ground cover, vine, bamboo and aquatic" is 5:5:2:1:1:3. And the proportion of layer structure can be classified in 5 levels on the basis of plant height. (Layer I: large tree, higher than 10 meters; Layer II: medium tree, 3-10 meters; Layer III: small tree and large shrub, 1-3 meters; Layer IV: small shrub and ground cover, up to 1 meters; Layer V: herbage and grass, up to 0.2 meters.) For different sites, the applications of plant communities could be analyzed further. And then, to the structure and stability of plant communities also could be investigated and classified (see figure 3).

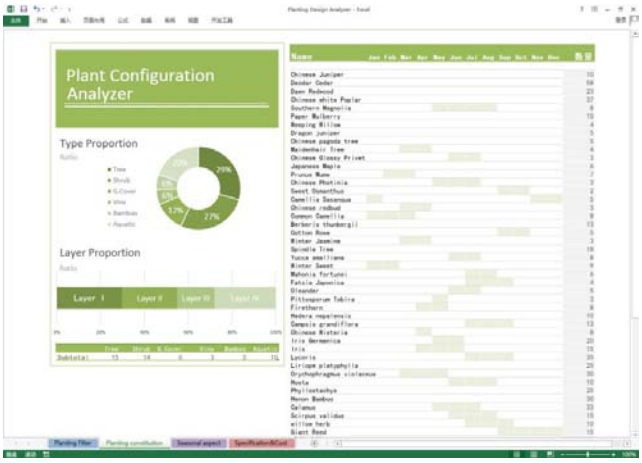

Fig. 3: Planting Analyzer

Analysis Point 2: Proportion of seasonal aspect

In the analyzer that devised by this study, the configurations of foliage color, flower color and aromaticity not only vary with month, but also show the seasonal aspect through diagrams in each month. Further, the analyzer makes it possible to contrast the color composition per unit area, corresponding to the area size of each color (see figure 4).

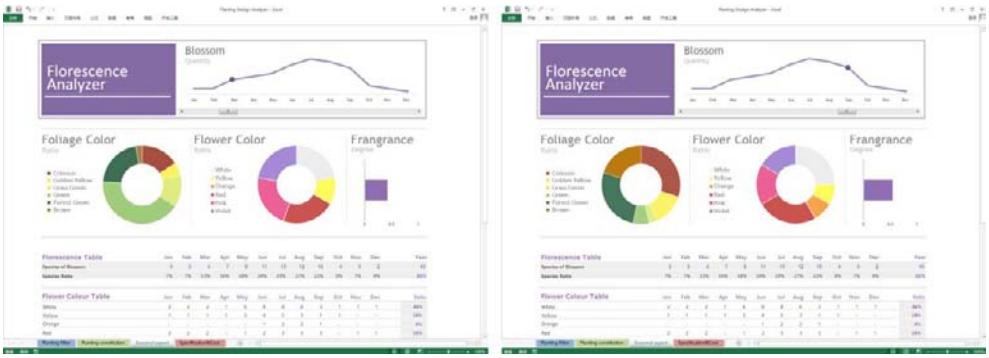

Fig. 4: Florescence Analyzer (March & September)

Analysis Point 3: Budget and Maintenance Management

In the database, the user can define the price of plant and therefore get understanding of the total planting budget by adding them up (see figure 5). Different specification has different price. The total cost of selected plants can be compared and analysed in the analyser. Also, with the addition of maintenance costs, the analyzer provides a more complete information of the plant's budget.

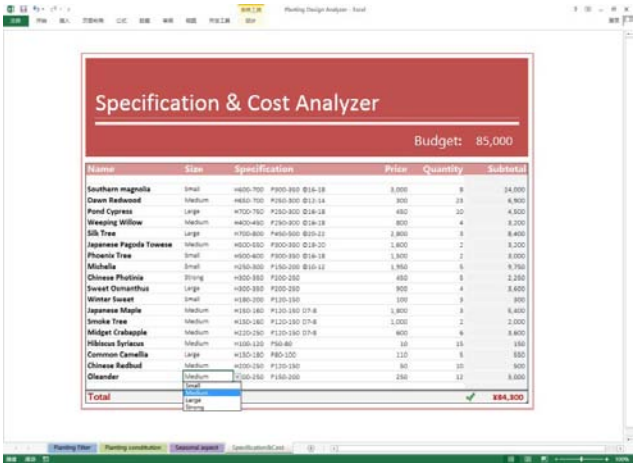

Fig. 5: Specification & Cost Analyzer

4.2.2 Streamline and integrate evaluation standards

The evaluation aiming at different places should be adjusted with different standards. Classical standards are based on the experiences which come from designer's practice and site investigation. Integrating and verifying the above-mentioned standards gradually, this study could streamline the evaluation standard and system that are more objective.

Generally, analysis and evaluation are specific to the aspect of biodiversity, visual aesthetic and space construction. And then, in the process of adjusting planting design on the basis of analysis, the interaction of the design plan and the evaluation standards in adjustment could be done. On this basis, after multi-plans comparison and evaluation, it is possible to gradually achieve the optimum design plant.

Planting design plays an important role in the modern landscape practice. With respect to ecological environment, ecological capacity, ecological suitability and ecologic sensitivity, the analysis and evaluation are of great significance. Digital planting design can not only optimize the design process, but also streamline and integrate the classical evaluation standards. Finally, the design goal that is more scientific and rational will come true.

5 Conclusion and Outlook

This study is a preliminary discussion and attempt upon the foundation of digital landscape architecture. In essence, using excel, the systematically research on design, analysis and evaluation based on digital plant database, is to set up a conversion between perceptual experience and rational numeric analysis in the design process. There are many aspects can be further expanded in this study. For instance, with regard to the different appearances of beds throughout the year, the relevant data could be collected and added to the system that is applicable to other areas and climates. As the different evaluation standers has been established and developed, expanding with GEO design software and visual landscape design software such as ArcGIS, VNS, etc., the establishment of a data exchange system can lay a strong foundation to fit more complex research goals.

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