

Design and Application of Plant-Bionic Public Art

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Abstract:

Plant bionic design emerged with bionics. It takes plants as the imitation object and uses bionic design methods to simulate the shape, structure, function, color, and life activity principles of plants, aiming to create products that meet people's daily needs. Its characteristics lie in adhering to the concepts of "people-oriented" and "harmonious coexistence", enabling the design to return to nature, possess natural aesthetics, better enhance the artistry of design works, and also raise people's environmental awareness. Public art is an indispensable part of modern cities. Plant bionic design has become an important design method in public art. However, due to the immature theoretical research on plant-bionic public art works, it is necessary to analyze and understand the design and application of plant elements in bionic public art works.

Keywords:

Plant Bionics, Public Art, Design

1. Introduction

Against the background of rapid urbanization, the concrete jungle has gradually replaced nature, and people's pursuit of the integration of nature and art has become increasingly strong. As a model of the combination of the two, plant bionic public art is of great significance.

In terms of enhancing the cultural connotation of cities, plant bionic public art takes plant morphology as a source of inspiration, skillfully integrates natural elements with artistic creation, and injects unique cultural charm into cities. It breaks the limitations of traditional public art and conveys the yearning and respect for nature through artistic expression, becoming an important carrier of urban culture. In terms of improving the urban environment, plant bionic public art not only beautifies the urban space but also alleviates the urban heat island effect, increases air humidity, and improves the local microclimate.

Europe and the United States have developed earlier in the field of plant bionic public art, with relatively mature theoretical research. They focus on integrating environmental aesthetics theory into it and emphasize concepts such as "low-carbon" and "environmental protection", developing from simple morphological bionics to the

simulation of energy conversion and environmental adaptation characteristics of plant systems. Domestically, related research has gradually increased; for example, the bionic robotic fish in Hangzhou West Lake is a typical case. With a body length of 60-70 cm, it adopts a streamlined body and a flexible tail design, which can accurately locate dropped mobile phones and monitor water quality, serving as a sample of the “ecology + technology” concept.

However, the theoretical research on plant bionic public art at home and abroad is still not systematic and in-depth, lacking a complete theoretical framework to guide practice. Moreover, this field involves multiple disciplines such as art, biology, materials, and engineering, but the current interdisciplinary cooperation is not close enough, leading to certain limitations in function realization and artistic expression. When imitating the morphology and function of plants, some works do not deeply explore the local cultural connotation, resulting in a lack of cultural characteristics and individuality.

2. Theoretical Basis of Plant Bionic Public Art

2.1. Connotation and Characteristics of Public Art

Public art is an art form that exists in public spaces and serves the public. Its scope is broad, covering urban sculptures, murals, landscape installations, new media art, etc. The publicity of public art is reflected in facing all the public and being shared by the public; the artistry emphasizes bringing aesthetic enjoyment through unique creativity and aesthetic expression; the interactivity encourages the public to participate in the experience and establish an emotional connection with the works.

In urban spaces, public art plays an important role: it can beautify the urban environment and improve the quality of space; carry the urban cultural memory and highlight regional characteristics; promote public communication and enhance community cohesion; and stimulate the public's artistic perception and improve cultural literacy, becoming an important business card of the city's image and a carrier of humanistic spirit.

2.2. Integration of Plant Bionics and Public Art

The integration of plant bionics and public art is feasible and inevitable. In terms of feasibility, the development of modern science and technology provides technical support for simulating plant structures and functions, and the diversified expression of public art also provides a display space for it. The inevitability lies in the fact that in the process of urbanization, people's desire for nature and the demand for the innovation of public art promote the integration of the two.

After the integration, public art breaks through the tradition in form and presents a richer and more natural form; in terms of connotation, it conveys attention and respect for ecology and enhances cultural depth; in terms of function, it realizes practical values such as ecological regulation and energy utilization, expanding from pure viewing to having both practical and aesthetic functions, so as to meet the dual needs of cities and the public for art and the environment.

3. Application Fields and Case Analysis of Plant Bionic Public Art

3.1. Application in Urban Landscapes

There are many plant bionic public art works in landscape spaces such as urban parks, squares, and streets.

Shanghai Chenshan Botanical Garden “Green Ring”: Its shape imitates plant vines, winding and twisting. The main body is made of weathering steel plates and glass fiber composite materials—weathering steel can resist outdoor wind and rain erosion, while glass fiber ensures structural toughness. Some joints are decorated with anti-corrosion wood to enhance the natural texture. The overall color is mainly dark reddish brown (the original color of weathering steel), with partial dark green anti-corrosion wood, forming a layered contrast with the emerald green of the surrounding green plants and the light green of the grass. This not only echoes the natural color of plant vines but also avoids homogenization with the environment.

Beijing Chaoyang Park “Dandelion” Sculpture: It takes dandelion as the prototype. The “flower stem” is a stainless steel matte light gray tube, which has both supporting force and rust resistance; the “fluff” is made of white polytetrafluoroethylene (PTFE) membrane material, which is light in texture and resistant to ultraviolet rays, and can produce a natural swaying effect when the wind blows. The base is made of granite to ensure stability. The core design integrates wind energy: the PTFE membrane “fluff” has low density and controllable wind-receiving area, so a light breeze can drive it to vibrate slightly (simulating the dynamic state of dandelion seeds floating with the wind), and the membrane material can stretch naturally in strong winds to avoid structural damage.

Bionic Plant Street Lamps: The “flower stem” is made of aluminum alloy, which is lightweight and corrosion-resistant; the “petals” are made of acrylic plates with strong light transmittance, mostly in soft colors such as warm yellow and light pink, presenting warm light when glowing at night (with both decorative and functional properties). The base is made of cast iron to enhance stability, and some details are shaped with ABS engineering plastics. High-end models integrate small wind turbines on the top—their blades are made of lightweight carbon fiber materials, which use the natural wind on the street to generate electricity and provide auxiliary power for the street lamps (achieving energy-saving effect). At the same time, the shape of the wind turbine is integrated with the “flower” design, without damaging the overall bionic beauty.

3.2. Application in Public Facilities

In the design of public facilities, plant bionic design significantly improves practicality, aesthetics, and interest:

Public Seats: They imitate the stretched shape of leaves, optimize the ergonomic curve to improve sitting comfort; the surface adopts a honeycomb bionic structure to enhance load-bearing performance and durability, and the leaf vein texture design is conducive to rainwater diversion.

Garbage Bins: They draw on the principle of flower opening and closing, and are designed with automatic induction opening and closing devices to facilitate garbage disposal; shaped like tree trunks, their natural brown color is harmonious with the environment.

Street Lamps: They imitate the upward growth posture of vines, and the spiral shape increases the height while saving space. The lampshade simulates the shape of petals—at night, the light passes through the translucent material, just like blooming flowers, with both lighting function and artistic beauty, making public facilities no longer monotonous.

3.3. Application in Indoor Spaces

In indoor public spaces, plant bionic public art significantly improves the space atmosphere by introducing natural elements:

Giant Bionic Tree Installation in High-end Hotel Lobby: The texture of the tree trunk is realistic, and the branches and leaves are made of optical fiber materials. At night, the light flows, creating a mysterious and romantic atmosphere and enhancing the artistic style of the space.

Bionic Vine Art Partition in Office Building Lobby: It uses metal and flexible materials to simulate the winding shape of vines. While dividing the space, it adds vitality and softness to the cold office environment.

Flower-shaped Interactive Device in Shopping Mall Atrium: It adopts intelligent sensing technology—when customers approach, the petals open and close automatically with changes in light, enhancing interest and interactivity, alleviating the sense of crowding in the indoor commercial space, and creating a comfortable and pleasant shopping environment.

4. Design Elements of Plant Bionic Public Art

4.1. Morphological Bionic Design

Inspiration for morphological bionic design can be obtained from plants from both overall and local aspects: in terms of the overall shape, it imitates the contour lines and growth posture of plants to endow the work with a natural and flexible feeling; in terms of local characteristics, it integrates elements such as leaves, flowers, and branches into the design through abstraction, deformation, and other methods.

Examples:

London “Dandelion Lamp”: Its overall shape imitates that of a dandelion. The white fluffy lampshade is composed of countless slender optical fibers—when the breeze blows, the optical fibers sway with it, just like real dandelion seeds floating, reproducing the charm of plants in a concrete way.

Shanghai World Expo Park “Seed Cathedral”: It uses tens of thousands of transparent acrylic rods to simulate the growth form of plant seeds. Each acrylic rod has a different plant seed placed at the top, interpreting the vitality of plants in an abstract way from local characteristics.

These cases all realize the ingenious integration of art and nature through the accurate extraction and innovative transformation of plant morphology, adding unique charm to public spaces.

4.2. Structural Bionic Design

The internal structure of plants contains exquisite engineering wisdom, which is of great application value in the structural design of public art:

Leaf Vein Structure: The networked conductive structure of leaf veins realizes efficient material transportation with the least material. This lightweight and high-strength characteristic is applied to the skeleton design of public art—for example, some large dome art installations draw on the leaf vein structure, and through the crisscross steel beam network, they disperse the load-bearing pressure, reducing the amount of materials used while ensuring structural stability.

Plant Fiber Structure: The mechanical structure of plant fibers shows strong tensile properties. Natural materials such as bamboo fibers and hemp fibers form orderly arranged fiber bundles during growth. In public art works, carbon fiber and other high-strength composite materials are used to imitate this structure, and sculptures or installations with both flexibility and bearing capacity are made through lamination, weaving, and other processes.

These bionic designs not only improve the ability of the work to cope with changes in the natural environment (such as wind force and gravity) but also endow the work with functionality (e.g., realizing rainwater diversion, wind power generation, etc. through structural optimization), making public art works have both practical value and environmental adaptability in addition to aesthetics.

4.3. Color Bionic Design

The rich color system of plants provides a natural source of inspiration for the color matching of public art. In the creation of public art, designers often draw on the color changes of plants in the four seasons (the light green of spring buds, the colorful flowers in summer, the gorgeous red leaves in autumn, the plain color of branches in winter—these colors can echo public art works with different seasonal themes) and the color characteristics of different plants (e.g., the purple of lavender, the bright yellow of sunflowers—these can endow the work with a unique visual identity).

Color plays a key role in the atmosphere creation and emotional expression of public art: warm colors such as orange-red and bright yellow (imitating the colors of autumn fruits and flowers) can convey vitality and enthusiasm, creating a cheerful and warm atmosphere; cool colors such as blue and green (drawing on the colors of plant leaves and plants by the lake) can bring a sense of tranquility and peace. Through the accurate selection and matching of plant colors, public art works are not only visually closer to nature but also can arouse people's emotional resonance with nature, making the works more infectious and emotionally in-depth.

4.4. Functional Bionic Design

Public art that imitates the ecological functions of plants transforms natural characteristics into practical functions through technological innovation:

Imitating Photosynthesis: Using photovoltaic materials to simulate the process of plants converting solar energy, public art installations are designed as “solar flowers” and “photovoltaic trees”, which can not only generate electricity for night lighting but also become urban landscapes.

Imitating Transpiration: Bionic spray devices simulate the evaporation of plant water, reduce the local temperature through water mist, alleviate the urban heat island effect, and increase air humidity at the same time.

Imitating Air Purification Function: Bionic air purification walls and sculptures using photocatalytic materials or plant filter materials can absorb and decompose pollutants in the air, improving air quality.

5. Design Principles of Plant Bionic Public Art

5.1. Scientific Principle

The scientific principle in the design of plant bionic public art emphasizes taking scientific knowledge as the foundation to ensure the rationality and feasibility of the design: on the one hand, it is necessary to accurately grasp the biological characteristics of plants such as morphology, structure, and function, and realize accurate bionics through scientific research and analysis; on the other hand, it is necessary to follow the principles of engineering science in material selection and technology application to ensure the safety, durability, and functionality of the work. In addition, it is also necessary to combine environmental science to ensure that the design is coordinated with the urban ecosystem, so as to achieve the purpose of beautifying the environment and improving the ecology, and closely combining artistic creation with scientific laws.

5.2. Artistic Principle

The artistic principle in the design of plant bionic public art focuses on aesthetic expression and emotional transmission, and enhances the artistic appeal of the work through the laws of formal beauty (such as symmetry and balance, rhythm and melody, contrast and harmony). In terms of shape shaping, through abstraction, deformation, exaggeration, and other artistic methods, the unique lines, outlines, and shapes of plants are extracted to endow the work with unique artistic tension and visual impact; in terms of color application, drawing on the rich color changes of plants, an artistic atmosphere that is either fresh and natural or gorgeous and dreamy is created. At the same time, attention is paid to the cultural connotation and spiritual expression of the work, integrating the vitality symbolized by plants and natural philosophy into the design, making the work a carrier of public emotional resonance, and enhancing the humanistic temperature and aesthetic style of the urban space with artistic appeal.

5.3. Functional Principle

The functional principle in the design of plant bionic public art aims to make the work have both artistic beauty and practical value: first, it is necessary to meet the basic physical functions (e.g., drawing on the plant structure to enhance the stability and load-bearing capacity of the work, so that it can stand safely in different environments); second, it is necessary to have ecological functions (imitating the photosynthesis, air purification, and other functions of plants to contribute to the improvement of the urban ecological environment); further, social functions should be considered (e.g., providing the public with spaces for rest and entertainment, or having cultural and educational functions to spread plant knowledge and environmental protection concepts), so as to realize the organic unity of art and function.

6. Development Trends and Prospects of Plant Bionic Public Art

6.1. *Technological Innovation Drives Development*

In the field of plant bionic public art, new materials and new technologies have broad application prospects and also bring changes to the design and production:

3D Printing: It can accurately shape complex plant forms and realize personalized and customized creation, allowing artistic concepts to be presented with high precision.

Intelligent Materials: They can make the work change its shape and color according to environmental changes (e.g., shape memory alloys enabling the opening and closing of petals), enhancing interactivity and interest.

Digital Technology: It provides a large amount of plant data for design and assists in simulating the creative effect; it can also enable the public to experience the work in an immersive way through virtual reality (VR) and augmented reality (AR) technologies, breaking the limitations of time and space.

These technologies open up new directions for public art, making it have both artistic beauty and technological charm.

6.2. *Integrated Development with Multiple Fields*

Plant bionic public art is accelerating its integration with multiple fields: combining with ecological protection, it can improve the urban environment through bionic purification devices; integrating into urban planning can optimize the space function and landscape quality, and create an ecologically livable city; in the field of cultural and creative industries, its unique shape and concept can derive cultural and creative products and expand the profit model. In cross-field cooperation, the collision of different professional knowledge and technologies not only brings innovative vitality to plant bionic public art but also provides new development directions for various fields, creating opportunities for coordinated and win-win development.

6.3. *Meeting Public Needs and Participation*

In the future, the design of plant bionic public art needs to focus on public needs and participation: interactive design can use intelligent sensing, VR, and other technologies to allow the public to interact with the work in real time through actions, sounds, and other methods (e.g., touching the bionic flower device to make it bloom with light and shadow), enhancing the interest of the experience; encouraging the public to participate in the creation process (through workshops, creative collection, and other forms) to absorb public creativity into the design, making the work the crystallization of collective wisdom. In this way, it can not only meet the public's personalized needs for art but also strengthen the emotional bond between the public and the work, allowing public art to truly take root in urban life.

7. Conclusions

Plant bionic public art takes the simulation of plant morphology, structure, and function as the core design concept, integrates science, art, and functionality, and aims to realize the integration of nature and art. Its application is characterized by cross-field combination, which is widely used in urban public spaces and indoor

environments, with both aesthetic appreciation and practical value. In terms of important value, it not only beautifies the environment and enhances the cultural connotation of the city but also improves the ecology and enhances public interaction.

The research finds that new materials and new technologies promote the morphological innovation and functional expansion of plant bionic public art, and cross-field cooperation brings new development opportunities. Future designs will focus on public participation, and deepen emotional connection through interactive design. This art form is becoming an important carrier of urban sustainable development and humanistic care.

Conflicts of Interest

The author declare that there is no conflict of interest regarding the publication of this article.

Author Contributions

Conceptualization: Yudan Gu.; Methodology: Yudan Gu.; Software: Yudan Gu.; Validation: Yudan Gu.; Formal analysis: Yudan Gu.; Investigation: Yudan Gu.; Data Curation: Yudan Gu.; Writing – original draft preparation: Yudan Gu.; Writing – review and editing: Yudan Gu.; Visualization: Yudan Gu.; Supervision: Tao Guo.; Project administration: Yudan Gu.

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