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A Research on Designing Plant Sculptures in Turkey[A]

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Abstract: Today, the increase of anthropological pressure on Earth dictates that design projects on landscape are more qualitative. Thus, with this scientific research, a new approach was offered on sculpturing, which is a valuable component of landscape design in an urban setting. The aim was to conceive ecologically sound and visually attractive spaces by creating sculptures with plants in place of traditional building materials such as stone and metal.

The design process of the sculpture involved a variety of steps, resulting in the finished item being realised through living material. Hence, an iron frame for the sculpture was constructed in agreement with its three-dimensional volume at the research fields of Ege University, Bayındır Vocational Training School. Following that, to keep the plant material alive, a geo-textile combined irrigation system was innovatively installed inside the frame and the outer side of the frame was donned with monofilament textile. The monofilament textile, filled with propagation material, helped to support the plants and create the realistic fleshy tissue of the sculpture. The sculpture, at its last stage, in accordance with the concept of the chosen figure, was clad with plant plugs that had high surface covering traits and a shallow root system.

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This research project can act as a source guide to encourage plant sculpture work in more ecological, visually distinguishable landscape design projects. Other significant outcomes of the research include rendering new usage to available materials, which will allow related industries to increase production and employment as well as decrease dependence on imports.

Keywords: Plant sculpture, living sculpture, mosaiculture, ground cover plants, landscape design.

Türkiye'de Bitkisel Heykellerin Tasarlanması Üzerine Bir Araştırma

Öz: Günümüzde, dünyada yaşanan antropolojik baskıların artışı, peyzaj üzerinde gerçekleştirilecek tasarımların daha nitelikli olması gerekliliğini de beraberinde getirmektedir. Buradan yola çıkarak, bu bilimsel araştırma projesi ile, peyzaj tasarımlarının kentsel ortamdaki değerli bir bileşeni olan heykel çalışmalarına yeni bir yaklaşım sunulmuş; bir heykel tasarımının taş, metal gibi geleneksel malzemeler yerine bitkiler ile gerçekleştirilmesi sonucu ekolojik yönden daha verimli ve estetik yönden daha çekici mekanların oluşturulması hedeflenmiştir.

Heykelin tasarım süreci, sonuç ürünün canlı materyal ile ortaya konması nedeniyle farklı basamaklardan oluşmaktadır. Bu doğrultuda, Ege Üniversitesi Bayındır Meslek Yüksekokulu araştırma alanında, figürün üç boyutlu hacmi doğrultusunda demirden bir iskelet kurulmuştur. Takiben, bitki materyalini canlı tutmak amacıyla, geotekstil ile birleştirilmiş yenilikçi bir sulama sistemi, heykel iskeletinin içine yerleştirilmiş ve iskelet yüzeyi monofilament örtü kullanılarak giydirilmiştir. Monofilamentin içi gerek bitkiyi destekleyecek gerekse figürün gerçeğine uygun et kalınlığını oluşturacak biçimde yetiştirme malzemesiyle doldurulmuştur. Son aşamada heykel, sığ kök sistemine sahip ve örtme özelliği yüksek bitkilerin tapalar halinde yerleştirilmesi sonucu, konseptine uygun şekilde kaplanmıştır.

Bu araştırma projesi ile, benzer bitkisel heykel çalışmalarının arttırılması; dolayısı ile ekolojik ve görsel yönden daha nitelikli peyzaj tasarımlarının gerçekleştirilmesi için rehber niteliğinde bir kaynak oluşturulmuştur. Ayrıca, mevcut malzemelere farklı bir kullanım alanı kazandırılması sonucu ilgili sektördeki üretim ve istihdamın arttırılması ve ithalata olan bağımlılığın azaltılması da projenin bir diğer önemli sonucudur.

Anahtar Kelimeler: Bitkisel heykel, canlı heykel, mozaik kültür, yer örtücü bitkiler, peyzaj tasarımı.

Introduction

Landscape architecture aims to integrate the ecological preservation of nature with human aesthetical values, particularly within urban landscapes. Thus, the discipline often performs together with plastic arts and an essential branch of this subject, sculpture. Conventionally, sculptures are formed of stone, clay, wood, metal etc.

which creates non-living objects that are ecologically dead. Hence, designing sculptures with plants could generate life into these formations, rendering it a beneficial component of the landscape.

The history of plant sculptures mainly consists of the art of Topiary. The practice of topiary covers both training and clipping the foliage of trees and shrubs into certain forms. Traditionally, *Buxus, Taxus, Ligustrum, Ilex, Thuja* species are favoured for their small, dense leaves and woody, compact and evergreen structure. These species, when sculpted on their own are visually limited and lack biological diversity. Whereas, the plant sculptures studied in this research offer a richer visual variety of plant species and are used in greater numbers creating a micro-ecosystem in return. The plant sculptures can offer relatively complex yet self-sufficient design concepts and are transportable to any desired location.

Examples of plant sculpture are relatively new in the world and currently there is no scientific study in this field, either in Turkey or abroad. In 2016, an international horticultural exposition - Expo was held in Antalya, Turkey; with the philosophy of 'Cultivating a Green Life for Future Generations', with the adopted sub-themes of biodiversity, sustainability, and green cities (URL-1, 2020). Within this event, ten plant sculptures imported from Canada, and realised by MosaiculturesInternationales de Montreal, gained many plaudits among visitors (URL-2, 2019). However, the financial cost of these plant sculptures was significant. Consideration of both these outcomes led to the establishment of a dedicated scientific research project in Turkey. Lastly, the benefit of increasing the number of domestic plant sculptures, both for the welfare of urban population and the local economy is given consideration.

Material and Method

The materials applied in this research project were composed of industrial items and living materials. Several sizes of galvanized metal profiles and wires; monofilament fabrics; drip irrigation pipes adorned with geo-textile; three different types of growing medium together with a slow release fertilizer; a range of succulents and cover plants made up the components. Additional items included a welding machine, hog rings with a pneumatic stapler, dibbers, multi-cell plug trays, silicon moulds and casting plaster.

The method of the project covered a set of steps. Firstly, the figure, a horse, was chosen as the sculpture concept. A small version of the figure was modelled before being proportionally increased to the size of the enlarged sculpture thus, allowing the total amount and cost of materials to be calculated and obtained accordingly. The site was prepared for the research which included a greenhouse for the plant material and a large open space for the construction itself. The remaining steps were, constructing the metal structural frame; dressing the inner structure with monofilament fabric; setting up the irrigation system with geo-textile; dressing the outer structure with monofilament fabric and filling it simultaneously with the growing medium. During the construction of the sculpture, plant materials were raised and prepared. As a final step, the plant materials were installed as plugs into the sculpture in accord with the design concept.

Results and Discussion

1. Structural Frame

Constructing the structural frame is the most crucial stage of the plant sculpture, as it carries the plant material, the growing medium, the monofilament fabric, and the irrigation system together with the geo-textile. The frame should be sufficiently strong enough to carry all the components, whilst being light enough to minimize the cost of the purchased material and the weight of the structure, thus enabling the transportation of the sculpture.

In order to prevent oxidation, galvanized metal profiles were used to build the sculpture in three sizes of contrast. The main structure was constructed with a 2-inch profile and a total of 24 metres was used for this purpose. The secondary structure consisted of a 1-inch profile using 12 metres total. The purpose of these two components was to carry the weight of the whole structure. Therefore, they were welded to one another to establish the skeleton of the sculpture. The third component was 5 mm thick galvanized wire, light and flexible, it was used to shape the fleshy parts of the sculpture. A total of 1500 metres was utilized for this purpose. The wires were attached to the main frame through 1.5 mm galvanized loops in 10 kilograms total.

Additionally, metal profiles were positioned underneath the plant sculpture in order to safely transport the structure to the desired location, using a crane and track.

The face and hooves of the horse figure were cast with silicon moulded plaster (Figure 1).

2. Monofilament fabric

The monofilament fabric helps create the fleshy parts of the sculpture by holding the growing medium in place while also functioning as the carrier of plant material on the sculpture's outer shell. Therefore, it is essential that the chosen fabric should be resistant to rot, and tear caused by the elements and human intervention. The monofilament fabric used in this sculpture was originally obtained for use as hail protection for plants. It was woven as a single fibre UV resistant polyethylene filament. Thus, it has high tensile strength and when needed it is recyclable.

Two densities of monofilament fabric were obtained for the study. The white coded sample was woven to a density of 72 grams per square metre and was found to be susceptible to wear and tear. On the other hand, the blue coded sample, which had a weight of 120 grams per square metre, was found to be tear resistant during stretching and planting.

The monofilament fabric sheet, which was obtained in standard width and length, was cut in fitting shapes for both the inner and outer shells of the sculpture. Between the two layers of these monofilament shells a minimum 25 cm distance was established for sufficient root growth. The purpose of using two layers was to create a gap in the middle of the structure, in order to minimize both the amount of growth material used and the total weight of the sculpture. The individually cut monofilament sheets were positioned slightly overlapping each through other and attached to the metal frame hog rings using a pneumatic stapler gun that was utilised to increase durability and gain construction time. It should be noted that at this stage only the inner layer of the

monofilament fabric was established to allow the irrigation system to be built (please see section 3). After the completion of the irrigation system, the outer layer of the sculpture was built, adopting the same steps as the inner layer. Crucially, where the inner layer is stapled tight and stretched, the outer fabric is left loose where needed, allowing the fleshy parts of the sculpture to be created realistically. In order to achieve that, the growing material should be filled simultaneously while attaching the monofilament fabric to the structure (Figure 2).

This fabric was used for plant sculpting for the first time in Turkey, enabling the material to be marketed in a new way.

3. Irrigation system

The presence of water is essential to keep plants alive. Plant sculptures established in Mediterranean conditions are in requirement of artificial watering in order to complement the natural levels of precipitation. Conversely, it is equally important to keep consumption low in areas where water resources are scarce. Additionally, visual properties of plant sculpture must be taken into consideration. Irrigation carried out through an irrigation system without the technical specifications creates a non-aesthetic appearance and also causes water to be wasted (Demirel et al, 2018) With these criteria in mind, it was decided that the irrigation system should be set up inside the sculpture, unlike the previous examples around the world.

In order to diffuse the irrigation water evenly and prevent leakage, a specially woven, felt like, geo-textile was chosen. The geo-textile fabric had the density of 250 grams per square metre. The material was cut in the shape of the parts of the figure and positioned on top of the inner layer of the monofilament fabric and attached to the galvanised wires with the pneumatic stapler gun.

Two types of irrigation pipes were chosen. Firstly, a 10-metre-long 16 mm naked pipe was positioned throughout the main structure of the sculpture. One end was covered with a blind plug and the other was attached to the main water source. Secondly, a total of 20 metres of 16 mm drip pipes were used, stemming from the main artery in accordance to the shape of the structure and dressed in 250 g/m^2 density geo-textile. Where it was required 16x16x16 T and L shaped nozzles, irrigation clamps and blind plugs were used. The distances and lengths of the pipes were determined to accord with the shape and size of the sculpture in unison with the effect of gravity (Figure 1).

An automated irrigation unit could be attached to the system to lower water consumption and reduce labour. This system also allows plants to be watered with hydroponic nutrients directly at the root area to obtain optimum results.

This under surface, geo-textile, combined, drip irrigation system is the first of its kind to be used in plant sculpture therefore, rendering the available materials with a new market for usage.

Figure 1. *Structural frame, geo-textile and irrigation system of the plant sculpture (Original, 2017)*

4. Growing medium

The growing medium is the essential substance which keeps the plant material alive and healthy. On the other hand, this medium should be sufficiently light to decrease the total weight of the plant sculpture and enable high water absorption, with the aid of the preinstalled geo-textile to prevent structural leakage. For these purposes, 30x30x15 cm dimensional boxes were prepared and filled with a variety of perlite, cocopeat and peat mixtures to assess the weight and water retention. As a result, 60% peat, 30% cocopeat and 10% perlite mixture was found to be the most efficient for the plant sculpture (Figure 2). The main purpose of including the cocopeat was to benefit from its fibrous trait and prevent the mixture diminishing through the monofilament fabric. Additionally, the presence of perlite helps the aeration of the mixture and therefore reduces the weight of the sculpture while retaining the water and preventing excessive leakage.

A range of sample plants were positioned on these boxes and on a larger prototype sculpture and, observed for a period of 3 months. It was found that plants developed a healthy root system and upper body.

Figure 2. *Growing medium and monofilament fabric of the plant sculpture (Original, 2017)*

5. Plant material

Plant material is the most crucial part of a plant sculpture. The plants that are suitable for a plant sculpture should have high surface covering properties together with a shallow root system. Also, they should be adaptable to the ecological conditions of the place where the sculpture is to be located.

Accordingly, in this research, *Sedum acre, S. hispanicum, S. reflexum* and four cultivars of *S. spurium*, 'Dragon's Blood', 'Fuldaglut', 'Green Mantle' and 'Tricolour', were examined, firstly for their suitability. The other species included in the study were the cultivars of *Alternanthera* sp. together with *Carex petriei* and *C. testacea*, *Festuca glauca*, *Mesembryanthemum barbatum*, *Dichondra repens* and, lastly, *Santolina chamaecyparissus.*

Sedum species and its cultivars were chosen as one of the main plant materials; as succulents, they demonstrate a rather uniform appearance throughout the year. Sedums also offer a range of colour and texture which is required for the visual properties of a plant sculpture. Additionally, they are suitable for Mediterranean conditions and are easily obtainable.

Sedum acre attracts the attention with its bright yellow succulent leaves. On the other hand, the plant blooms rather quickly and if the light is not sufficient leaf colour tends to turn green, which affects the visual appearance of the sculpture, and leads to the requirement of maintenance. Also, its leaf texture is relatively coarse, and the body is long which prevents the plant from covering the surface sufficiently. The observations show that in terms of the hierarchical order *Sedum acre* is not particularly dominant over other sedum species, yet it does not allow the *Alternanthera* cultivars to grow freely.

Sedum hispanicum 'Minus' is distinguishable with its elegantly frosted blue-green succulent leaves, which render it suitable for delicate design concepts. It has high surface covering properties and is rather dominant over *Alternanthera* cultivars. *Sedum hispanicum* 'Minus', with its late and modest bloom, appears to be a low maintenance plant.

Sedum reflexum is a striking plant with its frosty blue leaves. It demonstrates very similar properties to *Sedum acre* in terms of the long and coarse body structure, yet it does not have the same flowering issues. *S. reflexum* is dominant over the *Alternanthera* cultivars.

Sedum spurium, the rose sedum, is widely distinguished from the other sedum species with its rosette arranged wide leaves. As 'Dragon's Blood', 'Fuldaglut', 'Green Mantle' and 'Tricolour' cultivars belong to the same species, *spurium*, they are mainly differentiable in terms of leaf colour. Accordingly, 'Dragon's Blood' has red; 'Fuldaglut' has greenish red; 'Green Mantle' has green and 'Tricolour' has green foliage mottled with white. They all have high surface covering properties with dense foliage. Comparatively, *Sedum spurium* 'Dragon's Blood' flowers earlier than the other cultivars; 'Tricolour' appears to grow most moderately and 'Fuldaglut' is rather dominant over *Carex* sp. if used vertically.

Alternanthera species, a broad leaf cover plant, was also observed for this study. *Alternanthera*offers a range of foliage shape and colour; demonstrates high surface enveloping properties. It is a relatively new plant for Turkey, in demand in the Mediterranean region of the country. Accordingly, the cultivars provided were not

named accurately but were determined through their foliage characteristics as; narrow red, narrow reddish green, broad green, broad reddish green and curly broad reddish green.

All the *Alternanthera* varieties, observed over a period of one year, were found to lack winter hardiness in Aegean climatic conditions. *Alternanthera* thrives in constantly warm conditions with moist soil, producing small white blooms in the summer which do not detract from the visual appearance of the plant sculpture. The plant was unable to compete with the *Sedum* species on the sculpture and diminished over time.

Carex petriei and *Carex testacea* species were examined for this study for their visual characteristics and ecological requirements. As a member of Cyperaceae family *Carex* grasses have a stable colour and form throughout the year which renders them suitable for certain features of a sculpture such as the hair, mane or tail of an animal figure. It was found that *Carex* sp. cannot compete with the ground cover plants if used upside down on a sculpture.

Festuca glauca, as a member of the Poaceae family, is a true grass species. It tolerates most of the ecological conditions and is readily available on the market. *Festuca* offers frosted blue grey colour with its upright compact foliage yet develops haltingly and has low surface covering properties for plant sculpture.

Mesembryanthemum barbatum is an evergreen cover plant which tolerates drought and is winter hardy. Its small succulent foliage envelops the surface rapidly, yet if used vertically, its long slender stems fail to grab hold of the surface of a sculpture. The plant could be selected for its visually abundant summer bloom, which also encourages bee and butterfly activity.

'Silver Falls' is a relatively new cultivar of *Dichondra repens* that exhibits glistening silver hair on its foliage. With its small but round leaves, the species provides good ground cover when it receives a enough light. Otherwise, the plant will produce long internodes with few leaves, which require constant maintenance and are not visually desirable.

Lastly, within the research, *Santolina chamaecyparissus* was examined for its suitability. The plant is tolerant of most ecological conditions; also, with its greyish aromatic leaves, is preferable both for its visual and olfactory properties. *Santolina* is recommended when it is rather young; otherwise, its woody body becomes visibly naked which affects the sculpture surface undesirably.

The diversity of plants examined for suitability in plant sculpture could be increased over time, yet as this was the first project of its kind, a pre-set time frame was adhered to. The most important point is that a plant sculpture can have a rich variety of plants, if they match the requirements of the landscape, both visually and ecologically.

The final stage of the research was completed with the installation of the plant material on the surface of the sculpture. As the concept for this sculpture was a horse figure, it was adorned with only a few species. All the examined plants were propagated into 35 mm multi cell plug trays with a slow release fertilizer. After sufficient root development each plant was ready for insertion into the surface of the sculpture in the form of a plug. For this purpose, a 30 mm dibber tool was used to pierce open the monofilament fabric while allocating a 2 cm distance between each hole.

The project was completed by adorning the sculpture with plants in accord with the visual characteristics of the chosen figure (Figure 3 and 4).

Figure 3. *The side view of the final state of the plant sculpture (Original, 2017)*

Figure 4. *The front view of the final state of the plant sculpture (Original, 2017)*

Conclusion

This scientific research entitled 'A Research on Designing Plant Sculptures in Turkey' was the first project of its kind in Turkey. Additionally, other examples from around the world were limited, with no scientific documents to provide guidance on the subject.

To enable design of sustainable plant sculpture thorough consideration of these steps is recommended:

- The subject of the design should be chosen in accordance with the socio-cultural values of the destination of the plant sculpture.

- Similarly, the plant sculpture should be considered in relation to close landscape of its final location and not as an individual item of design.
- The ecological needs of plants chosen for the design concept should suit the final location of the sculpture.
- The cost of the construction should be evaluated when the plant sculpture is enlarged to any size.
- The enlarged volume of the plant sculpture should be in harmony with the landscape it will be set in.
- The location of the construction workshop should be viable in order to transport the plant sculpture.
- The maintenance contractor should be identified prior to the transport of the plant sculpture in order to keep the plant alive and healthy.

The significant benefits of this scientific research project could be summarized as follows:

- The fundamental aspects of designing a plant sculpture were laid down step by step and guidance was created for those who would like to continue with the subject matter.
- Being able to design plant sculptures in the country enables the Turkish economy to be less dependent on the imports.
- An ecologically sound and visually attractive landscape component was offered for urban design projects.
- The metal products used in the construction, the monofilament fabric used on the surface, the irrigation system, the geo-textile and the growing medium used inside and the plant material located over the face of the sculpture were all rendered with a new utilization as a result of this project, creating further employment opportunities within Turkey's manufacturing and horticultural sectors.

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